

113221

INSTRUCTION MANUAL

FOR



MODEL

38-R

Shovel—Dragline—Crane

SERIAL NO. 113221

This instruction book applies only to the machine of the model and serial number stamped above. Keep the book with the machine. If book is lost or damaged a replacement book can be obtained by writing to Department of Field Erection, Bucyrus-Erie Company, South Milwaukee, Wisconsin. In requesting book give model and serial number of machine and ask for book covered by Table of Contents No. 38-RS-S&P-RSM-22

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CARE, MAINTENANCE AND OPERATION INSTRUCTIONS

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GENERAL SUGGESTIONS FOR NEW OPERATORS

The machine covered by this instruction book represents the accumulated experience of the Bucyrus-Erie organization which has been building power excavators since 1882. Every effort has been made to build an easily operated machine which can produce large output with least effort on the part of the operator.

An excavating machine cannot perform efficiently unless there is a competent operator at the controls and there is much more to operating than simply "pulling the levers." A good way to become a good operator is to spend a training period as oiler or pit man on a machine which has an experienced operator. In this way the new man soon learns the capabilities of the machine and knows at a glance the best way to approach the job to be done.

A. INSPECT MACHINE REGULARLY:

To prevent breakdowns, the operator must follow a regular program of inspection, lubrication and adjustment.

Visual inspection will go a long way toward showing up parts needing attention. The experienced operator can also usually tell by the sound and the "feel" when anything is wrong. Make it a practice to look over the machinery each time there is a short wait for trucks or other such delay. At each stop, take one particular function of the machine and follow it through from power unit to see that each machinery part is in correct adjustment and all connections tight.

Remember that the matter of keeping bolts tight is just as much an item of maintenance as lubricating or adjusting the machine. A bolted connection which is not quite tight will quickly pound itself into a loose and dangerous connection. Similarly, a weld which has cracked due to excessive strain can be easily repaired by "V-ing" it out and rewelding, but if the crack is allowed to go it may spread so much that proper alignment of the parts is lost. A satisfactory repair is then hard to make.

B. KEEP MACHINE CLEAN:

No single item of maintenance helps the operator more in keeping the machine in running order than cleanliness. Adjustments and minor repairs are much easier to make if it is not necessary to dig through accumulations of oil and dirt. A clean machine also makes it easier to discover loose bolts, cracked welds or other conditions which might lead to a serious breakdown if neglected.

In addition to the practical value of cleanliness there is also a definite advantage in the effect on the operator's morale. A machine which is "ship-shape" inspires pride on the part of the operator as well as the owner of the machine.

Another item well worth attention is the matter of painting at least once a year every portion of the machine that is exposed to the weather. A machine which has started to rust where the paint has weathered away presents a very bad appearance and deteriorates rapidly. Machines operating in damp climates, particularly near salt water, will need extra attention. Keep up the appearance of the machine and you will prolong its useful life.

C. READ INSTRUCTION BOOK CAREFULLY:

For the operator's convenience this instruction book is written in sections. The first page of each section lists the headings contained in that section. Familiarize yourself with the instruction book so that you can easily locate the particular information you may need.

Section I gives a complete description of the machinery and the various types of Front End Equipment. To help the new operator learn how the machine works the following pages briefly describe the function of each unit. Study this Section carefully. A thorough understanding of the machinery will help in detecting quickly when anything is wrong and will save time in locating trouble.

Complete operating instruction for all types of Front End Equipment are given in Section II. Study the function of each operating lever before trying to operate the machine.

Before changing the adjustment of any unit, carefully read the instructions given in Section III. Make the adjustments as described.

Do not depend on your memory when lubricating the machine. Turn to Section IV of this instruction book and follow the recommendations given. Lubrication instructions are based on normal service in temperate climate. For extremes of temperature, either hot or cold, it may be necessary to obtain recommendations of special lubricants from the lubricant manufacturer.

Reeving of the various wire ropes used with different front end equipments is covered in Section V. Handle the wire rope with care and install each rope exactly as described in the instructions.

If your machine has more than one type front end equipment, read Section VI on Conversion. Complete instructions are given in that section for changing over from one type of front end equipment to another.

Section VII describes unloading procedures and will be helpful if it is necessary to unload the machine without the help of one of our Erecting Engineers.

DESCRIPTION OF MACHINERY

The modern power excavator has little similarity to the first steamshovel and the operator must know "what makes the wheels go 'round" if the power and speed of the machine are to be used effectively. The following description of the machinery is given to assist the new operator in visualizing the flow of power from the power unit to each operating function of the machine. In all references to right and left it is understood the right side of the machine is on the right side WHEN STANDING AT THE REAR OF THE MACHINE FACING THE BOOM.

For convenience the machine can be considered as made up of these three main units: (See Fig. 1)

1. Front End Equipment
2. Upper Works
3. Lower Works

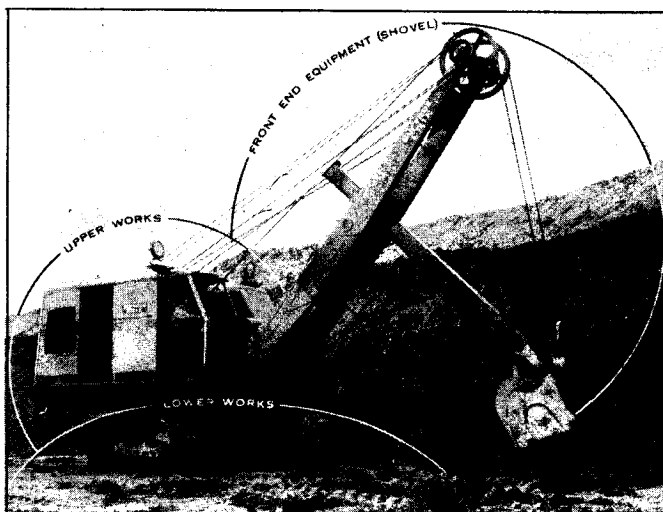


FIG. 1

A. FRONT END EQUIPMENT:

The Front End Equipment is the "business end" of the machine. The particular type of front end needed depends on how the machine is going to be used. Shovel, dragline, clamshell and crane front ends are interchangeable so that the machine may be quickly converted to which-ever type front end equipment is best suited to the work to be done. Brief descriptions of each type and suggestions as to where they can be used best are given in the following paragraphs.

a. Shovel

Shovel front end equipment consists of a comparatively short boom supporting a dipper handle to which the dipper is pin connected. (See Fig. 2). The dipper handle slides in and out through a saddle block pivoted on the shipper shaft of the shovel boom. The

lower end of the boom is pin-connected to the front of the Upper Works. The upper end of the boom is suspended by a wire rope reeved between sheaves at the point of the boom and sheaves on an A-frame or gantry.

Shovel front end equipment gives the fastest digging cycle and will dig relatively hard material. Its range is limited by the length of the boom and dipper handle, but the operator has complete control over the dipper and can dump it accurately.

This front end equipment is particularly suited to operation where the material dug is to be loaded into trucks.

Four basic motions make up the shovel digging cycle.

1. Hoist—raising and lowering the dipper.
2. Crowd—extending or retracting the dipper handle.
3. Swing—Swinging the "Upper Works" so the dipper is carried from digging to dumping point and return.
4. Dump—opening the dipper door to empty the dipper.

Easily operated levers in front of the operator control all four functions so that the experienced operator can combine them into a smooth, fast digging cycle.

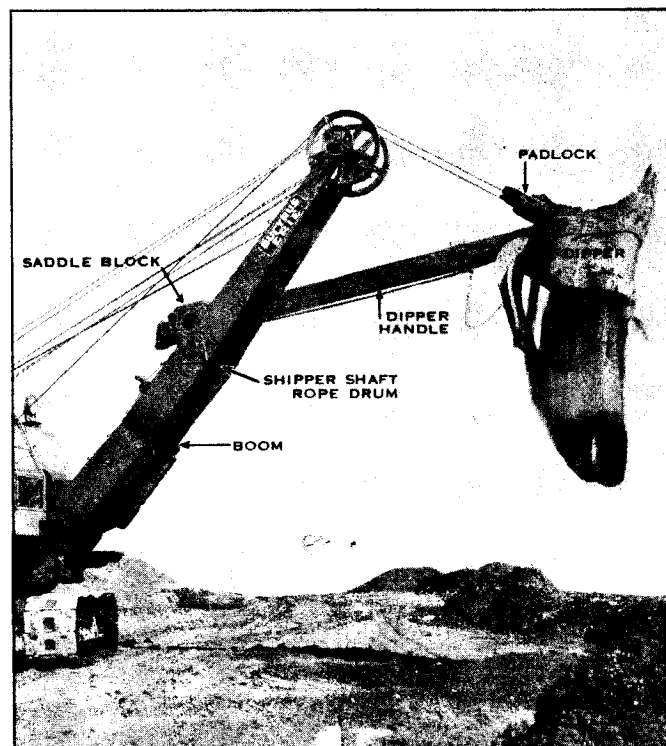


FIG. 2

b. Dragline

Dragline front end equipment (See Fig. 3) consists of a long, lattice-type, boom (also used for clamshell and crane) pin-connected to the front of the Upper Works and suspended from the A-frame. The dragline bucket is suspended by the hoist line running over a sheave at the point of the boom. It is pulled in toward the machine by a drag cable attached to the front of the bucket by chains.

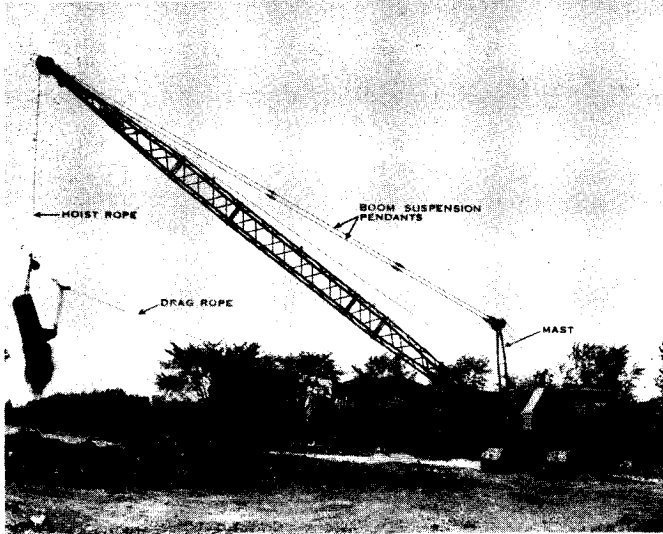


FIG. 3

This front end equipment gives greatest range to the machine and is particularly suited to work where the material is removed at one point and then dumped or "spoiled" nearby. The dragline cannot dig as hard material as the shovel, but is well suited to ditching or stripping.

Four basic motions make up the dragline digging cycle.

1. Drag—Pulling the bucket through the material to fill the bucket. (Also to control the drump.)
2. Hoist—Raising the bucket out of the pit to dumping height. (Also used in controlling depth of cut when digging.
1. Swing—Swinging the "Upper Works" so that the bucket is carried from digging to dumping points and returned.
4. Dump—Tipping the bucket vertically by releasing the drag cable.

The three hand levers and two pedals directly in front of the operator control all motions so that the experienced operator can combine the basic motions into a smooth cycle. Somewhat more skill is required to dig effectively with a dragline than with a shovel. A new operator may also have a little trouble in learning to "spot" the bucket for dumping into a truck or other small space.

c. Clamshell

Clamshell front end equipment (See Fig. 4) uses the same boom as the dragline. A second sheave is added on the boom-point shaft for two-line clamshell operation, the fastest and most flexible hook-up for buckets of this type.

This front end equipment is used where it is necessary to dig or dump within limited space such as when unloading gondola cars, placing material in a hopper, digging trenches, pits, shafts, etc. The material handled must be rather soft or loose as the only digging force available is the weight of the bucket and its closing effort. The work is often either out of sight or in a very limited space so the operator must use extra caution not to bump the boom either against an obstruction or with the bucket.

Three basic motions make up the clamshell digging cycle:

1. Hoist—Closing the bucket is done with one line. Lowering the open bucket with other line.
2. Swing—Swinging the "Upper Works" so that the bucket is carried from loading to dumping points and returned.
3. Dump—Releasing the closing line with the bucket held on the holding line dumps the bucket.

The three hand levers and the two pedals directly in front of the operator control all three motions so that the operator has complete control of the bucket at all times.

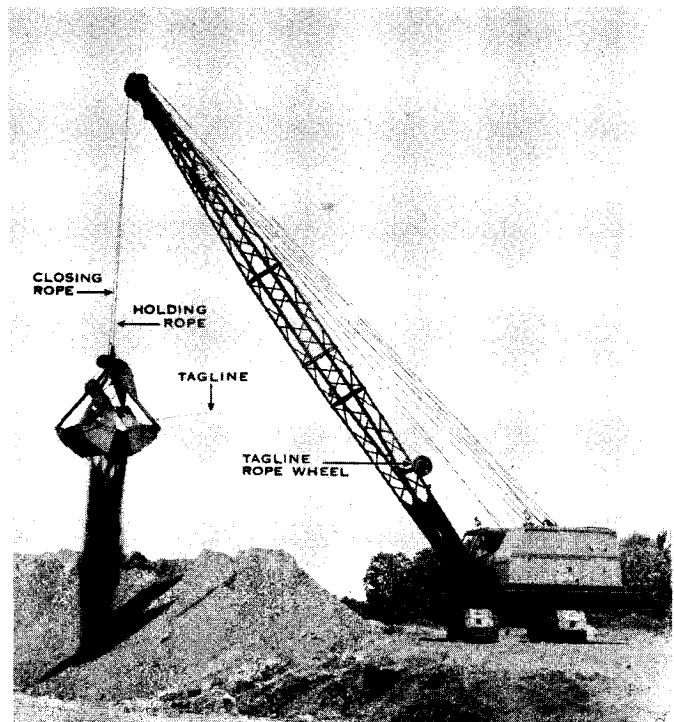


FIG. 4

d. Crane

Crane front end equipment uses the same boom as for dragline or clamshell operation. It may also have a jib or boom extension for an auxiliary or drop line. (See Fig. 5) This front end is used for lifting instead of digging. A simple hook block, suspended from a line over the boom-point sheave, replaces the dragline or clamshell bucket.

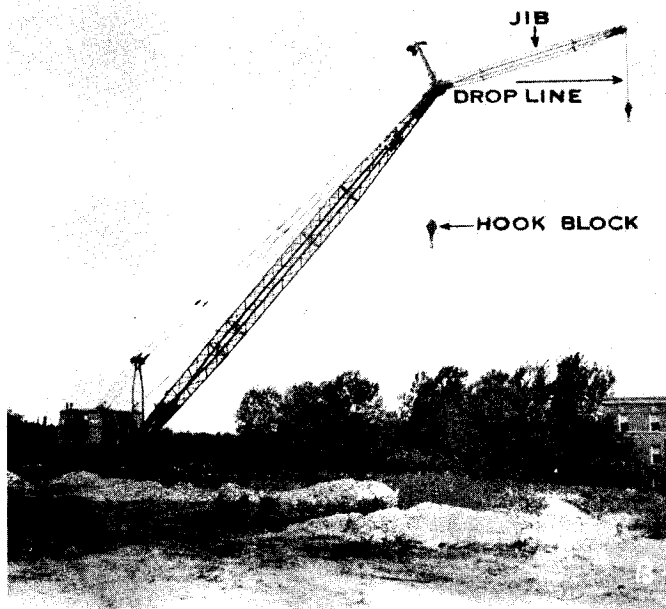


FIG. 5

Two basic motions make up the crane operating cycle:

1. Hoist—Picking up the load, (Either main hoist or auxiliary hoist).
2. Swing—Swinging the “Upper Works” to carry the load to final position and return.

The three hand levers and two pedals in front of the operator control these functions, (only two levers and one pedal are used if there is no auxiliary hoist line).

For accurately placing the load it may be necessary to also use:

1. Propelling — To move the load horizontally beyond the reach of the boom.
2. Boom Hoist—To help in accurately placing the load in the horizontal plane. (Lowering the boom moves the load out, raising the boom will bring it in.)

The Boom Hoist lever is also in the bank of levers in front of the operator. He has complete control of the load at all times and can spot it exactly. This is particularly useful on such jobs as steel erection work.

B. UPPER WORKS:

The Upper Works (See Fig. 1) consists of the revolving frame on which the power unit and machinery units are mounted. It is supported on the Lower Works by six conical hook rollers running between the double flanged roller path of the Lower Works. The four front rollers are mounted in equalizing pairs.

a. Independent Boom Hoist

The rope drum of the Independent Boom Hoist machinery is recessed in the revolving frame casting. (See Fig. 6). Two internal-expanding-band clutches mounted on the transmission shaft just to the left of the left side frame, give friction clutch control for both hoisting and lowering. A spring-set band brake on the lowering clutch housing is automatically released when raising or lowering the boom. The brake and both clutches are controlled by a single lever at the operator's position. The hoisting clutch drives the boom-hoist intermediate shaft through a roller chain. The lowering clutch drives the intermediate shaft in the opposite direction through a spur gear reduction. The boom-hoist intermediate shaft drives the boom-hoist drum through a double-strand roller chain. A ratchet locking pawl, controlled by a separate lever at the operator's position, keeps the boom-hoist drum from “creeping” in the lowering direction when the boom-hoist is not used for a long time (as may be the case with shovel or dragline front end equipment).

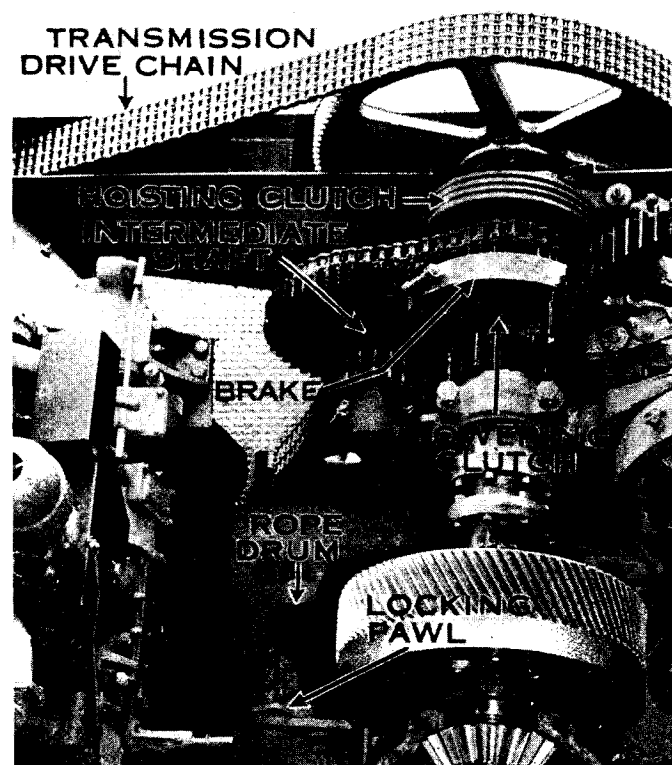


FIG. 6

b. Reversing Transmission

Power for the swing and propel functions of the machine (swing only, on machines having Independent Propelling) is controlled through the reversing transmission unit at the right end of the horizontal transmission shaft. (See Fig. 7).

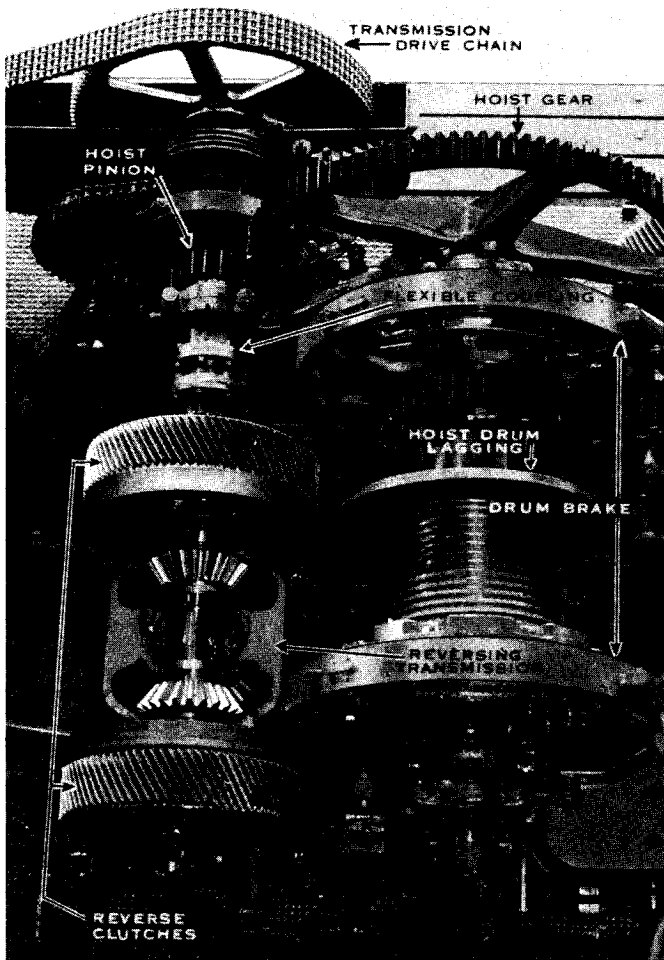


FIG. 7

A pair of internal-expanding-band clutches, controlled by a single lever at the operator's position, drives one or the other of the bevel gears on the horizontal shaft in the vertical transmission gear case. A spur pinion at the bottom of the vertical transmission shaft meshes with the swing gear recessed in the revolving frame casting. (For the swing motion the swing gear is connected to the vertical swing shaft by a jaw clutch at the top of the shaft. A lever at the operator's position controls both the swing jaw clutch and the propel jaw clutch. On machines with Independent Propelling the swing jaw clutch is permanently engaged.)

With the swing jaw clutch engaged, swinging the machine is controlled by the lever operating the transmission reverse clutches. The pinion on the lower end of the vertical swing shaft meshes with the swing rack casting bolted inside the double flanged roller path of the lower works.

c. Main Drum Shaft

The main drum shaft is driven through the hoist gear by the hoist pinion on the horizontal transmission shaft. (See Fig. 7).

The drum shaft turns at all times the engine clutch is engaged. The rope drums, mounted on the shaft, on anti-friction bearings, are driven by internal-expanding-band clutches. Disc type booster clutches, controlled from the operator's position, set the main clutch bands. Contracting-band brakes on the outside of the clutch housings hold the drums from turning. Pedals at the operator's position control the brakes.

d. Shovel Crowd Machinery

The shovel crowd machinery is mounted on a separate bracket bolted to the revolving frame just forward of the hoist shaft. (See Fig. 8). A spur pinion on the crowd sprocket shaft meshes with a two-piece gear rim bolted to the left drum friction housing, in place of the rope lagging used for dragline or clamshell service.

The left drum clutch is used to control the crowd motion of the shovel in the "crowd out" direction.

The dipper handle is retracted by engaging the back-haul clutch mounted on the left end of the back-haul shaft. The shaft is driven by a spur pinion meshing with the hoist gear on the left end of the hoist shaft. Another spur pinion on the right end of the back-haul shaft meshes with a spur pinion on the crowd sprocket shaft.

The crowd sprocket drives the crowd rope drum at the foot of the boom through a heavy roller chain. Twin crowd ropes and a single back-haul rope, reeved from the rope drum to the dipper handle, crowd out or retract the dipper handle. A single lever at the operator's position is connected to both the left drum booster and the back-haul clutch so that the one lever controls both crowd and retract. The left drum brake is used to hold the dipper handle when neither clutch is engaged.

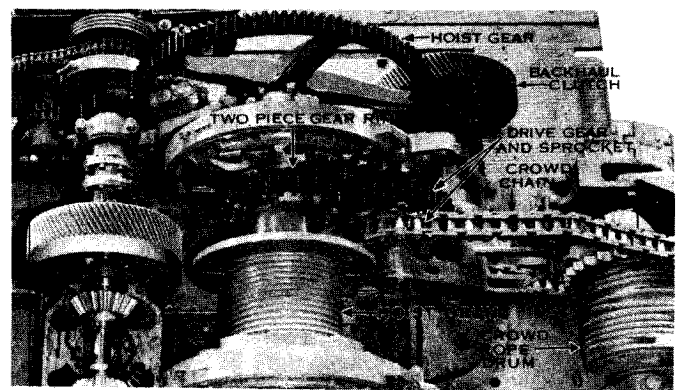


FIG. 8

e. Propelling Machinery

For the standard propel drive, the swing jaw clutch is disengaged and the propel jaw clutch, at the upper end of the vertical propel shaft, is shifted into mesh. The gear at the top of the vertical swing shaft then runs as an idler gear to transmit power from the vertical transmission shaft pinion to the vertical propel shaft through the center of rotation. (See Fig. 10).

The propel gear at the upper end of the vertical shaft has a slipping clutch built in the gear to absorb shock loads which might occur when propelling. (This slipping clutch is not used on machines having Independent Propelling.)

With the propel jaw clutch engaged, propelling the machine is controlled by the lever operating the reversing transmission clutches. The bevel pinion on the lower end of the vertical propel shaft meshes with the bevel gear on the lower propel shaft in the truck frame and the final drive is through the steering clutches and driving chains as described under "LOWER WORKS".

Available as special equipment machines which do not have shovel front end equipment can be furnished with Independent Propelling machinery in place of the shovel crowd machinery at the front of the revolving frame.

The Independent Propelling machinery is bolted to the revolving frame just forward of the hoist shaft. (See Fig. 9). The gear case near the center of the machine encloses a pair of bevel pinions, bronze-bushed on a horizontal shaft.

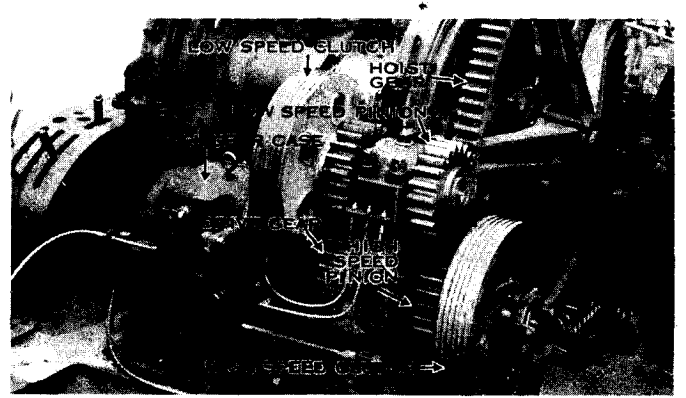


FIG. 9

The bearing bracket, just to the left of the gear case, carries the high-speed and low-speed clutch shafts. The upper, or low-speed shaft, is driven by a pinion meshing with the hoist gear. The low-speed clutch housing and pinion are mounted on anti-friction bearings at the right end of the upper shaft. When the low-speed clutch is engaged, the upper shaft drives the bevel gear reduction through the drive gear on the right end of the lower shaft which is connected to the horizontal shaft in the gear case by a jaw coupling.

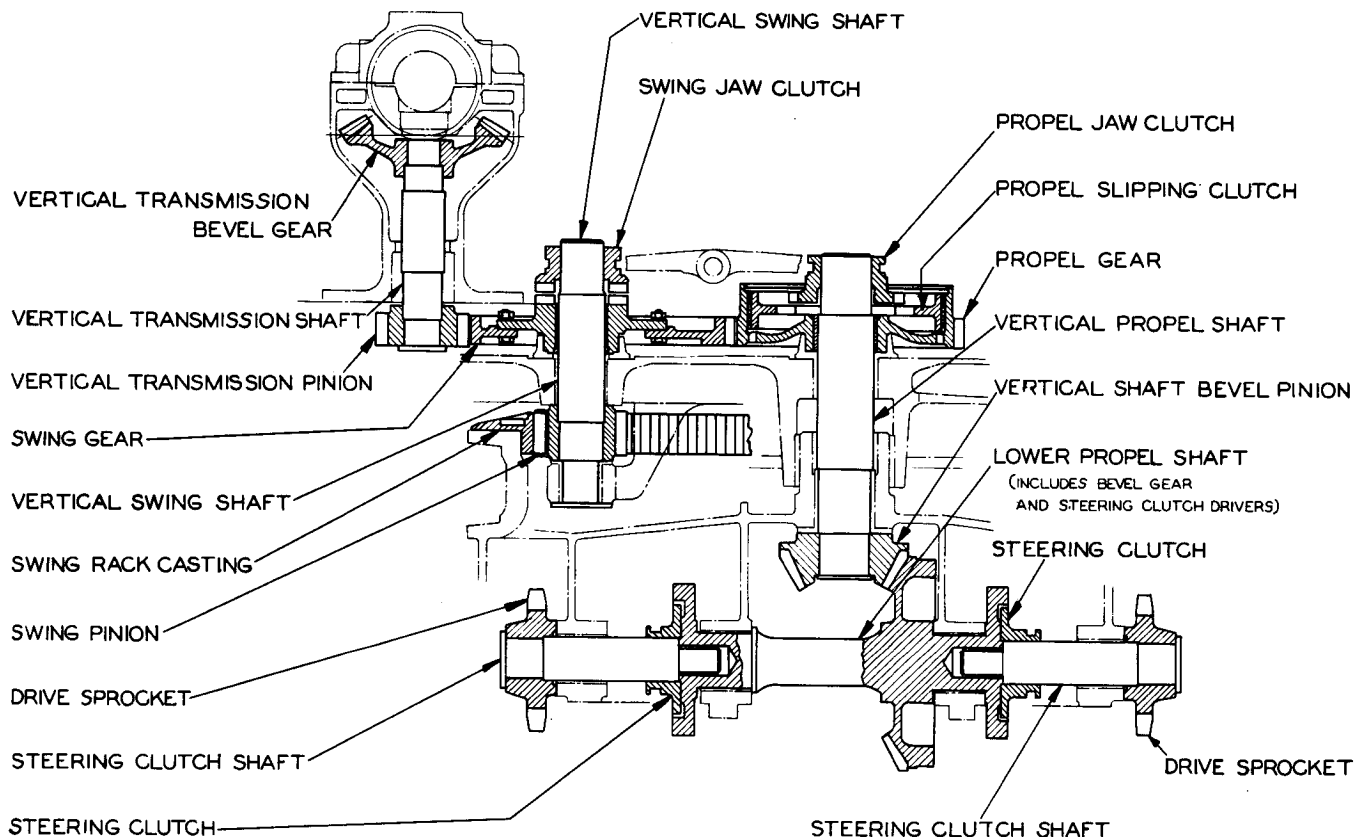


FIG. 10

A jaw clutch mounted between the bevel pinions in the gear case is controlled by a lever at the operator's left. (This lever is used for shifting the swing and propel jaw clutches on standard machines.) To propel at high speed, the jaw clutch is shifted into mesh with one of the bevel pinions. For high speed in the opposite direction the jaw clutch is engaged with the opposite bevel pinion. Both bevel pinions mesh with a bevel gear at the top of the short vertical shaft in the gear case. A spur pinion on the lower end of the short vertical shaft meshes with a gear on the upper end of the vertical propelling shaft through the center of rotation. (A plain spur gear replaces the slipping clutch arrangement used on machines with standard propelling.)

For the high speed drive, the bevel gear reduction is driven in the opposite direction by the high-speed clutch and pinion mounted on anti-friction bearings on the left end of the lower shaft.

Both the high-speed clutch and the low-speed clutch are controlled by the lever with the horizontal grip in front of the operator. (This lever is used to operate the dipper trip on shovels.)

With Independent Propelling, the machine will travel in one direction at high speed and in the opposite direction at somewhat reduced speed. By shifting the jaw clutch in the gear case, the direction in which high speed is obtained is reversed.

On machines having Independent Propelling, it is possible to swing the machine, travel, and raise or lower the boom at the same time the main drums are being used for their regular functions. This gives truly independent control, particularly valuable in crane or clamshell service.

f. Swing Lock

There is a positive lock to hold the Upper Works from turning when the swing jaw clutch is disengaged. The locking dog is pivoted in the revolving frame casting and may be swung into mesh with the swing rack teeth by a lever system which toggles into position to hold the locking dog engaged.

C. LOWER WORKS:

The Lower Works (See Fig. 11) is the base or foundation on which the Upper Works rotates. The truck frame casting has a double flanged roller path machined for the revolving frame cone rollers. All up and down digging reactions are carried by the cone rollers so no center pintle is required. There is a machined gudgeon to keep the revolving frame correctly centered. A renewable swing rack casting is bolted inside the cone roller path. The truck frame is bolted to two fixed axles supported on the caterpillar side frames.

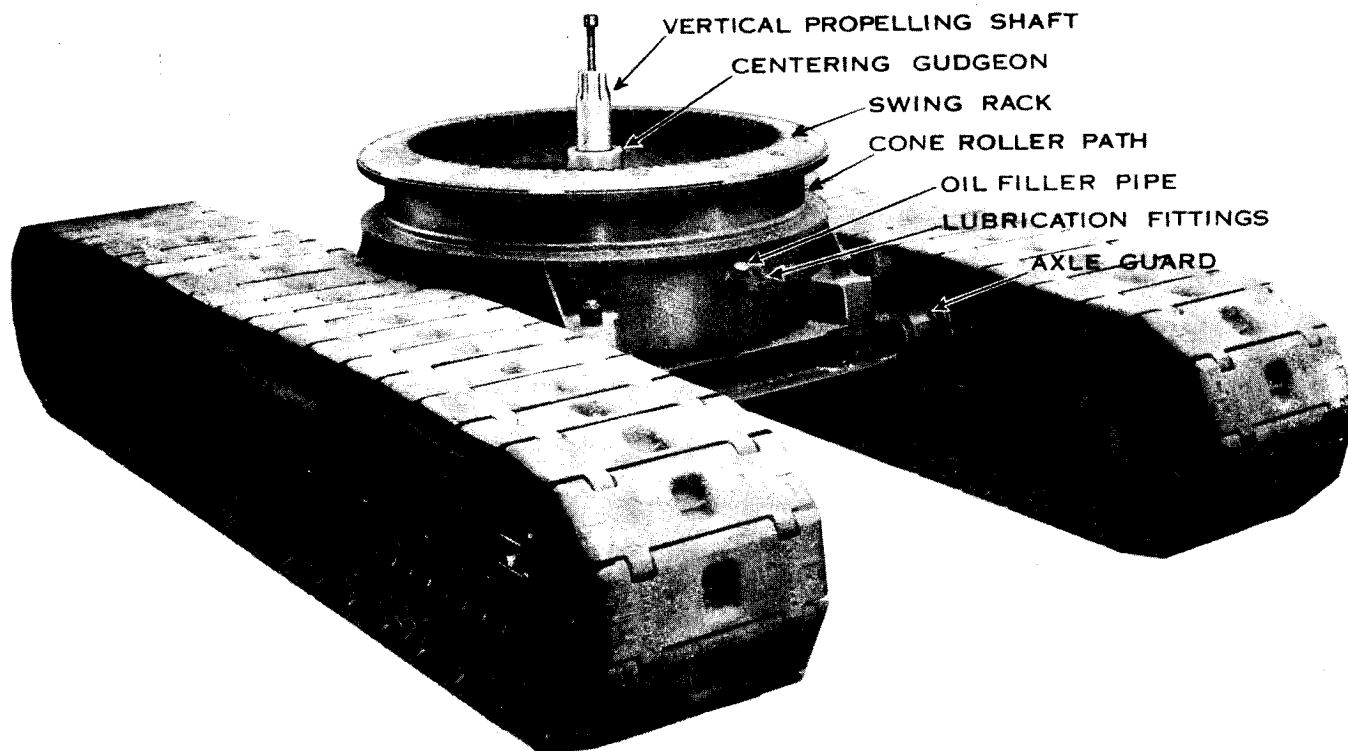


FIG. 11

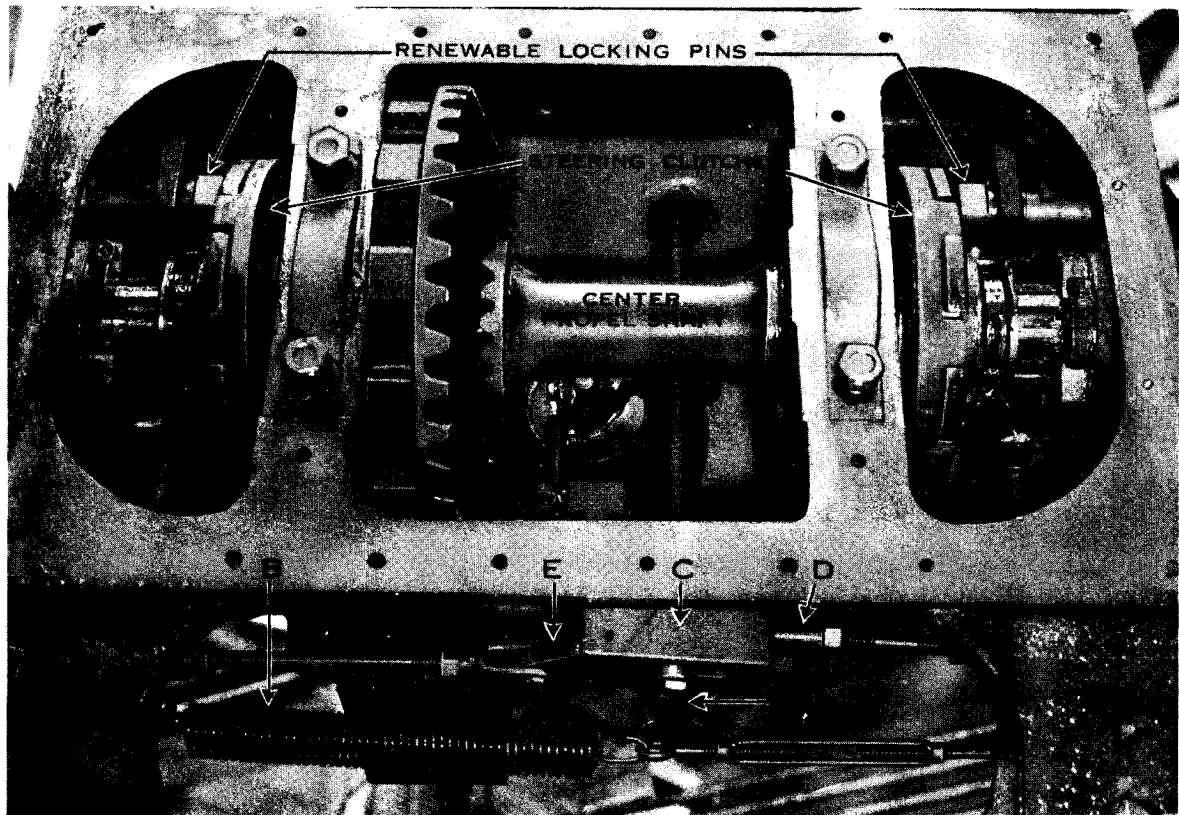


FIG. 12

Side frames of two different lengths as well as two different widths of track links are available so that the bearing area of the mounting can be ordered to suit ground conditions and loads to be handled. The long side frames are not used with shovel front end. For dragline work on soft footing the mounting can be furnished with tapered ends. The mounting is a factor in stability of the machine and care must be taken in using the Table of Maximum Allowable Loads included in the Machine Specifications to use the column corresponding to the mounting with which the machine is actually equipped.

a. Steering Clutches

The pinion on the lower end of the vertical propelling shaft through the center of rotation meshes with a bevel gear on the center propel shaft in the truck frame. (See Fig. 10). Jaws, machined on the outer ends of the center shaft, drive the steering clutches which slide on splines on the short clutch shafts on both sides. Sprockets on the outer ends of the clutch shafts drive the cat belts through heavy roller chains. Both steering clutches are controlled from the revolving frame by a reach rod through the center of rotation which operates the lever and reach rod arrangement shown in Figure 12.

When the Steering Clutch Lever is in the middle of its quadrant the coil spring "B" holds both clutches engaged so that the machine will propel either straight forward or backward.

For steering to the right (cat driving chains to the rear) the Steering Clutch Lever is shifted part way forward. This disengages the clutch from the driver on one side and the cat belt is free to idle or drift so that the machine will make a gradual turn. For a sharper turn the Steering Clutch Lever is placed all the way forward. This shifts the clutch an additional amount so that it engages a renewable locking pin in the truck frame and locks the cat belt on the one side so that the machine will turn sharply.

To steer to the left (cat driving chains to the rear) the Steering Clutch Lever is shifted part way or all the way toward the rear of its quadrant (depending on whether a gradual or sharp turn is desired).

A simple locking device operated by lever "A" prevents accidentally disengaging the steering clutch on one side before the steering clutch on the other side is fully engaged with the clutch driver. For the initial travel of the Steering Clutch lever toward neutral the lock bar "C" is locked to the slotted rod end "D" by a hardened steel ball so that the clutch is moved back into engagement with its driver. On neutral, the ball is released and further movement of the Steering Clutch lever starts to release the clutch on the opposite side. At the same time the ball locks the lock bar "C" to the slotted rod end "E" so that when shifting back to neutral the clutch will be positively pulled back into engagement with its driver.

b. Digging Lock

To lock the machine against digging reactions the locking pawl arrangement shown in Figure 13 is used. When the Digging Lock lever is in the next to the rear notch of its quadrant, the two pivoted pawls "A" and "B" engage lugs on the bevel gear on the center propel shaft. This locks the machine against movement in either direction.

When the Digging Lock lever is moved to the rear notch of its quadrant the pin in lever "C" engages the lug on pawl "B" and raises it up out of engagement with the bevel gear lugs so that the machine can be propelled forward (cat driving chains to the rear). It will still be held against backward movement by the pawl "A".

Moving the Digging Lock lever to the next to the front notch, drops pawl "B" back into engagement with the bevel gear lugs then (as the lever approaches the next to the front notch of its quadrant) the pin in lever "D" engages the lug on pawl "A" and raises it up out of engagement with the bevel gear lugs.

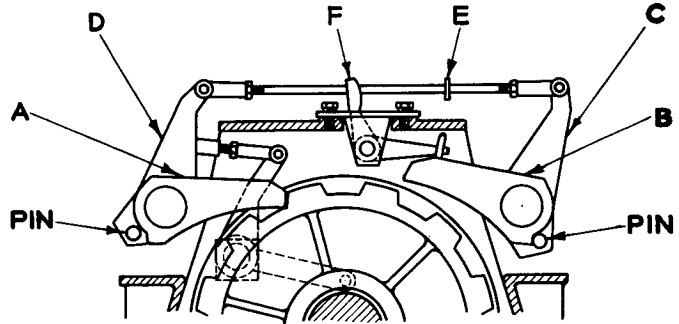


FIG. 13

— CHAPTER III —

MACHINE SPECIFICATIONS

The brief specifications tabulated on the following pages cover the main features of the machine such as drum laggings, rope speeds, mounting dimensions, etc. Tables of Working Range Dimensions for the shovel and dragline are included. There is also a chart from which the radius from the center of rotation corresponding to any given boom angle can easily be determined.

Use this information in determining whether or not the machine is suitable for the job in mind. Output is sacrificed and severe damage may result if the machine is moved in on a job beyond its capacity.

A table of Allowable Working Loads for dragline and clamshell operation and a table of Maximum Allowable Lifting Loads for crane service give the safe loads for various combinations. In using these tables be sure due allowance is made for the effect of wet material, suction (when working in wet or sticky material), weight of the tackle used in making a crane hitch, soft footing or working on a grade.

Be sure to use the correct column for the boom, bucket, counterweight, cat mounting and ballast combination actually on the machine. Change the boom angle, length of boom or both so that the loads to be handled come within the figures given.

Mounted on the side of the lattice-type boom, in full view of the operator, is a pendulum-type boom angle indicator which shows at all times the true angle of the boom with the horizontal.

Use the indicator to set the boom to the correct angle for the loads to be handled. Watch the indicator while operating and if the machine should "nose down" on soft footing, raise the boom to restore the correct boom angle.

If the loads given for any particular length of boom and working radius are exceeded, damage or excessive maintenance is likely to result.

DON'T operate shovels with the outside, rear end, counterweight casting in place.

DON'T operate cranes with boom raised more than 78° above horizontal.

DON'T operate draglines with boom at lower than 30° angle.

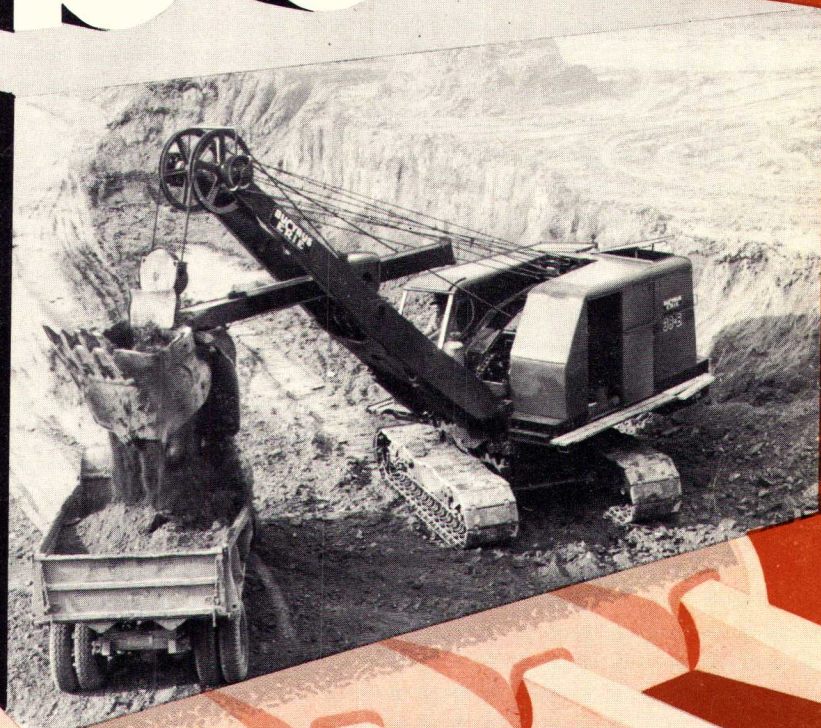
DON'T overload clamshells, particularly if rapid operation is required, nor operate with boom above 60° angle.

DON'T use crane jib for loads over 10,000 pounds.

SECTION I — CHAPTER III

BUCYRUS-ERIE

38-B



**BUCYRUS
ERIE**

SHOVEL • CRANE • DRAGLINE • CLAMSHELL • DRAGSHOVEL

diesel • gasoline • electric (SINGLE MOTOR)

**BUCYRUS
ERIE**



STRENGTH · CAPACITY · and SPEED in

38-B *performance*

There's plenty of reason behind the 38-B's popularity with owners and operators everywhere! Its exceptionally fast cycle, its capacity, durability and economy, and its ability to handle scores of different jobs with top-notch efficiency are only a few. The 38-B's fast cycle is achieved by balanced speeds and power without excessive speeds in any part of the machine — a combination that also means easy operation and long life. The 38-B is more than just a shovel that can be used with other front ends. The 38-B functions with high efficiency as a crane, dragline, clamshell, or dragshovel because its well-balanced basic design provides the best operating characteristics for any front end equipment. See a 38-B in action for yourself!

38-B FEATURES THAT MEAN HIGH OUTPUT!

CATERPILLAR MOUNTINGS, both standard and long, are available with either wide or standard treads. Long mountings are easily converted in the field from flat to tapered type for superior dragline service in soft ground. See page 10.

CURVED DRIVING LUGS on round driving tumbler engage similarly curved lugs on the treads for the smooth moving and easy maneuverability that saves moving time and increases working time. See page 10.

CONICAL HOOK ROLLERS in double flanged cast roller path take both upward and downward loads, eliminate center pintle, contribute to the 38-B's fast, smooth swing. See page 8.

ANTIFRICTION BEARINGS, liberally used throughout the 38-B, mean smoother power flow, less power loss through friction, maintain alignment and concentricity and contribute to lasting clutch and brake adjustment. See page 7.

BIG CLUTCHES AND BRAKES furnish unvarying, instant response throughout the shift, have large contact areas for easy, safe operation. Maintenance is simple; adjustments are long-lasting. See page 6.

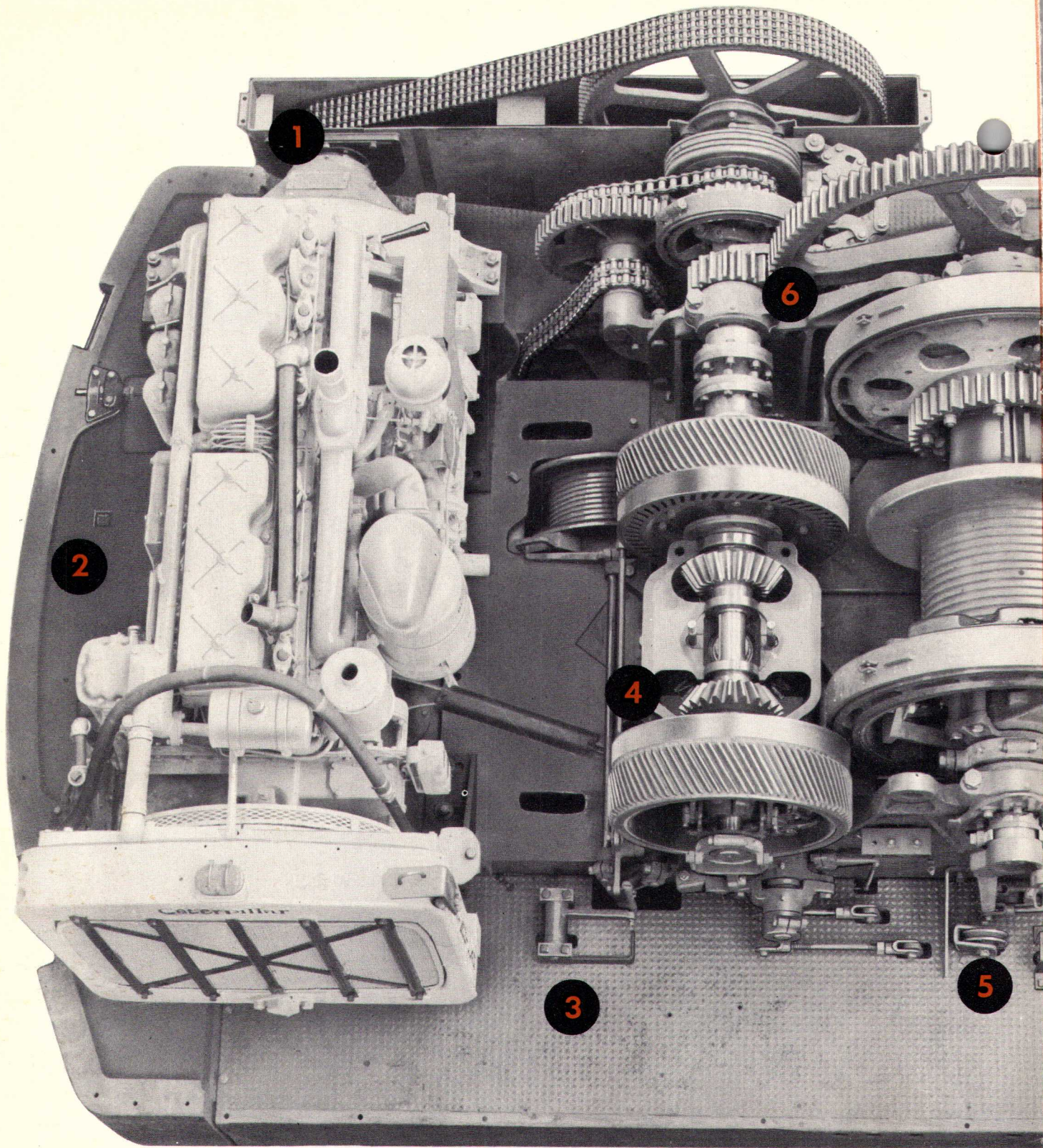
DISC-TYPE BOOSTERS on drum shaft clutches slip only to engage clutch. Loads can be lowered with clutch engaged for safe, exact control. See page 6.

HEAVY-DUTY SHOVEL DIPPER has high lip of long-wearing manganese steel, with integral sockets for inserted forged steel teeth. Curved door and clean-cut interior mean fast dumping. See page 16.

FULL-ROTATING FAIRLEAD with sheave frame mounted on roller bearings adjusts instantly to rope pull, provides correct lead to drums and helps prolong rope life. See page 21.

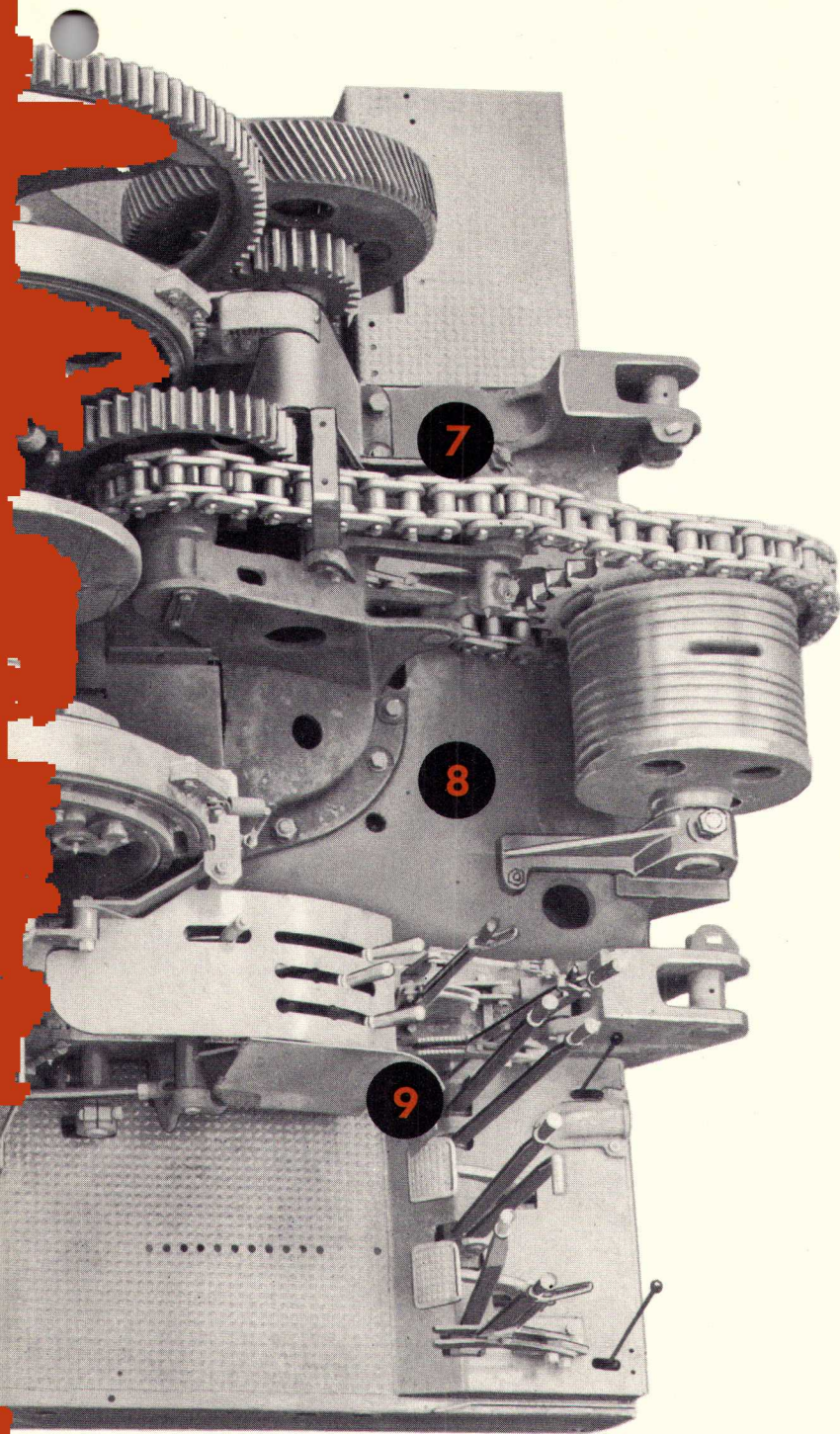
HIGH STABILITY to meet fast dragline, crane, or clamshell operation is provided by the 38-B's sturdy foundation on wide mounting. See page 11.

EASY-TO-OPERATE CONTROLS are all grouped conveniently at operator's position. Direct-connected full-feel controls give unvarying response with low hand lever loads, lessen operator fatigue, boost efficiency. See page 12.



**BUCYRUS
ERIE**

EFFICIENT 38-B MAIN



1

**MULTIPLE-STRAND
ROLLER CHAIN RUNS IN OIL**
Delivers full engine power to
transmission shaft.

2

HEAVY-DUTY DIESEL ENGINE
Gasoline engine or electric motor
also available.

3

**EASY ACCESS TO
MAIN MACHINERY**
Speeds maintenance work, cuts
down-time.

4

BIG, SIMPLE CLUTCHES
Mean fast, easy operation, low
maintenance.

5

SPLIT-SECOND DIPPER TRIP
Gives instant, positive response.

6

INDEPENDENT BOOM HOIST
Permits raising and lowering of
loads under full control.

7

**INDEPENDENT TWIN-ROPE
CROWD**
Eliminates heavy boom machin-
ery.

8

**SINGLE UNIT CAST STEEL
REVOLVING FRAME**
Assures lasting alignment of en-
gine and machinery.

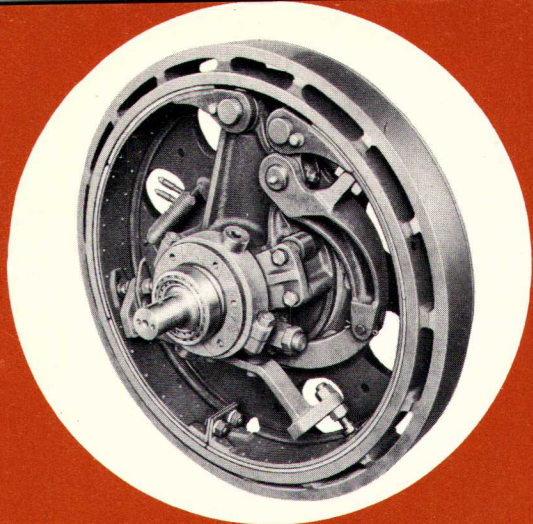
9

**CONVENIENTLY GROUPED
CONTROLS**
Direct-connected for full "feel,"
greater accuracy of control.

MACHINERY FOR BIG OUTPUT!

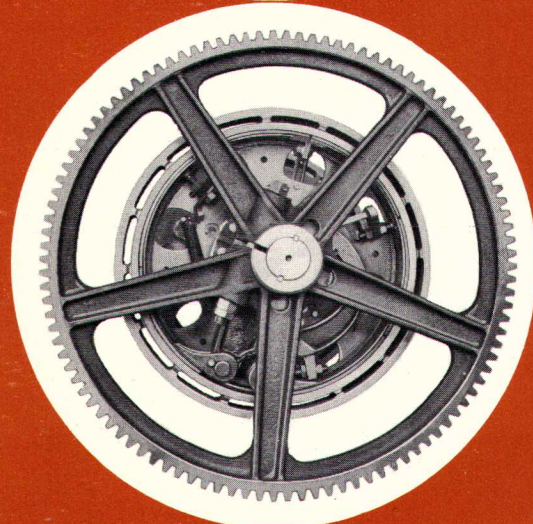
long-lasting machinery plus

EXTRA OUTPUT



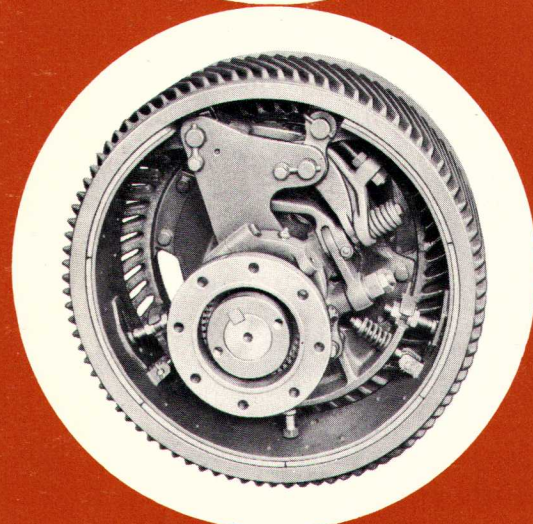
1

Drum shaft, removed from side frames, shows self-aligning roller bearing and single point clutch adjustment for wear. Split band means easy removal and replacement.



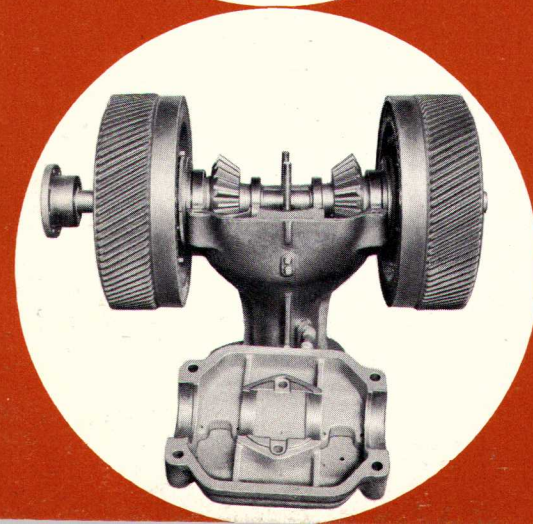
2

Accurately cut teeth of hoist gear mean quiet, efficient power transmission. An annealed steel casting hoist gear is located outside side frame, is removable without disturbing other machinery. Split hub provides for easy removal from end of shaft.



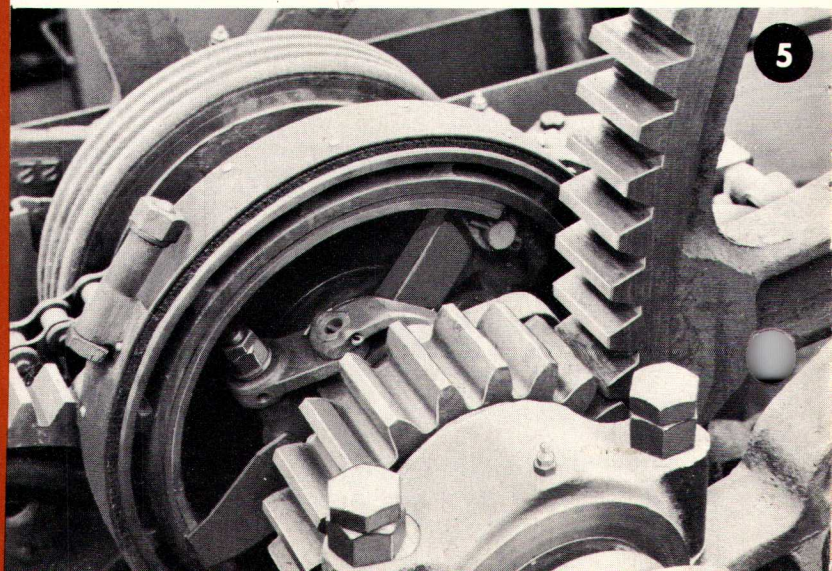
3

Swing clutches are large, quickly responsive. Many cooling fins allow rapid heat dissipation so clutches run cool, without loss of efficiency. All 38-B main operating clutch bands are reversible end for end, for long life. Smooth surface on clutch housing provided for shoe-type swing and propel brake.



4

Swing machinery, with cover removed to show bevel gears. Removal of flexible coupling spacer permits disassembly of swing machinery without disturbing other units.



5

Power boom lowering clutch and large capacity safety brake. 38-B operator has positive engine control of both raising and lowering over a wide range of engine speeds.

Heavy-duty diesel engine is especially adapted to hard excavator service, with quick recovery characteristics.

Transmission chain tension is adjusted by sliding engine on its base by means of two adjusting bolts shown at bottom. 38-B also available with gasoline or single-motor electric power.

efficient design means

••• EVERY SHIFT

- balanced speeds and power
- smooth power flow
- responsive clutches and brakes
- easy maintenance . . . lasting adjustments

A glance at the simple, effective deck machinery will show you why the 38-B can out-produce machines of similar size and capacity. Machinery is compact, carefully placed to keep counterweight requirements low, and built of steels and alloys specifically chosen for strength and resistance to wear. Antifriction bearings are liberally used for smooth power flow with minimum frictional loss, and enduring shaft alignment.

SUPERB BALANCE of speeds and power, smoothly coordinated by direct-connected mechanical controls, gives the 38-B its fast cycle. The conservatively-rated heavy-duty deisel engine is a power plant with operating characteristics especially well suited to hard excavating service . . . has quick recovery after hard pulls. (Gasoline and single-motor electric power plants of comparable ratings are also available.) The master engine clutch is of the disc type, and power transmission is by a multiple strand roller chain running in oil.

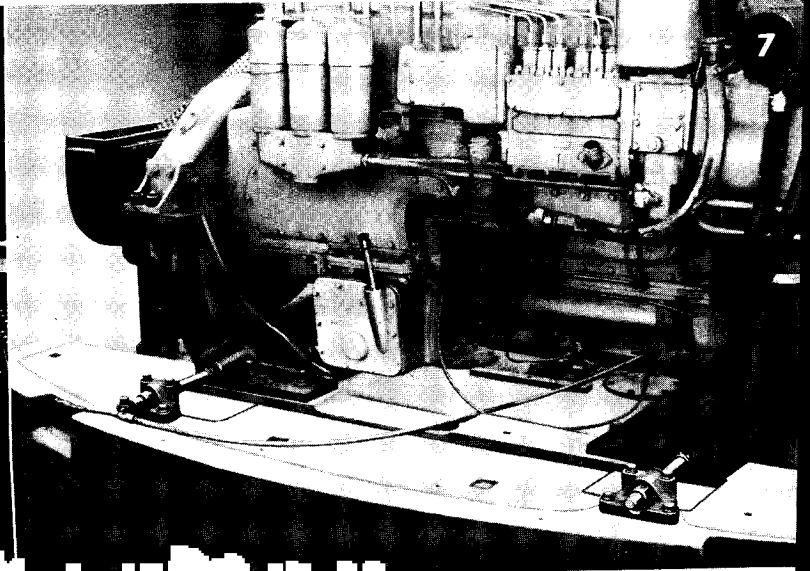
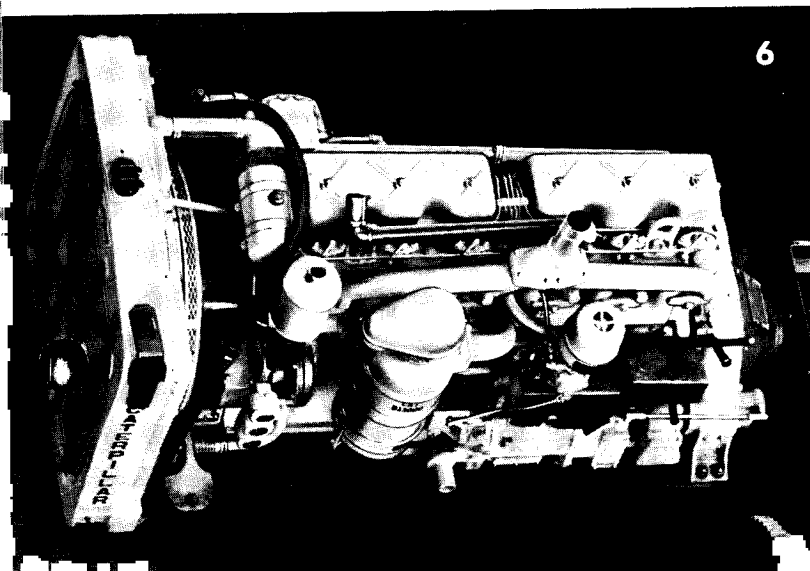
LARGE, HIGH-CAPACITY clutches and brakes give the operator full feel and instant, unvarying response for top-notch working efficiency. Internal-expanding clutches of basically simple yet effective design meet all demands of excavator and crane service, combining a high torque capacity for propelling with the "soft" action that means ease and accuracy of control in swing, hoist, and crowd. Large radiating areas dissipate heat quickly, so clutches run cool, don't waste power or lose holding capacity. Easily accessible single point wear adjustments on clutches and brakes make adjustments easy—and once made, they hold for long periods. Clutches are self-adjusting for weather and temperature variations, so there's never any lag or uncertainty in response.

DRUM CLUTCHES are operated by disc-type boosters bearing against the clutch housing, so hand-lever loads are unusually low, yet operator "feel" and quick response are retained. These boosters, unlike those generally used, slip only during the short period of clutch engagement—there's no energy lost in generating heat. Energy used in engaging boosters is not wasted, but is carried through to assist the main clutch band in rotating the housing. A special slipping clutch at the top of the vertical propelling shaft absorbs sudden shock loads which may result from accidental or emergency engagement of the positive digging lock while propelling.

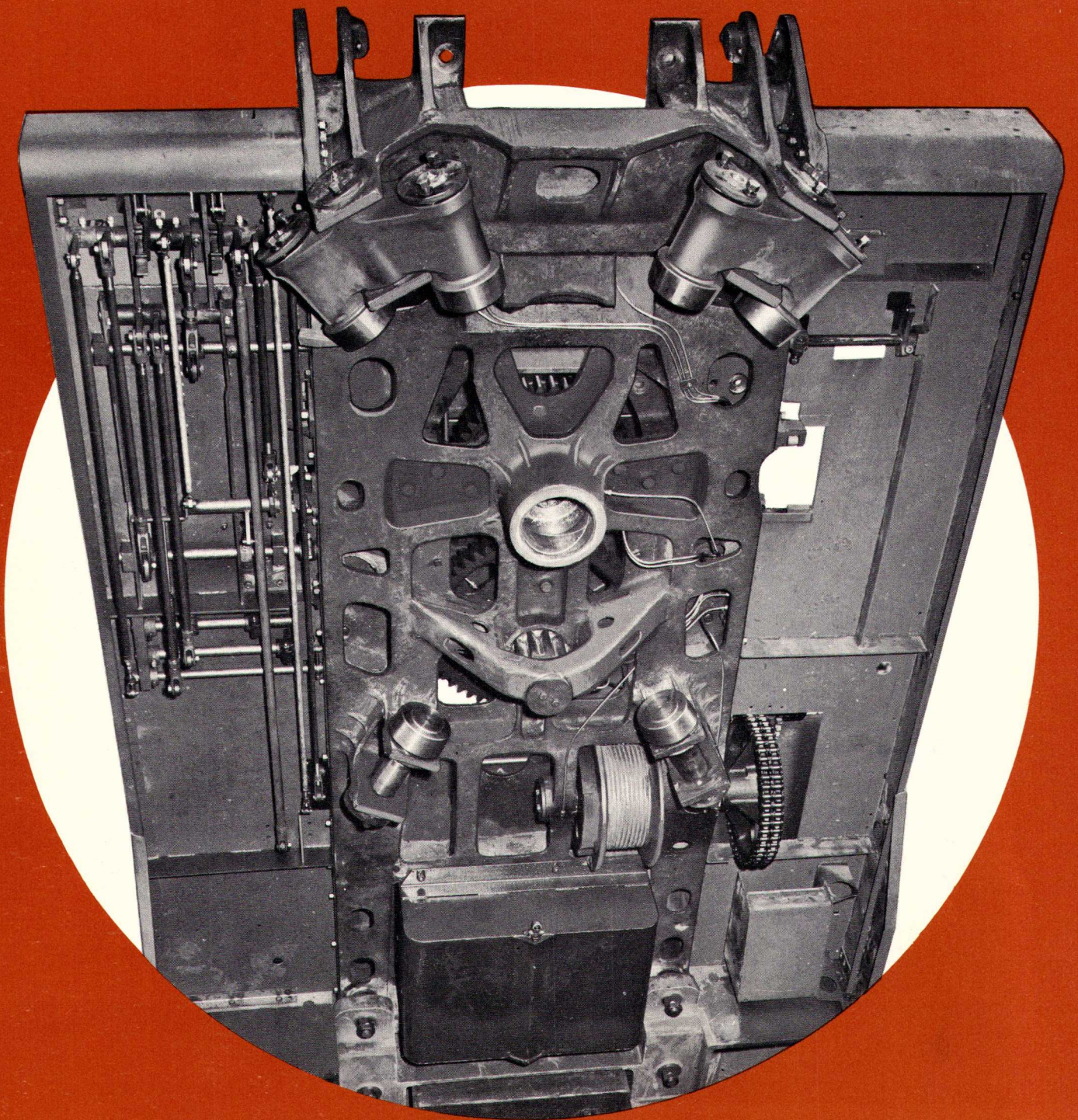
DRUM SLEEVES are mounted on antifriction bearings to provide enduring alignment of clutches and brakes. Main machinery and power unit are mounted on a single annealed steel casting which reduces vibration and maintains alignment of machinery with engine.

AMPLE WALKWAY is provided around the machinery for simplicity of maintenance and adjustment. Operators and oilers are fully protected from moving machine parts by mesh or plate guards carefully designed to permit full access to machinery. Special care has been taken to arrange machinery so it's easy to get at . . . so parts may be simply removed without dismantling other units. Lubrication is simple, too, with conveniently grouped grease fittings provided on all parts requiring grease lubrication.

By any standard of comparison—output, durability, control or economy—you'll find the 38-B the leader in its field!



A STURDY FOUNDATION . . .



Underside of 38-B revolving frame shows sturdy, clean design, free of excess weight. Hook roller brackets and boom-foot lugs are cast integral with frame. Note straddle-mounted swing pinion, straddle-mounted boom hoist drum.

for a Profit-Making Pace!

A solid "base of operations" for a fast, output-producing cycle is provided by the rugged 38-B revolving frame. A single annealed steel casting of deep, box-section design, it forms a rigid support for deck machinery and engine, effectively maintaining machinery alignment and reducing the harmful effects of vibration. Wide use of special steels developed by the Bucyrus-Erie metallurgical laboratories provides great strength yet eliminates all unnecessary bulk, thus contributing to a speedier operating cycle. Bolted to this revolving frame is a rear end casting which combines counterweight and rear end protection. Main machinery side frames are single unit steel castings securely fastened to the revolving frame by finished bolts, which are relieved of shear loads by large shear plugs. Integral lugs are provided in side frame castings for brake anchors and operating shafts.

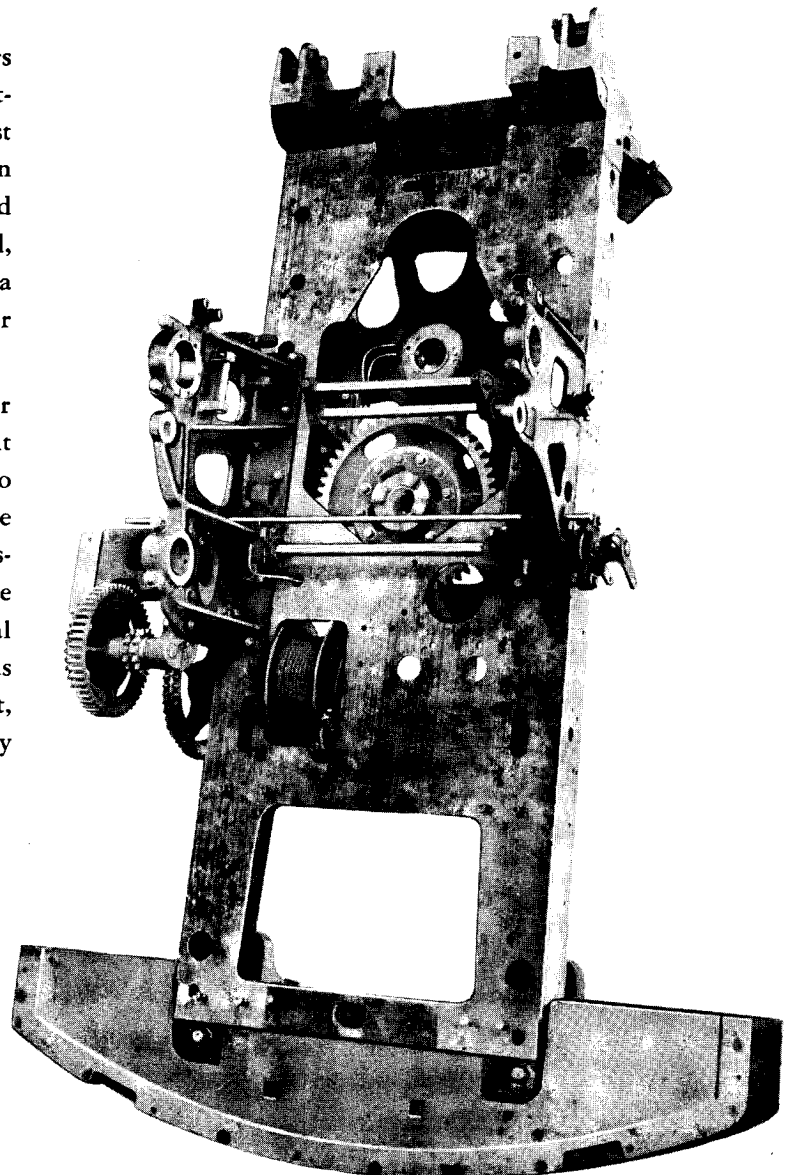
BEARING SUPPORTS for the conical hook rollers and carriers are incorporated in the revolving frame casting, as are bearings for vertical swing-shaft, boom-hoist drum-shaft and boom-foot sockets. Swing rack pinion and boom hoist drum are straddle mounted. Swing and propel gears on the vertical shaft are set into a covered, dirt-protected recess in the upper deck, permitting a clean-cut machinery arrangement and lowering the center of gravity for increased stability.

CONICAL HOOK ROLLERS eliminate the need for a center pintle and, accordingly, the heavy reinforcement necessary for its support. Each roller, including the two individual rollers at the rear, has ample strength to take heavy digging loads, evenly distributing the loads transmitted between upper and lower structures. Pins are hardened to take wear, and cone rollers follow the conical roller path naturally, with no tendency to skid and thus wear flat spots in the rollers. The result is the fast, smooth swing that saves seconds every cycle; saves money every shift.



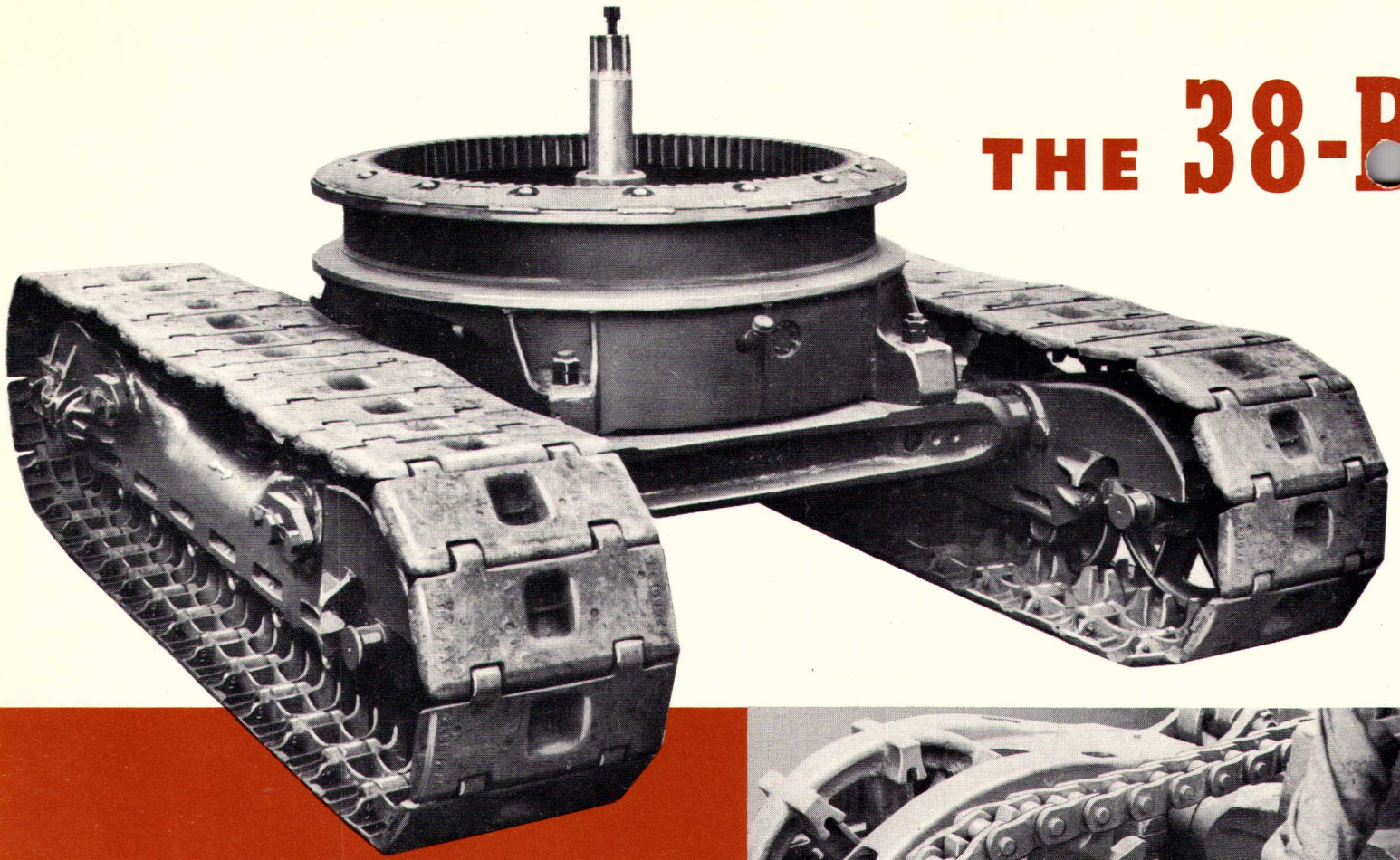
Conical construction of rollers combined with beveled roller path means easier swinging, longer roller life.

Deep box-section design of revolving frame provides strength for hard work, eliminates unnecessary bulk that slows operations.

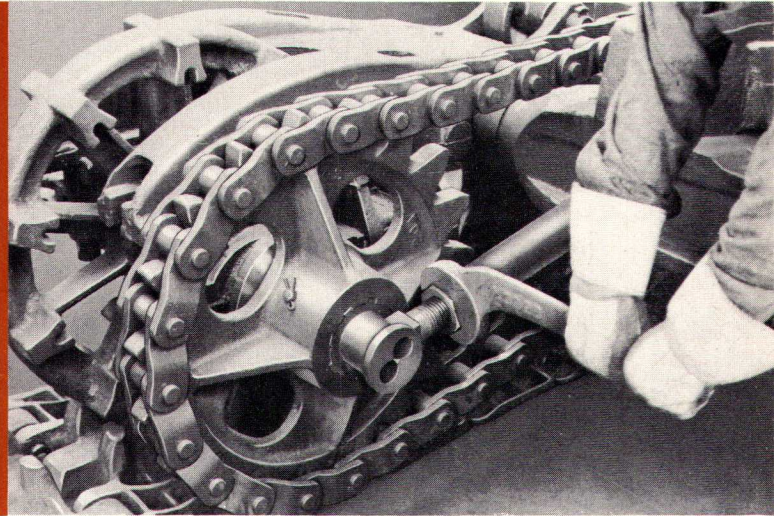


- deep box-section design
- conical hook rollers
- strength without bulk
- lasting alignment
- no center pintle

THE 38-B



- strength for hard work
- maneuverability
- heat-treated treads
- standard or wide mountings



Removable screw jack, stored in a built-in pocket under the revolving frame, permits easy adjustment of tread belt tension by inserting spacer bars.

Contributing to the long life and fast action of the 38-B, the truck frame is a single annealed steel casting combining bearings for the vertical and horizontal propelling shafts and the double-flanged roller path that evenly distributes roller loads throughout the frame. Selective hardening of the lower path has made it highly resistant to wear. Fitting into and resting on top of the frame is the replaceable swing rack gear of alloy steel, securely held by equally-spaced heavy stud bolts. The internal-cut teeth of this gear are selectively hardened to resist wear, and are lubricated from above deck. If subjected to concentrated wear on one section, the entire swing gear may be unbolted and turned 90 to 180 degrees to utilize the unworn part.

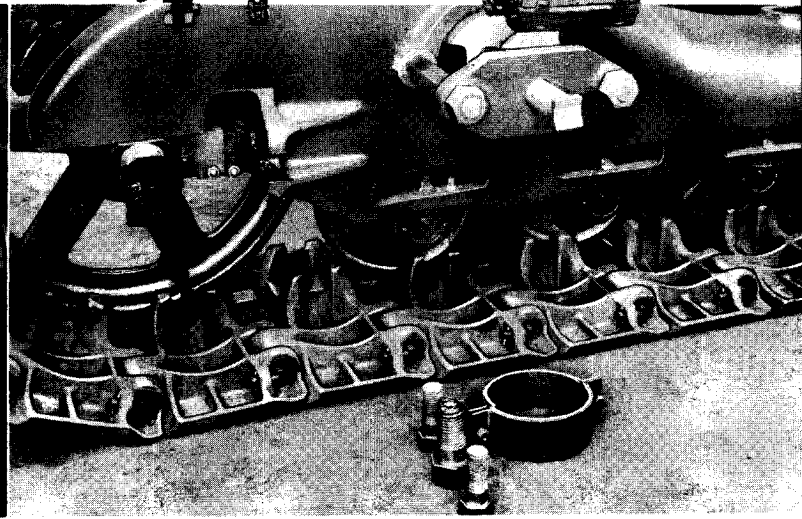
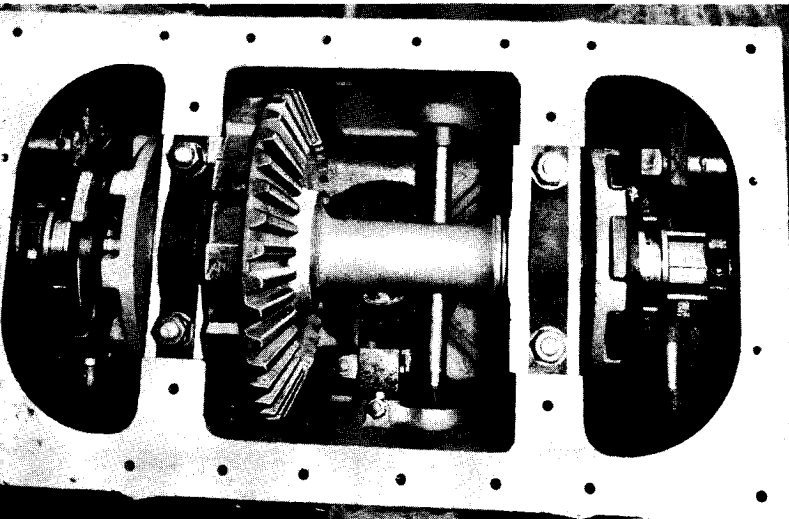
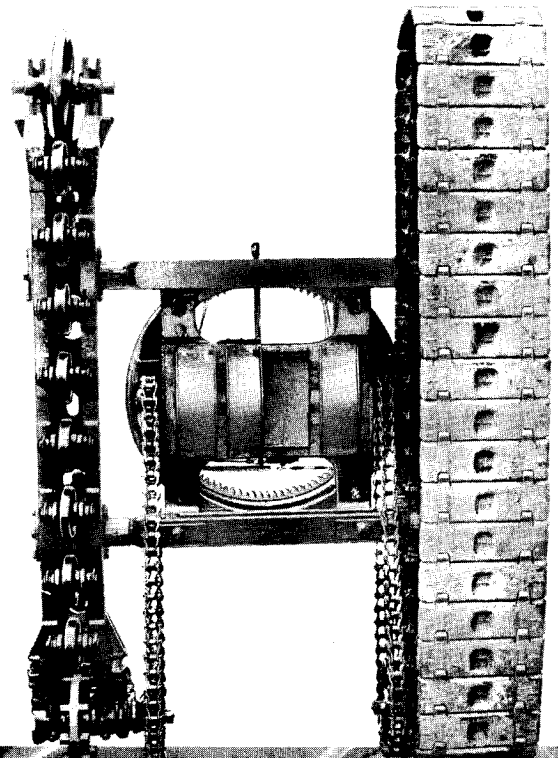
Like the revolving frame, the truck frame design pro-

vides exceptional strength without excess weight. Axles are heat-treated steel castings with ends turned to fit into the caterpillar side frames. Shear loads on the bolts connecting axles and truck frame are relieved by large shear plugs. Propelling gears and steering clutches are completely enclosed and bevel gears run in oil. Two digging lock pawls bear against ratchet lugs cast integral with the lower propelling bevel gear. These pawls are engaged by a single control at the operator's hand to permit (1) free movement forward or backward, (2) forward but not backward movement, (3) backward but not forward movement, or (4) no movement in either direction. Protection against abnormal loads of accidental or emergency engagement while moving is provided by a slipping clutch on the upper end of the vertical propelling shaft.

GETS AROUND!

strong truck frame and ground-gripping treads mean superior mobility, more working time.

Drive chains are placed outside treads so material won't jam between them and the treads. They move in same direction as belts, helping the machine climb over obstructions under chains or sprockets.



Truck frame covers removed to show propelling gears and steering clutches. Note large openings for easy access to machinery and quick adjustment of steering mechanism.

Screw jack shifts side frame inward on axle to bring overall width to U. S. railroad clearance for shipping the 38-B.

TWO LENGTHS of caterpillar are available for 38-B machines, with standard or wide treads for either length. The standard mounting with standard treads is well suited to average digging conditions and permits shipment of the machine on a U. S. flat car without dismantling. Wide treads provide increased bearing area for improved traction in tough going, or exceptional stability and maneuverability for fast dragline, crane, and clamshell work. With necessary extra equipment, long mountings can readily be changed from flat to tapered ends to provide a climbing angle that gives the 38-B superior maneuverability in soft ground.

CATERPILLAR FRAMES are single annealed steel castings that include bearings for the deep section axles and are rounded at the top to shed dirt freely. Rollers

are annealed steel castings with long-wearing bushings protected by dust shields. Curved lugs on the round driving tumblers engage similarly curved lugs on the treads, giving the 38-B its smooth-rolling tread belt movement that means longer life for treads and tumblers. The driving tumblers and large sprockets are mounted on splined shafts for efficient power transmission, long life, and ease of assembly or disassembly. Treads of heat-treated steel are selectively hardened in the roller path, with close-fitting hinged joints so pebbles or rocks won't be picked up and crushed between treads. From end to end, the 38-B truck frame and mounting are designed to give long service under hard working conditions—the kind of dependable service that means more hours on the job and more output every hour.



OPERATORS SET NEW OUTPUT

with 38-B quick-acting, easy control!

- fast-responding, direct-connected controls
- easy adjustments
- low hand-lever loads

Operators find the Bucyrus-Erie 38-B easy to operate, quickly responsive to their wishes, because direct-connected controls provide the "full feel" necessary to regulate power and coordinate machine functions into a smooth, fast cycle. Lever throws are short for minimum hand movement, yet require unusually low hand pressures for effective operation — thus helping to combat operator fatigue and "end-of-shift" letdown. Operators can always be sure of getting the same response to a given lever movement, early in the shift or late — another reason why the 38-B speeds working cycles. Bucyrus-Erie design and control means smooth synchronization of all operating motions, easy on machine and operator alike.

38-B DECK MACHINERY is compactly designed and arranged for operator convenience, too; easily accessible for maintenance or adjustment, yet well-guarded for safety. Mesh or plate guards are designed to combine utmost protection with freedom of access to machinery. Adjustments are simple to make and last for long periods without constant attention. Machine parts are large, simple, strong and few in number to keep repair time to a minimum.

STREAMLINED 38-B CAB features easy-opening doors and adjustable windows of tempered glass that provide unusually good operator visibility. A comfort-

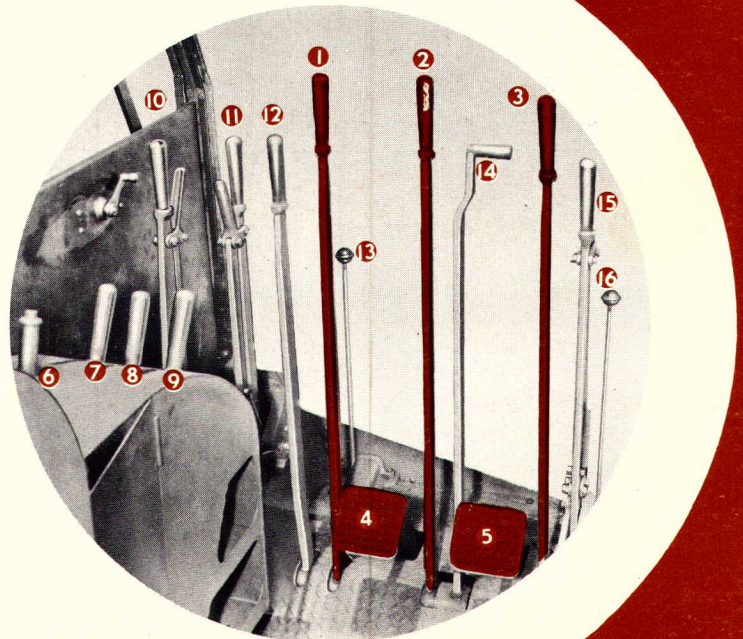
able, adjustable seat contributes to operator efficiency. Hatch openings over the engine help provide ventilation for the cab.

Three hand levers and two foot-brake pedals are the only controls necessary for normal shovel, dragline, crane or clamshell work with the 38-B. As shown in the photograph below, these simple controls consist of: (1) swing clutch lever, (2) lever to left clutch for shovel crowd and retract, clamshell holding or lowering, crane auxiliary drum; to right clutch for dragline drag, (3) lever to right clutch for shovel hoist, clamshell closing or hoisting, crane main hoist; to left clutch for dragline hoist, (4) pedal to left brake for shovel crowd or retract, crane auxiliary drum; to right brake for dragline drag, clamshell closing or hoisting, and (5) pedal to right brake for shovel hoist, crane main hoist; to left brake for dragline hoist, clamshell holding or lowering.

All 38-B controls are located conveniently at the operator's station. Other levers or controls shown are: (6) governor control, (7) engine clutch lever, (8) digging lock lever, (9) swing-propel jaw clutch lever, (10) swing lock lever, (11) transmission brake lever, (12) steering jaw clutch lever, (13) power boom hoist pawl lever, (14) dipper trip or independent propel clutch lever, (15) boom hoist lever, and (16) foot brake lock control.

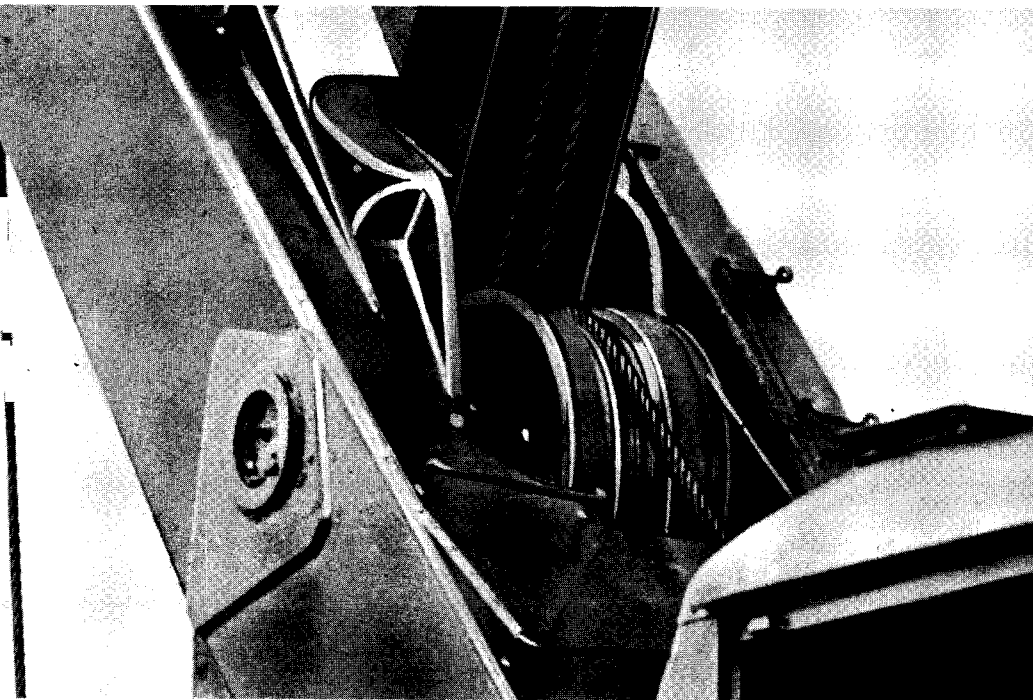
RECORDS

levers conveniently grouped
accessible machinery, amply guarded



INDEPENDENT TWIN-ROPE CROWD

for a shovel front-end that means business!



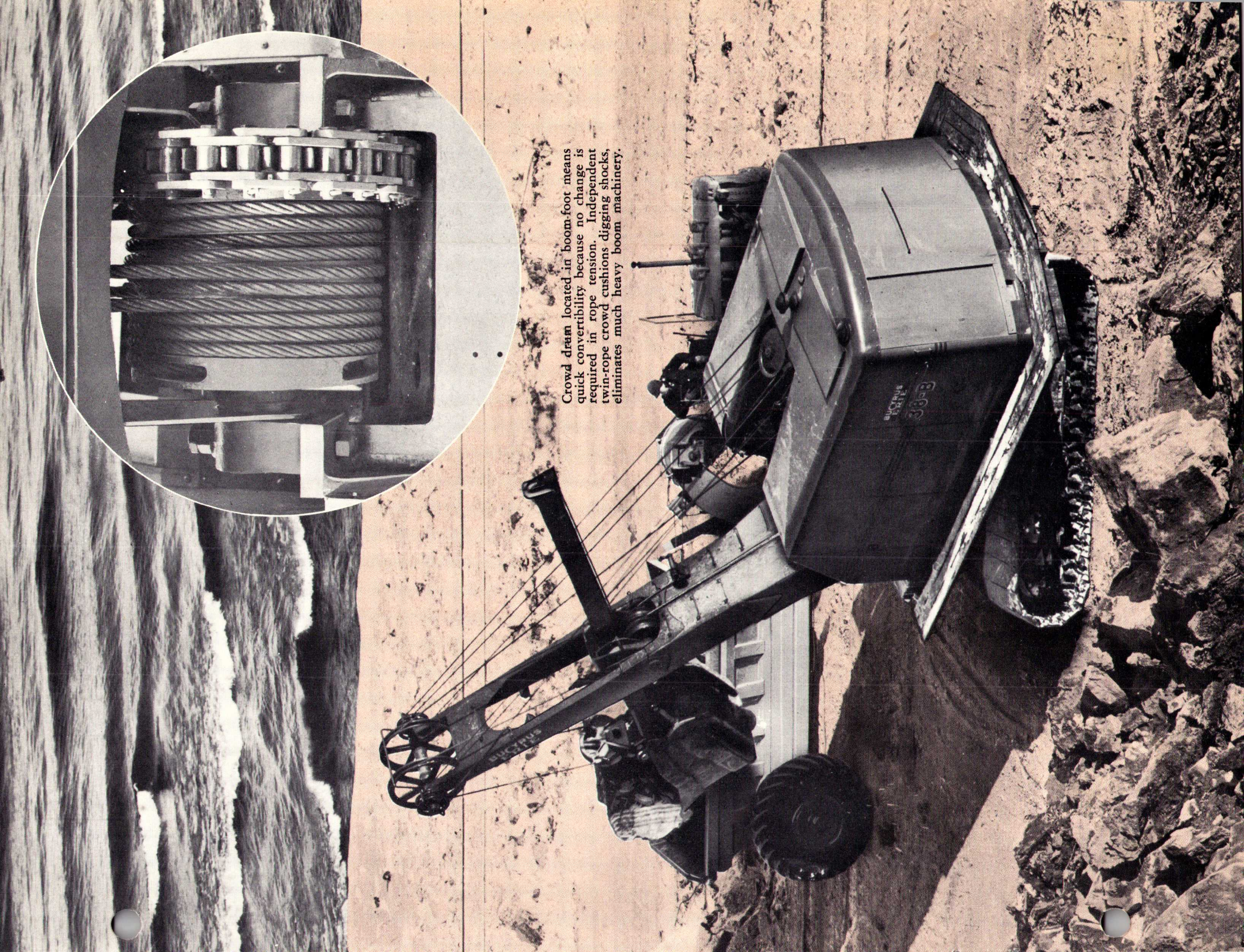
- positive action
- fully independent
- shock-absorbing
- speeds shovel cycle
- quick convertibility

Large shipper-shaft drum acts as a wide-faced roller for dipper handle. Twin crowd ropes and single retract rope pass over drum to anchor on handle, which "floats" on drum.

You'll find a real output-producing front end on the 38-B shovel, with its positive, independent, twin-rope crowd. Powerful crowd machinery, working through a roller chain that drives the crowd drum located in the boom foot, distributes the crowd-out load between two ropes with a single-rope retract. Both functions are completely independent of all others, giving the operator full, precise control of the load throughout the cycle. The twin-rope crowd eliminates heavy boom machinery, making possible a lighter, easier-to-swing boom and handle, and faster digging action. The twin-rope crowd absorbs harmful digging shocks, thus protecting machinery and reducing operator fatigue. The large, grooved crowd drum, turning on a shaft concentric with the boom-foot pin, is removable with the boom as a unit,

simplifying conversion from shovel to other front ends and permitting changes in shovel boom angles without altering chain or crowd rope tension.

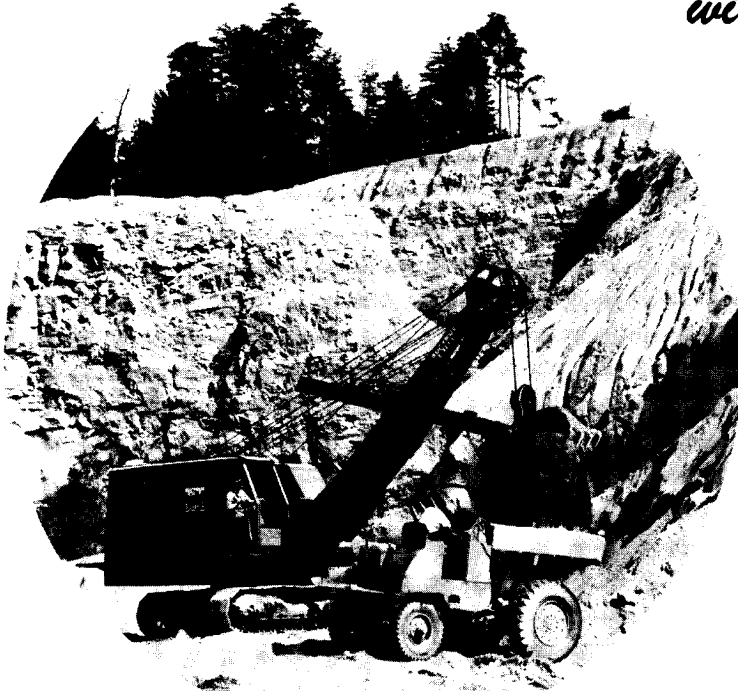
Shovel boom and handle are strong, welded box sections from which all excess weight has been eliminated while retaining resistance to torsional, compression and bending stresses encountered in tough, high-speed shovel work. A heat-treated saddle block carries the inside handle, which "floats" on the large shipper shaft drum — a combination roller and crowd-rope sheave. Both of the big boom-point sheaves are live full circles to help keep rope wear to a minimum, and are positioned to provide a direct hoist rope lead from sheaves to dipper padlock sheave.



Crowd drum located in boom-foot means quick convertibility because no change is required in rope tension. Independent twin-rope crowd cushions digging shocks, eliminates much heavy boom machinery.

GET BIG PAY-LOADS

with this fast-filling, hard-digging



Whether the digging is hard or easy, rock or dirt, you get bigger pay loads with the fast-filling, quick-dumping 38-B dipper.



Matching strength for hard work with streamlined design for easy loading and fast dumping, the heavy-duty 38-B dipper has gained a wide reputation in the field for high output in rock and dirt. Its high lip gives it the capacity to hold bigger loads, while the digging edge and teeth are effectively angled for most efficient penetration of hard-to-dig materials. The flared lip cuts a clearance for the whole dipper. The dipper mouth is wide and unobstructed, the inside smooth so dirt won't catch or cling. Swinging well back for a clean, quick dump, the curved dipper door provides the short back and long front that means improved clearance when digging close to the treads, and closes quickly without excessive impact.

Throughout the 38-B dipper you'll find strength where strength is needed, but no excess metal anywhere to add useless weight and slow shovel operations. High resistance to abrasion is offered by the manganese steel lip, which has integral sockets for the insertion of heat-treated, forged steel teeth. The dipper body is a long-lasting combination of tough alloy steel plates and castings, with pin-holes bushed for long wear, while back casting has renewable lubricated bushed connections for padlock sheave and hinges. The curved door is a durable steel casting with integral hinges and latch guides, while the back casting has connections for padlock and hinges, handle and pitch braces. The padlock is a rugged steel casting, which houses and protects the padlock sheave and is equipped with improved rope guides and a guard to prevent damage from hitting the handle. Forged steel Beco Tiger Teeth are selectively hardened for long life, reversible and removable for resharpening by forging or welding.

● streamlined design ● quick loading . . .

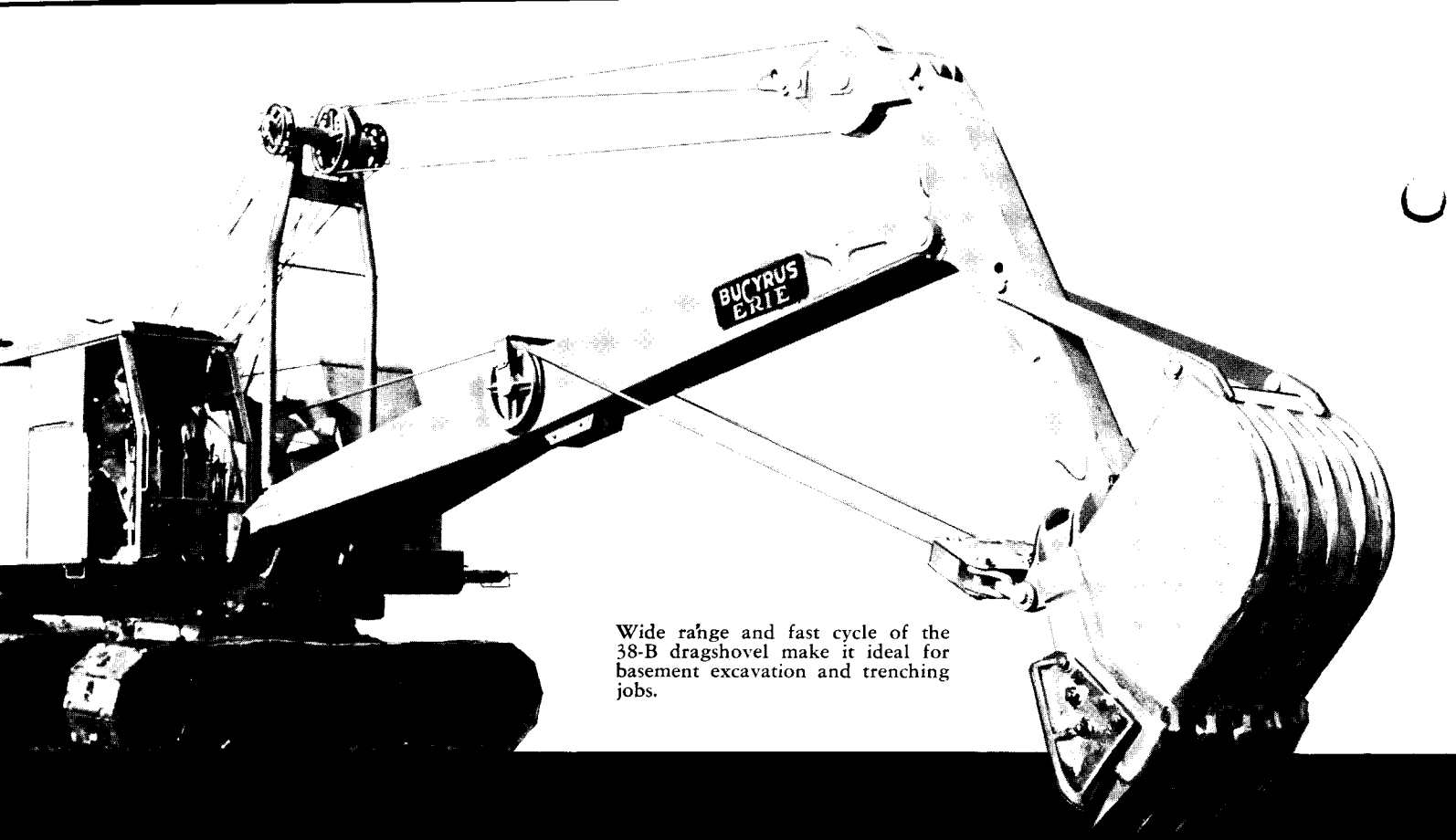


IN A HURRY

38-B *dipper!*

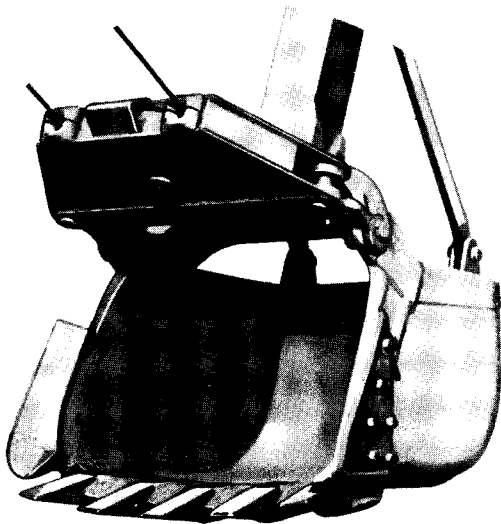


● easy dumping ● long-life construction ● curved door ● inserted forged steel teeth



Wide range and fast cycle of the 38-B dragshovel make it ideal for basement excavation and trenching jobs.

a top-level performer on below-level jobs!



Smooth interior of 38-B dragshovel dipper means fast, clean dumping.

High-output capacity for basement excavation and trenching jobs is offered by the 38-B dragshovel, because it combines a fast overall cycle with a slow, powerful digging stroke that enables the operator to get full dipper loads easily, even in hard digging. Its fast hoist and swing contribute speed in getting the dipper out of deep cuts and into dumping position. Boom and dipper handle are welded box sections, light in weight but providing plenty of strength for long, hard service.

The sturdy dragshovel dipper body is an all-welded steel shell reinforced by triangular box edging. A single casting forms the channel arch and dipper lip, providing a circle of rigid strength where it is most needed. The high arch and rounded heel mean fast filling, quick dumping, and good clearance in digging vertical walls. Reversible teeth are forged steel, selectively hardened for long service and quickly removable for resharpener by forging or welding. Two dipper sizes are available: a heavy-duty $1\frac{3}{4}$ -yard dipper with 48- or 54-inch sidecutters for hard digging in rock or shale; and a 2-yard dipper with 60-inch sidecutters for average dragshovel work.



- effective digging stroke
- fast hoist and swing
- digs deep . . . dumps high
- efficient dipper design

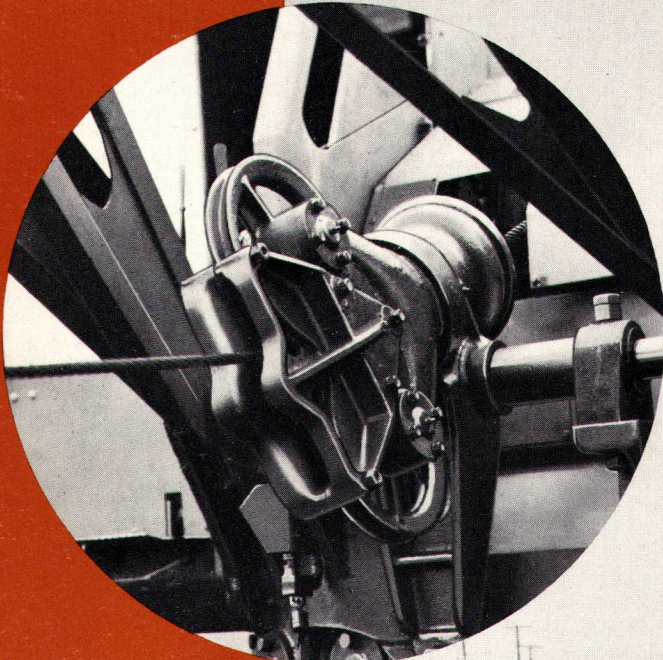


Fast swing and dump of 38-B dragshovel save seconds every cycle; move more dirt every shift.

Added to 38-B dragshovel's range is a powerful digging stroke that gets big loads whether the digging is tough or easy.

OUTSTANDING

- mast-type suspension
- long, tapered, wide-tread mounting
- fully responsive control
- full rotating fairlead
- red arch dragline buckets



Full-rotating fairlead gives most favorable lead to drag drum at all times . . . prolongs rope life.

Superior stability for fast dragline work is provided by wide-spread caterpillar mounting and ground-gripping treads.



DRAGLINE SERVICE

big capacity, long range make 38-B an output leader!

Fast, dependable operation characterizes the big production performance of the 38-B dragline, with its unusual ability to handle long booms without loss of capacity, to dig heaping bucket loads, to merge dig-swing-dump motions into a smooth, efficient cycle. All-welded booms of deep box-section construction are light in weight, yet have ample strength to permit fast dragline work, wide-spread feet to minimize swing stresses. Butt splices make it easy to insert or exchange extra boom sections to fit boom lengths to individual job requirements.

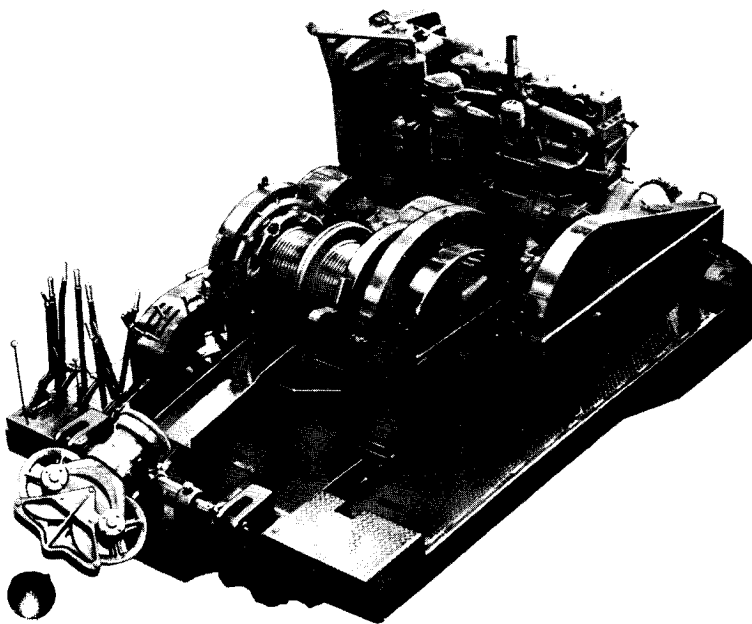
LOW-HIGH A-FRAME suspension — a mast fulcrumed at the boom-foot pin, with a cable-reeved back leg — adjusts automatically to provide favorable tackle loads for varying boom angles. By lowering the mast and adjusting the tackle, the 38-B may be propelled with an overhead clearance of only 13 feet. The 38-B power boom hoist furnishes unusually accurate, positive raising and lowering control through big, quickly responsive clutches and brakes.

FULL-ROTATING FAIRLEAD is symmetrical, carrying two identical anti-friction bearing sheaves, either of which may be up or down. Fairlead frame rotates on

anti-friction bearings in a trunnion sleeve mounted at the boom foot, so the slightest off-lead of the drag rope causes the sheave-frame to rotate into the plane of the rope pull. The rope contacts no other guide sheaves or rollers that may chafe it or cause undue wear.

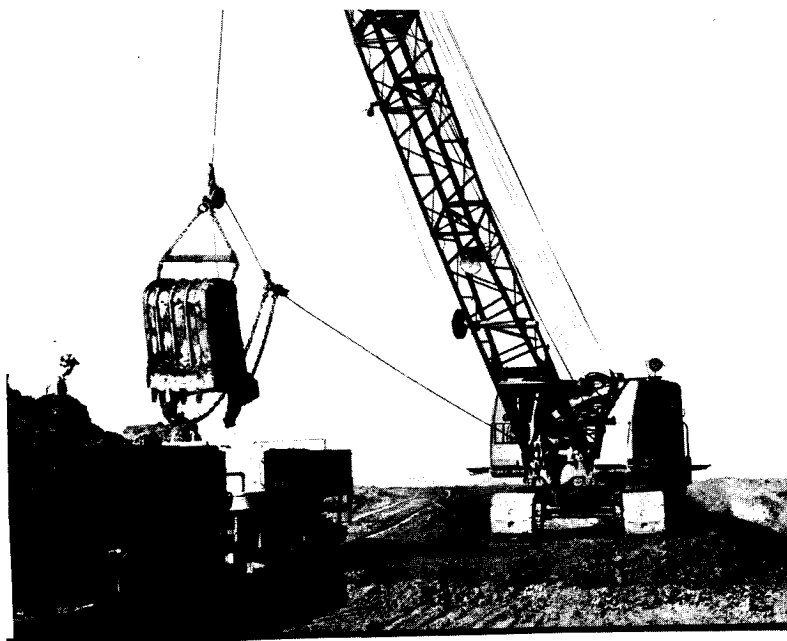
OUTSTANDING STABILITY for fast dragline operation is provided by special long, tapered, wide-tread mountings that give a large bearing area. These tapered-end units can be quickly converted in the field to flat-type mountings.

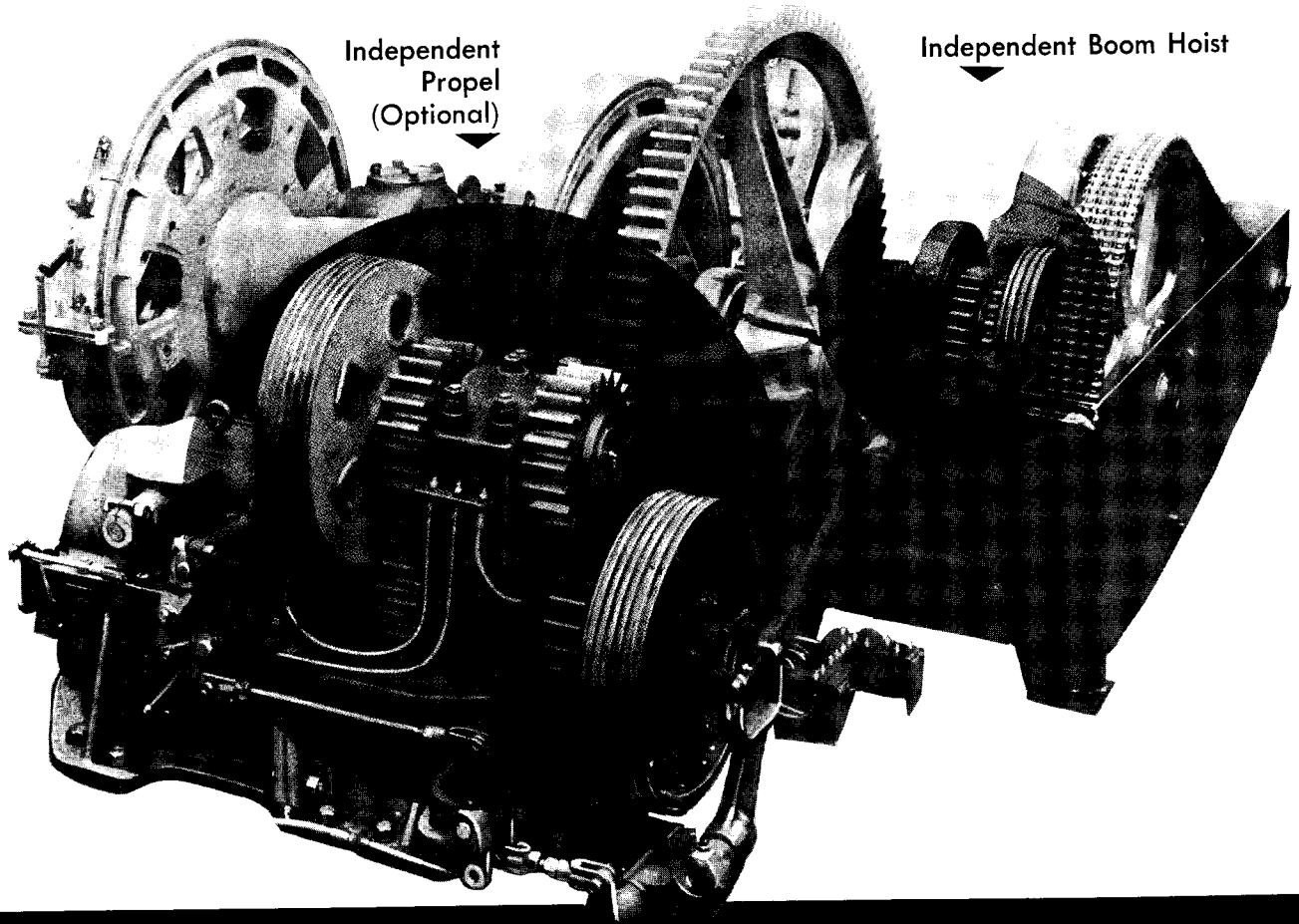
Bucyrus-Erie Red Arch dragline buckets are a "must" for the owner who wants peak performance from his 38-B dragline. Red Arch buckets are durably built of tough, long-lasting steels. Properly pitched teeth and correctly angled cutting edge means efficient digging and loading. The high arch permits dirt to flow in or out without obstruction, and clean interior lines offer no projections to hold dirt while dumping. Buckets are balanced to carry without spillage, and long-lasting to deliver many thousands of yards before any reconditioning is necessary.



Deck machinery is compactly arranged, easily accessible for maintenance, delivers power where you want it; when you want it.

Precision bucket control on 38-B dragline means speedy work in dumping to cars or trucks, no waste motion.





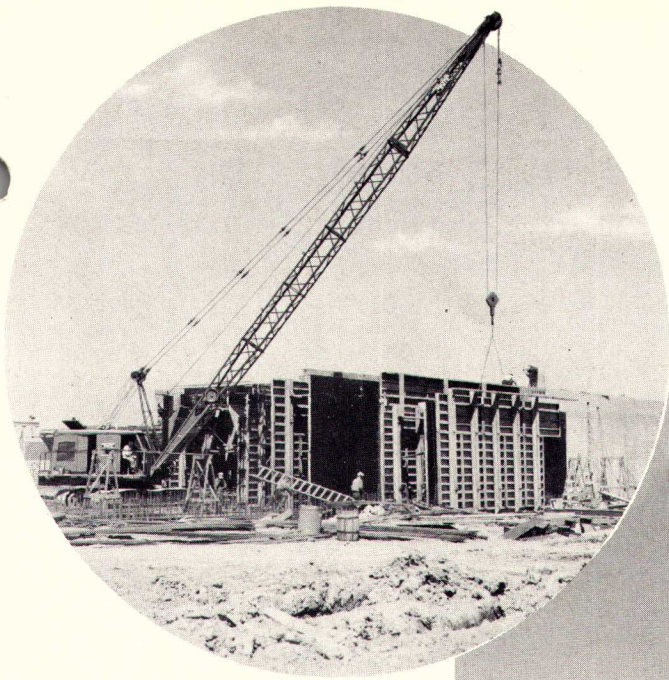
for peak efficiency in crane and clamshell work

The high-grade performance that makes the 38-B a standout in shovel and dragline work is duplicated in 38-B crane and clamshell operation. A sturdy foundation with long, widespread caterpillar units provides firm footing and high mobility. Strong, light crane booms are of lattice-type construction, with angle members welded to the inside of chord legs so there are no obstructions on the outside of booms. Inside lacing eliminates secondary stresses. With the Low-High A-Frame mast, long boom combinations can safely be raised from a horizontal position. The independent boom hoist provides positive power control through big, responsive clutches and brakes. An independent propel unit, available as extra equipment for crane, clamshell, and dragline work, takes the place of the shovel crowd unit. It furnishes

two-speed propel, completely independent of all other functions.

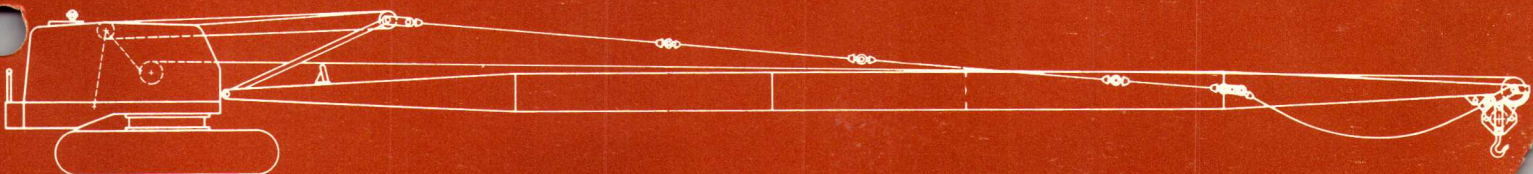
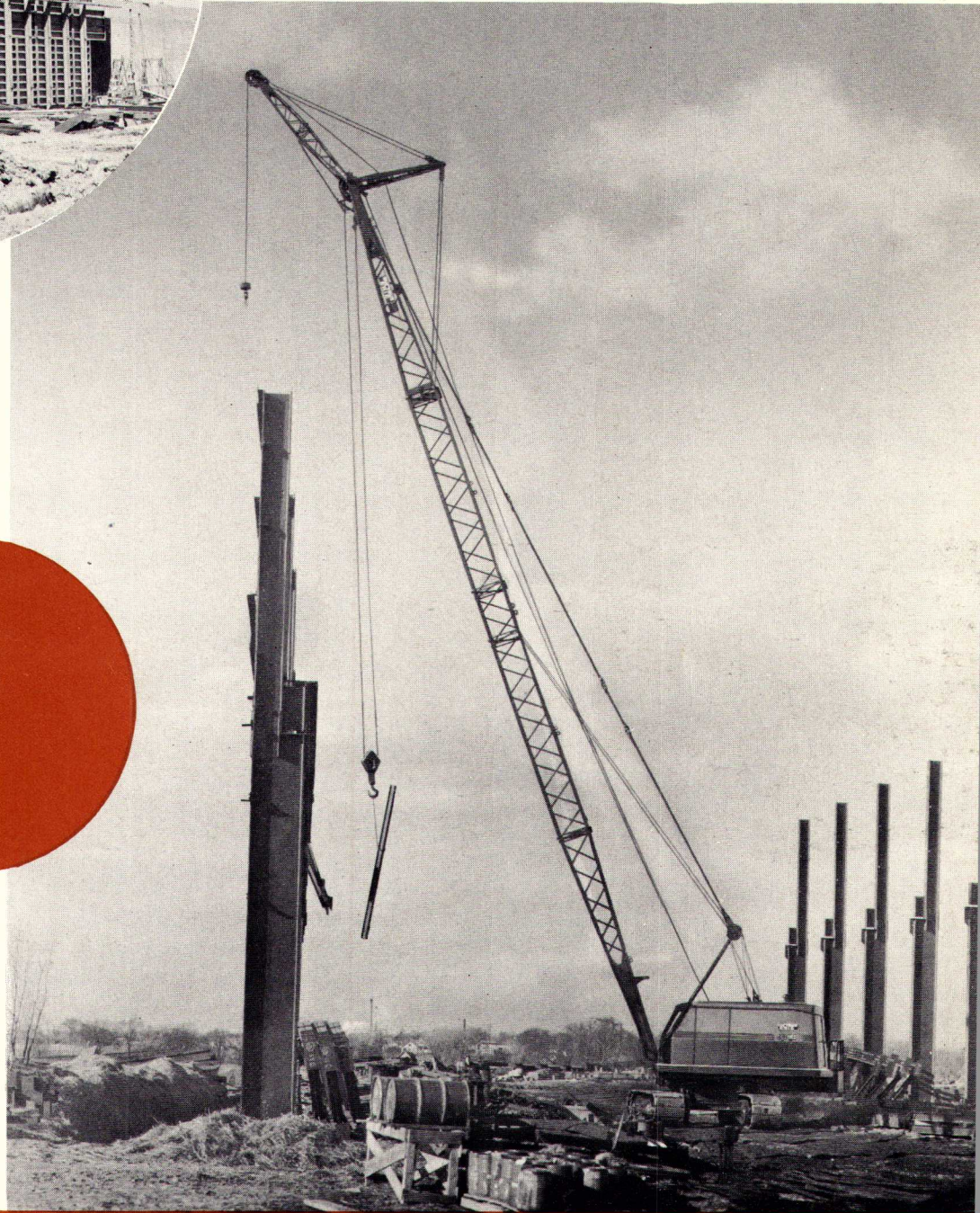
Use of special disc-type boosters on drum clutches gives the 38-B its exceptionally precise control for inching loads into place. Unlike band-type boosters, these do not "kick out" if the drum shaft reverses, so the operator can lower loads with hoist clutch engaged, using machinery friction and inertia as a brake when spotting loads. The transmission shaft brake also contributes to easy, precise lowering of crane loads. Instant, unvarying response from clutches and brakes means smooth, well-coordinated control for utmost operating efficiency.

A variety of boom lengths and jib extensions enable the 38-B to meet all job requirements.



Placing concrete forms or erecting steel, the 38-B offers positive power control through big, responsive clutches and brakes . . . gets jobs done quickly, safely, accurately. Jibs 15' to 30' available for crane work.

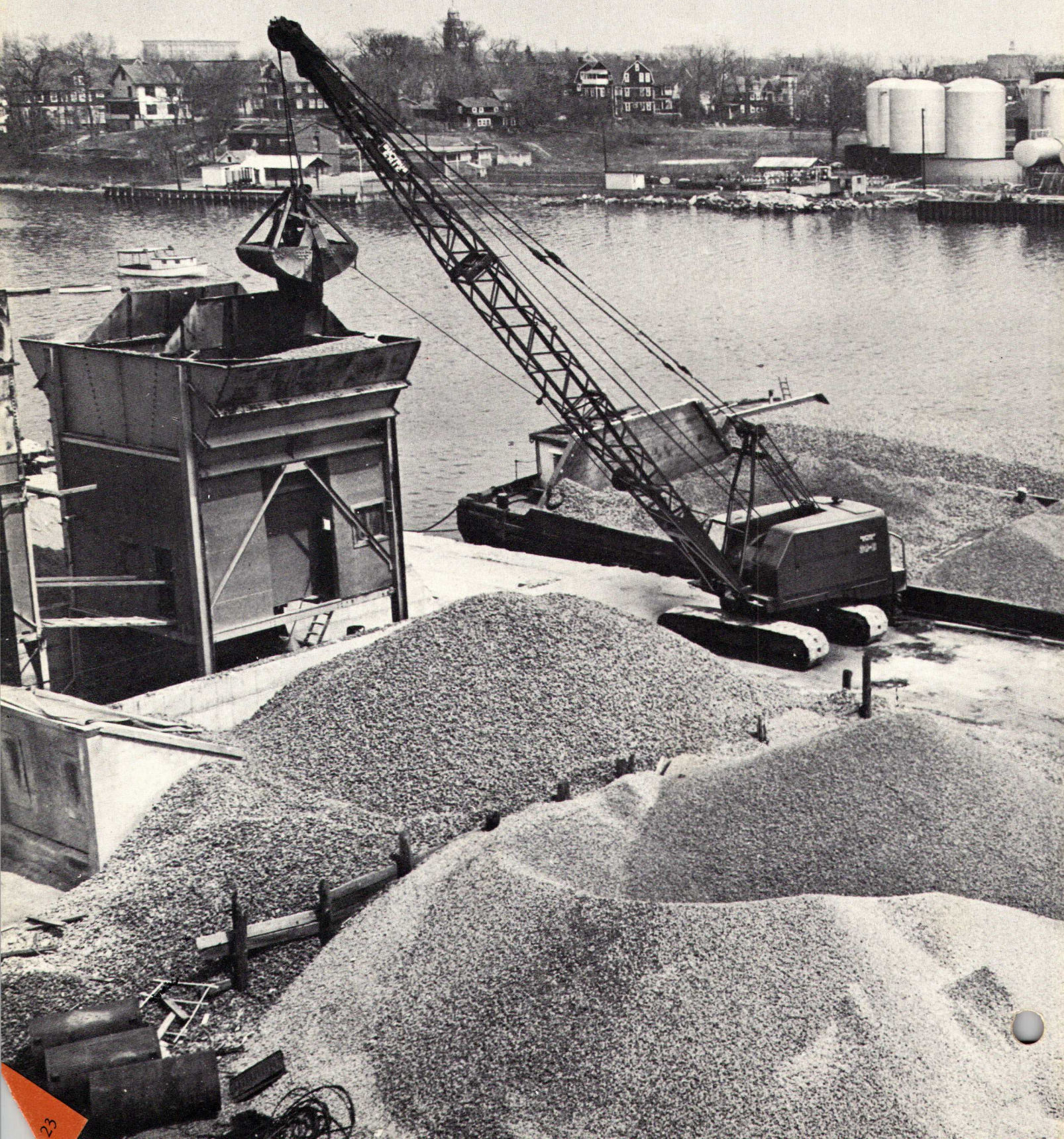
- long booms safely handled
- solid base for fast action



The 38-B crane may be propelled with an overhead clearance of just 13 feet.

38-B

GENERAL SPECIFICATIONS



DIESEL, GASOLINE, AND SINGLE MOTOR ELECTRIC

Shovel:

Hoist drum, grooved.....20" P. Dia.
 Hoist rope, 2 part.....7/8" Dia.
 Boom point sheave.....36" P. Dia.
 Padlock sheave22" P. Dia.

Dragshovel:

Hoist drum, grooved (L.H.) 22 1/2" P. Dia.
 Drag drum, grooved (R.H.)...20" P. Dia.
 Hoist rope, 3 part.....7/8" Dia.
 Drag rope, 2 part.....7/8" Dia.
 Hoist and drag sheaves (6)...22" P. Dia.

Clamshell:

Hoisting or closing drum,
 grooved (R.H.)20" P. Dia.

Holding drum,
 grooved (L.H.)22 1/2" P. Dia.
 Hoist rope, 1 part.....7/8" Dia.
 Holding rope, 1 part.....7/8" Dia.
 Boom point sheaves (2)20" P. Dia.

Dragline:

Hoist drum, grooved (L.H.) 22 1/2" P. Dia.
 Drag drum, grooved (R.H.)...20" P. Dia.
 Hoist rope, 1 part.....7/8" Dia.
 Drag rope, 1 part.....7/8" Dia.
 Boom point sheave (1)20" P. Dia.

Lifting Crane:

Hoist drum, grooved (R.H.)...20" P. Dia.
 Auxiliary hoist drum (L.H.) 22 1/2" P. Dia.
 Hoist rope7/8" Dia.

Boom point sheaves (2)20" P. Dia.
 Standard Lifting Crane rope is of sufficient length to set 2 part main hook block on ground with boom at minimum radius.

Boom Suspension:

Standard boom hoist rope 5/8" Dia., 8 part. Continuous rope suspension for all booms up to and including 65' long. Pendant suspension with mast, for booms 70' long and over. Pendant suspension available with or without mast, for shorter booms when ordered. Drum laggings listed are standard and will be supplied unless special conditions require modifications.

DRUM LAGGINGS

	1-Part Line		2-Part Line		3-Part Line	
	*Pull in lbs.	*Speed F.P.M.	*Pull in lbs.	*Speed F.P.M.	*Pull in lbs.	*Speed F.P.M.
20" P.D. (R.H.) grooved.....	25,200	149	49,200	74.5	71,000	49.7
22 1/2" P.D. (L.H.) grooved.....	22,600	166	43,800	83.	64,000	55.4
22 1/2" P.D. (R.H.) grooved.....	22,600	166	43,800	83.	64,000	55.4

*Speed and pull based on engine operating at full load speed.

POWER SPECIFICATIONS

Diesel Engine:

6 cylinder — 5 3/4" x 7" — International UD-24.
 Rated for excavator service:
 143 h.p. at 1250 r.p.m.—governed speed.
 130 h.p. net at 1190 r.p.m.—full load speed.
 Air cleaner.
 Starter — Electric (engine uses gasoline fuel for starting).
 Fuel tank capacity — 115 gals.
 Cooling system capacity — 37 gals.
 Crankcase capacity — 30 qts.
 *For use in elevation from sea level up to 9,000 ft.

Diesel Engine:

6 cylinder — 5 3/4" x 8" — Caterpillar.
 Rated for excavator service:
 142 h.p. at 900 r.p.m.—governed speed.
 126 h.p. net at 810 r.p.m.—full load speed.
 Air cleaner.
 Starter — Independent gas engine.
 Fuel tank capacity — 115 gals.
 Cooling system capacity — 29 gals.
 *For use in elevation from sea level up to 4,000 ft.

Electric Motor:

Single Motor Machine has 75 h.p. cont. 40° C. motor.
 Push button type starter.
 Standard voltages and frequencies.

Gasoline Engine:

Gasoline engines of standard make and comparable horsepower available in place of Diesel Engines if required.

*Engines for use in higher elevations also available.

CATERPILLAR MOUNTINGS

Travel speed on level ground with Standard Machinery — 1.01 miles per hour;
 with Independent Propel, 2 Speed — 0.9 and 1.6 m.p.h.

	Width of Treads	C. to C. of Tread Belts	Overall Width Working	Overall Width Shipping	C. to C. Tumblers Approx.	Overall Length Approx.	Height Tread Belts	Approx. Bearing Area Sq. Feet	Net Weight Addition
Standard	27"	8'-3"	10'-6"	10'-6"	10'-5"	13'-7"	3'-2"	52.0	0
Standard — Wide Tread	33"	8'-9"	11'-6"	10'-6"	10'-5"	13'-7"	3'-2"	64.0	2300
Long — Wide Treads	33"	8'-9"	11'-6"	10'-6"	14'-3"	17'-5"	3'-3"	85.3	9150
Long — Wide — Tapered Ends ...	33"	8'-9"	11'-6"	10'-6"	14'-1"	17'-3"	3'-7"	75 to 85	10550

Long mounting not suitable for shovel service.

Long — wide tread — tapered end mounting recommended for soft ground dragline operation.

Clearance under axle to ground 19" — (with tapered type mounting 23").

Clearance under truck oil pan 17" — (with tapered type mounting 21").

WEIGHTS

(With Standard Mounting and Standard Counterweight.) Diesel Power

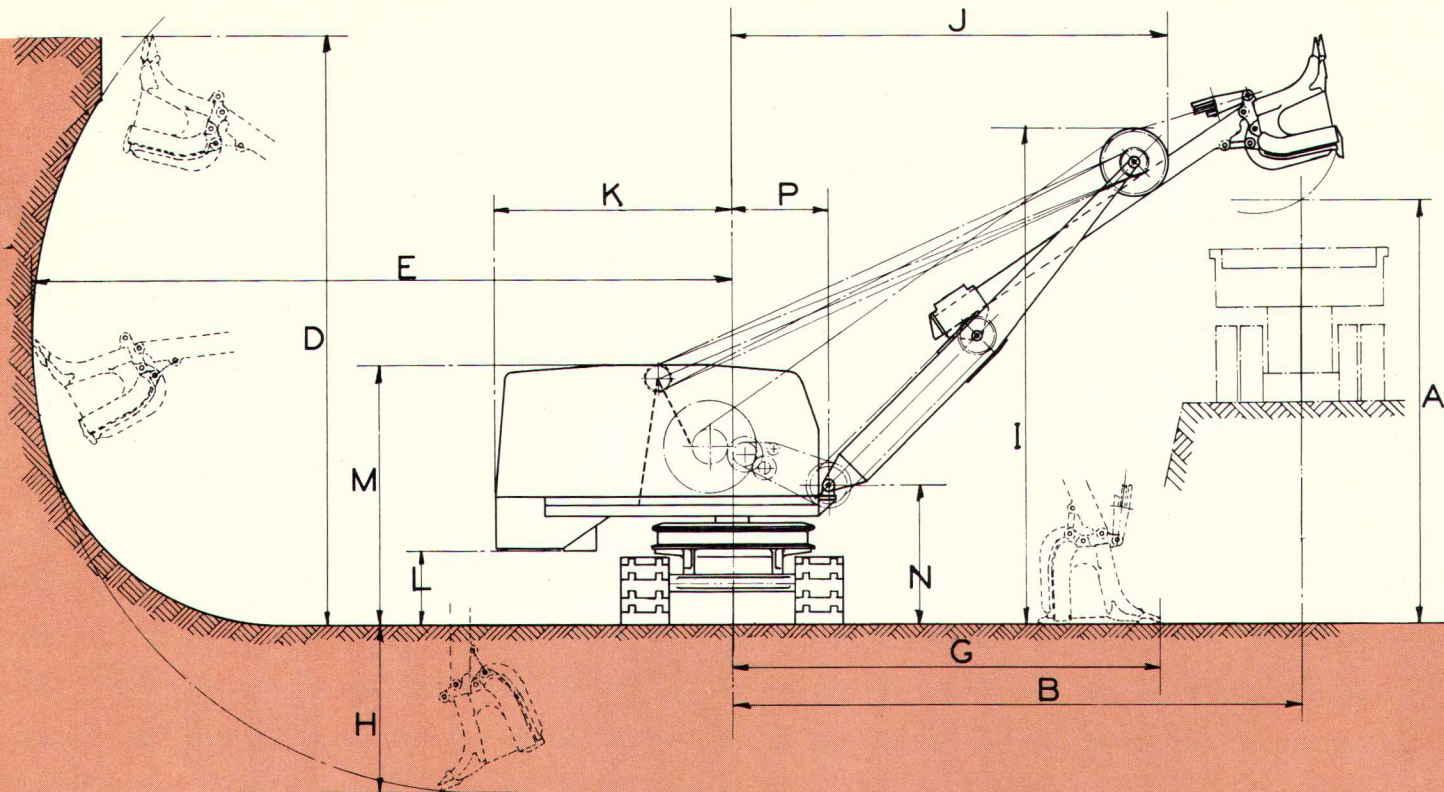
Equipment	Shovel	Dragline 45' Boom	Clamshell 45' Boom	Lifting Crane 45' Boom	Dragshovel
*Net Weight Approx. (Domestic).....	101,000 lbs.	87,700 lbs.	87,250 lbs.	87,450 lbs.	96,000 lbs.
Working Weight — Approx.	101,500 lbs.	91,400 lbs.	91,850 lbs.	87,950 lbs.	96,500 lbs.
Export Shipping Weight — Boxed, Approx.	107,000 lbs.	96,900 lbs.	97,350 lbs.	93,450 lbs.	102,000 lbs.
Ships Option Tons.....	75	81	84	78	74

Above weights are approximate only and will vary several hundred pounds for different combinations and power units.

*Add 1,500 lbs. blocking on car when estimating freight for domestic delivery.

These specifications are complete and accurate to the best of our knowledge at the time of publication but they do not limit or extend the express warranty contained in the contract of sale.

Buckets included in Export Shipping Weight and Working Weights for Dragline and Clamshell Machines.



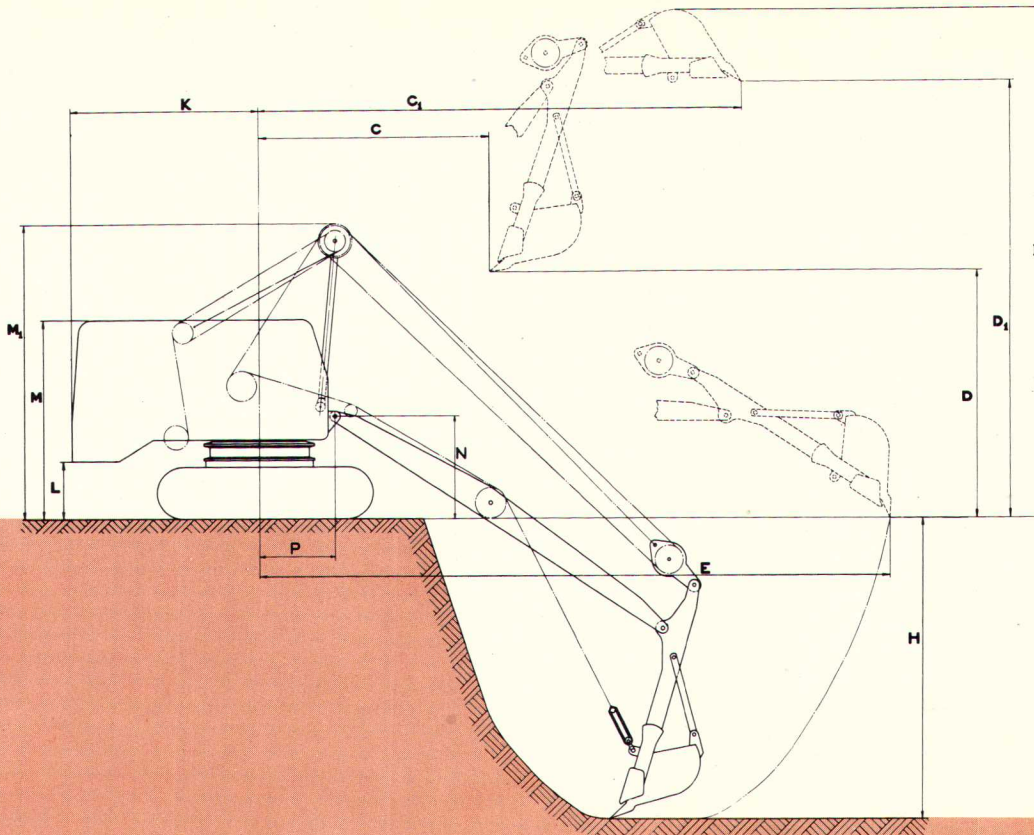
SHOVEL WORKING RANGE DIMENSIONS

Capacity of dipper..... Length of boom — center foot pin to center sheave... Length of handle.....	1½ cu. yd. Heavy Duty 21'-0" — (Effective length 22'-6") 17'-5"				
	40°	45°	50°	55°	60°
A — Dumping height, maximum.....	16'-3"	18'-0"	19'-9"	21'-3"	22'-6"
B — Dumping radius, at maximum dumping height.....	28'-0"	26'-9"	25'-3"	23'-6"	21'-9"
B ₁ — Dumping radius, maximum.....	29'-9"	29'-3"	28'-6"	27'-9"	27'-0"
D — Cutting height, maximum.....	25'-6"	27'-9"	29'-6"	31'-3"	32'-9"
E — Cutting radius, maximum.....	33'-6"	33'-0"	32'-3"	31'-6"	30'-9"
G — Radius of level floor, maximum.....	20'-0"	19'-6"	19'-3"	18'-9"	18'-0"
H — Digging depth below ground level, maximum.....	9'-0"	8'-3"	7'-9"	7'-3"	6'-9"
I — Clearance height of boom point.....	21'-3"	22'-6"	24'-0"	25'-0"	26'-0"
J — Clearance radius of boom point.....	22'-0"	20'-9"	19'-6"	18'-0"	16'-6"

*K — Clearance radius of revolving frame (std. cwt—no runboards)	11'-3"
L — Clearance under frame to ground level.....	3'-6"
M — Clearance height, boom lowered.....	11'-10½"
N — Height of boom foot pin above ground level.....	6'-1¼"
P — Distance boom foot pin to center of rotation.....	4'-6½"

*Runboard at rear increases radius to 13'-1".
Width of Cab 10'-1" — side runboards — 13'-5½" overall width.

38-B SHOVEL



DRAGSHOVEL WORKING RANGE DIMENSIONS

23'-6" Boom — 9'-2" Handle	1¾ cu. yd. Heavy-Duty Dipper	2 cu. yd. Medium-Duty Dipper
Width over side cutters.....	48" or 54"	60"
C — Radius at beginning of dump.....		14'-0"
C ₁ — Radius at end of dump.....		29'-0"
D — Clearance under dipper, beginning of dump.....		14'-6"
D ₁ — Clearance under dipper, end of dump.....		26'-0"
E — Digging radius, maximum.....		37'-9"
* *H — Digging depth over front or side of mounting.....	18'-0" to 22'-0"	
* *H ₁ — Digging depth over corner of mounting (std. or std. wide).....		18'-0"
* *H ₂ — Digging depth over corner of mounting (long wide tapered ends) ..		16'-6"
I — Clearance height over dipper, maximum.....		30'-0"
*K — Clearance radius of revolving frame, standard counterweight, no runboards.....		11'-3"
L — Clearance under frame to ground.....		3'-6"
M — Clearance height, auxiliary A-frame lowered.....		11'-10½"
M ₁ — Clearance height of auxiliary A-frame.....		17'-6"
M ₂ — Clearance height of auxiliary A-frame and boom — traveling position.....		13'-0"
N — Height of boom foot pin above ground level.....		6'-1¼"
P — Distance of boom foot pin to center of rotation.....		4'-6½"

*Runboard at rear increases radius to 13'-1".

* *The depths indicated are theoretical and are for comparison purposes only. The nature of the material being excavated will determine the actual depth obtainable.

Vertical dimensions D, D₁, I, L, M, M₁, M₂, and N increase 4" when long tapered end mounting is used.

Note how completely the 38-B specifications are given in these pages. These are working dimensions that can be depended upon in everyday performance. We publish all the figures on the 38-B including complete crane-ratings together with the percentage of tipping load they represent because we believe in laying all the cards on the table. You get all the facts in black and white as accurately as we can give them so you know what you buy and can be sure you get what you pay for.

38-B

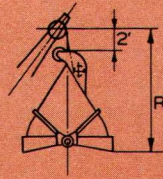
DRAGSHOVEL

38-B

DRAGLINE AND CLAMSHELL

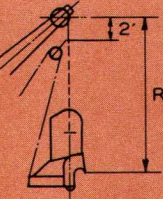
DIMENSIONS CLAM BUCKETS

CAP.Y.	R
2	11' 6"
1-3/4	10' 6"
1-1/2	10' 0"
1-1/4	9' 6"
1	9' 0"

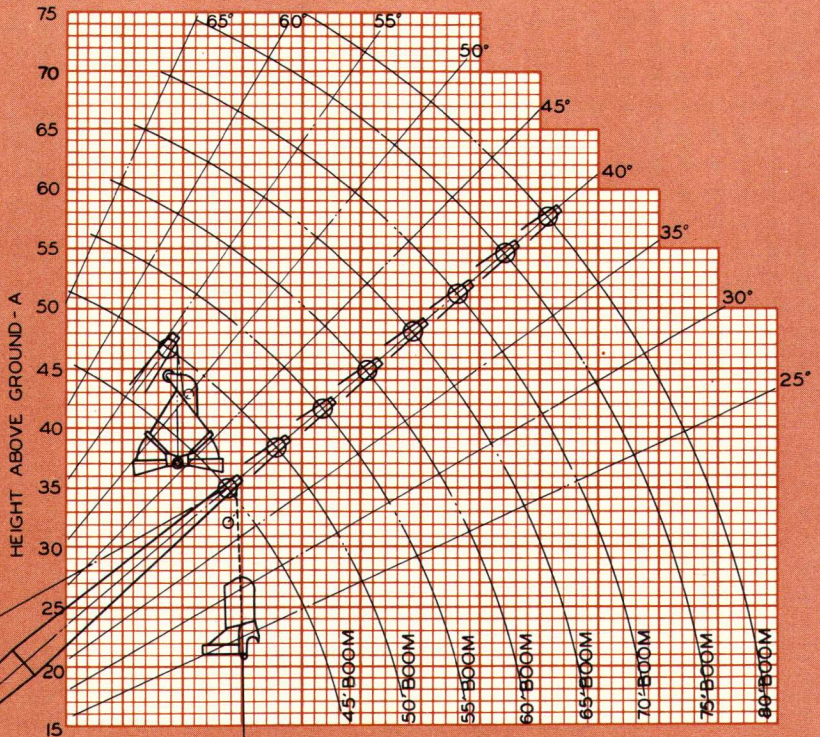
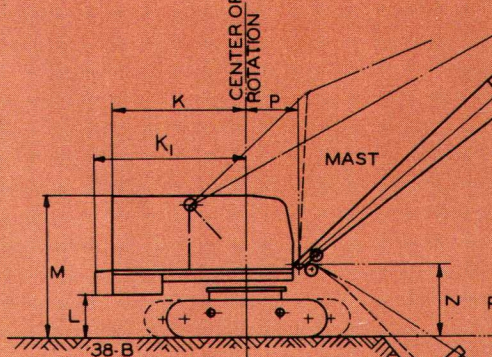


DIMENSIONS DRAG BUCKETS

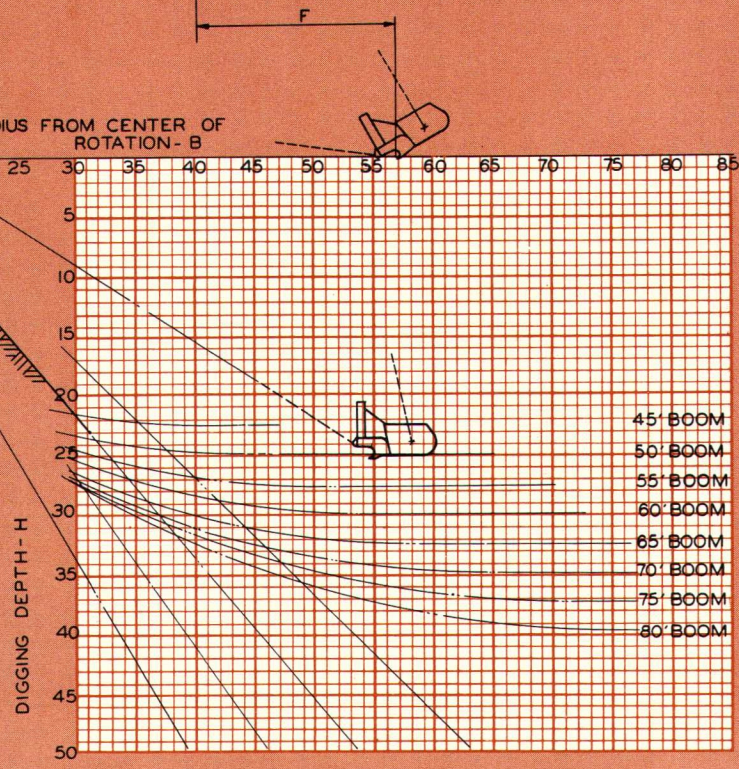
CAP.Y.	R
2	14' 0"
1-3/4	13' 6"
1-1/2	12' 6"
1-1/4	12' 0"
1	11' 6"



BOOMS 70' AND LONGER REQUIRE MAST TYPE SUSPENSION



DRAGLINE DIGGING DEPTH
WITH ROPES OF STANDARD LENGTH,
WITH ONE FULL WRAP ON THE DRUM
AND WITH BOOM IN POSITION SHOWN
IN FULL LINES--APPROXIMATE DEPTH
IS AS SHOWN.



DRAGLINE WORKING RANGES

- A — Dumping height, height of boom point sheave pin *minus* R. See Tables.
- B — Dumping radius, approximately same as operating radius.
- F — Throw of bucket, depends on ability of operator, usually 1/3 of boom length.
- H — Digging depth. Depends on character of material, size and type of dragbucket and whether end cut or side cut. Usually depth with end cut exceeds depth with side cut. Because of these variables, digging depths shown cannot be guaranteed.

Note: Diagram shows digging depths with standard ropes and for booms at radius indicated by full lines. Depths for other boom angles may be determined by striking equal arcs from any proposed location of boom point sheave pin.

- *K — Clearance radius of revolving frame — Cwt "A" (no runboard) 11'-3"
- K₁ — Clearance radius of revolving frame — Cwt "B" 12'-10"
- L — Clearance under frame to ground 3'-6"

- M — Clearance height — boom lowered 11'-10 1/2"
- N — Height of boom foot pin above ground 6'-11 1/4"
- P — Distance boom foot pin to center of rotation. 4'-6 1/2"

*Runboard at rear increases radius to 13'-1".
Vertical dimensions L, M, and N, increased 4" when long, tapered end mounting is used.

ALLOWABLE WORKING LOADS — Machines Having Standard Drums

Boom Length in Feet	Operating Radius in Feet	Equivalent Angle of Boom Approx. Degrees	Height of Boom Point Sheave Pin Above Ground	Dragline Service 66⅔% of Tipping Loads Average Dragline Working Conditions						Clamshell Service 66⅔% of Tipping Loads Average Clamshell Working Conditions					
				Cwtw A			Cwtw B — 6,000 lbs.			Cwtw A			Cwtw B — 6,000 lbs.		
				Std. Mounting 27" Treads	Std. Wide Mounting 33" Treads	Long Wide Mounting 33" Treads	Std. Mounting 27" Treads	Std. Wide Mounting 33" Treads	Long Wide Mounting 33" Treads	Std. Mounting 27" Treads	Std. Wide Mounting 33" Treads	Long Wide Mounting 33" Treads	Std. Mounting 27" Treads	Std. Wide Mounting 33" Treads	Long Wide Mounting 33" Treads
				45	25 30 35 40 42½	65 57 49 40 34	46'-9" 44'-3" 40'-0" 35'-0" 31'-6" 10300 * 8650 8000 11000 * 9200 8550 11600 * 9800 * 9100 10500 * 9800 * 9800 * 11100 * 11100 * 10350 * 11700 * 11700 * 10900 *	16000 * 12400 * 10300 8650 8000	17200 * 13400 * 11000 9200 8550	18200 * 14300 * 11600 * 9800 9100	15200 * 12400 * 12400 * 10500 9800	16200 * 13200 * 13200 * 11100 * 10350	16900 * 13900 * 13900 * 11700 * 10900
50	25 30 35 40 45 47½	67 61 54 46 38 33	52'-0" 49'-6" 46'-6" 42'-0" 36'-9" 33'-0"	..... ..... 10200 * 8550 7200 6800	..... ..... 10900 * 9100 7750 7300	..... ..... 11500 * 9700 * 8300 7850	..... ..... 10400 * 8900 7750 8350	..... ..... 11000 * 11000 * 9400 * 8850	..... ..... 11600 * 9900 * 9900 * 9350	15900 * 12300 * 10200 8550 7200 6800	17100 * 13300 * 10900 9100 7750 7300	18100 * 14200 * 11500 * 9700 8300 7850	15100 * 12300 * 10400 8900 8350 8350	16100 * 13100 * 11000 9400 9000 8850	16800 * 13800 * 11600 * 9900 9900 9350
60	30 35 40 45 50 55 57½	66 61 55 49 42 34 30	61'-0" 58'-3" 55'-0" 51'-3" 46'-3" 40'-0" 36'-0"	..... ..... 8350 7000 6100 5300 5000	..... ..... 8900 7550 6550 5700 5400	..... ..... 9500 * 8100 7100 6150 5800	..... ..... 10200 * 8700 7500 6600 6250	..... ..... 10800 * 9200 8000 7000 6650	..... ..... 11400 * 9700 * 8500 7450 7050	12100 * 10000 8350 7000 6100 5300 5000	13100 * 10700 8900 7550 6550 5700 5400	14000 * 11300 * 9500 8100 7100 6150 5800	14900 * 12100 * 10200 8700 7500 6600 6250	15900 * 12900 * 10800 9200 8000 7000 6650	16600 * 13600 * 11400 * 9700 8500 7450 7050
70 Mast Type Susp.	35 40 45 50 55 60 65 67½	65 60 56 50 45 39 32 27	69'-6" 67'-0" 64'-0" 60'-0" 55'-6" 50'-0" 42'-9" 38'-6"	..... ..... 6800 6000 5200 4500 3900 3750	..... ..... 7350 6400 5600 6000 4900 4250 4050	..... ..... 7900 6900 6000 6450 5200 4600 4400	..... ..... 8500 7400 6450 7000 5700 5000 4800	..... ..... 9000 7900 6900 7300 6100 5400 5200	..... ..... 9500 * 8400 7300 5200 6500 5700 5500	9800 8200 6800 6000 5200 4500 3900 3750	10500 8700 7350 6400 5600 4900 4250 4050	11100 * 9300 7900 6900 6000 5200 4600 4400	11900 * 10000 8500 7400 6450 5700 5000 4800	12700 * 10600 9000 7900 6900 6100 5400 5200	13400 * 11200 * 9500 8400 7300 6500 5700 5500
80 Mast Type Susp.	40 45 50 55 60 65 70 75	65 61 56 52 47 42 36 30	78'-3" 76'-0" 72'-6" 69'-0" 64'-6" 59'-6" 53'-3" 45'-6"	..... ..... 5900 5100 4400 3800 3400 2850	..... ..... 6300 5500 4800 4150 3650 3100	..... ..... 6800 5900 5100 4500 4000 3400	..... ..... 7300 6350 5600 4900 4400 3750	..... ..... 7800 6800 6000 5300 4700 4000	..... ..... 8300 7200 6400 5600 5050 4350	8100 6700 5900 5100 4400 3800 3400 2850	8600 7250 6300 5500 4800 4150 4000 3650 3100	9200 7800 6800 5900 5100 4500 4400 4000 3750	9900 8400 7300 6350 5600 5000 4400 4000	10500 8900 7800 6800 6000 5300 4700 4000	11100 * 9400 8300 7200 6400 5600 5050 4350

See notes 1 or 2 for loads marked () for maximum weights of buckets and contents.

BOOMS LONGER THAN THOSE SHOWN ABOVE MUST NOT BE USED FOR BUCKET SERVICE. BOOMS 70' AND LONGER REQUIRE MAST TYPE SUSPENSION.

1. DRAGLINE SERVICE NOTES

Loads shown in table above for dragline service are for normal operation with simultaneous hoisting and swinging and with machine on fairly level ground.

Allowances must be made when operating on a grade or under unfavorable conditions.

With standard 22½" diameter hoist drum the weight of

loaded bucket must not exceed 9,100 lbs. for operation at normal speed.

Loads slightly greater can be handled if within stability ratings and when angle of swing is relatively small, such as in most truck loading.

Operation of dragline with boom angle less than 33° to 35° is seldom advisable.

2. CLAMSHELL SERVICE NOTES

Loads shown in table for clamshell service are for normal operation with machine on firm level ground.

Allowances must be made when operating on a grade.

Favorable conditions may permit the handling of loads slightly greater than shown.

Weight of loaded bucket must not exceed 11,000 lbs. for operation at normal speed with standard drums.

For rapid operation, or when excavating sticky materials, loads less than shown are advisable.

Due to possibility of bucket striking the boom, operation with boom angles above 60° is not advisable when maximum lift is necessary.

Rudomatic tagline equipment furnished with clamshell machines.

Digging depth of clamshell bucket is approximately 20 percent of boom length with boom at 60° to horizontal when using standard ropes. When longer than standard operating ropes are used for deeper digging, overwinding on drums may result.

WEIGHTS OF DRAGLINE BUCKETS

Type of Bucket		Bucyrus-Erie Red Arch				
		Type AX				
Capacity of Bucket		2	1¾	1½	1¼	1
Weight of Empty Bucket		4,400	3,850	3,200	3,000	2,200
Weight of Bucket Loaded With	Earth, moist. (2,500#)	9,400	8,225	6,950	6,125	4,700
	Sand, dry. (2,700#)	9,800	8,575	7,250	6,375	4,900
	Sand, wet. (3,300#)	11,000	9,625	8,150	7,125	5,500
	Gravel. (2,900#)	10,200	8,925	7,550	6,625	5,100
	Loose stone. (2,700#)	9,800	8,575	7,250	6,375	4,900
	Clay, wet. (3,000#)	10,400	9,100	7,700	6,750	5,200

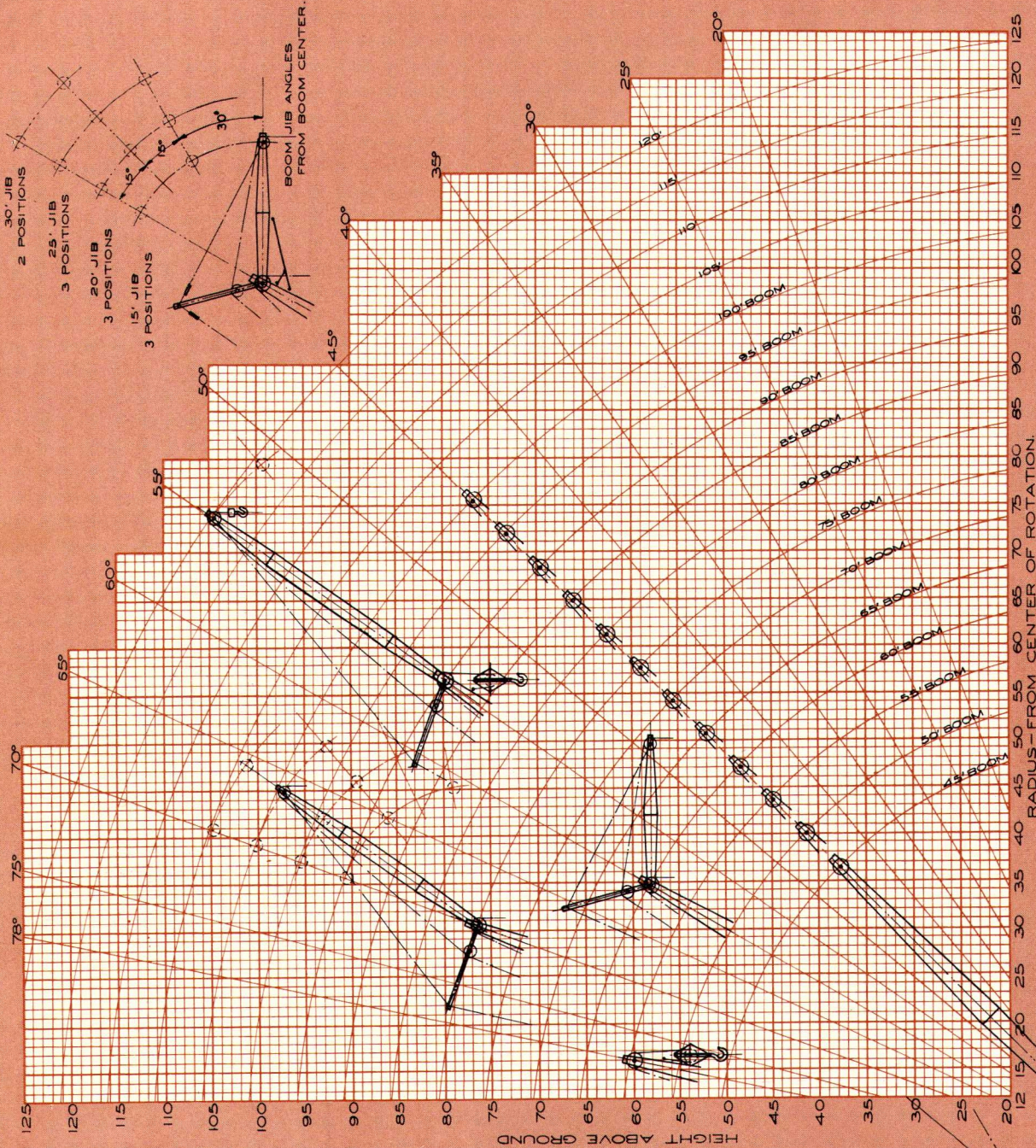
WEIGHTS OF CLAMSHELL BUCKETS

Type of Bucket		Average Rehandling Bucket					Average Light Excavating Bucket			
		2	1¾	1½	1¼	1	1¾	1½	1¼	1
Cap. of bucket — cu. yds.		5,000	4,400	4,100	3,500	3,000	5,500	5,000	4,200	3,600
Wt. of empty bucket, lbs.		5,000	4,400	4,100	3,500	3,000	5,500	5,000	4,200	3,600
Following weights are based on Rated Capacity. Allowance must be made for overload. (See note 3)										
Earth, moist. (2,500#)	10,000	8,775	7,850	6,625	5,500	9,875	8,750	7,325	6,100	
Sand, dry. (2,700#)	10,400	9,125	8,150	6,875	5,700	10,225	9,050	7,575	6,300	
Sand, wet. (3,300#)	11,600	10,175	9,050	7,625	6,300	11,275	9,950	8,325	6,900	
Gravel. (2,900#)	10,800	9,475	8,450	7,125	5,900	10,575	9,350	7,825	6,500	
Loose stone. (2,700#)	10,400	9,125	8,150	6,875	5,700	10,225	9,050	7,575	6,300	
Clay, wet. (3,000#)	11,000	9,650	8,600	7,250	6,000	10,750	9,500	7,950	6,600	
Coal. (1,350#)	7,700	6,765	6,125	5,190	4,350	.....	.....	.....	.....
Cinders. (1,150#)	7,200	6,325	5,750	4,875	4,100	.....	.....	.....	.....
Ashes. (900#)	6,800	5,975	5,450	4,625	3,900	.....	.....	.....	.....

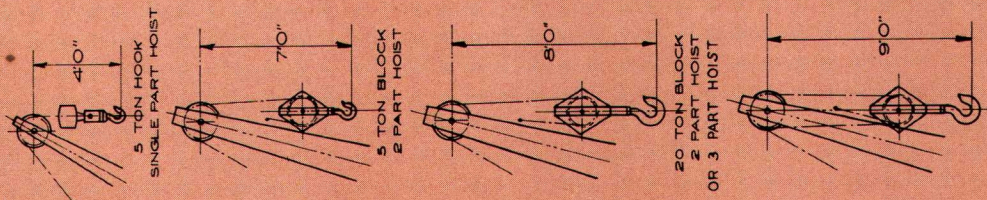
3. BUCKET NOTES

The weights of clamshell and dragline buckets are approximate only, and should be checked with actual weights. Rated capacity of clamshell buckets does not mean actual capacity: in materials such as sand, small gravel, coal, ashes and cinders the bucket will fill from 10% to 15% over capacity, while in loose stone and large gravel the loads picked up will be about rated capacity; in wet clay and earth excavation the bucket will load to about 10% over capacity, and in dry clay and shale the load will be slightly less than rated capacity.

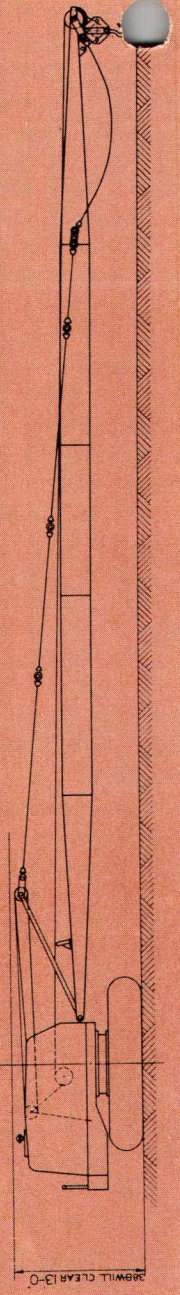
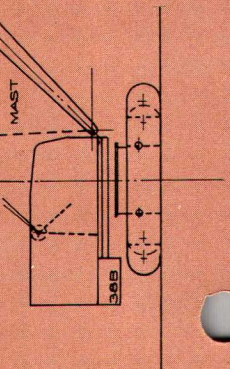
38-B LIFTING CRANE



MAXIMUM BOOM ANGLE = 78°
BOOMS 70' AND LONGER REQUIRE MAST TYPE SUSPENSION
JIBS CANNOT BE USED ON BOOMS OVER 90' LONG



CENTER OF ROTATION



MAXIMUM ALLOWABLE LIFTING LOADS WITH STANDARD DRUMS

Length of Boom of Boom in Feet	Oper. Angle of Boom	Equity-Approx. Degrees	Height of Boom Above Pin	Crane Service				Machine on firm level ground
				Crwt A		Crwt B — 6,000 lbs.		
45'	45'	45'	45'	Sid. Mount- ing 27"	Long Wide Mount- ing 33"	Sid. Mount- ing 27"	Long Wide Mount- ing 33"	See Note A
				Treads	Treads	Treads	Treads	
15	77	50°-0"	36500	39400	41900	43500	47000	49000
20	70	48°-6"	24400	27400	29400	31200	32600	
25	63	45°-3"	18000	19300	20600	21700	23000	
30	56	43°-3"	14000	15200	16100	17100	18200	
35	47	39°-3"	11600	12300	13100	14000	14800	
40	38	34°-0"	9750	10300	11000	11800	12500	
45	30	30°-0"	8100	8750	9350	10000	10700	
50	22	24°-0"	24000	25900	27400	29100	30800	
55	15	18°-0"	17700	19000	20300	21300	22600	
60	10	13°-0"	11300	12000	12800	13600	14450	
65	5	8°-0"	6000	6400	6950	7400	7900	
70	0	3°-6"	4400	4800	5200	5600	6100	
75	0	0°-0"	3200	3500	3850	4200	4500	
80	0	0°-0"	2400	2650	2900	3200	3450	
85	0	0°-0"	1850	2050	2250	2500	2700	
90	0	0°-0"	14100	15000	15900	17000	18000	
95	0	0°-0"	10500	11200	12000	12800	13700	
100	0	0°-0"	8600	9200	9900	10600	11400	
105	0	0°-0"	7150	7800	8400	9000	9700	
110	0	0°-0"	6100	6600	7150	7700	8300	
115	0	0°-0"	5200	5500	5950	6400	6900	
120	0	0°-0"	4400	4700	5000	5400	5800	
125	0	0°-0"	3700	4050	4450	4850	5200	
130	0	0°-0"	3200	3500	3850	4200	4500	
135	0	0°-0"	2700	3000	3300	3600	3900	
140	0	0°-0"	2400	2650	2900	3200	3450	
145	0	0°-0"	2050	2250	2450	2700	2900	
150	0	0°-0"	1850	2050	2250	2500	2700	

*Counterweight "B" is recommended with this boom length.
**Booms 85' and longer require intermediate suspension.

Nominal or theoretical crane rating for comparative purposes only, not for practical use. Ratings at 12 ft. radius with 45 ft. boom: Boom stops available. Loads shown for Crane Service are for booms without any jib extensions. Loads up to 15,000 lbs. may be handled with single part line. Loads over 15,000, use 2 part line. Loads over 30,000, use 3 part line. (4 part line requires a two-sheave swivel hook block — special equipment.) Deduct weight of hook block and slings from tabulated loads.

HOOK BLOCK NOTES

20 ton — single sheave, swivel hook block (Standard Equip-ment) 650 lbs.
30 ton — double sheave, swivel hook block (Special Equipment) 800 lbs.
5 ton — single sheave, swivel hook block (Special Equipment) 200 lbs.
5 ton — counterweighted hook (Standard with jib equipment) . . . 220 lbs.

JIB NOTES

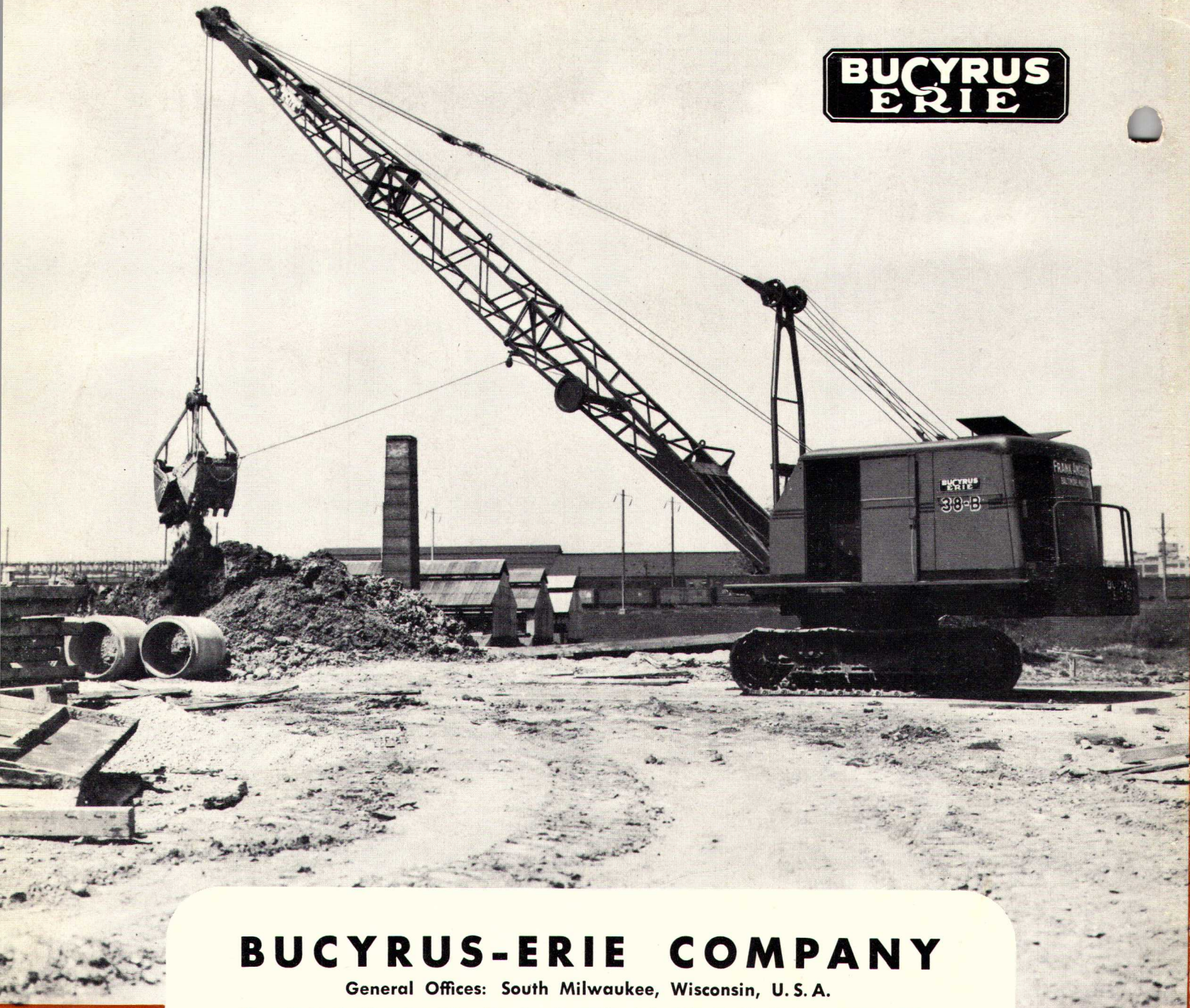
Jibs are for load lifting purposes only, and at angles with centerline of main boom, not to exceed the following:
15° jib 60° with boom center
20° jib 30° with boom center
25° jib 30° with boom center
30° jib 15° with boom center
(Jibs cannot be used on booms over 90' long.)

Allowable loads on main boom sheave when jib is attached must be reduced as follows:
15° jib 2,200 lbs.
20° jib 2,100 lbs.
25° jib 2,300 lbs.
30° jib 2,300 lbs.
The allowable load over the jib sheave at any radius, from center line of rotation of machine, is the same load that may be lifted over the boom sheave (without jib) with boom lowered to that radius, but not to exceed 10,000 lbs.
(Do not use jibs for bucket work.)

MAST TYPE SUSPENSION

Mast and pendant type suspension must be used with all booms 70 feet long and over and is available and may be used for shorter booms.
Maximum length of boom for bucket service is 80 feet.

NOTE A



BUCYRUS-ERIE COMPANY

General Offices: South Milwaukee, Wisconsin, U. S. A.

Plants in South Milwaukee, Wis.; Erie, Pa.; Evansville, Ind.; Chicago, Ill., U. S. A. District Offices in principal cities of U. S. A. Distributors and service throughout the U. S. A., Canada, and in all other principal countries of the world.

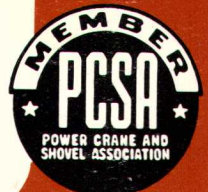
In British Isles: RUSTON-BUCYRUS, LTD., Lincoln, England

The manufacturer declares that this machine complies with all requirements of Commercial Standard CS90-49-Domestic and Commercial Standard CS90E-47-Export as developed by the trade under the procedure of the National Bureau of Standards and issued by the Department of Commerce of the United States of America. It is the policy of Bucyrus-Erie Company to improve its products continually. The right is reserved to make changes in specifications or design which in the opinion of this company are in accord with this policy, or which are necessitated by the unavailability of materials. The description herein is for the purpose of identifying the type of machine, and does not limit or extend the express warranty provisions in any contract of sale.

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Operating Instructions

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How to operate a power excavator efficiently must be learned in much the same way as any skilled trade. No one is a "born" operator. Regardless of previous experience, the new operator must use care to operate the machine safely so as not to endanger men or equipment.

At first glance the large number of operating levers looks as though operating the machine might be complicated, but most of them control some auxiliary function of the machine such as steering, digging lock, etc., and are not used in the regular operating cycle. The three tall levers and the two pedals in front of the operator are the principle controls used in the regular operating cycle and their use will be described in detail further on in these instructions. The first thing

the new operator must do is to familiarize himself with the purpose of each of these levers.

When learning to operate the machine it is a good plan to study each separate function until fully familiar with the control of all the auxiliary functions of the machine such as propelling, steering, etc.; then try out the main controls which are used in actual digging operations. The main functions can be tried separately until the operator becomes accustomed to the response of the machine to the controls. When learning to handle the controls be sure there is plenty of clearance and no danger spots around the machine such as overhead wires, culverts, ditches or embankments.

— CHAPTER IV —

OPERATING SUGGESTIONS, ENGINE INSTRUCTIONS AND SUMMARY OF CONTROL LEVERS

A. INSPECT MACHINE BEFORE STARTING SHIFT:

Before beginning to operate the machine at the start of a shift, make a general inspection of the machine to make sure it is ready for operation.

1. Look under the cats and around the machinery to see if there is any evidence of water, fuel or lubricating oil leaks. Correct any major leaks and refill to required level. Make a note of minor leaks and correct at first opportunity possible.
2. Check fuel tank to make sure there is enough fuel to run through the shift. If the machine has been idle for a few hours, drain off any water or sediment which may have settled in the fuel tank. Check engine crankcase oil and radiator water. Make any necessary replenishment. (Do not fill a cold radiator to overflowing.)
3. Look over the engine accessories to make sure all units are securely mounted and properly adjusted. Inspect air cleaner and service if required. Check adjustment of fan belts.
4. Start the engine (as described in the Engine Manufacturer's Instruction book) and allow it to idle while additional inspection and lubrication services are performed.
5. Lubricate all twice-a-shift (4-hour) and once-a-shift (8-hour) points as covered in the Lubrication Section of this instruction book.
6. Consult the lubrication record for the machine and service all points which have gone the specified length of time since the last previous servicing.
7. Check operation of all operating clutches to see

that they work freely without binding, yet with no lost motion. Adjust if necessary, and make note of any worn pins requiring replacement.

8. Engage the engine clutch lightly at first to see that there is nothing in the machinery, then toggle it into set position. It should engage with a distinct snap under a reasonably heavy pressure on the lever.

B. POINTS TO WATCH DURING SHIFT:

During the shift, watch for any signs of improper operation or adjustment. The following items are of particular importance.

1. Check engine for any unusual noise, loss of power or failure to respond to the Governor Control. Watch the oil pressure gauge and stop the engine immediately in case of a sudden drop in pressure.
2. Adjust the engine clutch immediately if it should start to slip.
3. Watch the cables to see that they do not become crossed on the drums.
4. When propelling, watch to make sure the drive chains do not whip excessively nor climb the sprocket teeth. Also check the tracking of the drive tumblers on the cat links and, if necessary, readjust the chains and belts to correct improper operation.
5. When operating auxiliary functions such as the digging lock, steering clutches, swing lock, etc., note any tendency of the controls to "hang up" or jam, which would indicate improper operation. Correct the adjustment at the earliest possible opportunity.

C. CHECK MACHINE AT END OF SHIFT:

At the end of the shift go over the machine again for evidence of excessive wear or damage which may have occurred during the shift.

1. Examine all cables carefully for broken strands or other evidence of weakness. Arrange to replace weakened cables before starting another shift.
2. Check the engine crankcase and radiator. Check anti-freeze and add if required to protect cooling system against freezing.
3. Clean out carefully any grease or dirt which may have accumulated around the machinery during the shift.
4. Clean out excessive mud or dirt in the cat belts. This is particularly important in freezing weather. Put planks, brush or dry material under cats before shutting down machine if it is likely to freeze.
5. If the machine is to be idle for several hours, move it away from a high bank where it might be damaged by a slide or falling rocks. Do not leave the machine in a low spot where there is any danger of flooding.
6. Let the dipper, bucket or load down to the ground, set all brakes (including digging lock and swing lock) and put all clutch levers in neutral.
7. Close and fasten rear doors, close the roof hatches, radiator shutters and all covers over the rope openings. Close the windows at the operator's position and lock all cab doors.

D. ENGINE INSTRUCTIONS:

The machine may be powered with a single electric motor or a gasoline engine but is usually equipped with a heavy duty Diesel engine.

The engine, mounted at the rear of the revolving frame casting, is a complete unit with starting equipment, air cleaners, oil filters, water pump, radiator, engine clutch and similar auxiliary equipment assembled on a sliding base.

An engine instruction book, supplied by the engine manufacturer, is furnished with this instruction book. Read it carefully for full instructions on the operation and maintenance of the engine and its auxiliaries.

a. Fuel Supply

Proper fuel, clean and free of water or dirt, is essential for good engine operation. The gasoline starting en-

gines on some machines does not require a high-test or ethyl gasoline but **A GOOD GRADE OF STANDARD GASOLINE MUST BE USED.** Do not try to save money by using cheap gasoline; if you do, you will sacrifice power and encounter unnecessary engine troubles. Under no circumstances add distillate or kerosene to gasoline for use in gasoline engines; such practice always results in excessive engine maintenance.

It pays to use a good grade Diesel fuel oil purchased from a reliable dealer so that it will be of uniform grade and free of impurities. Dirt in the fuel oil is a common cause of unsatisfactory operation of the engine and may result in serious damage to the fuel injection pump. A special storage tank on the job, with built-in strainer and a sump for settling out foreign matter, will help in delivering clean fuel to the machine. A hand pump is mounted at the right rear corner of the machine. Its discharge hose is permanently connected to the primary fuel oil filters on the Diesel engine. A long suction hose permits pumping oil. Be very careful to keep the suction hose clean so that the fuel oil will not be contaminated when pumping it into the machine.

In their instruction books, most Diesel engine manufacturers include specifications of fuels suitable for their engines. Follow these specifications when purchasing fuel. If you do otherwise, you're only courting trouble. The selection of the proper fuel is of great importance in obtaining satisfactory operation.

Cleanliness is the most important characteristic of Diesel fuel oil. To obtain **SATISFACTORY PERFORMANCE** of the engine, the **OIL MUST BE FREE FROM LINT, FIBER, SAND, GRIT, WATER** and other **MECHANICAL IMPURITIES.** **TOO MUCH EMPHASIS CAN NOT BE PLACED UPON THE IMPORTANCE OF THIS;** is it these impurities which clog the strainers, valves and spray tips, and cause excessive wear on all moving parts of the fuel system.

Next to cleanliness, in order of importance, is Cetane (or Ignition) Rating.

The Cetane Rating of a fuel is a number representing the ignition (firing) or burning quality of fuel oil. The higher this number the quicker the fuel will start to burn when injected into the engines.

The manufacturer builds a combustion chamber to use a fuel of definite burning characteristics represented by a cetane rating.

For satisfactory engine power and life the fuel supplied **MUST HAVE A CETANE RATING WITHIN THE LIMITS SPECIFIED BY THE ENGINE MANUFACTURER.**

b. Cooling System

The water in the circulating system absorbs heat from the engine parts and keeps the engine temperature within the correct limits.

GOOD, CLEAN WATER best absorbs the heat from the engine. Never use water containing oil, dirt or solid matter. Solids entering the circulating system can not escape. If dirty water is used, or added as make-up water, the whole cooling system becomes clogged in a short time and the engine will overheat. Hard water deposits lime on all hot surfaces with which it comes in contact. The hard deposit is a heat insulator and if allowed to accumulate will cause serious damage.

Be sure to use an anti-freeze solution whenever the machine is operating at temperatures below freezing. Check the solution frequently, particularly if alcohol is used, to be sure it is up to correct strength for the temperature encountered. The operating temperature of the Diesel engine is above the boiling point of alcohol, therefore the alcohol will evaporate rapidly. Alcohol should be added and the engine run for a short time before shutting down the machine.

There are several commercial anti-freeze solutions on the market which will not boil at the engine operating temperature. It is more economical in the long run to use an anti-freeze of this type.

Correct proportion of anti-freeze to use is dependent on the particular kind. Check with the supplier of the anti-freeze to be sure enough is used to fully protect the engine. The capacity of the cooling system of the General Motors Diesel engine is 21½ gallons. The caterpillar Diesel engine cooling system holds 29 gallons.

When operating in extremely cold weather it is advisable to heat the water in the cooling system before starting the engines. If the machine is going to be used regularly in severe cold weather an auxiliary heater, permanently installed in the cooling system, can be furnished for most engines as extra equipment. The purpose of this heater is to raise the temperature of both the engine and water to a point where the oil will flow freely and the engine start more easily.

Light the heater early enough so that the cylinders of the engine feel hot to the hand before you are ready to start. Keep the radiator shutter and cab doors closed to increase the effectiveness of the water heater by preventing cold air from passing through the radiator.

If the machine is to be used within eight or ten hours, light the heater when shutting down. A low fire will keep the water at the proper temperature until operation is resumed.

E. ENGINE CONTROLS AND INSTRUMENTS

For convenience, the controls for the engine clutch and governor are brought forward to the auxiliary lever bracket just to the left of the operator. (See Fig. 1).

The Engine Clutch lever is the lever nearest the center of the machine.

1. To engage the engine clutch pull back on the lever.
2. To disengage the clutch push the lever forward.

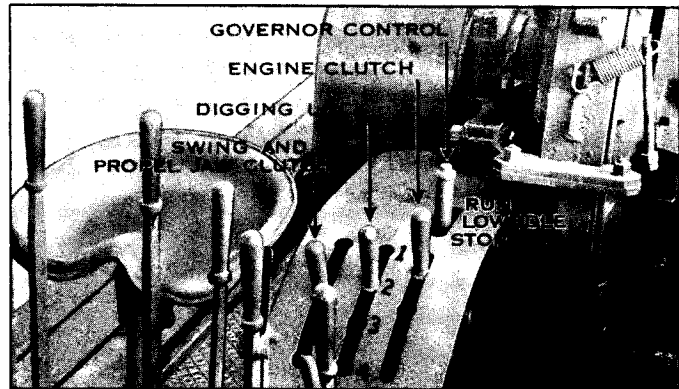


FIG. 1

The engine clutch has no regular operating function but must be disengaged (lever forward) when starting the engine. Use it also to disconnect the machinery in an emergency.

The Governor Control lever, the small lever on the auxiliary lever bracket, adjusts the governor on the engine to hold any desired governed speed.

1. Low idling speed—Slightly depress the button on the Governor Control and push lever forward.
2. Normal speed—pull all the way back.
3. Intermediate Speeds—for unusual operating conditions—place Governor Control lever in one of the in-between notches.
4. Engine Stop—Allow engine to run awhile at low idling speed without load.

On machines powered with Caterpillar Diesel engine, depress the button on the Governor Control and push lever all the way forward.

On machines powered with a General Motor Diesel engine, pull up on the "Stop" button mounted on the auxiliary lever bracket.

b. Starting Diesel Engine

Fill fuel tank with correct grade of fuel. Check cooling system to see that all connections are tight and the radiator full of clean water. Be sure the crankcase is full of the correct grade of lubricating oil.

Full instructions for starting the Diesel engine are given in the engine manufacturer's instruction book included with these instructions. Follow the procedure exactly as described except for the following points:

1. When starting the Caterpillar Diesel engine place the governor control lever in "stop" position while cranking the engine with compression released.
2. When starting the General Motors Diesel engine the "stop" button (which controls the engine throttle lever) must be pushed all the way down and the Governor Control at the forward end of its quadrant.
3. The heater ignition switch and heater fuel pump, used in starting the General Motor Diesel engine in cold weather, are mounted on the auxiliary lever bracket and the air heater should be used whenever starting the engine at temperatures below 40°F.

With engine clutch disengaged, start the engine and run it slowly for a few minutes. Watch the oil-pressure gauge and stop the engine at once if the pressure drops below ten pounds.

Until the engine is fairly broken in and one change of oil has been made, watch it carefully for signs of overheating.

Starting a cold engine without proper cylinder lubrication is likely to score the pistons and cylinders. Crank the engine over by hand a few times to restore the lubricating film on the cylinder walls.

In extremely cold weather, drain the crankcase when shutting the machine down. Before starting the engine, heat the oil before pouring it into the crankcase. This procedure makes hand cranking easier and tends to insure flow of the lubricating oil.

For best engine performance roof hatches and the radiator shutters on the right side of the machine should be kept closed until the engine has warmed up. The shutters are operated by a control rod at the lower rear corner of the shutter. In cold weather keep the cab doors closed also until the engine has warmed up. Be sure to open the roof hatches, shutters and the cab doors before the cooling water temperature goes above 170°.

c. Governor Setting

The governor is set at the factory for the correct engine speed and no further adjustment should be required. However, it is a good plan to check the speed occasionally to be sure the governor is functioning properly. The most convenient method for checking the engine speed is to put a mark on the hoist gear and count the revolutions of the drum shaft with the Governor Control lever pulled all the way back and the machinery idling with only the engine clutch engaged. (Be sure the transmission brake is fully released.) For correct engine speed the equivalent drum shaft speed is 31.6 R.P.M. or approximately 73 revolutions in two minutes. The corresponding speed of the General Motors Diesel engine is 1400 R.P.M. and for the Caterpillar Diesel engine, 900 R.P.M.

d. Engine Instruments

Fuel and lubricating oil pressure gauges and a gauge showing the temperature of the cooling system water are furnished. Look at these gauges occasionally to make sure the engine is operating properly.

THE LUBRICATING OIL PRESSURE GAUGE—must indicate within the "operating pressure range" whenever the engine is warm and operating at normal speed. Stop the engine immediately if there is a sudden or marked decrease in the oil pressure. Do not run the engine until after the cause for loss of oil pressure has been found and corrected.

THE FUEL OIL PRESSURE GAUGE (Furnished only on machines powered with Caterpillar Diesel engine)—reading is an indication of the condition of the fuel oil filters. As the filters accumulate dirt, there is a gradual loss of pressure. When the gauge drops below the "caution" range, the filters are becoming clogged. Stop the engine and service the fuel oil filters as described in the engine builder's book.

THE TEMPERATURE GAUGE—reading is often the first indication of faulty engine operation. It will seldom read higher than 170° even under heavy load and a higher reading or sudden increase usually indicates some trouble, such as lack of cooling water, obstruction in the circulating system, damage to the water pump or improper lubrication. Stop the engine and investigate carefully to locate and correct the cause of overheating.

THE CHARGING CURRENT AMMETER (Furnished only on machines having an electric starting system)—reading shows charging rate of the starting system battery. Reading will decrease as battery becomes fully charged but if ammeter reading is zero or shows discharge when the Diesel engine is operating at normal governed speed check for trouble in the starting system.

DON'T crank engine with engine clutch engaged.
DON'T leave machine without disengaging the engine clutch.

DON'T crank the Caterpillar Diesel engine on decompression unless Governor Control is in "stop" position.

DON'T continue operation if oil pressure gauge shows sudden decrease or loss of pressure.

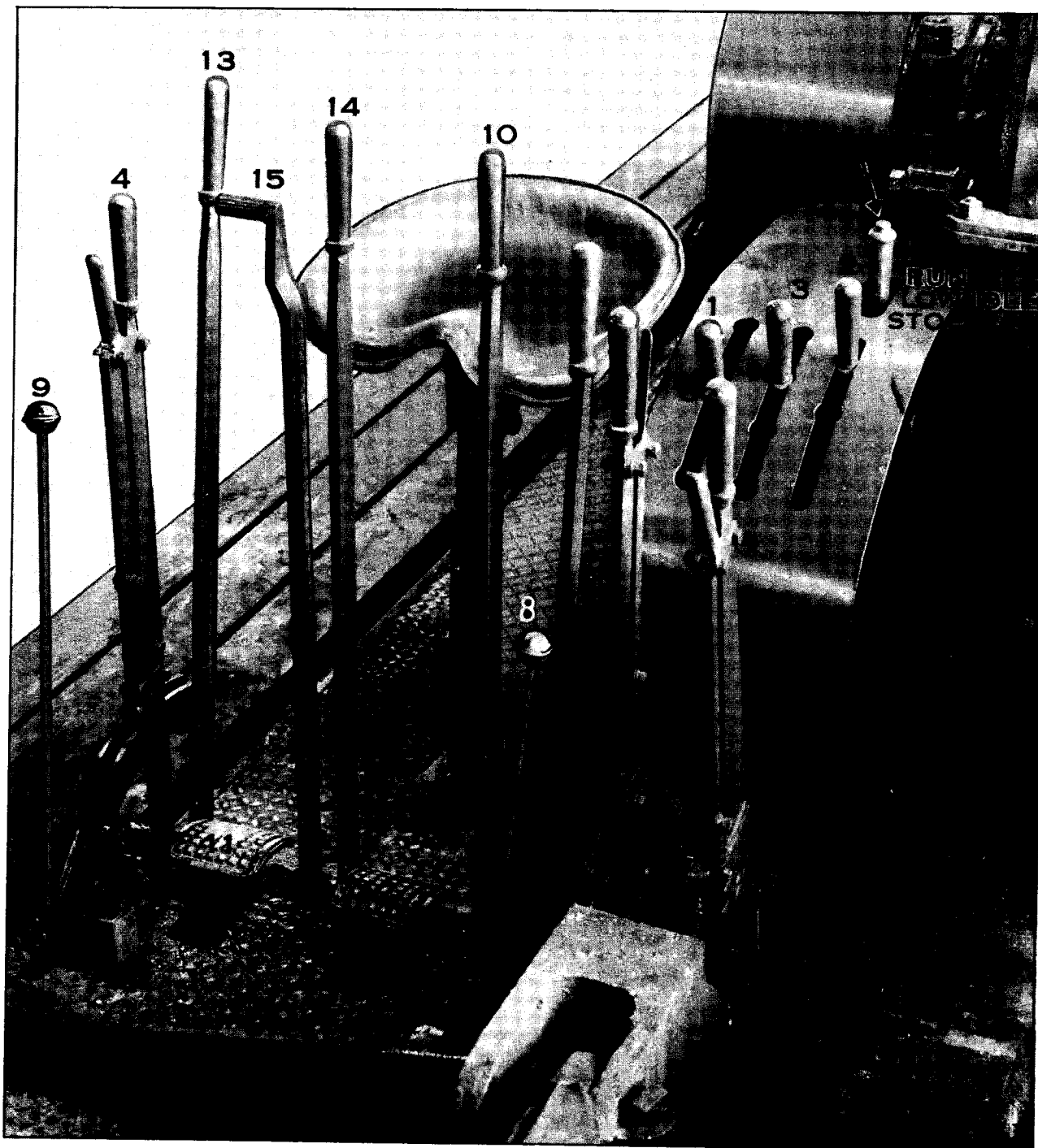


FIG. 2

F. SUMMARY OF CONTROL LEVERS (SEE FIG. 2)

LEVERS CONTROLLING AUXILIARY FUNCTIONS

	LEVER NO.	LEVER CONTROLS	PUSH FORWARD		MIDDLE POSITION	PULL BACK		
	COMMON TO ALL FRONT END EQUIPMENT	1.	Swing and Propel Jaw Clutches (Std.) Reverse Unit Jaw Clutches (Ind. Propel)	for propel position for high-speed forward (cat drive chains at rear)		for neutral both-jaw clutches released	for swing position for low-speed forward (cat drive chains at rear)	
2.		Engine Clutch	to release			to engage		
3.		Digging Lock	to front notch to release both ways	to next to front notch to lock against forward movement		to next to rear notch to lock both ways	to rear notch to lock against backward movement	
4.		Boom-Hoist-Clutch and Brake	to lower boom (when safety pawl released)		to hold boom	to raise boom		
5.		Steering Clutches	all the way to turn sharp right (cat drive chains at rear)	part way to turn right gradually	to steer straight ahead	part way to turn left gradually	all the way to turn sharp left (cat drive chains at rear)	
6.		Swing Lock	to release			to lock		
7.		Transmission Brake	to release			to brake		
			LEVER CONTROLS	PULL UP		PUSH DOWN		
8.		Boom-Hoist Safety Pawl	to lock			to release		
9.		Brake Pedal Lock	to allow locking			to allow release of brake pedals		

LEVERS CONTROLLING MAIN OPERATING FUNCTIONS

	LEVER NO.	LEVER CONTROLS	PUSH FORWARD		MIDDLE POSITION	PULL BACK		
	COMMON TO ALL FRONT END EQUIPMENT	10.	Swing and Propel Reverse Clutches (swing only on machines with Ind. Propel)	to swing left or to propel away from drive chain end		for neutral	to swing right or to propel toward drive chain end	
11.		Hoist Brake	to brake right-hand drum on shovel or crane and left-hand drum on dragline or clamshell			spring released unless locked		
12.		Second Drum Brake	to brake left-hand drum on shovel or crane and right-hand drum on dragline or clamshell			spring released unless locked		
SHOVEL	13.	HOIST (Right Drum)	to hoist			to release to lower		
	14.	Second Drum (Left Drum) CROWD	to crowd out		for neutral	to retract		
DRAGLINE	15.	Dipper Trip	to trip			spring released		
	13.	HOIST (Left Drum)	to hoist			to release to lower		
	14.	Second Drum (Right Drum) DRAG	to drag			to release to swing bucket out under boom-point		
CLAMSHELL	15.	Propel Clutches (Ind. Propel only)	to propel at high speed		for neutral	to propel at low speed		
	13.	HOIST-CLOSING (Right Drum)	to close and hoist loaded bucket			to release to dump		
	14.	Second Drum (Left Drum) HOLDING-LOWERING	to hoist empty bucket (hold with foot brake to dump)			to release to lower open bucket		
CRANE	15.	PROPEL CLUTCHES (Ind. Propel only)	to propel at high speed		for neutral	to propel at low speed		
	13.	HOIST (Right Drum)	to hoist			to release to lower		
	14.	Second Drum (Left Drum) AUX. HOIST	to hoist			to release to lower		
	15.	PROPEL CLUTCHES (Ind. Propel only)	to propel at high speed		for neutral	to propel at low speed		

LEVERS CONTROLLING AUXILIARY FUNCTIONS

A. DIGGING LOCK:

The middle lever in the bank of three levers at the operator's left controls the digging lock pawls mounted in the truck frame.

The lever has four positions marked by notches on the lever quadrant. (See Fig. 1).

1. Rear Notch—travel forward—locked against movement backward.
2. Next to Rear Notch—locked against movement either forward or backward.
3. Next to Front Notch—travel backward—locked against movement forward.
4. Front Notch—travel either forward or backward.

It may be necessary to turn the steering clutch driver slightly to relieve the load on the pawls before the Digging Lock lever is shifted. Do not use the digging lock to stop the machine when propelling. Bring the machine to a stop, then engage the lock.

Use Position "1", which permits moving the machine forward (cat drive chains to the rear) and prevents backward movement, for shovel or dragline work to lock the machine against the digging reaction yet permit moving up without changing the position of the Digging Lock lever.

Position "2", which locks the machine against movement in either direction, is seldom used except when working a shovel down grade where it is necessary to prevent the machine moving from gravity as well as digging reaction. Set the Digging Lock lever in this position when blocking the machine for shipment on a flat car or truck.

Place the lever in position "3" to release the opposite pawl to permit moving the machine backwards (cat drive chain to the rear) and prevent forward movement.

Use Position "4", which releases both pawls so that the machine can be moved in either direction, for crane or clamshell work when the machine is on level ground and there is no digging reaction.

DON'T engage digging lock when machine is in motion, except in an extreme emergency.

DON'T park machine on a grade without engaging the digging lock.

DON'T ship machine on trailer or flat car without having digging lock engaged to prevent movement in either direction.

B. SWING AND PROPEL JAW CLUTCHES:

On standard machines not equipped with "Independent Propelling" the lever nearest the operator, in the bank of three levers just to the left of the seat, controls the swing and propel jaw clutches. (See Fig. 1). (On machines having "Independent Propelling" this lever operates the selector jaw clutch of the propelling reverse unit.) The three positions of this lever, for standard machines, are as follows:

1. Rear Notch—swing jaw clutch engaged.
2. Middle Notch—both jaw clutches disengaged.
3. Front Notch—propel jaw clutch engaged.

When the lever is in the middle notch in the quadrant either reversing clutch may be engaged without the machine either swinging or propelling. This position is useful when lubricating the gear teeth on the swing and propel gears in the revolving frame.

For propelling; move the lever to the front notch of the quadrant.

For swinging; pull the lever back to the rear notch of the quadrant.

Remember in engaging these jaw clutches it is necessary to feel them into mesh by lightly engaging one or the other of the reverse clutches. Also throttle the engine down to idling speed to make it easier to get the jaw clutches into mesh.

DON'T disengage swing jaw clutch until swing lock is engaged.

DON'T try to shift swing and propel jaw clutches without slowing down engine.

C. SWING LOCK:

The lever at the extreme left, in the bank of levers in front of the operator, engages the swing locking dog with the teeth of the swing rack. (See Fig. 3).

To lock the machine against swinging, pull the lever back, feeling the dog into mesh with the rack teeth by **LIGHTLY** engaging one or the other of the reverse clutches. To release the swing lock, relieve the load on the dog by partially engaging the correct reverse clutch then push the Swing Lock lever forward.

DON'T try to engage the swing lock when the machine is swinging.

DON'T disengage the swing jaw clutch without first engaging the swing lock.

DON'T ship the machine on trailer or flat car without engaging swing lock.

D. TRANSMISSION BRAKE:

The lever, second from the left (with the toothed ratchet quadrant) in the bank of levers in front of the operator (See Fig. 3), controls the transmission brake shoe on the right hand reverse clutch housing.

1. Pull back on the Transmission Brake lever to set the brake for stopping the reversing transmission quickly.
2. Push the lever forward to release the brake.

Use this brake to control the machine when propelling down grades or to stop the swing in an emergency.

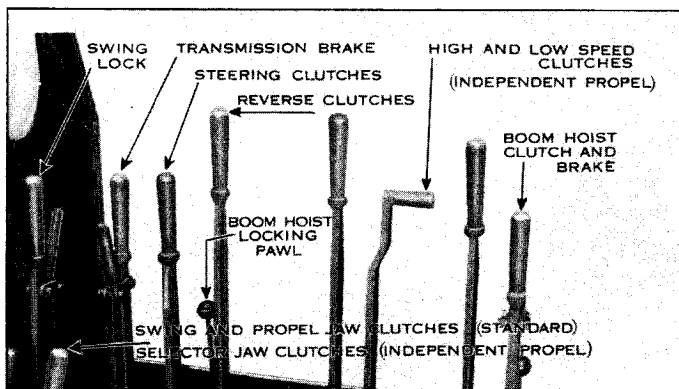


FIG. 3

E. STEERING CLUTCHES:

The lever third from the left (next to the transmission Brake lever) in the bank of levers in front of the operator (See Fig. 3) controls the steering clutches on the propel shaft in the truck frame.

1. To steer the machine straight ahead, put the Steering Clutch lever in the middle of its quadrant.
2. To turn gradually to the right (cat driving chains to the rear) push the Steering Clutch lever part way forward.
3. To turn more sharply to the right, shift the Steering Clutch lever all the way forward.
4. To turn to the left (cat driving chains to the rear) shift the Steering Clutch lever part way back from neutral for a gradual turn and all the way back for a sharp turn.

The steering clutches are in effect jaw clutches and must not be shifted when the machine is in motion. It is, however, generally necessary to lightly engage one or the other of the reverse clutches to relieve the load on the steering clutch being shifted.

DON'T shift the Steering Clutch lever while the machine is in motion.

DON'T steer the machine down grade. Always cut back up hill.

F. PROPELLING:

a. Standard Propelling

On standard machines, not equipped with "Independent Propelling," movement of the machine forward or backward is controlled by the Reverse Clutch lever in front of the operator. (See Fig. 3). (This lever is also used for swinging the machine, when the swing jaw clutch is engaged).

To propel the machine proceed as follows:

1. Move the Governor Control lever to low idle position.
2. Pull back the Engine Clutch lever.
3. Pull back the Swing Lock lever.
4. Move the Swing and Propel Jaw Clutch lever to the front notch of its quadrant.
5. Place the Digging Lock lever in the correct notch of its quadrant for the desired direction of travel.
6. Pull back the Governor Control lever to give the desired engine speed.
7. Push the Reverse Clutch lever to propel forward (cat driving chains to the rear). Pull the lever to propel backwards.
8. If on a grade, control propelling speed by slowing down the engine and pulling back the Transmission Brake lever.
9. Stop propelling by engaging the reverse clutch for travel in the opposite direction then set the Transmission Brake until the Digging Lock lever can be set to hold the machine against further movement.

NOTE: When propelling the machine where overhead clearance is limited, the shovel boom and the crane type boom on machines having continuous or pendant type suspension can be lowered to cab height, giving an overall clearance of thirteen feet. Machines with long booms, having mast-type suspension, can also be arranged for thirteen-foot overhead clearance by following the procedure outlined on Drawing 215605 included with the General Drawings in Section VIII of the instruction book on machines equipped with the special pendants and boom point section required for this arrangement.

After the move is completed prepare for swinging as follows:

1. Move the Governor Control lever back to low idle position.
2. Pull the Swing and Propel Jaw Clutch lever back to the rear notch of its quadrant.

3. Place the Digging Lock lever in the correct notch of its quadrant for the kind of work being done.
4. Push the Swing Lock lever forward.
5. Pull the Governor Control lever all the way back.
6. Control swinging with the Reverse Clutch lever.

b. Independent Propelling

On machines equipped with "Independent Propelling" (Special Equipment), the machine can be propelled either forward or backward at high or low speed without interference with the other functions of the machine. In normal service the Selector Jaw Clutch lever (nearest the operator in the bank of levers at his left) (See Fig. 3), is set in the forward notch of its quadrant so that the selector jaw clutch is engaged to give high speed propelling in the forward direction (cat driving chains to the rear).

1. To propel forward, at high speed, push the Propelling Clutch lever (with the horizontal grip) (See Fig. 3) in the bank of levers in front of the operator.
2. To propel backward at reduced speed pull the Propelling Clutch lever.
3. If necessary to propel up a grade (or to propel backward at high speed) shift the selector jaw clutch to the opposite position by moving the Selector Jaw Clutch lever to the rear notch of its quadrant. (Feel the selector jaw clutch into mesh by partially engaging one or the other of the propelling clutches.)

DON'T propel long distances except with the driving chains at the rear.

DON'T try to travel over boggy ground without using mats or placing brush, rocks, planks or other material to cover the soft spots.

DON'T propel the machine if the propelling slipping clutch is not holding properly.

DON'T propel crane with load suspended without snubbing load to prevent its swinging.

DON'T propel dragline, clamshell or crane with the boom at high angle.

DON'T propel machine if cat belts and driving chains are not correctly adjusted.

DON'T neglect extra lubrication of vertical and horizontal propelling shaft bearings, steering clutch shifter shoes, take up and driving tumblers, upper and lower idler rollers and propel chains when making long moves.

G. BOOM HOIST:

The boom hoist clutches and brake are controlled by the lever at the extreme right in the bank of levers in front of the operator. (See Fig. 3). The lever has three positions:

1. Neutral—both clutches released—brake set.
2. Forward notch—lowering clutch set—brake released.
3. Rear Notch—hoisting clutch set—brake released.

The locking pawl, to prevent the boom "creeping" down, is operated by the small lever with ball grip to the left in front of the main lever bank. (See Fig. 3).

If the boom hoist has not been used for some time it is advisable to check its operation carefully by raising the boom slightly before releasing the locking pawl. When the boom hoist unit is found to be operating properly and is to be used continuously the pawl may be left disengaged. It is a good safety precaution, however, to engage the locking pawl before raising the boom or lifting a heavy load with the boom hoist.

To release the pawl push down on the Boom Hoist Locking Pawl lever. (It will be necessary to relieve the load on the pawl by hoisting the boom slightly.)

To raise the boom it is not necessary to release the locking pawl.

1. Pull back on the Boom Hoist Clutch and Brake lever.
2. Stop the boom by returning the lever to neutral.
3. Push the lever forward to allow the drum to turn in the lowering direction until the locking pawl engages one of the ratchet teeth on the boom hoist drum.

On a job where raising and lowering the boom will be required frequently disengage the locking pawl as described above and use the Boom Hoist Clutch and Brake lever to control the boom.

1. Pull the lever back to raise the boom.
2. Return the lever to neutral to stop the boom.
3. Push the lever forward to lower the boom.

NOTE: If the boom should have a tendency to continue lowering after the lever is returned to neutral bring the boom to a stop by pulling back the Boom Hoist lever, then engage the locking pawl by pulling up the Locking Pawl lever. Check adjustment of the brake and clutches before again using the boom hoist unit.

DON'T raise the boom too close to vertical position, sudden release of load may throw boom back over cab.

DON'T change crane boom angle with maximum load suspended. Keep boom hoist locking pawl engaged on shovel or dragline, except when lowering boom.

DON'T neglect changing the boom hoist clutch and brake bands when nearly worn out. A scored housing will prevent smooth operation.

— CHAPTER VI —

LEVERS CONTROLLING MAIN FUNCTIONS

A. SWINGING:

Whenever the swing jaw clutch is engaged, swinging the machine to right or left is controlled by the Reverse Clutch lever which is the left hand lever of the three tall levers in front of the operator. (See Fig. 3). (This lever is also used for propelling the machine, when the propel jaw clutch is engaged.)

1. To swing to the right—pull the Reverse Clutch lever.
2. To swing to the left—Push the lever.
3. To stop the swing—engage the reverse clutch for swing in the opposite direction.

NOTE: To avoid concentrated wear on a small portion of the roller path and swing rack, which results if the machine is operated continuously over one end, it is advisable to reverse the position of the lower works every 5 shifts.

DON'T try to swing machine when swing lock is engaged.

DON'T swing machine into bank or other obstruction.

B. DRUM CLUTCHES:

The middle and right hand levers of the three tall levers in front of the operator (See Fig. 4) control the booster clutches which engage the main clutches for the drums. The middle lever (second drum lever) controls both the crowd and backhaul clutches on machines operated as shovels. The right hand lever controls the clutch for the hoist motion on all front end equipments, therefore is called simply the "Hoist lever". The functions of the levers change to some extent depending on the type of front end equipment, therefore use of the levers will be described under operation of each type of front end equipment.

C. DRUM BRAKES:

The two foot levers at the operator's position control the drum brakes and operation of the brakes will be fully described under operation of each type of front end equipment. The right pedal always controls lowering the main hoist line, therefore is referred to as the "Hoist Brake" pedal. The left pedal controls the brake on the second drum.

a. Brake Pedal Lock

To lock the brake in set position, pull up on the Brake Pedal Lock lever at the right front corner of the machine (See Fig. 4), then depress the pedal until the latch engages. To release the brake, push down the Brake Pedal Lock lever then depress the pedal. Only the pedal pushed down will unlatch.

DON'T leave the machine with dipper, bucket or load held on brake. Cooling of the brake housing might release the brake and drop the load.

D. SHOVEL OPERATION:

a. Hoist

For shovel operation the hoist line is controlled by the Hoist Brake Pedal and the Hoist lever in front of the operator. (See Fig. 4).

1. To hoist dipper, push the Hoist lever forward.
2. To hold the dipper suspended, return the Hoist lever to neutral and depress the Hoist Brake pedal.
3. To lower the dipper, release the Hoist Brake pedal.

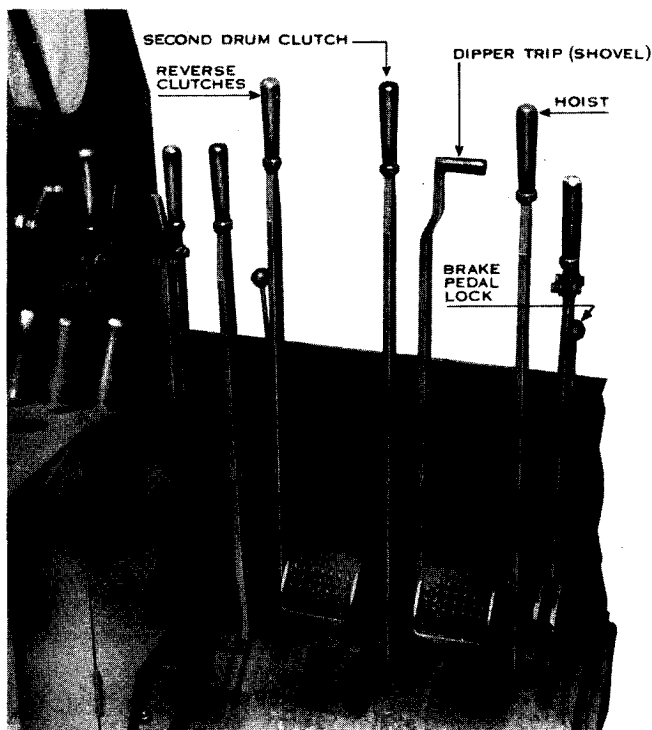


FIG. 4

b. Crowd

Movement of the shovel dipper handle in and out (retract and crowd) is controlled by the Second Drum Clutch lever in front of the operator. (See Fig. 3). On shovels this lever is referred to as the Crowd lever. The Second Drum Brake pedal controls the brake to the crowd motion therefore is called the "Crowd Brake" pedal.

1. To crowd out the dipper handle push the Crowd lever.
2. Pull the lever to retract the handle.
3. To hold the dipper handle extended, return the lever to neutral and depress the Crowd Brake lever.

c. Swing

Swinging the shovel is controlled by the Reverse Clutch lever in front of the operator as described in a preceding paragraph.

d. Dipper Trip

The lever with the horizontal grip (between the Hoist and Crowd levers), (See Fig. 4), operates the dipper trip unit which exerts the necessary pull to unlatch the dipper door at any point in the operating cycle, and thereby dump the dipper.

1. Push the Dipper Trip lever to dump the dipper.
2. The dipper door will latch by gravity as the dipper is lowered.

When dumping over a truck or hopper be sure to allow sufficient room so that when the door swings back it will not bump the truck or hopper.

c. Shovel Operating Hints

Actual digging operations with a shovel require combining the hoist, crowd and swing motion into a fast, smooth operating cycle which cannot be described in any step by step procedure, as actual movement of the levers depends on individual digging conditions. There are many little operating tricks which will come from experience and some of these are included in the following list of points to remember in operating the shovel.

1. When digging with the drive sprockets toward the work, be careful not to strike the sprockets with the dipper when lowering.
2. Keep the shovel as near the face of the bank as safety will permit and always move up before it is necessary to "reach out" with the dipper to dig the material.
3. Spot trucks so that the swing is kept as short as possible.

4. Take a shallow cut in the bank so that the dipper will just be full when the top of the cut is reached.
5. Crowd out only just enough to keep the dipper in the bank.
6. Hoist the dipper only just high enough to provide clearance for the door when the dipper is tripped.
7. Don't continue hoisting if the dipper handle is fully extended against the saddle block stop. Retract the handle a few inches by releasing the crowd brake slightly, then finish hoisting.
8. When lowering back into the pit, allow the dipper handle to run in by gravity while the handle is above horizontal and run out when the handle is below horizontal.
9. Be careful not to ride the crowd brake when either crowd clutch is engaged. Stop movement of the dipper handle by engaging the opposing clutch and use the crowd brake only when it is necessary to hold the handle in position with the crowd lever on neutral. (As when swinging and hoisting at the same time which requires use of both hands.)
10. Never leave the machine close to a high bank or in a hollow where a caving bank or flash floods would endanger the machine.

E. DRAGLINE OPERATION:

a. Hoist

For dragline operation the hoist line is controlled by the Hoist Brake pedal and the Hoist lever in front of the operator. (See Fig. 3).

1. To hoist the bucket, push the Hoist lever.
2. To hold the bucket suspended, return the Hoist lever to neutral and depress the Hoist Brake pedal.
3. To lower the bucket, release the hoist brake.

b. Drag

The drag cable is controlled by the Second Drum Brake pedal and the second Drum Clutch lever in front of the operator. In dragline operation these are referred to as Drag Brake pedal and Drag lever, respectively.

1. To drag in the bucket, push the Drag lever.
2. To hold the drag cable from paying out, return the lever to neutral and depress the Drag Brake pedal.
3. To pay out the drag cable, release the brake pedal.

c. Swing

Swinging the dragline is controlled by the Reverse Clutch lever as described in the preceding paragraph.

d. Dragline Operating Hints

Actual digging operations with the dragline require coordination between the hoist and drag motions which may be a little difficult to attain. Attention to the following suggestions and a little practice will soon give the operator the knack of filling the dragline bucket smoothly and quicky and permit accurate dumping.

1. Keep the boom angle as high as conditions will permit so as to provide maximum stability. Do not exceed figures given in the Table of Maximum Allowable Lifting Loads.
2. Use mats or corduroy the ground with saplings if footing is soft.
3. Regulate the depth of the cut by taking in or paying out hoist line.
4. Hoist the bucket out of the pit as soon as it is full and before dirt is pushed up against the front of the machine.
5. Start and stop the swing motion slowly so as not to place unnecessary strain on the boom.
6. Release the drag brake gradually when dumping the bucket to avoid jerking the boom.
7. When dropping back into the pit be careful to check the hoist and drag drums with the brakes so that the cables do not run off the drums.

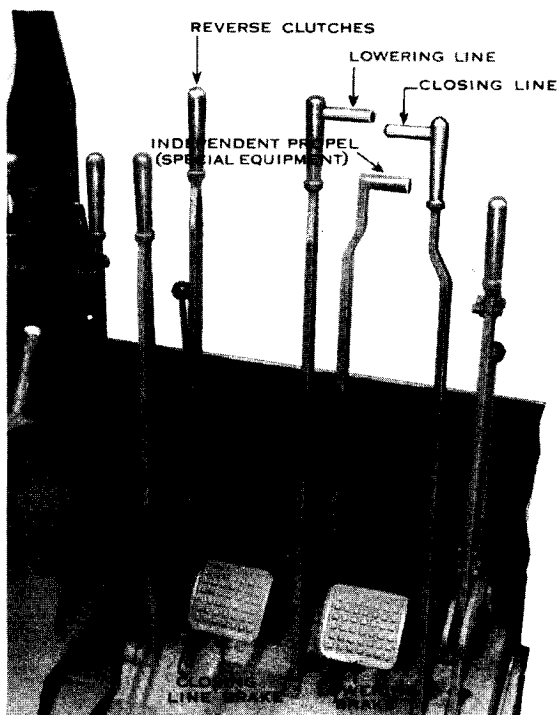


FIG. 5

F. CLAMSHELL OPERATION:

For clamshell operation the holding line is reeved to the left drum and the closing line to the right drum. Two methods of operation are available depending on the conditions on the job and the preference of the operator.

For "single lever operation" the left drum is larger in diameter than the closing line drum and there is a special clamshell spring installed on the left drum booster clutch instead of the standard booster release spring. (Refer to Section VI on Conversion for instructions covering installation of the special clamshell spring.) The clamshell spring holds the left drum booster clutch partially engaged so that slack is automatically kept out of the holding line while the bucket is being hoisted on the closing line.

For "two lever operation" the drums are of equal diameter and the standard booster release spring is used. The bucket is first closed with the closing line and when it starts to hoist the holding line clutch is also engaged. To permit disengaging both clutch levers simultaneously for dumping the bucket, horizontal grips are furnished for the clutch levers so that they can be operated with one hand (See Fig. 5).

The left drum brake (holding line) is operated by the Lowering Brake Pedal and the right drum brake (closing line) is operated by the Closing Line Brake pedal.

a. Single Lever Operation

When the clamshell is arranged with unequal drums and the special clamshell spring on the left drum booster clutch, operate the clamshell as follows:

1. To close and hoist the clamshell bucket, to pick up its load, push the Closing Line lever. **NOTE:** Adjust the clamshell spring on the left drum booster clutch so that there is sufficient drag of the booster clutch to partially set the main clutch band. Do not tighten the spring more than just enough to keep the slack out of the holding line while the clamshell bucket is being hoisted.
2. When raised to desired height, hold the closed bucket suspended by depressing the Closing Line Brake pedal and pulling back the Closing Line lever.
3. Dump the bucket by depressing the Lowering Brake pedal and releasing the Closing Line Brake pedal.
4. Lower the open bucket by releasing the Lowering Brake pedal.
5. Stop the bucket lowering by depressing the Lowering Brake pedal.

b. Two Lever Operation

When the clamshell is arranged with equal drums and horizontal lever-grips shown in Figure 5, operate the clamshell as follows:

1. To close and hoist the clamshell bucket, to pick up its load, push the Closing Line lever.
2. Just as the bucket starts to raise, push the Holding Line lever to engage the Left drum clutch so that the holding line will not develop slack.
3. When raised to desired height, hold the closed bucket suspended by depressing both pedals and pulling back the Closing Line and Holding Line levers simultaneously. (The horizontal grips on the levers permit one hand operation.)
4. Dump the bucket by releasing the Closing Line Brake pedal, holding the bucket with the Lowering Brake pedal.
5. Lower the open bucket by releasing the Lowering Brake pedal.
6. Stop the bucket lowering by depressing the Lowering Brake pedal.

c. Swing

Swinging the clamshell is controlled by the Reverse Clutch lever in front of the operator as described in a preceding paragraph.

d. Clamshell Operating Hints

The clamshell is an easy machine to operate as there is little overlapping of the motions but reasonable care must be used and the following points should be carefully followed.

1. Be sure the clamshell is on solid footing so that it will not "nose down" when hoisting the loaded bucket.
2. Keep the boom as high as conditions will permit but be careful not to let the bucket swing against the underside of the boom.
3. Clamshell buckets as well as material to be handled vary a great deal in weight therefore it is important to be sure that the combination of the boom angle, bucket and material comes within the limits of the Table of Maximum Allowable Lifting Loads for clamshell operation.
4. Keep sufficient tension on the bucket tagline so that the bucket will not spin and foul the cables.
5. Start and stop the swing motion slowly so that the loaded bucket will not swing excessively. If it swings out beyond the boom point the stability may be exceeded.
6. When lowering the open clamshell bucket, apply both drum brakes gradually to avoid jerking the boom but apply the brakes soon enough to prevent the cables overrunning.

G. CRANE OPERATION:

a. Main Hoist

For crane operation the main hoist line is controlled by the Hoist Brake pedal and the Hoist lever in front of the operator. (See Fig. 4).

1. To hoist the load, push the Hoist lever.
2. To hold the load suspended, return the Hoist lever to neutral and depress the Hoist Brake pedal.
3. To lower the load, release the hoist brake.

b. Auxiliary Hoist

On machines having two drums with an auxiliary hoist line reeved to the left drum, the auxiliary hoist line is controlled by the Second Drum Brake pedal and the Second Drum Clutch lever in front of the operator in a similar manner.

c. Boom Hoist

When performing work where accurate "spotting" of the load is required, use the Boom Hoist Brake and Clutch lever, as described under the Boom Hoist unit, to move the load in or out a short distance.

d. Crane Operating Hints

Crane work usually requires lifting heavy loads, placing them accurately and at times may require traveling with the load suspended and the crane operator must use extra caution and good judgment to avoid accidents or damage to the equipment.

1. Be sure the boom length and boom angle are such that the load to be lifted comes within the limit given in the Table of Maximum Allowable Lifting Loads.
2. Crane ratings are based on a firm foundation for the crane and if the footing is soft enough so that the crane will sink in to any extent due allowance must be made.
3. Swing the boom directly in line with the load before picking up the load.
4. Pick up the load gradually and do not catch it suddenly on the brake when lowering, as such practice places unnecessary strain on the boom.
5. If necessary to propel with the load suspended, snub it to the foot of the boom to prevent it swinging out beyond the boom point.
6. Keep the load as low as possible and use extreme care, when traveling with a high boom.
7. Use the auxiliary hoist line for light loads only.
8. Be sure hoist and boom suspension cables are in good condition before making any heavy lifts.
9. Use the boom hoist to change the boom angle for accurately spotting the load but avoid using the boom hoist with heavy loads suspended.

Adjusting Instructions

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This section covers all ordinary adjustments required in normal service and no unit should be adjusted without carefully reading the instructions covering that unit and following the procedure described. Keep your wrenches and other tools clean and in good repair. Do not try to work with tools that are in poor condition.

Remember that a unit which is in correct adjustment will operate easier and wear less than one which has been allowed to get out of adjustment. For instance, a clutch or brake which drags when released; overheats, requires excessive pressure to engage, and will not hold properly. It is much better to take out a few minutes to correct the adjustments than to try to "limp along" until the end of a shift.

Before changing the adjustments of any unit, check over the machinery and control very carefully to make sure a bent reach rod, worn pins, grease or oil on the

lining or housings, or binding of some part is not causing the trouble. Correct adjustment cannot be made unless the control levers, reach rods, bell cranks, etc., are in good condition.

For convenience in reference, adjustments will be covered starting with the Lower Works and proceeding up through the Upper Works to the Front End Equipment.

Many of the machinery units are protected by guards which must be removed when making adjustments. No mention is made of guard removal in the following instructions as it is a simple matter to take out the bolts holding the guards in place. In some cases, such as removal of the brake bands, it may be necessary to remove portions of the cab to give room to work. Always replace guards and cab parts after completing adjustments.

— CHAPTER VII —

LOWER WORKS ADJUSTMENTS

A. TREAD BELTS:

No definite rule can be given as to how tight or loose the tread belts should be as the correct adjustment depends on the type of ground over which the machine is to be moved. In general, the belts should be kept as loose as possible without losing proper tracking of the driving tumblers. For normal service, when the belt is tight on the bottom, it should sag about six inches between the upper idler rollers.

If the machine is operating on mats or other firm footing 3 or 4 inches sag will give better tracking. **WATCH THE BELTS CLOSELY WHEN THE MACHINE IS WORKING IN LOOSE DIRT, SAND, OR MUD AND LOOSEN THE ADJUSTMENTS OF THE BELT IF THE DIRT TAKES UP ALL THE SLACK.**

PROPELLING WITH TIGHT BELTS IS EXTREMELY HARD ON THE PROPELLING MACHINERY.

Tension of each tread belt is adjusted at the take-up tumbler end (opposite to the drive chain) by adding or removing slotted spacers which position the take-up tumbler shaft. Adjustment of the cat belts does not affect the adjustment of the cat propelling chains but the propelling chains must be correctly adjusted **BEFORE** adjusting the cat belts, therefore, always check the adjustment of the propelling chains and adjust if necessary before changing the adjustment of the tread belt.

In making adjustment of the tread belt, be sure that the same thickness of spacers is used at each end of the shaft so that the shaft is held in correct alignment. Extra spacers and two special jack screws are included in the tools and supplies. To adjust the tread belt tension proceed as follows (See Fig. 1).

1. Assemble one of the jack screws at each end of the take-up tumbler shaft.
2. Loosen the take-up tumbler shaft bearing bolts at both ends of the shaft.

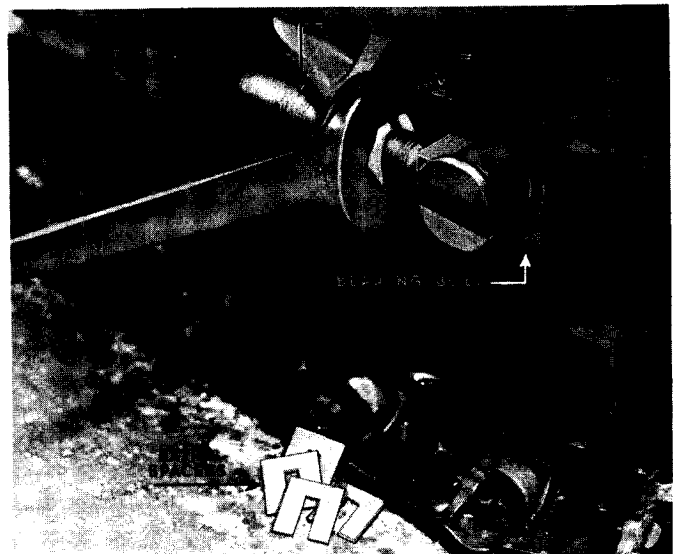


FIG. 1

3. Turn the nuts on both jack screws until the desired belt tension is obtained. (If the belt is being loosened it will be necessary to remove some of the spacers from both sides before backing off on the jack screw nuts.)
4. Insert an equal thickness of spacers on both sides to completely fill the gaps between the side frame and the take-up tumbler shaft bearings.
5. Remove the jack screws from both sides.
6. Tighten the bearing bolts securely.

If the take-up tumbler shaft bearing bolts are at the end of the slots in the side frame and the cat belt is still too loose, remove all spacers, back off the jack screw nuts, take out one track link, then readjust for correct tension.

After the adjustment of both tread belts is completed, clean and oil the jack screws and store them with extra spacers in the compartment under the left deck plate where they will be available the next time adjustments have to be made.

B. PROPELLING CHAINS:

Watch adjustment of the propelling chains. A roller chain which is too loose may jump the sprocket teeth or whip excessively. Too tight a chain will wear rapidly. For normal service, when the top side of the chain is tight the bottom side should sag from 4 to 6 inches below its tight position.

Tension of each propelling chain is adjusted at the driving tumbler end of the side frame by adding or removing slotted spacers which position the driving tumbler shaft. Adjustment of the propelling chain affects the tension of the tread belt, therefore, always adjust the propelling chain before changing the tread belt adjustment.

In making adjustment, be sure the same thickness of spacers is used at each end of the shaft so that it is held in correct alignment. The same spacers and one of the jack screws used for the tread belt adjustment are used in adjusting the propelling chain (See Fig 2a). The retaining bolt on the outside of the side frame serves as the second jack screw (See Fig. 2b). A jack screw sleeve is included in the tools for use with the jack screw on the sprocket end of the driving tumbler shaft. To adjust the propelling chain tension proceed as follows:

1. Loosen the cat belt by removing one or more spacers at each end of the take-up tumbler shaft as previously described.
2. Loosen the four driving tumbler shaft bearing bolts.
3. Assemble one jack screw with its sleeve and place the assembly in position between the axle and the end of the sprocket shaft (See Fig. 2a). (The pockets in the axle are to keep the end of the jack screw sleeve from slipping. Alternate positions are provided to suit different widths of track links. Line up the jack screw assembly to see which pocket should be used and fill the pocket with grease before putting the assembly in position).
4. Take out the bolt holding the retaining bolt nut lock and remove the nut lock.
5. Turn the nut on the jack screw and the nut on the retaining bolt until the desired chain tension is obtained. (If the chain is being loosened it will be necessary to remove some of the spacers from both sides before backing off the jack screw and retaining bolt nuts.)
6. Insert an equal thickness of spacers on both sides to completely fill the gaps between the side frame and the driving tumbler shaft bearings.

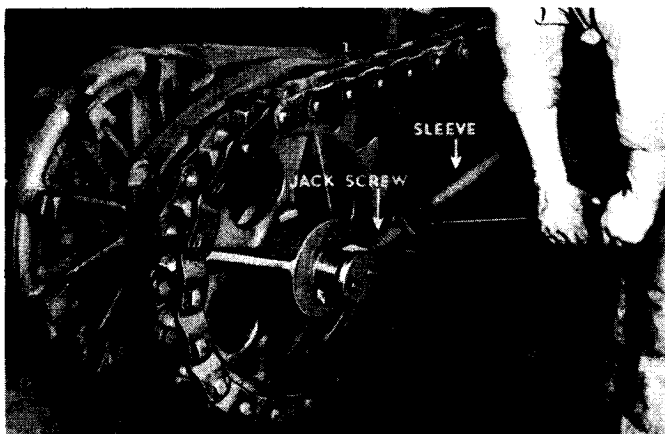


FIG. 2a



FIG. 2b

7. Remove the jack screw and sleeve assembly and tighten the nut on the retaining bolt against the end rib of the side frame so that the spacers are clamped in position.
8. Fasten the retaining bolt nut lock back in place with the bolt.
9. Tighten the four bearing bolts securely.
10. Adjust the tread belt at the take-up tumbler end of the side frame as previously described.

If the driving tumbler shaft bearing bolts are near the end of the slot so that further adjustment of the propelling chains cannot be made without the driving tumbler shaft bearings extending out beyond the end of the side frame, remove all spacers on both sides, take out one link of the propelling chain then readjust for correct tension.

C. DIGGING LOCK:

The digging lock (just above the bevel gear in the truck frame) has no friction linings or springs to get out of adjustment. It will seldom require attention, but if it is not operating properly, remove the curved covers and check the adjustments as follows (See Fig. 3):

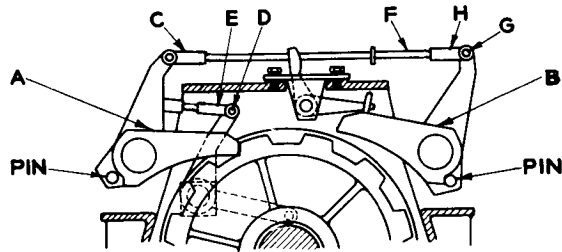


FIG. 3

Place the Digging Lock lever in the next to the rear notch of its quadrant and check to see that the two pawls "A" and "B" drop into full engagement with the ratchet teeth. Grind or file the ends of the pawls if a burr prevents full engagement. Clean and oil pawl pins so that the pawls move freely.

D. STEERING CLUTCHES:

The two steering clutches in the truck frame slide on splines on the clutch shafts and when the steering clutch lever is in neutral coil spring "A" holds both clutches in engagement (See Fig. 4). Adjustment should seldom be required. In case of faulty operation of the steering clutches clean the splines on both shafts and lubricate thoroughly. Adjust turnbuckle "B" so that spring "A" is under slight tension when the steering clutches are engaged.

If the clutches still do not operate properly check the adjustments of the reach rods as follows:

1. Place the Steering Clutch lever part way forward of neutral and check to see that the clutch shifter fork and lever "C" are both vertical.
2. If necessary, remove pin "D" and adjust the length of reach rod "E" (by turning it in or out of rod end "F") so that the levers are vertical when the pin is replaced.
3. Move the Steering Clutch lever part way back of neutral and check to see that the clutch shifter fork and lever "G" (on the other side) are both vertical.
4. Remove pin "H" and adjust the length of reach rod "I" by turning rod end "J" on or off so that the levers are vertical when the pin is replaced.
5. Check operation of the clutches with the Steering Clutch lever moved to the forward and rear of its quadrant. For each position of the lever one of the clutches should move into full engagement with its locking pin in the truck frame.

Replace the locking pin if it has become worn or damaged so that the clutch will not slide into full engagement.

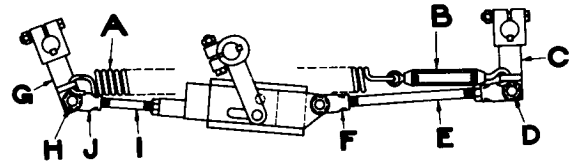


FIG. 4

E. PROPELLING SLIPPING CLUTCH:

(Not on machines having independent propelling)

The propelling slipping clutch, at the upper end of the vertical propelling shaft, is intended to slip only under severe overload, therefore the lining will wear very slowly and adjustment should seldom be required.

If the clutch will not transmit full power of the engine without slipping readjust it as follows:

1. Open the hinged panel at the front of the machine and remove the center covers under the drum.
2. Turn the vertical propelling shaft gear until the adjusting screw can be reached and remove the cap screws "A" holding lock plate "B". (See Fig. 5).

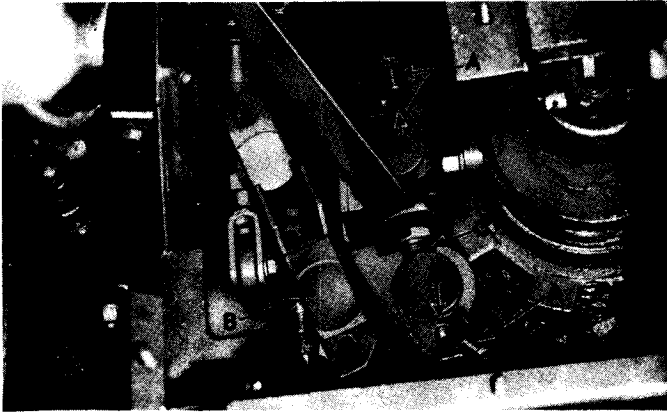


FIG. 5

3. Place the Digging Lock lever in the next to the rear notch of its quadrant to lock the machine against movement in either direction. Also move the Swing and Propel Jaw Clutch lever to the

front notch of its quadrant to engage the propel jaw clutch.

4. With the engine operating at normal governed speed, first engage engine clutch (pull lever back) then **GRADUALLY** engage either reverse clutch. Watch the slipping clutch and release the reverse clutch as soon as the slipping clutch starts to slip.
5. Tighten the adjusting screw "C" just enough so that the engine will stall when the reverse clutch is fully engaged.
6. If the clutch still slips after tightening as much as possible, back off the adjusting screw completely, remove the retaining plates "D" and lift out the two halves of the band. Clean off all oil or grease on the lining, reassemble and adjust as described above.

UPPER WORKS ADJUSTMENTS

A. ENGINE CLUTCH:

The disc-type clutch, mounted on the engine flywheel, is normally used only when starting the engine and will seldom require adjustment. However, if at any time it slips under normal operation, stop immediately and adjust it. Watch a new or relined clutch carefully as the clutch may require frequent adjustment until the friction surfaces are worn in to a good bearing. If at any time the clutch slips under normal operating conditions stop immediately and adjust it as described in the engine builder's instruction book.

When correctly adjusted the clutch will toggle in with a distinct snap under moderately heavy pull on the Engine Clutch lever.

B. TRANSMISSION CHAIN:

The roller chain, which transmits power from the power unit to the horizontal transmission shaft, operates in an oil bath and will seldom require adjustment. Take up any excessive slack which may develop by shifting the power unit sub-base as follows:

1. Loosen the engine sub-base foundation bolts and the oil seal retainer plate cap screws in the transmission case.
2. Take out the oil filler plug in the top of the transmission case and turn the drive sprocket so that the chain is tight on the top.

3. Accurately measure and make note of the distance from the top of the chain case to the chain.
4. Turn the drive sprocket so that all slack is in the top side of the chain and measure the distance from the top of the chain case to the chain.
5. Back off the jam nuts "A" on the engine adjusting bolts and loosen the lock nuts "B". Turn the bolts "C" until the engine is shifted so that the dimension taken as described in step "4" is 3 inches more than the measurement as made under "3" NOTE: Turn both adjusting bolts the same amount so as not to disturb alignment of the sprocket. If there is any question as to the alignment, check the dimension "D" at both ends of the engine and readjust adjusting bolts, if necessary so that it is exactly the same at both ends.
6. Tighten the lock nuts "B" then tighten the nuts and jam nuts "A".
7. Tighten the sub-base foundation bolts, replace the chain case filler plug and tighten the cap screws holding the oil seal retainer plate to the chain case.

If all adjustment of the sub-base is used up and the drive chain is still too loose, move the engine all the way forward, take out one link of the roller chain and readjust the chain as described above.

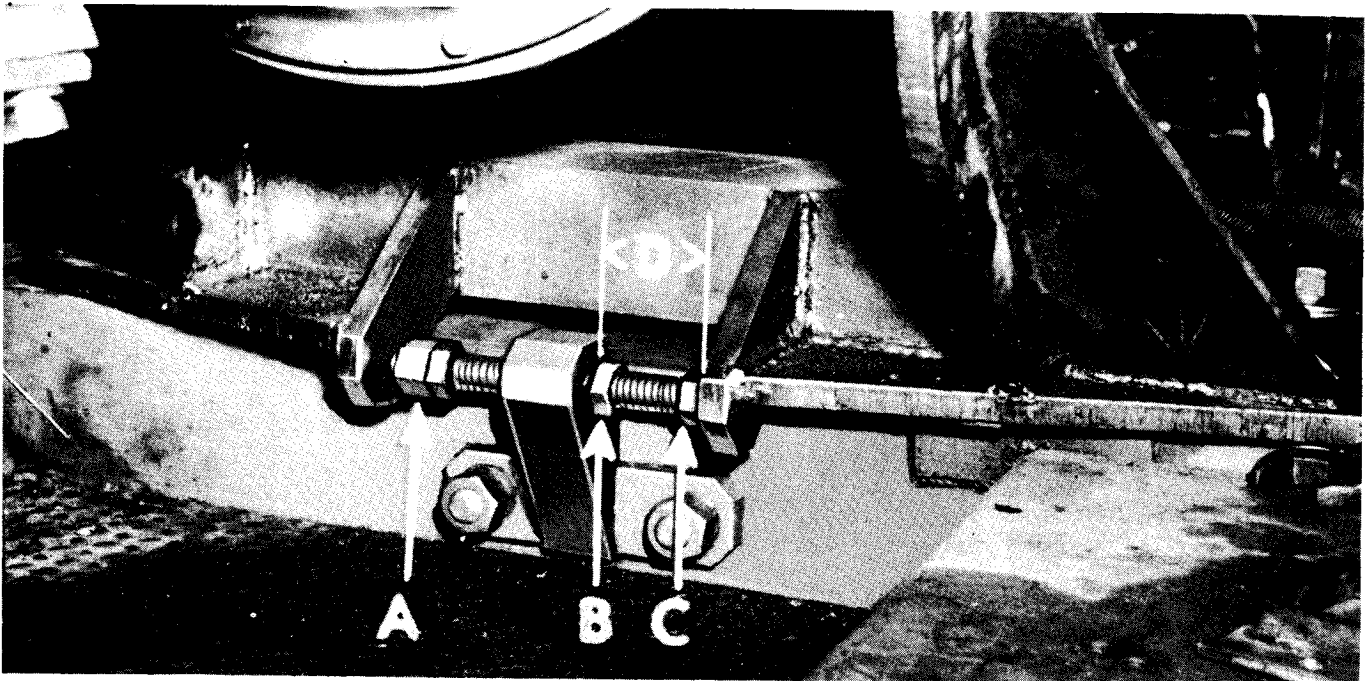


FIG. 6

C. BOOM HOIST CLUTCHES AND BRAKE:

The boom hoist hoisting and lowering clutches are duplicates and both clutches are adjusted in the same way. (See Fig. 7a). The spring "A" is set at the factory to a length of $2\frac{1}{8}$ inches and should not be disturbed. When the clutch band wears enough so that the clutch will not hold without slipping readjust each clutch as follows:

1. Check adjustment of reach rod between clutch cams. (Dimension should be 6 inches as shown in Fig. 7b.)
2. Place the Boom Hoist lever in either the hoisting or lowering position (depending on which clutch is being adjusted).
3. Adjust the nuts on eyebolt "B" until the gap between the lugs of lever "C" is $\frac{1}{16}$ inch when the clutch is cold. (Make gap smaller if housing is hot when making adjustment.)

When the clutch lining is worn almost down to the rivets the band may be removed for relining as follows:

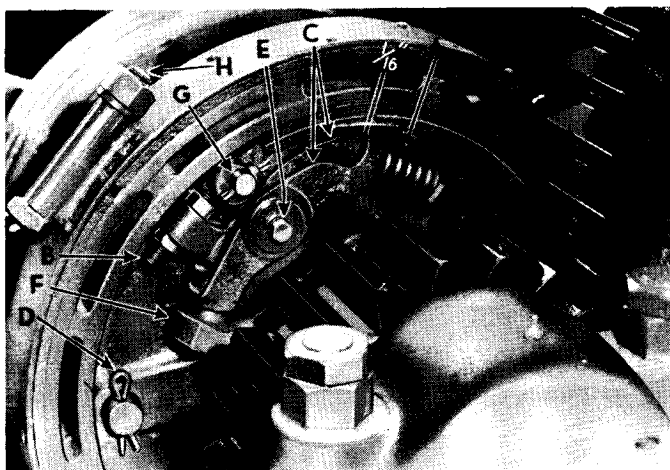


FIG. 7a

1. Take out the two cap screws holding the band guide (not shown) in place.
2. Remove the cotter "D" holding the dead end of the band and take out the cap screw "E".
3. Withdraw the entire band and lever assembly from the housing, rotating the band slightly to free the ball stud from the socket in the toggle yoke "F".
4. Remove pin "G" to separate the band from the lever assembly.

If a spare band is kept on hand a worn out band can be replaced with the spare one in a very short time, then the old band can be relined when convenient.

Bucyrus-Erie Company can supply bands already lined and shaped to fit; such bands need little wearing in.

The boom hoist brake band is set by spring "F" which is adjusted at the factory for correct load. When the brake will no longer hold properly, when the boom hoist lever is in neutral, take up on the brake band as follows: (See Fig. 7b)

1. Loosen the jam nut "A" at the upper end of the eye bolt "D" then turn the adjusting nut "B" to compress spring "C" until the cam lever JUST LIFTS OFF THE CAM ROLLER.
2. Be sure the band does not drag excessively when either clutch is fully engaged, then tighten the jam nut.

NOTE: With this adjustment correctly made the force in spring "F" should be sufficient to hold the boom. If necessary, additional force can be obtained by further compressing spring "C" at the same time tightening adjusting nut "E" at spring "F" to maintain minimum gap between the cam and cam roller.

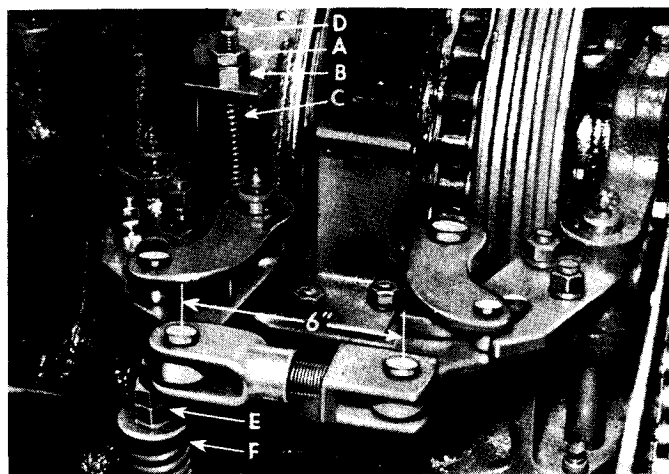


FIG. 7b

If the band will not hold without compressing spring "C" excessively, remove the band and clean it as follows (See Fig. 7b):

1. Remove the jam nut "A" and nut "B" on the upper end of eye bolt "D".
2. Take out the bolt "H" at the splice in the band (See Fig. 7a) and lift out the top half of the band.
3. Remove the dead end pin and slide out the lower half of the band.
4. Clean the band carefully with gasoline or other solvent, dry thoroughly then reassemble and adjust as described above.

D. REVERSE CLUTCHES:

The two reverse clutches (used for swinging and for standard propelling) are duplicates and both clutches are adjusted in the same way (See Fig. 8). The spring "K" is set at the factory to the length of $2\frac{1}{8}$ inches and should not be disturbed. To compensate for lining wear adjust each clutch as follows:

1. Push or pull (depending on which clutch is to be adjusted) the reverse clutch lever to set the clutch.
2. Loosen the lock nut "A" on the band adjusting bolt and turn up nut "C" until the gap measured between the lugs of split lever "B" is $\frac{3}{16}$ " when the clutch is cold. (Make the gap smaller if the housing is hot when making adjustment).
3. Reverse the clutch lever to set the opposite clutch and check to see if the cam roller at the lower end of the forked shifter lever "D" turns freely. If it does not, back off the band guide screws "E" enough so that the roller is free and there is uniform clearance all the way around the band and the housing.
4. Tighten the band release springs "F" only just enough to hold the band against the band guide screws when the clutch is rotating at full speed. (Tighten the spring at the live end of the band slightly more than the other one so that the dead end of the band will contact the housing first when the clutch is engaged.)
5. Place the clutch lever in neutral so that both clutches are released and check to see that the distance between the end of clutch shifter sliding sleeve and the base of the clutch driver hub is the same on both sides.

If necessary, adjust the length of the reach rod between the two clutches, (just above the deck, back of the vertical transmission gear case). The dimension center to center of pins is normally $38\frac{1}{8}$ ". This may have to be changed slightly to obtain the same dimension between sleeve and driving hub on both sides.

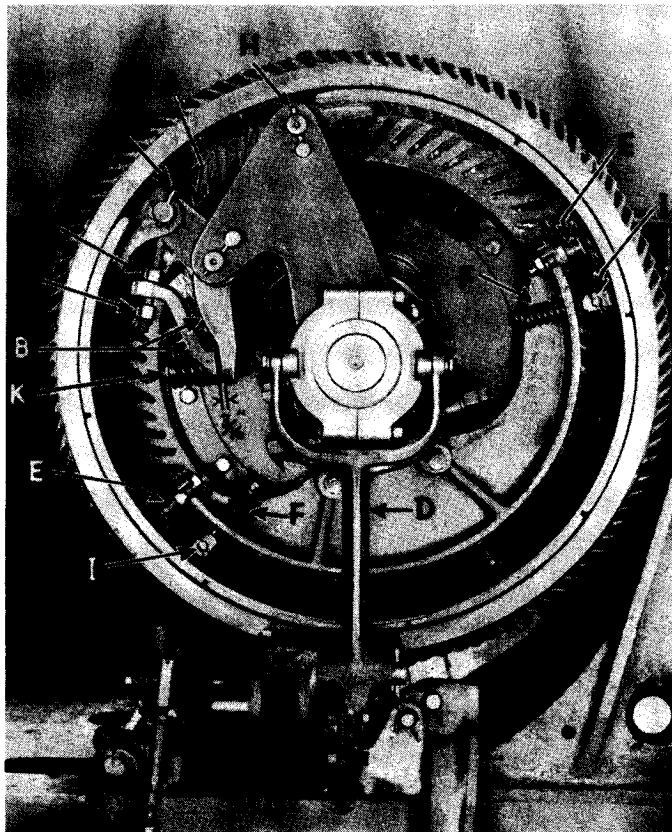


FIG. 8

When the lining at the live end of the band is worn about $\frac{1}{3}$ through, remove the band from the housing and turn it end for end as follows:

1. Remove the lock pins "G" and "H" and take out the live end and dead end pins.
2. Take out the pins "I" fastening the release spring guide rods to the band and turn up the band guide screws "E" until they clear the slots in the band.
3. Swing links "J" clear of the band lug, rotate the band slightly to free the dead end lug then slide the band out of the housing.
4. Turn the band around and replace it in the housing by reversing the procedure given in steps 1, 2 and 3.
5. Adjust the clutch for correct gap as previously described.

E. MAIN BRAKE BANDS:

The main brake bands, on the outside of the drum clutch housings, are easily adjusted to compensate for lining wear. (See Fig. 9a and 9b).

When the lining wears so that the brake will no longer hold when the brake pedal is pushed all the way down, take up on the short reach rod back of the operator's position. (See Fig. 9a). The outer reach rod "A" controls the left drum brake and the inner rod "B" controls the right drum brake.

1. Loosen the jam nut "C" or "D" (depending on which brake is being adjusted).
2. Turn the corresponding reach rod "A" or "B" until the brake pedal will just latch into position when the pedal is depressed and the Brake Pedal Lock lever is pulled up.
3. Tighten the jam nut "C" or "D" to lock the adjustment.
4. Adjust the tension springs, below the right deck plate, so they have just sufficient tension to return the brake pedals to high position when the brake is released.

To prevent the brake band dragging on the housing in the released position the bottom of each band is supported on a set screw just inside the side frame. Adjust these set screws so that the bottom of the bands clear the housing from 1/32" to 1/16".

The left drum brake band is supported by two of the compression spring suspension assemblies shown in Figure 9b. The right drum brake band has one of these assemblies at the rear of the band and a tension spring supporting the front of the band. A guide bar to limit the clearance between the band and the housing is bolted to an extension of the auxiliary lever stand.

Adjust the compression spring assemblies as follows:

1. Loosen the lock nut "A" and tighten nut "B" so that there is just sufficient compression in spring to lift the band clear of the housing.

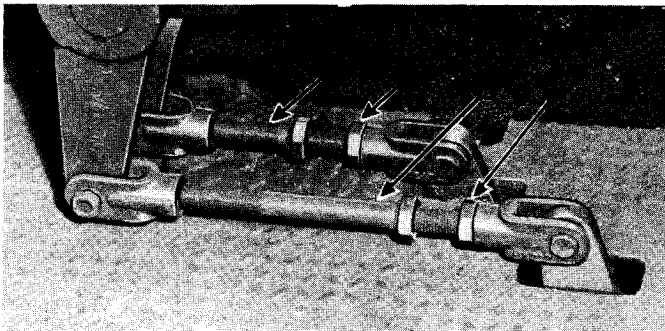


FIG. 9a

2. Loosen the lock nut "C" and adjust nut "D" so that there is from 1/32" to 1/16" gap when the brake is set.
3. Tighten the nuts "A" and "C" to lock the adjustment.
4. On the right hand band, tighten the nuts on the tension spring assembly (reached from outside the cab) just enough to hold the band clear of the housing and in contact with the guide bar when the brake is released. Adjust the guide bar to limit clearance between the band and the housing to not more than 1/16".

The brake bands are built in halves and may be removed for relining as follows:

1. Take out the pins "E" connecting the compression spring assemblies to the band and remove the assembly by taking off the nuts "F" (See Fig. 9b). (On the right brake band take off the nuts on the tension spring assembly and remove the guide bar bolted to the bracket on the auxiliary lever stand.)
2. Remove the pin connecting the live end of the brake band.
3. Back off the set screw, supporting the bottom of the band, to give the maximum clearance for removing the band.
4. Take out the split pin through the inner end of the dead end anchor pin and drive the pin out through the side frame.
5. Remove the bolts at the splice in the band and slide the top half of the band out toward the center of the machine.
6. Take out the bottom half of the band in the same manner.

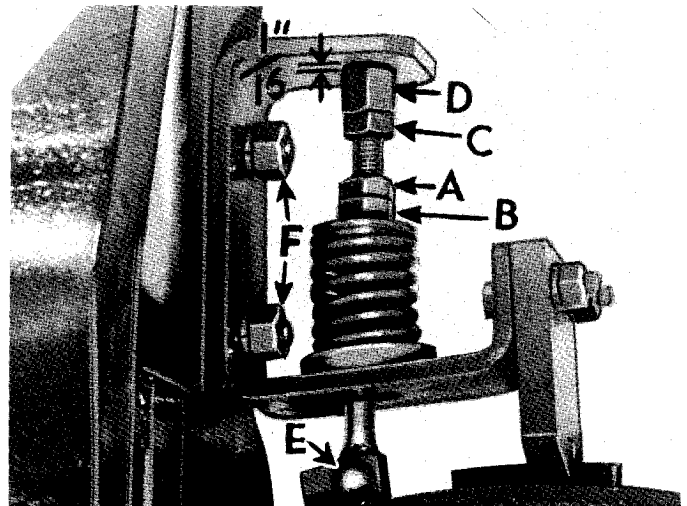


FIG. 9b

F. DRUM CLUTCHES:

The internal expanding drum clutches are easily adjusted to compensate for lining wear. If the main band will not carry the load without slipping when the disc type booster clutch is engaged, adjust the main band as follows: (See Fig. 10a)

1. Loosen lock nut "A" and tighten the adjusting nut "B" until the band will carry the load, without slipping.
2. Adjust the band guide screws "E" (See Fig. 10b) so that the clearance between the band and the housing is uniform all the way around when the clutch is released.
3. Tighten springs "F" just enough to hold band against screws "E" when shaft is revolving at normal speed, when clutch is released.

NOTE: When operating a clamshell with the holding drum of larger diameter than the closing drum, adjust the two nuts on the left-drum booster-spring so there is just sufficient compression to cause the holding line clutch to drag enough to keep slack out of the holding line when hoisting the closed bucket. (See Section VI on Conversion for instructions covering installation of the clamshell booster springs on the left drum clutch.) The clutch bands are built in halves and may be removed for relining as follows:

1. Turn the clutch until the band guide screws are near the top as shown in Figure 10b.
2. Remove cap screws "A" and plate "B." Remove pins "C" and back up guide screws "E."
3. Take out splice cap screw "D."
4. Turn the clutch until the lever end is at the top as shown in Figure 10a.
5. Remove the cap screws "C" and "D" holding the live and dead end pin locks.
6. Take out the pin locks and remove the live and dead end pins "E" and "F."
7. Loosen the cap screw "G" and take out the bell crank pin "H."

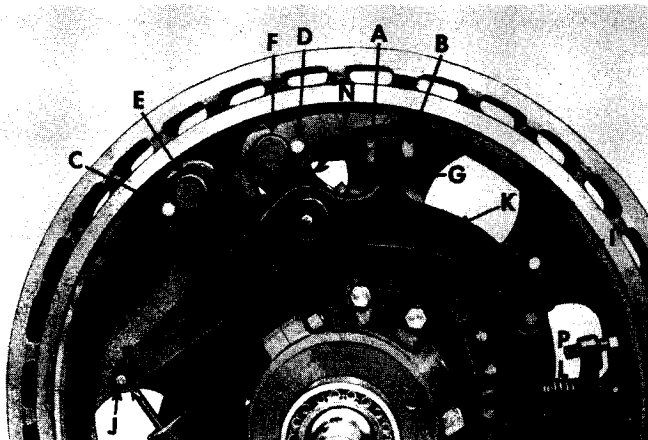


FIG. 10a

8. Take out the cotters and remove pins "I" and "J."
9. Take out lever "K" with the adjusting bolt. Links "M" and "N" come free as the lever is removed. Take care not to drop them.
10. Remove one-half of the clutch band at a time, rotating the clutch to bring the second half of the band to top position.

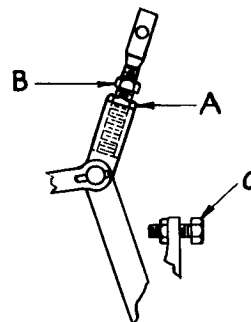


FIG. 11

The disc type booster clutches do not slip, once the main band is engaged, therefore should wear a long time. When the booster will no longer hold, compensate for lining wear as follows: (Figure 11 shows the toggle levers for the right drum booster clutch. The corresponding levers for the left drum booster are shown in Figure 11a.)

1. Loosen lock nut "A."
2. Turn adjusting sleeve "B" until booster clutch will toggle in under reasonable hand lever load.
3. Adjust stop screw "C" so that the levers are just in toggle.
4. Tighten lock nut "A" and the jam nut on screw "C."

NOTE: The toggle levers for the left drum booster clutch include a spring link. The spring is set at the factory to an overall length of 3-15/16". If the linkage is disassembled for any reason, be sure the spring is correctly set to this dimension when reassembling the levers.

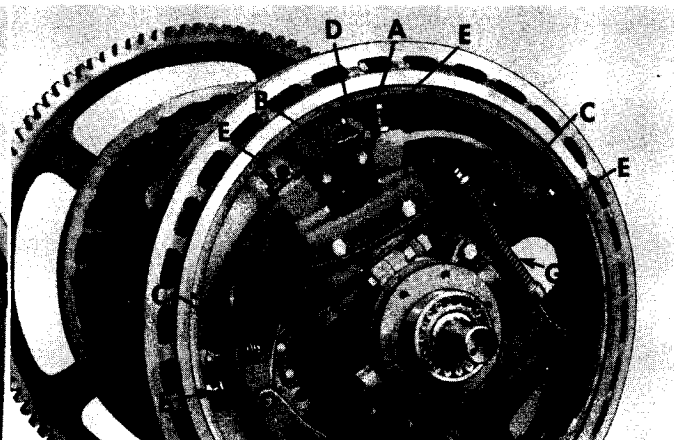


FIG. 10b

The booster clutch discs are in halves and may be removed for replacement as follows: (See Fig. 10a)

1. Take out the lock screws "P" in the retainer bars "L" and remove the four bars. (There are two retainers for each half.)
2. Release the booster clutch and back off on the toggle lever adjustment until the disc halves can be withdrawn.
3. Insert the new disc halves, replace the retainer bars and readjust the toggle levers as described above.

G. SWING LOCK:

No adjustment of the swing lock should normally be required but if it does not operate properly check the following points to see if it has been accidentally damaged from faulty operations, such as trying to engage it while the machine is still swinging. (See Fig. 11B.)

1. See that the teeth of the swing lock go into FULL mesh with the teeth on the swing rack.
2. Grind off any burrs on the swing lock teeth which may be keeping it from going fully into mesh.
3. Adjust the eye bolt "A" so that the lever linkage just goes into full toggle when the swing lock lever is pulled all the way back.

H. INDEPENDENT PROPEL CLUTCHES:

(Only on machines having Independent Propelling)

The independent propelling high-speed and low-speed clutches are duplicates and both clutches are adjusted in the same way. (See Fig. 12). The spring "B" is set at the factory to a length of $2\frac{5}{16}$ " and should not be disturbed.

When the clutch band wears enough so that the clutch will not hold without slipping readjust the clutch as follows:

1. Place the Independent Propel lever in either high-speed or low-speed position (depending on which clutch is being adjusted).
2. Adjust the nuts on eye bolt "D" until the gap between the lugs of lever "C" is $\frac{3}{16}$ " when the clutch is cold. (Make gap smaller if housing is hot when making adjustment.)

When the lining at the live end of the band is worn

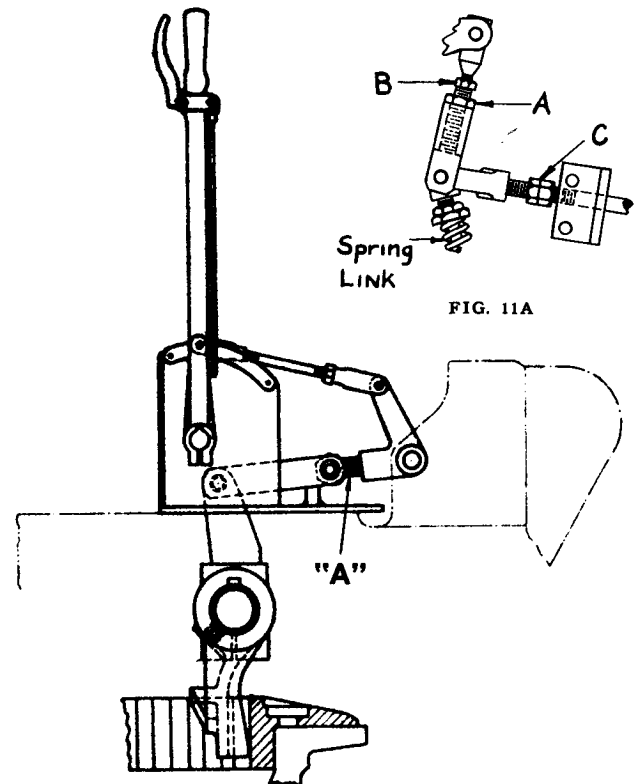


FIG. 11B SWING LOCK

about 1/3 through, remove the band from the housing and turn it end for end as follows:

1. Remove the lock pins in live and dead end pins "E" and "G" and take out the pins.
2. Turn up the adjusting eye bolt "D" until its head is clear of the band lug. Then swing links "F" clear of the band lug.
3. Turn up the release adjusting screws "A" until they clear the slots in the band, then slide the band out of the housing.

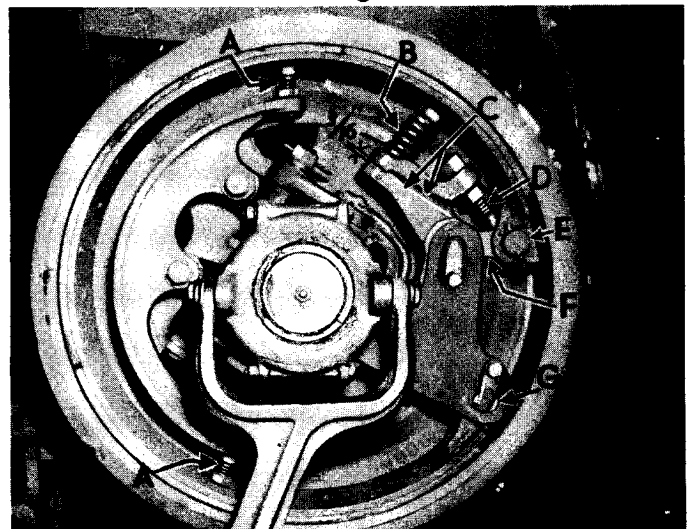


FIG. 12

FRONT END EQUIPMENT ADJUSTMENTS

A. BACKHAUL CLUTCH:

The shovel backhaul clutch, on the left end of the backhaul shaft (See Fig. 13) is similar to the reverse clutches and is adjusted in the same way except that spring "A" is set at the factory to a length of $2\frac{1}{4}$ ". Do not disturb the setting of this spring. To compensate for lining wear adjust the clutch as follows:

1. Pull the Crowd lever to toggle the clutch into set position.
2. Loosen the lock nut "D" on the band adjusting bolt and turn up the nut "C" on the end of the adjusting bolt until the gap measured between the lugs of split lever "B" is $\frac{3}{16}$ " when the clutch is cold. (Make the gap smaller if the housing is hot when making adjustments.)
3. Push the crowd lever forward to set the crowd clutch and check to see if the cam roller at the lower end of the forked shifter lever "H" turns freely. If it does not, reset the band guide screws "I" and "L" so that the roller is free and there is uniform clearance all the way around between the band and the housing.
4. Compress the band release springs "J" and "K" just enough to hold the band against the band guide screws so that it will not drag even when rotating. (Compress the spring "K" at the live end of the band slightly more than the other one so that the dead end of the band will contact the housing first when the clutch is engaged.)

When the lining at the live end of the band is worn about $\frac{1}{3}$ through, remove the band from the housing and turn it end for end as follows:

1. Remove the lock pins "F" and "G" in the live and dead end pins and remove the pins.
2. Take out the pins "M" and "N" fastening the release springs guide rods to the band and turn up the band guide screws "I" and "L" until they clear the slots in the band.
3. Swing links "E" clear of the band lug, rotate the band slightly to free the dead end lug, then slide the band out of the housing.
4. Turn the band around and replace it in the housing by reversing the procedure given in steps 1, 2 and 3.
5. Adjust the clutch for correct gap as previously described.

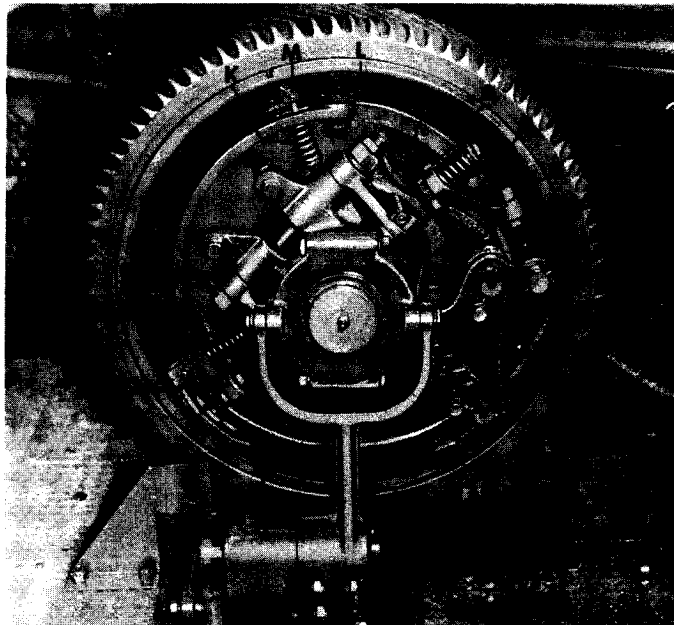


FIG. 13

B. CROWD CHAIN:

If the roller chain between the crowd drive sprocket and the rope drum at the foot of the boom becomes loose enough so that it rides the ends of the sprocket teeth or whips excessively adjust it as follows: (See Fig. 14).

1. Open the hinged panel at the front of the machine.
2. Loosen the jam nuts "B" at the upper end of the adjusting screws and turn both adjusting screws "A" counter-clockwise the same amount to raise the idler sprocket until there is about two inches up and down movement of the lower side of the chain when the upper side is tight.
3. Tighten the jam nuts against the idler sprocket shaft and close the hinged cab panel.

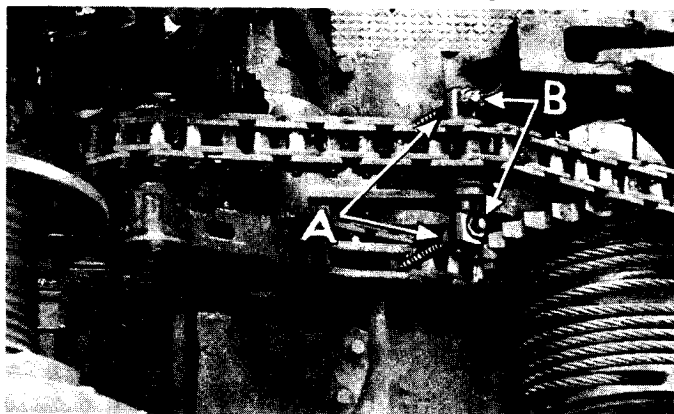


FIG. 14

C. CROWD AND BACKHAUL ROPES:

When installing new crowd or backhaul ropes or if the ropes develop excessive slack, adjust the ropes as follows: (See Fig. 15)

1. Crowd out the dipper so that the dipper handle is fully extended and hold it in that position with the crowd brake.
2. Place a wrench on the shaft of the rope take-up drum and turn the drum until all slack is taken out of the backhaul rope.
3. To release the ratchet drum for unwinding the backhaul rope put some pressure on the wrench and pinch the ratchet levers "A" together then turn the drum shaft back to unwind the rope.

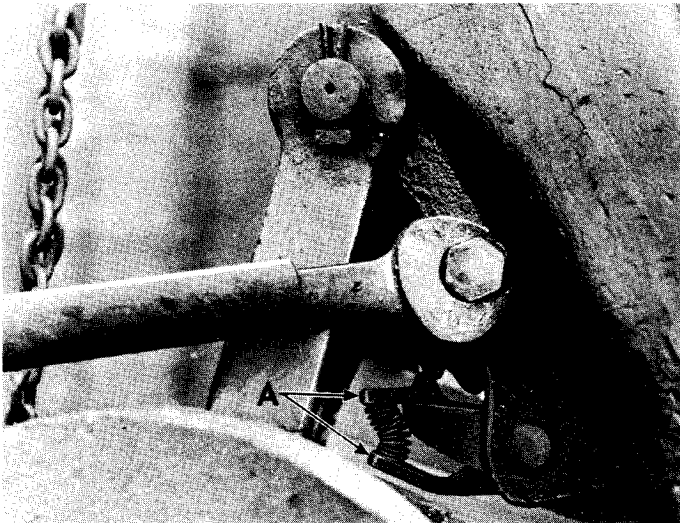


FIG. 15

D. DIPPER HANDLE SLIDE PLATES:

If the wearing plates which hold the dipper handle in the saddle block become worn so that there is more than $\frac{1}{8}$ " clearance between the handle and the wearing plates insert one or more of the shims included with the tools and supplies as follows: (See Fig. 16)

1. Raise the dipper so that the handle is horizontal.
2. Take out the cap screw lock wires and loosen the two cap screws holding each wearing plate. Insert one or more shims as needed to reduce the clearance to not more than $\frac{1}{8}$ ". (Be sure the two wearing plates on the same side of the handle have equal clearance so that the handle will not be forced out of line.)
3. Tighten the cap screws securely to clamp the shims in place and replace the lock wire.

If all the shims have been inserted and the dipper handle is still loose in the saddle block, remove the cap screws holding the shims and wearing plates in place and install new wearing plates.

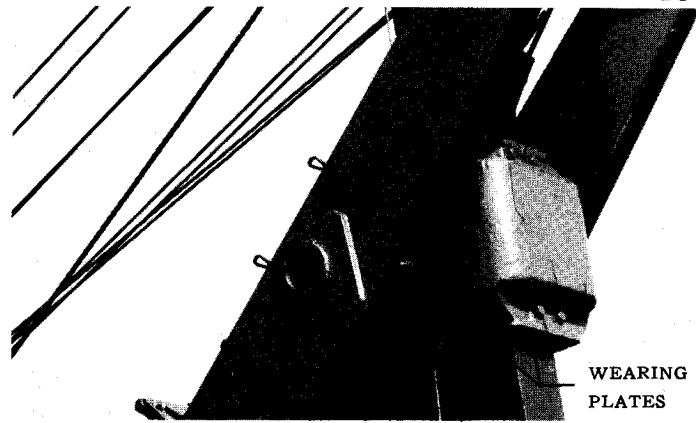


FIG. 16

E. DIPPER TRIP:

The dipper trip arrangement at the right end of the main drum shaft (See Fig. 18) provides a pull of fixed length on the dipper trip rope therefore the dipper trip latch on the dipper door must be correctly adjusted before the dipper trip will work properly.

If the dipper door will not stay closed or will not unlatch in response to push on the dipper trip lever, check adjustment of the latch on the dipper door as follows: (See Fig. 17)

1. Clean out any stones or dirt that may have become lodged in the opening in the latch keeper.
2. Inspect the latch keeper and the end of the latch bar "A". If either are badly worn they must be reconditioned to eliminate the rounded corners.

The latch keeper insert "B" is reversible, so when one edge is rounded off drive it out of the latch keeper, reverse it, drive it back into place. When both edges are rounded, replace it with a new one or build up the edges by welding and grind down to original size.

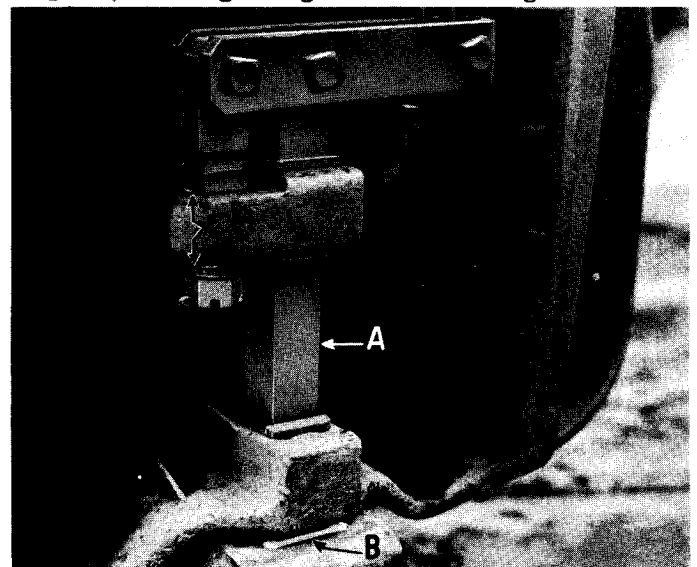


FIG. 17

To recondition a worn latch bar, grind off the tip to its original shape or build up by welding with high carbon rod and finish grind until the tip has straight sharp edges.

3. Adjust the latch bar for correct "bite". (The end of the bar should drop into the latch keeper about $\frac{1}{2}$ ".) Rough adjustment is made by attaching one or the other of the dump chain links in the pinch link.

Make final adjustment by moving the washers "C" on the fulcrum pin from one side of the door rib to the other. (Moving the washers from the upper side of the rib to the nut end of the fulcrum pin increases the "bite" of the latch bar in the keeper.) With the latch properly adjusted as described above adjust the dipper trip ropes as follows: (See Fig. 18)

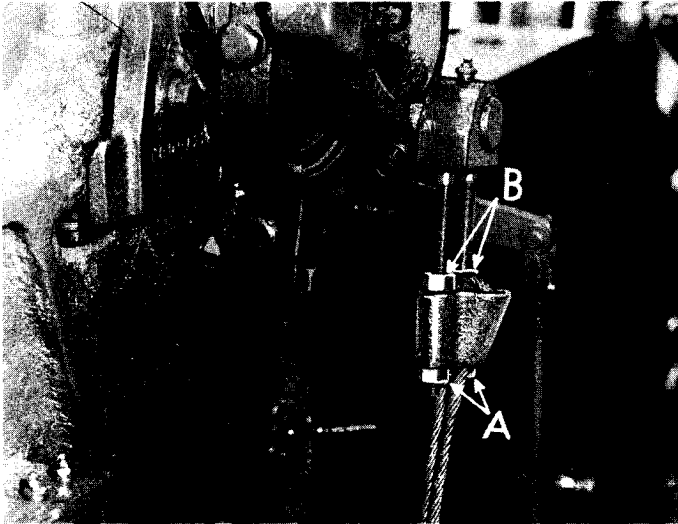


FIG. 18

1. Fasten the end of the dipper handle trip rope to the trip lever on the dipper handle with Crosby clips, pulling up the rope tight enough so that the lever of the trip sheave on the boom is nearly horizontal. (It may be necessary to lengthen the trip rope between the lever and the ratchet device in order to make this adjustment.)
2. Adjust the nuts "A" for the wedge rope socket on the ratchet device so that the socket is near the bottom of the adjusting bolts.
3. Fasten the other end of the trip rope in the wedge rope socket attached to the lever of the trip sheave on the boom. Be sure to take up the slack in the rope when socketing the rope.
4. Make final adjustment by means of the nuts "A" positioning the rope socket. Be careful not to take up on the rope socket enough to prevent free rotation of the ratchet lever.
5. Tighten the jam nuts "B" at the top of the rope socket.

After installing new dipper trip ropes it will probably be necessary to readjust both cables after the machine has operated a short time, as there is considerable stretch in a new wire rope. Once the initial stretch has worked out of the rope, adjustment to take care of slight additional stretch is made by taking up on the rope socket nuts on the ratchet lever adjusting bolts.

F. DIPPER TEETH:

Inserted dipper teeth wear away faster on the upper side and best life is obtained by reversing them occasionally so that they will wear uniformly on the two sides. To remove a dipper tooth for replacement or reversal proceed as follows: (See Fig. 19)

1. Remove the split pin (cotter) which prevents the tooth being pulled out of the socket.
2. Insert the wedge "A", (included with the tools and supplies) through the hole in the lip casting and drive in the wedge to loosen the tooth in its socket.
3. Take out the tooth and shims.

Always reverse all the teeth at the same time or install a full set of new teeth so that all points line up for even cutting. Replace the dipper teeth as follows:

1. Insert one of the soft steel shims "B" along either V-shaped side of the socket so that the tooth will be tight when the cotter pin hole is lined up with the opening in the dipper lip. If necessary in order to line up the teeth for even cutting, more than one shim may be used for some teeth but be sure there is not more than $\frac{1}{4}$ " between the base of the tooth shoulder and the dipper lip.



FIG. 19

G. DRAGLINE FAIRLEAD:

No adjustment of the fairlead is required except to line up the sheaves with the lead of the drag rope from the top of the drag drum as described in section covering conversion and installation of the various front end equipments.

H. DRAGLINE BUCKET TEETH:

The inserted teeth on the dragline bucket are similar to those on the shovel dipper although not interchangeable with them. To distribute the wear on both surfaces of the dragline bucket teeth reverse them as described for reversal of the shovel dipper teeth.

I. DRAG CHAINS:

The drag chains are attached to the front of the dragline bucket by reversible clevises. For ordinary digging the clevises are assembled so that the drag chains are carried in low position. For deeper cutting the clevises are reversed so that drag chains are carried in the high position.

For removal of the clevises for reversal or replacement proceed as follows:

1. Take out the lock pin holding the clevis pin in place.
2. Remove the clevis pin.
3. Free the clevis from the drag chain wearing ring, turn the clevis over, and replace it in the wearing ring. (The clevis must be reversed in the wearing ring so as not to twist the drag chains.)
4. Attach the clevis to the bucket by replacing the clevis pin and lock pin.

Better life of drag chains can be obtained by reversing them end for end periodically. Chain is attached at both ends by two-piece links. To separate links for reversal or replacement:

1. Drive out the rivets in the half links at both ends of the chain.
2. Take out the chain, turn it end for end and replace it.
3. Assemble the half links and install new rivets.

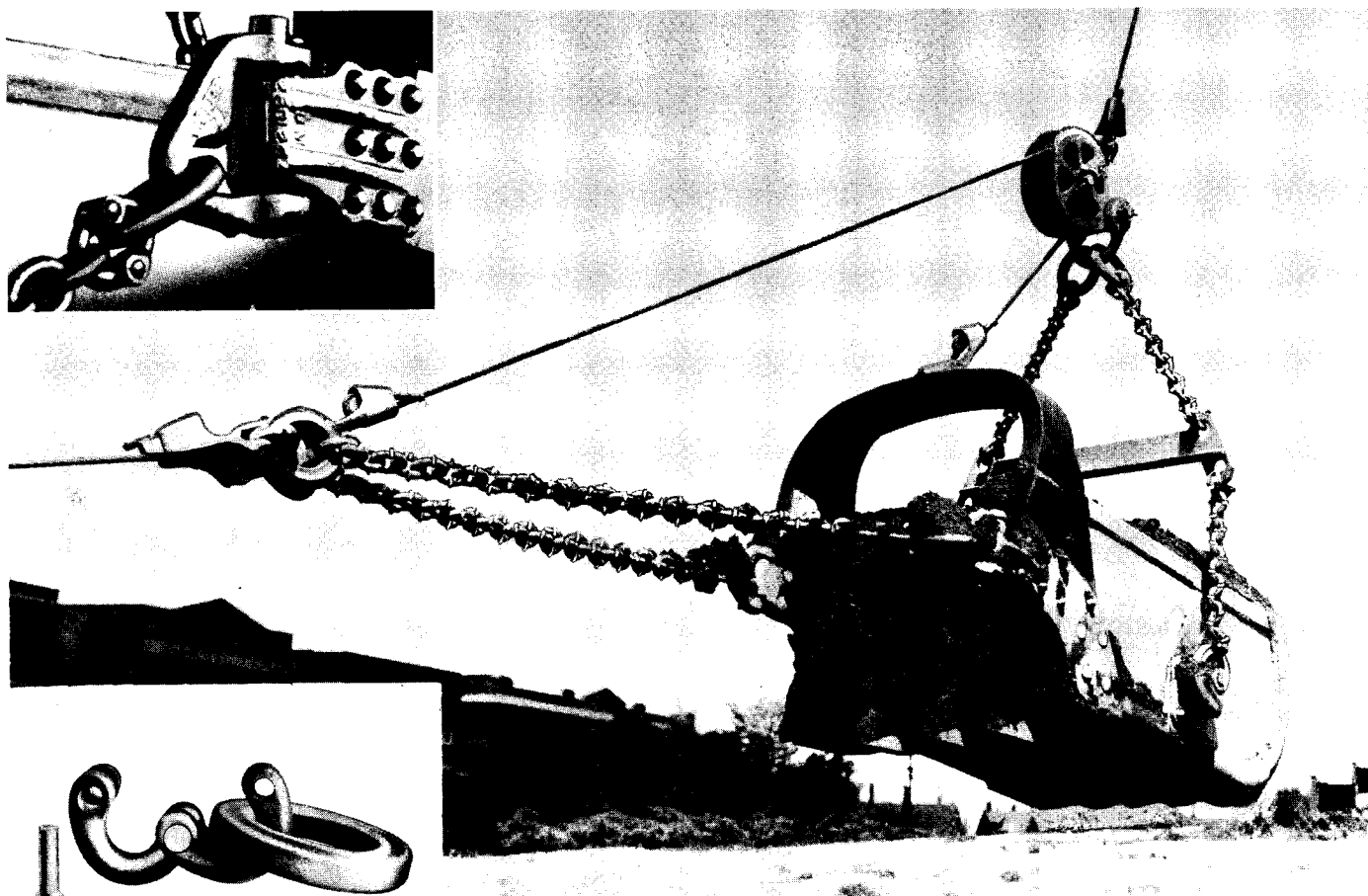


FIG. 20

J. CLAMSHELL TAGLINE:

The clamshell tagline is of the spring-loaded rope-wheel type mounted on the lower section of the boom as shown in Figure 21.

The fairlead sheave bracket may be clamped to the boom angle at any point and will require shifting only if the boom length is changed. Clamp the sheave bracket in the position that gives the most satisfactory rope lead for the working conditions.

Proper tension of the tagline is secured by turning or winding up the drum of the tagline counter-clockwise. The tension required will depend on boom angle, depth of digging, weight of bucket, weight of material, etc., therefore, the exact amount of tension is left to the discretion of the operator. Seven to nine turns of the rope wheel from neutral position will generally give satisfactory results.

Take care not to overwind the spring so as to pull it out of shape. If this should happen remove the spring from the barrel and bend a new hook on the end.

If the tagline rope becomes worn where it passes around the fairlead sheave, pull out the rope so that a different portion comes at the sheave, cut off the excess length at the bucket and readjust the rope wheel for correct tension.

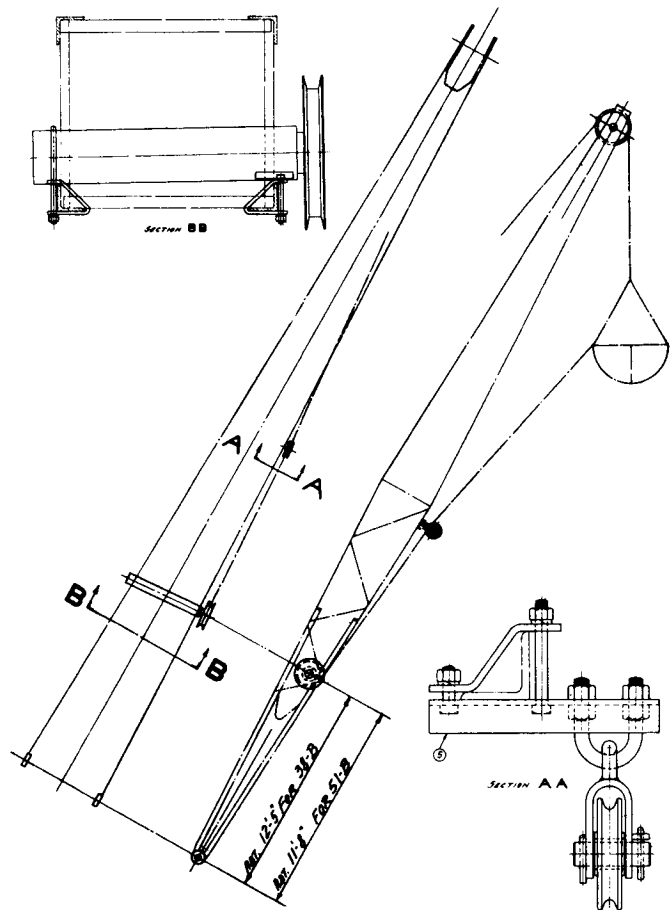


FIG. 21

Lubricating Instructions and Lists of Recommended Lubricants

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GENERAL INFORMATION

Unlike a truck or passenger car, a power excavator cannot be moved into a service station for periodic lubrication by experts. It is the duty of the operator to look out for this most important item of maintenance. Even though there is an "oiler" regularly assigned to the machine the operator should be responsible for correct lubrication of the machine. Much has been done to simplify the lubrication of the modern power excavator but no machinery can stand up under the severe duty of an excavator without regular application of the correct grade of lubricant at the right time and in the right amount.

This section is written to help the operator get the proper lubricant and to assist him in working out a schedule of lubrication that will fit his particular job. Lubricants that cost the least to buy may often prove to be the most expensive to use. If lubrication of the machine is given proper attention, money spent in buying a high grade lubricant will pay dividends in smoother operation and longer life of the machine. However, even the best grade lubricant will be of no use if it is carelessly handled or used in the wrong place.

A. SELECTION OF LUBRICANTS:

Included at the end of this section are a number of sheets prepared by some of the widely known oil companies showing the lubricants they recommend for various applications. We do not wish to imply that no other makes of lubricant would be satisfactory but would suggest that if a substitution is made, then the corresponding products should be the equivalent of those listed.

The lubricants required for successful lubrication of the machine are briefly described in the following paragraphs.

a. Oil

CRANKCASE—Most lubricant manufacturers make a high quality crankcase oil for engine service only. Do not use inferior lubricants in the engine. Change the grade of oil to correspond to the atmospheric temperature as recommended in the engine builders' instruction book. A lighter grade oil is recommended for the engine air cleaner.

ROLLER CHAIN—The oil used for lubrication of the enclosed roller chain transmission drive and also for brushing on the boom hoist roller chains must be light enough (about SAE 20 or SAE 30) to penetrate to the pins inside the rollers. The same oil used for

the engine crankcase is generally satisfactory although most lubricant manufacturers recommend a special oil for roller chain lubrication since it is not necessary to have an oil which will withstand the high temperatures and heavy loads encountered in an engine crankcase.

Refer to line 10 on the lists of recommended lubricants.

HEAVY ROLLER CHAINS—For the heavy roller chains used for the propelling drive and for driving the crowd rope drum a heavier bodied oil which is somewhat adhesive is required so that the oil will not drip or throw off when the chain is running.

This same oil is generally suited to use in an oil can for lubrication of reach rod end pins, bell cranks, shifter collars, toggle links and similar points not provided with grease fittings, although some lubricant manufacturers recommend a lighter grade oil for the oil can points.

Refer to Lines 1 and 9 on the lists of recommended lubricants.

ENCLOSED GEARS—BEARINGS SEPARATELY LUBRICATED—The enclosed bevel gears in the truck frame at the center of rotation carry heavy loads at slow speeds and the bearings are separately lubricated through grease fittings. Use a heavy bodied transmission or gear oil of about SAE 140 grade for summer service. The next lighter grade is preferable for cold weather use. This same oil is generally recommended for lubrication of the flexible coupling connecting the two sections of the horizontal transmission shaft.

Refer to lines 19 and 37 on the lists of recommended lubricants.

ENCLOSED GEARS—BEARINGS USING SAME LUBRICANT—The enclosed bevel gears in the reversing transmission gear case operate at higher speeds than the propelling gears in the truck frame and the same oil lubricates the anti-friction bearings on the transmission shaft, therefore, a lighter transmission or gear oil of about SAE 90 grade is recommended by most lubricant manufacturers. For cold weather operation it may be advisable to use an SAE 80 transmission oil so that it will flow freely at the lower temperature.

See Line 17 on the lists of recommended lubricants.

b. Grease

GENERAL PURPOSE GREASE—General purpose grease (often called chassis grease) should be used for lubrication of all bearings exposed to moisture, such as the bearings in the lower works and the front end equipment. This grease may be used for either plain or anti-friction bearings providing that the temperature of the bearing does not exceed 200° F. Grease must be water repellent type such as most cup grease having lime soap base. Use a grade that can be easily handled in the grease gun. If temperature variations are not too extreme one grade of grease can be used the year around.

Refer to Line 2b on the lists of recommended lubricants.

BALL AND ROLLER BEARING GREASE—Ball and roller bearing grease (often called wheel-bearing grease) is prepared especially for lubrication of anti-friction bearings, but may also be used for plain bearings provided the bearings are not subject to excessive moisture. This grease must be a high temperature type grease (melting point above 300° F) such as most soda base greases. Since this grease is used in the anti-friction bearings which are serviced at relatively long intervals it must have good stability and resistance to oxidation so that it will not separate, break down or become hard.

Refer to Lines 2a and 5 on the lists of recommended lubricants.

c. Gear Compound

Gear compound (also known as gear shield) is used on all open or partially enclosed gears (including the swing rack) and for protecting the double-flanged hook roller path. This may also be used to protect the grooves of the rope sheaves and drums. Most lubricant manufacturers also recommend gear compound for lubrication of the dipper handle slide plates although some manufacturers recommend a heavy oil or grease for slide plate lubrication, particularly in cold weather.

Gear compound must have heavy body to cushion the mesh of the gear teeth. It must also be adhesive to resist running or throwing off the gears. Most gear compounds are relatively hard at room temperature and must be heated to make them fluid enough to pour or brush on. Some lubricant manufacturers have a gear compound which contains a solvent so that the compound is fluid at ordinary temperatures but after application, the solvent evaporates and leaves a thin film of adhesive gear compound. **DO NOT** heat solvent-type gear compound before application.

Refer to Lines 12b, 14 and 15 on the lists of recommended lubricants.

For lubrication of the wire ropes use either a light gear compound or a heavy oil. If gear compound is used it is generally necessary to take the ropes off the machine and run them through a bath of gear compound heated until it is quite fluid. Where it is not practical to remove the ropes from the machine a heavy oil or fluid gear compound can be brushed or swabbed on the rope. A good method is to rub the lubricant on the rope by hand, protecting the hand with a leather glove.

Refer to Line 6 on the lists of recommended lubricants.

B. FREQUENCY OF LUBRICATION:

With greater use made of anti-friction bearings the number of points requiring frequent lubrication has been greatly reduced. It is necessary, however, to keep an accurate record or "log" of the machine lubrication in order to keep track of just when lubrication is required at any particular point.

When the machine is operated more than one shift each day, all crews must cooperate so that no lubrication point will be overlooked but at the same time over-lubrication can be avoided. It is usually best to take care of most of the lubrication at the beginning of the shift, while the engine is being warmed up. A few points that need lubrication more than once a shift can usually be taken care of during a short wait for a truck or some other such delay. If no such delay occurs the machine must be stopped and the lubrication attended to because serious damage can result if the machine is operated without proper lubrication.

Keep a written record on a calendar or in a notebook showing just which points have been serviced on a given date. Most engines can be equipped with some sort of "hourmeter" which automatically registers the hours of operation of the engine. Such a device is useful in keeping a lubrication "log". By looking at the hourmeter the operator on any shift can tell just how many hours the machine has been running since the last notation was made.

The lubrication charts in this section show the principal points requiring regular lubrication. The heavy lines are brought out from the point to be lubricated to the side of the chart. The number at the end of each line refers to the line numbers on the lists of recommended lubricants at the end of this section. The column in which the number appears determines the frequency for normal lubrication requirements. For instance all points requiring lubrication once a shift are brought out to the column headed "Once a shift".

In recommending frequency of lubrication five general divisions have been made, namely

1. Twice a shift (Every 4 hours)
2. Once a shift (Every 8 hours)
3. Every five shifts (Every 40 hours)
4. Every 20 shifts (Every 160 hours)
5. Every 60 shifts (Every 480 hours)

The frequency of lubrication, as given in the above tabulation, is intended as a guide and it does not mean that under certain unusual operating conditions some points may not require more frequent lubrication or other special attention. Use good judgment and common sense in lubricating a machine. If a bearing is showing signs of trouble by overheating or making an unusual noise it should get attention immediately. Possibly the grease was dirty or of the wrong grade.

New bushings sometimes overheat from being too tight a fit. An old bushing may overheat because it is worn so that the grease would not stay in for the full stated frequency of lubrication. In some cases it may be necessary to "baby" the bearing along by frequent greasing until the cause of the trouble is overcome. It is much better to lose a little time on one shift to give extra attention to a point which needs lubrication than to try to keep running until the end of the shift.

The most common cause of overheating of an anti-friction bearing is churning of the grease which occurs when the bearing is packed too full. If grease leaks out of an anti-friction bearing it is almost a sure sign that too much grease was added to the bearing. Don't change the frequency of greasing but decrease the amount of grease added at each servicing.

Lubrication of all points at specified 4 hour and 8 hour intervals must be taken care of but for the longer intervals, specified for the anti-friction bearings, etc., it is permissible to vary from the basic hours within reasonable limits. For instance, if the machine was working two shifts, of eight hours each, the forty hour interval would fall on opposite shifts each successive time. It would be quite satisfactory to lubricate the 40 hour points at the end of 32 hours or allow them to go until 48 hours have elapsed so that the same shift could take care of the lubrication. The important thing is to be sure not to omit any points requiring lubrication and not to over-lubricate the anti-friction bearings which need lubrication less frequently.

SECTION IV — CHAPTER X

A good operator never neglects lubrication of his machine. It may require a little study on his part to find out just how much lubricant should be added at each servicing, but such a study will be repaid by a smooth running machine and long wearing parts.

Most wearing parts need lubricants applied regularly in small quantities rather than large amounts at infrequent intervals. It does no good to pump grease into a plain bearing after the grease starts to come out except that bearings, such as the lower works bearings, which may collect dirt **SHOULD HAVE EXCESS GREASE ADDED TO THE BEARINGS TO FORCE OUT THE OLD GREASE** which may have collected grit. On the other hand, when lubricating anti-friction bearings the oiler must be careful not to force grease into the bearing under pressure. Too much grease will cause an anti-friction bearing to over-heat or may damage the grease seal.

No definite rules can be given as to how much grease should be added to any particular bearing. How much to add depends on the size of the bearing, how hard the machine is being worked, how much the bearing is worn and the grade of grease being used. Keep a close check on all of the bearings until you are sure the grease added at one servicing is enough to last until the next servicing.

C. KEEPING LUBRICANTS CLEAN:

Even the best lubricant is useless in preventing wear if it has become dirty by careless handling and storage methods. The manufacturer usually packs the lubricant in tight containers to keep it clean and it is the duty of the operator and the oiler (if one is assigned to the machine) to see that no dirt gets in the lubricant.

1. Keep all oil and grease in tightly covered containers.
2. Wipe off covers before opening containers.
3. Keep funnels, oil cans, grease guns, etc., in a clean place and wipe off before using.
4. Wipe off each grease fitting just before attaching grease gun. Wipe off oil filler caps before taking them off.

When making regular inspection of the machinery, watch for signs of incorrect lubrication such as an accumulation of excess grease. Be sure that the grease has not come from a broken or disconnected grease pipe. If a grease line or fitting is found damaged have it repaired at once so that proper lubrication can be restored.

LOWER WORKS LUBRICATION

A. SPECIAL INSTRUCTIONS:

All bearings in the truck frame are sleeve bearings, grease-lubricated through pressure fittings. The fittings for the propelling machinery in the truck frame are piped out to a lubrication "header" at the front end of the truck frame. Each fitting is marked to show which bearing it serves. The drive and take-up tumbler shafts and the idler roller shafts have individual grease fittings.

An oil filler pipe for the gear case is also brought out to the front of the truck frame. There are high and low level test plugs in addition to a drain plug in the gear case at the center of rotation. Watch under the machine for oil puddles which would indicate loss of oil from the gear case.

Since the crawler mounting may have to operate in water be sure the grease gun is filled with a water repellent General Purpose Grease when servicing the fittings in the Lower Works. Add grease to each bearing until some old grease is forced out. This will tend to flush out any dirt or grit which may have worked into the bearing.

Frequency of lubrication given on chart is based on normal operating service. When traveling on long moves, service the Lower Works grease fittings once every two hours. Watch all bearings closely and if there is any excessive heating, force in extra grease until the bearing starts to run cooler. Also give extra attention to the track link pins and propelling chains to prevent running with insufficient lubrication.

In addition to the fittings on the Lower Works service the following Upper Works fittings every two hours. (These four fittings are grouped on the lubrication header to the left side of the deck machinery.)

1. Vertical propel shaft upper bushing.
2. Propel gear thrust washer.
3. Swing gear bushings.
4. Swing gear thrust washer.

Remember that even though the machine is not propelled very much there is considerable back and forth movement while the machine is working. This movement tends to squeeze the grease out of the bearing and cutting will start if lubrication of the tumbler shafts and idler rollers is neglected.

a. Reference Notes and Lower Works Lubrication Chart

NOTE: 1. Clean fittings before applying the lubricant gun. Propel the machine back and forth a short distance after greasing to ensure distribution of the grease all the way around the bushings.

NOTE: 2. Fittings for front tumbler bushing may be on inside end of shaft or on outer end of shaft.

NOTE: 3. Track link pins—Some operators prefer to run these dry but field tests indicate better service can be obtained if a small quantity of drained crankcase oil is poured onto the tread pins at least each time the engine crankcase is drained. Lubricate the track link pins once each shift when the machine is being propelled long distances.

NOTE: 4. Propel Gear Case—Every five 8-hour shifts check level with machine on level ground and add lubricant if necessary. When machine has been operated in deep water or following a heavy rain remove drain plug and allow any accumulation of water to drain off.

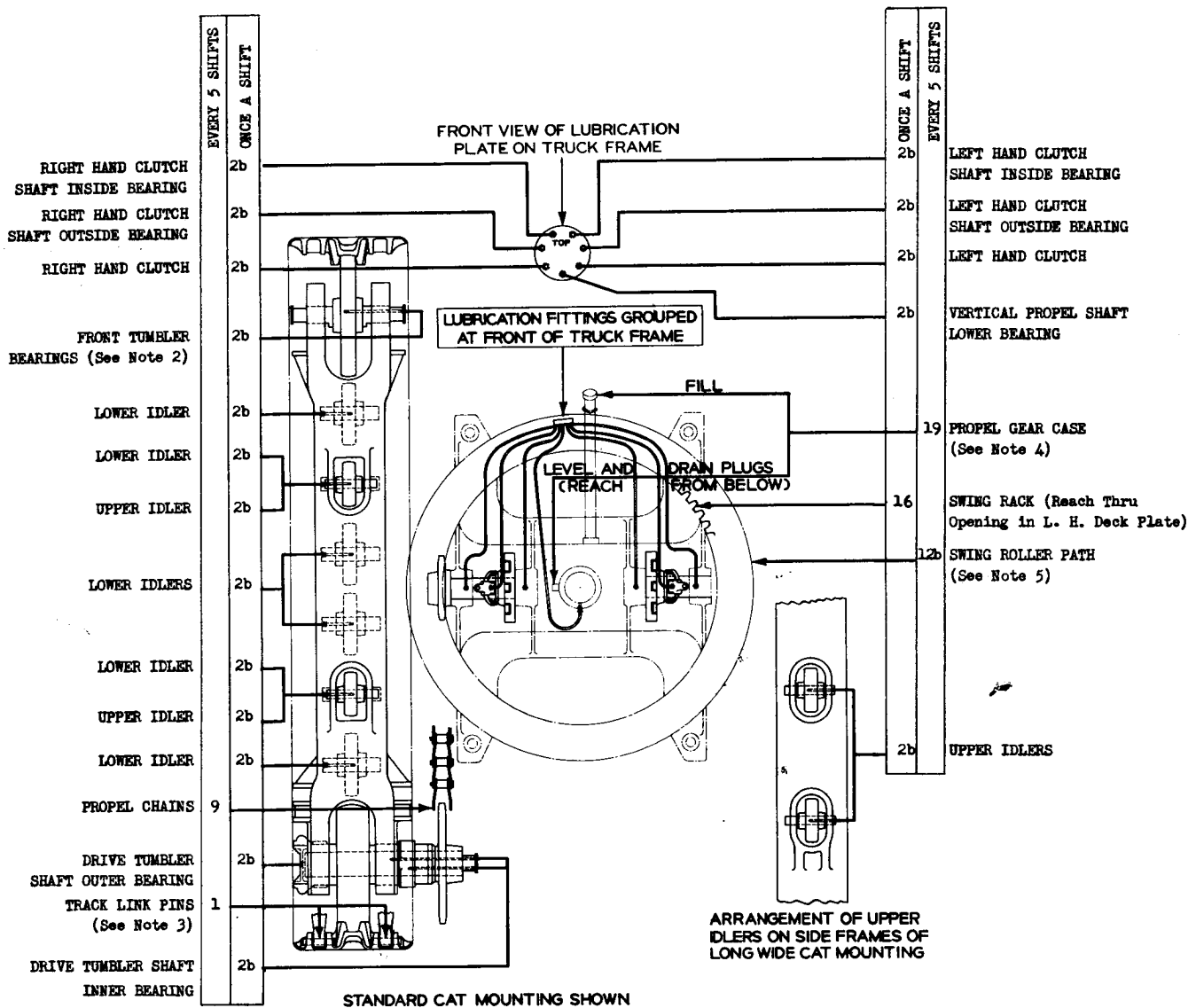
Twice a year, or when temperature changes make it necessary, drain the propel gear case immediately after propelling, and fill with three and one-half gallons of transmission oil of the correct grade.

NOTE: 5. Swing roller path—Keep all contact surfaces of the double flanged roller path thinly coated with gear compound. (The same as used on the swing rack.) If dirt accumulates, wash off old lubricant with gasoline or other solvent and apply fresh coat.

NOTE: 6. Steering Clutches—The Grease fittings on the header are piped to the clutch shifter levers which are drilled with a grease passage so that when the fitting is serviced grease drops down on the groove of the clutch shifter collar. (Be sure clutch is engaged for propelling straight ahead when servicing these fittings.) Occasionally remove the clutch covers and clean off any dirt which may have accumulated on clutch splines.

b. Lubrication Chart — Lower Works

For Reference Notes See Page 5



Oil Can Points—Every 8-hours oil all bell crank and lever pins of the steering clutch and digging lock lever assembly.

b. Reference Notes for Revolving Frame Lubrication Chart

- NOTE: 1. Clean fittings before applying the lubricant gun.
- NOTE: 2. For shovel, or similar service, where the boom hoist is seldom used it is not necessary to service the two fittings for the boom hoist drum shaft except just before using the boom hoist.
- NOTE: 3. Reach the cone roller and equalizer pin grease fittings from the ground. When starting a new machine watch the cone roller bushings carefully and lubricate frequently if they are running hot. Clean off excess grease which may ooze out of the bushings so that it will not get on the cone roller path.
- NOTE: 4. Every 8 hours inspect the propelling gear at the top of the vertical propel shaft from below and if there are any bright spots on it, or the mating vertical swing shaft gear, reach through the op-

ening in the deck just to the rear of the vertical transmission gear case and apply lubricant to the teeth of the vertical transmission shaft pinion until sufficient lubricant has followed through to coat both the swing and propel gears.

On machines with standard Propel set the Swing and Propel Jaw Clutch lever in neutral so that the machine will not swing while these gears are being lubricated.

On machines with Independent Propelling be sure there is sufficient clearance for full rotation of the Upper Works as the revolving frame will swing while the gears are being lubricated.

- NOTE: 5. The vertical transmission shaft lower bearing is an anti-friction bearing. Service its grease fitting only once each sixty 8-hour shifts.

B. DECK MACHINERY LUBRICATION :

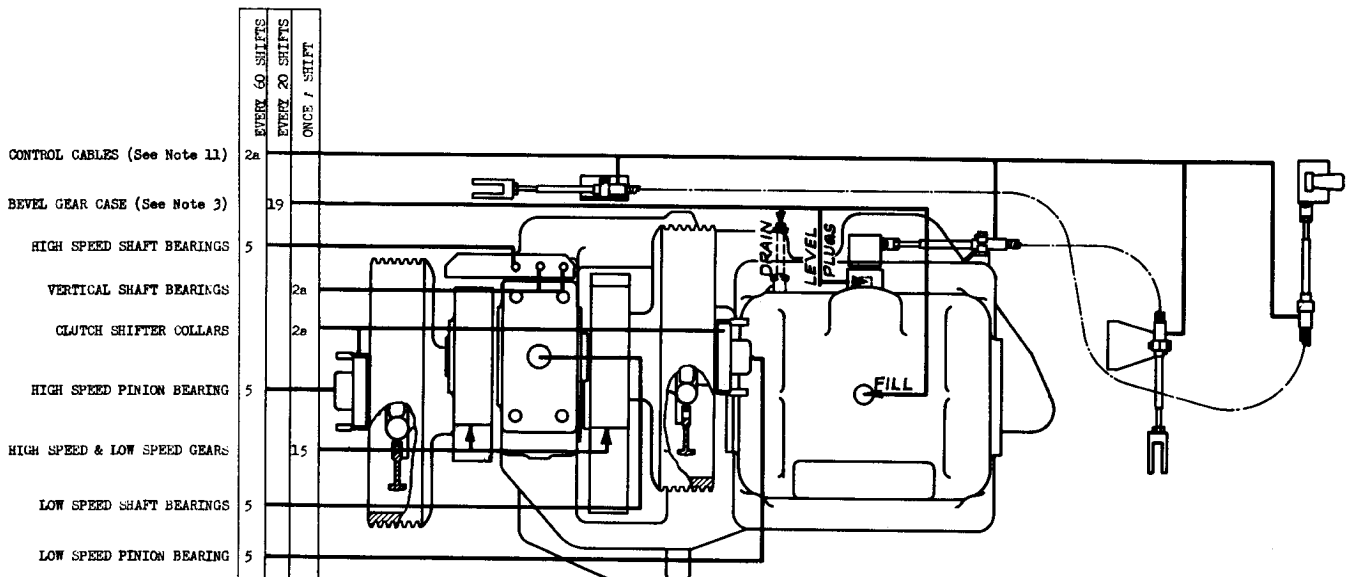
Most of the bearings for the deck machinery, operating levers, shafts, bell cranks, etc. have grease fittings tapped directly into the bearings. Location of most of these fittings, as well as the other points on the deck machinery requiring lubrication are shown on the Deck Machinery Lubrication Chart. The chart is shown with shovel crowd machinery installed. There

is a separate chart for the high and low speed propelling machinery installed in place of the shovel crowd machinery on machines having Independent Propelling.

For convenience, the same grease can be used in servicing all bearings but be sure that the grease you use is a high-temperature grease suitable for the anti-friction bearings used in many locations.

Lubrication Chart — Independent Propelling Machinery

For Reference Notes See Page 9

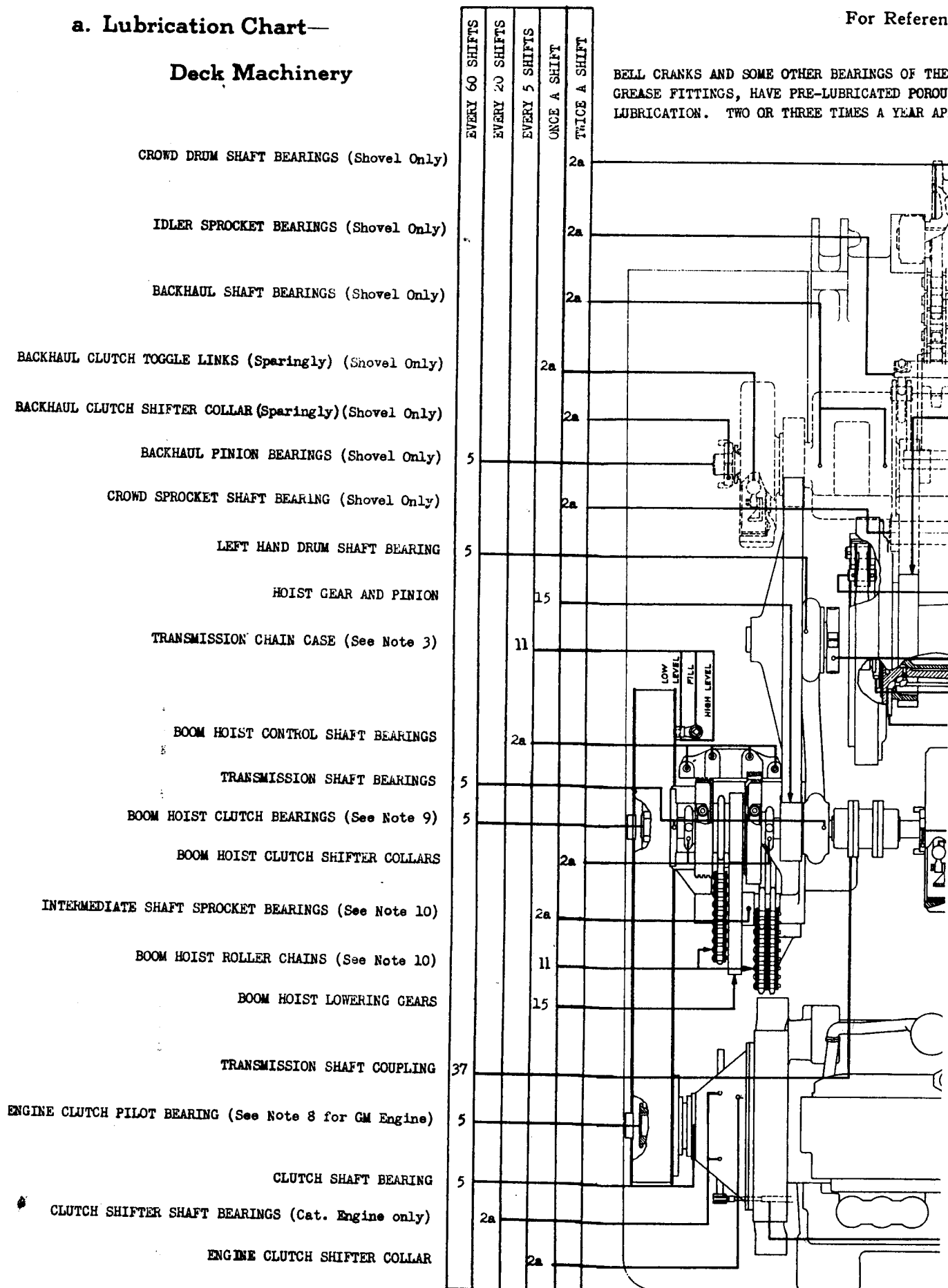


a. Lubrication Chart—

Deck Machinery

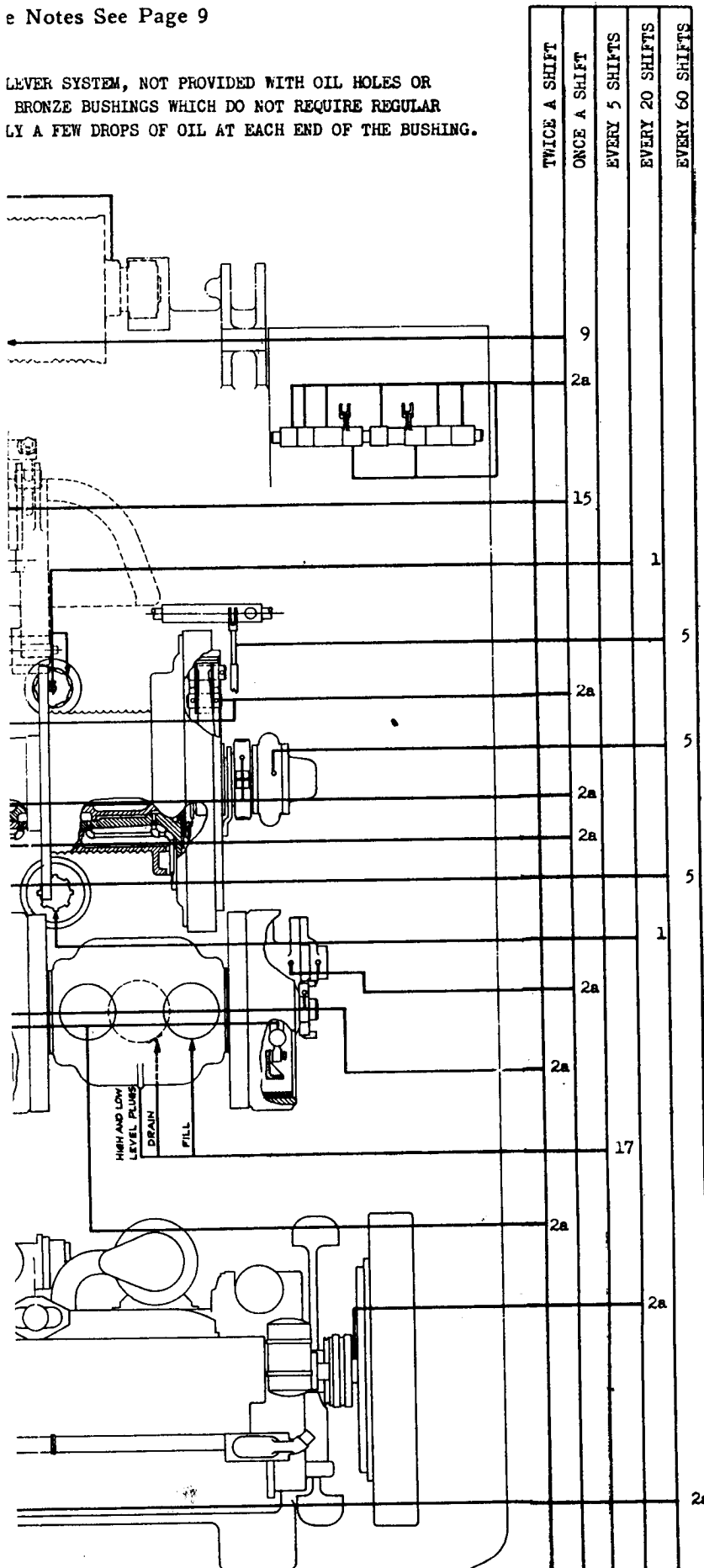
For Reference

BELL CRANKS AND SOME OTHER BEARINGS OF THE GREASE FITTINGS, HAVE PRE-LUBRICATED POROUS LUBRICATION. TWO OR THREE TIMES A YEAR APP



NOTE: On G.M.C. Engines With Rockford Clutch, Lubricate Both Clutch Cam Shaft Fittings Every 6 Months. (See G.M.C. Manual)

LEVER SYSTEM, NOT PROVIDED WITH OIL HOLES OR BRONZE BUSHINGS WHICH DO NOT REQUIRE REGULARLY A FEW DROPS OF OIL AT EACH END OF THE BUSHING.



	TWICE A SHIFT	ONCE A SHIFT	EVERY 5 SHIFTS	EVERY 20 SHIFTS	EVERY 60 SHIFTS
9					
2a					
15					
1					
5					
2a					
5					
2a					
2a					
5					
1					
2a					
2a					
17					
2a					
2a					
2a					

HIGH AND LOW
LEVEL, PLUS
DRAIN
FILL

b. Reference Notes for Deck Machinery Lubrication Chart

NOTE: 1. Clean fittings before applying lubricant gun.

NOTE: 2. Every 8 hours, inspect the swing rack on the truck frame from below. If there are any bright spots, coat the teeth with gear compound. Reach through the opening in the deck plate just to the left of the hoist gear and apply by brush. Swing the machine a little at a time to reach the points needing lubrication.

NOTE: 3. Drive chain and transmission gear cases—every five 8-hour shifts, with the machine on level ground, check level of oil in the drive chain case and the vertical transmission gear case. Add lubricant if necessary to bring it up above the low level plug. Twice a year, or when temperature changes make it necessary, drain the gear cases, (immediately after operation) and refill with the correct grade oil. The chain case requires 5 gallons to refill; the vertical transmission gear case requires 5 gallons.

The reversing transmission gear case of the Independent Propelling machinery holds 4 gallons.

NOTE: 4. Swing and Propel Jaw Clutch—Every twenty 8-hour shifts, remove the center cover just below the drum shaft, on standard machines (without Independent Propelling) pour engine oil over the splines of the vertical swing shaft and the vertical propel shaft. On all machines pour oil into the top of the vertical propel shaft to lubricate the swivel joints in the digging lock and steering clutch lever vertical reach rods.

NOTE: 5. Oil Can Points—Every 8 hours lubricate the clutch toggle link pins (very sparingly). Also oil occasionally all reach rod end pins and all parts of swing lock toggle levers.

NOTE: 6. Reach Rod Fittings—Every 8 hours service all grease fittings on ball and socket ends of some reach rods.

NOTE: 7. Once every sixty 8-hour shifts remove the plugs from the ends of the two lubrication pipes for the right drum sleeve, screw a fitting in one pipe and add grease, then remove the grease fitting

and replace plugs. Be careful not to force grease in under pressure or it will come out through the oil seal when operation is resumed. Repeat this procedure for the left drum.

NOTE: 8. Engine Clutch Pilot Bearing—Every sixty 8-hour shifts swing back the panel in the left side of the cab and remove the large diameter pipe plug in the side of the chain case. Lubricate the pilot bearing sparingly so that excess grease will not get on the clutch plates and cause slipping.

On machines powered with a General Motors Diesel engine the clutch pilot bearing is packed at the factory and requires no further attention except repacking when the clutch is removed for relining.

NOTE: 9. Boom Hoist Machinery—Every sixty 8-hour shifts swing back the cover plate over the hole in the cab at the left end of the transmission shaft, remove the large diameter pipe plug in side of the chain case and service the grease fitting for the boom hoist clutch bearings. (If there is a pipe plug in the end of the shaft, take it out and install a grease fitting. Replace the pipe plug after servicing the fitting.) CAUTION: Add grease sparingly. Excess grease may be pressed out through the ends and get on the clutch bands.

NOTE: 10. When the boom hoist is being used regularly brush oil on the roller chain once every five shifts and keep the teeth of the lowering gear and pinion coated with gear compound. Service the grease fittings for the boom hoist intermediate shaft bearing once every 8 hours if boom hoist is being used regularly, otherwise grease just before using the boom hoist.

NOTE: 11. Every sixty 8-hour shifts (or in case the operating lever "hangs up") service the grease fittings at both ends of the flexible cables used for operation of the engine clutch and the jaw clutch, high-speed and low-speed clutches of the Independent Propel. Add grease sparingly.

FRONT END EQUIPMENT LUBRICATION

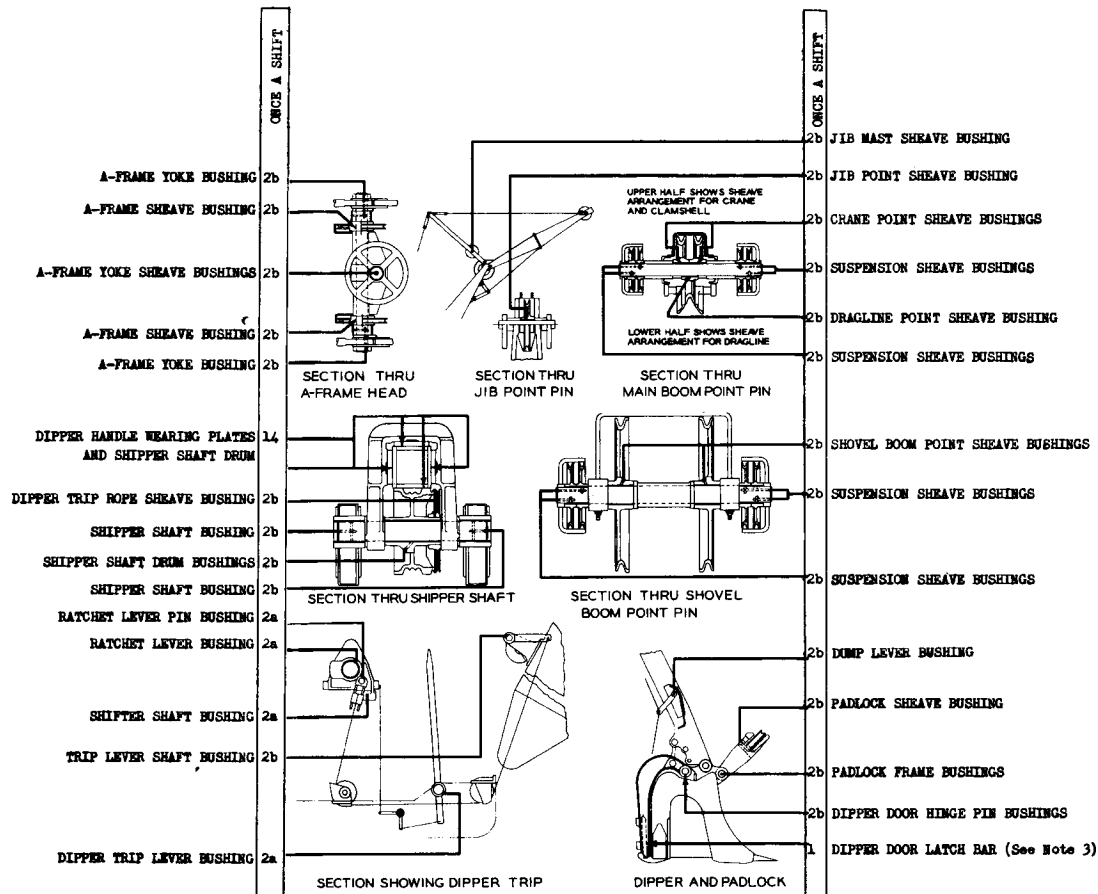
A. GENERAL:

When lubricating your machine do not neglect the Front End Equipment which is working under dirt and moisture conditions. Use a water repellent grease (chassis grease) for all grease fittings of the front end equipment. Be sure to add sufficient grease so that

a portion of the old grease is forced out of the bearings each time these fittings are serviced. This will keep dirt out of the bearings.

For convenience the various front end equipments are grouped on the following lubrication chart.

a. Lubrication Chart — Front End Equipment



b. Reference Notes for Front End Equipment Chart

NOTE: 1. Clean fittings before applying lubricant gun.

NOTE: 5. Fairlead—Every 8 hours service the dragline fairlead sheave fittings. (Fairlead shown on Revolving Frame Lubrication Chart in Chapter XII.)

NOTE: 2. Boom Suspension Sheaves—Every 8 hours lubricate all boom suspension sheaves (including the bridle sheaves on crane booms having pendent suspension.)

NOTE: 6. Tagline—Keep tagline barrel half full of oil, use same oil as used in engine crankcase. There is some slight leakage of oil through the bushings but one filling should last for several months. If leakage is excessive use heavier grade of oil.

NOTE: 3. Dipper Latch Bar—Every 8 hours lubricate all wearing surfaces of the latch bar by pouring on a little engine oil.

NOTE: 4. Wire Rope—Keep all wire ropes (except dragline drag rope) coated with lubricant, particularly where the rope passes over sheaves or winds on drums.

NOTE: 7. Dragline Bucket Dump Sheave—Once a shift, rotate sheave so plug is at top, remove plug and add heavy oil if needed. (See line 1 on Lists of Recommended Lubricants)

BUCYRUS-ERIE MACHINES

LUBRICANTS RECOMMENDED

by

STANDARD OIL COMPANY (IND.)

PARTS TO BE LUBRICATED	Line No.	RECOMMENDATIONS	
		WARM WEATHER (Above 32°F.)	COLD WEATHER (Below 32°F.)**
PLAIN BEARINGS			
Oil Lubricated	1	INDOIL Industrial Oil No. 51 or Motor Oil No. 30	INDOIL Industrial Oil No. 31 or Motor Oil No. 20
Grease Lubricated			
Upper Works (Deck Machinery).....	2a	STANDARD Lithium Multi-Purpose Greas or STANOLITH Grease No. 57	STANDARD Lithium Multi-Purpose Grease or STANOLITH Grease No. 42
Lower Works and Front End...	2b	STANDARD Lithium Multi-Purpose Grease or STANOLITH Grease No. 57	STANDARD Lithium Multi-Purpose Grease or STANOLITH Grease No. 42
BALL OR ROLLER BEARINGS			
Grease Lubricated.....	5	STANDARD Lithium Multi-Purpose Grease or STANOLITH Grease No. 57	STANDARD Lithium Multi-Purpose Grease or STANOLITH Grease No. 42
WIRE ROPE	6	INDOIL Industrial Oil No. 51 or Motor Oil No. 30	INDOIL Industrial Oil No. 31 or Motor Oil No. 20-20W
CLUTCHES AND BRAKES			
Air Operated.....	7	INDOIL Industrial Oil No. 51 or Motor Oil No. 30	INDOIL Industrial Oil No. 31 or Motor Oil No. 20-20W
CHAIN DRIVE			
Heavy Roller Chain.....	9	INDOIL Industrial Oil No. 51 or Motor Oil No. 30	INDOIL Industrial Oil No. 31 or Motor Oil No. 20-20W
Enclosed Transmission Chain....	10	INDOIL Industrial Oil No. 51 or Motor Oil No. 30	INDOIL Industrial Oil No. 31 or Motor Oil No. 20-20W
ROLLER PATHS			
Live Rollers.....	12a	CALUMET Compound No. 10 or No. 5 or CALUMET Viscous Lubricant No. 10-X or No. 5-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X
Hook Rollers	12b	CALUMET Compound No. 10 or No. 5 or CALUMET Viscous Lubricant No. 10-X or No. 5-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X
SLIDING SURFACES			
Rolling Contacts.....	13	CALUMET Compound No. 10 or CALUMET Viscous Lubricant No. 10-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X
Shoe Contacts	14	CALUMET Compound No. 10 or CALUMET Viscous Lubricant No. 10-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X
OPEN AND PARTIALLY ENCLOSED GEARS			
.....	15	CALUMET Compound No. 10 or CALUMET Viscous Lubricant No. 10-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X
RACK TEETH.....	16	CALUMET Compound No. 10 or CALUMET Viscous Lubricant No. 10-X	CALUMET Compound No. 5 or CALUMET Viscous Lubricant No. 5-X

PARTS TO BE LUBRICATED	RECOMMENDATIONS		
	WARM WEATHER (Above 32°F.)	COLD WEATHER (Below 32°F.)**	
	Line No.		
ENCLOSED GEARS			
Bearings Using Same Lubricant.....	17	STANOGEAR Compound No. 3 or STANDARD Multi-Purpose Gear Lubricant No. 90	STANOGEAR Compound No. 2 or STANDARD Multi-Purpose Gear Lubricant No. 80
Pressure Pump Oiling.....	18	STANOGEAR Compound No. 3 or STANDARD Multi-Purpose Gear Lubricant No. 90	STANOGEAR Compound No. 2 or STANDARD Multi-Purpose Gear Lubricant No. 80
Bearings Separately Lubricated	19	STANOGEAR Compound No. 5 or STANDARD Multi-Purpose Gear Lubricant No. 140	STANOGEAR Compound No. 2 or STANDARD Multi-Purpose Gear Lubricant No. 90
ELECTRIC MOTORS AND GENERATORS			
Ball or Roller Bearings Grease Lubricated.....	28	STANOBAR Grease No. 2	STANOBAR Grease "S"
Oil Lubricated.....	29	STANOIL Industrial Oil No. 31 or Motor Oil No. 20-20W	STANOIL Industrial Oil No. 15 or Motor Oil No. 10W
AUXILIARY AIR COMPRESSOR...	34	STANOIL Industrial Oil No. 31 or Motor Oil No. 20-20W	STANOIL Industrial Oil No. 31 or Motor Oil No. 20-20W
FLEXIBLE COUPLINGS			
Falk.....	36	STANDARD Wheel Bearing Grease Medium or STANDARD Lithium Multi-Purpose Grease	STANDARD Wheel Bearing Grease Medium or STANDARD Lithium Multi-Purpose Grease
Fast's and Poole.....	37	CALUMET Viscous Lubricant No. 2-X or STANDARD Multi-Purpose Gear Lubricant No. 140	CALUMET Viscous Lubricant No. 2-X or STANDARD Multi-Purpose Gear Lubricant No. 90

INTERNAL COMBUSTION ENGINE - Refer to Engine Builder's Recommendation

NOTE: *Builder also approves same oil as used in engine for items Nos. 1, 6, 7, 9 and 10

**For extremely low temperatures, the lubricant supplier should be consulted regarding the most suitable grade.

The services of an experienced Lubrication Engineer to assist you on any lubrication problem may be obtained without obligation by writing or telephoning to the nearest Standard Oil Company (Indiana) office listed below:

Billings, Montana	Evansville, Indiana	Joliet, Illinois	Minneapolis, Minnesota
Chicago, Illinois	Fargo, North Dakota	Kansas City, Missouri	Peoria, Illinois
Decatur, Illinois	Grand Rapids, Michigan	LaCrosse, Wisconsin	Saginaw, Michigan
Denver, Colorado	Green Bay, Wisconsin	Mankato, Minnesota	St. Louis, Missouri
Des Moines, Iowa	Huron, South Dakota	Mason City, Iowa	South Bend, Indiana
Detroit, Michigan	Indianapolis, Indiana	Milwaukee, Wisconsin	Wichita, Kansas
Duluth, Minnesota		Omaha, Nebraska	

(S - Friction Swing)
3000 - 1 - 54

LUBRICANTS
RECOMMENDED BY THE TEXAS COMPANY
FOR USE ON
BUCYRUS-ERIE MACHINES

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	<u>RECOMMENDED LUBRICANT</u>	
		<u>WARM WEATHER</u> <u>(Above 32°F.)</u>	<u>COLD WEATHER</u> <u>(Below 32°F.)</u>
PLAIN BEARINGS			
Oil Lubricated	1.	Texaco Ursa Oil Heavy Duty SAE 30	Texaco Ursa Oil Heavy Duty SAE 20-20W
Grease Lubricated			
Upper Works (Deck Machinery)	2a.	Texaco Marfak Heavy Duty 2	Texaco Marfak Heavy Duty 2
Lower Works and Front End	2b.	Texaco Track Roll Lubricant M	Texaco Track Roll Lubricant L
BALL OR ROLLER BEARINGS			
Grease Lubricated	5.	Texaco Marfak Heavy Duty 2	Texaco Marfak Heavy Duty 2
WIRE ROPE			
	6.	Texaco Crater A	Texaco Crater A
CLUTCHES AND BRAKES			
Air Operated	7.	Texaco Ursa Oil Heavy Duty SAE 30	Texaco Ursa Oil Heavy Duty SAE 20-20W
CHAIN DRIVE			
Heavy Roller Chain	9.	Texaco Ursa Oil Heavy Duty SAE 30	Texaco Ursa Oil Heavy Duty SAE 20-20W
Silent Chain	10.	Texaco Ursa Oil Heavy Duty SAE 30	Texaco Ursa Oil Heavy Duty SAE 20-20W
Enclosed			
ROLLER PATHS			
	12b.	Texaco Crater 2 (Apply Hot)	Texaco Crater 0
SLIDING SURFACES			
Rolling Contacts	13.	Texaco Crater 2	Texaco Crater 0
Shoe Contact	14.	Texaco Crater 2	Texaco Crater 0
OPEN AND PARTIALLY ENCLOSED GEARS			
	15.	Texaco Crater 2 (Apply Hot)	Texaco Crater 0

BUCYRUS-ERIE MACHINES (CONT.)

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	<u>RECOMMENDED LUBRICANT</u>	
		<u>WARM WEATHER</u> <u>(Above 32°F.)</u>	<u>COLD WEATHER</u> <u>(Below 32°F.)</u>
RACK TEETH	16.	Texaco Crater 2 (Apply Hot)	Texaco Crater 0
ENCLOSED GEARS			
Bearings Using Same Lubricant	17.	Texaco Meropa Lubri- c-3	Texaco Meropa Lubri- c-3
Pressure Pump Oiling	18.	Texaco Meropa Lubri- c-3	Texaco Meropa Lubri- c-3
Bearings Separately Lubricated	19.	Texaco Meropa Lubri- c-6	Texaco Meropa Lubri- c-3
ELECTRIC MOTORS AND GENERATORS			
BALL OR ROLLER BEARINGS			
Grease Lubricated	28.	Texaco Regal Starfak 2	Texaco Regal Starfak 2
Oil Lubricated	29.	Texaco Alcaid Oil	Texaco Cetus Oil
AUXILIARY AIR COMPRESSOR	34.	Texaco Ursa Oil Heavy Duty SAE 30	Texaco Ursa Oil Heavy Duty SAE 20-20W
FLEXIBLE COUPLINGS			
Falk	36.	Texaco Marfak Heavy Duty 2	Texaco Marfak Heavy Duty 2
Fast's & Poole	37.	Texaco Meropa Lubri- c-6	Texaco Meropa Lubri- c-6
INTERNAL COMBUSTION ENGINE DRIVE			
Diesel Engine) Gasoline Engine)		See Engine Manufacturer's Bulletin. (See Note.)	

Note: Builder approves use of engine oil for lines 1, 6, 7, 9 and 10.

(S - FRICTION SWINGS)

Lubricants

Recommended by Socony-Vacuum Oil Company, Inc.
for use on

Bucyrus-Erie Machines

PARTS TO BE LUBRICATED

RECOMMENDED LUBRICANT

WARM WEATHER
(Above 32° F)

COLD WEATHER
(Below 32° F)

LINE

PLAIN BEARINGS

Oil Lubricated

1. Mobiloil A or
Gargoyle Viscolite Oil Extra Heavy

Mobiloil Arctic or
Gargoyle Viscolite Oil Extra Heavy

Grease Lubricated
Upper Works
(Deck Machinery)

2a. Mobilgrease MP or
Gargoyle Grease Sovarex L-1

Mobilgrease MP or
Gargoyle Grease Sovarex L-1

Lower Works
and Front End

2b. Mobilgrease MP or
Gargoyle Grease Sovarex L-1

Mobilgrease MP or
Gargoyle Grease Sovarex L-1

BALL OF ROLLER BEARINGS

Grease Lubricated

5. Mobilgrease MP or
Gargoyle Grease Sovarex L-1

Mobilgrease MP or
Gargoyle Grease Sovarex L-1

WIRE ROPE

6. Mobiloil A or
Gargoyle Viscolite Oil Extra Heavy

Mobiloil Arctic or
Gargoyle Viscolite Oil Extra Heavy

CLUTCHES AND BRAKES

Air Operated

7. Mobiloil A or
Gargoyle DTE Oil Heavy Medium

Mobiloil Arctic or
Gargoyle Arctic Oil C

CHAIN DRIVE

Heavy Roller Chain

9. Mobiloil A or
Gargoyle Viscolite Oil Extra Heavy

Mobiloil Arctic or
Gargoyle Viscolite Oil Extra Heavy

Enclosed Transmission
Chain

10. Mobiloil A or
Gargoyle DTE Oil Heavy Medium

Mobiloil Arctic or
Gargoyle Arctic Oil C

ROLLER PATHS

Live Rollers

12a. Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

Hook Rollers

12b. Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

SLIDING SURFACES

Rolling Contacts

13. Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

Shoe Contacts

14. Gargoyle Dorcia No. 150
Pegasus Mobilcote S

Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S

**PARTS TO BE
LUBRICATED**

RECOMMENDED LUBRICANT

**WARM WEATHER
(Above 32° F)**

**COLD WEATHER
(Below 32° F)**

LINE

OPEN AND PARTIALLY ENCLOSED GEARS

- | | | | | |
|--|-----|---|--|---|
| | 15. | Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S | | Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S |
|--|-----|---|--|---|

RACK TEETH

- | | | | | |
|--|-----|---|--|---|
| | 16. | Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S | | Gargoyle Dorcia No. 150 or
Pegasus Mobilcote S |
|--|-----|---|--|---|

ENCLOSED GEARS

Bearings Using Same
Lubricant

- | | | | | |
|--|-----|---|--|---|
| | 17. | Mobilube GX 90 or
Gargoyle Compound DD | | Mobilube GX 80 or
Gargoyle Compound BB |
|--|-----|---|--|---|

Pressure Pump Oiling

- | | | | | |
|--|-----|---|--|---|
| | 18. | Mobilube GX 90 or
Gargoyle Compound DD | | Mobilube GX 80 or
Gargoyle Compound BB |
|--|-----|---|--|---|

Bearings Separately
Lubricated

- | | | | | |
|--|-----|---|--|--|
| | 19. | Mobilube C-140 or
Gargoyle Compound FF | | Mobilube C-90 or
Gargoyle Compound BB |
|--|-----|---|--|--|

ELECTRIC MOTORS AND GENERATORS

Ball or Roller Bearings
Grease Lubricated

- | | | | | |
|--|-----|---|--|---|
| | 28. | Mobilgrease No. 5 or
Gargoyle Grease BRB No. 1 | | Mobilgrease No. 5 or
Gargoyle Grease BRB No. 1 |
|--|-----|---|--|---|

Oil Lubricated

- | | | | | |
|--|-----|--|--|---|
| | 29. | Mobiloil A or
Gargoyle DTE Oil Heavy Medium | | Mobiloil Arctic or
Gargoyle Arctic Oil C |
|--|-----|--|--|---|

AUXILIARY AIR COMPRESSOR

- | | | | | |
|--|-----|--|--|---|
| | 34. | Mobiloil A or
Gargoyle DTE Oil Heavy Medium | | Mobiloil Arctic or
Gargoyle Arctic Oil C |
|--|-----|--|--|---|

FLEXIBLE COUPLINGS

Falk

- | | | | | |
|--|-----|--|--|--|
| | 36. | Mobilgrease MP or
Gargoyle Grease Sovarex L-1 | | Mobilgrease MP or
Gargoyle Grease Sovarex L-1 |
|--|-----|--|--|--|

Fast's and Poole

- | | | | | |
|--|-----|--|--|---|
| | 37. | Mobilube C-140 or
Gargoyle Grease Sovarex L-1 | | Mobilube C-90 or
Gargoyle Grease Sovarex L-1 |
|--|-----|--|--|---|

INTERNAL COMBUSTION ENGINE DRIVE

Diesel Engine)

Gasoline Engine) See Engine Manufacturer's Bulletin (See Note*)

*NOTE: *Builder also approves same oil as used in engine for lines
1, 6, 7, 9 and 10.*

L u b r i c a n t s

Recommended by Sinclair Refining Company

for use on

Bucyrus - Erie Machines

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	<u>RECOMMENDED LUBRICANT</u>	
		<u>WARM WEATHER</u> (Above 32° F)	<u>COLD WEATHER</u> (Below 32° F)
Plain Bearings			
Oil Lubricated	1	Rubilene Oil Light	Gascon Oil A
Grease Lubricated			
Upper Works (Deck Machinery)	2a	Litholine or H. D. Bearing Grease No. 2	Litholine or H. D. Bearing Grease No. 2, 1
Lower Works & Front End	2b	Litholine or H. D. Bearing Grease No. 2	Litholine or H. D. Bearing Grease No. 2, 1
Collar or Ring Oiled	3	Rubilene Oil Light	Gascon Oil A
Ball or Roller Bearings			
Grease Lubricated	5	Litholine	Litholine
Wire Rope			
	6	Jet Lubricant No. 10 * or Gear Protective Compound	Jet Lubricant No. 8 * or Gear Protective Compound (Use Jet Lubricant No. 20 below 0°F. *)
Clutches and Brakes			
Air Operated	7	Rubilene Oil Medium	Gascon Oil A
Chain Drive			
Heavy Roller Chain	9	Rubilene Oil Light	Gascon Oil A
Enclosed Transmission Chain	10	Rubilene Oil Medium	Gascon Oil A
Roller Paths			
Live Rollers	12a	Jet Lubricant No. 20 *	Jet Lubricant No. 20 *
Hook Rollers	12b	Jet Lubricant No. 20 *	Jet Lubricant No. 20 *
Sliding Surfaces			
Rolling Contacts	13	Jet Lubricant No. 20 *	Jet Lubricant No. 20 *
Shoe Contacts	14	Jet Lubricant No. 20 *	Jet Lubricant No. 20 *

* Apply direct from container—no heating required

(over)

RECOMMENDED LUBRICANT

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	<u>WARM WEATHER (Above 32° F)</u>	<u>COLD WEATHER (Below 32° F)</u>
Open and Partially Enclosed Gears	15	Onyx H, Jet Lubricant No. 10* or Gear Protective Compound	Onyx 500, Jet Lubricant No. 8* or Gear Protective Compound
Rack Teeth	16	Jet Lubricant No. 10* or Gear Protective Compound	Jet Lubricant No. 8* or Gear Protective Compound
Enclosed Gears			
Bearings Using Same Lubricant	17	Opaline Gear Lubricant BX	Opaline Gear Lubricant BX or AX
Pressure Pump Oiling	18	Opaline Gear Lubricant BX	Opaline Gear Lubricant BX or AX
Bearings Separately Lubricated	19	Opaline Gear Lubricant CX	Opaline Gear Lubricant BX
Electric Motors and Generators			
Sleeve Bearings			
Ring Oiled	26	Rubilene Oil Light	Gascon Oil A
Grease Lubricated	27	Litholine	Litholine
Ball or Roller Bearings			
Grease Lubricated	28	Litholine	Litholine
Oil Lubricated	29	Rubilene Oil Medium	Gascon Oil A
Auxiliary Air Compressor	34	Rubilene Oil Medium	Gascon Oil A
Flexible Couplings			
Falk	36	H. D. Bearing Grease No. 2	H. D. Bearing Grease No. 2, 1
Fast's and Poole	37	Opaline Gear Lubricant CX	Opaline Gear Lubricant BX
Internal Combustion Engine Drive			
Diesel Engine)			
) See Engine Manufacturer's Bulletin (See NOTE)†			
Gasoline Engine)			

* Apply direct from container — no heating required

† NOTE: Builder also approves same oil as used in engine for lines 1, 6, 7, 9, and 10.

LUBRICANTS

Recommended by Shell Oil Company
for use on

BUCYRUS-ERIE MACHINES

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	<u>RECOMMENDED LUBRICANT</u>	
		Warm Weather (Above 32°F.)	Cold Weather (Below 32°F.)
<u>PLAIN BEARINGS</u>			
Oil Lubricated	1	Shell Rotella Oil 40 * or Shell Carnea Oil 69	Shell Rotella Oil 20 * or Shell Carnea Oil 33
Grease Lubr. Upper Works (Deck Mchy.)	2a	Shell Retinax A ** or Shell Alvania Grease 2 **	Shell Retinax A ** or Shell Alvania Grease 2 **
Grease Lubr. Lower Works & Front End	2b	Shell Retinax A ** or Shell Alvania Grease 2 **	Shell Retinax A ** or Shell Alvania Grease 2 **
<u>BALL OR ROLLER BEARINGS</u>			
Grease Lubricated	5	Shell Retinax A ** or Shell Alvania Grease 2 **	Shell Retinax A ** or Shell Alvania Grease 2 **
<u>WIRE ROPE</u>			
Wire Rope	6	Shell Rotella Oil 40 * or Shell Iruis Oil 79 ***	Shell Rotella Oil 30 * or Shell Iruis Oil 72 ***
<u>CLUTCHES & BRAKES</u>			
Air Operated	7	Shell Rotella Oil 20 * or Shell Clavus Oil 33	Shell Rotella Oil 10 * or Shell Clavus Oil 29
<u>CHAIN DRIVE</u>			
Heavy Roller Chain	9	Shell Rotella Oil 40 * or Shell Carnea Oil 69	Shell Rotella Oil 20 * or Shell Carnea Oil 33
Enclosed Transmission Chain	10	Shell Rotella Oil 20 * or Shell Clavus Oil 33	Shell Rotella Oil 10 * or Shell Clavus Oil 29
<u>ROLLER PATHS</u>			
Live Rollers	12a	Shell Cardium Compound D	Shell Cardium Compound C
Hook Rollers	12b	Shell Cardium Compound D	Shell Cardium Compound C
<u>SLIDING SURFACES</u>			
Rolling Contacts	13	Shell Cardium Compound D	Shell Cardium Compound C
Shoe Contacts	14	Shell Cardium Compound D	Shell Cardium Compound C
<u>OPEN & PARTIALLY ENCLOSED GEARS</u>			
Gears	15	Shell Cardium Compound D	Shell Cardium Compound C
<u>RACK TEETH</u>			
Rack Teeth	16	Shell Cardium Compound D	Shell Cardium Compound C

RECOMMENDED LUBRICANT

<u>PARTS TO BE LUBRICATED</u>	<u>LINE</u>	Warm Weather (Above 32°F.)	Cold Weather (Below 32°F.)
<u>ENCLOSED GEARS</u>			
Bearings Using Same Lubricant	17	Shell Spirax 140 EP or Shell Macoma Oil 76	Shell Spirax 90 EP or Shell Macoma Oil 68
Pressure Pump Oiling	18	Shell Spirax 140 EP or Shell Macoma Oil 76	Shell Spirax 90 EP or Shell Macoma Oil 68
Bearings Separately Lubricated	19	Shell Spirax 140 EP or Shell Macoma Oil 76	Shell Spirax 90 EP or Shell Macoma Oil 68
<u>ELECTRIC MOTORS & GENERATORS</u>			
A-F Bearings - Grease Lubricated	28	Shell Retinax A or Shell Alvania Grease 2	Shell Retinax A or Shell Alvania Grease 2
A-F Bearings - Oil Lubricated	29	Shell Rotella Oil 20 * or Shell Clavus Oil 33	Shell Rotella Oil 10 * or Shell Clavus Oil 29
<u>AUXILIARY AIR COMPRESSOR</u>			
Compressor	34	Shell Rotella Oil 20 * or Shell Clavus Oil 33	Shell Rotella Oil 10 * or Shell Clavus Oil 29
<u>FLEXIBLE COUPLINGS</u>			
Falk	36	Shell Retinax A or Shell Alvania Grease 2	Shell Retinax A or Shell Alvania Grease 2
(Fast's (Poole	37	Shell Cardium Compound D Shell Spirax 140 EP or Shell Macoma Oil 76	Shell Cardium Compound C Shell Spirax 90 EP or Shell Macoma Oil 68
<u>INTERNAL COMBUSTION ENGINE DRIVE</u>			
Diesel or Gasoline Engine		Refer to Recommendations for Manufacturer.	

* A corresponding grade of Shell Talona Oil may be used.

** For grease lubricated plain, ball, or roller bearings which are severely loaded Shell Alvania EP Grease 1 or Shell Alvania EP Grease 2 is suggested.

*** A corresponding grade of Shell Rotella Oil, Shell Talona Oil, Shell Macoma Oil, or Shell Spirax EP may also be used.

Lubricants

Recommended by

GULF OIL CORPORATION—GULF REFINING COMPANY

for use on

BUCYRUS-ERIE EXCAVATING MACHINES

(FRICTION SWING)

PARTS TO BE LUBRICATED	Line No.	RECOMMENDED LUBRICANT	
		Warm Weather (Above 32° F.)	Cold Weather (Below 32° F.)
Plain Bearings Oil Lubricated Grease Lubricated Upper Works (Deck Machinery) Lower Works and Front End	1	Journal Oil B or Gulfube Motor Oil 30	Journal Oil A or Gulfube Motor Oil 20
	2a	Gulflex A or Gulf Precision Grease No. 2	Gulflex A or Gulf Precision Grease No. 1
	2b	Gulflex A or Gulf Supreme Grease No. 2	Gulflex A or Gulf Supreme Grease No. 1
Ball or Roller Bearings Grease Lubricated	5	Gulflex A or Gulf Precision Grease No. 2	Gulflex A or Gulf Precision Grease No. 1
Wire Rope	6	Gulf Lubcote No. 0	Journal Oil B
Clutches and Brakes Air Operated	7	Gulf Harmony Oil C or Gulfube Motor Oil 20	Gulf Seneca Oil A or Gulfube Motor Oil 10 W
Chain Drive Heavy Roller Chain Enclosed Transmission Chain	9	Journal Oil B or Gulfube Motor Oil 30	Journal Oil A or Gulfube Motor Oil 20
	10	Gulf Harmony Oil C or Gulfube Motor Oil 20	Gulf Seneca Oil A or Gulfube Motor Oil 10 W
Roller Paths Live Rollers Hook Rollers	12a	Gulf Lubcote No. 0	Gulf Lubcote No. 0
	12b	Gulf Lubcote HS (Apply Hot)	Gulf Lubcote HS (Apply Hot)
Sliding Surfaces Rolling Contacts Shoe Contacts	13	Gulf Lubcote No. 0	Gulf Lubcote No. 0
	14	Gulf Lubcote No. 0 or Gulf Graphite Grease No. 3	Gulf Lubcote No. 0 or Gulf Graphite Grease No. 3
Open and Partially Enclosed Gears	15	Gulf Lubcote HS (Apply Hot)	Gulf Lubcote HS or (Apply Hot) Gulf Lubcote No. 0
Rack Teeth	16	Gulf Lubcote HS (Apply Hot)	Gulf Lubcote HS (Apply Hot)

(OVER)

PARTS TO BE LUBRICATED	Line No.	RECOMMENDED LUBRICANT	
		Warm Weather (Above 32° F.)	Cold Weather (Below 32° F.)
Enclosed Gears Bearings Using Same Lubricant	17	Gulf Multi-Purpose Gear Lubricant 90 or Gulf E. P. Lubricant 95	Gulf Multi-Purpose Gear Lubricant 80 or Gulf E. P. Lubricant 75
	18	Gulf Multi-Purpose Gear Lubricant 90 or Gulf E. P. Lubricant 95	Gulf Multi-Purpose Gear Lubricant 80 or Gulf E. P. Lubricant 75
	19	Gulf Multi-Purpose Gear Lubricant 140 or Gulf E. P. Lubricant 145	Gulf Multi-Purpose Gear Lubricant 90 or Gulf E. P. Lubricant 95
Electric Motors and Generators Ball or Roller Bearings Grease Lubricated	28	Gulflex A or Gulf Precision Grease No. 2	Gulflex A or Gulf Precision Grease No. 1
	29	Gulf Harmony Oil C or Gulfube Motor Oil 20	Gulf Seneca Oil A or Gulfube Motor Oil 10 W
Auxiliary Air Compressor	34	Gulf Harmony Oil C or Gulfube Motor Oil 20	Gulf Seneca Oil A or Gulfube Motor Oil 10 W
Flexible Couplings Falk	36	Gulflex A or Gulf Precision Grease No. 2	Gulflex A or Gulf Precision Grease No. 2
	37	Gulf E. P. Lubricant 145 or Gulf Lubcote No. 0	Gulf E. P. Lubricant 145 or Gulf Lubcote No. 0
Internal Combustion Engine Drive Diesel Engine Cyl- inders and Bearings } Gasoline Engine Cyl- inders and Bearings }		Follow Engine Manufacturer's Instructions.	

NOTE—In order to simplify lubrication, the same oil as used in engine may be used for lines 1, 6, 7, 9 and 10.



ESSO STANDARD OIL COMPANY

LUBRICATION RECOMMENDATIONS

for
EXCAVATING MACHINERY
made by

BUCYRUS-ERIE COMPANY

South Milwaukee, Wisconsin

Esso Recommendations

Parts to be lubricated	Line	Warm weather (Above 32°F)	Cold weather (Below 32°F)
Plain bearings			
Oil-lubricated	1	ESSOLUBE HD 30 or ESSO MOTOR OIL 30 or CORAY 55	ESSOLUBE HD 20 or ESSO MOTOR OIL 20W or CORAY 55
Grease-lubricated			
Upper works (deck machinery)	2a	ANDOK LUBRICANT M-275*	ANDOK LUBRICANT M-275*
Lower works and front end	2b	ESSO CHASSIS GREASE XX* or CAZAR LUBRICANT 2	ESSO CHASSIS GREASE L* or CAZAR LUBRICANT 1
Ball or roller bearings			
Grease-lubricated	5	ANDOK LUBRICANT M-275*	ANDOK LUBRICANT M-275*
Wire rope	6	SURETT 310	SURETT 310
Clutches and brakes			
Air-operated	7	ESSOLUBE HD 20 or ESSO MOTOR OIL 20W or CORAY 50	ESSOLUBE HD 10W or ESSO MOTOR OIL 10W or CORAY 45
Chain drive			
Heavy roller chain	9	ESSOLUBE HD 30 or ESSO MOTOR OIL 30 or CORAY 55	ESSOLUBE HD 20 or ESSO MOTOR OIL 20W or CORAY 50
Enclosed transmission chain	10	ESSOLUBE HD 30 or ESSO MOTOR OIL 30 or CORAY 55	ESSOLUBE HD 20 or ESSO MOTOR OIL 20W or CORAY 50
Roller paths			
Live rollers	12a	SURETT 310	SURETT 310
Hook rollers	12a	SURETT 310	SURETT 310
Sliding surfaces			
Rolling contacts	13	SURETT 310	SURETT 310
Shoe contacts	14	SURETT 310	SURETT 310
Open and partially enclosed gears	15	SURETT 1500 (Apply hot)	SURETT 800
Rack teeth	16	SURETT 1500 (Apply hot)	SURETT 800

* ESSO MULTI-PURPOSE GREASE H may be used for these applications.

Parts to be lubricated	Line	Warm weather (Above 32°F)	Cold weather (Below 32°F)
Enclosed gears			
Bearings using same lubricant	17	ESSO XP COMPOUND SAE 140 EP or PEN-O-LED EP 6	ESSO XP COMPOUND SAE 90 EP or PEN-O-LED EP 3
Pressure pump oiling	18	ESSO XP COMPOUND SAE 140 EP or PEN-O-LED EP 6	ESSO XP COMPOUND SAE 90 EP or PEN-O-LED EP 3
Bearings separately lubricated	19	ESSO XP COMPOUND SAE 140 EP or PEN-O-LED EP 6	ESSO XP COMPOUND SAE 90 EP or PEN-O-LED EP 3
Electric motors and generators			
Ball or roller bearings			
Grease-lubricated	28	ANDOK LUBRICANT M-275*	ANDOK LUBRICANT M-275*
Oil-lubricated	29	ESSOLUBE HD 20 or ESSO MOTOR OIL 20W or ESSTIC 50	ESSOLUBE HD 10W or ESSO MOTOR OIL 10W or ESSTIC 45
Auxiliary air compressor	34	ESSOLUBE HD 20	ESSOLUBE HD 10W
Flexible couplings			
Falk	36	ANDOK LUBRICANT M-275*	ANDOK LUBRICANT M-275*
Fast's and Poole	37	ESSO XP COMPOUND SAE 140 EP or PEN-O-LED EP 6	ESSO XP COMPOUND SAE 140 EP or PEN-O-LED EP 6
Internal combustion engine drive			
Diesel		See engine manufacturer's bulletin†	See engine manufacturer's bulletin †
Gasoline			

* *ESSO MULTI-PURPOSE GREASE H may be used for these applications.*

† Builder also approves same oil as used in engine for lines 1, 6, 7, 9 and 10.

Conoco Lubricants

Recommended by Continental Oil Company
for use on

Bucyrus-Erie Machines

CONOCO LUBRICANT RECOMMENDED

PARTS TO BE LUBRICATED	LINE NO.	WARM WEATHER (Above 32° F.)	COLD WEATHER (Below 32° F.)
Plain Bearings Oil Lubricated	1	Conoco Motorine SAE 30 or Conoco Redind Heavy	Conoco Motorine SAE 30 or Conoco Redind Heavy
Grease Lubricated Upper Works (Deck Machinery)	2a	Conoco Super Lube or Conoco Pressure Lubricant Medium	Conoco Super Lube Light or Conoco Pressure Lubricant Light
Lower Works and Front End	2b	Conoco Super Lube or Conoco Pressure Lubricant Medium	Conoco Super Lube Light or Conoco Pressure Lubricant Light
Ball and Roller Bearings Grease Lubricated	5	Conoco Super Lube or Conoco Racelube	Conoco Super Lube or Conoco Racelube
Wire Rope	6	Conoco Coglube No. 5	Conoco Coglube No. 5
Clutches and Brakes Air Operated	7	Conoco Motorine SAE 30 or Conoco Dectol Medium	Conoco Motorine SAE 20-20W or Conoco Ice Machine Oil Medium Heavy
Chain Drive Heavy Roller Chain	9	Conoco Motorine SAE 30 or Conoco Redind Heavy	Conoco Motorine SAE 30 or Conoco Redind Heavy
Enclosed Transmission Chain	10	Conoco Motorine SAE 30 or Conoco Dectol Medium	Conoco Motorine SAE 20-20W or Conoco Ice Machine Oil Medium Heavy
Roller Paths Live Rollers	12a	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5
Hook Rollers	12b	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5
Sliding Surfaces Rolling Contact	13	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5
Shoe Contact	14	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5
Open and Partially Enclosed Gears	15	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5
Rack Teeth	16	Conoco Coglube No. 9 (Apply hot)	Conoco Coglube No. 5

CONOCO LUBRICANT RECOMMENDED

PARTS TO BE LUBRICATED	LINE NO.	WARM WEATHER (Above 32° F.)	COLD WEATHER (Below 32° F.)
Enclosed Gears			
Bearings using same lubricant	17	Conoco Redind X Heavy	Conoco Motorine SAE 30 or Conoco Redind Heavy
Pressure Pump Oiling	18	Conoco Redind X Heavy	Conoco Motorine SAE 30 or Conoco Redind Heavy
Bearings Separately lubricated	19	Conoco Redind X Heavy	Conoco Motorine SAE 30 or Conoco Redind Heavy
Electric Motors and Generators			
Ball or Roller Bearings Grease Lubricated	28	Conoco Super Lube or Conoco Racelube	Conoco Super Lube or Conoco Racelube
Oil Lubricated	29	Conoco Motorine SAE 30 or Conoco Dectol Medium	Conoco Motorine SAE 20-20W or Conoco Ice Machine Oil Medium Heavy
Auxiliary Air Compressor			
	34	Conoco Motorine SAE 30 or Conoco Dectol Medium	Conoco Motorine SAE 20-20W or Conoco Ice Machine Oil Medium Heavy
Flexible Couplings			
Falk	36	Conoco Super Lube or Conoco Racelube	Conoco Super Lube or Conoco Racelube
Fast's and Poole	37	Conoco Redind X Heavy	Conoco Redind X Heavy
Internal Combustion Engine Drive			
Diesel Engine) Gasoline Engine)		See Engine Manufacturer's Bulletin. (See Note*)	

*NOTE: Builder also approves same oil as used in engine for lines 1, 6, 7, 9 and 10.

LUBRICANTS

Recommended for Use On

BUCYRUS-ERIE MACHINES

by

THE ATLANTIC REFINING COMPANY

RECOMMENDATIONS

SUMMER
(Above 32° F.)

WINTER
(Below 32° F.)

PARTS TO BE LUBRICATED

LINE

PLAIN BEARINGS:

Oil Lubricated	1	Atlantic Ultramo A #30 or Ebony Oil P	Atlantic Ultramo A #30 or Ebony Oil I
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Grease Lubricated

Upper Works (Deck Machinery)	2a	Atlantic Lubricant 54	Atlantic Lubricant 54
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Lower Works and Front End	2b	Atlantic Chassis Lubricant or Atlantic Lubricant 54	Atlantic Chassis Lubricant or Atlantic Lubricant 54
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BALL OR ROLLER BEARINGS:

Grease Lubricated	5	Atlantic Lubricant 54	Atlantic Lubricant 54
-------------------------	---	-----------------------------	-----------------------

WIRE ROPE:

.....	6	Atlantic Ultramo A #30 or Ebony Oil P	Atlantic Ultramo A #30 or Ebony Oil I
-------	---	--	--

CLUTCHES AND BRAKES:

Air Operated	7	Atlantic Ultramo A #30 or Ideal Oil F	Atlantic Ultramo A #20 or Polar Oil Medium
--------------------	---	--	---

CHAIN DRIVE:

Heavy Roller Chain	9	Atlantic Ultramo A #30 or Ebony Oil P	Atlantic Ultramo A #30 or Ebony Oil I
--------------------------	---	--	--

Enclosed Transmission Chain	10	Atlantic Ultramo A #30 or Ideal Oil F	Atlantic Ultramo A #20 or Polar Oil Medium
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ROLLER PATHS:

Live Rollers	12a	Atlantic Lubricant 89	Atlantic Lubricant 89
--------------------	-----	-----------------------------	-----------------------

Hook Rollers	12b	Atlantic Lubricant 89	Atlantic Lubricant 89
--------------------	-----	-----------------------------	-----------------------

SLIDING SURFACES:

Rolling Contacts	13	Atlantic Lubricant 89	Atlantic Lubricant 89
------------------------	----	-----------------------------	-----------------------

Shoe Contacts	14	Atlantic Lubricant 89	Atlantic Lubricant 89
---------------------	----	-----------------------------	-----------------------

OPEN AND PARTIALLY

ENCLOSED GEARS:

.....	15	Atlantic Lubricant 89	Atlantic Lubricant 89
-------	----	-----------------------------	-----------------------

RECOMMENDATIONS

SUMMER
(Above 32° F.)

WINTER
(Below 32° F.)

PARTS TO BE LUBRICATED

LINE

RACK TEETH:

.....16	Atlantic Lubricant 89	Atlantic Lubricant 89
---------	-----------------------------	-----------------------

ENCLOSED GEARS:

Bearings Using Same Lubricant..17	Atlantic Ultragear Oil 90 or Premier Gear Oil 13	Atlantic Ultragear Oil 80 or Premier Gear Oil 12
Pressure Pump Oiling .....18	Atlantic Ultragear Oil 90 or Premier Gear Oil 13	Atlantic Ultragear Oil 80 or Premier Gear Oil 12
Bearings Separately Lubricated..19	Atlantic Ultragear Oil 140 or Premier Gear Oil 16	Atlantic Ultragear Oil 90 or Premier Gear Oil 13

ELECTRIC MOTORS AND GENERATORS:

Ball or Roller Bearings Grease Lubricated .....28	Atlantic Lubricant A or Atlantic Lubricant 54	Atlantic Lubricant A or Atlantic Lubricant 54
Oil Lubricated .....29	Atlantic Ultramo A #30 or Ideal Oil F	Atlantic Ultramo A #20 or Polar Oil Medium

AUXILIARY AIR COMPRESSOR:

.....34	Atlantic Ultramo A #30 or Ideal Oil F	Atlantic Ultramo A #20 or Polar Oil Medium
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FLEXIBLE COUPLINGS:

Falk36	Atlantic Lubricant 54	Atlantic Lubricant 54
Fast's and Poole .....37	Atlantic Ultragear Oil 140 or Premier Gear Oil 16	Atlantic Ultragear Oil 140 or Premier Gear Oil 16

INTERNAL COMBUSTION ENGINE DRIVE:

Diesel or Gasoline Engine	See Engine Manufacturer's Bulletin (See Note*)
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*NOTE: Builder also approves same oil as
used in engine for lines 1, 6, 7, 9, and 10.

Lubricants

Recommended by Standard Oil Company of California
for use on

Bucyrus-Erie Machines

RECOMMENDED LUBRICANT

PARTS TO BE LUBRICATED

WARM WEATHER
(Above 32° F)

COLD WEATHER
(Below 32° F)

	LINE		
Plain Bearings			
Oil Lubricated	1	Calol Vistac Oil 28x	Calol Vistac Oil 28x
Grease Lubricated			
Upper Works (Deck Machinery)	2a	Calol E.P. Roller Grease 1x	Calol E.P. Roller Grease 1x
Lower Works and Front End	2b	Calol E.P. Roller Grease 1x	Calol E.P. Roller Grease 1x
Ball or Roller Bearings			
Grease Lubricated	5	Calol E.P. Roller Grease 1x	Calol E.P. Roller Grease 1x
Wire Rope			
	6	Calol Vistac Oil 28x	Calol Vistac Oil 28x
Clutches and Brakes			
Air Operated	7	Calol Turbine Oil 15	Calol Turbine Oil 15
Chain Drive			
Heavy Roller Chain	9	Calol Vistac Oil 28x	Calol Vistac Oil 28x
Enclosed Transmission Chain	10	Calol Turbine Oil 15	Calol Turbine Oil 15
Roller Paths			
Live Rollers	12a	Calol Pinion Grease 2	Calol Pinion Grease 1
Hook Rollers	12b	Calol Pinion Grease 2	Calol Pinion Grease 1
Sliding Surfaces			
Rolling Contacts	13	Calol Pinion Grease 2	Calol Pinion Grease 1
Shoe Contacts	14	Calol Pinion Grease 2	Calol Pinion Grease 1
Open and Partially Enclosed Gears			
	15	Calol Pinion Grease 2	Calol Pinion Grease 1

RECOMMENDED LUBRICANT

PARTS TO BE LUBRICATED

**WARM WEATHER
(Above 32° F)**

**COLD WEATHER
(Below 32° F)**

	LINE		
Rack Teeth			
	16	Calol Pinion Grease 2	Calol Pinion Grease 1
Enclosed Gears			
Bearings using same Lubricant	17	Calol Gear Compound 100	Calol Gear Compound 80
Pressure Pump Oiling	18	Calol Gear Compound 100	Calol Gear Compound 80
Bearings Separately Lubricated	19	Calol Gear Compound 140	Calol Gear Compound 80
Electric Motors and Generators			
Ball or Roller Bearings Grease Lubricated	28	Calol SA Grease 1	Calol SA Grease 1
Oil Lubricated	29	Calol Turbine Oil 15	Calol Turbine Oil 15
Auxiliary Air Compressor			
	34	Calol Turbine Oil 15	Calol Turbine Oil 15
Flexible Couplings			
Falk	36	Calol E.P. Roller Grease 1x	Calol E.P. Roller Grease 1x
Fast's and Poole	37	Calol E.P. Roller Grease 1x	Calol E.P. Roller Grease 1x
Internal Combustion			
Engine Drive Diesel Engine Gasoline Engine	}	See Manufacturer's Bulletin	

For more information on above or other Petroleum Products write or call nearest Distributor
handling them or any of the companies listed below.

STANDARD OIL COMPANY OF CALIFORNIA - San Francisco
THE CALIFORNIA OIL COMPANY - Barber, N.J., Chicago, New Orleans

STANDARD OIL COMPANY OF TEXAS - El Paso, Texas
THE CALIFORNIA COMPANY - Denver, Colorado

Types of Wire Rope Inspection and Handling Reeving Instructions and Specifications

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CHAPTER XVII — **WIRE ROPE SPECIFICATION**

TYPES OF WIRE ROPE

The wire rope, used as the final link in the transmission of power from the power unit to the work, is just as much a part of the machinery as the gears, clutches, etc., and deserves the same attention to lubrication and inspection as any other part of the machine. Failure of a wire rope in service shuts the machine down immediately and all work is held up until a new rope can be installed, therefore it is only common sense to replace immediately any rope which shows signs of weakness which might lead to its sudden failure.

Wire rope manufacturers have developed many types of wire rope construction. Each feature of construction has some special advantage for a particular application. A wire rope of the wrong type will not give satisfactory service. Replace a worn out rope with the type recommended in the tabulation of wire rope specifications given in Chapter XVII of this Section.

A. SELECTING CORRECT ROPE:

The particular type of rope listed on the tabulation for each application has been selected on the basis of the wire rope manufacturer's recommendation and field experience. Use a rope of the recommended diameter (measured across the longest diameter. See Fig. 1) and cut it to the correct length. A rope which is too long will be damaged by overwinding and a rope that is too short may pull out of its attachment with serious results.

To help the operator in identifying different kinds of wire rope, the following characteristics of the rope should be examined.

How to Measure Wire Rope

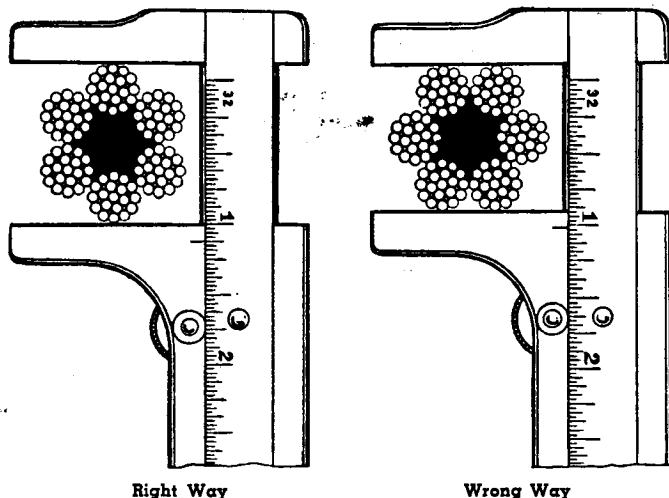


FIG. 1

1. Stranding (See Fig. 2).

This means number of strands in the rope and the number of individual wire or filaments in each strand. For instance, a 6x19 rope has 6 strands, each strand made up of 19 individual wires.

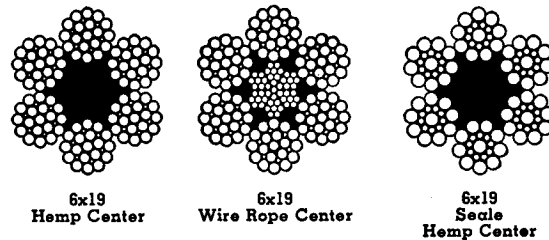


FIG. 2

2. "Lay" of Strands in Rope.

This means the direction of twist of the strands in the rope. The strands of a right lay rope spiral clockwise, while the strands of a left lay rope spiral counter-clockwise.



Right Lay, Regular Lay Wire Rope



Right Lay, Lang's Lay Wire Rope

FIG. 3

3. "Lay" of Wire in the Strands. (See Fig. 3).

If individual wires in the strands have a spiral opposite to the spiral of the rope strand, the rope is "regular lay." If the spiral of the individual wires is the same as the strands, then the rope is "lang day." A lang lay rope offers greater resistance to abrasion but will crush more easily.

4. Type of Rope Center or Core.

The strands of an ordinary wire rope are "laid up" on a hemp center but for greater strength an independent wire rope center is used with some loss in flexibility.

In addition to the above readily identified characteristics the grade of steel in the individual wires, and many variations in the arrangement of the wires in the strands effects the strength of the rope and its fitness for a particular application, hence it is important to use only ropes of the exact specification recommended.

Most rope manufacturers can supply ropes either of ordinary construction or "preformed". In the preformed rope the individual wires are in a more or less stress-free condition so that the rope has less tendency to kink or unravel at the ends and is generally easier to handle.

— CHAPTER XV —

INSPECTION AND HANDLING OF WIRE ROPE

A. INSPECT ROPES REGULARLY:

A wire rope gradually wears out in service and must be replaced before its strength is dangerously reduced if expensive delays due to rope failure are to be avoided. Inspect all ropes at least once every three shifts operation and replace at once any rope which has badly worn spots or an excessive number of broken strands.

Do not wait for a rope to fail in service as serious damage may result. Keep spare ropes on hand so that it will not be necessary to await arrival of a new rope if it is found a rope needs replacing. Store all unused ropes in a dry place and at least twice a year lubricate with a light oil to prevent surface corrosion and drying out of the core.

In addition to inspecting the wire ropes, examine the sheaves and drums for excessive wear. A sheave groove which is rough or worn will greatly shorten the rope life. Grooves that are too wide do not properly support the rope and a flattened rope results. Too narrow a groove pinches the rope and causes rapid wear. Replace any sheaves that have broken flanges or badly worn grooves.

The operator should make it a habit to watch the reeving of the ropes on the drum during operation so that if the rope does not spool evenly on the drum and one wrap crosses over another, operation can be stopped immediately and the rope spooled correctly before the rope is damaged.

Ropes, such as the dragline drag rope and the shovel hoist rope, often begin to show wear over a short length of the rope long before the rope is worn out. Longer service can usually be obtained by turning such ropes end for end before the wear has become excessive.

B. STORAGE AND HANDLING METHOD:

Careless handling of a wire rope may shorten its life even before it is placed on the machine. Keep wire rope stored in a dry place and protect it against damage from crushing.

The tendency of a rope to kink can be avoided by proper handling. If the rope is on a reel, place a pipe or shaft inside the reel and set it up on jacks so that the reel can be turned to pay off the rope. If in a coil, roll the coil along the ground like a hoop. (See Fig. 4).

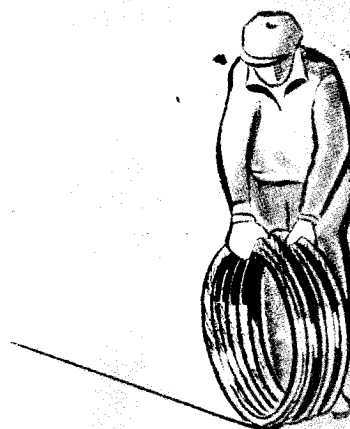
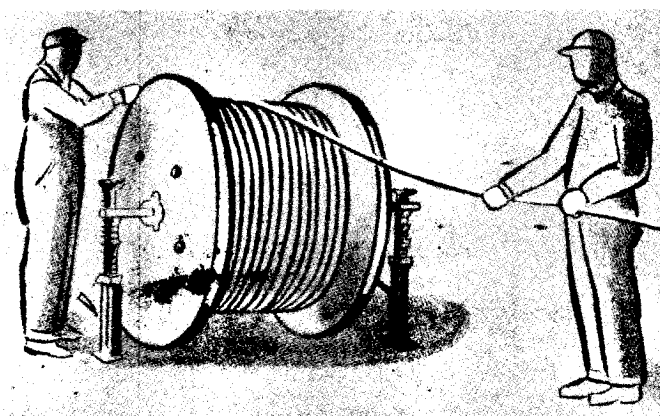


FIG. 4

When cutting a length of wire rope from a reel always apply 3 seizings (1 is enough if rope is "preformed") each side of the place where the rope is to be cut. (See Fig. 5). Use a small diameter soft wire and apply about eight wraps, keeping the seizing wire pulled tight. Twist the ends of the seizing wire together, pull up tight, cut off the ends of the wire and pound the twist flat against the rope.

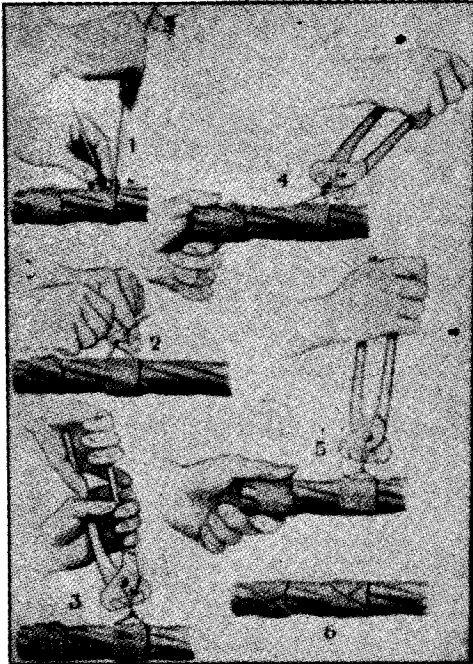


FIG. 5

C. METHODS OF ATTACHMENT:

Most ropes are anchored in wedge rope sockets of some type. The drums all have sockets cast in and the other ends of the running ropes are attached by wedge rope sockets (usually open) of the type shown in Figure 6. Bridge type wedge rope sockets are sometimes used where it is necessary to adjust the length of the rope.

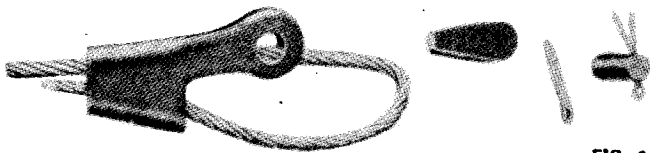


FIG. 6

To fasten a rope in a wedge rope socket proceed as follows:

NOTE: When fastening a rope in an open wedge rope socket it may simplify the work if the socket is disconnected from the machine by removing the socket pin.

1. Remove rope wedge from socket. If old cable is in place, drive out wedge by inserting a drift pin from the rope end of the socket.
2. Reeve the end of the rope through the socket then double the end back into the socket leaving

a generous loop at the wide end of the socket and an inch or two sticking out of the small end of the socket. (Be sure the rope is doubled back on itself so that the main part of the rope is at the straight side of the socket.)

3. Replace the wedge in the socket and pull the main part of the rope as tight as possible by hand. Hold the wedge out to keep it from seating until the main part of the rope has been pulled to take up the loop around the wedge. Help the wedge to seat properly by pounding the loop of the rope with a wooden hammer but be careful not to damage the rope.
4. Apply load gradually and make sure the wedge is pulled all the way in. The load does the final tightening.

Rope clips are sometimes used where rope sockets would not be satisfactory. Always use a rope thimble when making a connection with clips to prevent bending the rope on too small a radius. Three or four clips (Crosby type) are usually used. These must ALWAYS be applied with all the U-bolts on the short end of the rope as shown in Figure 7. Space the clips so that the distance between clips is about six times the diameter of the rope. Tighten the two nuts on each clip alternately and after the rope has been in service for an hour or two retighten all the clips. When inspecting the ropes always check to make sure the nuts are tight and that the rope has not slipped.

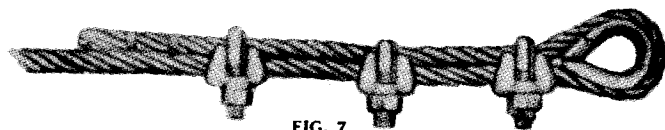


FIG. 7

Some ropes may have sockets in which the rope is fastened by zinc. Special tools and material are needed to socket a rope by this method and it is best to purchase ropes having sockets of this type with the sockets already installed at the factory.

DON'T cut wire rope without first applying proper seizing.

DON'T pull wire rope off coils or reels without rolling coil or turning reel to prevent kinking.

DON'T operate the machine with wraps crossed on the drum.

DON'T overlook suspension ropes when inspecting cables.

DON'T put off replacement of any rope which is badly worn or has many broken strands.

DON'T operate sheaves with worn grooves or broken flanges.

DON'T store wire rope without properly lubricating it.

REEVING INSTRUCTIONS

A. BOOM SUSPENSION:

The boom hoist tackle for all front end equipment consists of an eight-part line reeved to the boom hoist drum mounted in the revolving frame casting just back of the reversing transmission shaft.

For the shovel boom and crane type booms having continuous reeving the rope is reeved between the sheaves on the A-frame and four sheaves at the boom point. For long booms, having mast-type suspension, (as noted in the Machine Specifications) the boom-hoist rope is reeved to the sheaves at the top of an auxiliary A-frame or mast. Pendant-type suspension is sometimes used on cranes and for this type suspension the boom-hoist rope is reeved between the A-frame sheaves and four sheaves on a yoke or bridle from which the boom is suspended by pendants.

a. Continuous Reeving

For shovel booms or dragline, crane and clamshell booms having continuous reeving (as noted in the Machine Specifications), the eight-part suspension rope is reeved between the A-frame sheaves and the four small sheaves on the boom-point shaft exactly as shown in Figure 8. Note: For special 12 part suspension reeving refer to instruction sheet at the end of this chapter.

To replace the suspension rope proceed as follows:

1. Lower the boom onto suitable blocking at the point end so that it is nearly horizontal.

NOTE: To block the shovel boom, rest the dipper on the ground, with the handle full extended, then lower the boom until it rests on a timber placed across the dipper handle just back of the front stop.

2. Spool off all cable from the boom-hoist drum and drive out the rope socket wedge. Also remove the rope socket from the left side of the A-frame yoke and detach the rope by driving out the wedge.
3. Support the reel or coil of new rope so that it can be spooled off without kinking. Lead the rope over the left A-frame sheave, around the outer sheave on the left end of the suspension sheave shaft (from top to bottom), back around the bottom sheave, or sheaves, on the A-frame yoke (from left to right), thence around the outer sheave on the right end of the suspension sheave shaft (from bottom to top), back over and around the right A-frame sheave, then forward under the inner sheave on the right end of the suspension sheave shaft, back around the upper yoke sheave, or sheaves, (from right to left), forward over the inner sheave on the left end of the suspension sheave shaft (from top to bottom) back to the dead end anchor at the left side of the yoke.

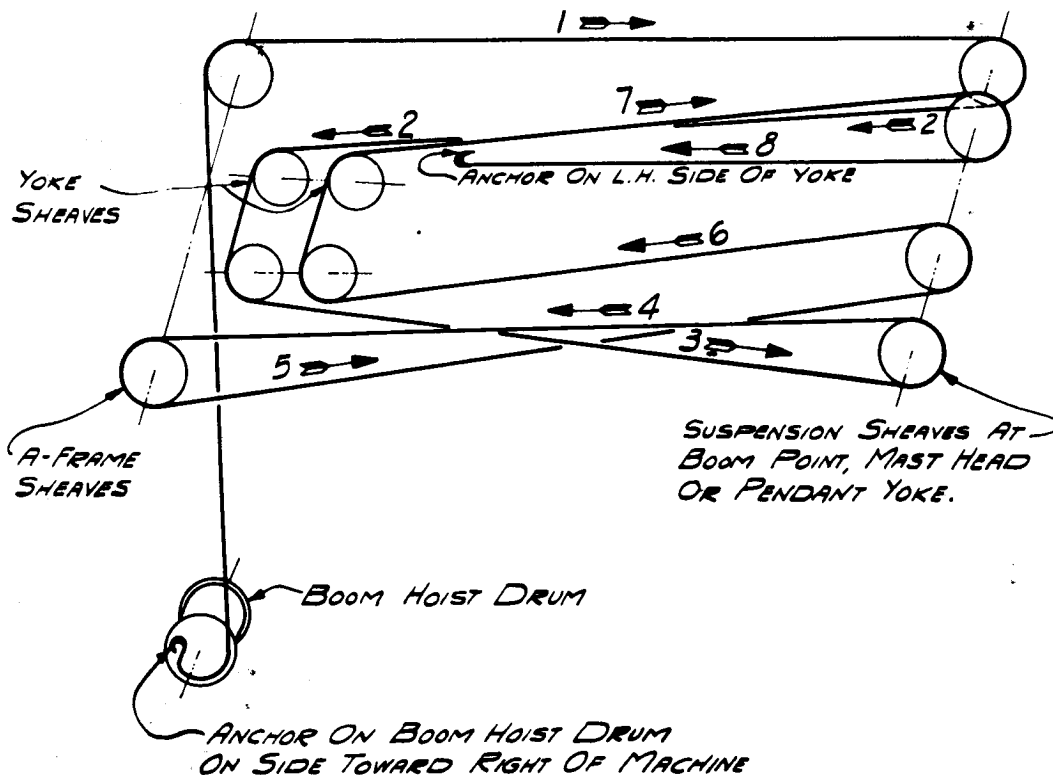


FIG. 8

4. Fasten the end of the rope in the wedge rope socket and replace the pin attaching the socket to the A-frame. Lead the free end of the rope over the left A-frame sheave, down to the boom-hoist drum. Fasten the rope to the right side of the boom-hoist drum by inserting the socket wedge.
5. Turn the boom-hoist drum in the hoisting direction until all slack is out of the suspension rope, check the rope wedges to be sure they are holding properly, then raise the boom to working position.

b. Mast-Type Suspension

Long booms, having mast-type suspension (as noted in the Machine Specifications), are supported by pendants from an auxiliary A-frame or mast as shown in Figure 9.

The overhead clearance of the machine with mast type suspension can be reduced to cab height. The method of doing this is described on drawing 215605. In order that this reduction in height may be accomplished quickly it is important that the boom pendants be installed in the correct order. One set of pendants has female sockets at both ends. These pendants must be attached to the boom point and have the intermediate suspension links installed at their lower ends as shown on the drawing in order that machine can be rigged for low clearance travel.

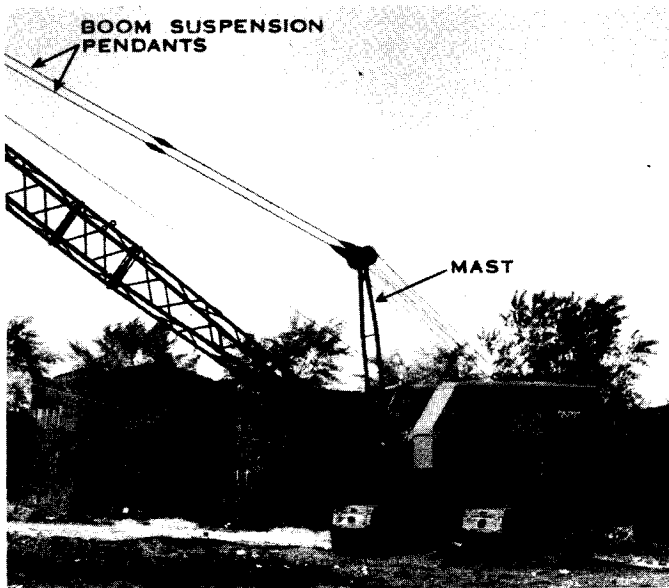
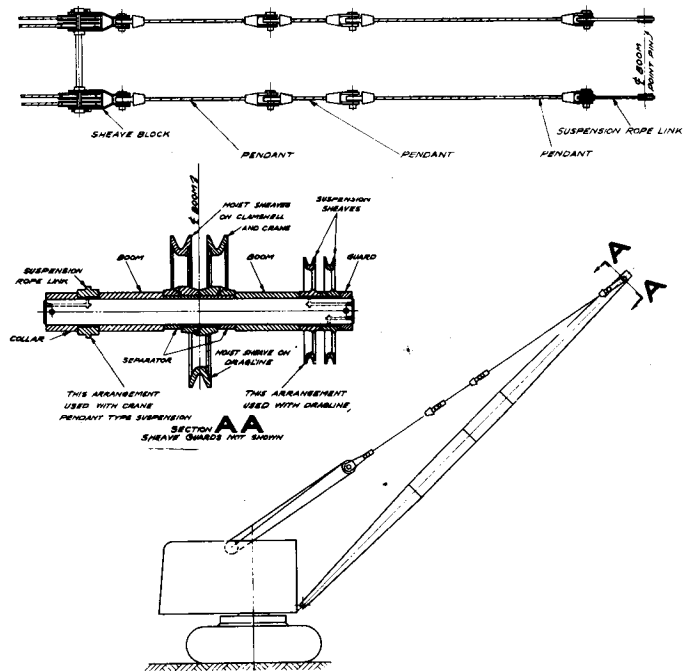


FIG. 9

The eight-part boom-hoist rope is reeved between the A-frame sheaves and the four small sheaves at the top of the mast as shown in Figure 8. To replace the suspension rope proceed as follows:

1. Lower the boom so that the boom point rests on a block or timber on the ground, then continue lowering until the upper end of the mast rests on the support bolted to the boom.
- 2, 3, 4, and 5. Proceed exactly as described in steps 2 to 5 under "Continuous Reeving".

The boom pendants have rope sockets "zincked" or spliced on each end at the factory so that the pendants are just the right length. If a pendant is damaged or shows signs of weakness, replace it with a new one ordered from the factory with sockets attached. Do not take any chances by trying to resocket boom pendants in the field.



c. Pendant Type Suspension

To make it easier to change the length of the crane boom (by adding or taking out center sections) pendant-type suspension can be supplied as shown in Figure 10. When a boom center section is added or removed a pair of pendants of the same length is inserted or taken out. The pendants have "zincked" or spliced sockets with pin connections.

The eight-part boom-hoist rope is reeved between the sheaves on the A-frame and four sheaves on the pendant yoke as shown in Figure 8.

To replace the suspension rope proceed as follows:

1. Lower the boom so that the boom point rests on a block or timber on the ground then continue lowering until the pendant bridle rests on the boom.
- 2, 3, 4, 5. Proceed as described in steps 2 to 5 under "Continuous Reeving".

The boom pendants have rope sockets "zincked" on each end at the factory so that the pendants are just the right length. If a pendant is damaged or shows signs of weakness, replace it with a new one ordered from the factory with sockets attached.

B. SHOVEL REEVING:

a. Hoist Rope

The two-part hoist cable is reeved to the drum on the right end of the hoist shaft as shown in Figure 11.

To install a new hoist cable proceed as follows:

1. Lower the dipper to the ground with handle fully extended.
2. Disconnect the rope anchor from the lug on the boom by taking out the pin, then drive out the wedge in the rope socket. Free the other end of the rope by driving out the rope wedge in the drum and remove the old rope.
3. Assemble the rope socket to one end of the new cable and replace the pin attaching the socket to the lug on the boom. Lead the rope over the left boom-point sheave, down through the padlock sheave (from left to right), then up over the right boom-point sheave back to the top of the hoist drum. Attach the end of the rope to the right flange of the drum by replacing the rope wedge.
4. Turn the hoist drum in the hoisting direction until the dipper is lifted just clear of the ground, then check the rope wedges (both in the drum and in the dead end socket) to be sure the wedges are holding properly.

b. Crowd and Back-haul Ropes

The twin crowd cable and single retract or backhaul cable are reeved between the dipper handle and the crowd drum at the foot of the boom as shown in Figure 11.

To replace the crowd and backhaul ropes proceed as follows:

1. Extend the dipper handle until the stop rests against the saddle block, then lower the dipper onto any convenient blocking.
2. Release the anchor drum ratchet dogs (by compressing the spring between the two levers) and unwind the backhaul rope from the anchor drum.
3. Loosen the set screw in the anchor drum to free the end of the back-haul rope. Drive out the wedges holding the ends of the crowd and backhaul ropes in the crowd drum at the foot of the boom and take off the old rope.
4. Apply a liberal coating of grease to the anchor casting on the end of the dipper handle so that the crowd rope will equalize more readily.
5. Loop the middle of the crowd rope over the anchor casting and between the lugs on the casting. Reeve one of the ends of the crowd rope around each of the outer large grooves of the shipper shaft drum (from top to bottom) down through the boom to the underside of the crowd drum. (Keep the crowd ropes parallel inside the boom.)

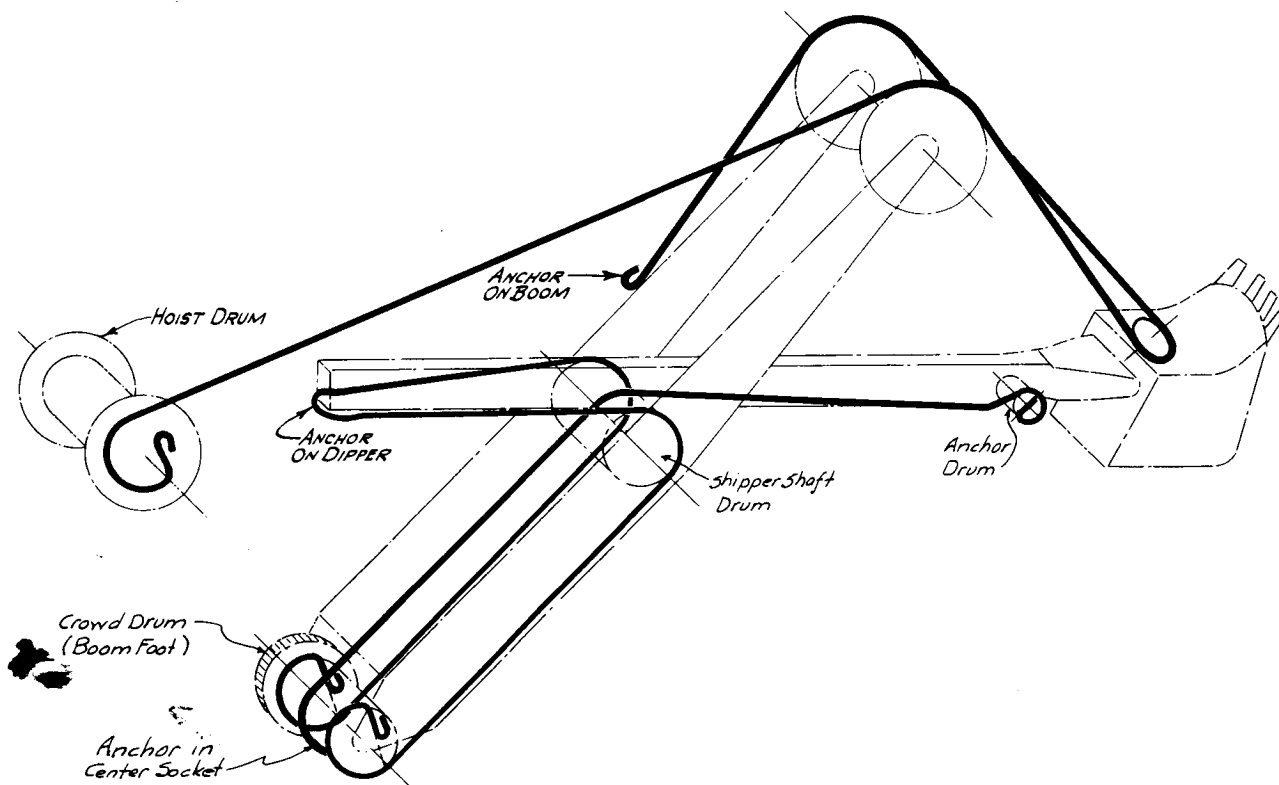


FIG. 11

6. Attach the ends of the crowd rope to the crowd drum by replacing the socket wedges. (Be sure the rope from the left groove in the shipper shaft drum is attached to the left end of the crowd drum and the rope from the right groove to the right end of the drum.)
7. Wind up all slack rope by turning the crowd drum in the direction for crowding out, then set the crowd brake to hold the drum.
8. Anchor one end of the back-haul rope in the socket at the center of the crowd drum (by inserting the socket wedge.)
9. Wind approximately one wrap on the drum, then lead the rope from the top of the drum, up outside the boom and over the center groove on the shipper shaft drum.
10. Insert the end of the back-haul rope in the hole of the anchor drum and tighten the set screw to hold the end of the rope.
11. Turn the anchor drum clockwise (with wrench) until all slack is out of the back-haul rope.
12. With the dipper handle horizontal and fully extended, check to see that there is not more than two inches sag in the back-haul rope. If greater than two inches turn the anchor drum one or more notches until the sag is correct.

c. Dipper Trip Ropes

Reeving of the two dipper trip ropes is shown in Figure 12. To replace the short rope (between the tripping ratchet and the lever on the boom) proceed as follows:

1. Drive out the rope wedge in the socket attached to the lever operating the pivoted sheave on the boom. Also drive out the wedge holding the other end of the rope in the socket on the tripping ratchet and take off the old rope.
2. Fasten one end of the new rope in the socket by replacing the wedge, lead the rope around the guide sheaves (one directly below the ratchet and the other at the front of the revolving frame) thence up to the lever on the boom.
3. Fasten the other end of the rope to the lever on the boom by replacing the rope socket wedge.

To replace the long rope (between the dipper handle end casting and the trip lever) proceed as follows:

1. Take off the rope clips fastening the rope to the end of the trip lever. Also drive out the wedge holding the other end of the rope in the socket of the handle end casting and take off the old rope.

2. Fasten one end of the new rope in the socket. (See the detail in Figure 12.) It is very important that the trip rope be anchored as shown with long end nearest the edge of the dipper stick. Lead the rope around the small groove at the right end of the shipper shaft drum, through the tube in the boom, back around the pivoted sheave, thence forward over the narrow sheave at the right end of the shipper shaft drum, forward to the trip lever.
3. Use two rope clips to fasten the end of the rope around the thimble on the trip lever.
4. Check operation of the dipper trip unit. If necessary, alter the length of the short trip rope by resetting the wedge of the rope socket attached to the lever on the boom. Change the length of the long trip rope by readjustment of the rope clips fastening it to the trip lever on the dipper handle. Minor adjustment of the short trip rope can be made by adjusting the position of the wedge rope socket on the tripping ratchet.

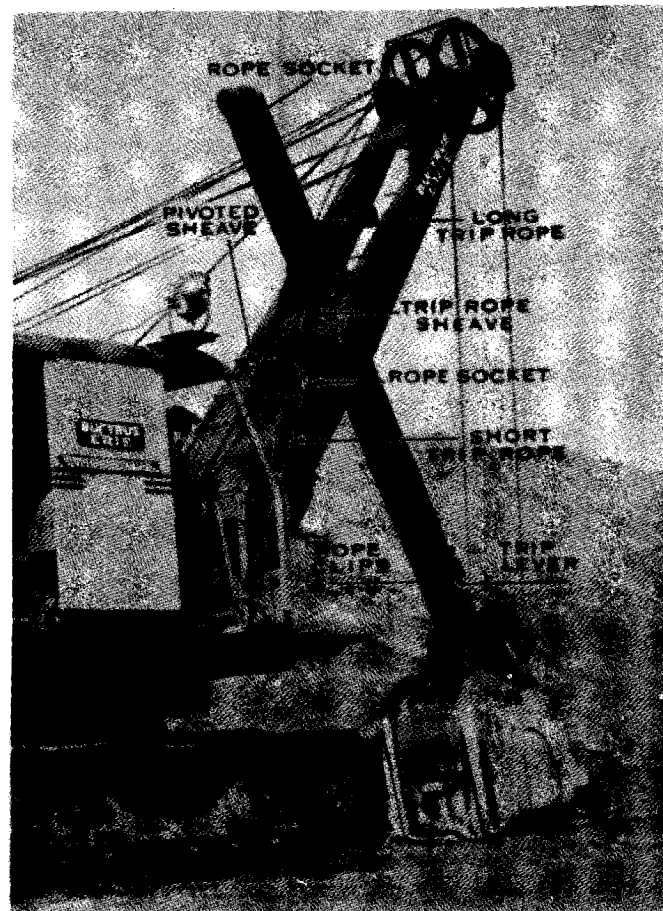
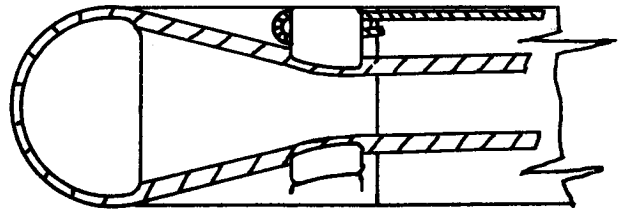


FIG. 12

C. DRAGLINE REEVING:

The hoist rope is reeved to the left drum and the drag rope to the right drum as shown in Figure 13.

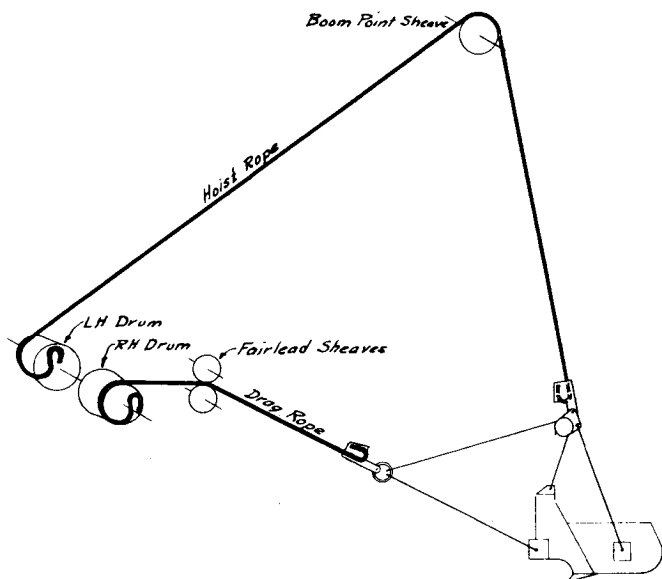


FIG. 13

To install a new drag rope proceed as follows:

1. Remove the rope wedges in the drum and in the drag rope socket attachment to the bucket chains and take out the old rope.
2. Lead the new rope between the fairlead sheaves and fasten the end to the right side of the right drum by replacing the socket wedge.
3. Attach the other end of the rope to the drag rope socket by replacing the wedge. Put a slight tension on the drag rope and check the socket wedges to see that they are holding properly before placing full load on the drag rope.

Drag ropes usually wear longer if they are turned end for end occasionally to distribute the wear. Do not lubricate the drag rope as the oil will simply pick up excess dirt and carry it into the machine. From time to time clean out the dirt troughs under the drum so that excess dirt does not accumulate.

To install a new hoist rope proceed as follows:

1. Lower the boom until it is nearly horizontal then remove the old hoist rope, first driving out the wedge in the drum socket and in the rope socket attached to the top of the dump sheave frame.
2. Lead the rope over the boom-point sheave and attach one end to the left side of the left drum by replacing the socket wedge.

3. Attach the other end to the rope socket on the dump sheave frame by replacing the socket wedge.
4. Raise the boom to working position, then hoist the bucket just clear of the ground and check the rope wedges to be sure they are holding properly.

D. CLAMSHELL REEVING:

a. Holding and Closing Ropes

The clamshell holding rope is reeved to the left drum and the closing rope is reeved to the right drum as shown in Figure 14.

The reeving of the closing rope around the clamshell bucket sheaves is different for various makes and types of buckets and it is not possible to include in these instructions a description of the many variations. Use extreme care in reeving the rope around the bucket sheaves to be sure the several parts of the ropes do not rub against each other.

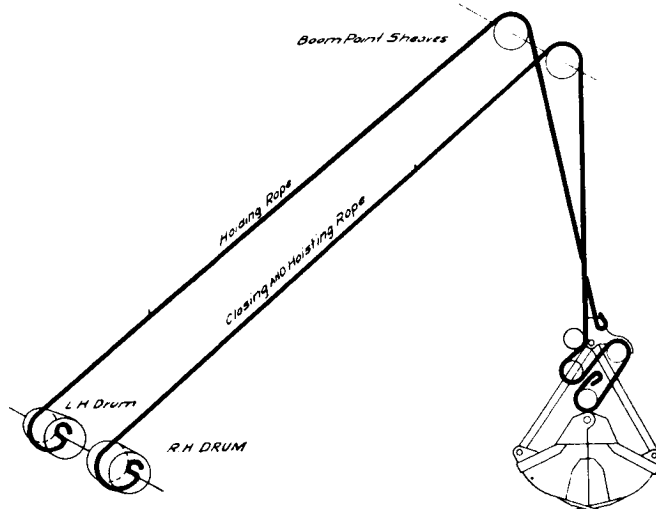


FIG. 14

To replace the clamshell holding rope proceed as follows:

1. Lower the boom until it is nearly horizontal, drive out the rope wedges in the left drum and at the top of the clamshell bucket and remove the old rope. (On some clamshell buckets the holding rope may be attached by a rope thimble and rope clips.)
2. Lead the new rope over the left boom-point sheave and attach one end to the flange of the left drum by replacing the socket wedge.

3. Attach the other end to the rope socket on the bucket by replacing the wedge (or fasten it around the thimble with rope clips, if the attachment is of that type).
4. Raise the boom to working position then hoist the bucket just clear of the ground and check the rope wedges to be sure they are holding properly.

To replace the clamshell closing rope proceed as follows:

1. Lower the boom until it is nearly horizontal, drive out the rope wedge in the right drum, free the rope attachment on the clamshell bucket and remove the old rope. (The exact method of attachment to the bucket depends on the make of bucket, although a wedge rope socket is usually used.)
2. Lead the new rope over the right boom-point sheave and attach one end to the right drum by replacing the socket wedge.
3. Reeve the other end of the rope between the guide rollers at the top of the clamshell bucket and around the bucket sheaves in such way as to give the required closing action. Attach the end of the rope to the bucket by replacing the wedge (or fasten it around the thimble with rope clips, if the attachment is of that type).

b. Tagline

The clamshell tagline is of the spring-loaded rope-wheel type and the tagline rope is simply reeved over a sheave block clamped to the boom angle and the end of the tagline is fastened to the corner of the clamshell bucket with rope clips. If the tagline rope becomes badly worn where it passes over the sheave block, disconnect the rope from the bucket, cut off about five feet and refasten it to the bucket. Also, reset the tagline spring for the correct number of turns as described in Section III.

E. CRANE REEVING:

For standard crane operation the hoist line from the right drum is reeved 2 part as shown in Figure 15. To replace the hoist rope proceed as follows:

1. Lower the boom so that it is nearly horizontal, then remove the old hoist rope, first driving out the wedges in the drum socket and in the rope socket attachment near the boom point. (It may be easier to drive out the wedge if the pin fastening the rope socket to the boom is first taken out).

2. Lead the rope over the left boom-point sheave and attach one end to the right side of the right drum by replacing the socket wedge.
3. Reeve the other end of the rope around the hook block sheave and attach to the rope socket by replacing the wedge. (Reassemble the socket to the boom if it was taken off.)

For heavy loads, reeve the hoist line three-part. (See Fig. 15.) To change from two-part to three-part reeving take the dead end rope socket off the boom, reeve the end of the rope over the right boom-point sheave down to the hook block. Attach the rope socket to the top of the hook block by means of the pin and links included in the tools and supplies. If four-part reeving is required to handle the load a special double sheave hook block must be used and the hoist rope is dead ended at the anchor on the boom.

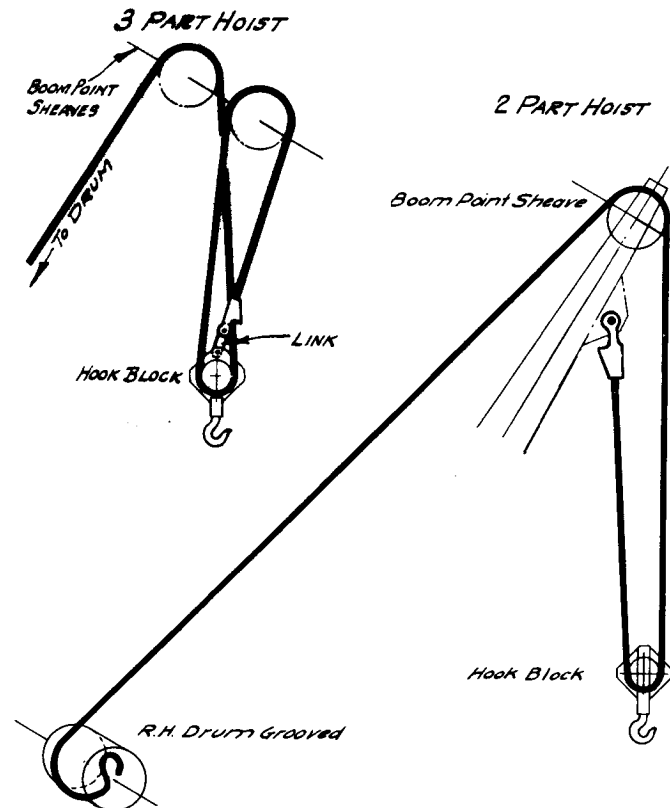


FIG. 15

When the crane is equipped with a jib reeve the auxiliary hoist line from the left drum over the deflecting sheave on the jib mast, thence over the jib point sheave as shown in Figure 16. For most work use a single-part line with the end of the hoist rope attached to a weighted crane hook either by rope clips or a wedge rope socket (use a rope clip to fasten the end or the rope just above the rope socket). If more accurate control is needed reeve the rope around the sheave of the hook block and dead end the rope in a rope socket pin-connected to the lug near the point of the jib.

b. Crane Jib Suspension

On cranes equipped with an offset boom or jib the jib is suspended by guys attached to the boom at the lower end of the upper boom section as shown in Fig. 16.

The jib itself is suspended from the mast by guy rope "A" of fixed length. A different length rope is required for each different length of jib.

To replace the upper guy rope "A" with a new one proceed as follows:

1. Lower the boom until the jib point rests on blocking placed on the ground to receive it. (Do not lower the boom beyond the limit of the safety guy rope "D".)
2. Take out the pins connecting the rope sockets to the jib point, drive out the wedges and remove the rope from the sheave on the front of the mast.
3. Reeve the new rope around the mast sheave, install a rope socket on each end of the rope by replacing the wedges and attach sockets to the jib point.

The jib mast is suspended by the lower guy rope "B" connected directly to the lower end of the upper boom section on one side and connected to the lower end of the upper boom section on the other side by jib adjusting guy ropes "C". The lower guy rope "B" is of fixed length and does not change for different length booms. Adjustment of the angular position of the jib is made by adding or removing one or more of the lower short adjusting guy ropes "C".

To change the jib angle, or to replace the guy rope proceed as follows:

1. Lower the boom until the jib point rests on blocking placed on the ground to receive it. Take off the safety guy rope "D" by removing the rope clips and driving the wedge out of the wedge rope socket.
2. Take out the pins in the rope sockets of the jib-adjusting guys and reconnect with jib-adjusting guys added or removed as required to obtain the desired jib angle. (It may be necessary to lower the boom an additional amount to make the connection.)

NOTE: The length of the jib boom determines the angle at which it must be carried. Only the 15 foot jib can be horizontal (with the main boom at 60°) and the angle between the 30 foot jib and the main boom must not exceed 15°.

In making up guy ropes for the jib be sure they are made to the exact dimension given in the rope specifications in Chapter XVII.

Adjust new safety guy rope "D" to suit the angular position of the jib.

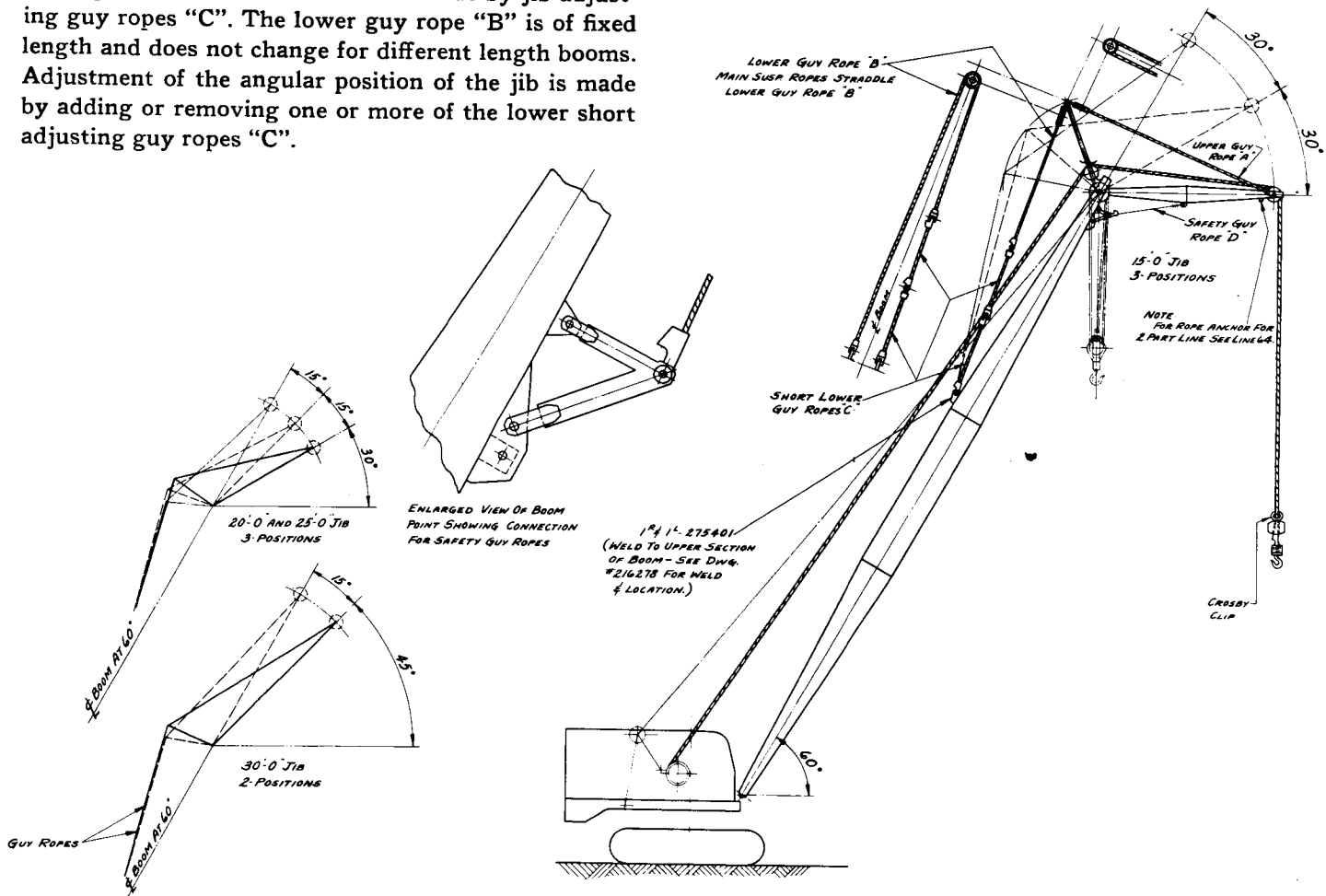


FIG. 16

WIRE ROPE SPECIFICATIONS

STANDARD SHOVEL

21'-0" Boom		17'-5" Handle	
Rope	Dimensions	Spec.	
Hoist	7/8" x 100'-0"	2	
Crowd	1" x 63'-0"	2	
Backhaul	1" x 36'-0"	2	
Dipper Trip	3/8" x 17'-0"	1	
	3/8" x 24'-0"	1	
Suspension	5/8" x 280'-0"	1	

CLAMSHELL

Boom Length	Dimensions		Spec.
	Closing	Holding	
45'	7/8" x 140'	7/8" x 110'	1
50'	7/8" x 150'	7/8" x 120'	1
55'	7/8" x 160'	7/8" x 130'	1
60'	7/8" x 170'	7/8" x 140'	1
65'	7/8" x 180'	7/8" x 150'	1
70'	7/8" x 190'	7/8" x 160'	1
75'	7/8" x 200'	7/8" x 170'	1
80'	7/8" x 210'	7/8" x 180'	1

BOOM SUSPENSION - - CONTINUOUS REEVING

Boom Length	Dimensions	Spec.
45'	5/8" x 470'	1
50'	5/8" x 510'	1
55'	5/8" x 550'	1
60'	5/8" x 590'	1
65'	5/8" x 630'	1
70'	Use mast type	
75'	suspension for all	
80'	booms 70' or longer	

DRAGLINE

Boom Length	Hoist rope		Drag Rope	
	Dimensions	Spec.	Dimensions	Spec.
45'	7/8" x 110'	1	7/8" x 65'	2
50'	7/8" x 120'	1	7/8" x 70'	2
55'	7/8" x 130'	1	7/8" x 75'	2
60'	7/8" x 140'	1	7/8" x 80'	2
65'	7/8" x 150'	1	7/8" x 85'	2
70'	7/8" x 160'	1	7/8" x 90'	2
75'	7/8" x 170'	1	7/8" x 95'	2
80'	7/8" x 180'	1	7/8" x 100'	2

Tagline Rope for Rud-o-matic Model 6-48 Reel 3/8" x 70'-0", 6 x 19 Plow Steel Hemp Center

SPECIFICATIONS

1. Improved Plow Steel Rope, Modified Seale Construction, 6 x 19, Regular Lay, Right Lay, Hemp Center.

2. Improved Plow Steel Rope, Modified Seale Construction, 6 x 19, Langlay Right Lay, Wire Rope Center.

6. Wire Rope 6 Strands @ 19 wires Regular Lay, Right Lay, Independent Wire Rope Center complete with one eye end and one open end "Tiger" thimble pins in same plane, length of pendants center to center of pins. Splice specially protected by lubricant and rubber covering. Pendant pairs matched and paint-stripped for identification.

BOOM SUSPENSION - PENDANT WITH MAST

8-Part Tackle	Dimension	Spec.				
Rope (All booms)	5/8" x 210'	1				
All Pendants 1-1/4" Diameter		6				
Boom Length	Lengths of Pendants and Number Required					
	5'1-23/8"	10'1-23/8"	15'1-23/8"	20'1-1/2"	8'6-1/2-23/8"	23'9"-21/2"
55'			2		2	2
60'			2	2	2	2
65'			2	2	2	2
70'		2	2	2	2	2
75'		2	2	2	2	2
80'			4	4	2	2
85'			4	4	2	2
90'	2		4	4	2	2
95'		2	4	4	2	2
100'			4	4	2	2

NOTE: 23'9" Pendants must always be attached to boom point and have intermediate suspension link attached to lower end.



BOOM SUSPENSION - PENDANT WITHOUT MAST

8-Part Tackle	Dimension	Spec.			
Rope (All booms)	5/8" x 210'	1			
All Pendants 1-1/4" Diameter		6			
Boom Length	Length of Pendants and Number Required				
	5'1-1/8"	10'1-1/8"	15'1-1/8"	20'1-1/8"	33'1-1/8"
45'					2
50'	2				2
55'		2			2
60'			2		2
65'				2	2

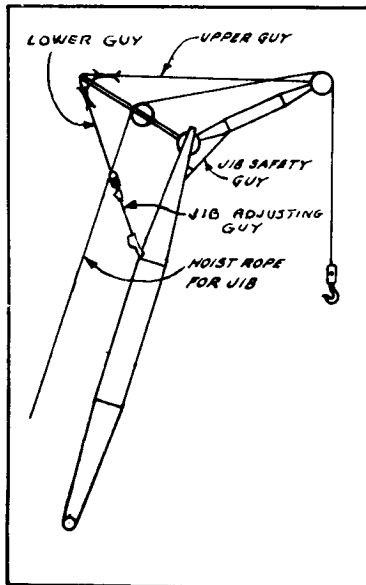
JIB EXTENSIONS

HOIST ROPE FOR JIBS

All 3/4" Diameter - Specification 1.				
Jib Length	15'	20'	25'	30'
Boom Length	Rope Length			
45'	140'	150'	160'	170'
50'	150'	160'	170'	180'
55'	160'	170'	180'	190'
60'	170'	180'	190'	200'
65'	180'	190'	200'	210'
70'	190'	200'	210'	220'
75'	200'	210'	220'	230'
80'	210'	220'	230'	240'
85'	220'	230'	240'	250'
90'	230'	240'	250'	260'

JIB SAFETY GUY ROPES

2 - Required 1/2" x 12' - Spec. 2.

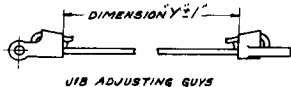


UPPER GUY ROPES FOR JIBS

All 7/8" Diameter - Specification 2.				
Jib Length	15'	20'	25'	30'
Dimension X	35'-6"	44'-6"	54'-0"	63'-9"
Rope Length	38'-6"	47'-6"	57'-0"	66'-9"

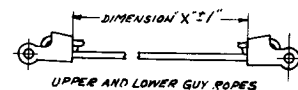
JIB ADJUSTING GUYS

All 7/8" Diameter - Specification 2.				
Jib Length	15'	20'	25'	30'
Required	2	2	2	1
Dimension Y	6'1"	2'9"	2'9"	2'9"
Rope Length	9'1"	5'9"	5'9"	5'9"



LOWER GUY ROPES FOR JIBS

All 7/8" Diameter - Specification 2.		
Boom Length	Rope Length	Dimension X
All	41'3"	38'3"



Conversion Instructions

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- D. INSTALLATION OF SHOVEL
BOOM, DIPPER AND HANDLE

CHAPTER XX — **DRAGLINE, CLAMSHELL AND CRANE CONVERSION**

- A. CHANGING BOOM LENGTH
- B. OPERATING LEVER CHANGES

The same deck machinery, with minor changes, is used for all types of front end equipment. Instructions for changing over a combination machine from one type of operation to another are covered in this Section. It is not possible to cover all details of conversion as the exact procedure will differ according to the lifting equipment, blocking, etc. that is available.

Installation of shovel equipment on a machine originally furnished as a dragline, crane or clamshell only, is not described although it is possible to convert to shovel operation. If shovel equipment is ordered

later, installation instructions will be furnished at the time the material is shipped.

Before starting any conversion, move the machine to a clear, level space having good drainage so that standing water will not interfere with the work. If possible, arrange to have a crane, or a good overhead hoist, to lift the heavy parts such as drum laggings, dragline fairlead, etc. Have plenty of sawed ties on hand so that good substantial cribs can be built. Don't take chances supporting heavy parts on rickety blocking.

— CHAPTER XVIII —

CONVERSION OF SHOVEL TO DRAGLINE, CLAMSHELL OR CRANE

A. REMOVAL OF SHOVEL BOOM, DIPPER AND HANDLE:

If the shovel equipment is going to be put back on the machine it is not necessary to take off the dipper handle. Remove the entire front end assembly as follows:

1. Fully extend the dipper handle and lower the dipper until the heel of the dipper rests on a couple of timbers placed on the ground just forward of the boom point.
2. Lower the boom with the boom hoist. As it nears horizontal, place a timber across the dipper handle just back of the handle stop. Continue lowering until the boom comes to rest on the timber.
3. Build a solid crib to support the foot of the boom.
4. Spool off the hoist cable, lubricate it thoroughly and store it in a dry place for future use. Also remove and store the short dipper trip cable from the boom to the ratchet arrangement on the right end of the hoist shaft.
5. If the dragline, clamshell or crane boom is to have continuous reeving of the boom suspension rope the shovel boom suspension rope is too short and must be replaced. Spool it off, lubricate and store it in a dry place for future use. Refer to the wire rope specifications in Section V for the correct length suspension rope to use.

If mast or pendant-type suspension is to be used, the shovel boom suspension rope can be used for the eight-part tackle between the sheaves on the A-frame and the mast or pendant yoke sheaves.

If care is used to avoid kinking the rope the eight-part tackle may be taken off the shovel boom point sheaves as follows:

- a. Take out the blank bolts which hold the suspension sheave rope guards on the shovel boom-point shaft and remove the guards.
 - b. Place a timber through the four loops of the suspension cable just back of the sheaves.
 - c. Lift each loop of the suspension rope off its sheave. (If there is any tendency for the loops to cross over on the timber, tie them to the timber so that the loops will stay in the correct relative position.)
 - d. Take off the four small suspension sheaves which will be used on the mast or pendant yoke. Replace the shovel boom point rope guards so they will not be lost.
6. Part the crowd drum roller chain at any link. Oil and store the chain.
 7. Take out the rod bolts "A" holding the crowd rope drum to the front of the revolving frame. (See Fig. 1.) (The rope drum shaft is carried by two plates bolted to the boom, therefore it is not necessary to disturb the crowd and backhaul ropes.) If the machine is being changed over to dragline operation, or is to have mast-type suspension, take off the shaft bearings to use with the fairlead or mast.
 8. Take out the locking bolts in the boom-foot pins and remove the pins. (It may be necessary to jack the foot of the boom slightly to relieve the load on the pins.)
 9. Back the machine away from the shovel boom, taking care that the boom suspension ropes do not get fouled.

B. DECK MACHINERY CHANGES:

For dragline, clamshell or crane operation the two-piece gear rim on the left drum is replaced by a grooved lagging. (Refer to the Machine Specifications for selection of the correct lagging.) To make the change proceed as follows:

1. Remove the hinged curved cover at the front of the revolving frame by taking out the hinge bolts. (See Fig. 2.) NOTE: The cover furnished for use with shovel front end equipment cannot be used on machines with mast-type suspension.
2. Take out the center cab panel (with the sliding covers) by removing the bolts around the outer edge.
3. Take off the retaining plate "B" at the right end of the crowd sprocket shaft. (See Fig. 1.) Pull out the shaft and remove the sprocket and pinion assembly. (Replace the sprocket shaft and retaining plate.)
4. Remove the bolts fastening the two halves of the crowd gear rim together. Take out one half of the rim at a time by removing the bolts holding it to the housing. (Turn the housing to reach the bolts conveniently.)
5. Place one half of the drum lagging in position on the drum sleeve and install the finished bolts. (Refer to the Machine Specifications for selection of the correct size lagging.) Reach through the opening in the clutch housing to insert the bolts from the left. Turn the housing 180° and install the other half of the lagging in a similar manner.
6. Since the backhaul clutch assembly will deteriorate less if it is left on the machine than it would in storage it should be left in its bearings. The pinion and clutch housing run on anti-friction bearings therefore will require little attention.
7. Bolt the center cab panel in place over the drums and replace the original hinged cover or, if the machine is to have mast-type suspension, install the special hinged cover. Take off the cover plates over the openings for the drag rope and the dirt trough. (See Fig. 2.) Fasten the covers in place over the openings for the crowd chain. (NOTE: Studs are furnished on which the covers not in use can be fastened so they will not become lost.)

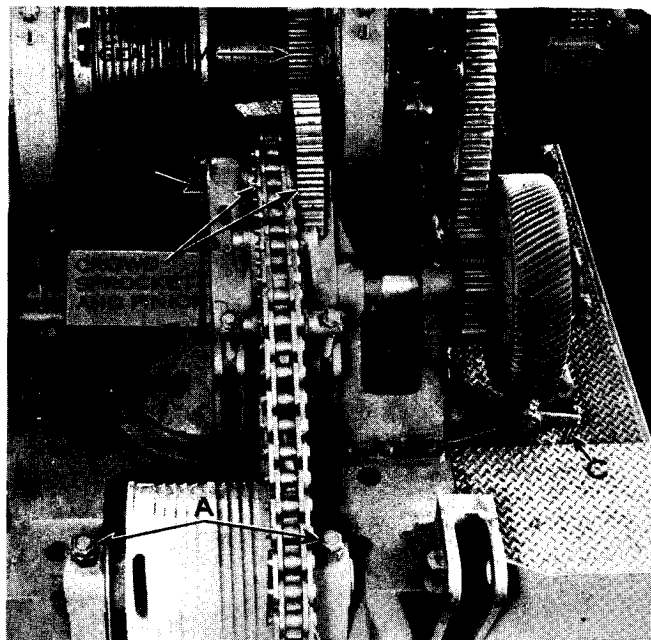


FIG. 1

C. OPERATING LEVER CHANGES:

For shovel operation the backhaul clutch and crowd (left drum) clutch are inter-connected so that both clutches are operated by the middle hand lever in front of the operator.

For dragline, clamshell or crane operation disconnect the backhaul clutch lever by disconnecting the short reach rod "C" passing through the left hand deck plate. (See Fig. 1.)

Remove the reach rod from the lower end of the Dipper Trip lever in front of the operator and hold the lever in the forward position by tightening the cap screw up against the under side of the deck plate.

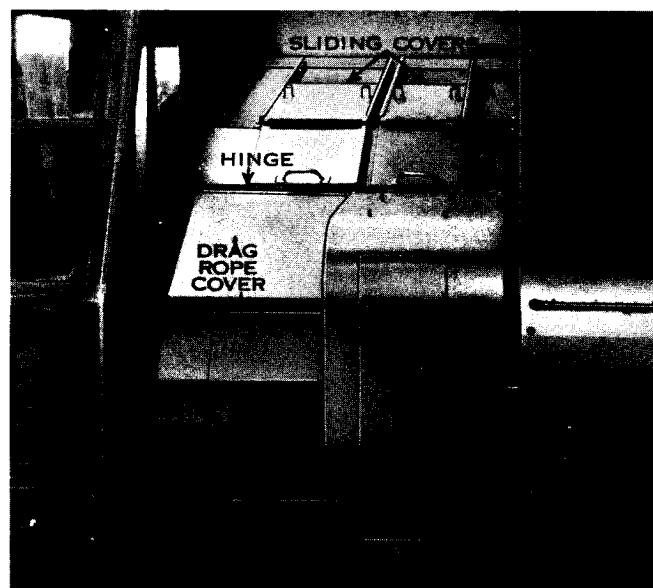
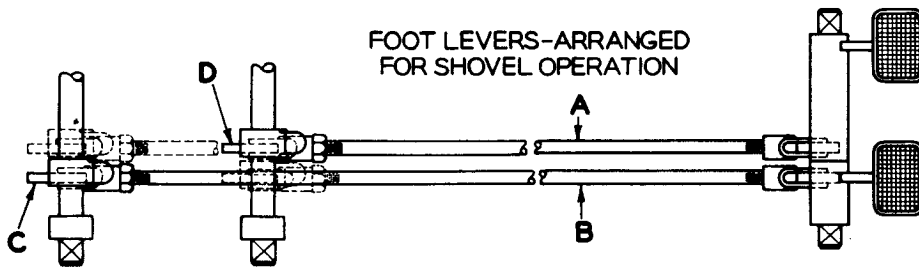


FIG. 2



For dragline service the functions of the main clutch hand levers must also be interchanged as follows: (See Fig. 4.)

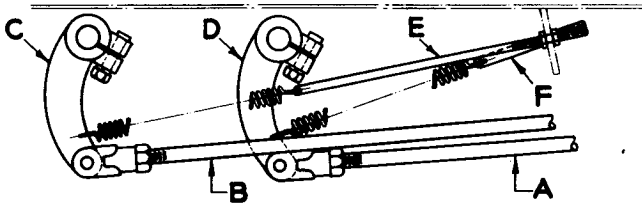


FIG. 3

For crane service no other change in operating levers is necessary. For dragline or clamshell service the functions of the brake pedals are interchanged as follows: (See Fig. 3.)

1. Disconnect both ends of reach rods "A" and "B" (below the right deck plate.)
2. Remove the release springs "E" and "F" and loosen the bolts clamping levers "C" and "D" on the two short shafts back of the operator's position.
3. Move the lever "D" on the forward shaft out to the position shown in dotted lines and tighten the clamp bolt.
4. Move the lever "C" on the rear shaft to position shown in dotted lines and tighten the clamp bolt.
5. Connect the reach rod "A" between the right foot lever and the lever "D" on the forward shaft.
6. Connect the reach rod "B" between the left foot lever and the lever "C" on the rear shaft.
7. Replace the release springs "E" and "F" reversing their position so that the spring with long rod end "E" is in line with lever "C" in its new position. Tighten the adjusting nuts just enough to hold the foot levers in high position.

The right foot lever will now operate the brake on the left drum and the left foot lever will operate the right drum brake.

1. Remove the short reach rod "A" connected between the middle hand lever and the lever "B" on the right end of the long transverse shaft at the front of the machine.
2. Remove the reach rod "C" connected between the right hand lever and the lever "D" on the short transverse shaft.
3. Move the lever "B" to the extreme right end of the shaft and connect short reach rod "A" as shown in dotted lines.
4. Move lever "D" to the left keyway position and install the long reach rod "C" in the position shown in dotted lines.

The middle hand lever will now control the right drum clutch and the right hand lever will control the left drum clutch.

HAND LEVERS-ARRANGED FOR SHOVEL OPERATION

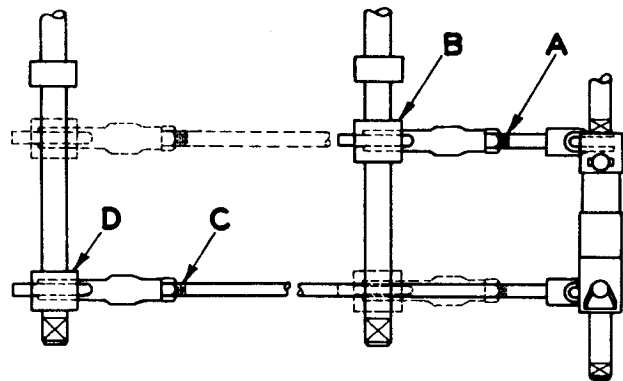


FIG. 4

For standard clamshell operation remove the booster release spring and eye bolt "G" on left driver (See Fig. 10b Section III). Install in its place the short clamshell spring and eye bolt "A" (See Fig. 5) using the same end washers and nuts. Adjust the compression in spring as described in Sec. III. For "two lever" clamshell operation, with drums of equal diameter, the special clamshell spring is not used and the booster release spring "G" is left in place. For convenience in handling the levers, horizontal extensions for the hand grips are furnished. Screw these into the tapped holes in the hand levers.

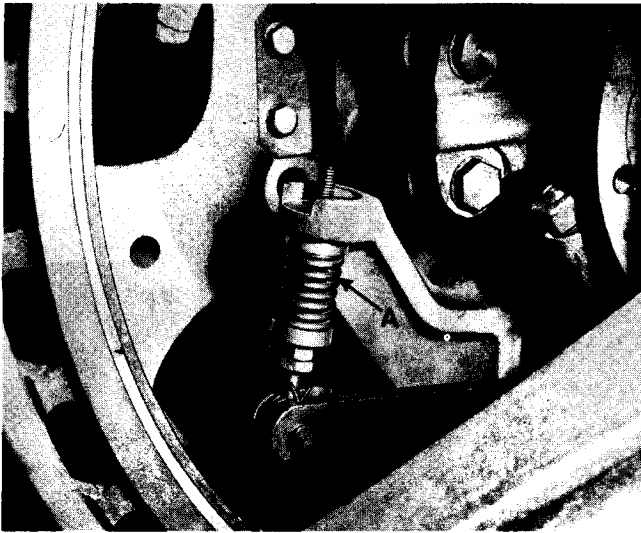


FIG. 5

D. INSTALLATION OF DRAGLINE FAIRLEAD:

For dragline operation a full rotating type fairlead for the drag cable is installed at the front of the revolving frame as shown in Fig. 6.

1. Place one of the crowd drum shaft bearings on each end of the fairlead shaft with the spacer sleeve on the shaft between the fairlead frame and the left bearing.
2. Raise the fairlead assembly into position at the front of the revolving frame and install the rod bolts, originally used for the crowd rope drum bearings.

NOTE: A clamshell or crane with mast-type suspension requires installation of the fairlead shaft in the crowd drum bearings for supporting the mast although no fairlead sheave assembly is used.

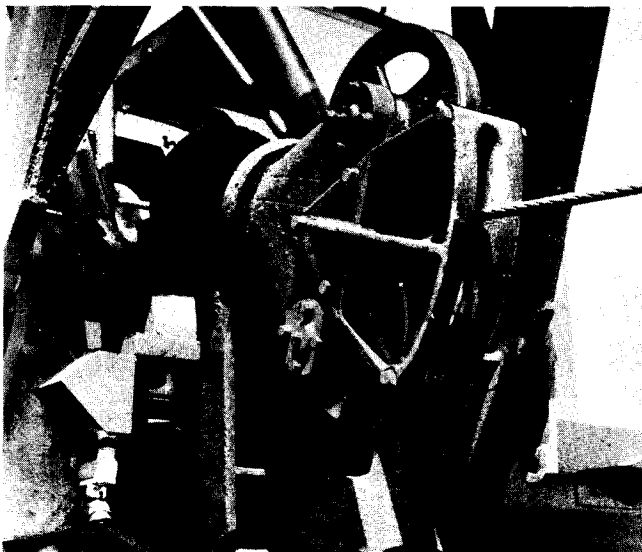


FIG. 6

E. BOOM POINT MACHINERY AND SUSPENSION YOKE CHANGES:

The arrangement of sheaves, guards, etc. on the shaft at the point of the lattice type boom depends on whether the machine is to be operated as a dragline, clamshell, or crane and whether continuous reeving or pendant suspension is used.

For clamshell service, or for a crane with 3 part hoist line, there are two sheaves on the boom point shaft with cast guards arranged as shown in Fig. 7.

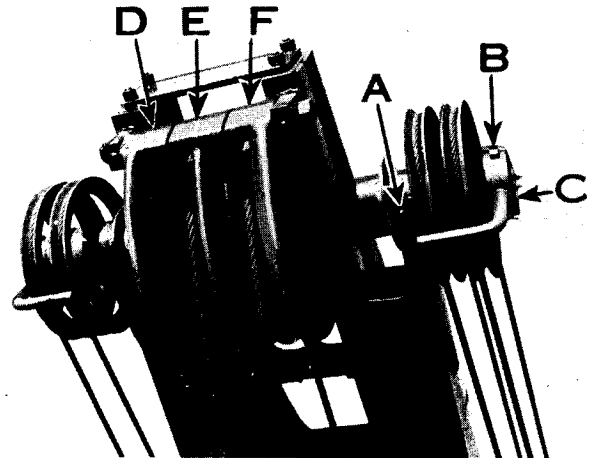


FIG. 7

To change the boom point machinery for dragline operation proceed as follows:

1. Take out the blank bolts "A" and "B."
2. Remove the rope guard "C" and pull out the boom point shaft.
3. Also remove the rope guides "D," "E" and "F."
4. Reassemble the boom point shaft as shown in Fig. 8 with spacers "A" on either side of the single sheave. Assemble the two outer rope guides with spacers "B" inserted as shown.

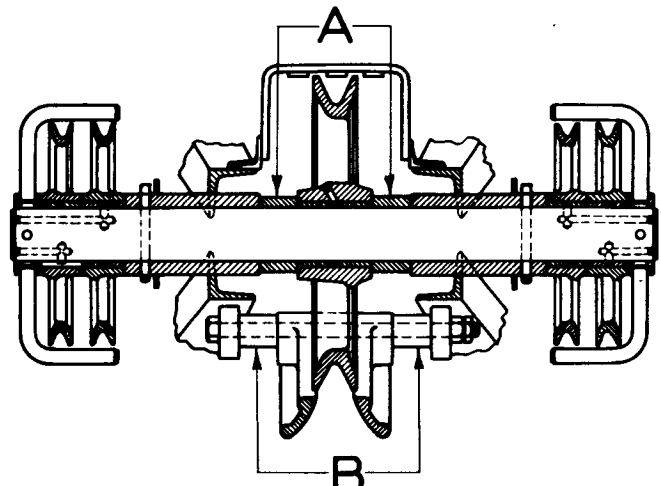


FIG. 8

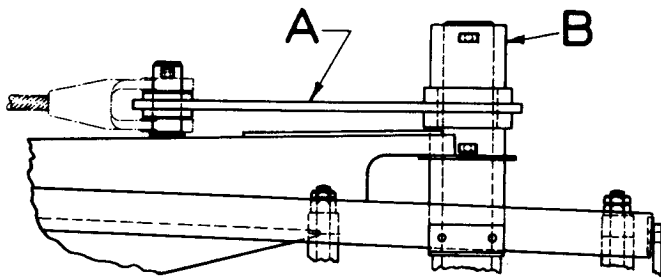


FIG. 9

5. If pendant suspension is to be used, replace the two sheaves and rope guard on each end of the boom point shaft by the pendant anchor link "A" and retainer "B" as shown in Fig. 9. The four small sheaves will be used in making up the suspension yokes at the outer end of the pendants as only one set of suspension sheaves is furnished on combination machines.

With mast type suspension, the pin at the top of the mast is assembled with four small sheaves and the pendant yokes as shown in Fig. 10. For removal or installation of the suspension sheaves take out the blank bolts "A" to permit sliding the yokes off the ends of the shaft.

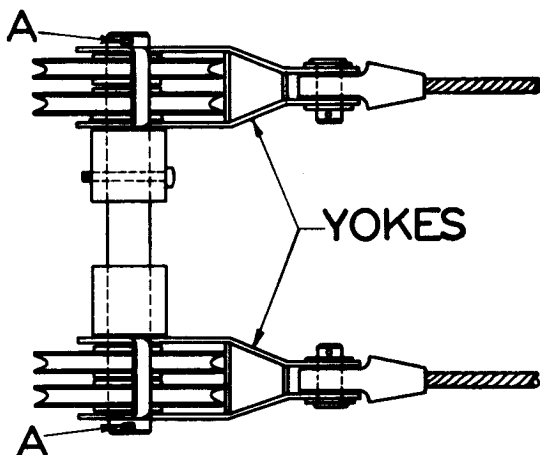


FIG. 10

For pendant suspension the suspension sheaves and pendant yokes are assembled on a pipe separator as shown in Fig. 11. To remove the suspension yoke for removal or installation of the suspension sheaves take out the blank bolts "A" and "B," slide the yoke in far enough to permit removal of the dowel pin "C," then slide the yoke off the end of the sheave pin.

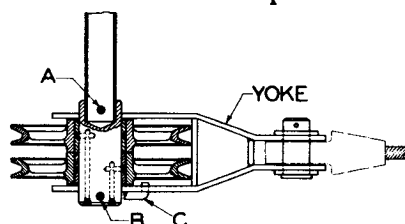


FIG. 11

F. INSTALLATION OF DRAGLINE, CLAMSHELL OR CRANE BOOM:

To install the lattice type boom used for dragline, clamshell or crane service proceed as follows:

1. Build two or more cribs as required to support the boom sections to make up a boom of the desired length. Build the cribs high enough so the boom foot will be at the same height as the boom foot lugs.
2. Insert the special splice bolts with fine threads. Pull the nuts up snug, but do not tighten so much that the bolts might be stretched.
3. Bolt the wooden splice guards across the top of the boom at each splice.
4. See that the boom-point machinery is correctly assembled for the type of operation desired. (Refer to paragraph "E" of this chapter.)
5. Propel the machine so that the boom foot enters the lugs on the revolving frame. (Raise or lower the boom foot slightly, if necessary.) Insert the boom foot pins and install the blank bolt lock pins.
6. If mast-type suspension is to be used, set the mast in position on the fairlead pin and install the mast foot retainer bolts.
7. For mast or pendant suspension, place the four loops of the shovel suspension rope around the suspension sheaves and assemble the sheaves on the mast pin or pendant bridle as shown in Fig 10 and 11. For continuous suspension, reeve the new suspension rope between A-frame and boom point sheaves as described in Section V.
8. On machines having mast or pendant-type suspension, assemble the required length of pendants between the mast or tackle yoke sheaves and the anchor links at the boom point.
9. Install the drum ropes in accordance with the instructions in Section V. Raise the boom to working position with the boom hoist.

For maximum stability and long operating radius an outside counterweight casting is also furnished. If maximum counterweight is required, install the casting as follows:

- a. Remove the rear running board used with the standard counterweight.
- b. Lift or jack the casting up into position and hook the lugs on the casting into the pockets at the rear of the revolving frame.
- c. Install the bolts fastening the counterweight to the rear end of the machine. **DO NOT LEAVE THE OUTSIDE COUNTERWEIGHT CASTING ON THE MACHINE WHEN OPERATING AS A SHOVEL.**

G. CLAMSHELL TAGLINE INSTALLATION:

If the machine is going to be used as a clamshell, it is also necessary to install the tagline to keep the clamshell bucket from spinning.

The tagline is of the spring loaded wheel type mounted on the bottom chord angle of the boom as shown in Fig. 12.

1. Place the tagline barrel in approximate position and assemble the clamping straps around the boom chord angle.
2. Shift the position of the tagline slightly so that the tagline wheel is directly in line with the bottom chord angle of the boom at a point about midway between the location of the tagline barrel and the point of the boom, then tighten the clamps securely.
3. Fasten the sheave block to the lower chord angle of the boom as shown in Fig. 12.
4. Check the oil in the tagline barrel. Add oil if necessary to half fill the barrel.
5. Install the tagline rope and wind up the spring inside the tagline barrel by turning the rope wheel. Approximately five turns should be satisfactory.
6. Attach the end of the tagline rope to the clamshell bucket using a rope thimble and rope clips.

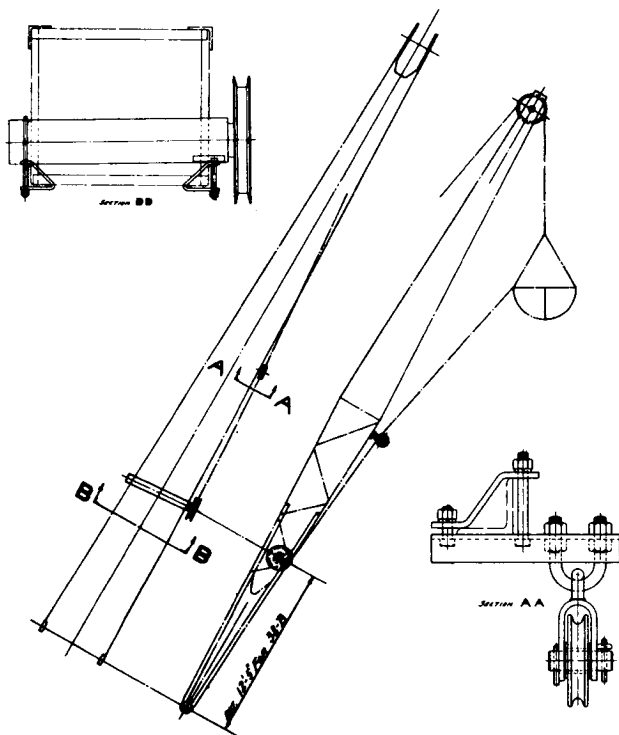


FIG. 12

H. INSTALLATION OF CRANE JIB:

If the machine is to be operated as a crane with a boom extension or jib; before raising the boom install the jib as follows: (See Fig. 13.)

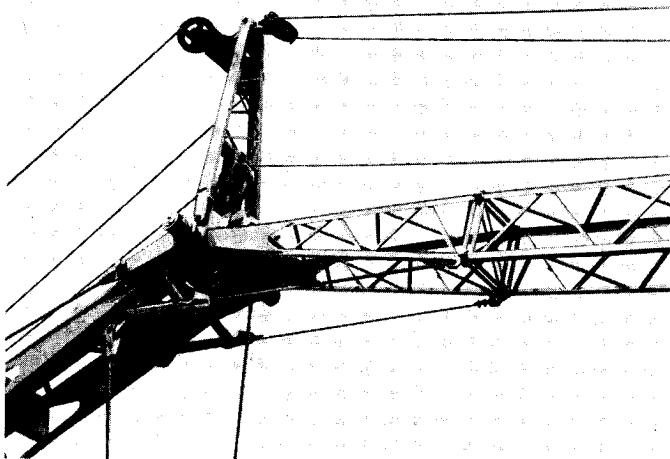


FIG. 13

1. Bolt the jib sections together using one or more center sections to obtain the desired length.
2. Slide the jib foot into position straddling the main boom point sheaves. Secure in place by bolting on the mast bearing caps.
3. Assemble the foot of the jib mast to the lugs on the jib foot section and lay the mast forward.
4. Install the jib upper and lower guy ropes as described in Section V.
5. Bolt the brackets for the safety guy ropes to the underside of the boom and attach one end only of the safety guy ropes.
6. Slowly raise the boom with the boom hoist. As soon as the slack is out of upper and lower guy ropes attach the other end of the safety guy ropes to the lugs on the outer end of the jib foot section.
7. Reeve the auxiliary hoist line from the left drum as described in Section V.

CONVERSION OF DRAGLINE, CLAMSHELL OR CRANE TO SHOVEL

If possible, start conversion of the machine near the place the shovel front end equipment is stored, so that it will not be necessary to move the shovel boom, dipper and handle.

A: REMOVAL OF DRAGLINE, CLAMSHELL OR CRANE BOOM:

Before removing the boom, on a machine having an outside counterweight, take off the counterweight casting so that the machine will have increased stability for propelling into the shovel boom foot. Take off the lattice-type boom as follows:

1. Prepare suitable cribbing to support the boom in lowered position.
2. Lower the boom onto the cribbing. **NOTE:** With mast or pendant type suspension watch the suspension ropes carefully. Ease the mast or tackle yoke to rest on the boom section so that the lacing angles will not be damaged.

If the machine is a crane with a jib, disconnect the jib safety guy ropes and support the point of the jib as the boom approaches horizontal position. Also lay the jib mast forward on the jib making sure that the upper guy ropes are kept clear so they will not be damaged.

3. Detach the dragline or clamshell bucket or crane hook block and take off the ropes. Lubricate the ropes thoroughly then coil them up or wind on a reel and store in a dry place. Tag each cable so that it can be easily identified when needed. **NOTE:** On machines that have mast or pendant type suspension, it is not necessary to unreeve the eight-part tackle between the A frame sheaves and the sheaves on the mast or tackle yokes. If care is used to avoid kinking the rope the tackle may be transferred to the shovel boom-point sheaves as follows:
 - a. Place a timber through the four loops of the suspension cable just back of the sheaves on the mast or tackle yoke.
 - b. Take out the blank bolts which hold the pendant yokes on the mast or tackle yoke pin. Slide the yoke and sheaves off the ends of the pins (first taking out the dowel pin which prevents the tackle yoke turning.)
 - c. Take out the sheaves and pendant yokes. (If there is any tendency for the loops to cross over on the timber tie them in place so the loops

will stay in correct relative position.) Reassemble the mast or tackle yoke sheaves so parts will not be lost.

4. Disconnect the crane jib (if any), unbolt the sections for convenience in storing and place on blocks. Use blocks between the sections if stored one on top of another.
5. If the machine had mast type suspension, remove the mast.
6. Take out the boom-foot pins and back the machine out of the way. If the machine is going to be used as a shovel for some time, separate the boom sections and pile on blocking.
7. If the machine was operating as a dragline, remove the fairlead by taking out the adjusting bolt at the lower end of the fairlead frame and the rod bolts holding the fairlead shaft bearings for installation of the shovel crowd drum. Store the fairlead with the other dragline parts. (The same shaft and bearings will be in place on clamshells or cranes having mast-type suspension and must be removed for installation of the shovel crowd rope drum.)

B. DECK MACHINERY CHANGES:

Before starting installation of the shovel deck machinery clean the machinery and parts carefully to remove dirt or rust which may have accumulated.

Install the crowd gear rim and drive sprocket as follows:

1. Remove the hinged curved cover at the front of the revolving frame by taking out the hinge bolts. (See Fig. 2.)
2. Take out the center cab panel (with the sliding covers) by removing the bolts around the outer edges.
3. Take out the two halves of the lagging on the left drum.
4. Place one half of the crowd gear rim in position and install the bolts fastening it to the left drum housing. Turn the housing 180°, bolt the other half of the gear in place, then install the bolts holding the two halves of the crowd gear together.
5. Take off the retaining plate at the right end of the crowd sprocket shaft, pull out the shaft and assemble the drive sprocket and pinion on the shaft. (See Fig. 1.) Replace the assembly and hold in position by installing the retaining plate.

C. OPERATING LEVER CHANGES:

For shovel operation, interconnect the backhaul clutch and crowd clutch (left drum clutch) by installing the short reach rod with ball and socket end passing through the left hand deck plate. (See Fig. 1.)

Loosen the set screw (below the deck plate) holding the dipper trip lever in forward position then install the reach rod between the lower end of the dipper trip lever and the bell crank connected to the vertical reach rod which operates the ratchet device on the right end of the hoist shaft.

If the machine had been operating as a crane no further change is required. However, if it has been operating as a dragline the functions of the hand levers must be interchanged as follows: (See Fig. 4.)

1. Disconnect the short reach rod "A" from the right hand lever to the short lever on the right end of the long transverse shaft.
2. Disconnect the reach rod "C" from the middle hand lever to the short lever on the rear transverse shaft.
3. Move the short lever on the long transverse shaft to the keyway position in line with the middle hand lever and install the short reach rod "A."
4. Move the short lever on the rear transverse shaft out to the right end of the shaft and install the long reach rod "C" between the right hand lever and the lever on the rear transverse shaft.

The levers will now be arranged as shown in full lines in Fig. 4. The right hand lever will now control the right drum clutch and the middle hand lever will control the left drum clutch.

When changing from clamshell or dragline to shovel operation the functions of the brake pedals must also be interchanged as follows: (See Fig. 3.)

1. Disconnect both ends of the two reach rods "A" and "B" below the right deck plate.
2. Loosen the clamp bolts on the short levers "C" and "D" on the two short shafts at the operator's position.
3. Move the lever on the forward shaft in against the bearing and tighten the clamp bolt.
4. Move the lever on the rear short shaft out to the right end of the shaft and tighten the clamp bolt.
5. Connect the short reach rod "A" between the left foot lever and the lever "D" on the forward short shaft.

6. Connect the long reach rod "B" between the right foot lever and lever "C" on the rear short shaft.

The levers will now be arranged as shown in full lines in Fig. 3. The left foot lever will now operate the crowd brake and the right foot lever will operate the hoist brake.

If the machine has been operating as a standard clamshell it is also necessary to take off the spring used to create drag on the holding line clutch. Install in its place the booster release spring used for all other types of operation. (See Fig. 5.)

On clamshells arranged for "two-lever" operation (with closing and holding drums of equal diameter) the clamshell spring arrangement is not used and the booster release spring will already be properly installed but the horizontal extensions for the middle and right hand levers in front of the operator should be taken off.

D. INSTALLATION OF SHOVEL BOOM, DIPPER AND HANDLE:

If the boom, dipper and handle are not already assembled, proceed as follows:

1. Jack up the shovel boom on cribbing so that boom foot is the same height as the lugs on the front of the revolving frame.
2. Propel the machine into the boom foot. Attach the boom by inserting the boom foot pins and lock pins.
3. Bolt the crowd drum to the front of the revolving frame using the bearings and rod bolts used for the fairlead shaft.
4. Install the crowd chain around the drive sprocket, over the take up sprocket and around the crowd drum sprockets. Use the chain connecting tool, shown assembled in Fig. 14, for ease in inserting the pin.
5. Assemble two of the small suspension sheaves on each end of the boom point shaft, if not already in place.
6. Reeve the 8 part suspension rope as described in Chapter XVI of Section V.

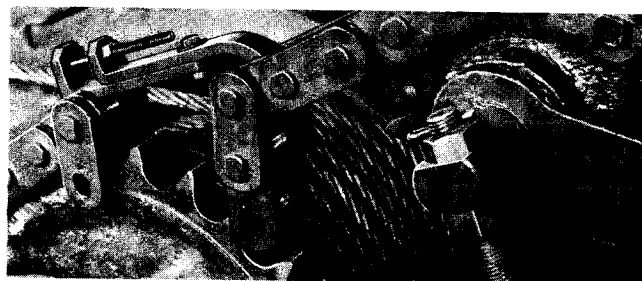


FIG. 14

7. Use the boom hoist to raise the boom to about 45° with the horizontal.
8. If not already assembled, attach the dipper handle to the dipper back by inserting the pitch brace and handle end pins. Also attach the dipper padlock to the dipper.
9. Remove the lock bolt at the upper end of the dipper handle. Drive out the pin through the side of the handle and take off the anchor casting.
10. Raise the saddle block up to approximate working position and fasten it in place.
11. Propel the machine forward and guide the end of the dipper handle between the saddle block slide plates.
12. Replace the anchor casting on the end of the dipper handle.
13. Reeve the hoist, crowd, backhaul and dipper trip ropes as described in Chapter XVI of Section V.

If the shovel front end equipment had been used previously, it should have been stored with the dipper and dipper handle assembled and the crowd and backhaul ropes in place. Installation on the machine is then greatly simplified as it is only necessary to propel the machine into the boom foot, attach the boom, reeve the suspension and hoist ropes and raise the boom into working position then install the short dipper trip rope from the lever on the boom to the tripping ratchet at the right end of the drum shaft.

— CHAPTER XX —

DRAGLINE, CLAMSHELL AND CRANE CONVERSION

Draglines, clamshells and cranes are easily changed from one type of operation to the other as it is generally unnecessary to make any change in the front end equipment. The dragline fairlead can be left in place as it does not interfere with either clamshell or crane operation.

Similarly, the clamshell tagline can be left in place on the boom when the machine is operating as a dragline or crane.

On combination machines the boom point shaft can be arranged with two sheaves as shown in Fig. 7. One of the sheaves will not be used for dragline operation.

No change in drum lagging is required if standard drum combinations are used.

A. CHANGING BOOM LENGTH:

The length of the boom is easily changed to suit the job as follows:

1. Lower the boom on cribbing built in front of the revolving frame, remove the wood rope guards and take out the boom splice bolts.
2. Pay off the suspension and main drum ropes enough to accommodate the new length boom. If the boom length is changed more than 10 feet it may be necessary to install new ropes. Refer to the Wire Rope Specifications in Section V for correct length of ropes to use.

(If the machine has mast type or pendant suspension, pay off the suspension rope to provide the necessary slack and part the pendants at any pin connection for addition of more or longer pendants to match the length of the boom inserts added.)

NOTE: If the new boom length exceeds the maximum allowable length of boom for continuous or pendant suspension, it will be necessary to change over to mast-type suspension. Refer to "E" in Chapter XVIII for procedure to follow in making this change.

B. OPERATING LEVER CHANGES:

The arrangement of main hand levers (controlling the drum booster clutches) and brake pedals is somewhat different for the various front end equipments.

For clamshell or crane operation the Hoist lever is connected to control the right hand drum and the middle hand lever controls the left drum clutch, as shown by full lines in Fig. 4. When converting from clamshell or crane to dragline operation interchange the function of the hand levers so that the hoist lever controls the left drum clutch and the middle hand lever controls the right drum clutch. This interchange of functions is described under "C" in Chapter XVIII of this section.

To change back to the arrangement for clamshell or crane operation follow the procedure given under "C" in Chapter XIX.

For dragline or clamshell operation the Hoist Brake pedal is connected to operate the left drum brake and the left brake pedal is connected to operate the right drum brake as shown by dotted lines in Fig. 3. When converting from dragline or clamshell to crane operation interchange the functions of the brake pedals so that the Hoist Brake pedal controls the right drum brake. This interchange of functions is described under "C" in Chapter XIX of this section.

To change back to dragline or clamshell operation follow the procedure given under "C" in Chapter XVIII.

Unloading Instructions

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CHAPTER XXI — **PRELIMINARY WORK**

- A. PREPARING TO UNLOAD
- B. SERVICING MACHINE
- C. CONSTRUCTION OF UNLOADING RAMP

CHAPTER XXII — **UNLOADING PROCEDURE**

- A. LOWER WORKS ASSEMBLY
- B. INSTALLATION OF FRONT END EQUIPMENT
- C. ASSEMBLY OF UPPER WORKS ON LOWER WORKS

Although the machine is compactly designed to reduce overall dimensions it is not always possible to ship the machine fully assembled. Section VII has been written to assist the operator in unloading and assembling the machine as shipped from our factory.

It is not possible to give full unloading details as local conditions will determine the best way to handle the job. These instructions simply give a suggested method and will serve as a guide to the unloading procedure.

— CHAPTER XXI —

PRELIMINARY WORK

A. PREPARING TO UNLOAD:

Plan ahead for unloading the machine so that necessary material and tools will be at hand. If there is no unloading ramp where the car is to be spotted for unloading, about 50 to 75 sawed ties will be needed as well as 6 or 8 heavy stringers for building a ramp. Ordinary tools, such as a cross cut saw, sledges, pinch bars, etc. will also be needed.

When the cars are first received make a careful inspection and notify the railroad freight agent of any apparent loss or damage.

Included on one of the cars (usually just in front of the machine) is a box of tools furnished with the machine. Unpack this box first so as to have the wrenches, etc. available for unloading. A small bag containing the keys for the cab locks will also be found in the box of tools.

Remove the cables, tie rods, etc. used to secure the machine and take out as much of the blocking as necessary to permit moving the machine. Open up the cab doors and take off the covers bolted over the windows to protect them in transit. Bolt running boards to revolving frame.

B. SERVICING MACHINE:

Generally there is an accumulation of cinders which have blown into the machine. Clean them out carefully paying particular attention to the gears, clutch housings, roller path, etc. as cinders between the contact surfaces of heavily loaded parts will cause serious damage.

Fill the radiator of the engine with clean soft water. In freezing weather use an anti-freeze solution of the required strength. Check the engine crankcase to be

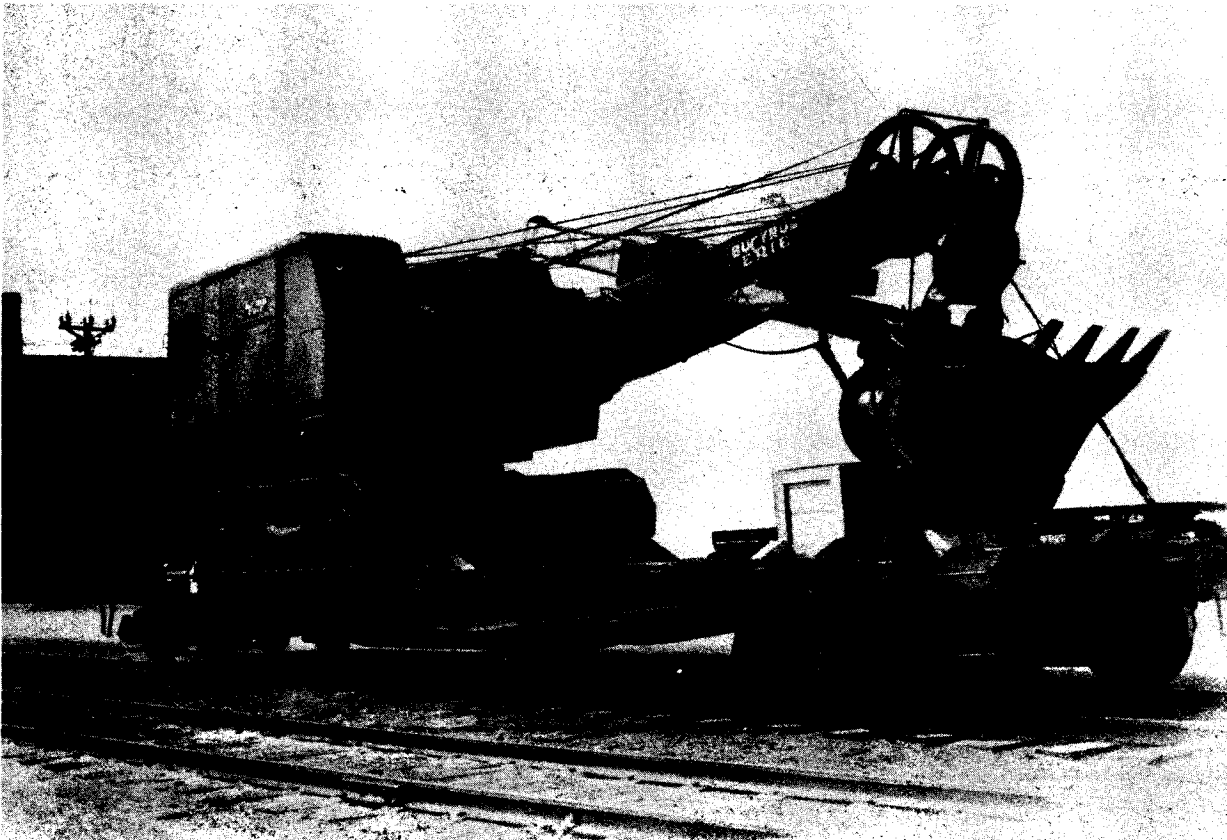


FIG. 1

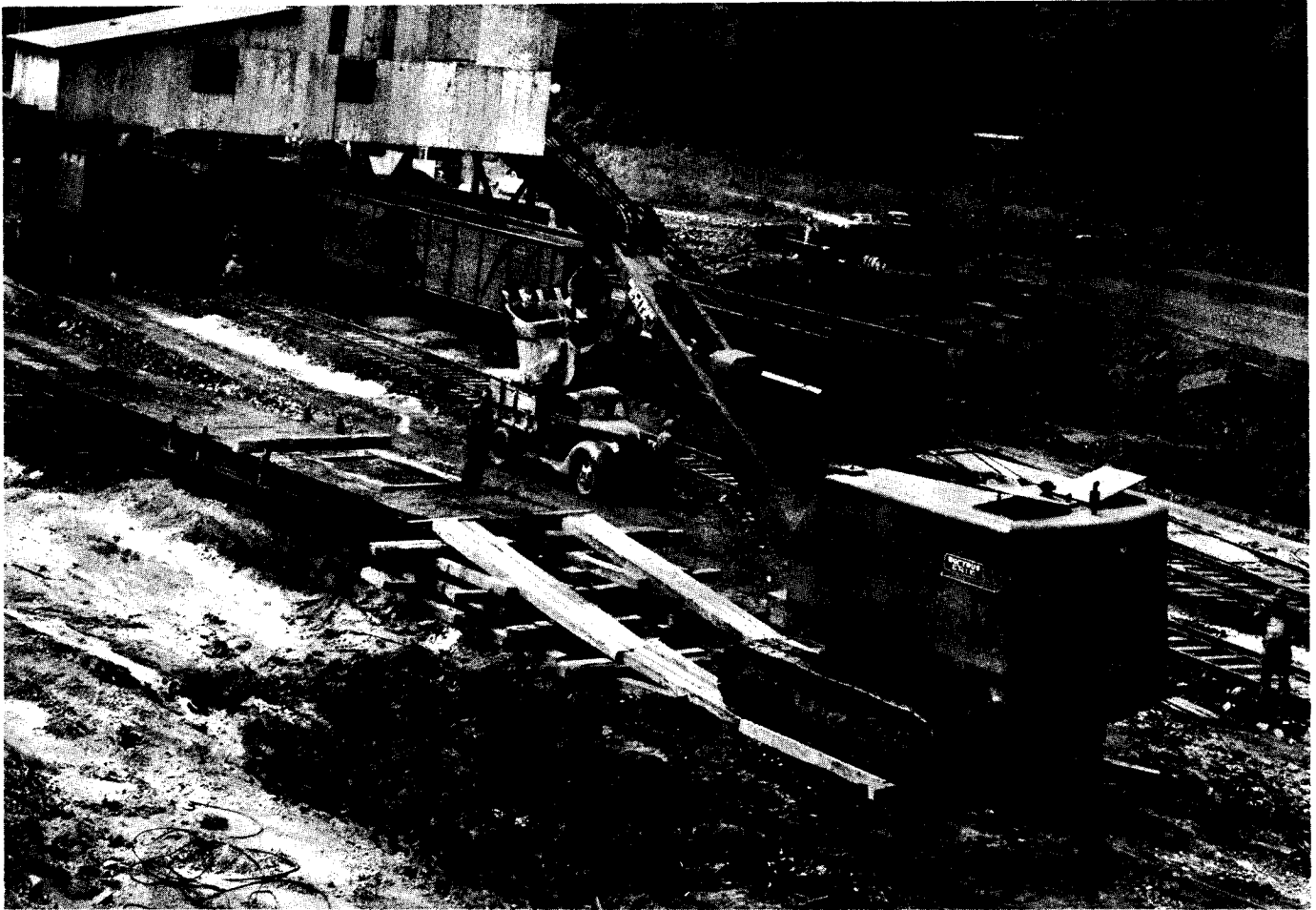


FIG. 2

sure that the oil is up to the indicated level. (A complete change of suitable crankcase oil was shipped with the machine.) On machines powered with Diesel engines the Diesel fuel tank is shipped full. Arrange for additional fuel so that there will be no danger of the fuel tank running dry. Read the engine builder's book included with this instruction book. Check the oil level in the truck-frame gear case at the center of rotation, the transmission chain case and the reversing transmission gear case.

Also study Section II of this instruction book so as to be fully familiar with the controls before trying to unload the machine.

C. CONSTRUCTION OF UNLOADING RAMP:

While the machine is being prepared for unloading, build a ramp at one end of the car similar to the arrangement shown in figure 2. Block the car and use track jacks or pieces of ties sawed to exact length, under each corner of the flat car so that the car will not tip while the machine is being unloaded. **CAUTION: DO NOT SWING OR PROPEL THE MACHINE UNTIL THIS HAS BEEN DONE.**

If the cat belts extend beyond the car floor it is advisable to build substantial cribbing alongside the car so that the cat belts will have solid footing.

— CHAPTER XXII —

UNLOADING PROCEDURE

If a flat car of 140,000 pounds capacity is available the machine equipped as a shovel can be shipped on one car. See Fig. 1. Machines with dragline, clamshell or crane front end equipment are usually shipped with the Lower Works and Upper Works assembled on one car and the Front End equipment loaded on a second car.

Maximum width of loads on most U. S. railroads is 10'-6", therefore, the width of the Lower Works on machines having wide treads is reduced for shipment by sliding the cat side frames in against the truck frame. On machines with standard width treads the Lower Works is shipped completely assembled.

A. LOWER WORKS ASSEMBLY:

On machines shipped with the side frames pushed in they must be pulled out before the machine can be moved. See figure 3.

1. Place a 25 to 35 ton screw or hydraulic jack under each axle, next to the side frame.
2. Jack up one side of the machine so the tread belt clears the car floor.
3. Assemble two of the jack screws "A", and side frame retainer plates "B" with the jack screw nut turned all the way on the jack screw and locked by inserting a cotter key through the nut and the hole in the jack screw.
4. Screw four of the studs "C" into the holes in the side frame and assemble one of the jack screws on each pair of studs. (The jack screws "A" must be screwed into the holes in the axles until the retainer plates "B" come up against the shoulders on studs "C.")
5. Turn the jack screws "A" counterclockwise. If two wrenches are available, turn both jack screws simultaneously. If there is only one wrench, turn the jack screws alternately a little at a time so that the side frame does not become jammed on the axle. As the jack screws are turned out of the axles the side frames are pulled out to working position.
6. Continue turning the jack screws until the side frame has been pulled out beyond the end of the axles a distance equal to the length of spacers "D."
7. Remove the jack screws, retainer plates and studs. Bolt the retainer plates to the side frames and axles with spacers "D" on the axle bolts "E." It is a good plan to fill the space at the end of the axle inside the side frame with heavy grease or oil soaked waste to keep dirt or mud out of the cavity.)
8. Securely tighten the cap screws "F" holding the retainer plates to the side frames. Tighten the axle cap screws "E" tight enough to make sure the spacers are clamped between the retainer plates and the ends of the axles then back off the axle cap screws "E" one or two flats.
9. Wire the heads of both sets of cap screws "E" and "F" so that they cannot back out.
10. Remove the jacks under the axles and clamp the axle guards "G" to the axles between the side frame and the truck frame.
11. Place the drive sprocket on the end of the clutch shaft and install the retaining washer and cap screws. (It may be necessary to jack up the center of the tread belt to get enough clearance to put the sprocket on the clutch shaft.)
12. Assemble the propelling drive chain between the drive sprocket and the sprocket on the driving tumbler. Use the special chain connecting tool included in the tools and supplies. NOTE: Install the chains so the head ends of the pins are toward the center of the machine.
13. Pull out the side frame on the other side following the same procedure.

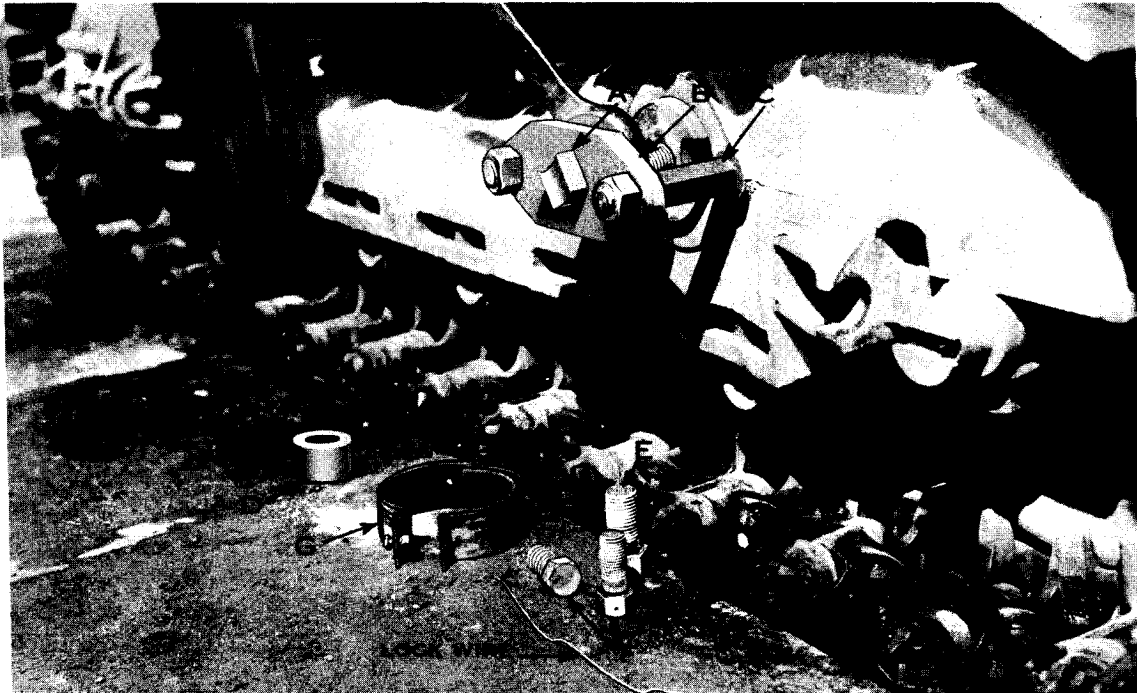


FIG. 3

B. INSTALLATION OF FRONT END EQUIPMENT:

If the front end equipment was loaded on a second car, block that car also so that the machine can be propelled over onto it for installation of the front end equipment. If necessary, build cribbing between the two cars with timbers on top so the machine can cross from one car to the other.

a. Shovel

Shovel front end equipment is usually shipped with the boom, dipper and handle assembled.

1. Crib the foot of the boom to the same level as the lugs on the front of the upper works.
2. Propel the machine into the boom foot and insert the boom foot pins. Lock in place with the blank bolts and cotter pins.
3. Bolt the crowd rope drum shaft bearings to the front of the revolving frame and connect the crowd roller chain. (A chain connecting tool for holding the ends of the chain while the connecting pin is being inserted is included in the tools and supplies. See figure 14 in Section VI.)
4. Reeve the hoist and suspension ropes as described in Section V and raise the boom to about 30° above horizontal. Swing the upper works around so that the boom is facing the ramp and propel the machine off the car.

NOTE: Be sure the machine is headed exactly in line with the ramp just before it breaks over the end of the car to start down the ramp. Do not try to steer the machine while it is coming down the ramp.

If the dipper handle and boom were shipped disassembled proceed as described above except install the dipper and handle as described below before reeving the hoist rope.

1. Take out the lock bolt holding the handle anchor casting and remove the casting.
2. Fasten a rope on the saddle block to hold it up in position so the end of the dipper handle can be entered between the slide plates.
3. With the end of the handle entered between the slide plates, propel the machine forward far enough so that the anchor casting can be replaced.
4. Reeve the hoist and crowd and dipper trip ropes as described in Section V.
5. Swing the upper works around and propel off the car, as described above.

b. Dragline, Clamshell or Crane

The lattice-type boom of machines having dragline, clamshell or crane front end equipment, may be loaded in several different ways therefore it is impossible to give detailed instructions to cover all conditions.

1. It is generally best to assemble the complete boom on the car. Use the special bolts with fine threads for the splice connections. Pull the nuts up snug but do not tighten so much that the bolts are stretched.
2. Slide the assembled boom over to the center line of the car.
3. Raise the foot of the boom on cribbing so that the boom foot lugs are in line with the lugs on the front of the revolving frame casting.
4. Propel the machine into the boom foot lugs. Insert the boom foot pins and lock in place by installing the blank bolts and cotter pins.
5. Install the boom suspension tackle as described in Section V for the type of suspension furnished.
6. Raise the boom to about 30°, swing the Upper Works around until the boom faces the ramp end of the car and propel the machine off the car the same as with the shovel.
7. Reeve the hoist and drag ropes and connect to the dragline bucket as described in Section V.
8. If outside counterweight casting is furnished it may now be installed. Use the hoist cable to set the counterweight on cribbing high enough so it can be fastened in place when machine is backed into it.

C. ASSEMBLY OF UPPER WORKS ON LOWER WORKS:

In some cases it may be necessary to ship the machine with the Upper Works removed from the Lower Works. If such is the case it will require an additional supply of ties or timbers for cribbing and two lengths of rails about 30 feet long as the Upper Works must be jacked over into position on the Lower Works. To unload the machine shipped disassembled proceed as follows:

1. Pull out the cat side frames as described in A.
2. Solidly block the four corners of the car and build a ramp at the end of the car. See figure 2. Use a tractor or winch truck to pull the Lower Works off the car. **NOTE:** Attach a snub line from the Lower Works to the car to check it in going down the ramp.
3. Move the Lower Works into position along side the car parallel to it and as close as possible.

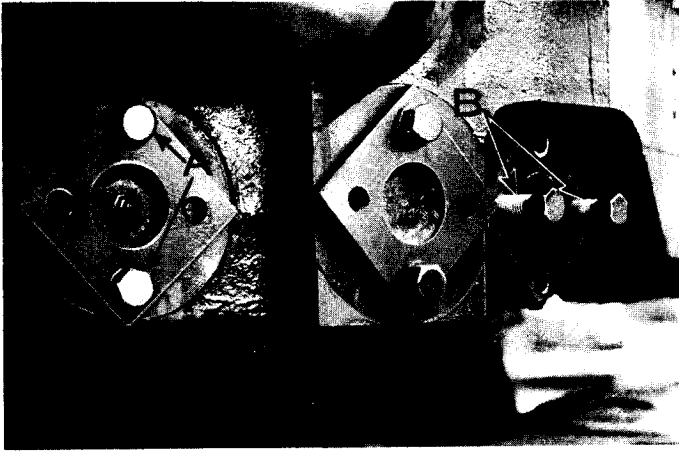


FIG. 4

4. Raise the Upper Works on blocking high enough so that the center bushing will clear the reach rods through the center of rotation of the Lower Works.
5. Remove the cone roller pins if they were shipped in place on the Upper Works. See Fig. 4. Take out the cap screws "A" insert them in the tapped holes as shown at "B" and tighten them equally to start the pin out.
6. Remove the hinged cover at the front of the cab and take off center covers below the rope drums to expose the levers at the center of rotation. See figure 5. (It will be necessary to remove parts of the dirt trough on machines having dragline front end equipment.)
7. Take out the split pins through the set screws "A" and back out the set screws. Remove reach rod end pin "D" thus allowing lever "B" to rotate freely as it is guided into the slot in the center vertical reach rod when the Upper Works is lowered.
8. Build substantial cribbing around the Lower Works to the same height as the blocking under the Upper Works. Coat the center gudgeon and vertical propel shaft with a liberal amount of grease.
9. Place the two rails under the Upper Works and extending over the Lower Works, the outer ends of the rails resting on substantial cribbing.
10. Apply a liberal coating of grease on the rails, lower the Upper Works onto the rails and pull or jack the Upper Works over into position above the Lower Works.
11. Center the Upper Works over the Lower Works, raise the Upper Works slightly on jacks and remove the rails.
12. Jack the Upper Works down, one end at a time, until the Upper Works center bushing engages the centering gudgeon on the Lower Works.
13. Support the Upper Works on four jacks, one at each corner and continue lowering it using **EXTREME CAUTION** to keep it level. As it moves down into position turn the propelling gear at the center of rotation so that the splines are correctly meshed with the vertical propel shaft. (See Fig. 5.) Also enter the lever "B" in the slot in the center reach rod as soon as possible.
14. Continue lowering the Upper Works until the cone rollers can be installed. Install the cone rollers by placing them in position between the flanges of the roller path and replacing the cone roller pins.
15. Position lever "C" so that set screws "A" can be entered in holes in outer reach rod. Tighten set screws "A" and replace split pins. Reconnect the reach rod by replacing pin "D".
16. Remove the jacks and cribbing, replace the center covers, install running boards and proceed with installation of the Front End Equipment.

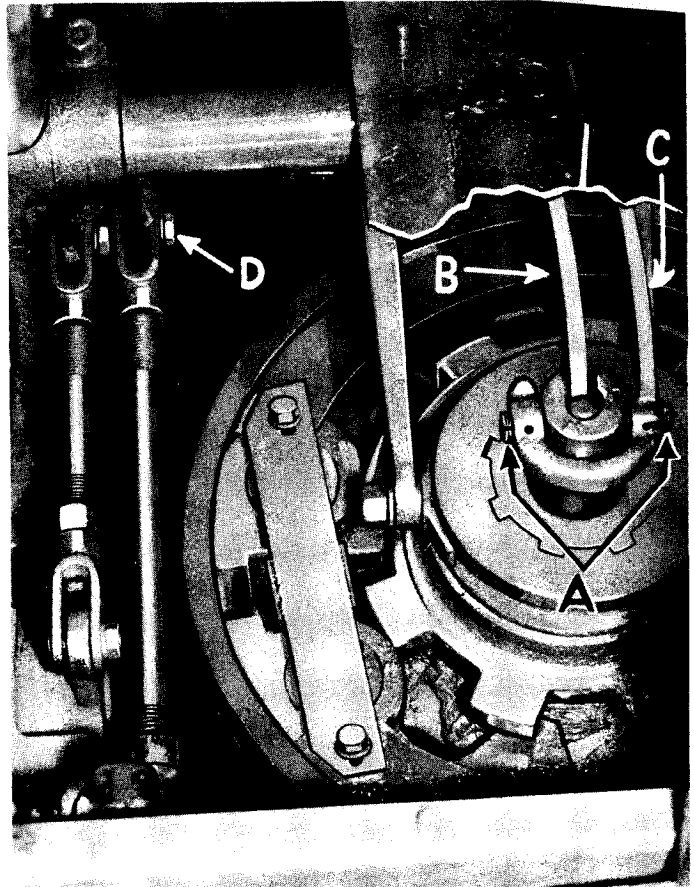


FIG. 5

Disassembly Instructions and General Drawings

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DISASSEMBLY INSTRUCTIONS

The service required of an excavating machine is very severe. It is therefore of the utmost importance to care for adjustments and lubrication as described in SECTION III and SECTION IV. Abuse or neglect is certain to result in damage to the machine.

In spite of the operator's best efforts accidents sometimes occur which require replacement of some shaft or other part. This section has been prepared to give the operator an idea as to how to go about the job of replacing a damaged part.

— CHAPTER XXIII —

DISASSEMBLING SUGGESTIONS

Instructions for removal of clutch and brake bands which will eventually require relining even in normal service, are given in SECTION III under the adjusting instructions for the part involved. The following pages briefly describe the removal of other principal parts of the machinery. The identifying numbers used in describing the procedure to be followed refer to the piece marks on the General Arrangement drawings included in this Section.

No attempt is made to describe removal of guards or cab parts which may have to be removed to reach the machinery parts being disassembled. When removing guards it is a good plan to replace the bolts and nuts after taking off the guards so that the correct bolt will be immediately available when reassembling the guards.

Instructions are given covering disassembly only. It is understood that parts are to be reassembled by following the reverse of the procedure outlined. Whenever possible, the disassembly of parts should be done by the same person who will reassemble them.

The following pointers will help in making the job easier:

1. Before starting on a repair or overhaul job move the machine to a dry level spot. If much disassembling is to be done the machine should be moved to a shop or other building where it will be protected from the weather.
2. Clean as thoroughly as possible all parts of the unit which is being disassembled.
3. When disassembling any control linkage do not disturb the adjustments of reach rods any more than necessary. If it is necessary to remove or

change the position of a reach rod end make a record of the exact length before disassembling it so the original length can be restored.

4. In removing levers or other parts with split hubs, loosen the clamp bolt and expand the hub by driving in a small wedge.
5. When disassembling any unit, especially one with a number of similar parts, keep the parts together and in order as far as is possible. It is a good plan to loosely reassemble parts after removal from the machine so that small parts will not be mislaid.
6. Attach tags or identify all parts by match marking.
7. Before assembling any unit be sure all parts are in good condition and thoroughly clean.
8. Apply grease or oil to bearing surfaces at the time of assembly.
9. In making press fits, coat the contact surfaces with white lead so they slide easily.
10. When assembling parts on a shaft make sure the shaft and the bore of the parts being assembled are smooth and completely free of burrs. Use a file or emery cloth to smooth up any rough spots.
11. Carefully examine all keyways to make sure the metal has not been upset along the edges.
12. In replacing bolts and pins be sure they are locked by means of lock washers, split pins, lock nuts, etc. as in the original assembly.
13. After operating the machine a few hours, check over a new assembly and tighten all bolts.

MACHINE DISASSEMBLY

A. FRONT END EQUIPMENT:

When the machine is to be shipped on a trailer or where clearances are limited it is sometimes necessary to take off the Front End Equipment and remove the Upper Works from the Lower Works. This can be done with very little disassembly of the machinery.

Shovel, dragline, clamshell or crane front end equipment is easily removable from the machine without disassembly of any of the deck machinery.

Full instructions on the procedure to follow in removing the various front end equipments is given in SECTION VI covering conversion of the machine from one front end equipment to another.

On machines having the outside counterweight casting on the rear of the revolving frame it is advisable to take off the outside casting before trying to propel the machine with the front end equipment removed.

B. UPPER WORKS:

The entire Upper Works with all machinery assembled can be removed from the Lower Works (either standard or long cats.) The following instructions assume that the Upper Works is being removed for shipment on a trailer or freight car where weight or load dimension limits make it impossible to ship the machine assembled.

A supply of sawed ties for cribbing and two rails about 30 feet long are required if there is no crane of sufficient capacity to lift the entire Upper Works. Four hydraulic or screw jacks of from 25 tons to 50 tons capacity and two track jacks of 25 tons capacity are also necessary.

Before starting removal of the Upper Works take off the running boards on both sides of the revolving frame and also the outside counterweight casting on machines having maximum counterweight. Remove the Front End Equipment as described in Section VI covering conversion from one Front End Equipment to another. If the machine is to be shipped on flat cars it is generally possible to load the Front End Equipment directly on a flat car as it is being taken off the machine.

With the Front End Equipment removed, propel the machine alongside the flat car with the cat side frames parallel to the car and as close to it as convenient, then proceed as follows:

1. Build suitable cribbing under the rear end and around the cats at the front end so that jacks can be placed under the revolving frame casting.
2. Jack up the Upper Works just enough to remove the load from the cone rollers.
3. Take out the two cap screws "A" in the retainer plate at the end of each cone roller pin. (See Fig. 4, Section VII).
4. Insert the cap screws in the tapped holes "B" in each retainer plate and tighten each pair of cap screws to start the roller pin out.
5. Pull the roller pins part way out, roll the cone rollers to one side and lift the rollers off the roller path.
6. Raise the hinged cover at the front of the cab and remove the covers under the drums to expose the reach rods at the center of rotation. (See Fig. 5, Section VII).
7. Remove the split pins holding the dowel pointed set screws "A" and back off the set screws to free the reach rod tube through the center of rotation.
8. Disconnect the reach rod "C" so that the digging lock lever "B" can rotate out of the slot in the digging lock reach rod through the center of rotation.
9. The Upper Works can now be jacked up off the Lower Works. Jack each corner evenly to keep the Upper Works level and follow up closely with blocking to prevent accidents.
10. Raise the Upper Works approximately two feet to clear the reach rods through the center of rotation of the Lower Works.

NOTE: About 6 inches of lift can be saved by removing the steering clutch and digging lock control rods and an additional 18 inches saved by taking out the vertical propel shaft as described below. However, if the Upper Works is being loaded on a flat car, a crib high enough to bring the Upper Works even with the car floor generally gives sufficient clearance so that it is not necessary to take out these parts.

11. With the Upper Works on cribbing built up to the level of the car floor, place two rails across the cribbing and the car floor. Place one rail under the extreme rear end of the revolving frame and the front rail under the cone roller equalizers.

CAUTION: CRIB UNDER THE RAILS BETWEEN LOWER WORKS AND THE CAR AND BLOCK UNDER EACH CORNER OF THE CAR SO THAT IT WILL NOT TIP WHEN MOVING THE UPPER WORKS OVER ONTO THE CAR.

12. Grease the rails liberally and jack the Upper Works down onto the rails.
13. Use track jacks (or a winch if available) to slide the Upper Works over into position on the flat car.

14. Jack up the Upper Works to remove the rails and lower it onto low blocking on the flat car.
15. Block it securely in place on the flat car so it will not shift during shipment.

If the Upper Works is not to be loaded on a flat car but it is desired to separate the Upper Works and the Lower Works the same general procedure as that outlined above should be followed except for convenience in blocking the Upper Works should be swung crosswise of the Lower Works. Do not build cribbing in front of one end of the Lower Works so that after the Upper Works is raised and supported on rails placed on cribbing built on both sides of the Lower Works the entire Lower Works can be pulled out from under the Upper Works. The Upper Works can remain on the cribbing until the Lower Works is replaced.

— CHAPTER XXV —

LOWER WORKS DISASSEMBLY

A. CAT MOUNTING:

(Refer to Drawing 237320)

The standard cat mounting has six lower idler rollers and two idler rollers in the top of the side frame. The special "long" mounting is similar to the standard mounting except there are eight lower idler rollers and four idler rollers on the top of the side frames. For convenience, the General Arrangement drawing of the "long" mounting will be referred to for piece marks but the instructions for disassembly of tread belts, idler rollers, drive and take-up tumblers apply to the standard mounting as well.

a. Track Link Removal

To remove one track link propel the machine so that the link to be removed is at the take-up tumbler end and just below the center, then proceed as follows:

1. Place a block or timber under the link just below the one to be removed.
2. Remove one or more spacers "20," "21" and "22" to give sufficient slack in the belt.
3. Take out the pin locks "8" in the link pin "7" on both sides of the link.
4. Drive out the link pins at the bottom of the link. Swing the link forward, drive out the link pins at the top and lift out the link.

b. Removal of Tread Belt

To remove the entire tread belt, part it at one link as described above and proceed as follows:

1. Roll top half of belt back off cat frame.
2. Jack machine up so that lower rollers clear treads.

NOTE: If jacks are not available cat frame may be raised by tipping the machine with hoist cable. To do this swing boom over opposite crawler. Attach cable to a tree or some other substantial object and hoist. **CAUTION: BLOCK MACHINE SECURELY UNDER AXLES BEFORE ATTEMPTING ANY FURTHER WORK.**

3. Drag belt out from under cat frame.

NOTE: Track belt may be pulled clear of cat frame with power by swinging boom point in line with track belt and attaching hoist cable. **CAUTION:** Lower boom to almost horizontal before applying power.

c. Installation of New Tread Belt

To install an entire new tread belt without the necessity for jacking up the machine, proceed as follows:

1. Split old belt as described under "Track Link Removal."
2. Assemble correct number of links to make up the new belt then connect end link of new belt to top end link of old belt.
3. Propel machine backward until the new belt is in place.
4. Disconnect the old belt and then connect ends of new belt.

d. Upper Idler Rollers

The upper idler rollers which support the top of the tread belt can be removed without disconnecting the belt as follows:

1. With machine on firm level ground, travel it forward for a distance equal to length of machine so that all slack in belt is at the top.
2. Jack up tread belt near roller for clearance and insert blocking to hold tread belt clear of roller. NOTE: If more slack is needed, release take-up tumbler adjustment.
3. Remove lock pin "14," withdraw roller pin "13" and remove roller "4."

e. Lower Idler Rollers

Any one or all of the lower idler rollers on the side frame (six rollers on the standard mounting, eight on the long cats) may be removed without taking the tread belt apart by proceeding as follows:

1. Release take-up tumbler adjustment to provide ample slack.
2. Propel onto a timber so that timber is under end tumbler nearest roller to be removed. (If jacks are used instead of timbers, place jacks under truck frame axles just inside of tread belts. Machine can also be raised by tipping the machine with hoist cable and then blocking at axles, just inside of tread belt.)
3. Remove the two lower U-bolts "12" which will allow roller shaft assembly to drop down.

f. Lower Idler Rollers (Tapered End Mounting)

The lower idler rollers of the "tapered end" cat mounting are mounted in pairs on bearing blocks secured to the side frame by long U-bolts. Additional clearance is required to remove the long U-bolts, therefore a slightly different procedure is required to remove the lower idler rollers of the tapered end mounting as follows:

1. Swing boom to opposite side from that which idler rollers and bearing blocks are being removed.
2. Lower boom to a position so that with loaded bucket machine can be tilted. CAUTION: Keep loaded bucket on ground when doing so and raise machine on hoist line.
3. Machine must be raised about 8" so that U-bolt "50" can be taken out between lower face of bearing block "48" and inner face of cat link "6".
4. Block machine up with timbers just inside of cat belt at axles, allowing room between timbers and cat belt so that inner U-bolts can be removed.
5. With machine in raised position place jack or blocking between lower face of bearing block and cat belt so that bearing block will remain in place when removing U-bolts.
6. Remove U-bolts "50", cross tie rod bolt "49" and bearing blocks "48". The idler rollers may then be taken out.

If it is desired to change the mounting from "tapered end" to "flat"; after removing all bearing blocks "48" leave the idler rollers in place, carefully lined up by blocking, then lower the machine about four inches and reassemble the idler rollers to the side frames by installing shorter U-bolts.

The "flat" mounting can be converted to "tapered end" by installing the 4" bearing blocks and longer U-bolts by following a similar procedure.

g. Take-Up Tumblers

The take-up tumblers, at the end of the side frames opposite to the drive chains can be taken out as follows:

1. Travel machine so as to get all slack on top.
2. Place a 4" x 4" or suitable timber on ground. Travel machine over timber until same is under the first idler roller back of tumbler.
3. Split belt as under "Track Link Removal." Fold back upper part of tread belt to expose tumbler.
4. Remove bolts "18" and roll tumbler assembly out.

h. Drive Tumblers

To remove the drive tumblers, at the drive chain end of the side frame, proceed as follows:

1. Prepare machine as described in items 1 and 2 under "Take-Up Tumblers".
2. Part the drive chain at any convenient link. Use tool furnished (see Fig. 14 in Section VI on Conversion).
3. Remove eye bolt pin "35" and bearing block bolts "32" then roll tumbler assembly out.

B. PROPELLING AND STEERING MACHINERY:

(Refer to Drawing 237257)

a. Steering Clutch Shafts

1. Provide sufficient slack on top of tread belt so that belt can be blocked up to clear drive sprocket "9" for removal.
2. Remove propel chain from sprocket. (It can be parted at any convenient place.)
3. Remove cap screws "11" and retainer plate "10" at outer end of shaft "8".
4. Slide off driving sprocket "9".
5. Remove clutch cover "13" on under side of truck frame.
6. Remove clamp collar "15".
7. Block up sliding clutch "16" and remove shaft "8" from outer side.

b. Center Propel Shaft

To remove the center propel shaft, take out both clutch shafts as described above, then proceed as follows:

1. Drain oil and remove bevel gear case cover "20".
2. Jack or block up center propel shaft "21" near bevel gear side.
3. Remove bearing bolts and caps "19".
4. Lower jack or blocking permitting shaft to set on ground.

c. Vertical Propel Shaft (Standard Propel)

The vertical propel shaft and the steering clutch and digging lock reach rods through the center of rotation can be removed without taking the Upper Works off the Lower Works by proceeding as follows:

1. Remove one half of drum shaft lagging. (In case of two drum machine, remove one half of each lagging.) Also remove the center covers over the propel shaft gear under the drums.
2. Drain oil and remove bevel case cover "20".
3. Remove dowel cap screws "44" and "84" so that bell crank "47" and shifter fork "43" at lower end of shaft can be moved down to obtain more room for removal of bevel pinion "36".
4. Securely block up bevel pinion, remove the three cap screws and retaining washer "37" at lower end of shaft. (NOTE: If shaft only is to be removed, blocking at bevel pinion can remain in place. Be sure that thrust washer "35" also remains in place so that reassembly of shaft to frame will not be hampered.)
5. Remove the reach rod end pins in horizontal reach rods at steering and digging lock cross shaft just above spur gear on deck, so that the two horizontal levers to center of rotation can be folded back and out of the way after having removed cap screws to vertical rod in the hook shaped lever at center of rotation.
6. Loosen the clamp bolts in swing and propel jaw clutch shifter levers and slide them to each side for clearance.
7. Jaw clutch "25" can now be removed, also the vertical steering and digging lock rods through center of rotation.
8. Vertical shaft "24" can now be taken out from above.

d. Vertical Propel Shaft

(Independent Propel)

The arrangement of the propelling machinery through the center of rotation is the same on machines equipped with independent Propelling as it is on the standard machine except that instead of the jaw clutch and combination spur gear and slipping clutch used on the standard machine there is a plain spur gear at the upper end of the vertical shaft as shown on Drawing 237352.

To remove the vertical propel shaft on machines equipped with Independent Propelling, follow the instructions in steps 1 to 7 inclusive given above for the standard machine, then proceed as follows: (See Drawing 237352).

1. Lift spur gear "62" off the splines at the upper end of the vertical shaft "61".
2. Lift out vertical shaft "61" from above.

DECK MACHINERY DISASSEMBLY

Disassembly of the deck machinery should not be undertaken without making proper provision for adequate lifting equipment and a place to put the parts removed where they will not become lost. Since it is generally advisable to remove portions of the cab it is best to carry on the work under cover.

Before starting to disassemble any part of the main machinery, lower the front end equipment on suitable blocking. With shovel front end equipment, place a timber across the dipper handle just back of the front stop and lower the boom until it comes to rest on the timber.

Clean the machinery carefully before starting disassembly. Provide an ample supply of cleaning cloths and kerosene or solvent so that small parts can be thoroughly cleaned at the time of removal.

Keep subassembly parts together but take care not to mix up similar right hand and left hand parts.

A. MAIN DRUM SHAFT:

(Refer to Drawing 237726.)

a. Removal of Drum Shaft

To take the entire drum shaft assembly out of the machine, proceed as follows:

1. Remove cables from drums.
2. Remove top center section of cab or complete front half section of cab depending on available lifting equipment.
3. Remove complete brake release assembly attached to A-frame by removing pin "88" and bolts holding bracket "82."
4. Remove complete brake release assembly attached to left-hand side frame at forward end of brake by removing pin "88" and bolts holding bracket to side frame. Unhook spring "102" from brake band at forward end of right hand brake.
5. Remove pin "95" attached to live end of brakes also dead end anchor pin by removing blank bolt and sliding anchor pin out through hole in main side frame.
6. Remove the two dowel point cap screws in shifter collar "17".
7. Remove the six cap screws "64" in right-hand bearing cover plate and the six cap screws "9" in left-hand bearing cover plate.
8. Remove the two right hand and two left hand bearing cap bolts "7" and remove caps "6" and "62".
9. Complete shaft assembly can now be hoisted out of main side frames. CAUTION: Do not move the assembly horizontally until it has been lifted far enough so the gears are out of mesh.
10. Remove brake bands "27" before unit is set down if further disassembly is to be done.

b. Drum Shaft Disassembly

After the main drum shaft assembly has been removed from the machine it can be further disassembled, starting from the right hand end, as follows:

1. Remove cap screws "68" and retainer plate "67" and slide off spacer "66" in case of a machine not having a dipper trip. Complete trip assembly in case of a shovel can also be removed after retainer plate "67" has been removed.
2. Remove roller bearing "61". In most cases this can be removed by lightly tapping retainer plate "60". If bearing does not come off easily, use a puller arrangement of some sort. Also remove retainer plate "60".
3. Remove tension release spring "80".
4. Remove the four bolts "78" together with rubber bumper "99" holding shifter sleeve "18" to clutch booster "100" and then slide off sleeve "18".
5. Remove clutch band guide bar "70", booster link pins "36" and "72", booster link "37", band live and dead end pins "23", bell crank pin "20", link bars "25" and bell crank "58". Clutch band "24" can now be removed.
6. Loosen clamp bolt "69" in driver "56". Drive wedge into slot of driver hub and slide off driver. Clutch booster "100" will also come off with driver since this is mounted on hub of driver. Also remove key "74".
7. Remove bolts holding lagging to clutch housing and lift off half sections of lagging "45".
8. Remove cap screws holding bearing carrier "44" to hub of clutch housing "29".
9. Clutch housing "29" can now be slid off end of shaft. CAUTION: Take care not to damage the outer race of bearing "35" and oil seal "33" which will remain in hub of clutch housing.

10. Remove spacer "34" bearing "35" spacer "41" bearing "42", carrier "44" and spacer "57".
NOTE: The outside diameters of spacers "34" and "57" have a polished finish for oil seals and should be protected against damage.

Other end of shaft can be dismantled in the same manner as described above except that hoist gear "2" must first be removed. Be careful not to mix up right and left hand pieces if other side of shaft is also going to be dismantled.

B. ROLLER CHAIN:

The four strand transmission drive chain and the lower boom hoist roller chains have press-fit pins except for one set of connecting links which have slip-fit center plates. The center plates of all links, except the connecting link, have chamfered (or beveled) edges. The center plates of the connecting links have flush edges and are therefore easily recognizable. As further identification it is customary to assemble the connecting link pins with the cotters on the opposite side of chain from all the other links.

a. Transmission Chain

To remove the transmission drive chain proceed as follows:

1. Remove the chain case cover.
2. Turn the transmission sprocket until the connecting link is in mesh with the sprocket on the transmission shaft.
3. Remove connecting link cotters.
4. Pull out the connecting link and remove the slip-fit center plates.

NOTE: When reassembling the transmission drive chain be sure to put the chain on the sprockets so the cotter pins of the links, except the connecting link, are toward the engine. Install the connecting link from the opposite side so the cotters of the connecting link are toward the cab.

b. Boom Hoist Chains

The lower boom hoist roller chains are similar in construction and it is necessary to locate the connecting link before trying to split the chain. Look for the slip-fit center plates with straight edges if the chain was assembled without putting the connecting link in so that the cotter would be on the opposite side from all the other cotters.

When reassembling the boom hoist chains they may be installed with the cotters on either side but be sure to install the connecting link so that its cotter will be on the opposite side.

C. ENGINE TAKE-OFF CLUTCH:

(Refer to Drawing 237234.)

a. Removal of Complete Clutch

The engine take-off clutch, between the engine and the transmission drive chain case, is bolted to the flywheel housing of the engine. In order to remove the clutch assembly it is necessary to take off the chain case as follows:

1. Remove the left rear side panel of the cab.
2. Drain oil from chain case and remove cover "122".
3. Remove the four cap screws holding bearing "2" to case.

Remove the five cap screws holding oil seal retainer "112" to case. NOTE: Seal retainer "112" together with seal cover "113" and seal "114" can be left on hub of bearing carrier "120".

4. Remove the two bolts in flange of oil sump holding case to deck plate. Remove the two cap screws and two bolts in support at rear end of case. Take out support and lower chain case to deck.
5. Disconnect transmission drive chain "111", as described above, and remove from small sprocket "109".
6. Disconnect the control rod at outer end of clutch shifter lever.
7. Take out the cap screws in flange of clutch housing. Two jack screws, on center line of clutch housing, are provided to assist in removing the clutch housing from the flywheel housing. Turn the two screws down evenly to prevent binding.

b. Disassembly of Clutch

For further instructions on removal of the clutch and disassembly of the clutch as furnished with the General Motors Diesel engine refer to Section 20 of the General Motors Maintenance Manual.

For disassembly of the clutch furnished with the Caterpillar Diesel engine, proceed as follows:

1. Withdraw the clutch assembly from the flywheel housing. NOTE: The driving ring, with internal gear teeth is bolted to the flywheel and need not be disturbed unless it requires replacement.
2. Remove the double row pilot bearing.

3. Remove lock washer and lock nut at inner end.
4. Disconnect the lubrication line to sleeve collar.
5. Remove clutch back plate complete with driving plates, floating plate, adjusting yoke assembly and sliding sleeve assembly. Shifter shaft assembly need not be removed since this will roll off collar pins when unit is being removed.
6. With parts removed from shaft, remove lever in pin and unscrew adjusting yoke assembly from hub of back plate.
7. Lift off floating plate; friction discs can now be lifted off for replacement.

Further disassembly should seldom be required but if the clutch shaft bearing needs replacement proceed as follows:

1. Remove the six bearing housing cap screws and remove complete housing assembly including shaft and sprocket.
2. Remove bearing retainer lock and unscrew bearing retainer.
3. Remove sprocket and key. This is a press fit and will require a puller.
4. Pull shaft through bearing housing.
5. Remove bearing snap ring and tap bearing off shaft.

D. HORIZONTAL TRANSMISSION SHAFT:

(Refer to Drawings 237254 and 237234)

The horizontal transmission shaft running across the machine, just forward of the engine, is made up of two parts joined by a flexible coupling.

a. Boom Hoist Clutch Shaft

The left section of the shaft carries the boom hoist clutches and may be removed as follows:

1. Remove boom hoist brake holding spring "62", spring washer "70", brake rod "71", nuts on upper end of eye bolt "59", anchor pin "67", brake band bolt "47" and the two halves of brake band "31" all shown on Drawing 237254.
2. Remove dowel set screws "74" in ends of shifter yokes "72", shifter yoke shafts "73" and shifter yokes "72".
3. Remove the single strand roller chain "21" as described in "b" under "ROLLER CHAIN".
4. For better access to machinery and ease of working it is advisable to remove the left hand side panels of cab.

NOTE: For the following part Nos. refer to drawing 237234.

5. Remove the chain case cover "122" and part the four strand roller chain "111" as described in "a" under "ROLLER CHAINS".
6. Remove the two foundation bolts in outer bearing "2".
7. Drain oil from the transmission shaft flexible coupling, remove the bolts holding coupling half "18" to center spacer "20" and slide out of counterbore in spacer.
8. Remove bolts "133" in right hand bearing cap "11" and remove cap.
9. Complete shaft assembly can now be raised up and removed from machine.

b. Disassembly of Boom Hoist Clutch Shaft

After the left portion of the transmission shaft has been removed from the machine it may be further disassembled as follows: (Refer to Drawing 237234.)

NOTE: Be careful not to mix up right and left hand pieces.

1. Remove the cap screws and retainer plate "5" and gasket "6" from end of shaft "4".
2. Slide off sprocket "1". Roller bearing "3" will come along since it is mounted on inner hub of sprocket.
3. Remove bearing bracket "2".

NOTE: For the following part numbers refer to Drawing 237254.

4. Remove the outer shifter sleeve "36".
5. Remove the two cap screws "46" and band guide plate "45".
6. Remove toggle yoke pins "42" and toggle yoke "39".
7. Remove cotter pin in dead end anchor and live end pin "53". Take out clutch band "32".
8. Loosen nut and lock nut on driver clamp bolt "43". Drive wedge in slot in hub of driver "33" and slide off driver. NOTE: Bell crank "51", toggle lever "50", spring "61", pin "60" and eye bolt "54" can remain attached to driver if so desired. Inner driver can be removed in the same manner but not until parts ahead of it are removed, since shoulder on shaft at outer face of hoist pinion will not permit removal.
9. The outer clutch housing "23" together with sprocket "24" and bearings "28" can now be pulled off. (Light tap fit.) Take care not to damage bearing shield. Ball bearings

can then be driven out by lightly tapping same with a suitable bar.

10. Inner clutch housing "25" together with spur gear "26" and ball bearings "29" can now be taken off in same manner.
11. Remove inner driver "33" as described in item 8 and slide off shifter sleeve "35" together with collar "34".

NOTE: See transmission drawing 237234 for the following part numbers.

12. Remove hoist pinion "9" and key "10". NOTE: Pinion is put on with a press fit and will require a puller or press of some sort.
13. Remove coupling "18" which consists of an outer shell having internal gear teeth and a hub keyed to shaft having external gear teeth. Hub has a press fit on shaft and will require a puller.
14. Remove retaining collar "12" and spacer "13".
15. Remove roller bearing "3". This can be removed by lightly tapping inner race.

c. Reversing Transmission Clutch Shaft

The right end of the transmission shaft carries the reverse clutches and may be removed without taking out the left end of the shaft. If complete disassembly is to be made it may be advisable to remove the horizontal transmission shaft and vertical transmission gear case as a unit in which case the center section of the cab must be removed and the A-frame rotated forward to give overhead clearance.

If no lifting equipment is available for handling the assembly the transmission shaft can be disassembled as follows: (Refer to Drawing 237234.)

1. At each clutch remove the two dowel pointed cap screws holding shifter fork to shifter collar "23" also the fulcrum pins and remove the forked shifter levers. Also remove the transmission brake shoe.
2. Remove all bolts in both flanges of coupling "18" and "20". Move the end covers "18" just enough so that center section "20" can be lifted out because this sets into a counterbore in end covers "18".
3. Remove pins "71" connecting spring guide rod "70" to clutch band "74". Remove bolts and completely assembled band guide "66". Remove clutch band live and dead end pins "32". Remove eye bolt "82" at live end of clutch band. Remove clutch band "74". Remove toggle pins "88". Slide off shifter sleeve "24" together with collar "23". Remove toggle yoke "29". Loosen nuts on driver clamp bolt "26". Drive a wedge into hub of driver "48" and slide off driver and remove driver key "27".

4. Remove all the bolts holding the right hand clutch housing "34" to clutch sleeve "42". Rotate housing so that mating lugs clear each other and withdraw housing "34". NOTE: If housing "34" only is being replaced clutch driver "48" need not be removed since housing can be rotated to clear driver.

5. Remove the six foundation bolts in bottom flange of vertical transmission case "60". Rotate complete unit, turning the coupling end toward the engine, so that the left hand clutch housing is in the walkway in front of the engine.

NOTE: If complete shaft is being dismantled or if oil seal "50" at outer end of clutch sleeve requires replacement, then it will first be necessary to remove the half coupling "18" on left hand end of shaft "30". This is put on with a press fit and therefore will require a puller arrangement of some sort.

6. Having removed coupling "18" then all clutch parts including driver and housing can be removed as described in item 3 above. NOTE: Housing "34" only can be removed when unit is setting in this position, by removing clutch band, since housing will pass in between the two halves of coupling.

7. Remove all cap screws in retainer plates "35" and "36" at each side. NOTE: Outer retainer plate "35" is in halves and can be lifted out. This has been made in halves so that oil seal "33" can be replaced when worn. Oil seal "33" is of the split ring type and can also be replaced if desired.

8. Remove cover bolts "130", "132" and cover "45". NOTE: Be careful when removing cover so as not to tear gaskets.

9. Shaft with balance of parts on it can now be lifted out and taken off machine through doorway for further shop work if so desired.

10. Clutch sleeve "42" together with bevel pinion "39", bearings "43", "38", "51", oil seal "50", collar "49", and retainer "36" can now be removed over ends of shaft by lightly tapping end of sleeve. NOTE: Be careful not to damage oil seal "50" when doing so. Bearing "43" can be removed from sleeve by lightly tapping it. Bevel pinion "39" is put on with a press fit and will require a puller. Bearing "38" and retainer "36" can now be removed by lightly tapping outer face of retainer "36". Collar "49", oil seal "50" and bearing "51" can be withdrawn from outer end.

NOTE: If oil seal "50" at outer end of RIGHT HAND clutch sleeve requires replacement then remove all parts as described in item 3 above. If oil seal "50" at outer end of LEFT HAND clutch sleeve requires replacement then remove all parts as described in items 1 to 8 inclusive.

E. VERTICAL TRANSMISSION SHAFT:

(Refer to Drawing 237234.)

The vertical transmission shaft, in the reversing transmission gear case at the right end of the horizontal transmission shaft, cannot be removed without first taking out the right hand horizontal transmission shaft assembly as described above. If the vertical transmission shaft is to be removed without taking the transmission gear case off the machine the gear case must be raised about 10". After securely blocking the transmission gear case in raised position proceed with removal of the vertical shaft as follows:

1. Remove the two cap screws "64", retainer plate "63" and pinion "62".
2. Remove the two lock nuts "53" and lock washers "54" at upper end of shaft.
3. Drive shaft down by lightly tapping at upper end. Upper ball bearing "55" will remain in case, bevel gear "61" will move down with shaft until it touches case. Continue driving shaft down until it clears gear hub. Lower roller bearing "59" and retainer "57" will also move down with shaft. Remove bevel gear "61" after having cleared hub with upper end of shaft.
4. Remove the upper ball bearing "55" from seat in case.
5. Remove the lower roller bearing "59" and retainer "57".
6. Shaft can now be lifted out from top of case. **CAUTION:** There are two oil seals at lower end of case. Be careful not to damage these when removing shaft. Lip of oil seals point toward top of case.

F. VERTICAL SWING SHAFT:

(Refer to Drawing 237234.)

The vertical swing shaft shown in Section AA on drawing 237234 may be removed without dismantling other parts of the machinery except that one half of each drum lagging must be unbolted and blocked up so that the flanges on the laggings will not interfere. Proceed with removal of the shaft as follows:

1. Loosen the clamp bolt in hub of the two horizontal shifter levers and move over to each side.
2. Slide off jaw clutch "98".
3. Remove the two cap screws "107" and retaining washers "106" at lower end of shaft.

4. Shaft "97" can now be removed from above. Pinion "105" need not be removed since lower bearing in revolving frame will retain pinion until shaft is again reinstalled.
5. Gear hub "100" and spur gear "101" can be tilted and lifted out, should they require attention.
6. Combination grease seal and thrust washer "103" can be lifted out since this is only held by a dowel pin which prevents turning.

NOTE: If repair involves only the replacement of rack pinion this can easily be done by removing the two cap screws "107" and retaining washer "106" at lower end, and raising shaft "97" high enough so that pinion can be slid out. Drum laggings need not be removed.

G. BOOM HOIST INTERMEDIATE AND DRUM SHAFTS:

(Refer to Drawing 237254.)

The boom hoist intermediate shaft and the drum shaft can be removed without disturbing other machinery parts.

a. Intermediate Shaft

To remove the intermediate shaft proceed as follows:

1. Disconnect both the single and double strand roller chains, as described under "ROLLER CHAIN", and fold aside.
2. Remove lock bolt "22".
3. Combination gear and large sprocket "20" is one piece and is keyed to hub of small sprocket "16". Provide blocking under gear and remove shaft "15".
4. Combination gear and large sprocket "20" and small sprocket "16" with bushings "17" and "18" can be removed in one piece. Bushings can then be replaced if desired.

b. Boom Hoist Drum Shaft

The boom hoist drum assembly, recessed in the revolving frame casting, can be dismantled as follows:

1. Remove boom suspension rope and rope socket wedge "10".
2. Disconnect double strand chain "9" and lay aside.
3. Remove sprocket guard "90" on under side of revolving frame and take off deck plate cover held to deck by four bolts.

4. Remove cap screw "7" and retaining washer "6" at outer end of shaft.
5. Remove sprocket "3" and key "4".
6. Provide suitable blocking under drum "2" so that shaft "1" can be removed.
7. Remove cap screw "7" and retainer plate "6" at inner end of shaft.
8. Remove shaft "1" from outer left side of revolving frame.
9. Lower drum "2" by removing blocking.

H. SWING LOCKING DOG:

The swing locking dog, pivoted on the underside of the revolving frame casting, may be taken out as follows:

1. Disconnect the toggle link bars above deck attached to lever on right hand end of shaft.
2. Remove cover plate in structural deck at left side of machine. Loosen set screw in hub of locking dog.
3. Screw a $\frac{3}{4}$ " diameter bolt in left end of shaft and pull shaft out towards left side of machine. First pull shaft out far enough so that key in dog can be removed as it comes into the center opening. Also remove key in lever at right end of shaft when it is out of lever hub. CAUTION: Provide blocking for locking dog before pulling shaft all the way out.

I. SHOVEL CROWD MACHINERY:

(Refer to Drawing 237246.)

a. Backhaul Clutch Shaft

To remove the backhaul clutch shaft assembly proceed as follows:

1. Remove dowel pointed cap screws in shifter yoke at shifter collar.
2. Remove shifter yoke fulcrum pins and shifter yoke.
3. Loosen bolts in flange of shifter yoke bracket so that end of outer bearing can drop about 2 inches to clear clutch housing when shaft assembly is pulled to the left for removal.
4. Remove cap screws "48" and retaining washer "47" and collar bolt "44". Block up pinion "46".
5. Shaft "34" complete with clutch assembly, housing "37" and pinion "39" can now be removed as one unit.

b. Disassembly of Backhaul Clutch Shaft

After the backhaul shaft assembly has been removed from its bearings it can be further disassembled as follows:

1. Remove the two spring guide rod pins "31".
2. Remove the two cap screws "26" and band guide "24".
3. Remove toggle yoke pin "21" and slide off shifter sleeve "20" together with collar "33".
4. Remove toggle yoke "19".
5. Remove blank live end pin "10" and dead end pin "13".
6. Swing the two live end links "12" away from live end of band and loosen lock-nut "8" on adjusting bolt "9" to give maximum clearance.
7. Rotate band "36" a few inches so that live-end approaches dead-end anchor position and slide it out.
8. The two toggle links "2" and their bushings are readily removed by taking off nuts on ends of long clutch-driver bolt "1". The bolt itself cannot be removed unless clutch-driver "18" is shifted on shaft enough to allow bolt to clear clutch-housing (loosen clutch-driver bolt and wedge hub open).
9. Remove sub-assembly of driver "18" bell-crank "6", toggle-lever spring "3" and live-end links "12". Remove driver key "27".

CAUTION: Toggle lever spring "3" is set at the factory at the correct adjustment. Do not disturb by disassembly unless necessary.

10. The clutch-housing "37" with the bearing "38" can now be pulled off. (Light tapping fit. Take care not to damage bearing shield.) Bearings "38" can be removed from housing by lightly tapping them.

11. Pinion "39" is a press fit on hub of clutch-housing "37" and will require a puller of some sort.

J. DRAGLINE FAIRLEAD:

(Refer to Drawing 215272.)

For convenience in disassembling the dragline fairlead it is advisable to first remove it from the front of the revolving frame as follows:

1. Remove the special bolt "18" at the lower end of the fairlead frame. Be careful not to loose washers "17" and separator "20" used to adjust the pitch of the fairlead.

2. Take out the two rod bolts (1-293361) holding bearings 290692-A to the deck.
3. Slide the fairlead assembly along the drag rope and lower it to the ground **CAUTION:** Either remove bearings 290692-A, spacer "7" and support pin "8" or take special care that they do not fall off when lowering the fairlead assembly to the ground.
4. Detach drag cable rope socket in drag drum and pull cable out of fairlead.

For further disassembly of the fairlead, move it to a clear level spot and proceed as follows:

1. Take out the three cap screws "14" on each side and remove guide plates "4".
2. Take out the cap screws "16" for both the upper and lower sheaves on both sides of the fairlead frame and withdraw the flanged bushings "6".
3. Remove pins "9", being careful not to lose Woodruff key "10", and lift out sheaves "5".
4. Take out cap screws "13" and unscrew bearing cover "2". Be careful not to loose shims "11".
5. Slide fairlead frame "3" out of bracket "1". **NOTE:** The complete upper roller bearing "12" and the outer race of lower roller bearing "12" will remain in bracket "1" but can be removed for replacement by tapping out with a wood block.

K. INDEPENDENT PROPELLING MACHINERY:

(Refer to Drawing 237352.)

The independent propelling machinery (special equipment) is mounted on the deck just forward of the drum shaft. The machinery consists of a reverse gear and jaw clutch unit near the center of rotation and the high-speed and low-speed clutch shaft assembly on the left side of the machine. Either unit can be disassembled independently.

a. Low Speed Clutch Shaft

The upper shaft assembly in the left hand unit is the low-speed shaft and may be removed as follows:

1. Remove the two dowel pointed cap screws in shifter yoke.
2. Remove the four cap bolts in bearing cap "2" and remove cap.
3. Completely assembled shaft can now be lifted out.

b. Disassembly of Low Speed Clutch Shaft

After the low speed shaft assembly has been removed from its bearings it may be further disassembled as follows:

1. Remove the two cap screws and band guide "73".
2. Remove toggle yoke pin "79" and slide off shifter sleeve "67" together with collar "75".
3. Remove toggle-yoke "68".
4. Remove band live-end pin "83" and dead-end pin "81".
5. Swing the two live-end links "76" away from live-end of band and loosen lock-nut "91" on adjusting bolt "85" to give maximum clearance.
6. Rotate band "65" a few inches so that live-end approaches dead-end anchor position and slide it out.
7. The two toggle links "69" and their bushings "80" are readily removed by taking off nuts on ends of long clutch-driver bolt "90". The bolt itself cannot be removed unless clutch-driver "66" is shifted on shaft far enough to allow bolt to clear clutch-housing "45".
8. Remove sub-assembly of driver "66" (drive wedge into opening in hub), bell crank "72", toggle-lever "70", toggle-lever spring "89" and live-end links "76". Also remove driver key "49".

CAUTION: Toggle-lever spring "89" is set at the factory for correct adjustment. Do not disturb by disassembly unless necessary.

9. Clutch-housing "45" with bearings "54" can now be pulled off. (Light tapping fit. Take care not to damage bearing shield.) Bearings "54" can be removed from housing by tapping them lightly.
10. Pinion "56" is a press fit on clutch-housing hub "45" and will require a puller of some sort.
11. Remove spacer "60" bearing "55" and spacer "58".
12. Pinion "57" is a press fit on shaft "59" and will require a puller or press.

c. High-Speed Clutch Shaft

The Lower shaft assembly in the left hand unit is the high-speed shaft and may be removed as follows:

1. Remove the two dowel-pointed cap screws in shifter yoke. Loosen cap screw in hub of shifter yoke fulcrum pin. Remove fulcrum pin and shifter yoke.

2. Remove clamp collar "13".
3. Slide jaw clutch coupling "17" into space occupied by clamp collar "13".
4. Remove retainer collar "18" and block gear "46" in place. Shaft complete with clutch, clutch housing and all bearings can now be slid out of bearing bracket "1".

d. Disassembly of High Speed Shaft

After the high speed shaft assembly has been removed from its bearings all clutch parts, housing, pinions and bearings can be removed as described above for the low-speed shaft assembly. Bearing "55" and spacer "53" are a light tap fit. Take care not to damage the bearing shield in removing the bearing or the spacer from the shaft.

e. Removal of Jaw Clutch Shaft

The horizontal shaft in the reverse gear unit near the center of rotation carries the reversing bevels and jaw clutches. Completely assembled shaft can be removed as follows:

1. Remove control rod pin at jaw clutch shifter lever "16".
2. Remove the six cap screws "30" and end cover "7" with gasket "22".
3. Remove clamp collar "13".
4. Slide jaw clutch coupling "17" into space occupied by clamp collar "13".
5. Remove retainer collar "18".

6. Remove the six cap screws holding cover "8" to case.
7. Remove the eight cover bolts "31", "32" and "33" and remove cover "4". Shaft complete with coupling "17", cover "8", oil seal "21, bearing "20", bevel pinions "9", jaw clutch "10", bushing "12" can now be lifted out.

f. Disassembly of Jaw Clutch Shaft

After the shaft has been removed it may be further disassembled as follows:

1. Slide off coupling "17", cover "8" together with oil seal "21" and gasket "22".
2. Remove bearings "20", at each end. (Light tapping fit.)
3. Slide bevel pinions "9" together with bushings "11" and sleeves "12" off each end of shaft. Slide jaw clutch "10" off either end of shaft.

g. Vertical Shaft

After the horizontal shaft has been removed from the gear case, as described above, the vertical shaft can be removed as follows:

1. Insert a $\frac{5}{8}$ eye bolt or regular bolt into upper end of shaft. Shaft "42" including bevel gear "40" can then be lifted out. Spur pinion "41" can then be slid out through opening in side of case "3".
2. Bushings "5" and "6" and oil seal "44" can then be replaced if desired.

— CHAPTER XXVII —

BOOM MACHINERY AND SUSPENSION

A. BOOM SUSPENSION:

(Refer to Drawing 237339.)

All front end equipment is suspended by an eight-part tackle reeved between the A-frame sheaves and four suspension sheaves, at the boom point (where continuous reeving is used), in the suspension bridle (if pendant suspension is used) or at the top of the mast (in the case of mast-type suspension). It may eventually be necessary to replace the bushings in the sheaves in which case they may be removed as described below.

a. A-Frame

To disassemble the suspension shaft assembly at the top of the A-frame, proceed as follows:

1. Lower the boom to a safe position on suitable cribbing and slack off the suspension cable. NOTE: Suspension cable may be taken off, but it is generally preferable to leave it in place, simply laying the loops to one side as the sheaves are removed, so that reassembly can be made without having to re-reeve the cable.

2. Block up the A-frame front legs to relieve the load on the pin at the apex.
3. Remove sheave guards "22", horizontal sheave pin "12" and horizontal sheaves "9" in yoke "8". **CAUTION:** If the suspension cable is being left in place, fasten the two loops of cable when the sheaves are removed so that the cable will not become twisted.
4. Remove pin-lock blank-bolts "18" and drive out apex pin "11" to the right, so the pin can be taken out through the door on the right side. **CAUTION:** Support A-frame yoke "8" with blocking on the roof and remove units of the assembly as they come free of the pin.

If the A-frame is to be removed completely take out lower pins "5", and take out back legs "2". Then take out lower pins "3" and remove front legs "1".

b. Mast

For disassembly of the suspension sheaves at the top of the mast proceed as follows:

1. Lower the boom to a safe position on suitable cribbing and slack off the suspension cable until the mast "24" comes to rest on the boom. **NOTE:** Suspension cable may be taken off but it is generally preferable to leave it in place, simply laying the loops to one side as the sheaves are removed so that reassembly can be made without having to re-reeve the cable.
2. Remove pendant anchor pins "29".
3. Remove T-head blank bolt "26",
4. Slide pendant anchor yoke "28" off end of pin "25" removing sheaves "33" as they come free.
5. Remove lock bolt "27" and drive out top pin "25".

If the mast itself is to be removed take out the mast foot retainer bolts and lift the mast off the support pin (also used to support the dragline fairlead assembly).

c. Pendant Suspension Bridle

On machines having pendant type suspension the four sheaves for the suspension rope are carried in a bridle as shown in Half Section BB for pendant suspension. To disassemble the bridle proceed as follows:

1. Lower the boom to a safe position on suitable cribbing. Pay out suspension rope until the bridle rests on the boom. Keep the boom pendants on top of the boom so that the pendant anchor pins can be more easily removed.

NOTE: Suspension cable may be taken off but it is generally preferable to leave it in place, simply laying the loops to one side as the sheaves are removed so that the reassembly can be made without having to re-reeve the cables.

2. Remove blank bolts "38" holding pin "35" to spacer "37".
3. Pin "35" may now be pulled out of yoke "28" thus freeing sheaves "33".

When reassembling the bridle be sure dowel pin "36" is in place in pin "35" and enters the hole in yoke "28".

B. DRAGLINE, CLAMSHELL AND CRANE BOOM MACHINERY:

(Refer to Drawing 215351.)

The same boom point shaft is used for dragline, clamshell or crane operation although the arrangement of sheaves and guards is changed to suit the particular type of operation. To disassemble the boom point machinery proceed as follows:

1. Lower boom to rest on blocking built to support the boom about six feet back of the boom point. **NOTE:** Suspension cable may be taken off but it is generally preferable to leave it in place, simply laying the loops to one side as the sheaves are removed, so that reassembly can be made without having to re-reeve the cable.
2. Remove T-head blank bolts "10" and suspension sheave rope guards "8" also the point sheave guard "7" on top side of boom.
3. Slide suspension sheaves "3" off pin "6". **NOTE:** On machines having pendant or mast-type suspension the suspension sheaves "3" and sheave guards "8" are replaced by the pendant anchor straps "15" and separators "13".
4. Remove T-head blank bolts "10" holding boom point pin in boom bearing hubs.
5. Remove point pin "6", lifting point sheaves "1" out through opening in top of boom.

The outer rope guards "4" need not be removed but can be taken off for installation of the center guard "5" by removing bolts "9". Be careful not to loose spacers "12" used when no center guard is installed.

C. SHOVEL BOOM MACHINERY:

(Refer to Drawing 237273.)

The shovel boom, complete with dipper handle and boom-foot crowd drum with crowd and backhaul wire ropes in place can be removed from the machine as described in Section VI. The following instructions cover removal of the dipper handle, shipper shaft and other boom machinery.

a. Boom Point Shaft

For convenience in disassembly of the boom point shaft, lower the boom so that the boom point is within easy reach. Fully extend the dipper handle and set the dipper on the ground. Place a timber across the dipper handle back of the front stop and lower the boom to rest on the timber. Disassemble the boom-point shaft as follows:

1. Take out the blank bolts "27" holding the suspension sheave guards "19" in place and remove the guards. Also take off the point sheave rope guard "22".
2. Lay the loops of the suspension cable to one side and remove the suspension sheaves "20". NOTE: A timber placed through the loops of the suspension cable will help in keeping the cables straight. If preferred, the suspension cable can be removed completely, but if left in place it will save considerable work in reeving the cable when reassembling.
3. Support point sheaves "23" and separator "25" then drive out boom point pin "24". Lift the loops of the hoist rope out of the sheave grooves and take out one sheave at a time.

b. Dipper Handle

For convenience in removing the dipper handle the machine must be in condition to operate and so located that it can be propelled backward a short distance. Proceed with removal of the dipper handle as follows:

1. With the boom in normal working position, extend the dipper handle and set dipper on ground below the boom-point.
2. Detach the back-haul cable at take-up drum "29" at dipper end of handle.
3. Slack off on the crowd cable and remove it from the groove in anchor casting "61".
4. Detach the dipper trip cable at trip lever "48" on dipper end of handle.
5. Take out lock bolt "63" and remove anchor pin "62" and anchor casting "61" on upper end of handle.

6. Fasten sling cable around dipper handle close to saddle block and suspend from boom point.
7. Tie a rope to saddle block "12" to control its position when removing handle.
8. Propel machine slowly backward until handle is drawn out of saddle block.
9. Lower boom until dipper handle rests on ground.

The dipper handle can be detached from the dipper by removing the handle end pins and pitch brace pins. If the saddle block is also to be taken off, lower it to hanging position.

c. Saddle Block and Shipper Shaft

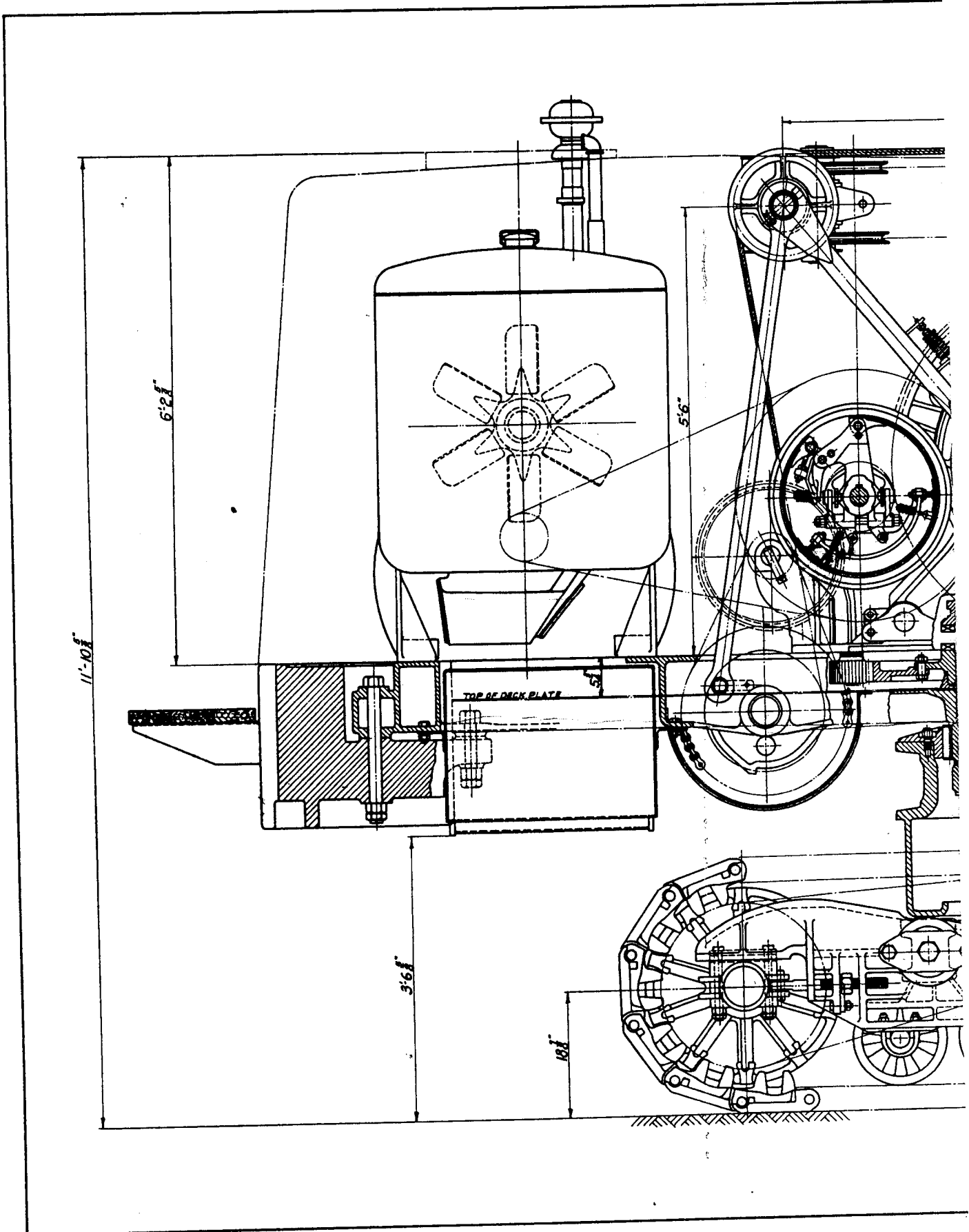
If the saddle block and shipper shaft are to be removed, first take out the dipper handle as described above then proceed as follows:

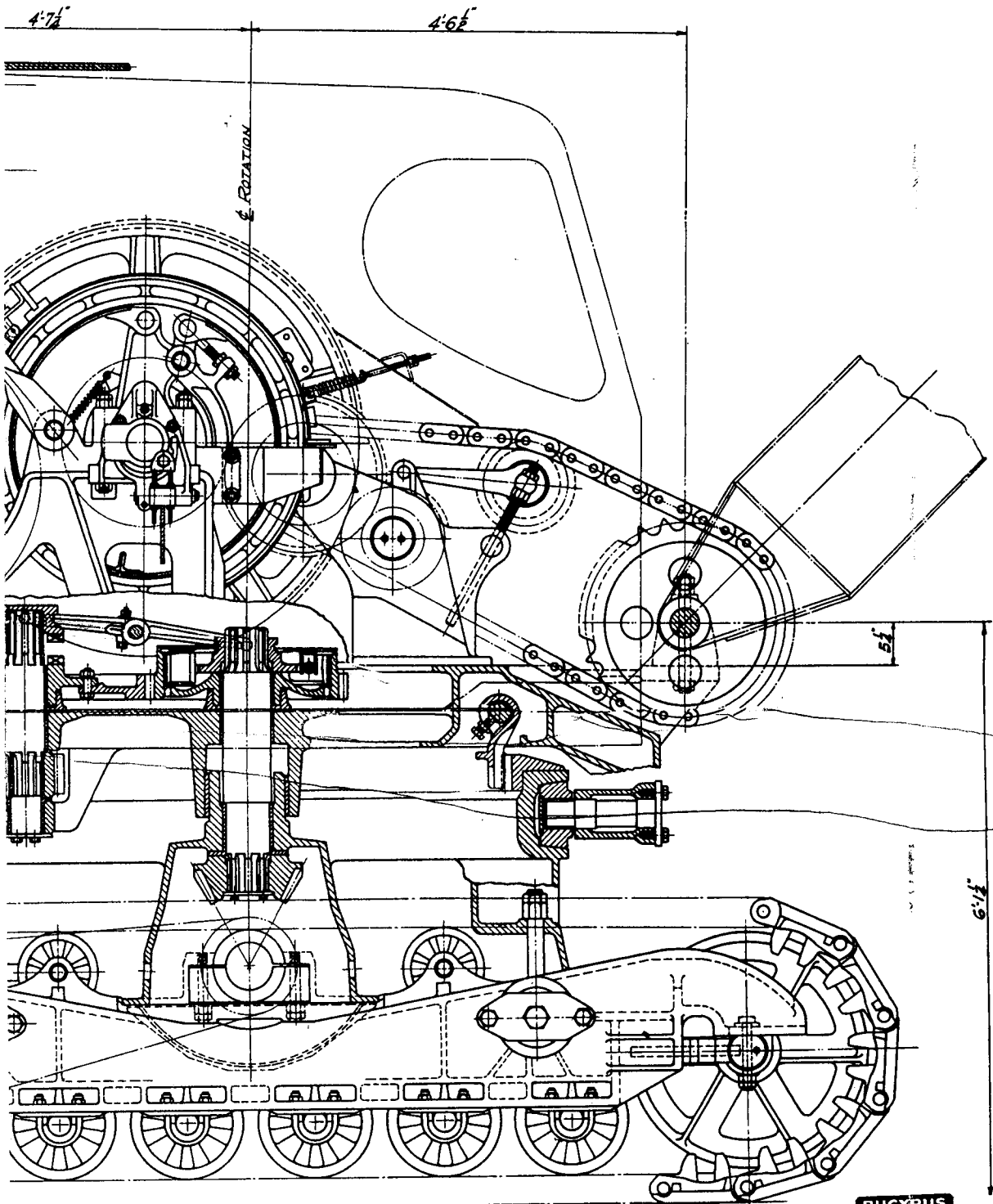
1. Remove the two saddle block clamp bolts "13".
2. Take out the two set screws "17" through the openings in sides of saddle block, then drive out tapered dowels "18" by using a drift pin in the hole in bottom of saddle block at the split hubs.
3. Block the shipper shaft drum "15" and saddle block "12" in position.
4. Use cold chisels to wedge open the split hubs of saddle block "12" then drive out shipper shaft "10".
5. Shipper shaft drum "15" and saddle block "12" may now be lifted out.

d. Boom-Foot Crowd Drum

The crowd drum at the boom foot can be left attached to the revolving frame when removing the boom or can be taken off with the boom without disturbing the crowd and backhaul ropes, but if it is necessary to disassemble the drum, proceed as follows:

1. Raise boom to approximately 60° angle and part the crowd chain at any convenient link.
2. Take off the crowd and backhaul ropes.
3. Remove the six bolts in drum support plates "2" and "3" attached to boom foot.
4. Make a suitable hitch to the drum for lowering the assembly to the ground.
5. Take out the two shaft rod bolts "9" and lower the assembly to the ground.
6. Bearings "8" can now be taken off and shaft "7" pulled out of drum.





FOR PLAN SEE DWG. #213880

BUCCYRUS
ENGINE
 38-B DIESEL
 GENERAL ARRANGEMENT
 MACHINERY-ELEVATION
 ISSUED-JUNE-1945
 DWG 213879

213880

OUTSIDE
COUNTERWEIGHT

12'-0" RADIUS

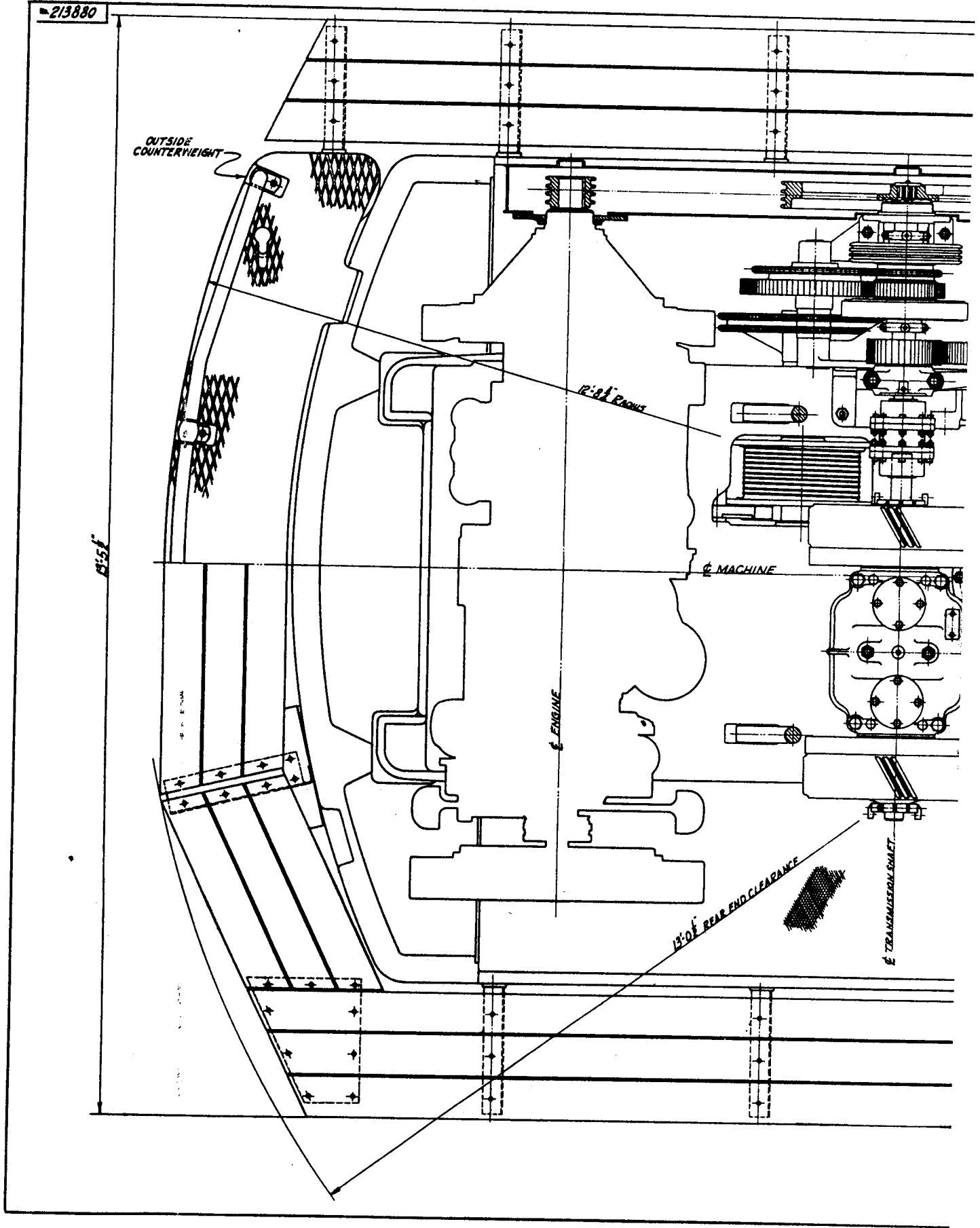
ENGINE

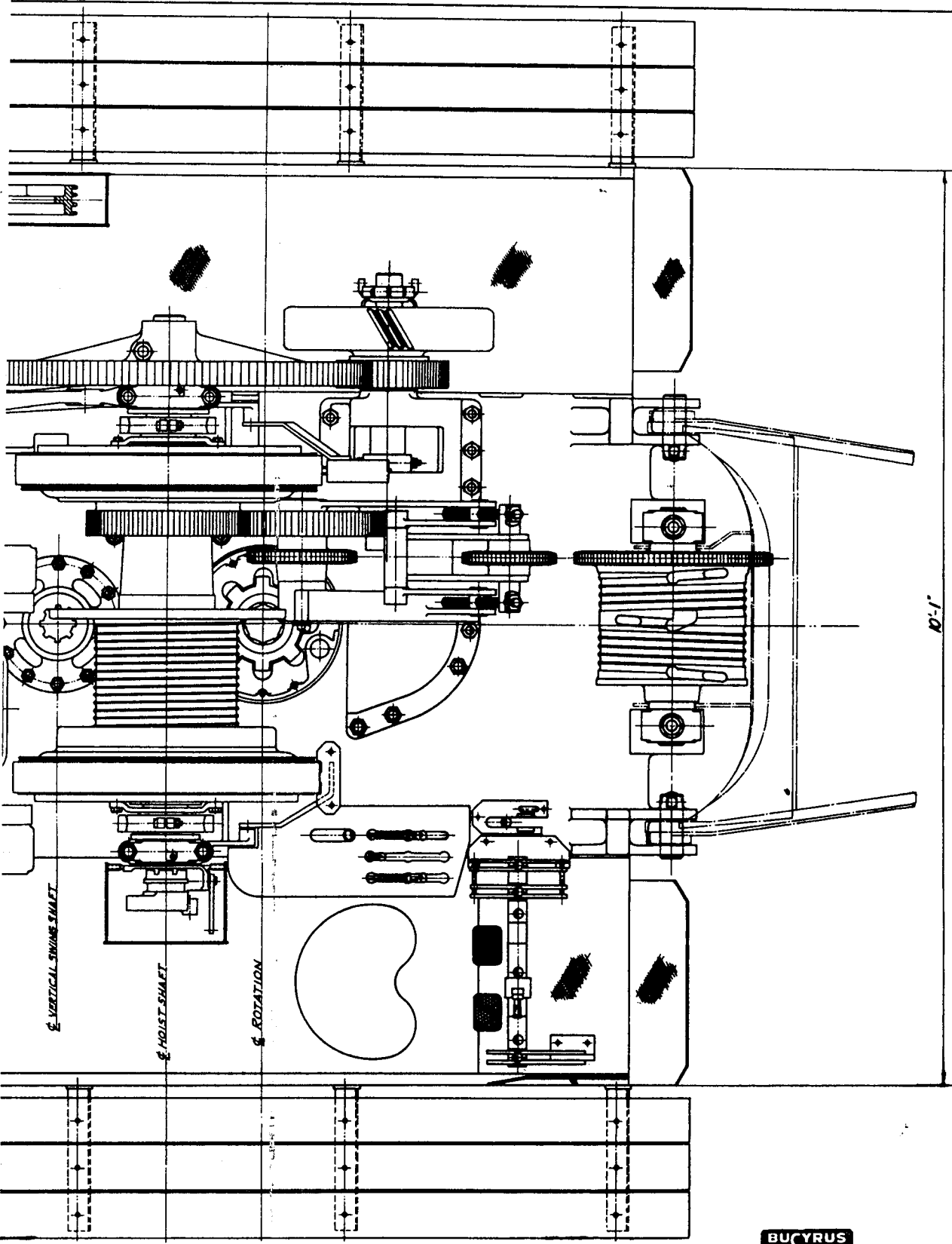
12'-0" REAR END CLEARANCE

TRANSMISSION SHAFT

12'-5"

12'-0"





**BUCYRUS
ERIE**

38-B DIESEL
GENERAL ARRANGEMENT
MACHINERY - PLAN
ISSUED - JUNE - 1945

DWG 213880

OIL LEVEL P-VEE

SLIPPING CLUTCH
NOT USED WITH
IND. PROPEL SEE

ENLARGED DETAIL
OF VERTICAL RODS.

REV. FRAME

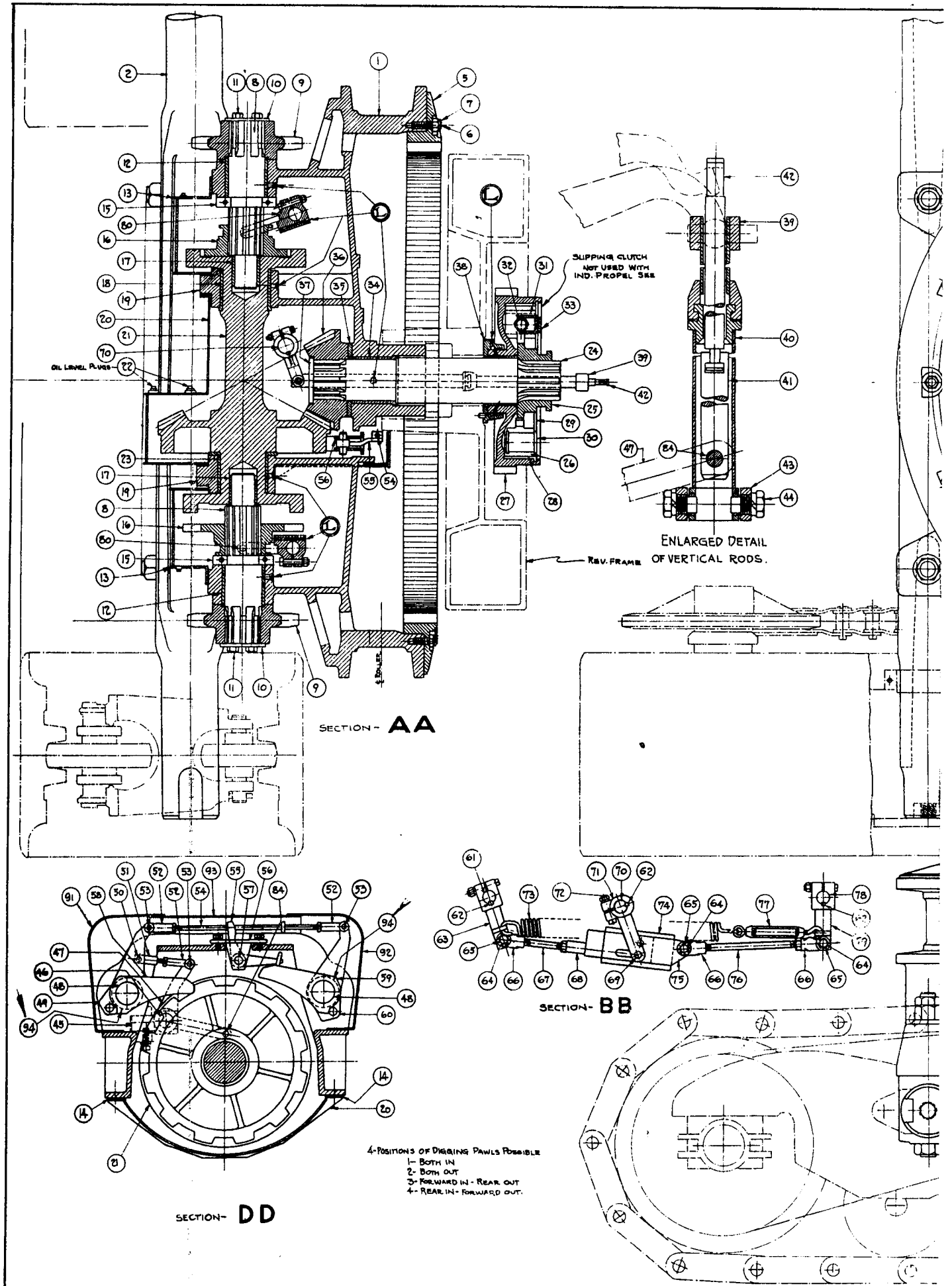
SECTION - AA

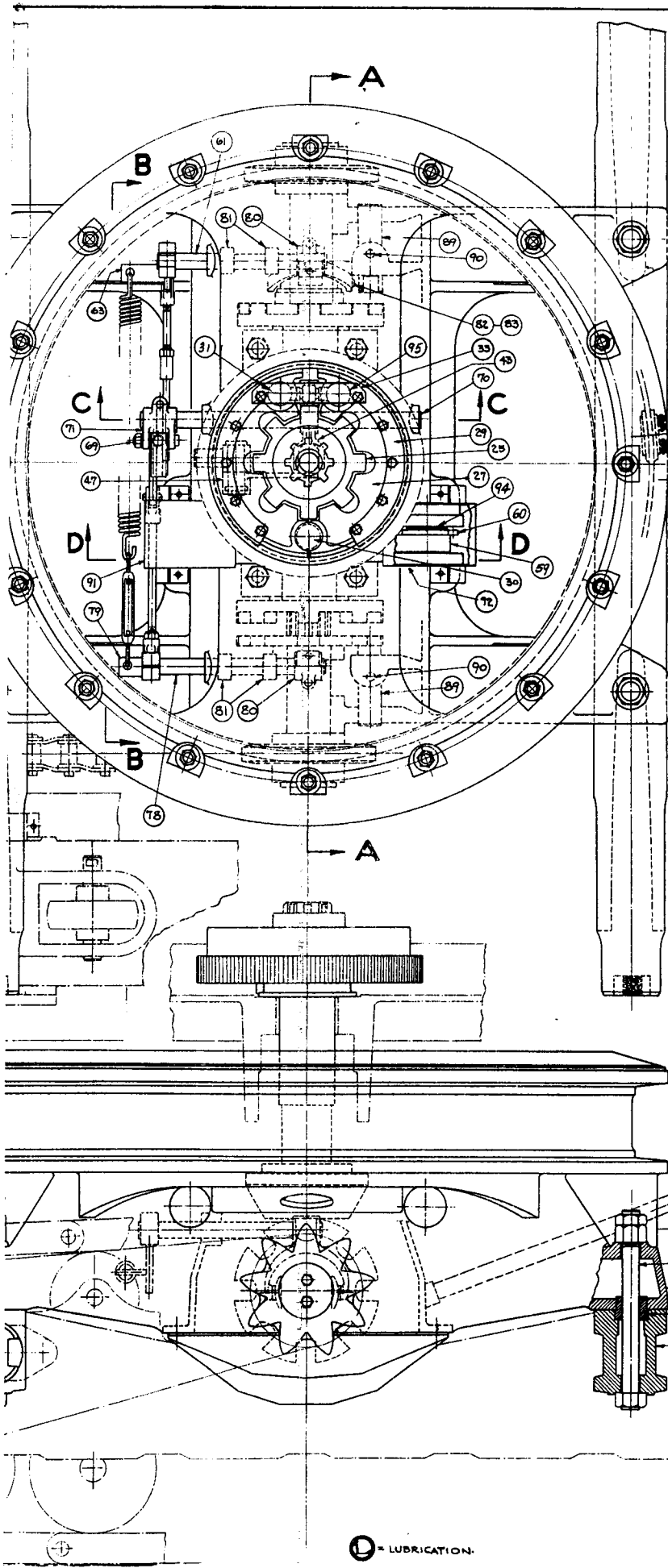
SECTION - BB

SECTION - DD

4- POSITIONS OF DIGGING PAWLS POSSIBLE

- 1- BOTH IN
- 2- BOTH OUT
- 3- FORWARD IN - REAR OUT
- 4- REAR IN - FORWARD OUT.

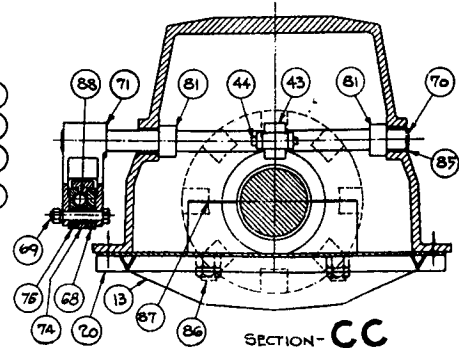




NO. NAME OF PIECE.

- 1 TRUCK FRAME
- 2 AXLE
- 3 SHEAR PLUG
- 4 ROD BOLT
- 5 SWING RACK 96T
- 6 STUD
- 7 ELASTIC STOP NUT
- 8 CLUTCH SHAFT
- 9 SPROCKET 9T-4.073" P.
- 10 WASHER
- 11 SPECIAL CAP SCREW
- 12 BUSHING
- 13 CLUTCH CASE
- 14 FELT LINING
- 15 CLAMP COLLAR
- 16 SLIDING CLUTCH
- 17 BUSHING
- 18 BUSHING
- 19 BEARING CAP
- 20 LEVEL GEAR CASE
- 21 CENTER PROPEL SHAFT 84T
- 22 PIPE PLUG
- 23 BUSHING
- 24 VERTICAL SHAFT
- 25 JAW CLUTCH
- 26 CLUTCH SHOE
- 27 GUY GEAR 42T - 1 1/2 D.P.
- 28 CLUTCH LINING
- 29 RETAINING RATE
- 30 CENTERING PIN
- 31 ADJUSTING PIN
- 32 ADJUSTING SCREW
- 33 LOCK RATE
- 34 BUSHING
- 35 THRUST WASHER
- 36 CAST LEVEL PINION 20T-2 1/2 P.
- 37 LEVEL PINION RETAINER
- 38 THRUST WASHER & SEAL
- 39 CENTER REACH ROD - UPPER
- 40 CENTER REACH ROD - LOWER
- 41 VERTICAL ROD
- 42 VERTICAL ROD
- 43 SHIFTER FORK
- 44 ROWEL CAP SET SCREW
- 45 BEARING
- 46 PIN BAR
- 47 BELL CRANK
- 48 PAWL PIN
- 49 BELL CRANK
- 50 PIN BAR
- 51 REACH ROD
- 52 YOKE END
- 53 YOKE END PIN
- 54 REACH ROD
- 55 LEVER
- 56 BEARING
- 57 PIN
- 58 PAWL
- 59 PAWL
- 60 BELL CRANK
- 61 OUTER SHAFT LK
- 62 1/2 B WOODRUFF KEY
- 63 LEVER
- 64 BUSHING
- 65 PIN
- 66 REACH ROD END
- 67 REACH ROD
- 68 SLOTTED ROD END
- 69 BOLT & BCD TUBE
- 70 CENTER SHAFT
- 71 LEVER
- 72 BOLT
- 73 SPRING
- 74 LOCK BAR
- 75 SLOTTED ROD END
- 76 REACH ROD
- 77 HOOK & EYE TURN BUCKLE
- 78 OUTER SHAFT R.H
- 79 LEVER
- 80 SHIFTER FORK
- 81 SET COLLAR
- 82 CLUTCH SHOE
- 83 CLUTCH SHOE PIN
- 84 ROWEL CAP SCREW
- 85 DILITE BUSHING
- 86 BEARING CAP STUD
- 87 BUSHING
- 88 HARDENED STEEL BALL
- 89 LOCK PIN
- 90 T-HEAD BOLT
- 91 COVER
- 92 COVER
- 93 COVER
- 94 WASHER
- 95 ADJUSTING PIN

LUBRICATING HEADER.



SECTION-CC

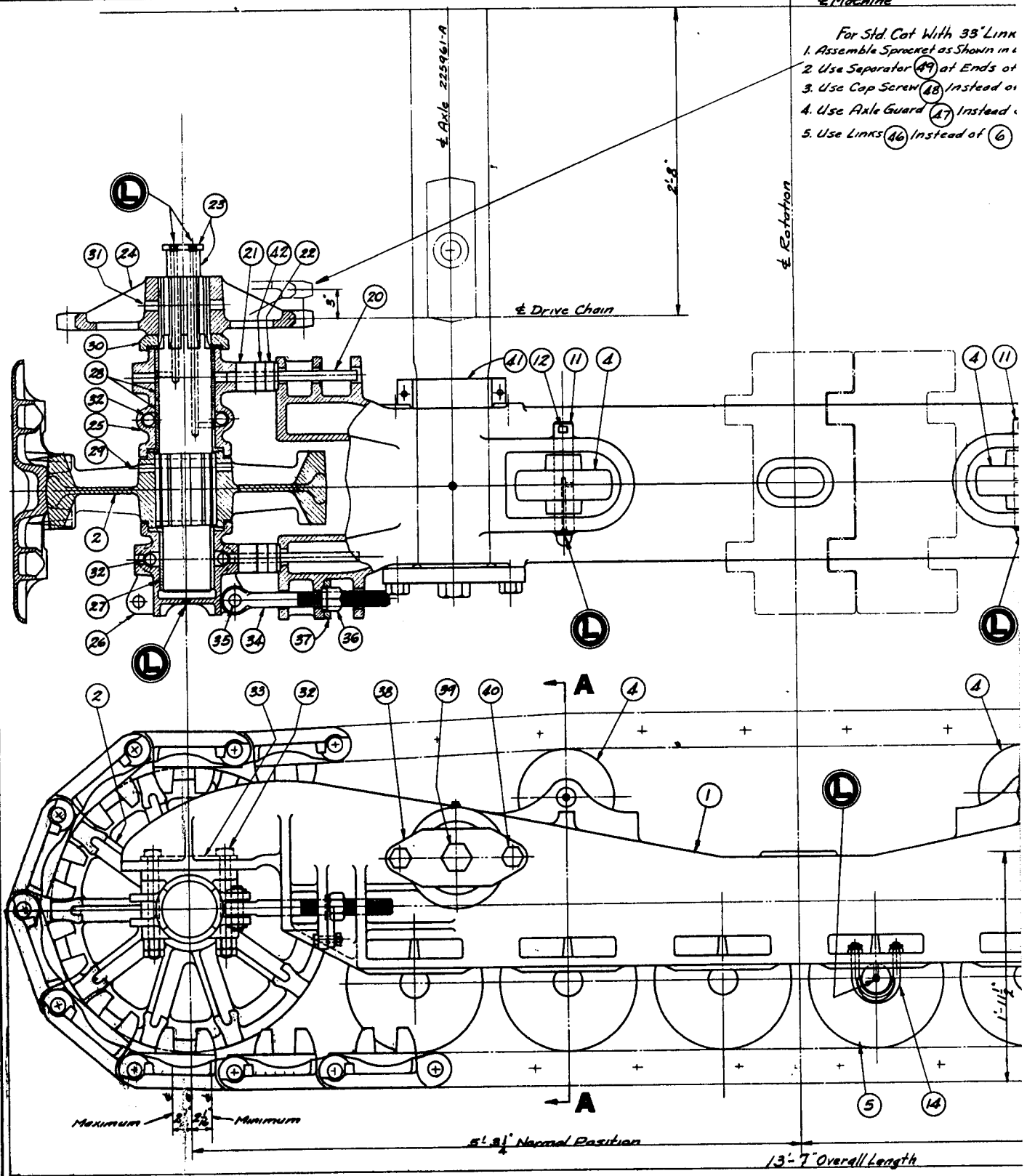
38 B & 51 B DIESEL
 GENERAL ARRANGEMENT
 PROPEL & STEERING MACHINERY
 REISSUED-SEPT. 1946 DWG. 237257

LUBRICATION.

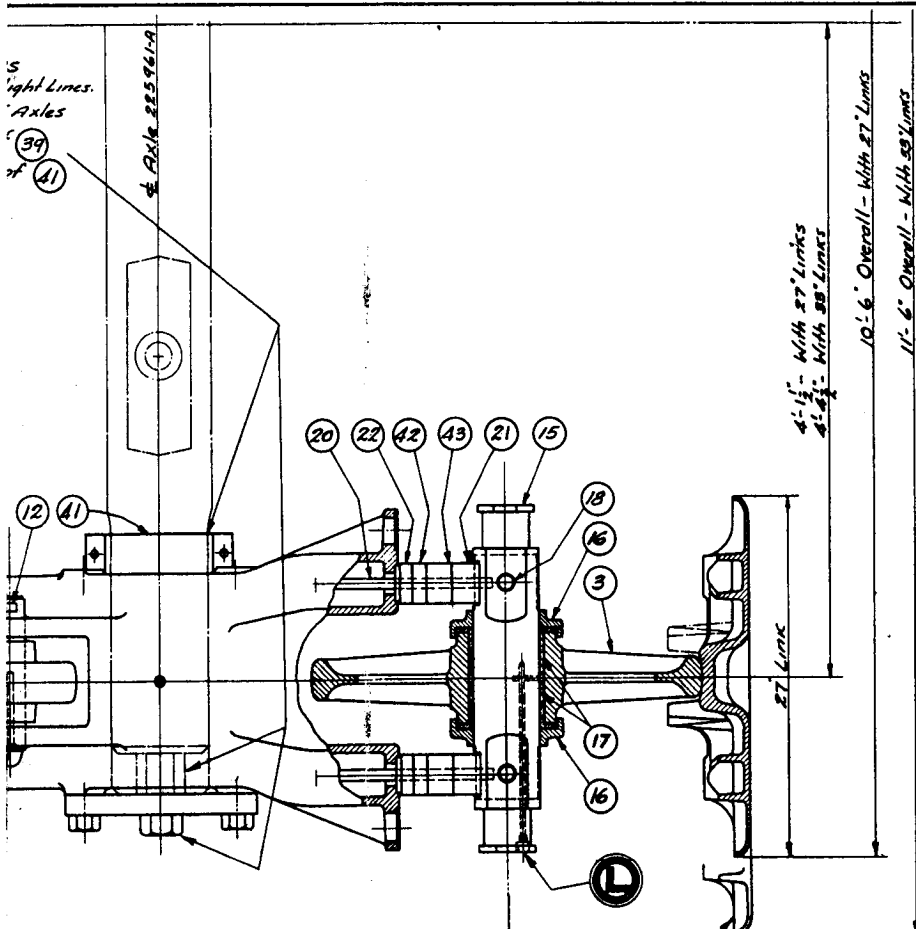


Machine

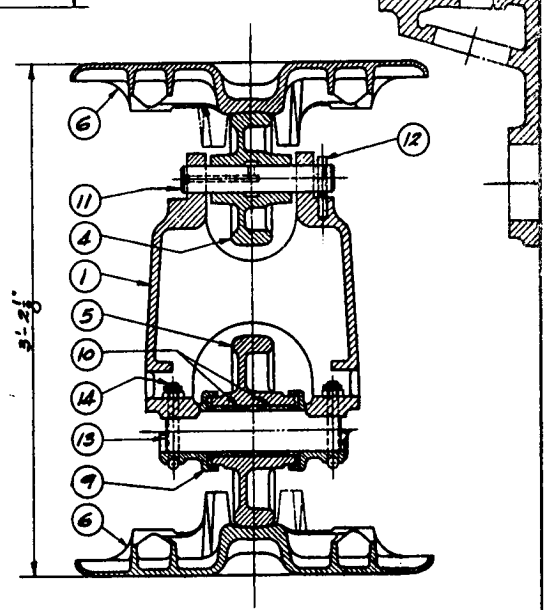
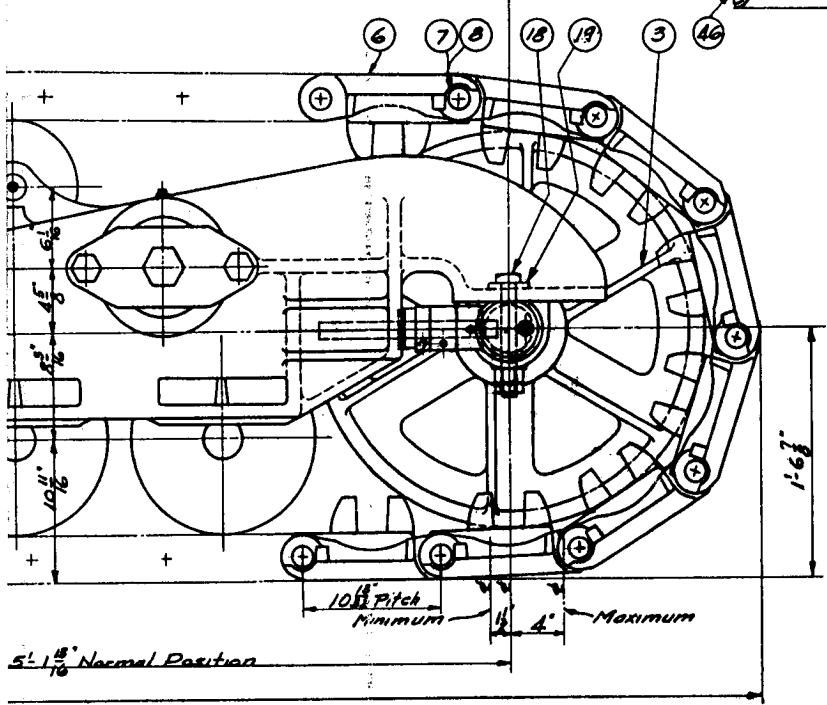
- For Std. Cat With 33" Link
1. Assemble Sprocket as Shown in 1
 2. Use Separator (49) at Ends of
 3. Use Cap Screw (48) Instead of
 4. Use Axle Guard (47) Instead of
 5. Use Links (46) Instead of (6)



Bearing Area With 27" Treads - 52 Sq. Ft.
 Bearing Area With 33" Treads - 64 Sq. Ft.



Item	Name of Piece
1	Cap Screw
2	Driving Tumbler
3	Truss Up Tumbler
4	Upper Ball
5	Lower Ball
6	Cap Link 27°
7	Link Pin
8	Lock Pin
9	Dust Shield (Lower Ball)
10	Bushing (Lower Ball)
11	Shell (Upper Ball)
12	Shell (Lower Ball)
13	Shell (Lower Ball)
14	U. Ball - Lower Link Nut
15	Truss Up Tumbler Shell
16	Dust Shield
17	Bushing
18	Sp. Hd. Bolt
19	Spacer Washer Bar
20	Spacer Guide Bar
21	Spacer
22	Spacer (Welded to Cap Bar)
23	Driving Tumbler Shell
24	Spacer
25	Upper Bearing
26	Upper Bearing
27	Bushing (Lower Ball)
28	Bushing (Lower Ball)
29	U. Ball Blank Bolt
30	Collar
31	U. Ball Blank Bolt
32	Sp. Hd. Bolt
33	Spacer Washer Bar
34	Eye Bolt
35	Eye
36	Sp. Nut
37	Washer
38	Bar (Ride Control)
39	Spacer Cap Screw
40	Spacer Cap Screw
41	Ball Guard
42	Spacer
43	Spacer
44	Spacer
45	Spacer
46	Link 27°
47	Ball Guard
48	Spacer Cap Screw
49	Separator 3" Dia.

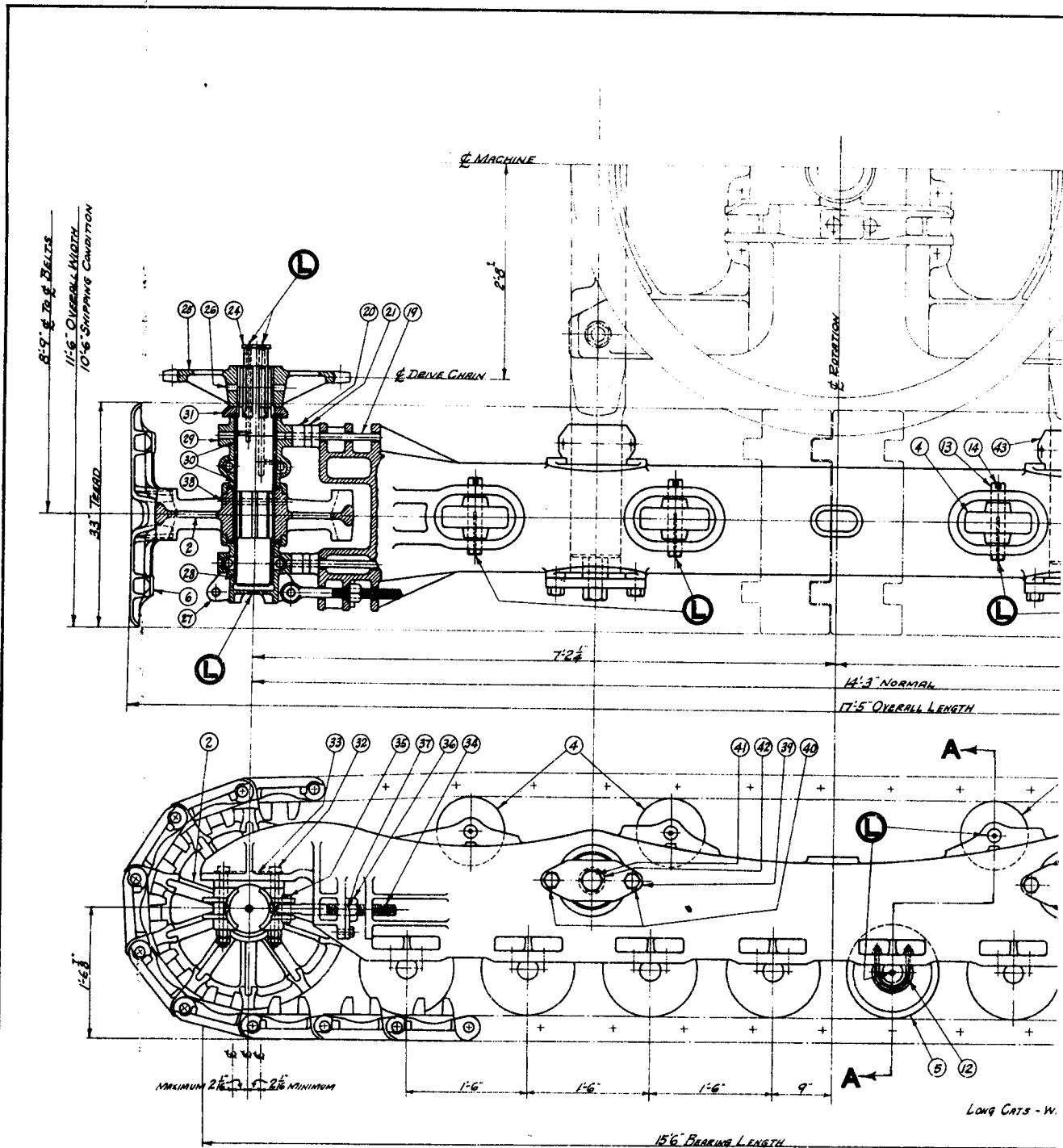


Section AA

L Lubrication - Grease



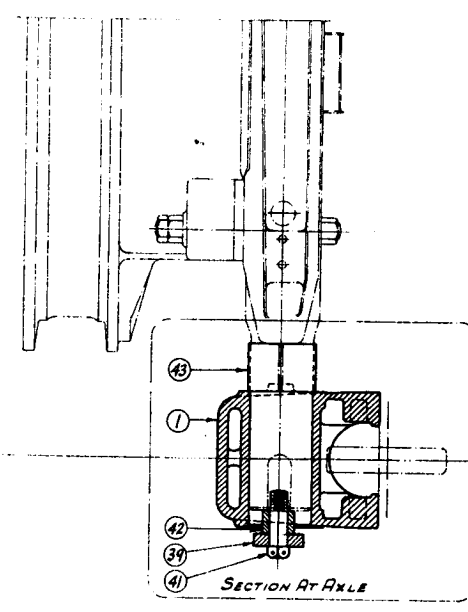
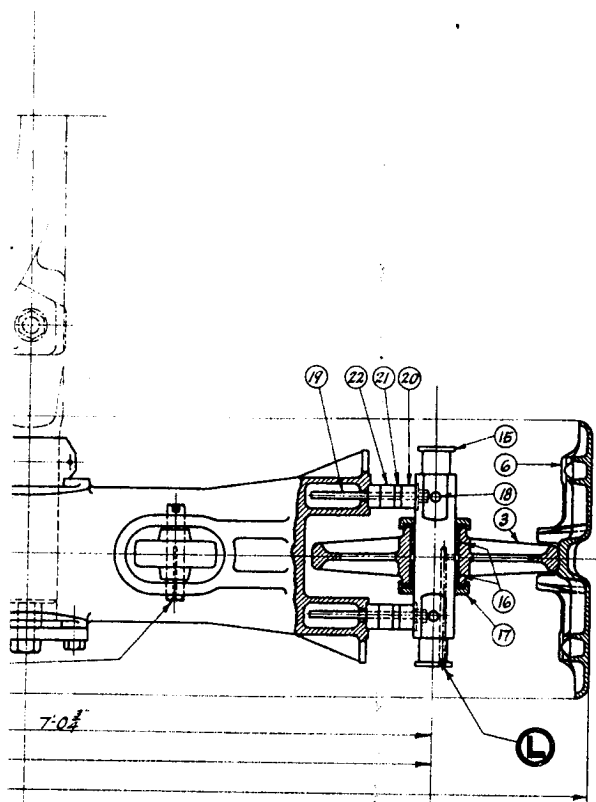
38-B DIESEL
STANDARD MOUNTING
ISSUED
JUNE-45
DWG 214453



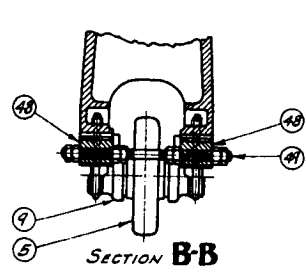
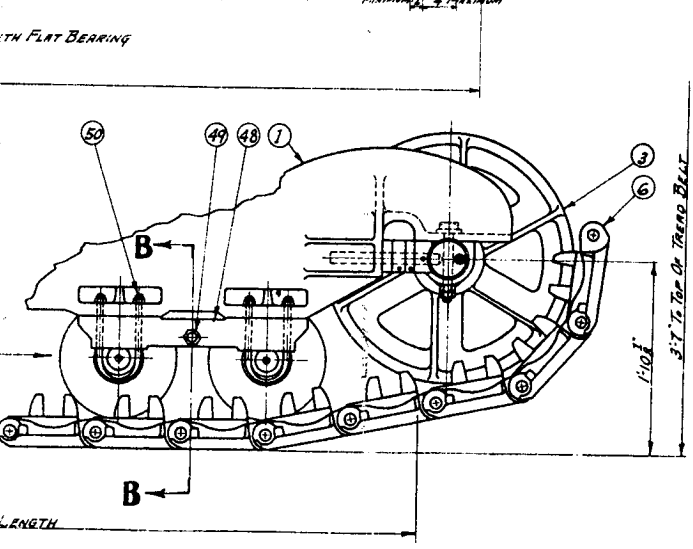
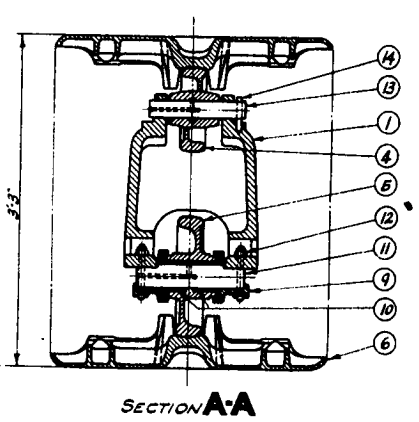
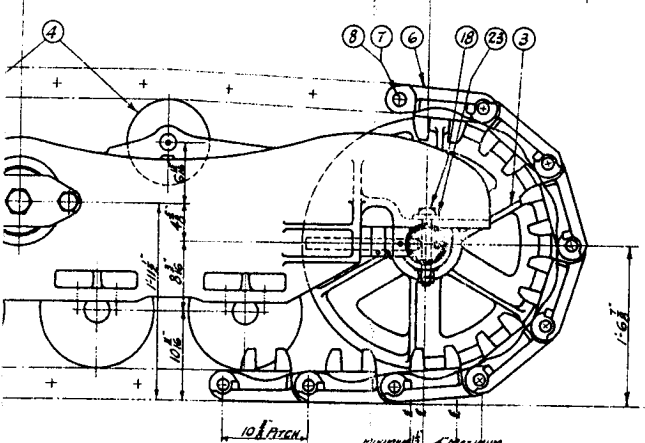
CATS WITH FLAT BEARING - 85.3 Sq. Ft. BEARING AREA
CATS WITH TAPERED ENDS - 75.1 Sq. Ft. BEARING AREA

LONG CATS
WITH TAPERED ENDS
RAISES MACHINE 4" DUE TO BEARING

13'-8" BEARING



ITEM	NAME OF PIECE	QTY
1	CAT FLANGE	1
2	DRIVING THIMBLER	1
3	THICK UP THIMBLER	1
4	UPPER ROLLER	1
5	LOWER ROLLER	1
6	CAT LINK	2
7	LINK PIN	2
8	LOCK PIN	1
9	DUST SHIELD	1
10	THIMBLER (LOWER ROLLER)	1
11	SHOULDER (LOWER ROLLER)	1
12	THIMBLER (UPPER ROLLER)	1
13	SHOULDER (UPPER ROLLER)	1
14	FLANGE BOLT	1
15	THICK UP THIMBLER SHIRT	1
16	ROCKER (THICK UP THIMBLER)	1
17	DUST SHIELD	1
18	SPACER	2
19	SPECIAL GUIDE BAR	1
20	SPACER	2
21	SPACER	2
22	SPACER	2
23	SPECIAL WHEELER BAR	1
24	DRIVING THIMBLER SHIRT	1
25	SPACER	2
26	THICK UP FLANGE BOLT	1
27	LOWER ROLLER	1
28	FLANGING	1
29	LOWER ROLLER	1
30	FLANGING	1
31	ROLLER	1
32	SA. HO. BOLT	2
33	SPECIAL WHEELER BAR	1
34	FLY BOLT	1
35	FLY	1
36	SPECIAL NUT	1
37	NUT LOCK	1
38	THICK UP FLANGE BOLT	1
39	BAR (ANGLE RETAINER)	1
40	SPECIAL CAT SCREW	1
41	SPECIAL CAT SCREW	1
42	SPACER	1
43	ROLLER SHIRT	1
44	FLY	1
45	FLY	1
46	FLY	1
47	FLY	1
48	BEARING	1
49	SPECIAL HO. BOLT	1
50	FLY BOLT (MINI LOCK NUT)	1



L LUBRICATION

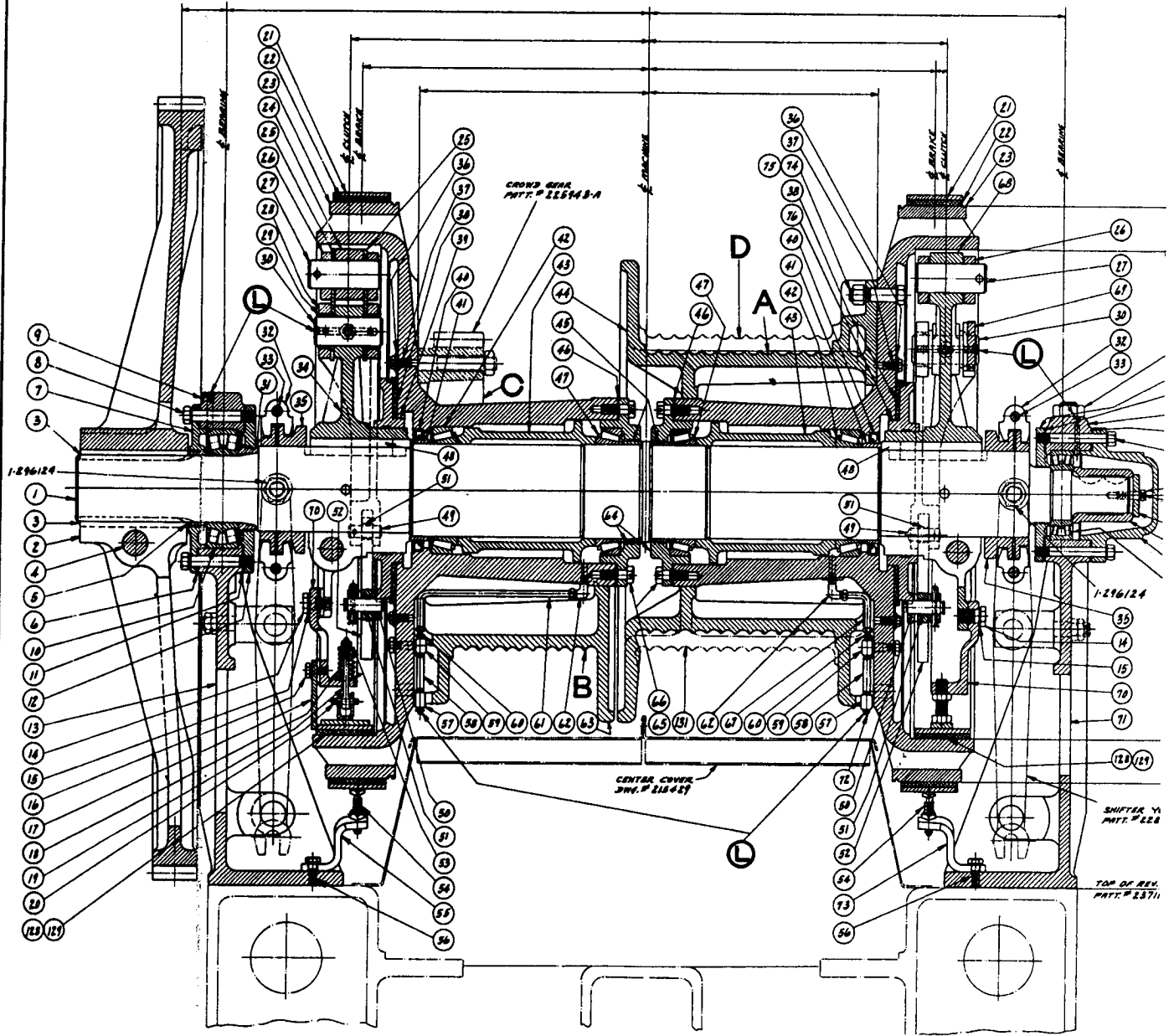
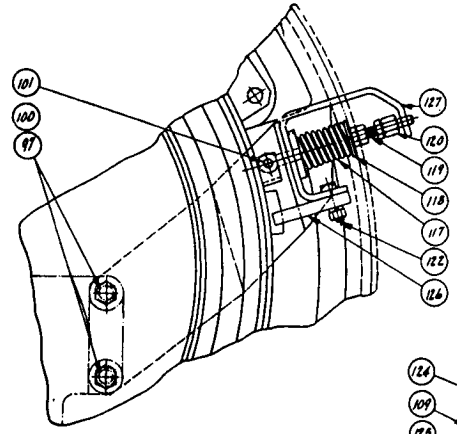
**BUCYRUS
ERIE**

38-B DIESEL
LONG MOUNTINGS
FLAT & TAPERED

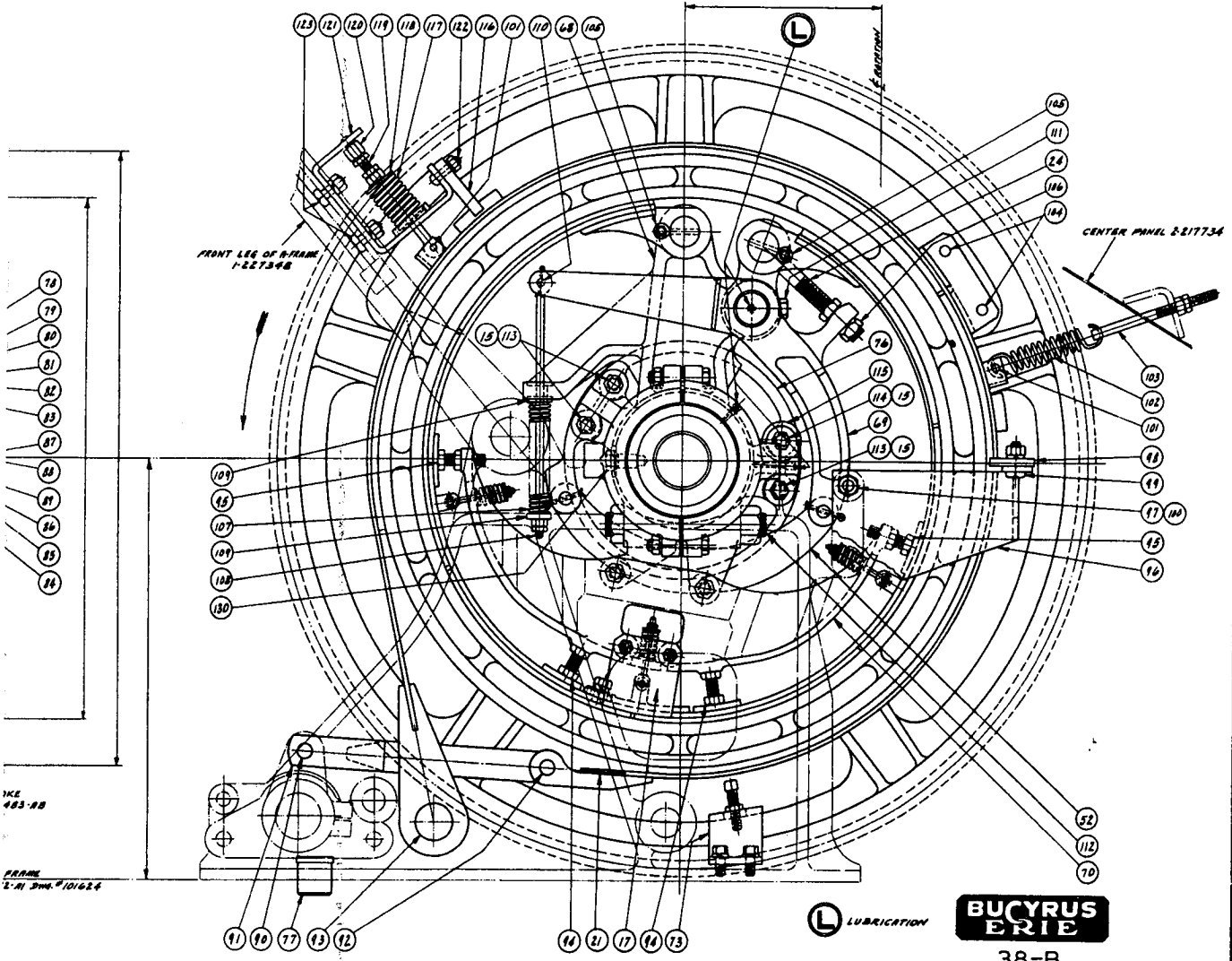
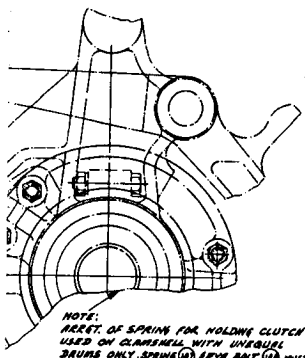
ISS. JEF - JUNE 1945

DWG 237320

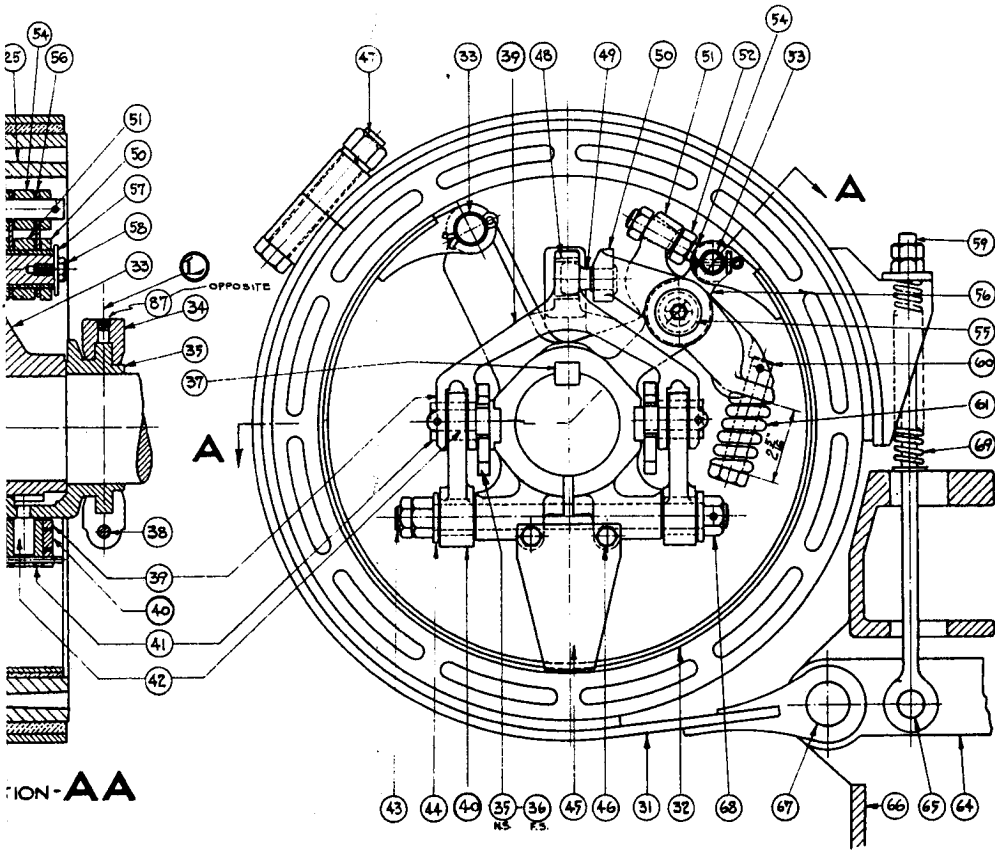
TYPE OF MACHINE	LEFT DRUM			RIGHT DRUM		
	LETTER	USE	PITCH DIA.	LETTER	USE	PITCH DIA.
SHOVEL	C	CROWD	GEAR	A	HOIST	20"
DRAGLINE	B	HOIST	22 1/2"	A	DRAG	20"
CLAMSHELL LINEAR DRUMS	B	HOLDING	22 1/2"	A	CLOSING	20"
CLAMSHELL FOUR DRUMS	B	HOLDING	22 1/2"	D	CLOSING	22 1/2"
CRANE	B	HOIST	22 1/2"	A	HOIST	20"



NO.	NAME OF PIECE	NO.	NAME OF PIECE	NO.	NAME OF PIECE
1	BOLT WASH	49	LINK PIN	116	LINK
2	BOLT WASH	50	LINK PIN	117	PIN
3	KEY	51	LINK PIN	118	PIN
4	WASHER	52	LINK PIN	119	CAPSCREW
5	SPACER	53	LINK PIN	120	CAPSCREW
6	WELLBORN GASKET	54	BOOSTER LINK ASSEMBLY	121	BRACKET
7	CLUTCH RETAINING COLLAR L.H.	55	BOOSTER LINK	122	BOLT
8	CAPSCREW	56	SPRING WASHER	123	GUIDE BAR
9	BEARING CAP	57	SAFETY BRACKET L.H.	124	BOLT
10	KEY	58	CAPSCREW	125	CUT WASHER
11	WELLBORN GASKET	59	1/4" STD. PIPE COUPLING	126	SPECIAL B.H. EYE
12	LEFT UNDER DRG. RETAINER	60	3/4" STD. PIPE	127	NUT
13	TRAVEL FRAME L.H.	61	PIPE CLAMP	128	SPECIAL TENSION SPRING
14	SPECIAL CAPSCREW	62	IMPERIAL "G" CONNECTOR	129	ADJ. BOLT
15	SHOCK-PROOF L.H. #1234	63	COPPER TUBING	130	PIN
16	CAPSCREW	64	IMPERIAL "G" ELBOW	131	PIN LOCK
17	CLUTCH LINKS RETAINER	65	DRUM 2 1/2" D.	132	SPECIAL NUT
18	COMPRESSION SPRING	66	BEARING COVER	133	COMPRESSION SPRING
19	EYE BOLT	67	SPECIAL CAPSCREW	134	ADJ. BOLT
20	PIN	68	WIRE "L"	135	SPRING WASHER
21	SPRING BAND	69	COPPER TUBING	136	PIN
22	BEARING BAND LINKING	70	CLUTCH DRIVER R.H.	137	DRUM SCREW
23	CLUTCH WASHER	71	BELL CRANK R.H.	138	SPECIAL PAD BOLT
24	EYE BOLT	72	BAND GUIDE	139	SPECIAL CAPSCREW
25	LINK	73	ROD FRAME L.H.	140	SPECIAL CAPSCREW
26	CLUTCH BAND	74	1/4" STD. PIPE PLUG	141	RUBBER SHOCK ABSORBER
27	CLUTCH BAND PIN	75	SUPPORT BRACKET R.H.	142	GUIDE BLOCK
28	BELL CRANK L.H.	76	PIN BOLT	143	COMPRESSION SPRING
29	WASHER	77	ALYDIED CUSHION PIN BOLT	144	SPRING WASHER
30	BELL CRANK PIN	78	CLUTCH BOOSTER R.H.	145	EYE BOLT
31	SPACER	79	SHOCK PLUG	146	SPECIAL NUT
32	SWIFTER COLLAR	80	ROD BOLT	147	BRACKET
33	PIN BOLT	81	INVAR RETAINING COLLAR R.H.	148	BOLT
34	CLUTCH DRIVER L.H.	82	WELLBORN GASKET	149	EYE BOLT
35	SWIFTER SLAVE	83	BEARING CAP	150	COMPRESSION SPRING
36	BOOSTER LINKS RETAINER	84	WELLBORN GASKET	151	GUIDE BLOCK
37	CAPSCREW	85	CAPSCREW	152	BRACKET
38	BOOSTER LINKING	86	SKT BEARING "E" 2218	153	BAND LINKING
39	CLUTCH BOOSTER L.H.	87	SPACER	154	ADJ. LINKING
40	ROCKET ASSEMBLY STD. TYPE	88	CAPSCREW	155	SPECIAL CAP SCREW
41	SPACER	89	LOCKWIRE	156	DRUM 2 1/2" D.
42	TURKEY BUSH #1234-1234	90	RETURNING WASHER	157	
43	SPACER	91	PIN	158	
44	DRUM 2 1/2" D.				
45	SPACER				

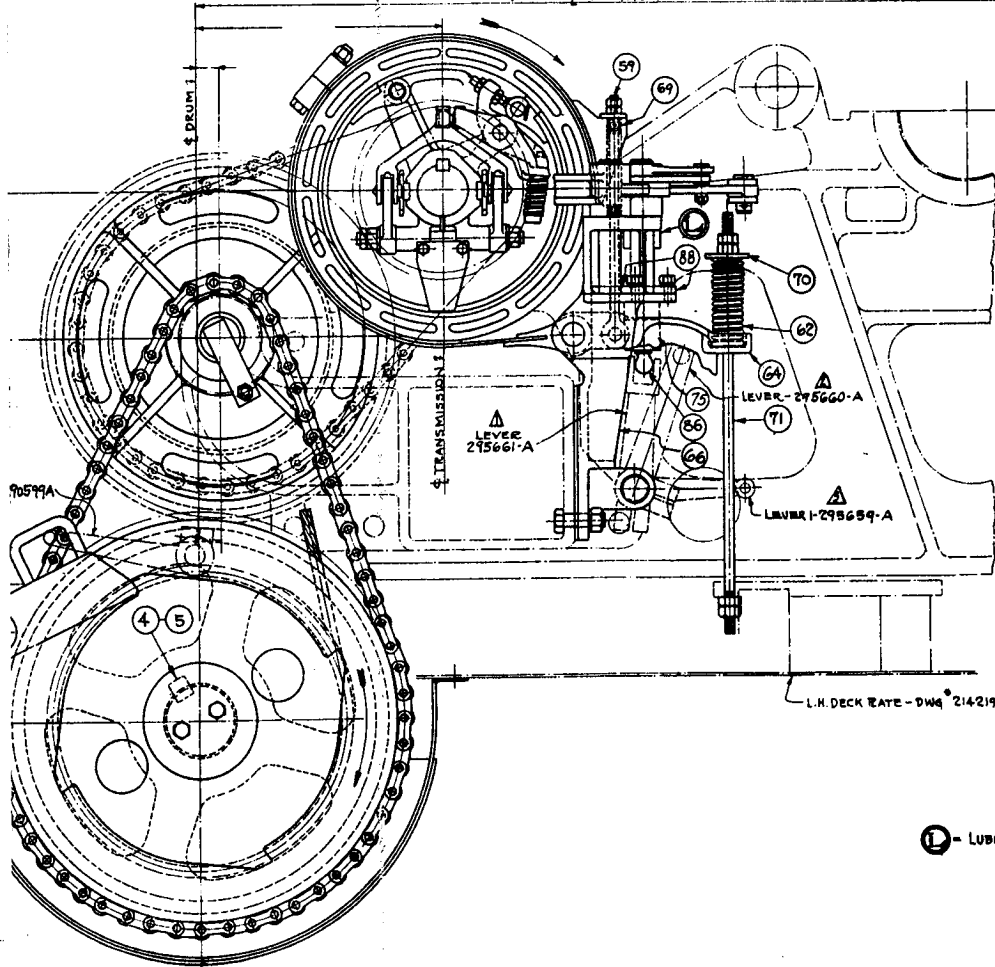


BUCRUS ERIE
38-B
HOIST SHAFT
ISSUED NOV. '53 DWG. 239755



ENLARGED CLUTCH ASSEMBLY.
SCALE 6" = 1'-0"

31.250" TO 4 ROTATION

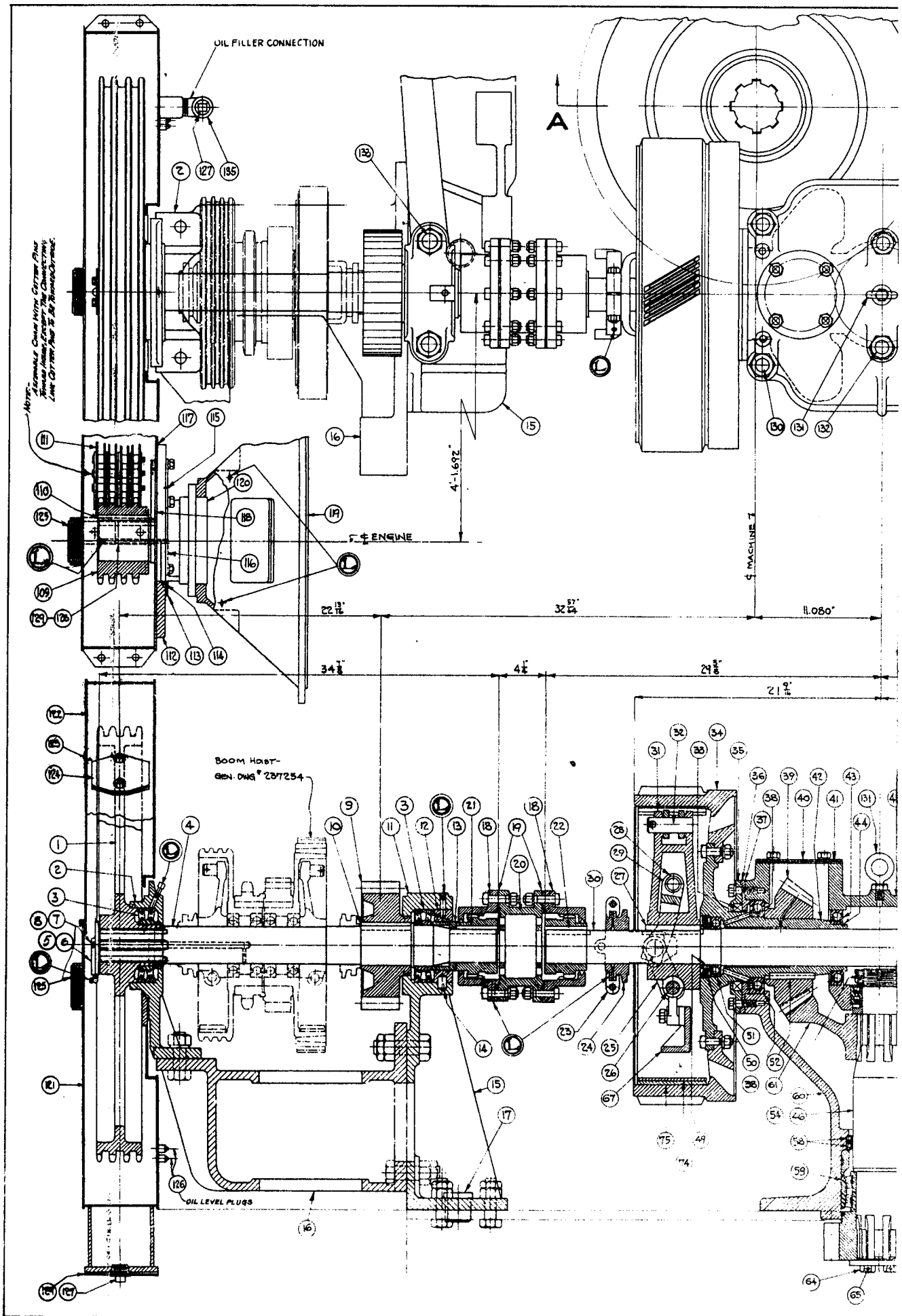


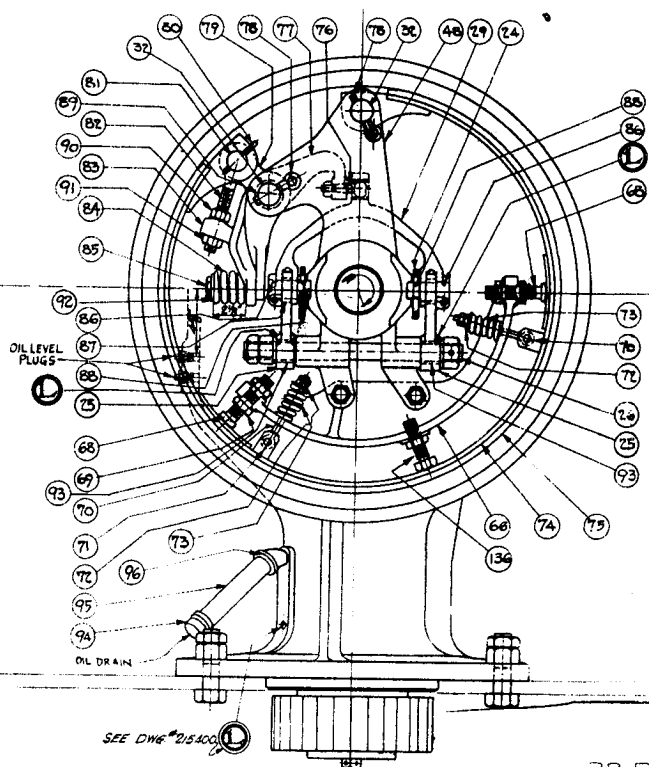
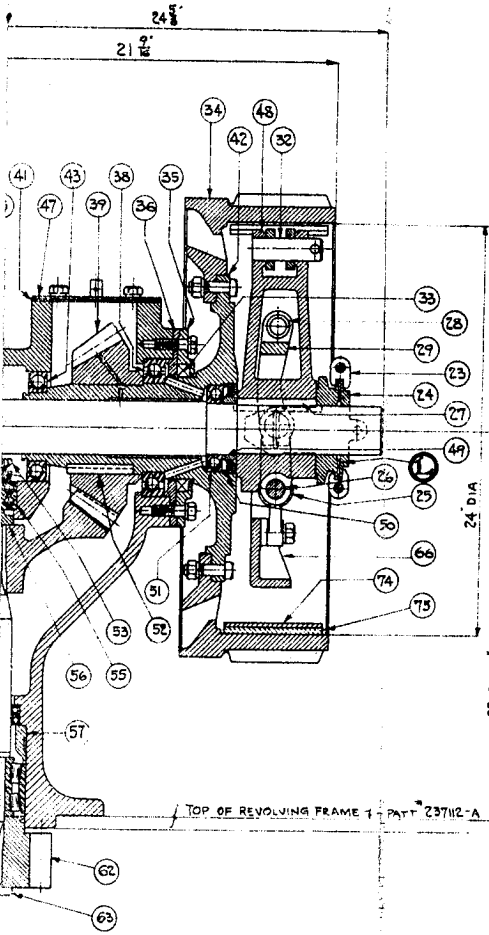
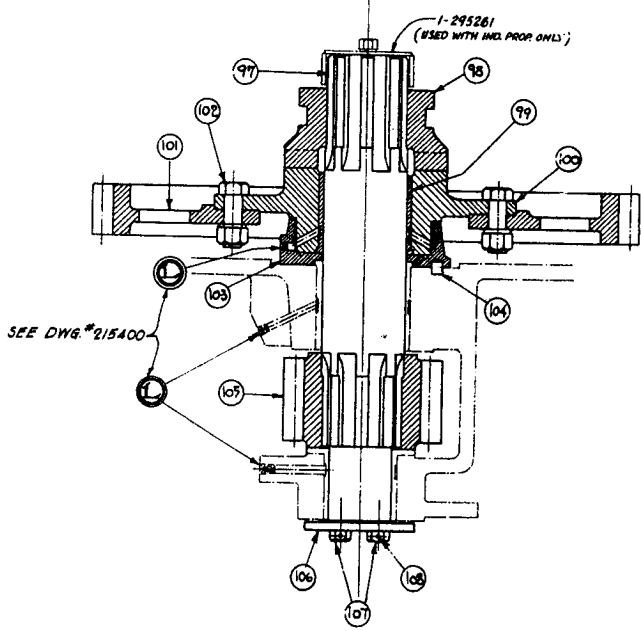
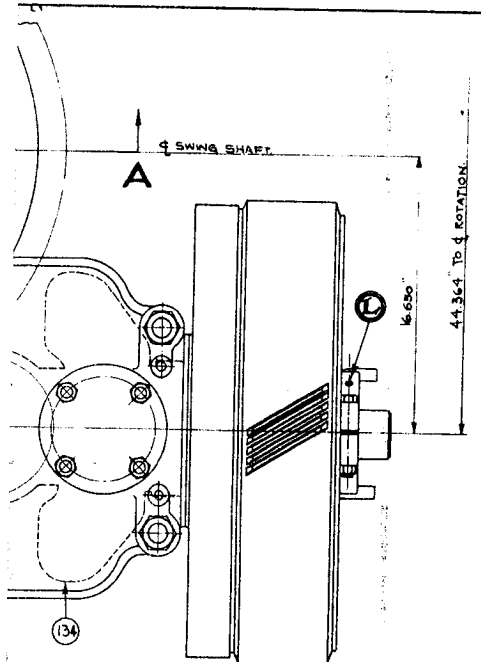
L.H. DECK RATE - DWG 214219.

No	NAME OF PIECE
1	SHAFT
2	DRUM
3	CHAIN SPROCKET 20T-11P
4	STRAIGHT KEY
5	STRAIGHT KEY
6	WASHER
7	SPECIAL CAP SCREW
8	LOCK WIRE
9	WATE-DIAMOND-ASA-D120
10	ROPE SOCKET WEDGE
11	PAWL PIN
12	PAWL
13	T-HEAD BOLT
14	T-HEAD BOLT
15	INTERMEDIATE SHAFT
16	SPROCKET 14T-11P
17	BUSHING
18	BUSHING
19	STRAIGHT KEY
20	WEAR 55T SPROCKET 20T-11P
21	WATE-DIAMOND-ASA-D120
22	LOCK BOLT
23	CLUTCH HOUSING
24	CHAIN SPROCKET 20T-11P
25	CLUTCH & BRAKE HOUSING
26	PINION 20T-24T-11P
27	STRAIGHT KEY
28	PAWL PIN
29	PAWL
30	SPACER
31	BRAKE BAND
32	CLUTCH BAND
33	CLUTCH DRIVER
34	SHIFTER COLLAR
35	SHIFTER SCREW (29560-A)
36	SHIFTER SCREW (29561-A)
37	STRAIGHT KEY
38	SHIFTER COLLAR BOLT
39	TOGGLE YOKE
40	TOGGLE LINK
41	BUSHING
42	PIN
43	ROD BOLT
44	BUSHING
45	BAND GUIDE
46	BAND GUIDE CAP SCREW
47	BRAKE BAND BOLT
48	BUSHING
49	BALL STUD
50	TOGGLE LEVER
51	BELL CRANK
52	SPECIAL NUT
53	LIVE END PIN
54	EYE BOLT
55	BUSHING
56	LINK
57	WASHER
58	CAP SCREW
59	EYE BOLT
60	SPECIAL BOLT
61	HELICAL COMPRESSION SPRING
62	HELICAL COMPRESSION SPRING
63	BRAKE CAM LEVER
64	PIN
65	LEVER BRACKET
66	DEAD END PIN
67	SPECIAL NUT
68	HELICAL COMPRESSION SPRING
69	SPRING WASHER
70	ROD BOLT
71	SHIFTER YOKE
72	SHAFT
73	SHIFTER SCREW
74	LEVER
75	CAM BAR
76	PIN
77	ROLLER
78	CLUTCH CAM LEVER
79	CLUTCH CAM LEVER
80	PIN
81	YOKE END BAR
82	REACH ROD END
83	SHAFT
84	BUSHING
85	BALL STUD BAR
86	1/2 STD PIPE PLUG
87	EYE BOLT
88	SPROCKET GUARD
89	
90	
91	
92	
93	
94	
95	

L - LUBRICATION. **BUCYRUS ERIE**

38-B DIESEL BOOM HOIST
ISSUED JUNE-45 DWG 237254

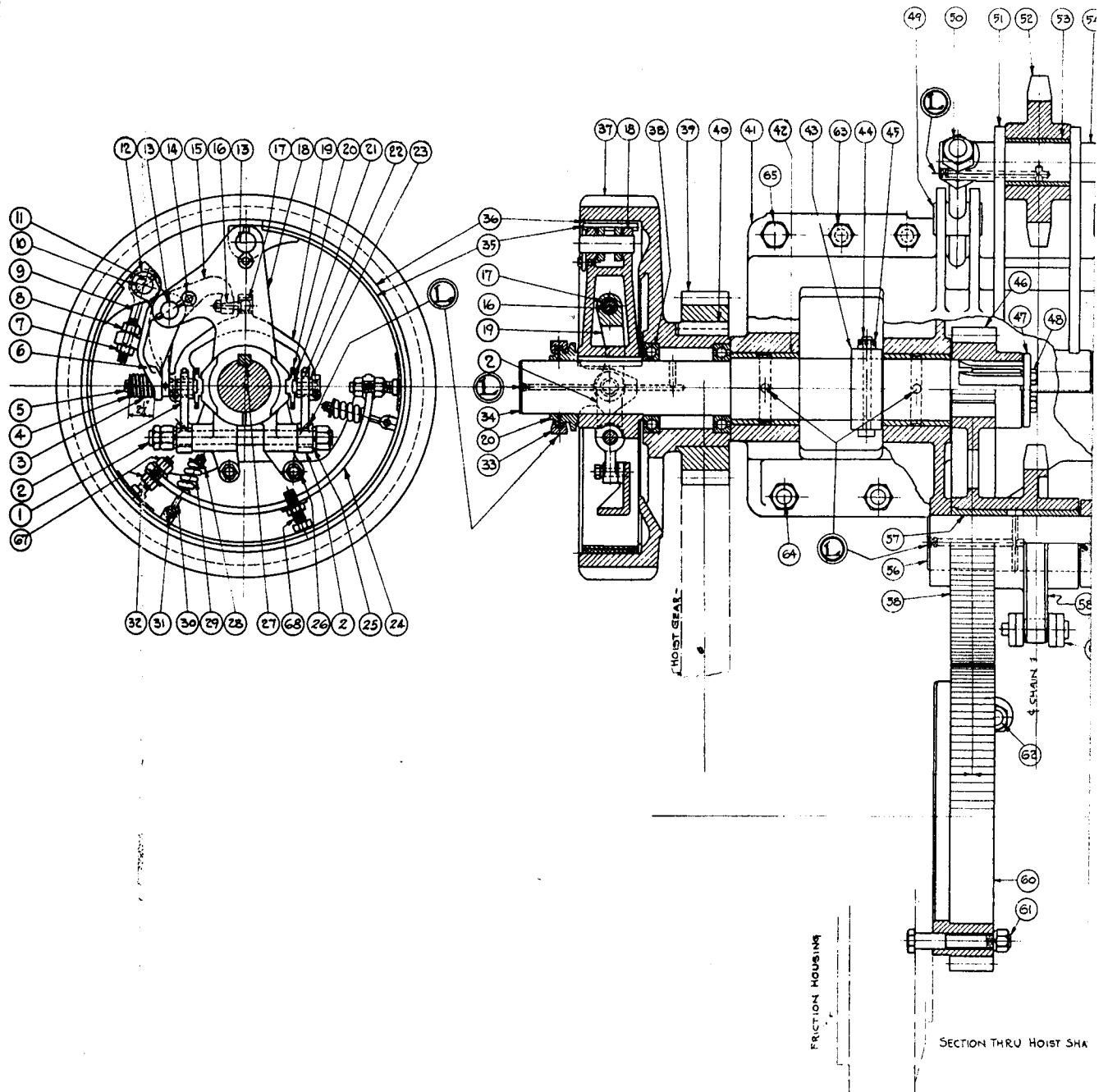


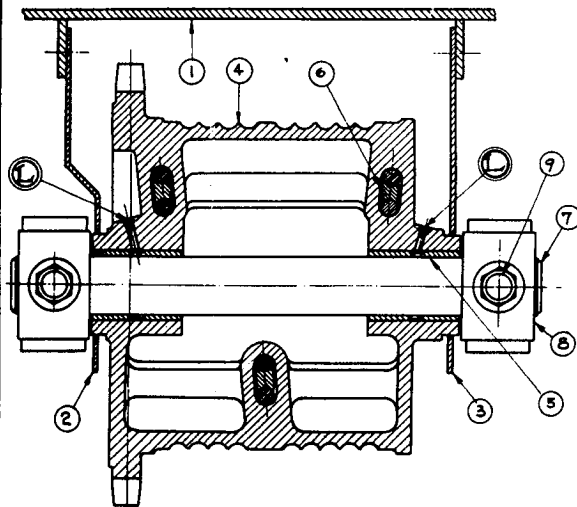


No	NAME OF PIECE
1	SPROCKET 11-11/16"
2	BEARING
3	LINK BELT BEARING - DE
4	HORIZONTAL SHARP
5	SPROCKET RETAINER
6	GASKET
7	SPECIAL CAP SCREW
8	LOCK WIRE
9	HUB PINION
10	STRAIGHT KEY
11	L.H. BEARING CAP
12	RETAINING COLLAR
13	SPACER
14	DOVETAIL
15	TRANSMISSION FRAME
16	TRANSMISSION BRACKET
17	SHEAR PLUG
18	3RD. POLE BEL. COMP.
19	GASKET
20	TOOTH LINE SPACER
21	STRAIGHT KEY
22	SHIFTER COLLAR
23	SHIFTER SLEEVE
24	YOKALE LINK
25	SPECIAL ROD BOLT
26	STRAIGHT KEY
27	BUSHING
28	TOGGLE YOKM
29	SHAFT
30	CLUTCH DRIVER L.H.
31	PIN
32	OIL SEAL RING #1002
33	CLUTCH HOUSING
34	RETAINING COLLAR
35	RETAINING COLLAR
36	VELUMOID GASKET
37	PAPRIR BALL BEARING
38	LEVEL PINION SET-2.00"
39	COVER
40	VELUMOID GASKET
41	CLUTCH SLEEVE
42	PAPRIR BALL BEARING
43	PAPRIR BALL BEARING
44	TRANSM. CASE COVER
45	VERTICAL SHAFT
46	COVER
47	CLUTCH DRIVER R.H.
48	COLLAR
49	SEAL RING SEAL #1002
50	PAPRIR BALL BEARING
51	PAPRIR BALL BEARING
52	STRAIGHT KEY
53	PAPRIR LOCK NUT
54	PAPRIR LOCK WASHER
55	KEY DEPARTER BALL BEAR.
56	COLLAR
57	REARING KEYPINNER
58	PERFECT OIL SEAL
59	TOWREN ROLLER DRG.
60	VERTICAL SHAFT
61	LEVEL SPACER-1.47"
62	PINION SET-WADP
63	RETAINING WASHER
64	CAP SCREW
65	LOCK WIRE
66	HAND GUIDE R.H.
67	HAND GUIDE L.H.
68	ADJUSTING BOLT
69	SPECIAL NUT
70	GUIDE ROD
71	PIN
72	SPRING WASHER
73	SPRING
74	CLUTCH BAND
75	CLUTCH BAND LINING
76	BALL STUD
77	TOGGLE LEVER
78	LIVE BOLT
79	LIVE NUT
80	PIN RETAINER
81	LIVE END PIN.
82	PIV BOLT
83	DEL CRANK
84	MECH. COMP. SPRING
85	SPECIAL BOLT
86	BUSHING
87	BUSHING
88	TOGGLE PIN
89	BUSHING
90	SPECIAL NUT
91	SPECIAL NUT
92	SPRING WASHER
93	BUSHING
94	PIPE CAP
95	PIPE NIPPLE
96	45° STREET ELBOW
97	VERTICAL SHAFT
98	RAW CLUTCH
99	NUMMER
100	GEAR HUB
101	GEAR SET-WADP
102	SPECIAL BOLT
103	SEAL
104	DOVETAIL
105	PINION
106	RETAINING WASHER
107	CAP SCREW
108	LOCK WIRE
109	SPECIAL CLAMP STRIP
110	STRAIGHT KEY
111	DIAMOND STEEL ROLLER
112	SEAL RETAINER
113	SEAL COVER STRIP
114	KA-LOCK STRAP
115	RETAINER CLAMP STRIP
116	RETAINER CLAMP STRIP
117	CORK GASKET
118	FILER PATE
119	CLUTCH HOUSING
120	BLARING CARRIER SHAFT
121	CHAIN CASE
122	CHAIN CASE COVER
123	OIL HOSE COVER
124	CORK GASKET
125	PIPE PLUG
126	PIPE PLUG
127	PIPE PLUG
128	SUPPORT
129	SHIM
130	BOLT
131	EYE BOLT
132	STUD
133	BOLT
134	GASKET
135	1/4" STREET ELBOW
136	SPECIAL ADJ. SCREW

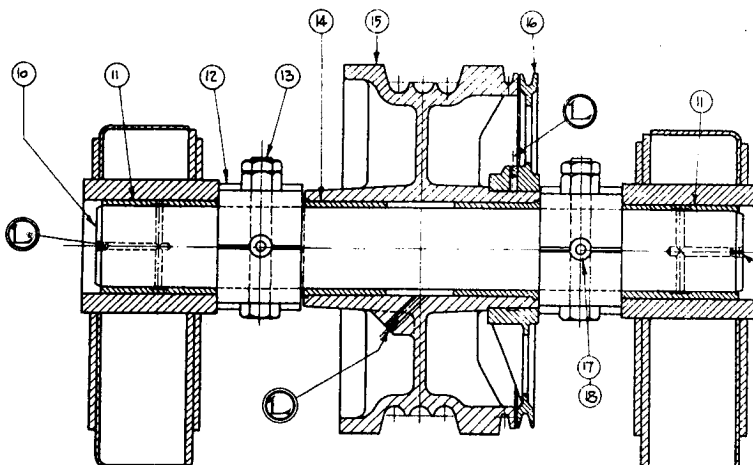
38-B DIESEL
TRANSMISSION
REISSUED
APRIL 1946
DWG 237234





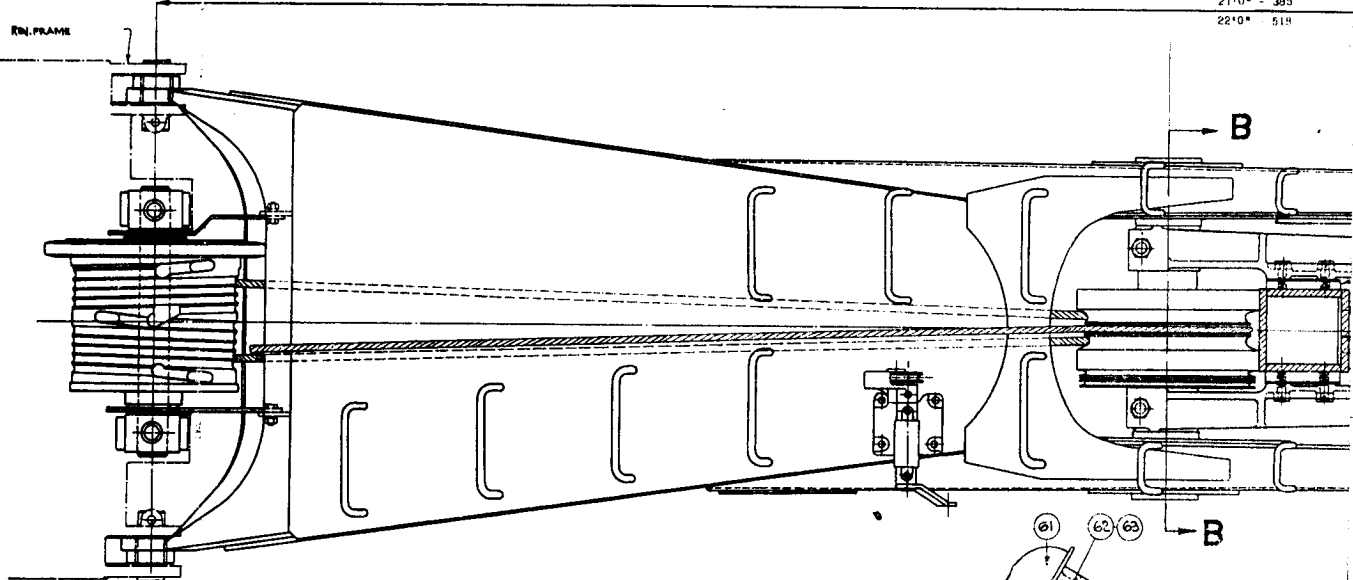


SECTION-AA

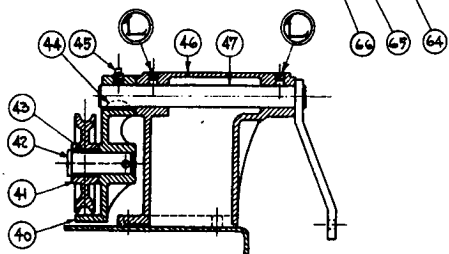
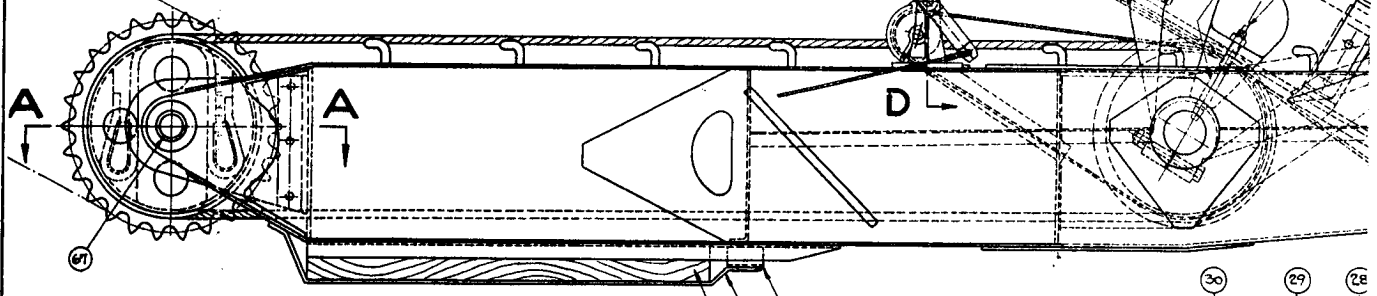


SECTION-BB

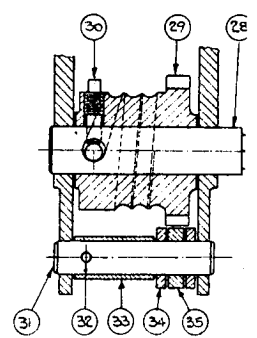
2110 - 393
2210 - 51R



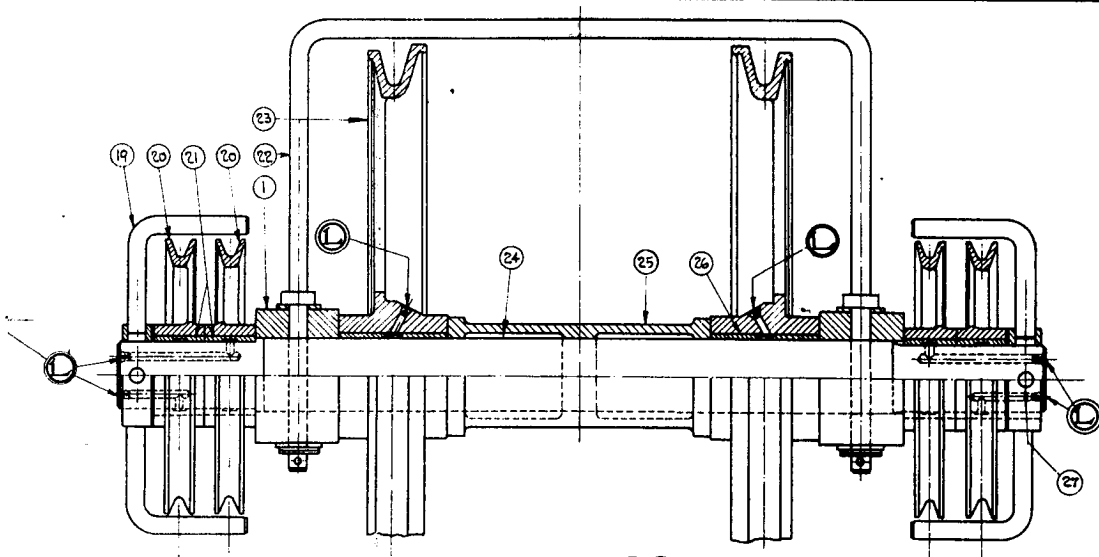
FOR CROWD MACHINERY
SEE DWR 237246



SECTION-DD

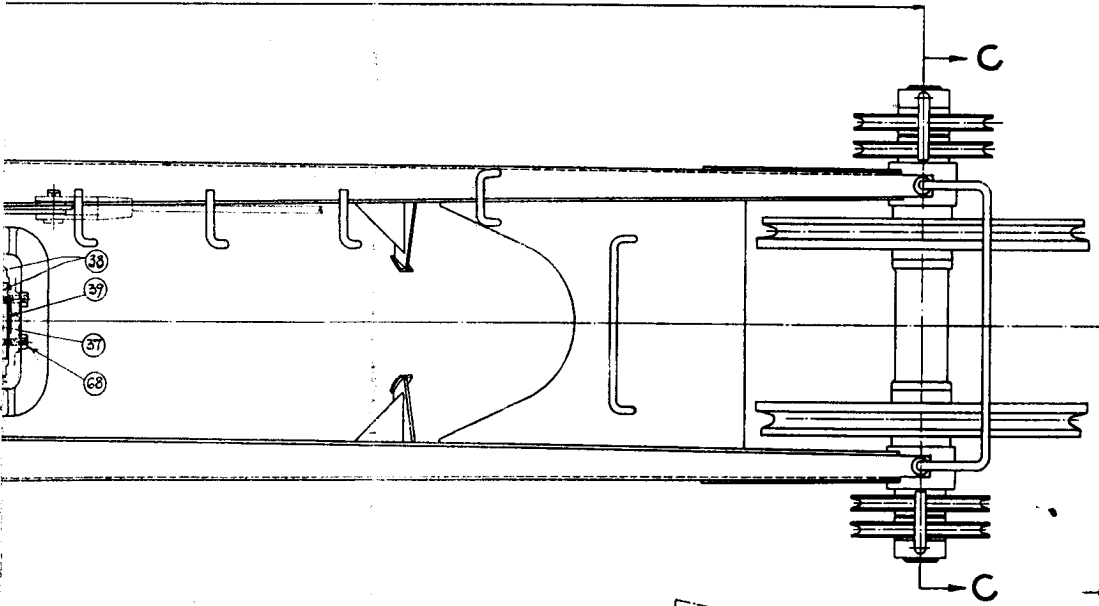


SECTION-EE

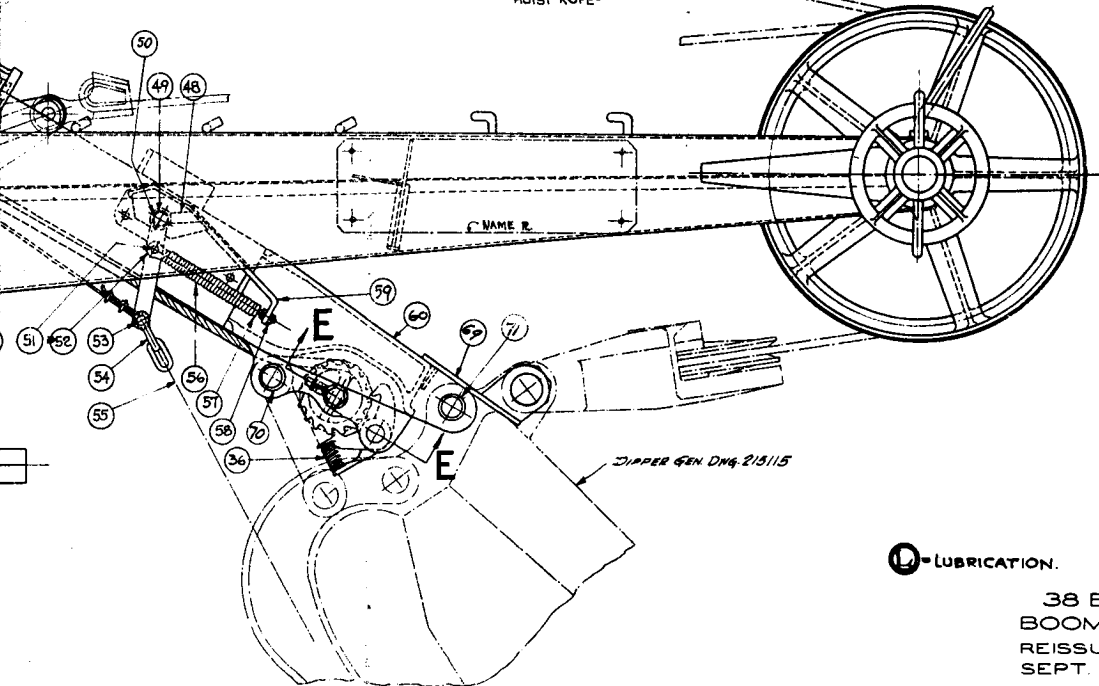


SECTION - CC

No.	NAME OF PIECE.
1	BOOM
2	DRUM RATE L.H.
3	DRUM RATE R.H.
4	DRUM - 20" PD.
5	BUSHING - 5 1/2" L.A.
6	ROPE SOCKET WEDGE
7	PIN
8	BEARING
9	ROD BOLT
10	SHIPPER SHAFT
11	BUSHING
12	SADDLE BLOCK
13	PIN BOLT
14	BUSHING - 5" L.A.
15	DRUM
16	SHEAVE
17	FLAT POINT SET SCREW
18	DOWEL
19	GUARD
20	SHEAVE - 19" PD.
21	BUSHING
22	ROPE GUARD
23	ROD POINT SHEAVE - 36"
24	SHEAVE PIN
25	SEPARATOR
26	BUSHING - 6 1/2" L.A.
27	T.H.D. BLANK BOLT
28	DRUM SHAFT
29	DRUM
30	SPECIAL SET SCREW
31	PAWL SHAFT
32	PIN LOCK
33	SEPARATOR
34	PAWL
35	PAWL
36	SPRING
37	HANDLE
38	WEARING PLATE
39	WEARING RATE SHIM
40	SHEAVE FRAME
41	SHEAVE - 5" PD.
42	SHEAVE PIN
43	OLITE BUSHING "A"
44	22 WOODRUFF KEY
45	5/8" HD SET SCREW
46	BEARING
47	LEVER
48	LEVER
49	BUSHING 1 9/16" L.A.
50	PIN
51	ANCHOR PIN
52	SPRING ANCHOR
53	PIN
54	3/8" SHACKLE
55	TRIP CHAIN
56	1/2" STEEL TENSION SPRING
57	TAKE UP ANCHOR
58	ADJUSTING BOLT
59	BRACKET
60	HANDLE END CASTING
61	ANCHOR CASTING
62	PIN
63	PIN LOCK BOLT
64	BAR
65	BAR
66	TIMBER
67	BUSHING
68	SPEC. CAP SCREW
69	GUARD
70	BUSHING
71	BUSHING



Hoist Rope-

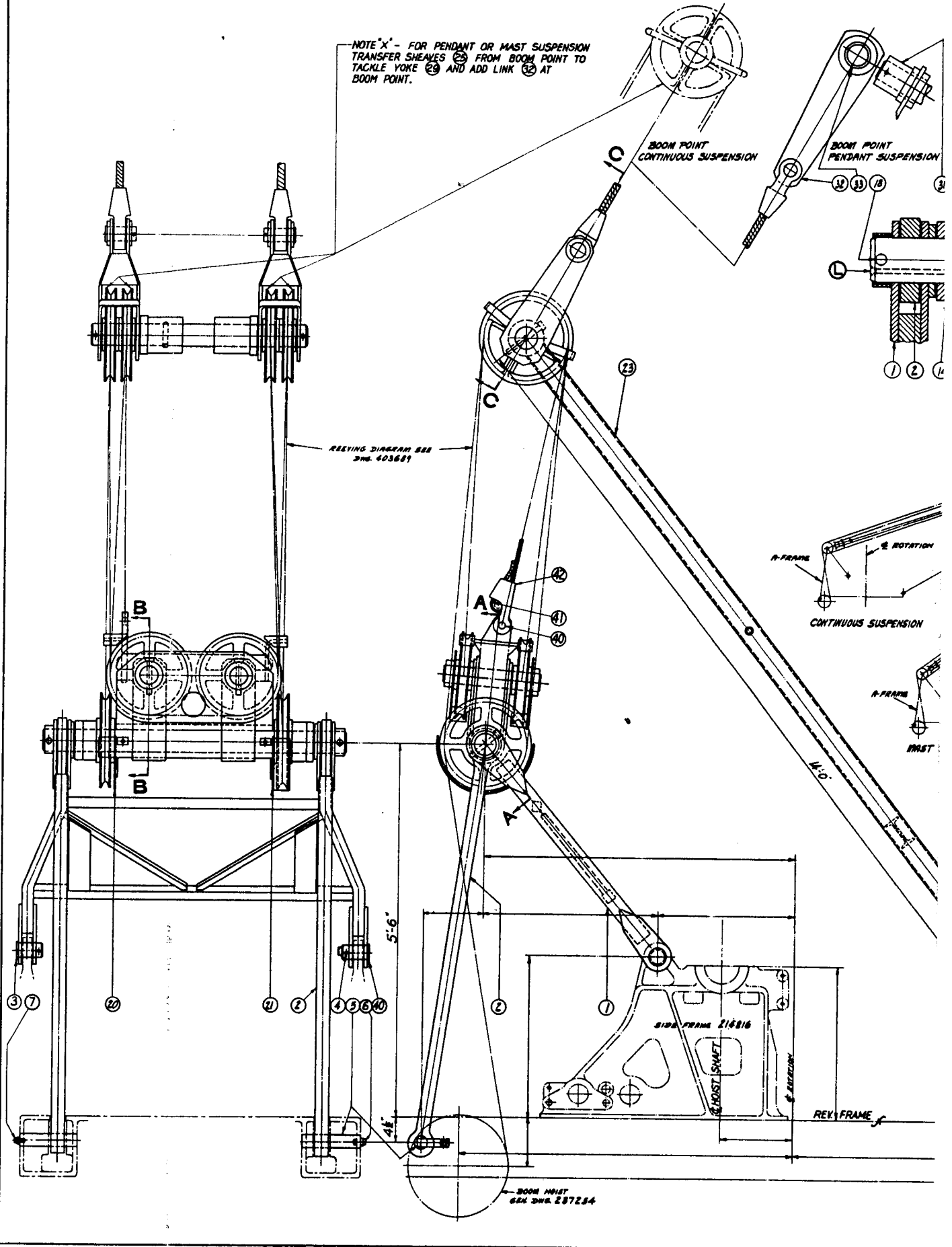


LUBRICATION.

BUYRUS
ERIE

38 B & 51 B DIESEL
BOOM & MACHINERY
REISSUED
SEPT. 1946 DWG 237273

NOTE 'X' - FOR PENDANT OR MAST SUSPENSION
TRANSFER SHEAVES (2) FROM BOOM POINT TO
TACKLE YOKE (2) AND ADD LINK (2) AT
BOOM POINT.



REEVING DIAGRAM SEE
DWG. 423621

BOOM POINT
CONTINUOUS SUSPENSION

BOOM POINT
PENDANT SUSPENSION

A-FRAME
ROTATION
CONTINUOUS SUSPENSION

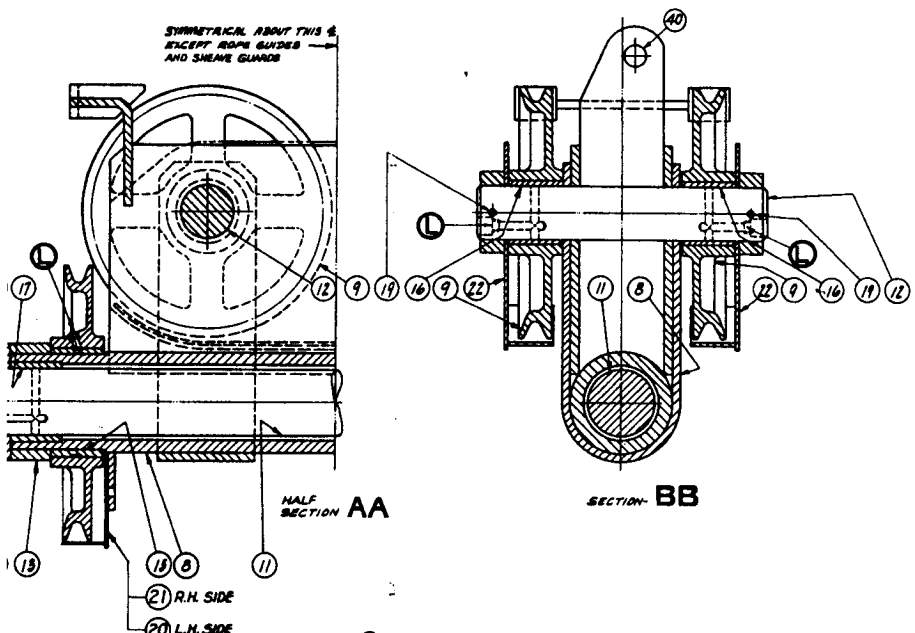
A-FRAME
MAST

SIDE FRAME 216816

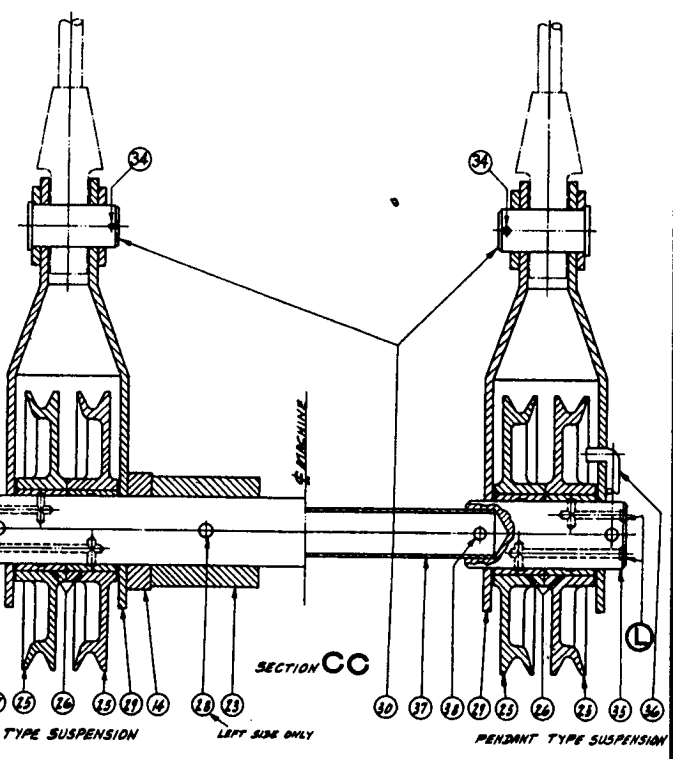
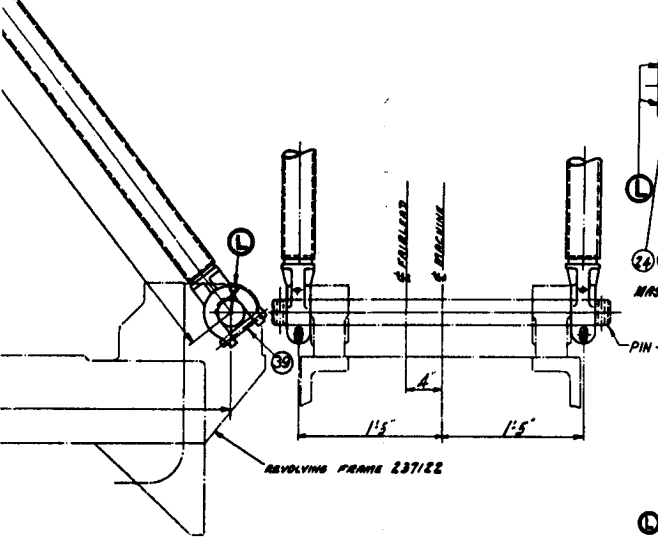
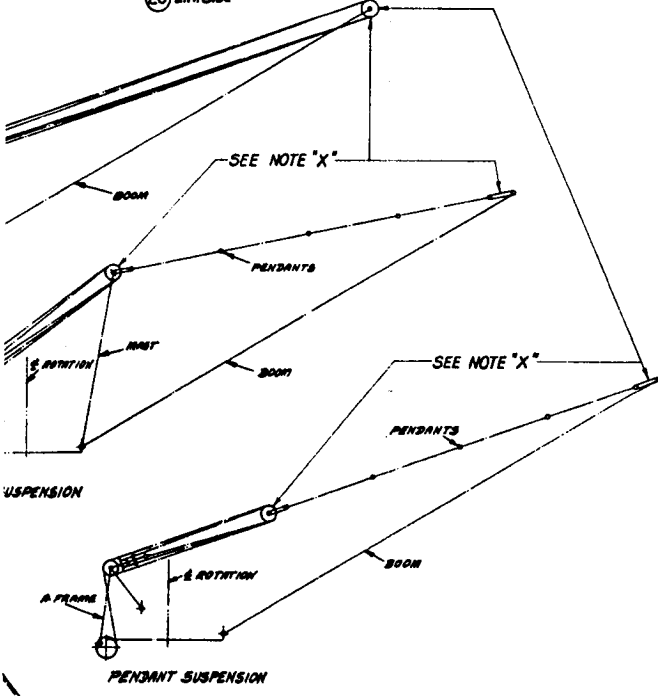
HOIST SHAFT

REV. FRAME

BOOM HOIST
SEE DWG. 237254



NO.	NAME
1	FRONT LEG
2	BACK LEG
3	FRONT LEG PIN
4	BLANK BOLT
5	BACK LEG PIN
6	BOLT
7	CAP SCREW
8	YARKE
9	SHEAVE
10	SHEAVE
11	PIN
12	PIN
13	SEPARATOR
14	SPACER
15	BUSHING
16	BUSHING
17	BUSHING
18	T-HEAD BLANK BOLT
19	T-HEAD BLANK BOLT
20	SHEAVE GUARD L.H.
21	SHEAVE GUARD R.H.
22	SHEAVE GUARD
23	MAST
24	PIN
25	SHEAVE
26	BUSHING
27	T-HEAD BLANK BOLT
28	T-HEAD BLANK BOLT
29	YARKE
30	PIN
31	COLLAR
32	LINK
33	BUSHING
34	BLANK BOLT
35	PIN
36	SHOVEL PIN
37	SPACER
38	BLANK BOLT
39	T-HEAD BLANK BOLT
40	DIY
41	SHOVEL SOCKET WEDGE
42	WEDGE OPEN ROD SOCKET



FOR INSTRUCTION DRAWING FOR LOWERING MAST AND CARRYING BOOM AT CAB HEIGHT, SEE DWG. 215805

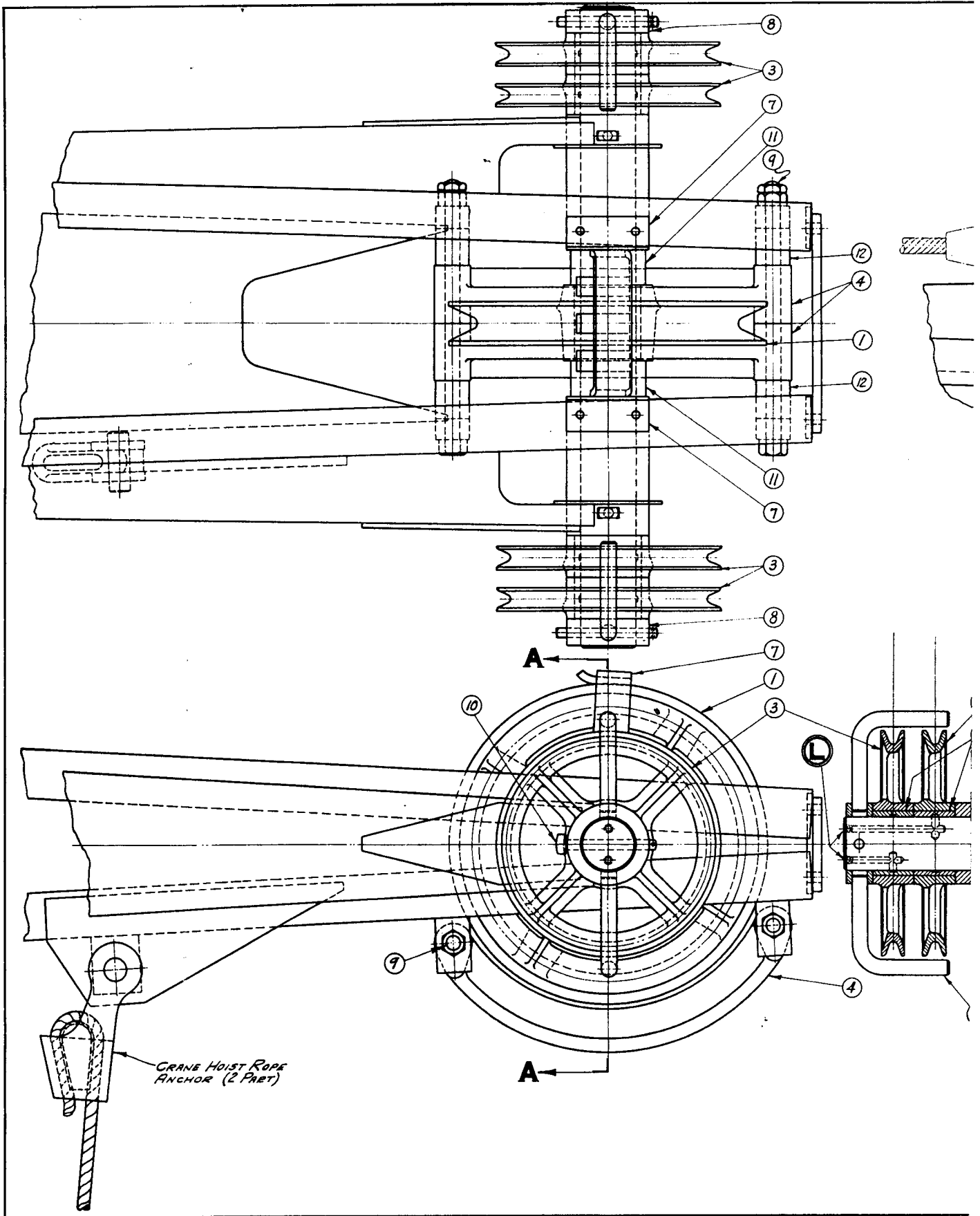
BUCRUS ERIE

38-B

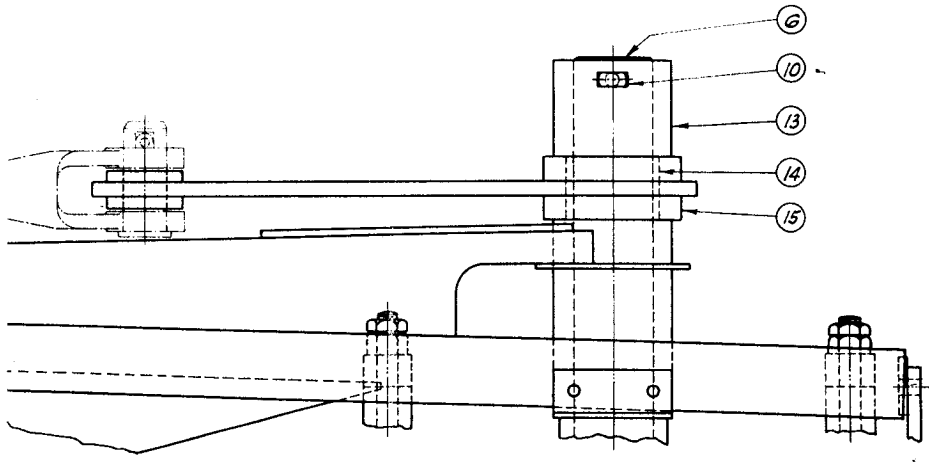
A-FRAME-MAST - SUSPENSION

ISSUED NOV. '50 DWG. 238904

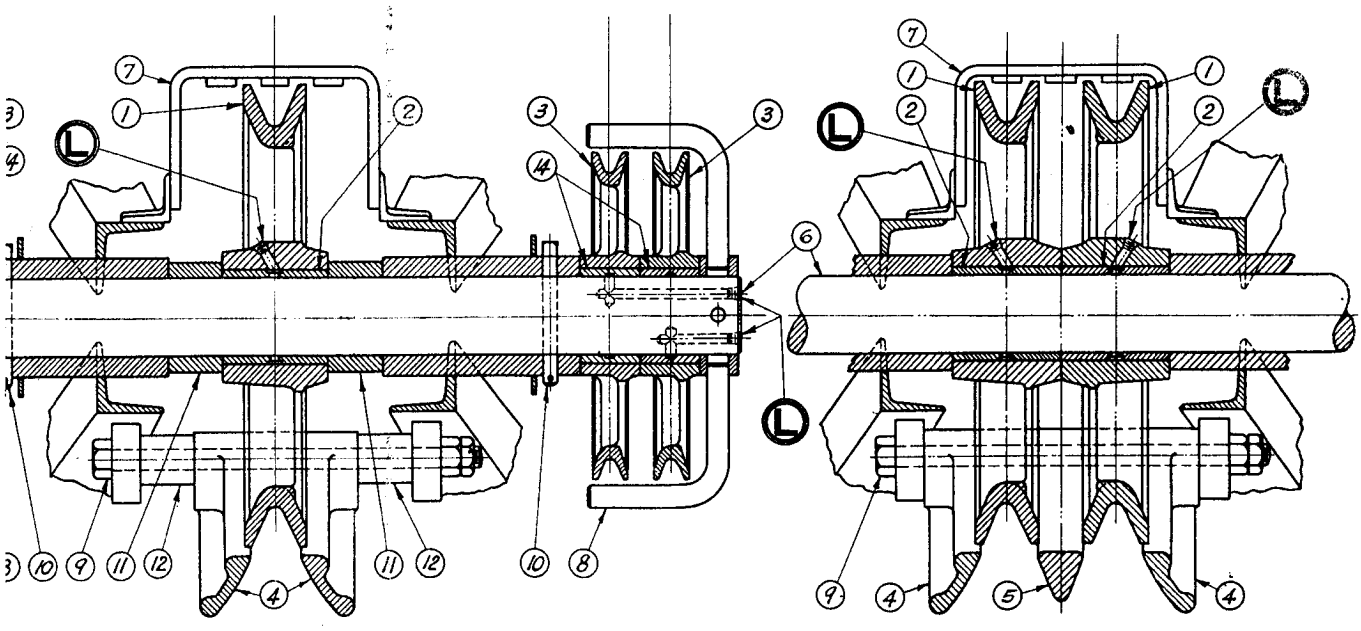
L - LUBRICATION



NO.	NAME OF PIECE
1	SHEAVE 20" PITCH DIA.
2	BUSHING
3	SHEAVE 15" PITCH DIA.
4	SHEAVE GUARD (OUTER)
5	SHEAVE GUARD (CENTER)
6	PIN
7	ROPE GUARD (UPPER)
8	ROPE GUARD (LOWER)
9	ROD BOLT
10	END BLANK BOLT
11	SEPARATOR
12	SEPARATOR
13	COLLAR
14	BUSHING
15	LINK



ARRANGEMENT OF POINT PIN
FOR PENDANT SUSPENSION



SECTION A-A DERAGLINE

L LUBRICATION

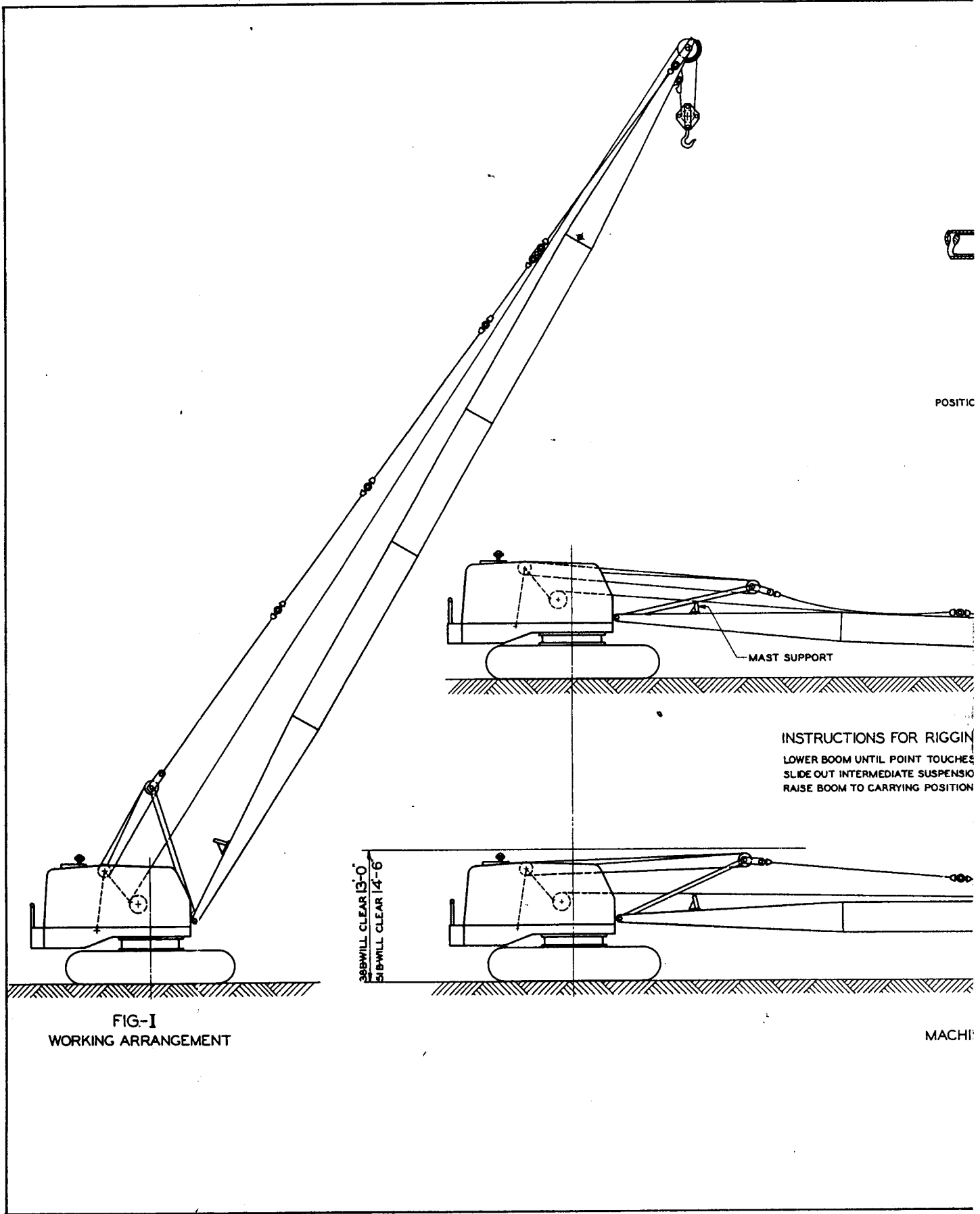
SECTION A-A CLAMHELL & CRANE

**BUCCYRUS
ERIE**

38 B & 51 B DIESEL
CRANE BOOM MACHINERY

REISSUED
SEPT-1946

DWG. 215351



POSITIC

INSTRUCTIONS FOR RIGGIN
 LOWER BOOM UNTIL POINT TOUCHES
 SLIDE OUT INTERMEDIATE SUSPENSIO
 RAISE BOOM TO CARRYING POSITION

FIG-I
 WORKING ARRANGEMENT

MACHI

**INSTALLATION,
OPERATION AND ADJUSTMENT
INSTRUCTIONS**

3H4770

OUTPUT SHAFT GOVERNOR GROUP

for

CATERPILLAR

REG. U.S. PAT. OFF.

D 3 3 7 OR D 3 2 6

ENGINE

**EQUIPPED WITH
A TORQUE CONVERTER**

CATERPILLAR TRACTOR CO.
PEORIA ILLINOIS U. S. A.

FORM 30883

X-1521

The following instructions cover the installation, operation and adjustment of the 3H4770 Output Shaft Governor Group.

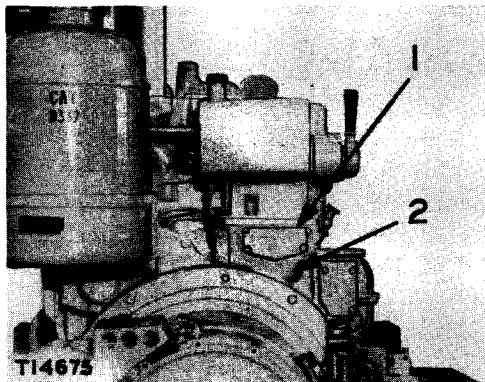
GOVERNOR GROUP INSTALLATION

Install the output shaft governor group on the engine as follows:

1. Remove the cover (1) from the engine flywheel housing (2).

REMOVING COVER FROM FLYWHEEL HOUSING

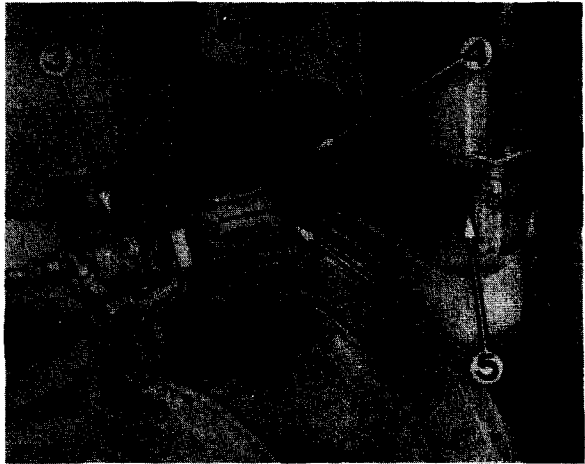
- 1-Cover.
- 2-Flywheel housing.



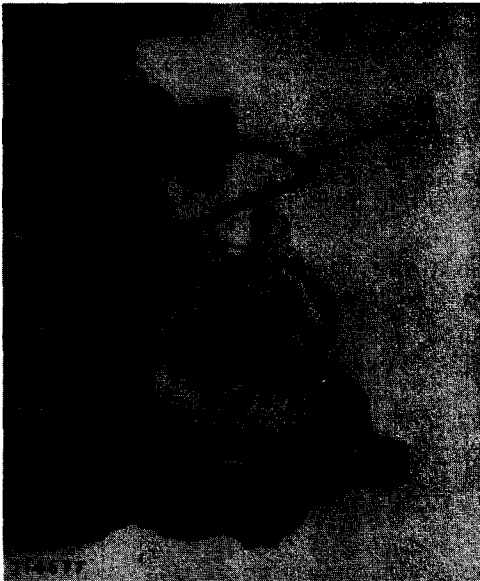
2. Position the gasket on the dowels located in the forward face of the hydraulic servo mechanism (4). Be certain the oil holes (5) in both the servo housing and the engine flywheel housing are open.
3. Lift the hydraulic servo mechanism and the output shaft governor (3) into place on the flywheel housing, and install the mounting capscrews.
4. Move the Diesel engine governor control lever to the full open position several times to make sure the engine fuel rack moves freely. If the rack does not move freely, locate and correct the cause before attempting to adjust the output shaft governor. See the topic, ADJUSTING THE OUTPUT SHAFT GOVERNOR, for method of making proper governor adjustments.

**INSTALLING
OUTPUT SHAFT
GOVERNOR GROUP**

- 3-Output shaft governor.
- 4-Hydraulic servo mechanism.
- 5-Oil holes.



- 5. Connect the flexible drive cable (6) to the output shaft governor and converter output shaft cable connection.



**INSTALLING
GOVERNOR DRIVE
CABLE**
6-Drive cable.

GOVERNOR OPERATION

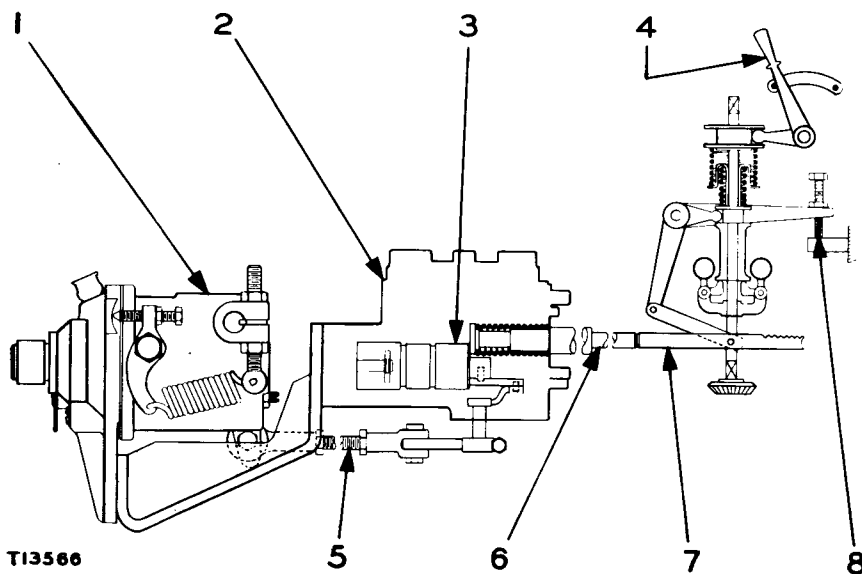
Basically the governor group consists of the output shaft governor (1) and the hydraulic servo mechanism (2).

The servo mechanism contains the valve and piston assembly (3) and the rack follower rod (6).

The governor is driven by the converter output shaft, through a flexible drive cable.

The governor is connected to the hydraulic servo mechanism by the link rod (5).

The link rod transfers the effort of the governor to the servo mechanism where the effort is multiplied, before being exerted against the engine fuel rack (7) by the rack follower rod (6).



T13566

OPERATION OF THE OUTPUT SHAFT GOVERNOR GROUP

1-Output shaft governor. 2-Hydraulic servo mechanism.
3-Valve and piston assembly. 4-Diesel engine governor control lever.
5-Link rod. 6-Rack follower rod.
7-Engine fuel rack. 8-Rack adjusting screw.

The servo mechanism is operated by engine oil pressure.

When the valve portion of the valve and piston assembly (3) moves, in response to the output shaft governor effort being exerted on the valve through the link rod, the piston portion of the assembly moves a corresponding distance in the same direction, but with considerably greater force.

This transfers the motion originating in the output shaft governor to the engine fuel rack (7) through the rack follower rod (6).

To illustrate how the output shaft governor actually operates, assume that the governor has been set to maintain a converter output shaft speed of a given RPM and the Diesel engine governor control lever (4) is moved to the full open position.

The effort of the output shaft governor (in opposition to the action of the Diesel engine governor) is transferred by the link rod (5) to the valve and piston assembly located in the hydraulic servo housing.

The motion causes the valve and piston to move forward. The piston contacts the follower rod forcing it in the same direction.

The follower rod contacts the end of the engine fuel rack (7), causing it to move toward the closed position, until only enough fuel is delivered to the engine to maintain the proper output shaft speed of the converter.

Assume now that a load is imposed on the output shaft, which causes the shaft speed to decrease. The effort being exerted by the output shaft governor will decrease correspondingly, to permit the valve and piston assembly (3) and the follower rod (6) to move toward the rear or to the left in the illustration.

The engine fuel rack is then able to move toward the open position the amount required to keep the output shaft turning the desired RPM.

In the event the load on the output shaft continues to increase, the RPM of the shaft will continue to decrease. This reduces the output shaft governor effort to the point where the valve and piston assembly (3) and the rack follower rod (6), are permitted to travel toward the rear of the servo housing until the follower rod no longer contracts the engine fuel rack.

When the follower rod reaches this position, the fuel rack movement becomes limited only by the Diesel engine rack adjusting screw (8), located within the Diesel engine governor housing.

When this condition exists, any additional loading of the output shaft will cause a further decrease in the output shaft RPM to a point below that which is desired, since there will be no further increase in fuel being delivered to the engine to overcome the additional loading of the output shaft.

ADJUSTING THE OUTPUT SHAFT GOVERNOR

The output shaft governor must be properly adjusted upon initial installation on an engine.

If an engine is equipped with an output shaft governor and the governor has been set for a given engine rack setting, then at a later time the rack is changed, it will be necessary to readjust the output governor to agree with the new rack setting.

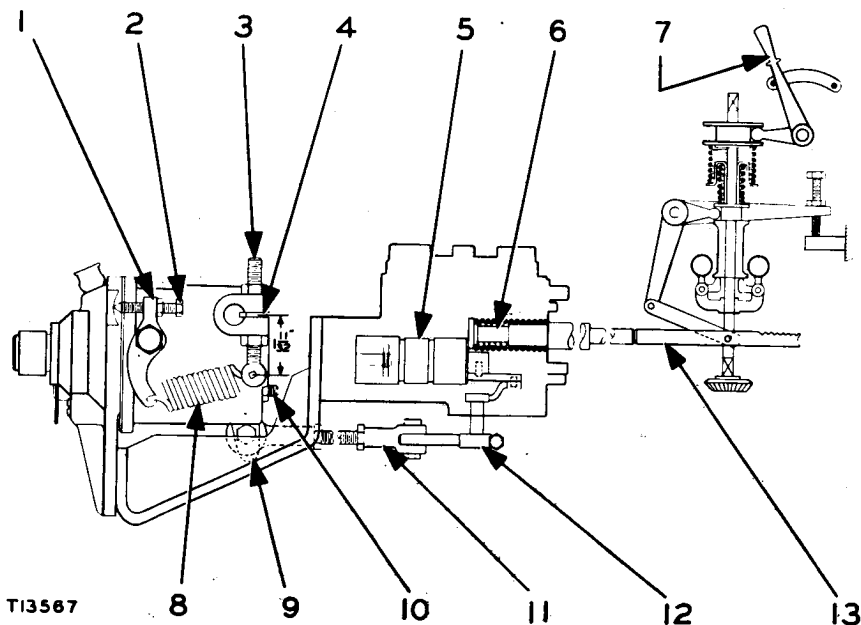
In the event the output governor is for some reason removed from one engine and installed on another, it may be necessary to readjust the governor, even though the rack setting of both engines is the same.

Adjusting a governor to the point where it is extremely sensitive will decrease the stability of the governor. Therefore, when making governor adjustments, an effort should be made to obtain the closest regulation possible without increasing the sensitivity to the point at which the governor action will no longer be stable.

It is possible through careful adjusting, to obtain a reasonably close regulation of the governor and still obtain stable but "snappy" response to output shaft load changes.

With the governor group installed on the engine, make the adjustments described in the Steps 1 through 10, before starting the engine.

1. Adjust the governor rate adjusting screw (3) to obtain a measurement of $1 \frac{11}{32}$ " between the center of the washer (4) and the center of the spring hole in the adjusting screw. See illustration.
2. By turning the output shaft speed adjusting screw (2) clockwise in the lever (1), place just enough tension on the spring (8) to hold the output governor weights in their closed position.
3. Back the bumper screw (10) out until approximately $\frac{3}{4}$ " of screw protrudes from the governor housing.
4. Connect the link rod (11) into the center hole of the servo lever (12). Do not connect the rod to the output governor lever (9) at this time.
5. Place the Diesel engine governor control lever (7) in the full open position.
6. Move the link rod (11) and the servo lever (12) which actuates the piston and valve assembly (5) toward the front of the engine, until contact is felt between the rack follower rod (6) and the engine fuel rack (13).
7. Hold the link rod and servo lever at this position with just enough force to keep contact between the rack follower rod and rack. Never apply enough force to start compression of the Diesel engine governor spring.



TI3567

ADJUSTING THE GOVERNOR

1-Lever. 2-Output shaft speed adjusting screw. 3-Governor rate adjusting screw. 4-Washer. 5-Piston and valve assembly. 6-Rack follower rod. 7-Governor control lever. 8-Spring. 9-Output governor lever. 10-Bumper screw. 11-Link rod. 12-Servo lever. 13-Fuel rack.

8. With the link rod and servo lever held forward to keep the rack follower rod in contact with the rack, adjust the link rod (11) until the hole in the end of the rod will be short of alignment with the hole in the output shaft governor lever (9), by 1/8" or approximately one-half hole. The lever (9) on a few early output shaft governors has three holes into which the link rod (11) can be connected. In this case, the rod adjustment should be made for the center hole in the lever.

This measurement is to be obtained without moving the lever (9). The 1/8" adjustment is very important, since it provides the proper clearance necessary between the rack follower rod and the engine fuel rack, to permit the rack to reach its full open position.

9. When the 1/8" adjustment has been obtained, connect the link rod to the lever (9).
10. Fill the output shaft governor to the proper level with S.A.E. No. 30 lubricating oil. The proper oil level can be checked by removing the small level plug located in the drive cable end of governor housing. When checking the oil level, do not lose the oil level plate which is held in place by the plug.
11. Start the engine and after a suitable warm up period, advance the Diesel engine governor control lever (7) to the full open position.
12. Adjust the output shaft speed adjusting screw (2) to obtain the desired output shaft high idle RPM.

NOTE

Turning the adjusting screw (2) in raises the shaft RPM and backing it out lowers the the RPM.

13. Remove any surging by turning the bumper screw (10) inward until the surging is eliminated. Never turn the bumper screw in enough to raise the output shaft high idle RPM established in Step No. 12. After all surge has been eliminated, it is advisable to recheck the output shaft RPM to determine if the bumper screw has possibly been turned in enough in the process of removing the surge, to raise the output shaft high idle RPM.

14. If it is found that the shaft RPM has been increased, back bumper screw (10) out again and lower the governor rate adjusting screw (3) a slight amount. Readjust the output shaft speed adjusting screw (2) to produce the proper converter output shaft high idle RPM. Turn the bumper screw (10) inward again to remove any surging. Repeat this procedure until all surging can be successfully removed with bumper screw (10), without increasing the high idle RPM of the converter output shaft.

NOTE

Lowering the governor rate adjusting screw (3) produces wider governor regulation and raising it will produce closer regulation.

The stability of the governor can be quickly checked as follows:

Operate the engine and converter with the governor control lever at the full open position without load.

Pull the output shaft governor lever (9) back and permit the engine speed to rise, then release the lever.

The governor should return the converter output shaft RPM to its proper value quickly without hunting or surging.

CATERPILLAR TRACTOR CO.

PEORIA, ILLINOIS, U.S.A.

Diesel Engines . . Tractors . . Motor Graders
. Earthmoving Equipment

THERE IS A "CATERPILLAR" DEALER NEAR YOU

use PMAK ECU in conv.

RECOMMENDED ENGINE SPEEDS - TORQUE CONVERTER DRIVE - 38-B MACHINE

<u>Engine Make & Model No.</u>	High Idle Speed	Stall Speed	No Load Gov. Speed
GENERAL MOTORS 6-71	2050	1880	1305
BUDA 6DA-779	2050	1805	1305
CATERPILLAR D-326	2050	1850	1242

Tolerance - High Idle +100 -0
Stall +0 -50

No load governed speed equals an equivalent drum shaft speed of 34.6 RPM with machinery turning over with no load and governor control hand lever in full open position.

High idle speed is maximum engine speed with master clutch disengaged and governor control hand lever in full open position. Check with tachometer.

Stall speed is maximum engine speed with out put shaft of converter stalled and governor control hand lever in full open position. Check with tachometer.

All speeds should be checked only after engine and machinery has been thoroughly warmed up. Operate machine for at least one hour before checking speeds.

CAUTION: When checking stall speed, watch converter oil temperature and avoid holding the converter at stall when the temperature of the oil reaches 300°F. If the temperature reaches 300°F allow the converter to cool by operating at the no load governed speed until temperature at the converter is down to about 225° before resuming stall speed check.

SPECIAL INSTRUCTIONS - TORQUE CONVERTERS

A. GENERAL DESCRIPTION AND FUNCTIONING OF CONVERTER

The torque converter is a hydraulic transmission with an infinitely variable ratio from zero speed up to the maximum output shaft speed as determined by the governor setting of the engine which drives the input shaft of the converter. The maximum output shaft speed is achieved only when the converter is carrying no load. Under these conditions the engine will be running at about 60% of its maximum speed. As soon as a load is placed on the output shaft it will slow down. This will cause the governor which is driven by the output shaft to act to increase fuel to the engine; thus increasing the engine speed and, consequently, the horsepower input to the converter. Thus the engine under the influence of the output shaft governor will constantly strive to maintain the output shaft speed at, or near, maximum until the engine reaches full load speed.

When the full load speed is reached the converter output shaft will have dropped about 100 RPM below the maximum output shaft speed and the engine will be running very close to its maximum speed. Further increase in load will not cause the engine speed to increase as the output shaft governor has already reached the end of its travel in the direction of increasing fuel to the engine. If the load continues to increase the output shaft will slow down and if the resistance of the load is great enough the output shaft will finally stall. When the stall point is reached, the engine speed will be from 50 to 100 RPM slower than it was at the so-called "full load" point and at the same time torque multiplication will have reached its maximum value.

As the load is decreased from the stall point the output shaft will begin to turn and if the load decreases to zero the chain of events previously described will occur in reverse order until the engine and converter stabilize at the no load speed.

The converter consists of an external housing, the lower portion of which forms an oil sump, a pump driven by the input shaft, a turbine connected to the output shaft and a reaction member which redirects the oil from the turbine back to the pump. Both the turbine and the reaction member are mounted concentrically with, and inside, the pump casing. A gear type circulating pump picks up oil from the sump and discharges into the converter pump casing keeping it full of oil when the converter is running. Oil discharged from the converter pump is circulated through an oil cooler mounted on the engine and returned to the converter sump. A filter is included in the circulating system.

As the input shaft is rotated by the engine the converter pump rotates with it and the oil from the converter pump impinges on the turbine blades. The kinetic energy of the oil striking the turbine blades causes the output shaft of the converter to rotate. Oil leaving the turbine strikes the blades of the reaction member and is redirected into the converter pump. The relative speed of the converter pump and the turbine determines the angle and velocity at which the oil leaving the turbine strikes the reaction blading. This, in turn, determines the amount of torque increase which takes place in the converter up to the point where the turbine and with it, the output shaft, is stalled. The stalling point is the point of maximum torque and no further increase can take place unless the so-called "stall speed" of the engine is increased.

The foregoing description is a simplification of the functioning of the converter. The hydro-kinetic principles upon which the converter depends for its successful operation are far too complex to be discussed here.

B. CONVERTER AND CLUTCH LUBRICATION

The converter itself requires no external lubrication as all moving parts within the converter housing are lubricated by the power transmitting oil. The gear type circulating pump supplies an excess of oil to the converter pump casing and this oil circulates through the bearings on which the input and output shafts rotate. The level of oil in the converter sump should be checked daily while the converter is running. Add oil as required to maintain the level to the full mark on the dipstick.

Any heavy duty engine oil of S.A.E. 10 viscosity and containing detergent and foam depressing additives is suitable for use in the converter. Oils conforming to U. S. Army specifications 2-104B or MIL 2104 are sold by every major oil company and any of these are suitable.

Change oil after every 1000 hours of operation. If at any time the oil color suddenly changes, this is due to severe overloads and heat and the oil should be drained immediately. All oil lines and the oil sump should be flushed thoroughly. In severe cases the converter should be taken apart and cleaned.

The following is the recommended procedure for changing the oil:

1. Remove drain at bottom of oil sump.
2. Remove converter housing inspection plate and take out the two 1/8 pipe plugs located in the converter pump cover. Rotate converter until one hole is at the bottom so that the oil will drain out.

3. Remove drain plugs at bottom of heat exchanger.
4. Reinstall all plugs.
5. Install a new oil filter cartridge.
6. Fill sump to full mark on dipstick. Start converter slowly and continue filling sump until oil remains at full mark.

The oil pressure should range between 35 and 45 pounds per square inch. Observe oil pressure every shift. The oil pressure regulating valve piston should be removed and cleaned once a week before starting up.

The normal temperature of the oil leaving the converter is 225 degrees. Temporary oil temperatures of 300 degrees may be encountered for a short period of time under very severe service conditions without damage to the unit.

Except under extreme hot weather conditions (90° to 100° F. for a month or more) do not use oil heavier than S.A.E. 10. In extreme hot weather S.A.E. 20 may be used. It should be understood that the power transmitting ability of the converter will not be increased and may, in fact, be reduced by the use of oil heavier than S.A.E. 20. Heavy oil will not circulate as fast in the converter and it is the velocity of the oil striking the blades of the turbine that transmits the power. If it was not necessary to provide lubrication for the working parts of the converter, water would be suitable as a power transmitting fluid.

The output shaft governor drive cable should be lubricated at least once a month. Proceed as follows:

1. Remove the shaft from the casing.
2. Coat the entire shaft lightly with a good grade of general purpose grease.
3. Reassemble shaft and casing and install on machine.
4. Never force grease into the casing with a grease gun or pressure lubricator.

If, at any time, the cable starts to squeal or gets uncomfortably hot to touch, the machine should be shut down and the cable lubricated in accordance with the above instructions.

The engine clutch requires grease lubrication by the operator. Machines equipped with Twin Disc clutches have only one fitting and that is located on the outside of the clutch housing. This fitting lubricates the clutch throw-out collar and should be serviced once a shift. Use general purpose grease and not over three strokes of the grease gun.

Machines equipped with Rockford clutches have a fitting on the outside of the housing which connects with the throw-out collar, similar to the Twin Disc clutch. This fitting should be serviced once a shift as described for the Twin Disc clutch. In addition, the Rockford clutch is provided with three fittings on the operating cam shafts. These fittings are reached through the hand hole which is provided for clutch adjustment. These fittings should be very sparingly lubricated about every five shifts. It is necessary to rotate the clutch to reach all three fittings.

Most machines equipped with torque converters have sealed clutch pilot bearings which require no lubrication other than repacking when and if the clutch is disassembled. On 71-B and 88-B machines, however, a grease fitting for the pilot bearing is located in the rim of the flywheel. This bearing should be lubricated with high temperature ball and roller bearing grease at 100 hr. intervals. Grease the bearing sparingly as over-lubrication can cause trouble due to grease on the clutch driving disc. It is necessary when greasing the pilot bearing on these machines to bar the engine over until the grease fitting lines up with the hole in the flywheel housing.

C. ADJUSTMENT OF MASTER CLUTCHES

Because of the slippage which takes place in the torque converter as an inherent characteristic of this type of drive, it is of the utmost importance that the engine clutch be watched and checked daily for correct adjustment. Failure to observe this precaution can result in burning out the master clutch before the operator realizes that it is the clutch rather than the converter that is slipping. On machines with direct hand set clutches, this danger is not so great because the operator can tell by the feel of the hand lever if the clutch needs adjusting. However, on air-controlled machines the air cylinder sets the clutch and the operator, when using the air valve, cannot tell if the clutch is in need of adjustment. For this reason air-controlled machines have a hand lever attached to the master clutch throw-out shaft at the engine and the operator should engage the clutch manually once a day to check it for adjustment.

If the clutch engages with relatively little effort, it should be adjusted until it requires a very definite tug to engage it over center. Do not wait for the clutch to start slipping before adjusting it.

To adjust the Rockford clutch proceed as follows:

1. Remove hand hole cover.
2. Bar engine over until the small locking plate which engages the notched locking ring can be reached.

3. Loosen the nut which holds the lock plate and slide the plate in until the plate is free of the notches in the locking ring.
4. Rotate the adjusting ring in a clockwise direction to tighten the clutch. Check clutch engagement after passing each notch and stop when the feel of the lever indicates the clutch is tight enough.
5. Push the lock plate into engagement with the lock ring and tighten the nut to hold the lock plate in position. Replace the hand hole cover.

To adjust the Twin Disc clutch proceed as follows:

1. Remove the hand hole cover.
2. Bar the engine over with the clutch engaged or turn the clutch while it is disengaged until the lock pin in the adjusting ring can be reached.
3. Pull out the spring loaded lock pin and rotate the adjusting ring clockwise until the pin indexes with the next hole. Advance the adjusting ring one hole at a time until the correct feel of the lever is obtained.
4. Replace the hand hole cover.

After adjusting either the Twin Disc or the Rockford clutch, check to make sure it does not drag when released. If the clutch drags, back off the adjustment one notch.

A pamphlet covering the torque converter governor is enclosed with these instructions. Refer to this pamphlet before attempting any adjustment of the governor. If the power of the machine is falling off, call in a competent engine serviceman who will have a tachometer with which to check the engine speeds on accordance with the tabulated high idle, stall and no load governed speeds shown on the following page. If adjustment of the governor will not restore the speed to normal in accordance with the tabulation, then trouble in the engine is indicated and possibly a tune-up or overhaul is needed.

Operator's Instructions

for

CATERPILLAR

REG. U.S. PAT. OFF.

D337 ENGINE D326 ENGINE

Serial Numbers	
D337	{ 22B1-up
	{ 23B1-up
	{ 24B1-up
D326	{ 25B1-up
	{ 26B1-up
	{ 27B1-up

CATERPILLAR TRACTOR CO.
PEORIA . ILLINOIS . U. S. A.

X-1469 FORM 30110-1

Avoid Accidents

Most accidents, whether they occur in the air, in industry, on the farm, at home, on the highways, or at sea, are caused by someone's failure to follow simple and fundamental safety rules or precautions. For this reason most accidents can be prevented by recognizing the real cause and doing something about it before the accident occurs.

Regardless of the care used in the design and construction of any type of equipment, there are many conditions that cannot be completely safe-guarded against without interfering with reasonable accessibility and efficient operation.

A careful operator is the best insurance against an accident.

The complete observance of one simple rule would prevent many thousands of serious injuries each year. That rule is: "Never attempt to clean, oil or adjust a machine while it is in motion."

Foreword

"Caterpillar" products are a combination of advanced engineering, skilled manufacturing, and the finest materials metallurgical science can select. Thousands of satisfying, economical working hours are built into each machine.

Whether or not the owner derives the maximum of service from his machine depends largely on the care exercised in its operation and maintenance. This book is written to give the operator essential information regarding the day-to-day operation, lubrication and adjustment of the machine. Careful adherence to these instructions will result in assured economy.

A great many "Caterpillar" owners depend upon their dealer for service other than the care and adjustments described in this book. This practice is recommended because "Caterpillar" dealers have stocks of genuine "Caterpillar" parts and are equipped with tools designed and built by "Caterpillar". Their servicemen are factory-trained and are kept closely informed by the factory regarding advanced methods of servicing "Caterpillar" products — thus, in all ways they are equipped to render the best of service.

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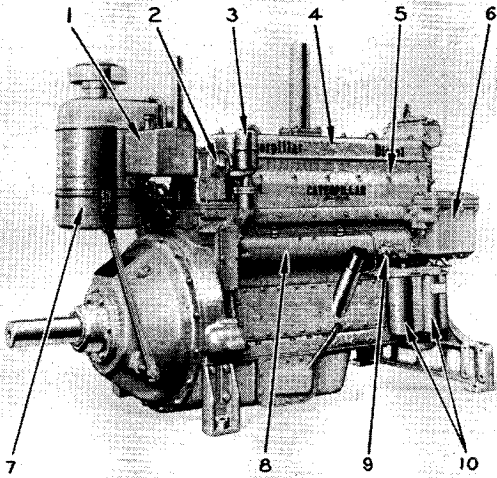
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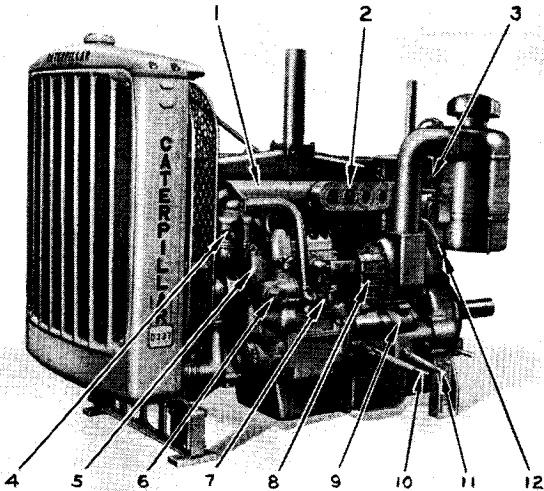
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T10501

D337 ENGINE—RIGHT REAR VIEW

1—Starting engine fuel tank. 2—Diesel engine governor. 3—Diesel engine crankcase breather. 4—Diesel engine valve cover. 5—Diesel engine camshaft housing cover. 6—Diesel fuel filter housing. 7—Diesel engine air cleaner. 8—Diesel engine camshaft housing. 9—Hour meter. 10—Diesel engine crankcase lubricating oil filter.



T10502

D337 ENGINE—LEFT FRONT VIEW

1—Diesel engine inlet manifold. 2—Instrument panel. 3—Governor control lever. 4—Starting engine air cleaner. 5—Starting engine magneto. 6—Starting engine starting crank gear housing. 7—Starting engine carburetor. 8—Diesel engine blower. 9—Starting engine electric starter. 10—Starting engine clutch control lever. 11—Starter pinion control lever. 12—Compression release control lever.

Introduction

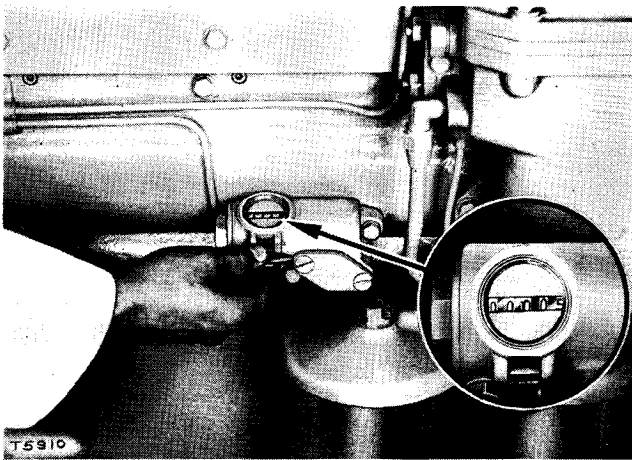
These instructions will cover Lubrication, Operation and Maintenance of the various available arrangements of two engines—the Diesel D337 engine and the Diesel D326 engine. The D337 engine is a 6 cylinder, 4 cycle, valve-in-head Diesel engine equipped with a gear driven blower which is mounted on the left side of the engine at the rear. The D326 engine is basically the same as the D337 engine but it is not equipped with a blower.

Lubrication Instructions

GENERAL LUBRICATION INFORMATION

Careful attention to the following information on lubricants and their proper selection will add much to performance, economy and long life of your engine. The lubrication chart specifies the lubricants to be used, the points to be serviced and the hourly intervals of servicing according to "Hour Meter" hours.

All time intervals in the lubrication chart and maintenance instructions are for "Hour Meter" hours, therefore, daily readings will tell when to service the engine. The "Hour Meter" is located on the right side of the engine near the back of the fuel filter housing. It does not keep pace with the clock but when the crankshaft turns as many revolutions as are made in an hour at normal operating speed, the dial advances one number.



COVER ON HOUR METER RAISED TO OBSERVE DIAL READING

Drain oil, check oil levels and refill compartments with the engine level. It is best to drain oil when it is warm, after the engine has run for some time. Then, most of the sediment will be in suspension, and therefore will readily drain.

Use the brush supplied in the tool equipment when removing dirt from fittings and cleaning around air cleaners, breathers, and inspection covers. Lubricate all miscellaneous points, not equipped with fittings, with crankcase lubricating oil every 60 hours.

Naturally, any precautions taken during cold weather to house the engine, cover it with a tarpaulin, or warm it before starting, will cause more rapid oil distribution and contribute to quicker starting. The engine should always be allowed to idle at approximately half engine speed for several minutes after starting to assure adequate lubrication before operating at normal load.

All oil companies have adopted the S.A.E. (Society of Automotive Engineers) viscosity number system which classifies crankcase lubricating oils and transmission oils in terms of viscosity or fluidity. The oils with the lower numbers are lighter, and flow more readily than do the oils with higher numbers. The S.A.E. number refers only to the viscosity of the oil, and has reference to no other characteristics or property.

The following topic recommends the types, viscosities and grades of lubricants best suited for use in your engine for various operating temperatures.

LUBRICANTS

Crankcase Lubricating Oil: (Abbreviated CO)

At temperatures above freezing, S.A.E. No. 30 oil should be used in all compartments.

At temperatures below freezing, S.A.E. No. 10W oil should be used to provide better lubrication at low temperature and also to make cranking easier. For a number of years S.A.E. No. 10 grade crankcase lubricating oil as classified by the Society of Automotive Engineers was recommended. A change in S.A.E. specifications for crankcase lubricating oil eliminates the S.A.E. No. 10 grade which is replaced by S.A.E. No. 10W grade.

S.A.E. No. 10W oil should be fluid enough for easy cranking at temperatures down to at least -10°F . Neither grade of oil used in this Diesel engine crankcase or air cleaners should be diluted, instead the oil and coolant should be warmed to provide fluidity in cold weather. See the topic, OPERATING IN COLD WEATHER.

For an approximate check to determine if the oil will flow, remove the oil level gauge and if the oil on it will flow off, the oil is fluid enough to properly circulate in the engine.

(CO) Superior Lubricants (Series 2): Only those lubricating oils known as Superior Lubricants (Series 2) for "Caterpillar" Diesel Engines should be used in the crankcase. These oils are recommended for meeting the operating requirements of the engine on both low and high sulphur

LUBRICATION CHART

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DIESEL D337 and D326 ENGINES

The folded page is arranged for two purposes:

First, it is a complete outline of all the information required to lubricate the engine.

Second, the illustration and identification of points of lubrication can be used with the detailed illustrations and information on the pages following the chart as a reference for lubrication and service information.

Key To Lubricants

CO Crankcase Lubricating Oil.

BR Ball and Roller Bearing Lubricant.

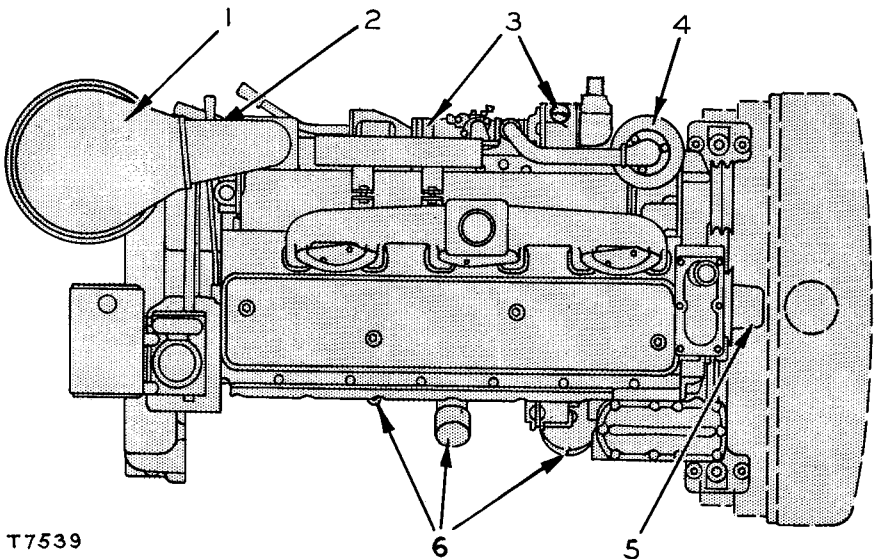
Lubrication Points Charted Under Hourly Intervals By Lubricants

INTERVALS	Every 10 HRS.	Every 60 HRS.	Every 120 HRS.	Every 240 HRS.	Every 900 HRS.
LUBRICANTS					
CO	1-3-6-7	1-4-6	2-3-6	1-3-4	2
BR				5	

Identification Of Points Of Lubrication And Lubricants To Apply

- | | | |
|----------|---------------------------------------|-----------|
| 1 | DIESEL ENGINE AIR CLEANER | CO |
| 2 | STARTER PINION HOUSING | CO |
| 3 | STARTING ENGINE CRANKCASE | CO |
| 4 | STARTING ENGINE AIR CLEANER | CO |
| 5 | FAN BEARINGS | BR |
| 6 | DIESEL ENGINE CRANKCASE | CO |

Location Of Points Of Lubrication



fuels. Consult your "Caterpillar" dealer for brand names of Superior Lubricants (Series 2) lubricating oils.

Change Periods: When the sulphur content of the fuel does not exceed 0.4%, oil change periods should be every 120 hours. When the sulphur content of the fuel is between 0.4% and 1.0% oil change periods should be reduced to every 60 hours.

NOTE

Detergent type oils that are recommended for use in "Caterpillar" Diesel Engines will, within a short period of operation, become much darker in color. This should not be any cause for concern. The darkening of the oil is due to minute particles of carbon, resulting from the combustion process, being held in suspension in the oil. This ability to hold carbon particles in suspension is one of the primary functions of a detergent type lubricant. Otherwise, these particles would settle out, eventually leading to objectionable deposits in the engine. When the oil darkens, therefore, it is an indication that it is keeping the engine clean and insuring satisfactory lubrication performance.

(CO) Straight Mineral Or Superior Lubricants (Series 2): In compartments other than the Diesel engine crankcase where crankcase lubricating oil is recommended, (such as starting engine crankcase, Diesel and starting engine air cleaners†) use either straight mineral crankcase lubricating oil or Superior Lubricants (Series 2) whichever is most convenient and economical.

Ball And Roller Bearing Lubricant: (Abbreviated BR).

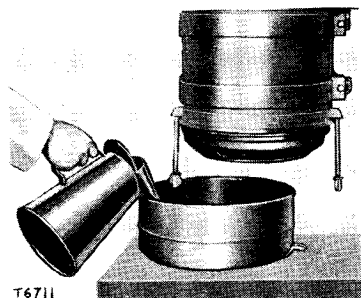
(BR) This lubricant is a mixture of mineral oil and metallic soaps. Use No. 2 grade for most temperatures. For extremely low temperatures use No. 0 or No. 1 grade.

This grease can be applied to all bearing points — plain bushings, ball bearings and roller bearings — where equipped with hydraulic pressure fittings or when bearings are hand packed.

Use only a high grade Ball and Roller Bearing Grease of short fiber. This grease must be satisfactory in anti-friction bearings at speeds up to 3000 RPM at a maximum temperature of 300° F. It is a grease with sufficient adhesive qualities to cling to the bearings in all extremes of high and low operating temperatures. Greases of this kind have been classified by grades by the N.L.G.I. (National Lubricating Grease Institute) designated in order of "worked" penetration or consistency.

†For air cleaners it is permissible to use clean, undiluted reclaimed oil or the most inexpensive mineral oil. Be sure to change oil in the air cleaners regularly.

CO CRANKCASE LUBRICATING OIL



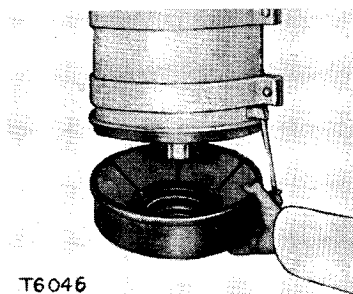
T6711

1

DIESEL ENGINE AIR CLEANER CUP

Inspect the oil in the air cleaner cup every 10 to 60 hours depending upon dust conditions. Wash and refill cup to oil level bead either when the oil will not flow freely, the sediment in the cup is $\frac{1}{2}$ inch deep, or every 60 hours, whichever occurs first. See the topic, "Air Cleaners."

Refill the cup with the same S.A.E. grade of oil as is used in the Diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil. See the topic, "Lubricants."

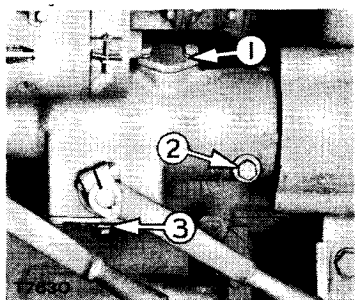


T6046

1

DIESEL ENGINE AIR CLEANER TRAY ASSEMBLY

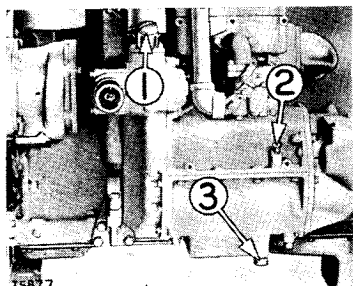
When the oil cup is removed for inspection, remove the air cleaner separable tray screens, inspect and wash them if dirty. Inspect the inside of the air cleaner inlet pipe and clean if necessary. Clean the inside of the air cleaner inlet pipe every 60 hours. See the topic, "Air Cleaners."



2

STARTER PINION HOUSING

Check oil level every 120 hours. Oil should be up to level plug opening at (2). Drain at (3), wash and refill housing at (1) every 900 hours.



T5877

3

STARTING ENGINE CRANKCASE

Check oil level every 10 hours. Oil should be up to full mark on gauge (2).

Every 120 to 240 hours, depending on dust conditions, drain at (3) and wash the crankcase. When draining be sure the engine is level so the oil in the starting engine clutch compartment will drain. Refill the crankcase at (1). Refill with 4 qts. of oil which will bring the level $1\frac{1}{2}$ inches above the full mark on the gauge. Start and run the engine at least one minute. Check the oil again with engine stopped. Oil should be up to full mark on gauge.

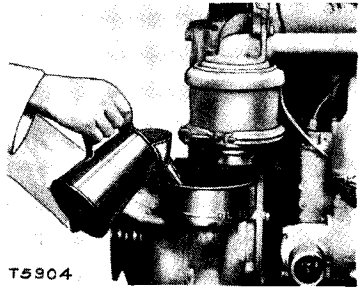
CO CRANKCASE LUBRICATING OIL

STARTING ENGINE AIR CLEANER

Inspect the oil in the air cleaner cup every 60 hours. Wash and refill cup to oil level bead when oil will not flow freely or if the sediment in the cup is $\frac{1}{4}$ inch deep. See the topic, "Air Cleaners".

4

Refill the cup with the same S.A.E. grade of oil as is used in the Diesel engine crankcase and the same type of oil may also be used. However, it is permissible to use clean, undiluted reclaimed oil or the most inexpensive straight mineral oil. See the topic, "Lubricants".

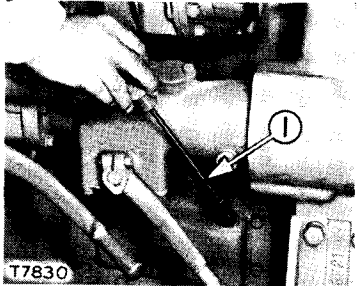


T5904

CHECK DIESEL ENGINE CRANKCASE OIL LEVEL

6

Every 10 hours check oil level with engine running. Oil should be up to full mark (1) on gauge. See the topic, "Crankcase Lubricating Oil."

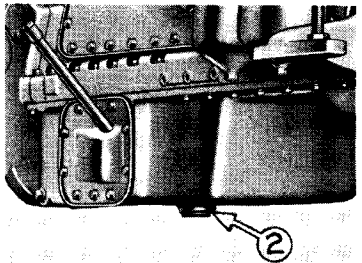


T7830

DRAIN DIESEL ENGINE CRANKCASE

6

Every 60 to 120 hours, depending on the sulphur content of the fuel, drain crankcase (2) (or at the drain plug in the right front corner of the crankcase) while the engine is hot. See the topic, "Crankcase Lubricating Oil"—Also see note A.

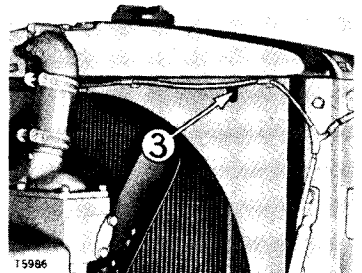


T12449

VENT DIESEL ENGINE CRANKCASE OIL COOLER

6

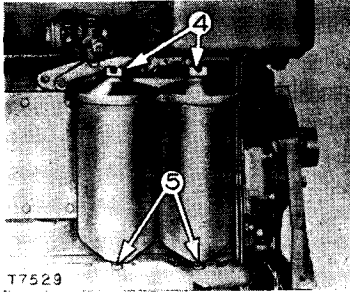
Open oil cooler vent valve (3) on engines equipped with an air cooled oil cooler so the oil will drain more rapidly from the oil cooler each time the crankcase is drained.



T5986

NOTE A: "Caterpillar" Diesel engines are built in a clean modern Diesel engine factory and each crankcase is filled with a good quality of new crankcase oil. For these reasons the initial crankcase oil change period for this engine can be at the usual 60 to 120 hour period depending on sulphur content of the fuel. See the topic, "Crankcase Lubricating Oil."

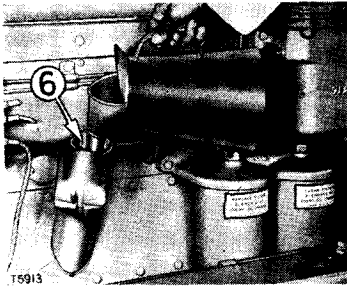
CO CRANKCASE LUBRICATING OIL



SERVICE DIESEL ENGINE CRANKCASE LUBRICATING OIL FILTER

6

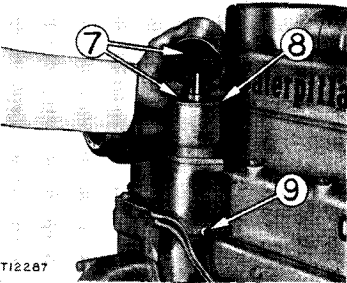
While oil is draining from crankcase, remove the filter drain plugs (5). Then remove the housing by unscrewing the nuts (4) on top of the housings. Wash the filter housings. Replace filter elements with new elements at each oil change.



FILL DIESEL ENGINE CRANKCASE

6

After draining crankcase, refill at (6) and start the Diesel engine. Run engine for two minutes then add oil to bring level to full mark on gauge.

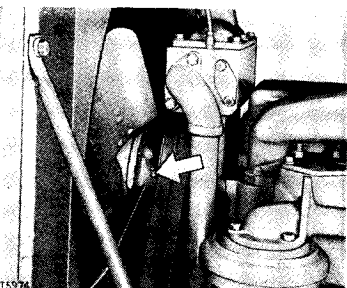


DIESEL ENGINE CRANKCASE BREATHER

6

Wash breather elements (7) each time crankcase oil is drained. Pour $\frac{1}{4}$ pint (0.12 liter) oil through element. On engines so equipped remove the drain plug (9) from the breather base at each oil change period to drain the accumulated oil. Pour slowly 1 pint (.5 liter) kerosene in breather element compartment (8) (not through the center opening) to wash dirt out. Install breather elements and drain plug.

BR BALL AND ROLLER BEARING LUBRICANT



FAN BEARINGS

5

Lubricate Fan Bearings every 240 hours.

Lubrication Of Attachments

The following list of identifying letters, names of attachments requiring lubrication, and type of lubricant required will help in lubrication of attachments. For further attachments information see page 53.

A.	WOODWARD GOVERNOR	CO
B.	TACHOMETER DRIVE	BR
C.	ENCLOSED CLUTCH SHAFT AND THROWOUT BEARINGS	BR
D.	ENCLOSED CLUTCH PILOT BEARING	BR

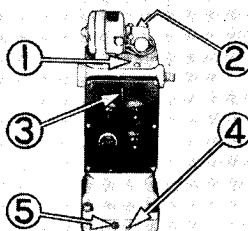
CO CRANKCASE LUBRICATING OIL

WOODWARD UG8 GOVERNOR

Check oil level every 10 hours. Oil level should be visible in gauge and up to the full mark (3). Replenish with STRAIGHT MINERAL lubricating oil at (2) to bring the oil level to full mark. Use the same viscosity oil as is recommended in the topic, "Crankcase Lubricating Oil," except in extremely hot weather use S.A.E. 50 oil.

A

Every 480 hours drain, wash and refill governor housing. To do this, remove drain plug (4) and needle valve plug (5). Unscrew the needle valve three turns and fill governor housing with clean kerosene or Diesel fuel. Run engine for thirty seconds then drain and refill with STRAIGHT MINERAL lubricating oil. Start the engine then screw the needle valve in three turns and install the needle valve plug (5).



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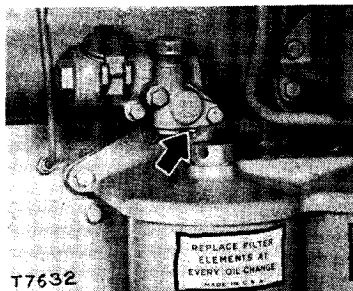
Every six months, regardless of hours operated, remove top cover (1) from governor and governor from engine then drain by turning the governor upside down. Fill and flush the governor with clean kerosene or Diesel Fuel. The friction cover may fall out, if loose, but no other governor parts will be dislocated by turning the governor upside down. Reinstall the governor and fill with STRAIGHT MINERAL lubricating oil. Replace the friction cover and top cover.

BR BALL AND ROLLER BEARING LUBRICANT

TACHOMETER DRIVE

B

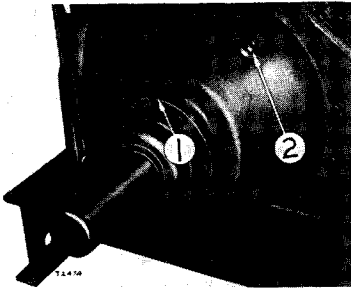
Remove pipe plug, insert $\frac{1}{8}$ inch hydraulic fitting and lubricate with one stroke of the grease gun every 900 hours. See Note B.



T7632

NOTE B: The number of strokes given in the detailed instructions are to be used with the lever type gun. When the push type gun is used, three times the number of strokes given in the detailed instructions should be applied.

BR BALL AND ROLLER BEARING LUBRICANT

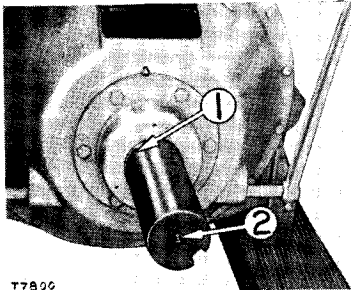


C

ENCLOSED CLUTCH SHAFT AND THROWOUT BEARINGS (Rockford Clutch)

Lubricate clutch throwout bearing at (2) every 10 hours with engine stopped.

Lubricate shaft bearing at (1) every 60 hours.



D

ENCLOSED CLUTCH PILOT BEARING (Rockford)

Lubricate clutch pilot bearing at (2) with one stroke of the grease gun every 20 hours of operation. See Note B.

When fitting at (2) can not be lubricated, remove pipe plug at (1) insert 1/8 inch hydraulic fitting and lubricate with one stroke of the grease gun every 20 hours. See Note B.

Operation Instructions

PREPARING THE ENGINE FOR USE

New Engine Initial Service: The first duty of anyone charged with the care and operation of an engine is to give it a detailed inspection, and to lubricate all parts as directed in the LUBRICATION INSTRUCTIONS section of this book.

Fill the Diesel fuel tank, taking care no dirt, water, or other foreign substances are admitted with the fuel. Give particular attention to the details of fuel handling as outlined under the topic, CARE OF THE FUEL SUPPLY. Fill the starting engine fuel tank with gasoline.

Fill the cooling system with clean soft water, or with the correct anti-freeze solution if temperatures below freezing are likely to be encountered. See the topic, COOLING SYSTEM.

New Engine Recheck: After the first thirty days of operation, tighten the Diesel engine inlet manifold, exhaust manifold, the starting engine cylinder head and the starting engine manifold assembly. Check the valve clearances and if necessary adjust them as described in the topic, VALVE CLEARANCE ADJUSTMENT.

New Operator's Responsibility: The operator who is given the responsibility of care and operation of an engine already in service, should first, check it for necessary lubrication, fuel supply and coolant in the radiator.

Second, the engine should have any necessary adjustments made to obtain satisfactory performance.

STARTING THE ENGINES

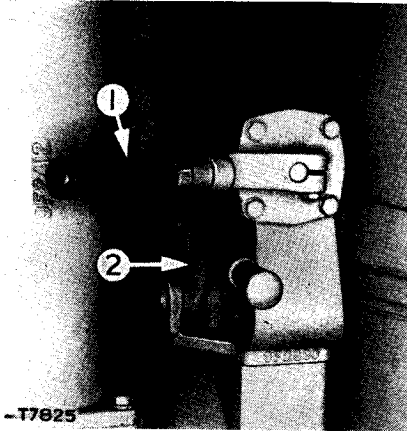
Starting Engine

Before attempting to start the starting engine check the Diesel engine controls as well as the starting engine controls to see that they are in the correct position for starting.

Position Controls For Starting:

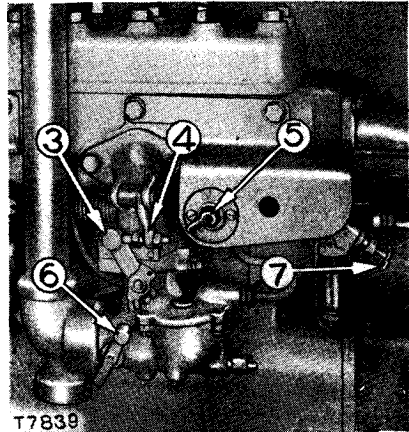
- 1—Check the crankcase oil level of the Diesel engine and the starting engine to be sure the oil is up to the full mark on the gauge.

- 2—Move the compression release control lever (2) to the START position.
- 3—Disengage the starting engine clutch by pushing down the clutch control lever.
- 4—Move the governor control lever (1) to the stop position to shut off the fuel injection pumps.



SETTING CONTROLS FOR STARTING

- 1—Governor control lever.
- 2—Compression release control lever.



STARTING ENGINE CONTROLS

- 3—Throttle control.
- 4—Idling latch.
- 5—Ignition switch.
- 6—Choke control.
- 7—Fuel valve control.

- 5—Open the starting engine fuel valve (7).
- 6—Move the starting engine choke control knob (6) (clockwise) to the ON position.
- 7—Move the idling latch (4) to hold the starting engine throttle control lever (3) in the idling position.
- 8—Turn ON the ignition switch (5).
- 9—Insert the crank in position and crank until the engine starts.

Do not spin the crank.

- 10—Move the choke control knob (6) (counter-clockwise) when the engine will run with the choke OFF. Temperature and altitude will vary the length of time it is necessary to have the choke ON. Actual experience in starting will determine this interval.

When the engine starts keep the speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.

Helpful suggestions for starting the starting engine in cold weather are in the topic, OPERATING IN COLD WEATHER.

Operating Starting Engine Electric Starter

Position Controls For Starting:

- 1. Check the crankcase oil level of the Diesel engine and the starting engine to be sure the oil is up to the full mark on the gauge.**
2. Move the compression release control lever **(2)** to the START position.
3. Disengage the starting engine clutch by pushing down the clutch control lever.
4. Move the governor control lever **(1)** to the stop position to shut off the fuel injection pumps.
5. Open the starting engine fuel valve **(7)**.
6. Move the starting engine choke control knob **(6)** (clockwise) to the ON position.
7. Move the idling latch **(4)** to hold the starting engine throttle control lever **(3)** in idling position.
8. Turn ON the ignition switch **(5)**.
9. Press the starting engine electric starter switch.
10. Move the choke control knob **(6)** (counter-clockwise) when the engine will run with the choke OFF. Temperature and altitude will vary the length of time it is necessary to have the choke ON. Actual experience in starting will determine this interval.

When the engine starts keep the speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.

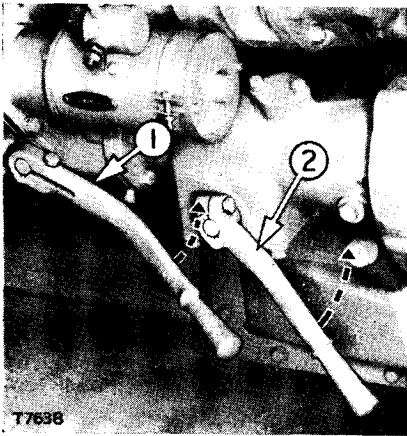
Helpful suggestions for starting the starting engine in cold weather are in the topic, OPERATING IN COLD WEATHER.

Diesel Engine

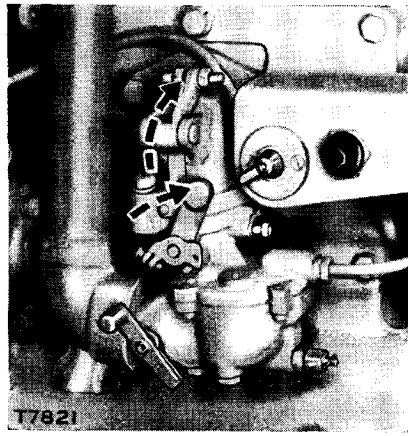
If equipped with oil pressure safety shut-off see the topic, OIL PRESSURE SHUT-OFF. If equipped with Woodward UG8 Governor see the topic, WOODWARD UG8 GOVERNOR OPERATION.

The following steps should be carefully followed to prevent damage to the starter pinion or flywheel ring gear.

1. Check to see that the starting engine clutch is disengaged.
2. Check to see that the starting engine is running at low idle speed.
3. Apply the starting engine clutch brake to stop the starter pinion from rotating, by pushing the clutch control lever (1) all the way down, and hold it in the brake applied position.
4. Engage the starter pinion with the flywheel ring gear by pulling up on the starter pinion control lever (2), then release the clutch brake



**STARTER PINION AND CLUTCH
CONTROL LEVERS**
1—Clutch lever. 2—Pinion lever.



**STARTING ENGINE THROTTLE AND
CHOKE CONTROL POSITIONS FOR
FULL GOVERNED SPEED**

and partially engage the clutch to be sure of full engagement of the starter pinion.

5. Release the throttle control idling latch to let the starting engine run at full governed speed.

- Engage the starting engine clutch by pulling the lever upward until it snaps over center. If the engine slows to the stalling point when the clutch is engaged, as it might in cold weather, disengage the clutch and let the engine pick up speed again.

**COMPRESSION RELEASE CONTROL
LEVER IN RUN POSITION**



- Move the compression release control lever to the RUN position when the starting engine is cranking the Diesel engine at normal cranking speed.
- Move the governor control lever to the half engine speed position.
- Disengage the starting engine clutch by pushing down on the control lever.
- Stop the starting engine by moving the idling latch to hold the starting engine throttle control lever in the idling position. Close the fuel valve control at the carburetor, allowing the engine to burn all the fuel in the carburetor. Then turn OFF the ignition switch.
- Allow the Diesel engine to idle 5 minutes with the governor control lever in half engine speed position before applying load.

The heat generated when the starting engine is cranking the Diesel engine against compression, and the circulation of the starting engine exhaust through the tube in the Diesel engine air inlet pipe warms the cylinders, pistons, and combustion chambers to the starting temperature.

Allow the starting engine to crank the Diesel engine against compression for a few minutes to add heat to the Diesel engine before starting it. Actual experience will determine the length of time necessary to crank

the Diesel engine to warm it sufficiently to assure easy starting. Altitude and temperature cause a variation in the length of time required to warm the engine before starting. In cold weather the cylinders and pre-combustion chambers must absorb more heat before reaching starting temperature than in warm weather. Even in warm weather some heat must be added by turning the engine against compression a few minutes before injecting fuel.

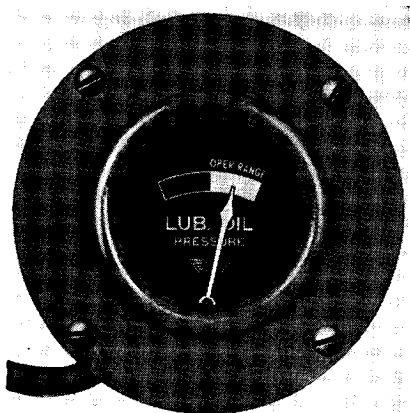
If the Diesel engine is thoroughly heated but does not start, see that everything is correctly set for starting. If smoke has been coming from the Diesel engine exhaust pipe, fuel has been reaching the cylinders. If no smoke is evident when the governor control lever is in the half engine speed position, check the fuel supply. If the Diesel fuel tank is empty, or if the valve was closed, it will be necessary to prime the fuel system as outlined under the topic, PRIMING THE FUEL SYSTEM. In case there may be water or dirt in the fuel system, or if the fuel injection equipment is suspected, see the topic, FUEL INJECTION EQUIPMENT.

When the Diesel engine begins to run, the starter pinion automatically disengages, but it is necessary to disengage the starting engine clutch.

Check the lubricating oil pressure gauge to see that it is registering pressure. When the engine is warm and running at rated engine speed the gauge should register at the high end of the "Operating Range." A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.

Check to see that there is proper circulation of coolant through the engine and water cooled oil cooler on engines so equipped.

The Diesel engine is designed to operate normally at a minimum water temperature of 170° F. (77° C.). This is controlled by a water temperature regulator in the engine outlet water passage.



**LUBRICATING OIL
PRESSURE GAUGE**



Using Diesel Engine Electric Starter: The Diesel engine electric starter can be used successfully in atmospheric or engine room temperatures of 50°F. (10°C.) or above without the use of the ether starting aid. It is not advisable to use the Diesel engine electric starter in temperatures below 50°F. (10°C.) without the use of the ether starting aid. See the topic, STARTING AIDS. Even when the starting aid is used in lower temperatures, it may be advisable to use crankcase lubricating oil of lower viscosity in the engine crankcase to reduce the cranking effort required. See the topic, LUBRICANTS.

The engine must be kept in the best mechanical condition possible, the batteries kept fully charged and all terminals kept clean and tight for satisfactory performance of the starting system in lower than atmospheric or room temperatures. In extremely cold temperatures the use of an engine room heater or cooling system auxiliary heater will make starting easier.

Normally, the compression release lever remains in the RUN position unless it is desired to turn the engine over for some purpose other than starting.

See that the flywheel clutch control lever is in the neutral position and that the governor control lever is at approximately half engine speed position.

Press the starter button to turn the Diesel engine against compression.

If the engine does not start within a few seconds, shut off the fuel supply by moving the governor control lever to the stop position for about ten seconds before returning it to its original position.

Do not run the starter for more than thirty seconds at a time. Then, allow two minutes intermission for cooling before using it again.

As soon as the engine starts, the starter button should be released.

If the starter pinion disengages for any reason before the engine starts, it will be necessary to repeat the starting operation.

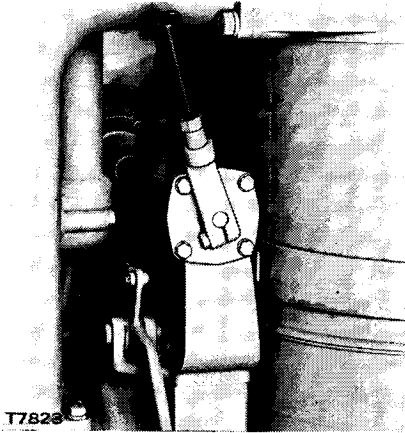
Check the lubricating oil pressure gauge to see that it is registering pressure. When the engine is warm and running at rated engine speed the gauge should register at the high end of the "Operating Range". A lower pressure reading is normal at low idling speeds. If no pressure is indicated, investigate at once.

Check to see that there is proper circulation of coolant through the engine and water cooled oil cooler on engines so equipped.

Allow the Diesel engine to idle 5 minutes with the governor control lever at about half engine speed position before applying the load.

STARTING THE LOAD

When the engine has run long enough to warm up, move the governor control lever to the full governed speed position to bring the engine to operating speed. Move the flywheel clutch lever forward slowly, and after the load has started, push the clutch lever firmly until it snaps over center.



**GOVERNOR CONTROL LEVER
IN FULL GOVERNED SPEED
POSITION**



STOPPING THE LOAD

For a temporary stop — that is, when it becomes necessary to stop transmitting power — disengage the flywheel clutch and move the governor control lever to reduce the engine speed.

STOPPING THE DIESEL ENGINE

After the normal load is removed from the engine, allow it to run at low idle speed a few minutes before stopping. To stop the engine, close the fuel injection pumps by moving the governor control lever to the stop position.

If the engine must stand without shelter, cover the exhaust pipes to exclude rain and snow.

If the temperature is below freezing or if freezing weather is expected before the engine will be started again, drain the cooling system or protect it with anti-freeze solution. See the topic, **COOLING SYSTEM**.

DAILY CARE

A daily check of the engine should be made to see if there are any loose nuts, bolts, capscrews, or parts worn to such an extent that they are no longer serviceable. Particular care should be taken to keep the inlet manifold tight to prevent leakage and possible damage to the engine through entrance of dirt. If corrective steps are taken immediately upon discovery of loose or worn parts, fewer enforced stops and more economical operation will result.

Dirt should not be allowed to accumulate on the engine. A few minutes spent daily in keeping it clean are well repaid in improved appearance, and greater ease and safety in operation and maintenance.

Check the cooling system each day, and if necessary, add water or anti-freeze solution.

The "Hour Meter" which is located on the right side of the engine, near the back of the fuel filter housing, should be read daily. From the daily readings, the lubricating time of all parts as directed under the topic, LUBRICATION CHART, can be determined. The "Hour Meter" readings should also be used in determining maintenance service periods.

Fill the Diesel fuel tank at the end of the day's run. See the topic, CARE OF THE DIESEL FUEL TANK for other periodic care.

When the Diesel engine is operating continuously, the starting engine should be run for a few minutes each day to dissipate condensation and renew the oil film on the bearing surfaces and cylinder walls.

OPERATING IN COLD WEATHER

If the electrical system, starting engine and the Diesel engine are all in good condition, and the precautions necessary for cold weather operation are taken, ordinary cold weather will not cause difficulty in starting or loss of efficiency.

Lubricants: As the atmospheric temperatures become lower, warm housing facilities should be made available. It is not recommended to dilute the crankcase lubricating oils with kerosene to provide fluidity but the oils should be kept fluid by keeping them warm. Fluid oils are necessary to properly lubricate gear trains, bearings, pistons, and cylinder walls when starting. See the topic, LUBRICANTS.

Coolant: When the temperature is below freezing, sufficient anti-freeze solution should be used in the cooling system to prevent freezing. See the topic, COOLING SYSTEM.

The liquid in the cooling system may be warmed to make starting easier and quicker. When warming anti-freeze solutions, keep away from flames, as some of these solutions may be inflammable. Avoid getting the solution hot, and even a warm solution should be poured very slowly into a cold cooling system to prevent damage by sudden expansion.

Fuel: Fuel must be "free flowing" enough to flow readily through the fuel lines at the lowest temperature at which the engine will be started and operated. For additional information on this subject, see the topic, FUELS.

Electrical Equipment: During cold weather, more attention should be given the condition of the battery. It should be tested frequently and charged as often as necessary to insure sufficient power for starting. All switches and connections in the electrical system should be inspected and kept in good condition to prevent losses through improper contacts.

Starting The Starting Engine: If the engine has been standing without shelter in extremely cold weather, the following suggestions will materially assist starting.

It is very important to keep low viscosity crankcase lubricating oil up to the full mark on the gauges in both the Diesel engine and starting engine to provide proper lubrication when starting. Refer to the topic, LUBRICANTS.

Crank the starting engine several revolutions with the ignition switch off, and the starting engine clutch disengaged. This will better distribute oil to the bearings and cylinder walls.

Sometimes moisture, or fuel which has not vaporized, collects on the starting engine spark plugs. They may be dried out by removing them and pouring gasoline over the electrodes. Ignite the gasoline and allow it to burn. **Use care to prevent fire.**

Pouring a small amount of gasoline on the electrodes before they are replaced in the engine is more effective in promoting combustion than priming the cylinders with gasoline. A small amount of gasoline in the cylinders will remove the film of oil from the cylinder walls and interfere with compression.

Sometimes the starting engine can be started more quickly by leaving the idling latch free of the throttle control lever. **When the engine starts lock the throttle control lever with the idling latch to keep the engine speed low until the crankcase lubricating oil has a chance to warm up and better lubricate the engine.**

STORAGE

Lubricate all points mentioned in the lubrication chart if the engine is to be stored or left standing for any length of time. This will protect against rusting.

Diesel Engine: If the engine is to be stored or left standing for a long period of time, the lubricating oil may drain away from the cylinder walls and piston rings. This lack of lubricant permits the rings and liners to rust. It also permits unnecessary wear caused by metal-to-metal contact between the pistons, rings and liners when the engine is started before fresh oil has reached these surfaces. The lack of lubricant may not cause any noticeable change in engine operation after it has been started but it does contribute to shorter engine life.

On the Diesel engine the film should be renewed by running the engine once a week until it is thoroughly warm. This will circulate the oil and prevent rusting from condensation.

Starting Engine: The oil film should be renewed in the starting engine by running the engine once a week until it is thoroughly warm. If it is not convenient to start the engine, remove the spark plugs once a month and pour $\frac{1}{8}$ pint (0.06 liter) of oil into each cylinder. Then spin the fly-wheel several revolutions and replace the spark plugs. Thereafter, turn the engine once a week between monthly oiling intervals to distribute the oil on the cylinder walls and pistons.

Battery: Periods of two weeks or more when the engine is not operated necessitates provisions being made to keep the battery charged. This may be done by running the engine once a week or taking the battery to your "Caterpillar" dealer for charging.

When replacing a battery that has been removed, make certain the correct battery post is connected to the ground cable. Failure to connect the battery terminal to the correct post will damage the voltage regulator. See the topic, WIRING DIAGRAMS.

Cooling System: If the temperature will be below freezing, the cooling system should be drained if it has not been serviced as indicated in the topic, COOLING SYSTEM.



Maintenance Instructions

The foregoing paragraphs have been devoted to instructions which are necessary for day-to-day operation of the engine. The following topics give detailed instructions regarding the care and adjustment of the various parts.

AIR CLEANERS

The air cleaners do their work efficiently only as long as the oil in the cups flows freely at operating temperature, so it will spray into the filter sections and wash back the dirt collecting there. For this reason, the air cleaners should be inspected frequently and serviced according to the following instructions.

Diesel Engine Air Cleaners: The air cleaner on a Diesel engine will clean and pass a greater volume of air in a day's run than the air cleaner on a spark ignition engine doing the same work under like conditions. Each Diesel cylinder draws in a full charge of air on every inlet stroke, regardless of the engine speed or the amount of work the engine is doing; whereas the total volume of air taken in by a spark ignition engine is regulated by the position of the throttle plate in the carburetor and changes with varying loads.

The interval between the oil changes and cleaning will vary with the weather and the working conditions. During the dry, dusty months, and on jobs where dust conditions are severe, it may be necessary to service the Diesel engine air cleaner very frequently, possibly every 10 hours. In damp weather, and on jobs where there is little or no dust, this operation may be necessary only once every 60 hours. However, dependence should not be placed in visible detection of the dust, or lack of dust, in the surrounding air as a basis for servicing the air cleaner. The oil in the air cleaner may become saturated with dust, due to its fineness, much more rapidly than in instances where dust is more apparent in the incoming air.

Accumulations of sediment in the oil cup indicate that the heavier particles of dust have been satisfactorily removed from the incoming air. Some fine particles of dust become suspended in the oil without leaving any noticeable sediment in the cup. The oil in the cleaner cup should be changed either when it will not flow freely at operating temperature, because of the fine dust particles in it, or when the accumulated sediment in the bottom of the cup is approximately $\frac{1}{2}$ inch deep or every 60 hours, whichever occurs first.

Inspect the Oil in the Diesel and Starting Engine Air Cleaner Cups: Every 10 to 60 hours, depending upon operating conditions, inspect the oil in the Diesel engine air cleaner cup. The air cleaner cup should be washed and refilled every 60 hours or when the oil in the cup will not flow freely at operating temperature, or if the sediment in the cup is $\frac{1}{2}$

inch deep ($\frac{1}{4}$ inch in a starting engine air cleaner), whichever occurs first. It may be necessary to inspect the oil in the starting engine air cleaner cup only every 60 hours.

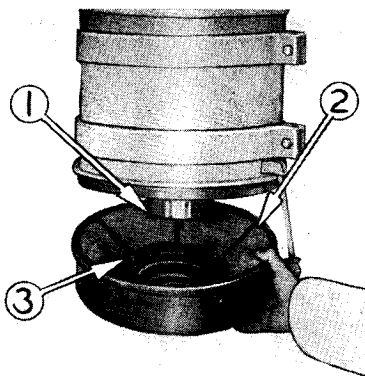
1. Loosen the wing nuts and take off the Diesel engine air cleaner cup.
 - a. On starting engine air cleaners the oil cup is removed by loosening the screw clamp.

Some thickening of the oil in the cup should be no cause for alarm, actually it can be considerably thicker than the S.A.E. grade that was last put in the cup, as long as the oil at operating temperatures will flow freely. For a check to determine if the oil will flow freely, dip into the oil with a finger and if the oil on it will flow off, the oil is fluid enough.

2. Service other parts of the air cleaner while the oil cup is removed, as indicated in the following topics.
3. When refilling the oil cup, care should be taken to see that both the inner and outer cups are filled to the oil level bead. In temperatures above freezing S.A.E. No. 30 oil should be used. In temperatures below freezing use S.A.E. No. 10W oil. Do not dilute S.A.E. No. 10W oil.
4. When replacing the oil cup, check to see that the seal between the air cleaner cup and body is in place and in good condition. This seal prevents oil running over the cup during hillside operation, and air leakage at this point can possibly upset proper air cleaner action.

Never attempt to change the oil in the air cleaner cup when the engine is running. This will cause dirty oil to be held in the filter section by intake action. The dirty oil held in the filter section will contaminate the fresh oil, and also cause an abnormally high oil level which may allow oil in the screens to be carried into the engine resulting in overspeeding.

Wash Air Cleaner Lower Filter Section: At every air cleaner cup service period, between 10 to 60 hours, depending on operating conditions, wash the separable tray screens.



REMOVING AIR CLEANER SEPARABLE TRAY

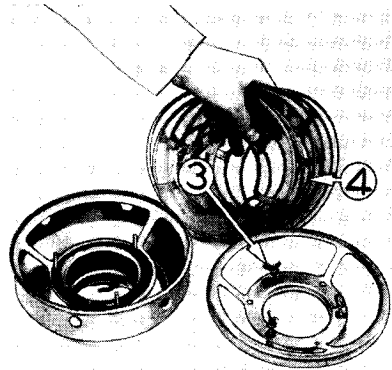
- 1—Wing nuts. 2—Separable tray.
3—Thumb screws.



1. Remove the separable tray (2) by loosening the wing nuts (1) that hold it in place.
2. Turn the separable tray slightly and slip it off the air inlet pipe.
3. Disassemble the separable tray by loosening the thumb screws (3) and lift out the screens (4) and lift out the screens.
4. Wash the separable tray screens with a brush in kerosene or some non-inflammable cleaning fluid.

**AIR CLEANER SEPARABLE TRAY
DISASSEMBLED**

3—Thumb screws. 4—Screens.



T7848

5. Assemble the separable tray by placing the screens (4) in the tray, and tightening the thumb screws.
6. Install the separable tray to the air inlet pipe.
7. Make sure all connections are tight and install the air cleaner cup.

Inspect the Inside of the Air Cleaner Inlet Pipe: Every 10 to 60 hours, depending on operating conditions, when the air cleaner cup is removed to clean the separable tray screens, inspect the inside of the air cleaner inlet pipe by reaching up from the bottom of the pipe. If heavy accumulations of dirt is noticed, clean the pipe.

Inspect the Air Cleaner Upper Filter Section: Inspect the bottom screen of the air cleaner upper filter section whenever chaff, lint, leaves or other such material shows up in the oil or in the separable tray. This material must be cleaned out to maintain proper air cleaner performance.

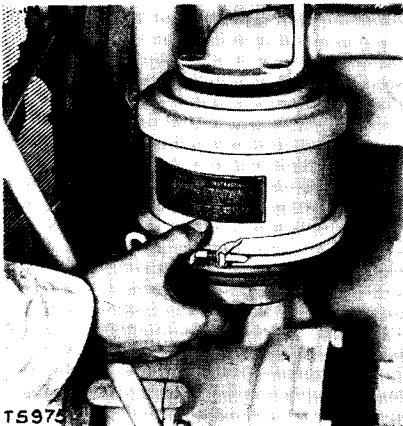
Wash the Entire Air Cleaner: At least once a year—more often in dusty conditions—wash the entire air cleaner.

1. The entire air cleaner should be removed from its support in order to thoroughly clean the upper filter section in the cleaner body.

2. Remove the oil cup and separable tray.
3. Immerse the entire cleaner in kerosene or some non-inflammable cleaning fluid. Steam cleaning is not recommended because some forms of dust rolls into small balls when steam is applied, and these balls cannot be washed out of the screens.
4. Wash the oil cup and separable tray as outlined in the preceding topics.
5. Dry the air cleaner parts thoroughly and reassemble them, making certain all connections are air tight.

Wash Starting Engine Air Cleaner: Twice a year wash the starting engine air cleaner.

1. Loosen the screw clamp and remove the oil cup.
2. Remove the cleaner body by taking out the capscrews at the top of the cleaner.
3. Wash the filter by shaking the air cleaner body in a pan of kerosene or some non-inflammable cleaning fluid.
4. Wash and refill the oil cup.

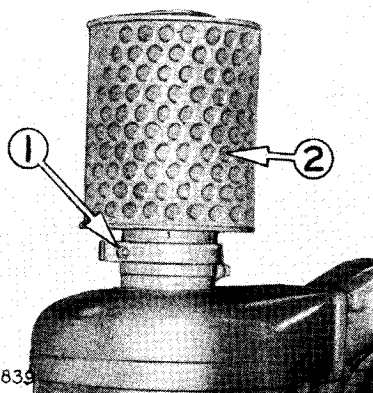


**REMOVING STARTING
ENGINE AIR CLEANER**



5. Assemble and install the air cleaner, but be sure the mating faces of the air cleaner and the cleaner pipe are clean, the gasket between them is in place and all connections are air tight.

Prescreener Care: Where the air contains objectionable foreign material, such as, cotton lint, small leaves or other particles the special prescreener should be used to prevent these materials entering the air cleaner. When the prescreener is used, inspect the screen (2) regularly



PRESCREENER

1—Clamp bolt. 2—Screen.



and when it is dirty remove by loosening the clamp bolt (1) which holds it in place. Clean the screen with a dry brush or wash it in water.

CRANKCASE LUBRICATING OIL SYSTEM

The crankcase lubricating oil flows from the oil pump, located in the crankcase, to the oil cooler where it is cooled; then flows to the oil filter base, through the filters and distributed to the bearings and all points of lubrication in the engine.

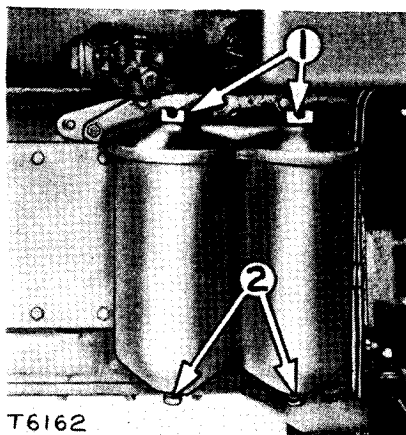
The oil is cleaned by a full flow filtering system incorporating four filter elements. These filters, located on the right front side of the engine below the fuel filter housing, are installed in the main pressure line so that the entire pump capacity is put through these units.

Servicing the crankcase lubricating oil filters as described, should be performed each time the lubricating oil is drained.

Crankcase Lubricating Oil Filters: While the oil is draining from the crankcase and oil cooler, remove the drain plugs (2) from the oil filter

CRANKCASE LUBRICATING OIL FILTER SERVICING

1—Retaining nuts.
2—Drain plugs.



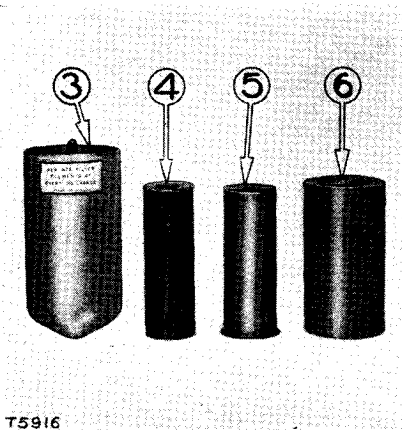
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housings. Loosen the retainer nuts (1) and remove the filter housings. Remove the filter elements and discard them.

If there is excessive sludge in the bottom of the housings, remove the snap ring from the center post and remove the bottom retainer and spring. After cleaning the housings, replace the spring, retainer and snap ring. Both filter elements in each housing should be replaced with new "Caterpillar" elements at each oil change period.

Installing The Filter Elements: It is possible to install the filter housings even if the filter elements and separator are incorrectly assembled. For this reason, care should be exercised to be sure the filter elements and separator are correctly installed in the housings (3) as mentioned in the following paragraph.

Assemble the new filter elements by first installing the inner element (4) in the housing. Install the separator (5) and press it firmly down over the inner element. Install the outer element (6) over the separator. Lift the



**CRANKCASE LUBRICATING
OIL FILTER ELEMENTS**

3—Housing. 4—Inner element. 5—Sepa-
rator. 6—Outer element.



housing into position on the base assembly and tighten with the retainer nut. As the retainer nut is tightened the top and bottom ends of the elements are pressed against the adapter cup and separator to seal the dirty oil from the filtered oil. Install the drain plugs.

Wash The Suction Bell Screen: If sludge is noticeable when draining the crankcase, the oil pump suction bell screen should be removed and cleaned. The suction bell can be removed after removing both side plates from the oil pan. Remove the capscrews which hold the bell to the pump case. The bell can now be removed from the crankcase pan through the left opening. Remove the capscrews which hold the cover and screen in position on the bell and wash the screen in kerosene or non-inflammable cleaning fluid.

When installing the bell be sure the spring and gasket are in their correct position between the pump case and bell.

FUELS

As a source of power the Diesel engine has two outstanding advantages over the gasoline engine. The first is its lower rate of fuel consumption — the second its ability to use cheaper fuels. Customers should always buy the **lowest priced fuel giving satisfactory operation.**

Your "Caterpillar" dealer is familiar with fuels that are giving good results in "Caterpillar" Diesel Engines in his territory. If necessary, consult him for his recommendations. He will be glad to advise you.

Because of the lack of world-wide standardization of Diesel fuel classifications, it is not possible to make specific recommendations for export territories. For best results see your "Caterpillar" dealer for brand names of satisfactory fuels in your particular area.

In the United States and Canada Diesel fuels are available under two general classifications. One is "premium" fuel and the other is "domestic furnace oil."

"Caterpillar" Diesel Engines are designed to operate on the less expensive domestic furnace oils. For a number of years No. 3 domestic furnace oil as classified by the American Society for Testing Materials was recommended. A change in furnace oil specifications eliminates the No. 3 grade which is now described as No. 2 grade. Fuels falling within this general class are widely available, give satisfactory results and cost considerably less than "premium" fuels.

During recent years because of the tremendous demand for petroleum products, there has been appreciable variation in the composition of fuels furnished under the domestic furnace oil classification. Some of these fuels, while not affecting ease of starting, rate of fuel consumption and horsepower output, have increased the wear rate of piston rings and cylinder liners many times, or ring sticking may become a factor in controlling engine life. Usually this has been due to the higher sulphur content of the fuel.

As the sulphur content of the fuel increases above 0.4 per cent, the oil change periods should be reduced as indicated in the topic, CRANK-CASE LUBRICATING OIL.

In subzero ($-18^{\circ}\text{C}.$) weather, where warm storage is not provided, fuels with unusually low pour points may be required. It is necessary that it be fluid enough to flow from the Diesel fuel tank to the engine transfer pump at the lowest temperature at which the engine must start and operate.

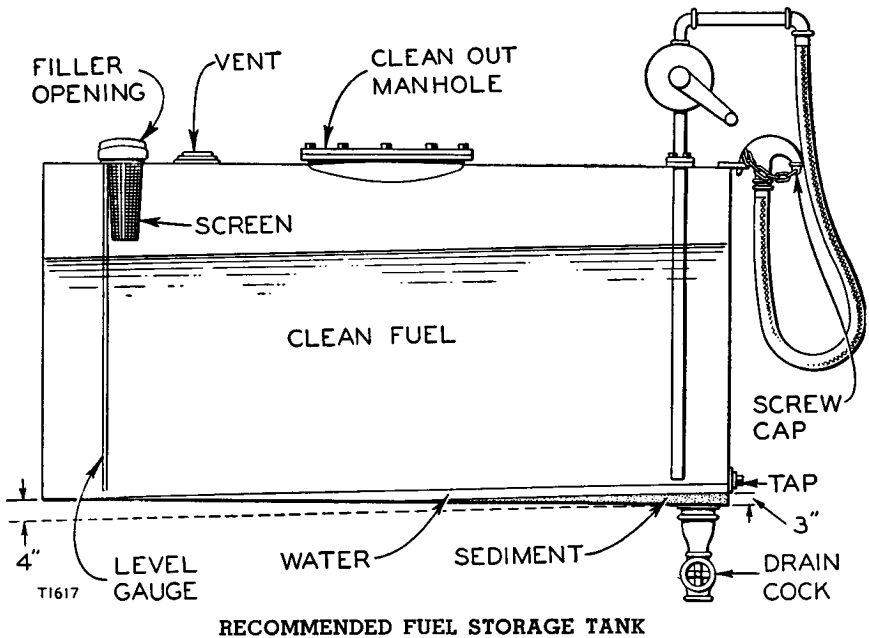
CARE OF THE FUEL SUPPLY

Keep The Fuel Clean: Too much emphasis cannot be placed on the importance of using only clean Diesel fuel. In selecting a fuel, it should be pointed out that distillates are especially desirable because, in refin-

ing, they are heated to a vaporous state and condensed in another container; thus, all the sediment and residue remain in the still.

It is important to buy clean fuel, and keep it clean. The best fuel can be rendered unsatisfactory by inadequate storage facilities or careless handling. The clearance between the fuel injection pump plunger and the barrel is very small, actually less than .0001 inch (0.00254 Mm.), which makes it evident that the invisible particles of dirt which might pass through the filters can damage these finely finished parts.

Effort should be constantly expended to prevent contamination of the fuel. An important step is to reduce the number of times the fuel must be handled. When the fuel can be delivered by the distributor to storage tanks and then pumped from the storage tank to the engine tank, the handling is reduced to a minimum.



The illustration of a fuel storage tank is a typical, satisfactory installation. Since natural settling is an effective method of cleaning Diesel fuel, the fuel should be allowed to stand at least 24 hours in the storage tank after it has been filled before fuel is transferred to the Diesel fuel tank. Be sure to drain all water and sediment that has settled to the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

The use of cans, funnels and drums should be discouraged since it is practically impossible to keep this equipment absolutely clean. If drums must be used, they should be allowed to stand for at least 24 hours before drawing off fuel. A pump installation similar to that shown with the storage tank should be used. The drum should stand on end and the inlet for the pump be kept several inches above the bottom to prevent stirring up the sediment that settles to the bottom.

Whatever method is used, see that only clean fuel enters the Diesel fuel tank.

CARE OF THE DIESEL FUEL TANK

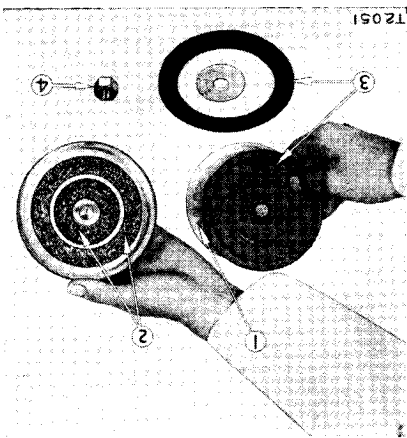
Fill the Diesel fuel tank at the end of the day, because the incoming fuel will drive out the moisture-laden air and prevent condensation.

Diesel Fuel Tank: The fuel level in the Diesel fuel tank may be checked with the plunger gauge in the filler opening.

Every 120 hours, before starting the engine, loosen the drain plug under the Diesel fuel tank and drain off any water which may have accumulated. The strainer in the fuel tank filler opening should be removed and cleaned regularly. Remove the snap ring and lift out the strainer.

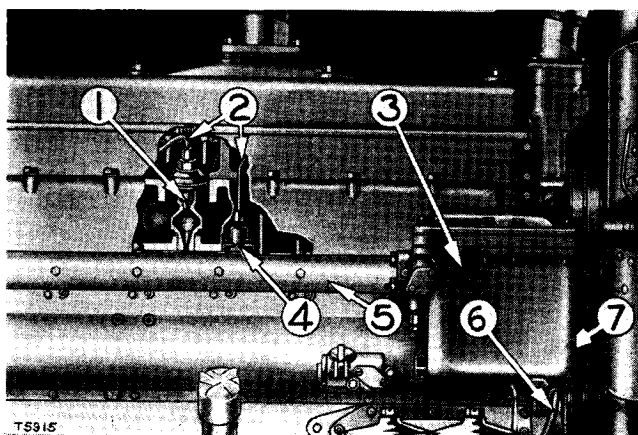
Diesel Fuel Tank Filler Cap: The Diesel fuel tank filler cap elements (2) should be washed every 60 to 240 hours depending upon the amount of dust in the air. To do this, remove the nut (4) from the stud and take out the bottle plate (1) and gaskets (3). Wash the cap and elements in kerosene or some non-inflammatory cleaning fluid. After the cap is washed, pour a small amount of crankcase lubricating oil on the filter elements.

FUEL TANK FILER CAP
 1—Plate, 2—Elements,
 3—Gaskets, 4—Nut.



FUEL SYSTEM

The fuel flows from the Diesel fuel tank through the fuel line (6) to the fuel transfer pump (7). The fuel transfer pump supplies the fuel under pressure to the fuel filter housing (3), the filters remove the dirt and other foreign particles. From here the fuel is supplied to the fuel manifold (5) for the individual fuel injection pumps (4). The fuel injection pumps meter and force the fuel through the fuel injection lines (2) and the fuel injection valves (1) in the cylinder head, into the pre-combustion chamber where it is ignited and passed into the main combustion chamber or cylinder.

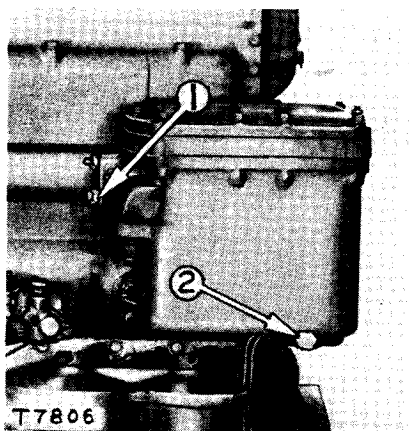


FUEL SYSTEM

1—Fuel injection valve. 2—Fuel injection line. 3—Fuel filter housing. 4—Fuel injection pump. 5—Fuel manifold. 6—Fuel line. 7—Fuel transfer pump.

CARE OF THE FUEL FILTER

Draining Fuel Filter Housing: Every 60 hours, drain the filter housing of sediment and water which settles to the bottom of the compartment. Remove the filter housing drain plug (2) and open the filtered fuel section



DRAIN FUEL FILTER HOUSING

1—Filtered fuel section vent valve.
2—Drain plug.



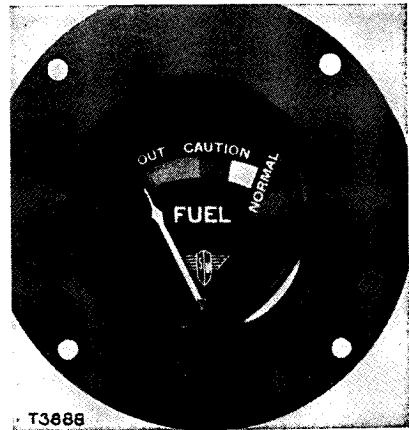
vent valve **(1)** in the housing. The filtered fuel section vent valve is connected to the filter cover with drilled passages. Replace the drain plug, and prime the system. See the topic, PRIMING THE FUEL SYSTEM.

Fuel Filter Elements: When the absorbent filter elements have collected enough contamination to interfere with free flow of fuel, they must be replaced with new elements. These elements will continue to absorb particles until fuel will no longer flow through them at a rate to maintain maximum engine performance. They will not discharge their burden into the clean fuel; this is prevented by the fine grade filter paper at the core.

Because these filter elements absorb and hold contaminants, they cannot be washed or otherwise restored.

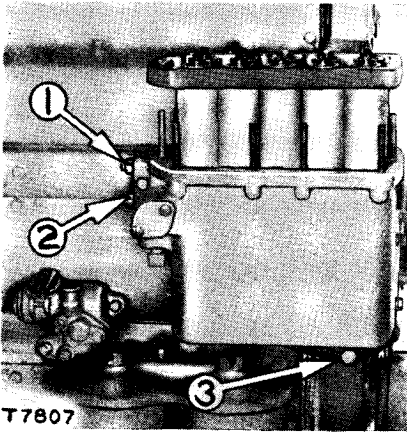
As the filters gradually become clogged with foreign material, the position of the fuel gauge indicator will work back from the original position in the NORMAL (white) range, to the CAUTION (green) range, and later into the OUT (red) range. When the indicator shows in the OUT (red) range the filters should be changed and all new filter elements installed — never only one.

FUEL PRESSURE GAUGE



Removing Used Filter Elements: Thoroughly clean the top of the filter cover and around the edges of the gasket joint between the filter housing and cover to guard against loose dirt dropping into the filter housing when the cover is removed. Remove the filter housing drain plug **(3)** and open the filtered fuel section vent valve **(2)**. The fuel injection pump vent valve **(1)** is the upper vent and vents the fuel injection pumps.

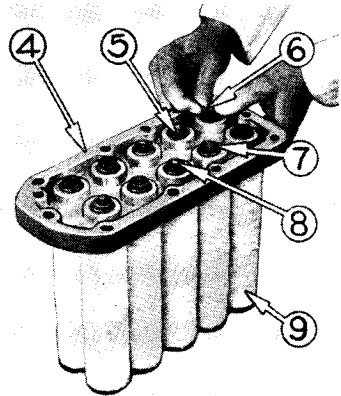
Remove the cover, and lift the assembly of filter element plate and all filter elements out of the housing.



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REMOVING FUEL FILTER ASSEMBLY

- 1—Fuel injection pump vent valve.
2—Filtered fuel section vent valve. 3—Drain plug.



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REMOVING FILTER ELEMENT

- 4—Filter element plate. 5—Spring. 6—Pin.
7—Retainer. 8—Retainer rods.
9—Element.

To remove the used filter elements, set the assembly on a flat surface and compress each spring (5) until the retainer (7) will permit removal of the pin (6). Lift off the filter element plate (4) and remove the elements (9) from the retainer rods (8).

Attaching New Filter Elements To Filter Element Plate: Thoroughly wash the plate, retainer rods, retainers, pins and springs in clean kerosene, Diesel fuel or a non-inflammable cleaning fluid. Make sure that the hands are clean before attempting to install the new parts. Place the retainer rods into each new filter element and attach to the plate individually by compressing the spring and inserting the pin so it is held securely in the counterbore of the retainer. Grasp each element at the bottom end and give it approximately a half turn under light pressure to seat the ends of the element against the plate and against the disc on the bottom of the retainer rod. Keep the elements parallel and square with the bottom plate while performing this operation.

Installing Filter Elements In Housing: Before installing the elements in the housing, flush out the housing with clean fuel and replace the drain plug. Install the new plate gaskets supplied with each set of elements.

Exercise extreme care to see that the top side of the retainer plate, retainer assembly, and the inside of the housing cover are clean. These parts are on the clean side of the elements and if dirt is not completely removed, it will find its way into the fuel injection equipment. Replace the cover and follow the instructions for PRIMING THE FUEL SYSTEM.

Keep New Filter Elements On Hand: An extra set of filter elements should be kept on hand for replacement. Always keep the elements wrapped in their original cartons to insure against dust and dirt accumulation which will shorten the life of the elements if it gets on the outside

or may cause damage to the fuel injection equipment if it gets on the inside.

PRIMING THE FUEL SYSTEM

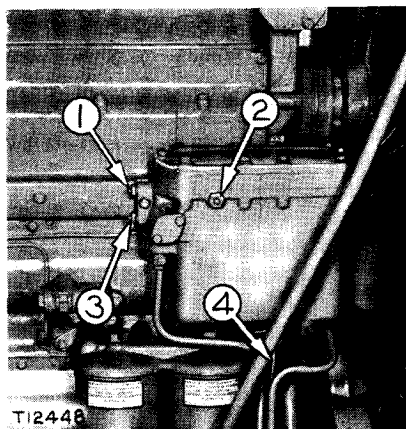
Any time the fuel flow is broken and air is allowed to get into the fuel system, the fuel system must be primed. If air is left in the lines, the fuel system may become air bound, resulting in inability to start the Diesel engine or the misfiring of one or more cylinders.

Priming When Equipped With Gasoline Starting Engine: Priming the fuel system will allow the fuel transfer pump to force air and fuel through the fuel filters and the fuel injection pump vents if the engine is level. Prime the system as follows:

1. Close all the vent valves.
2. Check to see that the Diesel fuel tank valve is open.
3. Move the governor control lever to the stop position so the fuel injection pumps are closed.
4. Move the compression release lever to the START position.
5. Start the starting engine, engage the starter pinion and the starting engine clutch. Allow the starting engine to crank the Diesel engine at starting engine low idle speed.
6. On later engines open the unfiltered fuel section vent valve (2). When the flow of fuel is continuous and contains no air bubbles, close the vent valve. Earlier engines have no vent at this point.
7. Open the filtered fuel section vent valve (3). When the flow of fuel from fuel vent dRAINTUBE (4) is continuous and contains no air bubbles, close the vent valve.
8. Open the fuel injection pump vent valve (1). When the flow of fuel from the fuel vent drain tube (4) is continuous and contains no air bubbles, close the vent valve. Open and close the fuel injection pump vent valve several times in succession to be sure all air is bled from the system.

FUEL SYSTEM VENTS

- 1—Fuel injection pump vent valve.
- 2—Unfiltered fuel section vent valve.
- 3—Filtered fuel section vent valve.
- 4—Fuel vent drain tube.



Priming With Diesel Engine Electric Starter: Check to see that the Diesel fuel line valve is open, and open the fuel filter vent valves. Then loosen the knurled top of the fuel priming pump. Operate the fuel priming pump until fuel flows from the fuel vent drain tube. Close the fuel filter vents and open the fuel injection pump vent. Continue to operate the fuel priming pump until the flow of fuel through the fuel vent drain tube becomes continuous and contains no air bubbles; then close the vent. Open and close the fuel injection pump vent valve several times in succession to be sure all of the air is bled from the system.

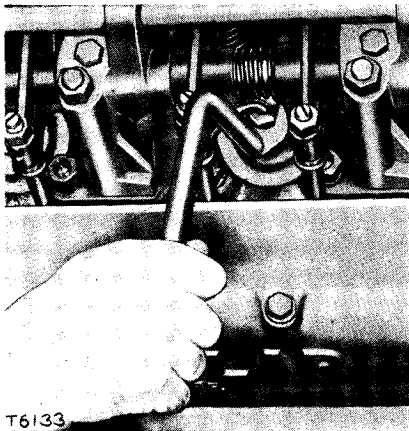
Tighten the knurled top of the fuel priming pump to its original position.

FUEL INJECTION EQUIPMENT

When improper fuel injection is affecting the Diesel engine operation, a systematic check should be made to determine the cause. The most likely cause is dirt or water in the fuel. Drain the sediment from the Diesel fuel tank and drain the fuel filter housing. Check the fuel pressure gauge as mentioned in the topic, CARE OF THE FUEL FILTER. Replace the filters if necessary. Then prime the fuel system until clean fuel passes out the fuel vent overflow line. If the fuel system is air bound, priming the system will overcome this difficulty.

Fuel Injection Valves

Testing Fuel Injection Valves: Whenever an engine performs in such a manner that a fuel injection valve is suspected of causing trouble, test the fuel injection valves. To test the injection valves remove the rocker arm cover and loosen the fuel injection line nuts at the fuel injection valves, one at a time, while the engine is running. When a nut is loosened and the exhaust smoking is completely or partially eliminated and the irregularity in running is not affected, this identifies the defective valve and a new one should be installed in that cylinder. **When testing fuel injection valves, as mentioned above, fuel will enter the crankcase and for this reason the test should be completed as quickly as possible.**

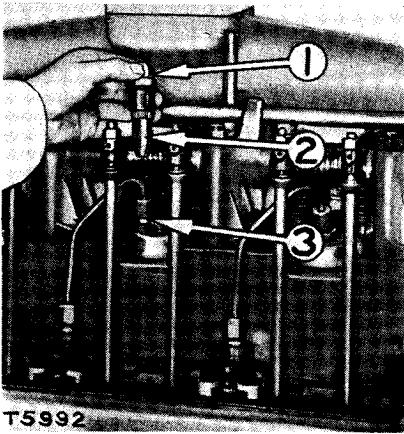


LOOSEN FUEL LINE NUTS
TO TEST VALVES



Removing Fuel Injection Valves: Before removing a valve, clean the wrench to prevent any dirt being deposited in or around the valve and being carried into the crankcase.

Disconnect the fuel injection line nut from the injection valve and loosen the nut on the pump. Immediately install plug (3) and cover (1) to prevent the dirt entering the fuel passages. Remove the valve retainer nut and lift out the nozzle assembly (2) and body as a unit.



REMOVING FUEL INJECTION VALVE
(Camshaft housing cover removed for illustration purposes only)

1—Cover. 2—Fuel injection valve nozzle assembly. 3—Fuel line plug.

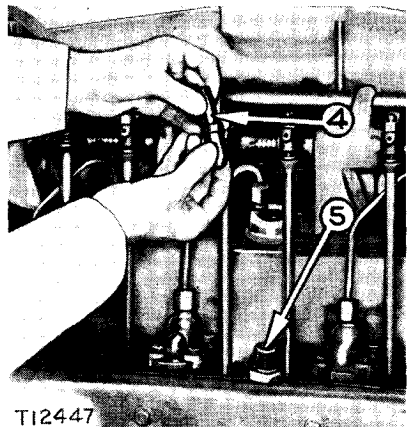


Installing Fuel Injection Valves: Before installation of a fuel injection valve, be sure the wrench is clean as any dirt dropped around the valve can easily get into the crankcase. Put the dust cover on the valve body as soon as possible to prevent dirt entering the fuel passage. Install the fuel injection valve in the following manner:

1. Screw the valve body (4) into the fuel injection valve nozzle assembly only finger tight. The threads of the body and nozzle assembly are made to fit loosely. The clearance between the threads provides a passage for fuel to enter the nozzle assembly from the body.

INSTALLING FUEL INJECTION VALVE
(Camshaft housing cover removed for illustration purposes only)

4—Fuel injection valve body.
5—Retainer nut.



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2. Insert the nozzle assembly and valve body as a unit into the pre-combustion chamber opening. Turning the body in a clockwise direction and at the same time pressing down will assure alignment of the serrations.
3. Tighten the retainer nut (5) good and tight to prevent leaks between the nozzle assembly and the nozzle assembly seats. For proper installation of the valve use one of the following three methods.
 - a. Tighten with a torque wrench to 100 pounds feet.
 - b. Tighten good and tight with a steady pull using the special wrench supplied in the tool equipment or a wrench with a 12 to 14 inch handle. If a standard wrench is used it must be shaped for clearance—otherwise rocker arms must first be removed to permit access to the nut.
 - c. Tighten the nut $\frac{1}{4}$ turn beyond noticeable metal to metal contact with the valve body when a new valve is installed or $\frac{1}{8}$ turn if a used valve is installed.
4. Connect the fuel injection line and tighten the nuts.

Fuel Injection Pumps

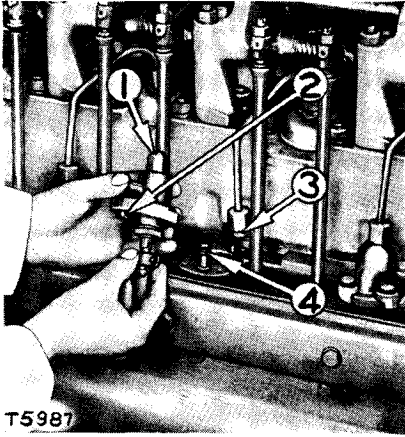
Testing Fuel Injection Pumps: It is not usual for one pump on an engine to require replacement unless all the pumps are worn. Worn fuel injection pumps will result in loss of power and hard starting. When loss of power and hard starting are accompanied with a clear exhaust, good compression and no blow-by gases from the crankcase breather, it indicates worn injection pumps. These pumps can be checked by your "Caterpillar" dealer.

Removing Fuel Injection Pumps: Every precaution should be taken to prevent dirt from getting into the fuel injection pumps or around them because the dirt will be carried into the crankcase. When fuel injection pumps are removed the pump plungers must not be taken from the barrels because dirt or dust will scratch these finely finished parts.

Remove the camshaft housing cover, taking particular care to avoid damaging the gaskets.

Remove the fuel injection line from the pump and immediately cap and plug the openings with cover (1) and plug (3) provided in the tool equipment.

Remove the capscrews and clamps which hold the fuel injection pump in place and lift the pump straight up only enough to clear the dowel pins, then shift the pump to one side so that the end of the pump plunger will free itself from the slot in the lifter. Place the ferrule cap seal (4) and plug (2) furnished in the tool equipment over the fuel outlet and in the inlet of the pump to keep out dirt.



REMOVING FUEL INJECTION PUMP

- 1—Cover. 2—Plug. 3—Fuel line plug. 4—Ferrule cap seal.



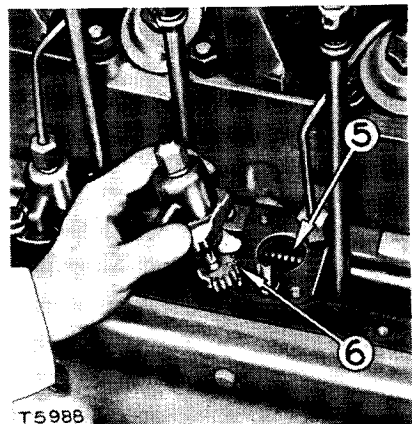
Should the plunger accidentally be removed from the pump barrel, take every precaution to avoid nicking or scratching it since the slightest rough spot will cause undue wear in the barrel and shorten the life of the pump. The plunger should be rinsed in clean kerosene or Diesel fuel before putting it back in the barrel. Be sure the plunger is replaced in the barrel from which it was withdrawn.

Each fuel injection pump assembly (plunger and barrel) is machined as a unit and finished to such exact limits that it must be used, removed, and replaced as a unit.

Installing Fuel Injection Pumps: Lower the pump and plunger into the housing, taking care that the pump plunger does not slide out of the barrel. Line up the marked tooth (6) of the injection pump plunger gear with the mark (5) on the rack as the plunger is lowered into place. Slide the end of the plunger into the slot in the lifter. Remove the ferrule cap seal and plug from the fuel passage and lower the pump onto the dowel pins. Fasten the pump in place.

INSTALLING FUEL INJECTION PUMP

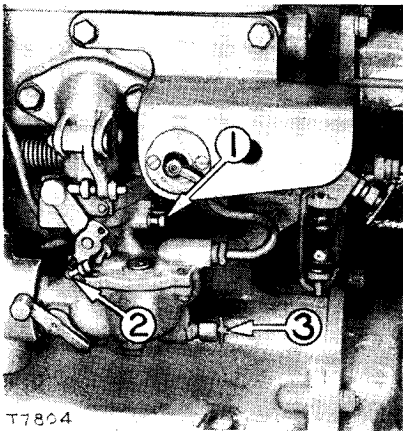
- 5—Mark on rack. 6—Marked gear tooth.



STARTING ENGINE FUEL SYSTEM

Keeping the starting engine fuel tank filled will prevent condensation in the tank. Periodically drain any water which may have accumulated in the starting engine fuel tank sediment bowl.

Carburetor Adjustment: To obtain an approximate carburetor adjustment, turn the adjusting screws gently against their seats. Then back off the high speed screw (3) one turn from the closed position and the idling speed adjusting screw (1) one-half turn from the closed position.



CARBURETOR ADJUSTMENT

1—Idling speed adjusting screw. 2—Idling speed control screw. 3—High speed adjusting screw.

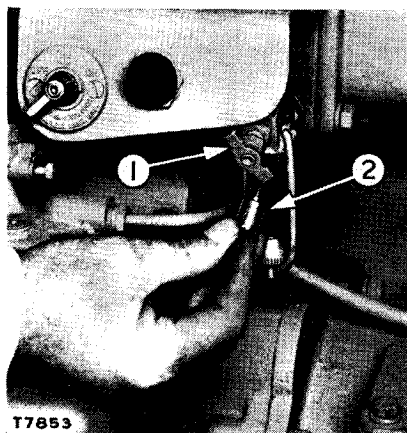


A more accurate adjustment can be obtained while the engine is running by turning the high speed adjusting screw out to make the mixture richer or in to make it leaner. Adjust this screw to a point that will give the greatest amount of power with a clear exhaust. Turn the idling speed adjusting screw until the engine will idle regularly at slow speed without emitting black smoke from the exhaust. Turn this screw out to make the mixture richer or in to make it leaner. Turn the idling speed control screw (2) to the left (out) to decrease idling speed or to the right (in) to increase the speed.

Sediment Bowl Filter: The sediment bowl collects water and sediment that may be in the fuel. To remove the collected water and sediment, close the valve (1) and remove the bowl by unscrewing the nut that clamps it to the body of the valve. Unscrew the edge-type filter (2) and shake it in kerosene or some non-inflammable cleaning fluid. When the bowl is replaced see that the gasket is clean, is in the correct position, and is not broken.

STARTING ENGINE SEDIMENT BOWL FILTER

- 1—Fuel shut-off valve.
- 2—Edge-type filter.

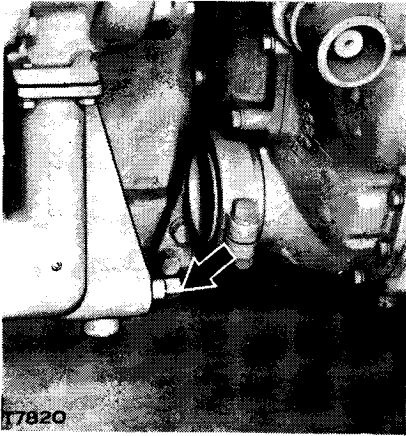


COOLING SYSTEM

Coolants: Water used in the cooling system should be soft, or as free as possible from scale forming minerals. If it is impossible to obtain soft water it is advisable to treat the available water with "Caterpillar" Rust Inhibitor. The use of this rust inhibitor in the cooling system will prevent the formation of rust. It will also retard, and in some cases completely eliminate mineral deposits within the engine. Most commercial anti-freeze solutions contain rust inhibitors, therefore, it is not necessary to use rust inhibitors with those anti-freeze solutions which do contain inhibitors. Your "Caterpillar" dealer stocks "Caterpillar" Rust Inhibitor in convenient one quart cans. Directions for its use are printed on each can.

When the temperature is below freezing sufficient anti-freeze should be used in the cooling system to prevent freezing. Various anti-freeze mixtures such as ethylene glycol (Prestone, G.M., Permaguard, Zerex, etc.) denatured ethyl alcohol, methanol (synthetic wood or methyl alcohol) and glycerine are all suitable for use. Alcohol can be used successfully but, because it readily evaporates at the normal operating temperature of the Diesel engine the solution should be tested frequently—even daily—and kept up to correct strength. This loss by evaporation is objectionable **but the temperature regulator should not be removed.** Doing so might make the solution run cooler and save the alcohol, but is not desirable for good performance. It is essential, therefore, that the coolant be tested frequently to assure adequate protection.

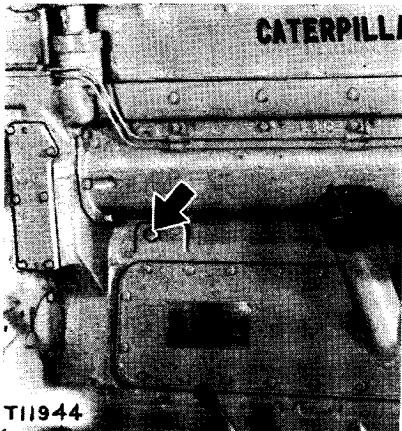
Cleaning The Radiator: Dirt in between the tubes of the radiator and oil cooler may cause excessively high operating temperature. This dirt may be easily removed by removing the capscrews which hold the radiator screen in place. Then wash, brush or blow the dirt out with which ever method is available and most effective.



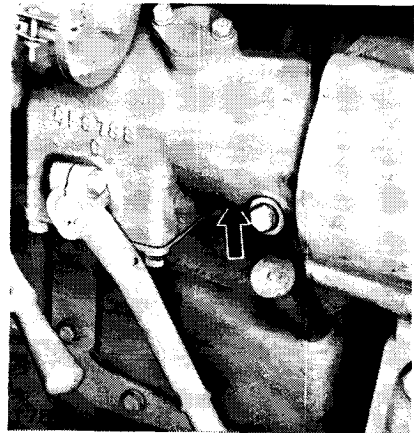
RADIATOR
DRAIN VALVE



Draining: Open the radiator drain valve on the left rear side of the radiator bottom tank and remove the plug on the right side of the engine block under the Diesel engine camshaft housing. On earlier engines the cylinder block drain plug is on the left side of the engine below the starter pinion housing. This will drain the entire cooling system of the Diesel and starting engines if the engine is level.



(Later Engines)
CYLINDER BLOCK
DRAIN PLUG



(Earlier Engines)
CYLINDER BLOCK
DRAIN PLUG

Cleaning The Cooling System: The cooling system should be drained occasionally to remove dirt and sediment which accumulates. The draining should be done at the end of the day's run, when the foreign material is in suspension and will easily drain with the liquid.

The cooling system should be washed out occasionally. To do this, run the engine until the liquid in the cooling system is at operating temperature, and the loose foreign material is stirred up. Then stop the engine, and drain as quickly as possible before the sediment has time to settle. Close the drain and pour in kerosene equal to about one-tenth the capacity of the cooling system and fill the remainder with a solution of one-half pound (226.8 grams) of washing soda to each gallon (3.8 liters or .8 Imp. Gal.) of water. Run the engine for about one-half hour, and again drain and flush the system with clean water.

In more obstinate cases, if the above treatment does not prove effective, an acid solution may be used; but acid must be used with extreme care, and only after other means have proven ineffective. Immediately after the system has been washed with the soda solution described, fill the cooling system with a solution of five parts hydrochloric (commercial muriatic) acid, one part formaldehyde and forty-eight parts water and allow it to remain in the system for a few hours at operating temperature. The formaldehyde should first be mixed with the water, then the acid added to the solution. Drain immediately after stopping the engine and thoroughly flush the system with clean water to which has been added a handful of washing soda, which acts as a neutralizing agent.

After using the acid treatment, the cooling system should be drained and flushed with clean water the second time at the end of the day's run.

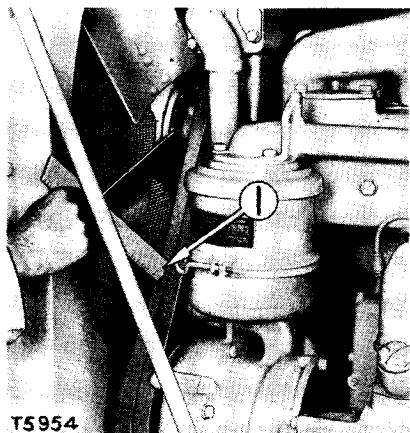
CAUTION

The acid solution is also a solvent of the metals of which radiators are made, therefore, great care must be exercised to avoid continuing the operation beyond the point where the scale is dissolved. It is highly important that no trace of the acid be left in the cooling system.

FAN BELT ADJUSTMENT

If the fan belts are operated too loose, they will slap against the pulleys, causing unnecessary wear to the belt and possibly slipping to the extent that the engine will overheat. If the belts are too tight, unnecessary stresses are placed upon the fan bearings and belts, which might shorten the life of both.

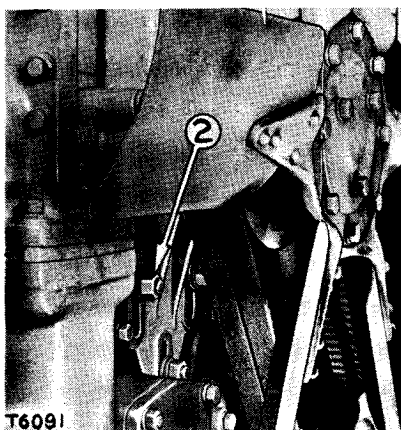
When it becomes necessary to replace a belt because of breakage or deterioration, it is recommended to replace both belts at the same time.



T5954

CHECKING FAN BELT TENSION

1—Correct adjustment allows approximately $1\frac{1}{2}$ inch (3.75 cm.) slack at this point.



T6091

FAN BELT ADJUSTMENT

2—Retaining nuts.

To adjust the fan belt tension, loosen the retaining nuts (2) and place a bar under the fan bearing bracket and pry the bracket up until the belts can be pushed inward at the center about one and one-half inches (3.75 cm.) as shown at (1). Recheck the adjustment after tightening the retaining nuts.

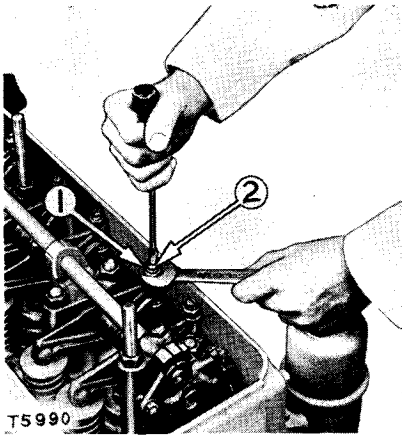
VALVE CLEARANCE ADJUSTMENT

The valve clearances should be checked and adjusted if necessary after the first thirty days of operation. Thereafter, the clearances should be checked and adjusted if necessary after every 480 hour operating interval.

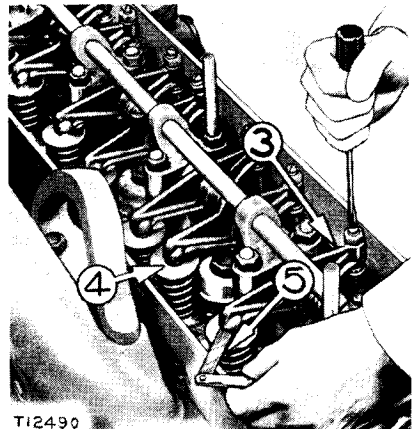
The valve clearance adjustment should be made while the engine is hot, either while the engine is running or before it has been stopped twenty minutes after having run long enough to thoroughly warm up. If the adjustment with the engine stopped is not completed during the twenty minute interval, start the engine and allow it to warm up.

The valve clearance adjustment must be made or the clearances checked, with the compression release control lever in the RUN position. If the adjustment is made with the engine stopped, turn the engine until the valve closes and push rod it at its lowest point.

To Adjust: Loosen the valve adjusting screw lock nut (1), turn the adjusting screw (2) to allow a thickness gauge (5) to pass between the top of the valve stem and the end of the valve rocker (3) at the correct clearance. On the D337 Engine set this clearance at .015 inch (.038 cm.) for inlet valves and .020 inch (.051 cm.) for exhaust valves. On the D326 Engine set this clearance at .025 inch (.063 cm.) for the inlet valves and .030 inch (.076 cm.) for exhaust valves. Tighten the adjusting screw lock nut and check the adjustment.



LOOSENING LOCK NUT
 1—Adjusting screw lock nut.
 2—Adjusting screw.



ADJUSTING VALVE CLEARANCE
 3—Valve rocker. 4—Spring retainer.
 5—Thickness gauge.

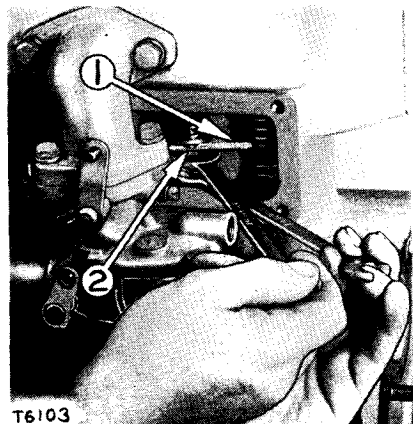
Checking Valve Rotators: Check the valve rotators with the engine running after valve clearance adjustment check has been made to see if the valves rotate. The rotating of the valves decreases carbon build up and uneven wear, thereby increasing the life of the valves. To check, draw a pencil line on the spring retainer (4) and observe the valve rotation. If the valves do not turn the valve rotators should be replaced, see your "Caterpillar" dealer.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

The valve clearance adjustment should be made when the engine is hot. To adjust, crank the engine until the valve closes and the valve-lifter is at its lowest position. Loosen the lock nut on the adjusting screw and turn the screw until there is .008 inch (0.2 mm.) clearance between the end of the valve stem and the head of the adjusting screw as shown at (2). Check this clearance with a thickness gauge (1). Recheck the adjustment after the lock nut is tightened.

STARTING ENGINE VALVE CLEARANCE ADJUSTMENT

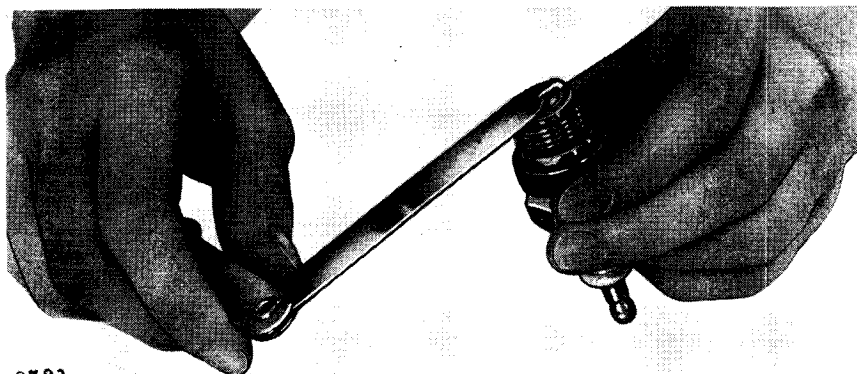
- 1—Thickness gauge. 2—There should be .008 inch (0.2mm.) clearance at this point.



T6103

SPARK PLUG ADJUSTMENT

The spark plugs should be examined often enough so the gap may be kept at approximately .040 inch (1.02 mm.). Measure this gap with a thickness gauge. To adjust the gap, bend the outer electrode.



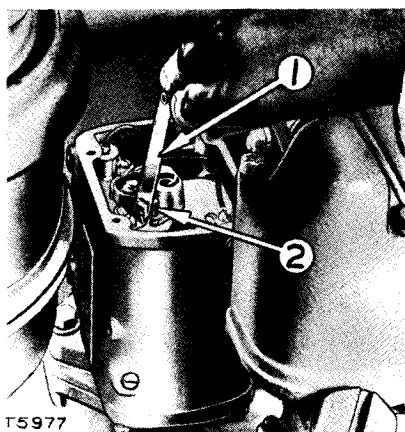
9783

STARTING ENGINE SPARK PLUG ADJUSTMENT

STARTING ENGINE MAGNETO

Do Not Lubricate The Magneto At Any Point: The bearings are packed with a ball and roller bearing grease when assembled, and this should be replaced only when the magneto is taken to your "Caterpillar" dealer for checking or reconditioning.

Checking Contact Point Opening: Every 1,200 hours check the contact point opening.



T5977

CHECKING CONTACT POINT OPENING

- 1—Thickness gauge.
- 2—Bumper block.



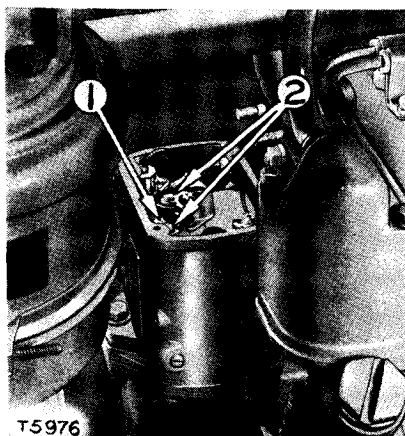
To check with magneto in place, first remove the distributor cover and pull out the distributor rotor, then turn the engine flywheel until the contact point bumper block (2) is on one of the highest elevations of the

magneto cam. Check the clearance with a thickness gauge (1). This clearance should be .014 to .018 inch (0.35 to 0.45 mm.).

Adjusting Contact Point Opening: Loosen the screws (2) which hold the adjustable contact point bracket and move the bracket by inserting a screw driver in the eccentric slotted-head screw (1) and turn until the

ADJUSTING CONTACT POINT OPENING

- 1—Eccentric slotted-head screw.
2—Bracket fastening screws.

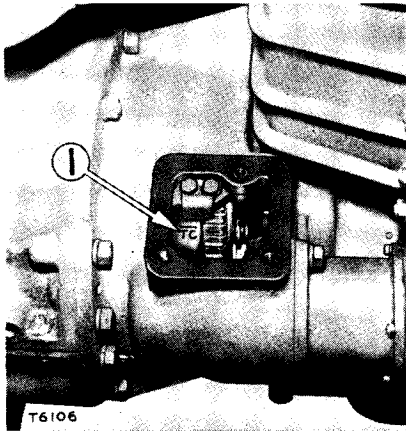


correct point opening is obtained. Then tighten the fastening screws and recheck the adjustment.

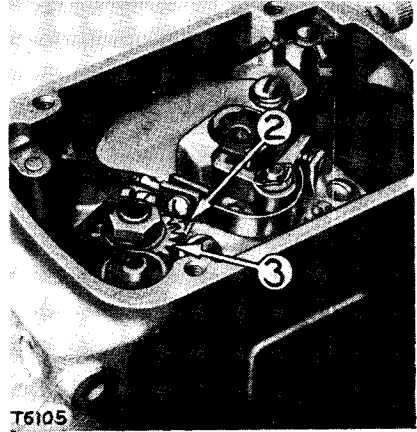
Testing: A magneto may be tested when coupled to the engine by turning the switch ON, removing the cable from a spark plug and holding the terminal $\frac{1}{8}$ inch (3.17 mm.) away from the metal base of the plug while turning the engine flywheel. If no spark passes from the terminal to the plug base, disconnect the magneto switch wire from the magneto where it is connected to the terminal on top of the magneto housing and test again. If a spark passes from the terminal to the plug base with the switch wire removed, the wire running from the magneto to the switch has become grounded or the switch requires replacement. If, with the switch wire off, the magneto still does not fire, remove the magneto as instructed in the next paragraph and take it to your "Caterpillar" dealer for testing.

To Remove Magneto For Testing: Disconnect the cables from the magneto. (One of the magneto outlets should be tagged or marked in some convenient manner which will designate the proper position of cables.) Remove the two capscrews that hold the magneto to the timing gear housing and lift off the magneto. Do not remove the magneto mounting trunion when lifting the magneto from the engine.

To Time The Magneto To The Engine: Carefully check the contact points for the proper opening. Locate the firing point of No. 1 cylinder by removing the cover from the top of the starting engine clutch housing and the spark plug from the No. 1 cylinder. Crank the engine slowly until



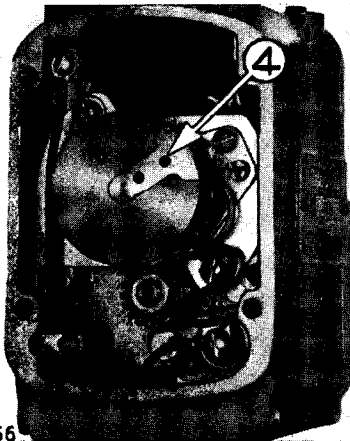
TIMING MARK AND POINTER
1—"TC" mark.



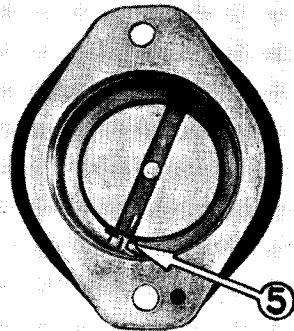
TIMING MARKS ON MAGNETO
2—Mark "A" on the distributor gear.
3—Magnet rotor shaft gear.

air is forced from the spark plug opening. This indicates that the piston is coming up on compression stroke. Continue to turn the crank until the mark "TC" (1) (top center) on the flywheel is even with the timing pointer.

Remove the plate at the end of the magneto by taking out the four small fastening screws. Turn the magneto shaft backwards (to prevent the impulse from catching) until the mark "A" on the distributor gear (2) lines up with the red line on the magnet rotor shaft gear (3). At this point if the distributor rotor is installed the distributor rotor contact (4) should be in the position shown. When the distributor plate is installed the No. 1 cylinder spark plug wire conductor in the plate will contact the rotor contact (4).



DISTRIBUTOR ROTOR POSITION TO TIME MAGNETO TO ENGINE
4—Rotor contact.



TIMING MARKS ON MAGNETO MOUNTING TRUNNION
5—Mark "TC" in magneto mounting trunnion.

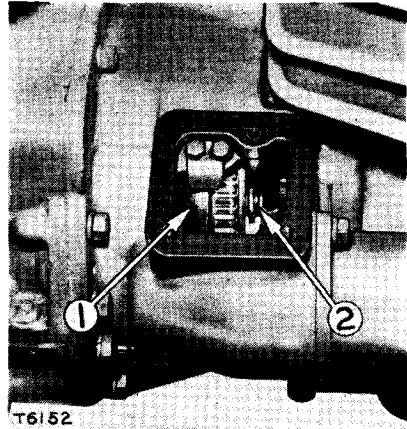
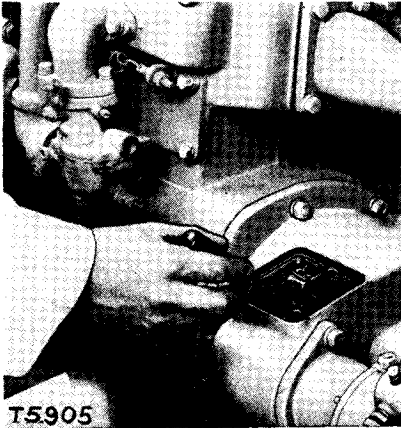
Place the magneto into position, making sure the mark on the impulse lug lines up with the mark "TC" (5) in the magneto mounting trunnion, and bolt the magneto into place. Check the location of the rotor before replacing the plate to be sure it has not changed its position and then replace the plate on the magneto.

STARTING ENGINE CLUTCH

To Test The Adjustment: Pull the clutch lever up to the engaged position. The lever should go into position with a distinct snap, and should require a reasonably hard pull.

To Adjust: Remove the plate from the top of the clutch compartment. Engage the clutch and turn the flywheel (1) with a screwdriver until the lock pin (2) is accessible. Disengage the clutch, pull the lock pin out and turn the collar to the right until the lock pin drops into the next hole.

Test the adjustment by engaging the clutch. If one hole gives a slightly loose adjustment and the next gives too tight an adjustment, use the looser adjustment.



STARTING ENGINE CLUTCH ADJUSTMENT

1—Flywheel. 2—Lock pin.



Attachment Instructions

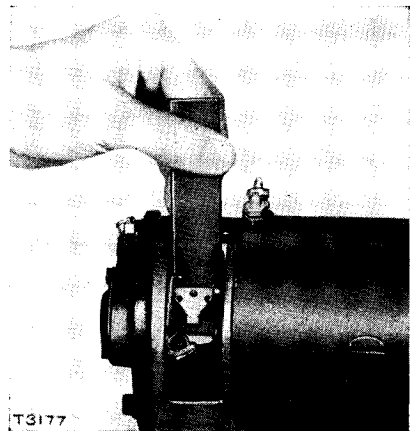
Attachments are available from your "Caterpillar" dealer. Many of these attachments will add to operator convenience as well as increase the usefulness of your engine.

GENERATOR AND STARTING ENGINE ELECTRIC STARTER

Never operate a generator with an open circuit between it and the battery.

Cleaning Generator Or Electric Starter: Approximately every 1,200 hours, the inspection cover should be removed from the generator and starter and a check made of the commutator. If it is glazed or darkened, polish it with "00" sandpaper. To polish, hold the sandpaper on the commutator with a stick while the commutator is turning. The polishing should be done on the generator when the Diesel engine is running at low idle speed. It should be done on the starter by pressing the starter switch with the magneto switch turned off. Turn the sandpaper over to clean the contact surfaces of the brushes. The commutator should not be turning when the brushes are being cleaned. Make sure all trace of sand particles is removed from the commutator, brushes, and brush holders by blowing out with air or an equally effective method.

SANDING GENERATOR BRUSH



Brush Replacement: Brushes should be inspected and replaced if badly worn. When a new brush is installed, seat it properly with the contour of the commutator by using "00" sandpaper. Remove all sand particles and make certain the connections are all tight. A poor connection in the charging circuit will cause the generator to build up excessive voltage

which may result in burned field or armature windings. A poor connection of the generator field circuit will cause a low voltage.

General Reconditioning: Approximately every 4,000 hours, the generator and starter should be removed so they may be completely disassembled, washed and have all parts replaced showing evidence of being unsatisfactory for reason of wear. It is suggested this reconditioning be entrusted to your "Caterpillar" dealer.

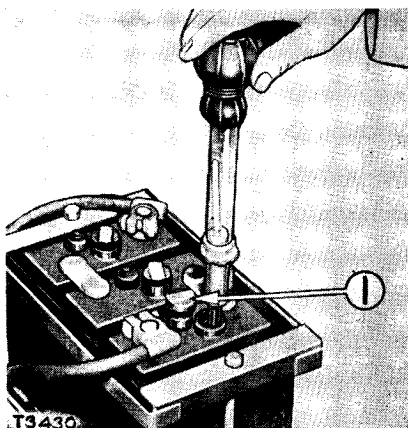
BATTERY CARE

Every 60 hours, or more often if continuous operation without the use of the battery is encountered, the following attention should be given to the battery to insure high efficiency and maximum operating life.

The battery should be tested with a hydrometer and kept within a margin of safety to a specific gravity of above 1.275. A dangerously low point of charge is indicated by a hydrometer reading of 1.150 which will permit the battery to freeze. A specific gravity of 1.250 will permit the battery to withstand temperatures as low as -30°F . without freezing.

Water that escapes by evaporation should be replaced with distilled water or "approved water" (water free from impurities by analysis). The level should be maintained $\frac{3}{8}$ inch above the top of the separators or insulators. Do not overfill or underfill the cells of the battery as either has a detrimental effect on battery life.

Most batteries are provided with filler plugs (1) having special construction. These plugs, when removed for filling the battery, should be pressed on the raised portion of the vents. This prevents overfilling, as air entrapped in the top of the cells forces the excess water out through the



TESTING SPECIFIC GRAVITY OF ELECTROLYTE

1—Plugs should be placed on rubber vents to prevent overfilling.



filler openings. When the filler plugs are removed from the vents the entrapped air escapes, dropping the water to the proper level in the battery.

If it is necessary to add water too frequently to the battery, it is probably being overcharged and checks should be made to find and correct the trouble. Loose ground connections or a poorly functioning voltage regulator will cause overcharging of the battery.

Always test a battery for degree of charge before adding water, otherwise before an accurate reading can be obtained it will be necessary to operate the engine for a short period to charge the battery; thus allowing the water to mix with the electrolyte.

If when making weekly tests the battery shows evidence of becoming gradually discharged, that is, when the specific gravity reading drops below 1.250, the battery should be removed and completely recharged.

Check to determine the reason for the battery becoming discharged. Inspect the battery terminals and other points in the wiring. A loose connection or worn insulation may be the reason for the battery becoming discharged. Also check for an improperly functioning voltage regulator. Refer to the topic, VOLTAGE REGULATOR.

Keep the top of the battery clean and dry to prevent current losses and keep the terminals clean and tight. To clean corrosion from the battery terminals, scrub them with a weak solution of bicarbonate of soda (baking soda) and water. Dry the battery thoroughly, then coat the terminals with lubricant to prevent corrosion. Keep the battery securely fastened in its compartment at all times.

When replacing a battery that has been removed, make certain the negative post marked with a dash (—) or "N" is connected to the ground cable. Failure to connect the battery terminal to the correct post will damage the voltage regulator.

VOLTAGE REGULATOR

The voltage regulator is properly adjusted at the factory and should not be changed except in case of failure when both the regulator and generator should be taken to your "Caterpillar" dealer, where the output of the generator can be checked and the regulator adjusted accordingly.

If the contact points of the reverse current relay wear rapidly or burn, it may be that the engine has been operated over a long period of time at a speed which is critical to cutting in and out of the relay. To prevent this condition recurring, operate the engine at slightly higher or lower speeds than have formerly been used.

If the ammeter shows a low charging rate, it is not an indication that the equipment is at fault unless the battery shows a low reading when checked with the hydrometer. The regulator permits a heavy flow of current from the generator to the battery only when the battery electrolyte has a low specific gravity. As the battery becomes charged, the ammeter reading decreases proportionately until at full charge practically no ammeter reading is evident.

If the hydrometer reading is low and no charge is evident on the ammeter, check the entire system for loose connections or broken wires. If all connections are satisfactory, check the generator for worn, broken or poorly seating brushes; also check the commutator to determine whether it is glazed or darkened. Refer to the topic, GENERATOR AND STARTING ENGINE ELECTRIC STARTER.

Be sure the proper regulator is used for the battery requirements of the installation, that is, 6-volt regulator with 6-volt battery, 12-volt regulator with 12-volt battery, 24-volt regulator with 24-volt battery, 30-volt regulator with a 30-volt battery and 32-volt regulator with a 32-volt battery. Special attention should be given to the 30- and 32-volt systems.

The standard voltage regulators furnished with 32-volt generators are adjusted for use with 15 cells of battery (30 volts). This information is stated on a rating plate attached to the side of the voltage regulator.

The reason for using a 30-volt instead of a 32-volt battery is that stock batteries are made up in units of three cells each making it possible for an owner to buy only five three-cell batteries.

The 30-volt regulator will not function with a 16-cell or 32-volt battery. If for some reason it is desirable to use a 32-volt battery arrangement, the voltage regulator should be readjusted by your "Caterpillar" dealer and a new rating plate attached before the engine is operated.

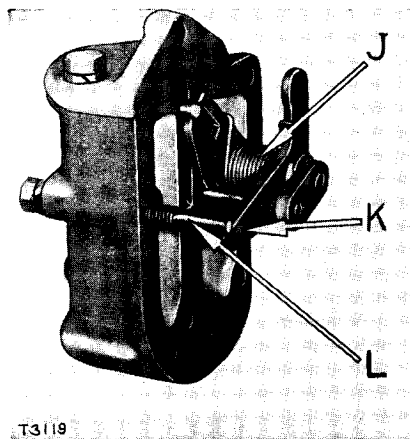
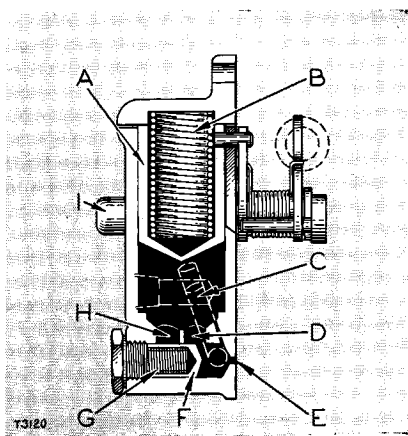
Whenever an order is placed for a new regulator it should be stated whether it is to be used with 15 or 16 cells of battery (30- or 32-volts) to insure receipt of the proper regulator.

SAFETY SHUT-OFF CONTROLS

The purpose of safety shut-off controls is to provide means of automatically stopping the engine to prevent damage if the lubricating oil pressure becomes dangerously low or excessively high cooling system temperatures occur. The cause for either low oil pressure or high cooling water temperatures should be determined and whatever corrective measures required should be taken. See your "Caterpillar" dealer if the cause cannot be determined.

Oil Pressure Shut-Off: When the engine is running and the lubricating oil pressure is normal, oil is forced by the crankcase lubricating oil pump through a passage in the fuel pump and governor drive housing and enters the shut-off mechanism at opening (E), causing the pilot piston valve (F) to move thus opening passage (D) to allow oil to raise the shut-off piston (A) against pressure of spring (B). When pilot valve (F) is forced against spring (G) the passage (H) is closed to prevent oil returning to crankcase. When the shut-off piston is in raised position the shut-off lever (K) is held against stop (L) by spring (J) permitting the fuel pump rack to be moved by governor action.

Should the oil pressure become dangerously low the oil pressure exerted on the pilot valve (F) will diminish allowing spring (G) to force



OIL PRESSURE SHUT-OFF OPERATION

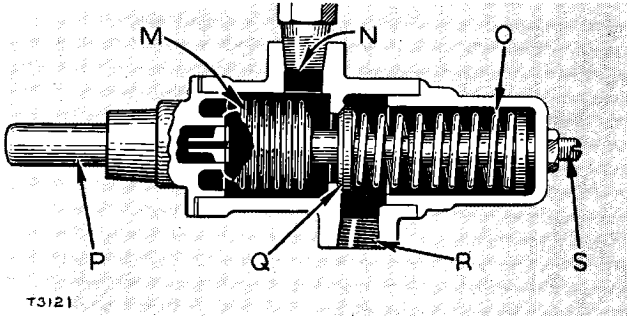
A—Shut-off piston. B—Shut-off piston spring. C—Oil pressure passage to the over speed shut-off and the water temperature shut-off. D—Oil supply passage to shut-off piston chamber. E—Oil inlet opening. F—Pilot piston valve. G—Pilot valve spring. H—Oil exhaust passage from shut-off piston chamber. I—Safety shut-off reset push button. J—Shut-off lever return spring. K—Shut-off lever. L—Shut-off lever stop.

the pilot valve toward oil entrance opening (E), opening passage (H) and releasing the oil pressure in the chamber thus allowing spring (B) to force down the shut-off piston (A). This causes the shut-off lever (K) to be forced against the shut-off push rod bolt and in turn on the end of the fuel pump rack, pushing it to the stop position.

Water Temperature Shut-Off: The water temperature shut-off in itself is a control valve for the oil pressure shut-off, as it is actually the oil pressure shut-off that functions to stop the engine. The water temperature shut-off is used only with the oil pressure shut-off.

When the water temperature is normal, spring (O) holds valve (Q) on its seat which prevents oil flowing from the oil pressure shut-off through opening (N), of the water temperature shut-off, and on into the engine

crankcase through outlet opening (R). This allows oil pressure to build up in the safety shut-off system with the result that the oil pressure shut-off functions to permit the governor to control the engine speed in the manner already described.



WATER TEMPERATURE SHUT-OFF CONTROL

M—Bellows. N—Inlet opening. O—Spring. P—Temperature bulb.
Q—Valve. R—Outlet opening. S—Adjusting screw.

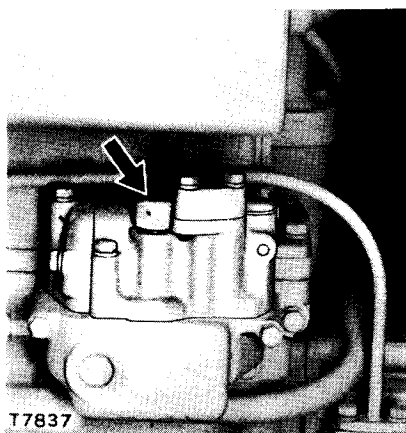
Occurrence of abnormally high engine water temperature heats temperature bulb (P) which is immersed in the engine water at the rear of the manifold. As heat on the temperature bulb increases, bellows assembly (M) expands, unseating valve (Q) allowing oil under pressure in the safety shut-off control system to return to the engine crankcase through outlet opening (R). A drop in the oil pressure in passage (C), then causes the oil pressure shut-off to stop the engine.

The temperature at which the water temperature shut-off operates is adjusted by use of screw (S).

Reset Push Button: The reset button (I) is provided to disengage the shut-off lever so the engine can be started after the engine has stopped for any reason. Pushing the reset button releases shut-off lever (K) from shut-off position allowing the rack to be moved by governor action. When sufficient oil pressure is developed to raise shut-off piston (A) the shut-off lever is re-engaged so that the shut-off mechanism can function properly. This re-engagement is evident when the reset button snaps out to its original position.

CAUTION

After starting, if sufficient oil pressure is not developed, it is possible for the engine to run but the safety shut-off mechanism will be inoperative. Therefore, **check the oil pressure immediately** after starting either by observing that the oil pressure gauge indicator is in the operating range or by watching the reset button snap out to the engaged position.

RESET PUSH BUTTON

Water Temperature Shut-Off Adjustment: The water temperature adjustment should be made when the engine is operating without load. The shut-off has an adjustment range from 188° F. to 208° F. (87° C. to 98° C.) when there is no load on the engine. However, an engine operating under load may cause a variation of approximately 5° F. (3° C.) in the point at which the water temperature shut-off will open. This should be considered when adjusting the water temperature shut-off.

To Adjust: To raise the temperature at which the shut-off valve operates, loosen the lock nut and turn the adjusting screw counterclockwise. This applies more tension on the pressure control spring, making a higher water temperature necessary to create sufficient pressure in the bellows to unseat the control valve. To lower the temperature, turn the adjusting screw clockwise. Always tighten the lock nut and replace the cotter pin after making an adjustment.

The most practical method of making the adjustment is as follows: Turn the adjusting screw counterclockwise about three turns; then reduce the flow of water through the cooling system or cover the radiator and operate the Diesel engine at no load until the water temperature reaches that selected for shutdown. Then, slowly turn the adjusting screw clockwise until the engine stops after which the lock nut should be tightened. Check the correctness of adjustment by operating the Diesel engine with full flow of water through the cooling system or without the radiator covered; then again reduce the flow of water through the cooling system or cover the radiator to determine whether shut-down occurs at the desired temperature. If not, repeat this procedure until proper results are obtained.

WOODWARD UG8 GOVERNOR OPERATION

Starting The Engine

Make the usual checks of lubricant, coolant, fuel supply, cranking capacity (if air starting is used) and disengage the flywheel clutch or remove any load from the engine then perform the following steps:

1. Turn the load limit knob **(3)** indicator between "5" and "7" on the dial.
2. Turn the synchronizer knob **(2)** clockwise or in "fast" direction as far as possible and then turn it backwards five complete turns. The synchronizer knob controls engine speed the same as a governor control lever or throttle.
3. Crank the engine and allow it to run at about half normal engine speed for five minutes (700 to 800 RPM on electric sets). To adjust the engine speed, turn the synchronizer knob.
4. Turn the load limit knob indicator to "10" which will allow the engine to carry the load as it is applied in step 7. This can be done without overloading of the engine as the load is applied in step 7 because all "Caterpillar" engines have a separate rack stop to prevent engine overloading.
5. Turn the synchronizer knob clockwise until the engine runs at full speed.
6. Three general groups of applications have different speed droop knob settings preliminary to applying the load in step 7 as follows:

A—Single Unit Application:

If the engine is to operate as a single unit, that is, not compounded with other electric sets or line shafts, the speed droop knob **(1)** indicator should be left at "0", then proceed with step 7.

B—A. C. Generator Paralleling Application Or Solid Line Shaft Compounding.

If the engine is operating on an A.C. generator which is to be paralleled with other A.C. generators, or is to be compounded on solid line shafting, set the speed droop knob indicator between "30" and "70", then proceed with step 7.

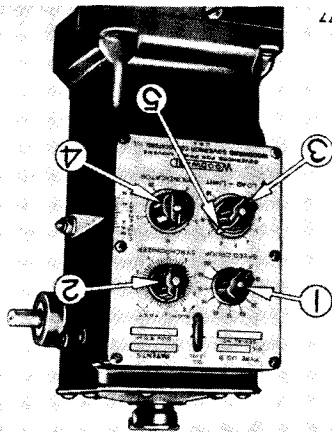
C—D. C. Generator, Fluid Coupling And Other Compound Applications:

If the engine is operating a D.C. generator or applications other than an A.C. generator which is to be compounded with units with similar drives, the speed droop knob indicator should be set at the lowest value which will give a satisfactory load division when the load is applied in step 7. Experience will determine this setting.

7. Apply the load. Readjust synchronizer knob and/or speed droop knob if necessary to secure load division if the unit is paralleled or compounded. The load indicator pointer (5) behind the load limit knob indicates the relative position of the fuel rack and indicates relatively the load on the engine.

WOODWARD UG8 GOVERNOR

1—Speed droop knob. 2—Synchronizer knob. 3—Load limit knob. 4—Synchronizer indicator. 5—Load indicator pointer.



The above steps are basically what should be done to start and run the engine when equipped with Woodward UG8 Governor. There are differences in installation and applications, particularly compounded applications, which require adjustments so varied that specific instructions cannot be given in this book. However, the adjustments to the governor after the load is on the engine have the effects as follows:

The engine with the lowest speed droop setting will be the engine which will respond to and carry load increases. The speed droop may have to be adjusted on one or both engines to give speed droops which will result in stable operation and yet provide for load division as the amount of load increases.

To cause an engine to assume more of the continuous load, turn the synchronizer knob clockwise. When the engines are paralleled on A.C. generators or solid line shafting, etc., individual engine outputs are adjusted by turning the synchronizer knob.

The synchronizer indicator (4) merely indicates how many turns of the synchronizer have been made.

To Stop The Engine

1. Remove the load and turn the synchronizer knob to allow the engine to idle at about half engine speed (approximately 700 to 800 RPM on electric sets) for five minutes before stopping. (If the knob is left in this position, step 2 of starting need not be observed at the next start.)

2. Stop the engine by turning the load limit knob to "0". If the temperature is below freezing, or if freezing weather is expected before the engine will be started again, drain the cooling system or protect it with an anti-freeze solution. See the topic, COOLING SYSTEM.

STARTING AID

Ether Starting Aid

General Information: Diesel engines which depend upon electric or air cranking systems present some problems when starting in lower temperatures. With these systems, some form of external aid is necessary to assure reasonable quick starting. The ether starting aid provides a means of starting the engine when ambient temperatures are as low as -10° F. It is not advisable to use air or electric starting in temperatures below the pour point of S.A.E. No. 10W oil without addition of some heat to the cooling system of the engine. When electric starting is used an oversize or paralleled battery may be required in temperatures below 0° F. to maintain cranking speeds. The coolant should be maintained between $+15^{\circ}$ and $+30^{\circ}$ F. for easy cranking, quicker starting and rapid oil distribution.

One discharger is used to inject ether into the inlet manifold. When the discharging lever is moved the metal capsule is pierced. Ether is forced out of the capsule by a small quantity of gas at high pressure into the inlet manifold where it is ready to be taken into the cylinders for quick starting aid.

In normal temperatures only one capsule is required. The capsules were made of a definite size (8 cubic centimeters) to limit the quantity of ether to be injected. In extremely cold operation, two capsules may be necessary.

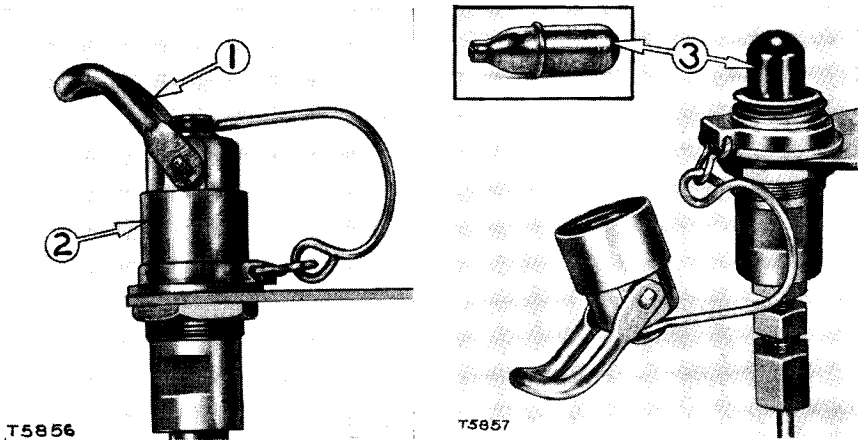
The following table shows requirements that may be helpful when starting with the ether starting aid. The electrical system must be maintained to give 90 RPM cranking speed, or the ether starting aid may not be effective.

Capsule Requirements For Starting

Temperature	$+50^{\circ}$	$+20^{\circ}$	$+10^{\circ}$	0°
Number of Capsules Required	1	2	2	2

NOTE: Due to the difference in starting characteristics of engines, experience will show whether it is desirable to use any capsules when starting in temperatures above 50° F. with electric starting and 30° F. with air starting.

Operation: To inject the ether into the manifold, load the discharger by unscrewing the nut (2), removing the spent capsule and placing the new capsule (3) in the discharger as shown. Install the nut finger tight. Only when more than one capsule is to be used, should any ether be injected before starting to crank the engine. Crank the Diesel engine with the compression release lever in the RUN position and the governor control lever in the starting position, then move the discharging lever (1) to pierce the capsule. Be sure the nut (2) is finger tight on the discharger to keep dirt out of the engine.



ETHER PRESSURE PRIMER DISCHARGER

1—Discharger lever. 2—Nut. 3—Capsule.

If more than one capsule is needed, discharge the first capsule and install the second capsule in the discharger before cranking the Diesel engine. Only one capsule should be discharged into the manifold before cranking the engine as excess quantities may cause internal damage when starting a cold engine. The second capsule can be discharged when the engine has been cranked a few revolutions, or when it starts to stall.

Never discharge ether into the manifold of a hot engine.

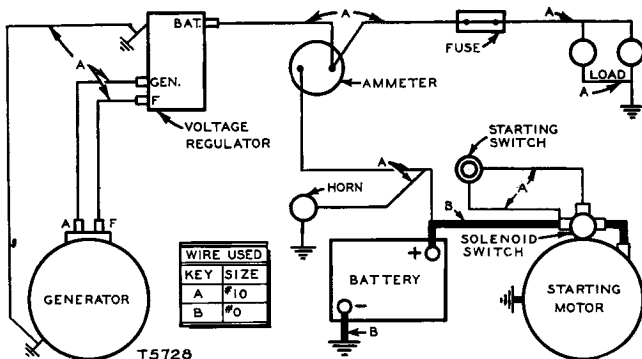
PRECAUTIONS

Capsules are filled with ether which is highly flammable. These capsules are pressurized at approximately 250 pounds pressure to act as an expellant. They are made of steel with welded closures and their bursting pressure is in excess of 6000 pounds per square inch. This type of packaging provides maximum safety in storage, handling and use. The principal precautions to be taken are:

- A. Do not heat the capsules.
- B. When the discharger is being used for testing, inspecting or demonstrating purposes, and is not installed on an engine, the contents of the capsules should **not** be discharged in confined areas or near an open flame.

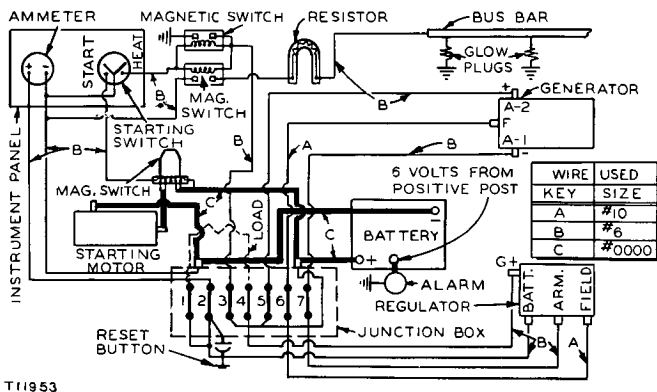
WIRING DIAGRAMS

These wiring diagrams are furnished so that when it becomes necessary to install or to disturb electrical equipment on engines for purposes of reconditioning or parts replacement, a convenient reference to insure satisfactory assembly will be at hand.



WIRING DIAGRAM FOR 6 VOLT ELECTRICAL SYSTEM WHEN EQUIPPED WITH 20 AMPERE GENERATOR

For 12 volt, 40 ampere system, use above diagram and ground the positive post of the battery.



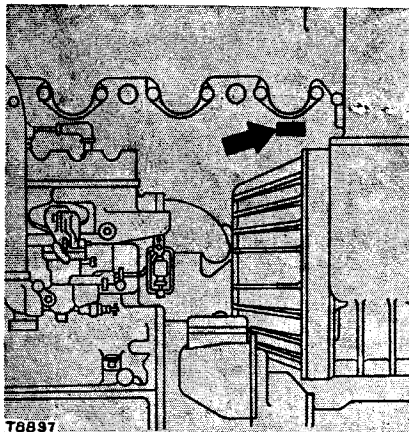
WIRING DIAGRAM FOR 32 VOLT ELECTRICAL SYSTEM WHEN EQUIPPED WITH EITHER 15 OR 50 AMPERE GENERATOR

Capacities

Approximate quantities

Crankcase Lubricating Oil System,	
D337 Diesel Engine	33 qt.
D326 Diesel Engine	31 qt.
Crankcase, Starting Engine	4 qt.
Air Cleaner,	
D337 Diesel Engine	6 qt.
D326 Diesel Engine	4½ qt.
Starting Engine	½ qt.
Starter Pinion Housing	½ qt.
Fuel Tank, Starting Engine	4½ qt.
Cooling System	
Engine With Radiator*	21 U.S. Gal.
Engine Without Radiator and Heat Exchanger	10.5 U.S. Gal.
Engine With Heat Exchanger ..	19 U.S. Gal.
* Earlier Engines—with smaller top tank	19 U.S. Gal.

Location Of Serial Number



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