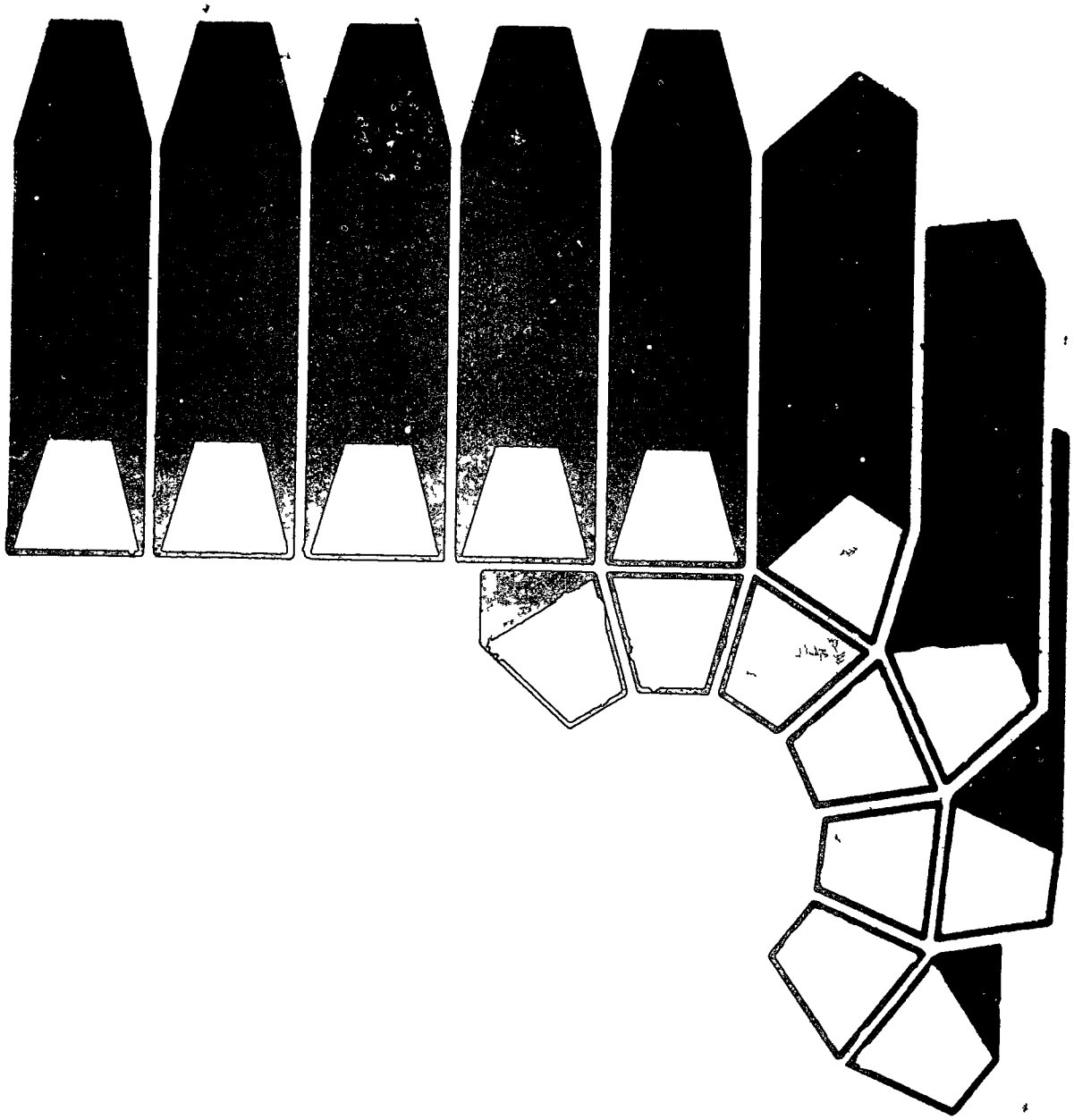

Agricultural Machinery Mechanic

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CBC CINTERFOR BASIC COLLECTIONS

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FOREWORD

1) The following sheets will serve as patterns for preparing masters or stencils to be used on office offset machines, mimeographs, or other types of duplicators.
They should be handled carefully so as not to damage or soil the paper.

2) It is advisable to check the sheets before making the masters so that faint or broken lines can be retouched with an ordinary pencil or drawing ink, and spots and imperfections masked with gouache (white tempera).

3) Any addenda to the sheets, e.g. local codes, may be written on white paper and pasted into position. The same procedure can be used when correcting misprints or other errata.

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02/AgM	Removing and replacing pins and keys
03/AgM	Removing and replacing circlips (Safety rings)
04/AgM	Removing and replacing pins
05/AgM	Removing and replacing clamps
06/AgM	Removing and replacing compression springs
07/AgM	Checking springs
08/AgM	Sharpening discs
09/AgM	Riveting
10/AgM	Checking cylindrical shafts
11/AgM	Checking cylinders
12/AgM	Disassembling safety mechanisms
13/AgM	Repairing, assembling and regulating safety mechanisms
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15/AgM	Removing and mounting chains
16/AgM	Removing and mounting gears and pulleys
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19/AgM	Preparing surfaces for painting
20/AgM	Brush painting
21/AgM	Testing the hydraulic system (With analyser)
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34/AgM	Removing the steering unit (tractors)
35/AgM	Mounting the steering unit (tractors)
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and machinery mechanics)

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002	Pliers (Types and uses)	
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(TIS.001 to 111) (cont'd)

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(TIS.001 to 111) (cont'd)

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NOTE: When preparing each specific manual for the courses, other sheets such as those corresponding to materials, tools and equipment which correspond to other occupational groups, may be added. For that purpose it is suggested to consult the indexes corresponding to the "General Mechanics" group.

OPERATION SHEETS

This operation consists of unscrewing and screwing nuts and bolts in order to disassemble and assemble machines or parts of them.

PROCEDURE

CASE I - REMOVING NUTS AND BOLTS

1st Step - *Loosen the nut* thus:

a) Hold the bolt with one spanner and loosen the nut with the other.

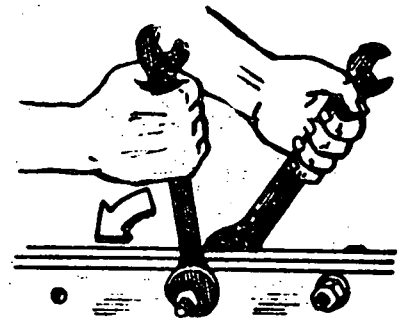


Fig. 1

SAFETY MEASURE

TO LOOSEN OR TIGHTEN A BOLT OR NUT, PULL THE SPANNER TOWARDS YOURSELF. IT WILL TAKE LESS EFFORT.

OBSERVATIONS

1) To loosen nuts screwed to unfastened bolts, keep the bolts from turning by holding the bolt with a spanner (Fig. 1).
2) To loosen bolts and nuts bear in mind the direction of the thread. It may be right or left.
3) Use a lubricant or penetrating oil to loosen stuck bolts and nuts.
4) Use the appropriate spanner for nut and bolt.

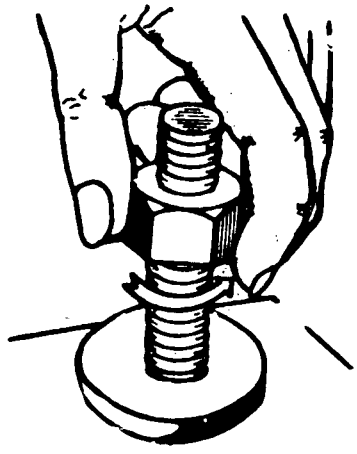


Fig. 2

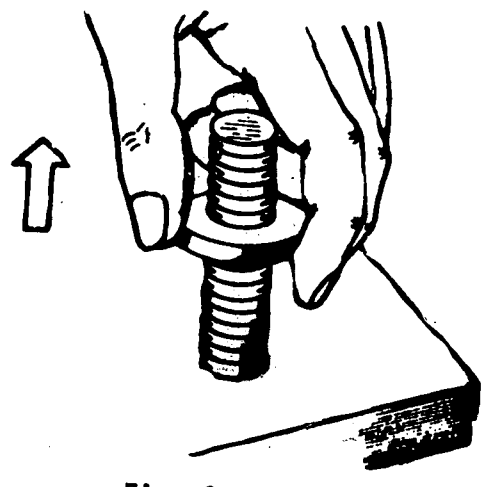


Fig. 3

b) Turn the nut until it comes off (Fig. 2),
c) Remove the washer (Fig. 3).

2nd Step - *Remove the bolt* by rotating it.

3rd Step - *Wash the bolts and nuts* thus:

a) Put them in kerosene until the dirt is softened.

b) Clean them with a paint brush or wire brush (Fig. 4).

OBSERVATION

Change bolts or nuts which are in bad condition.

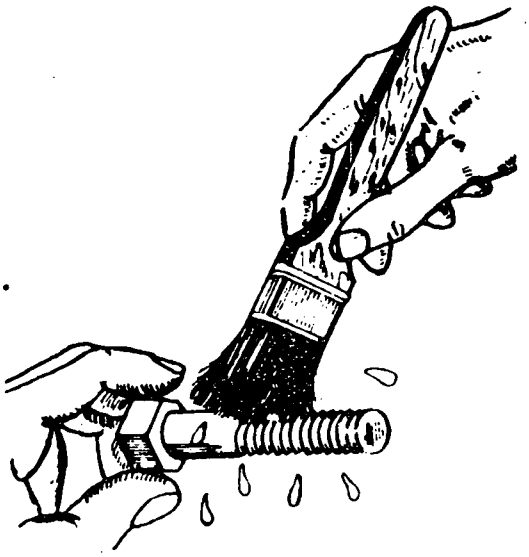


Fig. 4

CASE II - REPLACING NUTS AND BOLTS

1st Step - *Replace nuts and bolts* thus:

a) Put in the bolt.

b) Put on the washer.

c) Put the nut on the bolt and rotate it by hand screwing it on.

d) Tighten the bolt with the spanner. Avoid leaving it loose or too tight.

CBC

OPERATION:
REMOVING AND REPLACING PINS AND KEYS

REF. OS.02/AgM | 1/4

Caribbean

This operation is done when removing and replacing with different tools the keys that fasten shafts with pinions or pulleys or support parts of a mechanism.

PROCEDURE

CASE I - REMOVING PINS AND KEYS

Process I - Removing the split pin

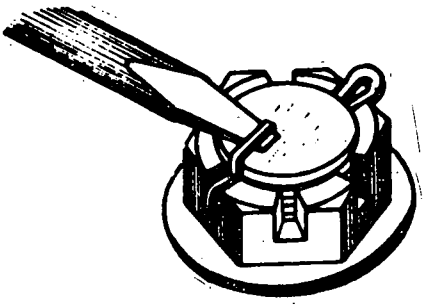


Fig. 1

1st Step - *Lift the points of the split pin* (Fig. 1).

OBSERVATION
Use a screwdriver or combination pliers to lift the points.

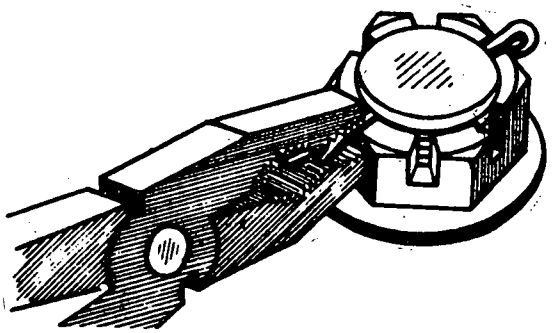


Fig. 2

2nd Step - *Close the points of the split pin with a pair of pliers (Fig. 2).*

OBSERVATION
Straighten the split pin to make removal easy.

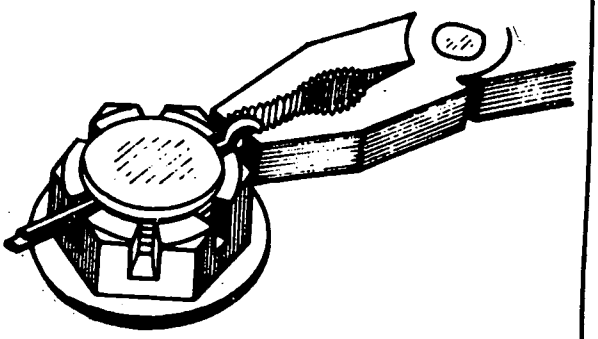


Fig. 3

3rd Step - *Pull the head with the pliers* (Fig. 3).

OBSERVATION
If the split pin is very tight, pull and rotate it simultaneously until it comes out.

Process II - Removing the Gib key

1st Step - *Remove the key* by pushing it outwards with the aid of a hammer and a suitable drift punch resting on the heel of the key (Fig. 4).

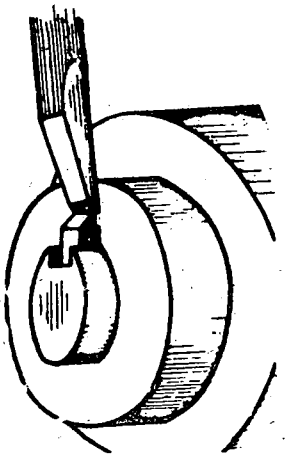


Fig. 4

Process III - Removing the square key

1st Step - *Remove the key* sliding it in its keyway with the aid of a hammer and a punch (Fig. 5).

OBSERVATION
Select the appropriate punch so as not to damage the key or the keyway.

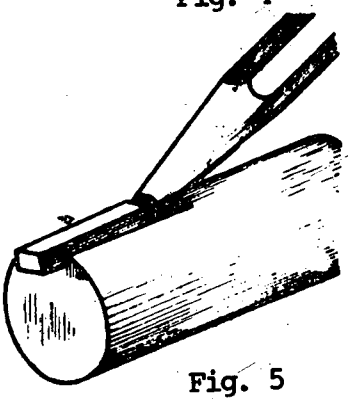


Fig. 5

Process IV - Removing the Woodruff key

1st Step - *Remove the key* by making it turn in its keyway with the aid of a punch and a hammer (Fig. 6).

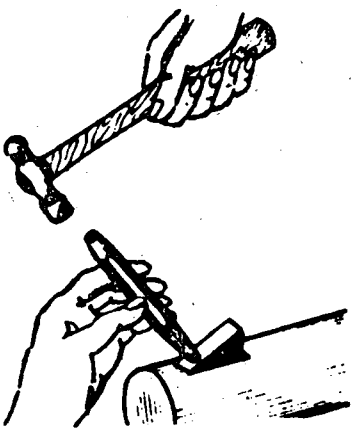


Fig. 6

Process V - Removing the inset key

1st Step - *Remove the key* by pulling it with a pair of combination pliers (Fig. 7).

OBSERVATION
If the key is very tightly fitted, loosen it by tapping with a plastic hammer or bronze punch.

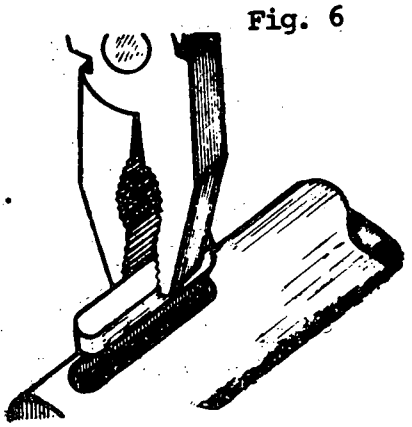


Fig. 7

CASE II - REPLACING PINS AND KEYS

Process I - Replacing the split pin

1st Step - *Insert the pin.*

OBSERVATIONS

1) Change the open-pins each time they are removed.
2) Select the appropriate pin.

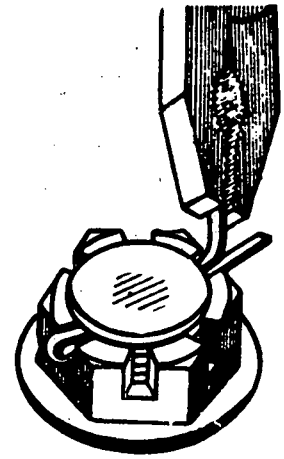


Fig. 8

2nd Step - *Open the ends of the pin (Fig. 8).*

Process II - Replacing the Gib key

1st Step - *Make a check on the state of the key and keyway* thus:

a) Check the adjustment of the key.
b) Change the key if it is worn.
c) Repair the keyway if necessary.

2nd Step - *Align the keyways.*

3rd Step - *Put in the key* by tapping it with a hammer (Fig. 9).

OBSERVATIONS

1) The keyways should be clean.
2) When it is required to tap a key, do it with a plastic hammer or a bronze punch.

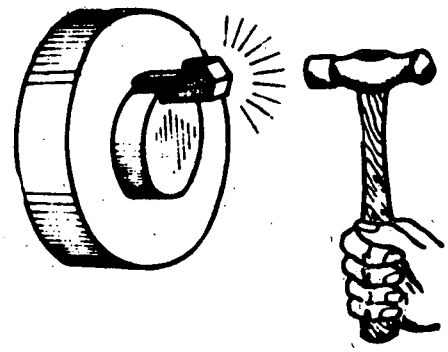


Fig. 9

Process III - Replacing the square key

1st Step - *Check the state of the key and keyway.*

2nd Step - *Align the keyways.*

3rd Step - *Put the key in its keyway.*

Process IV - Replacing the Woodruff key

1st Step - *Check the state of the key and keyway.*

2nd Step - *Put in the key* thus:

a) Replace the key in the keyway of the shaft, slightly tilting it forward (Fig. 10).

b) Align the shaft with its bore using the key and keyway as guides.

c) Put the shaft in its bore.

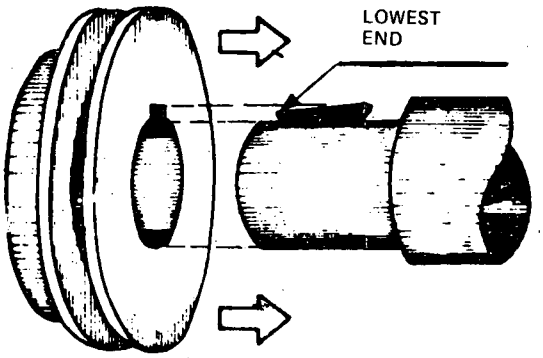


Fig. 10

Process V - Replacing the inset key

1st Step - *Check the state of the key and keyway.*

2nd Step - *Put in the key* thus:

a) Replace the key in the keyway of the shaft.

b) Align the shaft with its bore using the key and keyway as guides.

c) Put the shaft in its bore.

CBC

OPERATION:
REMOVING AND REPLACING CIRCLIPS
(Safety Rings)

This operation consists of removing or replacing circlips which limit the movements of a part to allow for disassembling or securing the part in a mechanical unit.

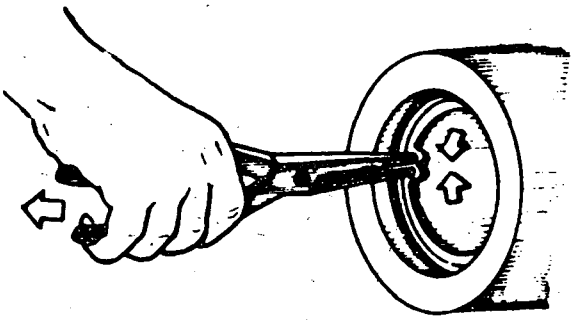
PROCEDURE

CASE I - REMOVING CIRCLIPS

Process I - Removing the inside circlip with holes

1st Step - *Remove the circlip* thus:

a) Place the circlip pliers in the holes of the clip.
b) Close the circlip and remove it (Fig. 1).



OBSERVATION
Use the pliers to close the circlip.

SAFETY MEASURE
CIRCLIPS SPRING EASILY: ALWAYS CONTROL THEIR SPRINGING ACTION TO AVOID ACCIDENTS. USE SAFETY GLASSES.

Process II - Removing exterior clip with holes

1st Step - *Remove the circlip* thus:

a) Place the appropriate circlip-pliers in the holes.
b) Open the circlip and remove it (Fig. 2).

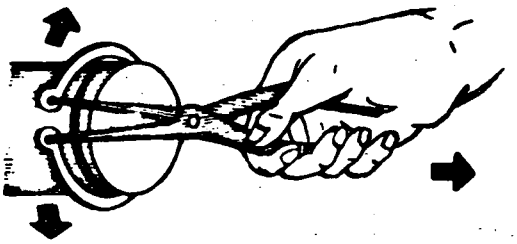


Fig. 2

OBSERVATION
Use the pliers to open circlips.

Process III - Removing the pointed inside circlip

1st Step - *Remove the circlip* thus:-

a) Hold one end of the circlip.

b) Lift the other end with a screwdriver using a circular motion to remove it (Fig. 3).

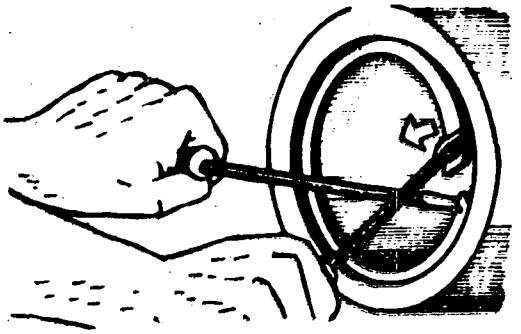


Fig. 3

Process IV - Removing the pointed outside circlip

1st Step - *Open the circlip* with the circlip pliers.

2nd Step - *Remove the circlip from its groove* and slide it along the shaft until it is removed (Fig. 4).

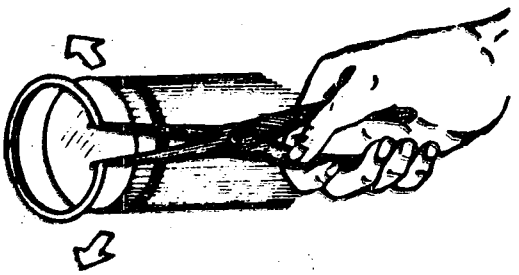


Fig. 4

CASE II - REPLACING CIRCLIPS

Process I - Replacing the inside circlip with holes.

1st Step - *Close the circlip* with the aid of the appropriate pliers.

2nd Step - *Place the circlip in its groove* and remove the pliers.

3rd Step - *Check the position of the circlip* and ensure that it is correctly seated.

Process II - Replacing the outside circlip with holes

1st Step - *Open the circlip* with the appropriate pliers.

2nd Step - *Place the circlip* in its groove and remove the pliers.

3rd Step - *Check the position* and fitting of the circlip.

CBC

OPERATION:

REMOVING AND REPLACING CIRCLIPS
(Safety Rings)

REF. OS.03/AgM | 3/3

Caribbean

Process III = Replacing the pointed inside circlip

1st Step = *Compress the circlip* and place it in the orifice.
2nd Step = *Slide the circlip to the groove.*
3rd Step = *Check the position* and fitting of the circlip.

Process IV = Replacing the pointed outside circlip

1st Step = *Open the circlip* and place it on the shaft.
2nd Step = *Slide it along the shaft to its groove.*
3rd Step = *Check the position* and fitting of the circlip.

OBSERVATION

Avoid scratching the shaft when sliding the circlip.

SAFETY MEASURE

USE SAFETY GLASSES OR A PROTECTING MASK WHEN WORKING WITH CIRCLIPS.

CBC

OPERATION:
REMOVING AND REPLACING PINS

REF. OS. 04/AgM | 1/2

Caribbean

This operation consists of removing and replacing pins so as to free or secure different components or machine parts.

PROCEDURE

CASE I - REMOVING PINS

Process I - Removing pressure pins

1st Step - *Loosen the pin* with a punch and hammer (Fig. 1).

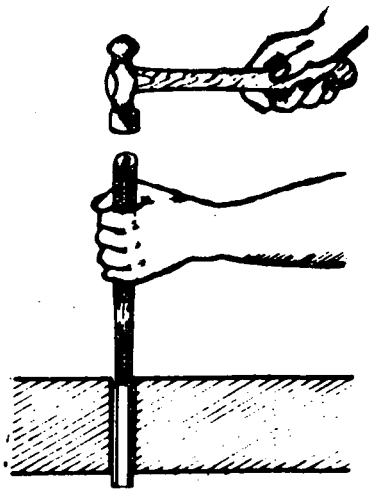


Fig. 1

OBSERVATION
Use a punch appropriate to the diameter of the pin.

SAFETY MEASURE
KEEP THE FACE OF THE HAMMER AND THE HEAD OF THE PUNCH CLEAN AND FLAT.

2nd Step - *Push out the pin* with an appropriate punch (Fig. 2).

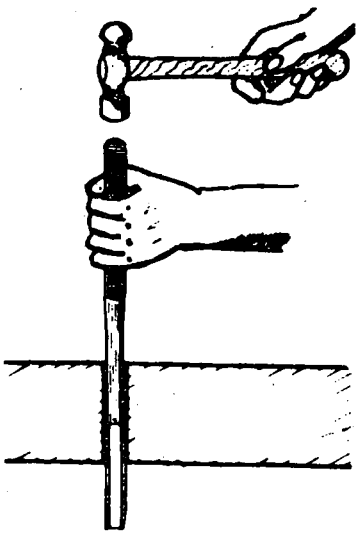


Fig. 2

Process II - Removing the Clevis pin

1st Step - *Extract the retaining element from the pin.*
2nd Step - *Push out the pin* with a punch and hammer.

CASE II - REPLACING PINS

Process I - Replacing the expansion pin

1st Step - *Check the state of the pin.*

2nd Step - *Repair or change the pin,* if damaged.

3rd Step - *Replace the pin* thus:-

a) Insert the pin, tapered end first (Fig. 3).
b) Be sure the pin fits correctly.
c) Tap the pin until it is completely driven in.

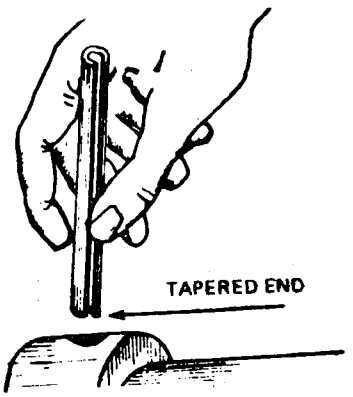


Fig. 3

Process II - Replacing the Clevis pin

1st Step - *Check the state of the pin.*

2nd Step - *Repair or change the pin,* if necessary, thus:

a) Replace the pin.
b) Secure it with the retaining element (Fig. 4).

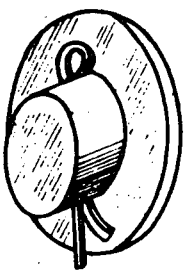


Fig. 4

CBC

OPERATION:
REMOVING AND REPLACING CLAMPS

This operation consists of loosening or tightening securing devices to remove or replace clamps. This allows for changing the clamp. It also allows for freeing or securing such parts as pipes and dust covers.

PROCEDURE

CASE I - REMOVING CLAMPS

Process I - Removing bolted or screwed clamps

1st Step - *Turn the bolt or nut* until the clamp is loose (Figs. 1 and 2).

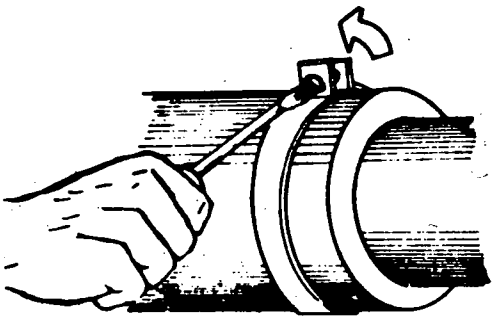


Fig. 1

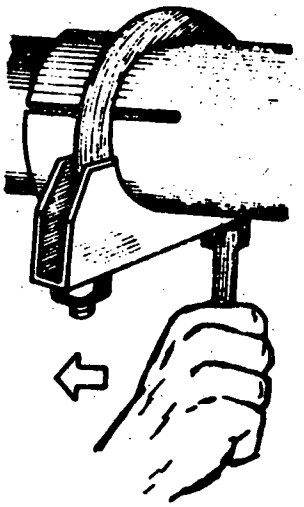


Fig. 2

2nd Step - *Shift the clamp* until the parts are free.

Process II - Removing spring clamps

1st Step - *Place the pliers* in such a way that the points hold the ends of the clamp (Fig. 3).

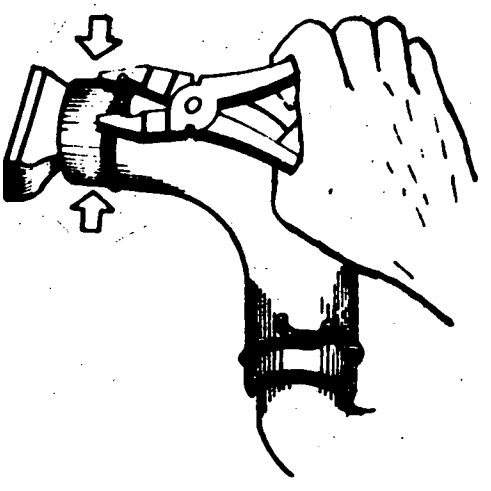


Fig. 3

2nd Step - *Squeeze the pliers* until the clamps open.

3rd Step - *Shift the clamp* until the parts are free.

Process III - Removing Jubilee Clamps

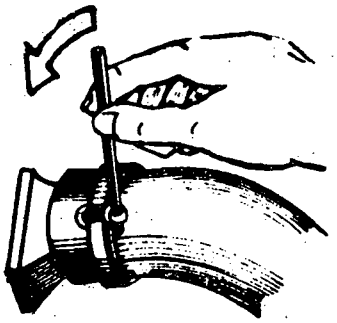


Fig. 4

1st Step - *Insert a pin in the head of the screw* (Fig. 4).
Turn the screw counter-clockwise until the clamp opens.

OBSERVATION
Sometimes it is necessary to remove the metal band from the screw.

Process IV - Removing notched clamps

a) Place the pliers so that the points hold both ends of the clamp (Fig. 5).
b) Exert pressure on the pliers trying to make both ends meet and at the same time lift the top band from the notch.

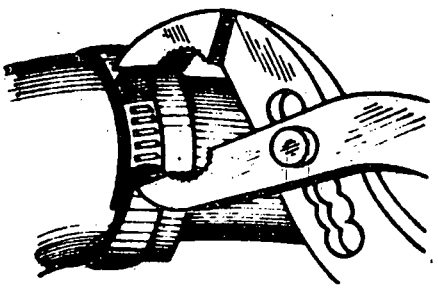


Fig. 5

CASE II - PLACING CLAMPS

Process I - Placing screwed clamps

1st Step - *Place the clamp* on the parts.
2nd Step - *Place the clamp* where it holds the parts better (Fig. 6).

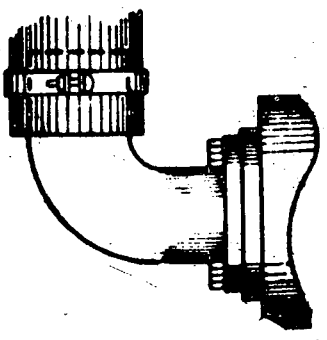


Fig. 6

3rd Step - *Tighten the screw or nut* until the clamp is fixed.

Process II - Placing spring clamps

1st Step - *Open the clamp* and insert the part.
2nd Step - *Place the clamp* where it holds the part better.

Process III - Placing Jubilee Clamps

1st Step - *Place the clamp* on the part.
2nd Step - *Insert a pin in the head of the screw.*
3rd Step - *Turn the screw* clockwise until the band of the clamp is closed.

Process IV - Replacing notched clamps

1st Step - *Place the clamp on the part.*
2nd Step - *Place the pliers* so that its ends hold the end of the clamp.

3rd Step - *Exert pressure* on the pliers forcing both ends together and at the same time press down the top of the clamp and engage the selected notch.

CBC

OPERATION:

REMOVING AND REPLACING COMPRESSION SPRINGS

This operation consists of removing or installing springs when checking their condition, changing them or when trying to gain access to other mechanisms.

PROCEDURE

CASE I - REMOVING COMPRESSION SPRINGS

Process I - Removing springs with a "C" spring compressor

1st Step - *Place the* fixed jaw of the compressor on the spring and the movable jaw on a flat base (Fig. 1).
2nd Step - *Close the compressor*
3rd Step - *Remove the safety lock* from the spring (pin or key) (Fig. 2).

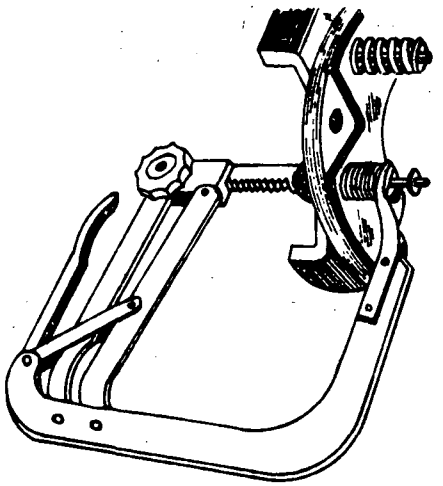


Fig. 1

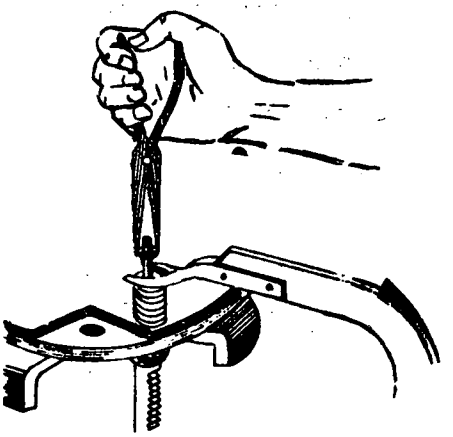


Fig. 2

4th Step - *Release the spring* by slowly opening the compressor.
5th Step - *Remove the compressor and the spring.*

SAFETY MEASURE

USE SAFETY GLASSES.

Process II - Removing springs with bolt or nut

1st Step - *Turn the bolt or nut* until the pressure of the spring is released (Fig. 3).

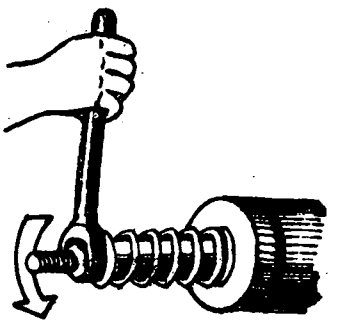


Fig. 3

2nd Step - *Remove the nut or bolt.*

3rd Step - *Remove the spring.*

SAFETY MEASURE

SOMETIMES WHEN THE SPRING IS TOO BIG, PRESSURE CANNOT BE RELEASED BY MEANS OF THE BOLT OR NUT. IN THIS CASE A COMPRESSOR SHOULD BE USED TO KEEP THE SPRING FROM FLYING OUT.

Process III - Removing springs with a lever compressor

1st Step - *Set the compressor* on an appropriate support (Fig. 4).

2nd Step - *Compress the spring* by pressing the lever.

3rd Step *Remove the safety lock, then remove the compressor and spring.*

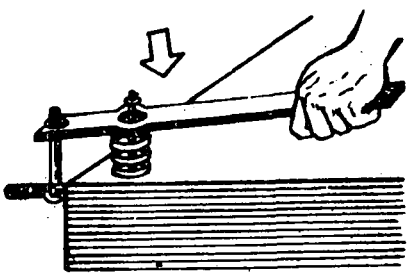


Fig. 4

Process IV - Removing springs with a plate compressor

1st Step - *Mount the plate* so that the holes coincide with the springs (Fig. 5).

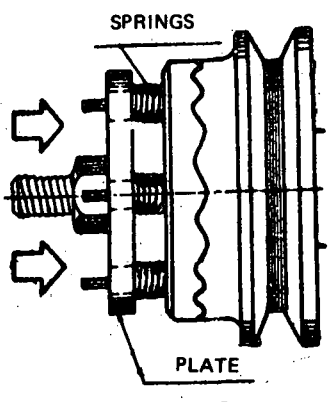


Fig. 5

OBSERVATION

To compress the springs, a nut and bolt or a hydraulic press may be used.

2nd Step - *Compress the springs.*

3rd Step - *Remove the safety locks.*

4th Step - *Remove the compressor and the springs.*

CASE II - REPLACING COMPRESSION SPRINGS

Process I - Replacing springs with a "C" spring compressor

1st Step - *Place the spring and its accessories* in their position.

OBSERVATION
When positioning the springs, be sure that the spirals are in the correct direction (Fig. 6).

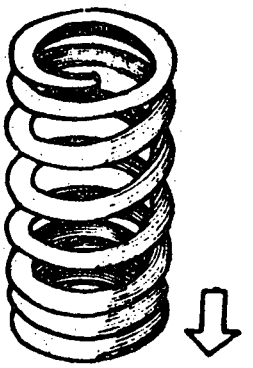


Fig. 6

2nd Step - *Place the compressor* (Fig. 1).
3rd Step - *Compress the spring.*
4th Step - *Replace the safety locks* (pin or key).

OBSERVATION
The safety lock must be well placed so as to keep the spring from flying out.

5th Step - *Decompress the spring* by slowly releasing the compressor.
6th Step - *Lightly tap* the centre of the spring with a plastic hammer to ensure its proper seating.

Process II - Replacing springs with nuts and bolts

1st Step - *Place the spring* with its accessories in its position.
2nd Step - *Turn the nut or bolt* until the spring is compressed.

OBSERVATION
The manufacturer's instructions should be consulted to ascertain whether the spring has a specific rating or tension.

Process III - Replacing springs with lever compressor

1st Step - *Position the spring and its accessories* in their place.
2nd Step - *Place the compressor* (Fig. 4).
3rd Step - *Compress the spring.*
4th Step - *Install the safety lock.*
5th Step - *Decompress the spring.*
6th Step - *Test the action of the spring and seating.*

Process IV - Replacing springs with plate compressor

1st Step - *Position the springs and their accessories* in their place.
2nd Step - *Install the plate* (Fig. 5).
3rd Step - *Compress the springs.*
4th Step - *Install the safety locks one by one.*
5th Step - *Decompress the springs.*
6th Step - *Check the action and seating of the spring* by lightly tapping the centre of each spring with a plastic hammer.

TECHNICAL VOCABULARY

Rating - Setting (springs)

This operation consists of checking the springs using testing tools and instruments for the purpose of determining their condition.

PROCEDURE

1st Step - *Check the alignment* thus:

a) Place the spring beside a square on a flat surface (Fig. 1).
b) Slowly turn the spring to determine if it is at right angles with the square.

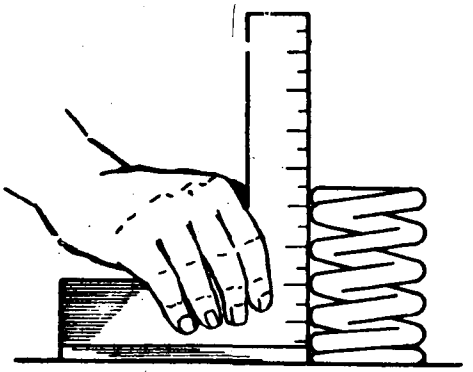


Fig. 1

OBSERVATION
The spring is aligned when all its spirals make uniform contact with the edge of the square.

2nd Step - *Check the free height* thus:

OBSERVATION
Consult the manufacturer's instructions for the free height.

a) Place the spring on a flat surface beside a rule or a graded square (Fig. 1).
b) Measure the height and compare it with specifications.

3rd Step - *Check the tension* thus:

a) Place the spring in the tester.

b) Compress the spring to the specified height and observe the reading on the scale (Figs. 2 and 3).

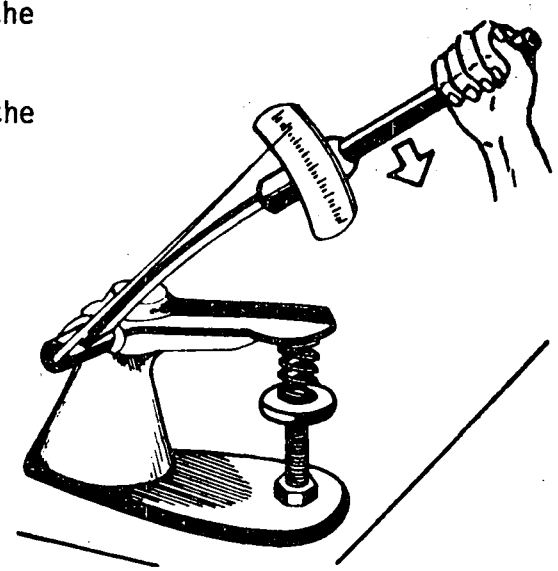


Fig. 2

OBSERVATION

If the spring is not within specifications, it should be changed.

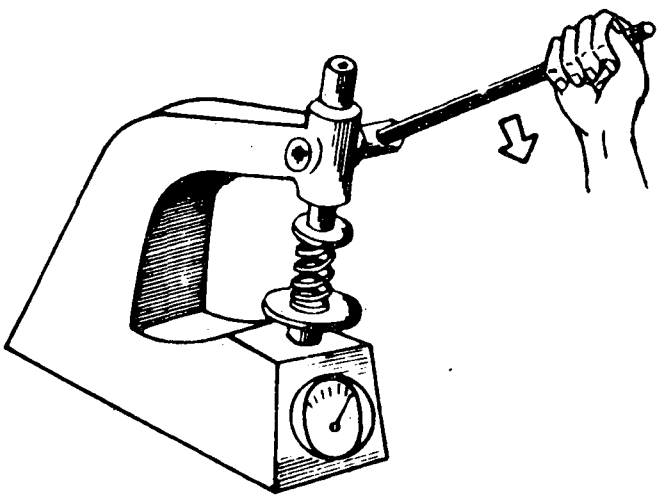


Fig. 3

SAFETY MEASURE

WHEN CHECKING SPRING TENSION IN THE TESTER, USE SAFETY GLASSES OR PROTECTIVE MASK.

CBC

OPERATION:
SHARPENING DISCS

REF. OS.08/AgM | 1/2

Caribbean

This operation consists of grinding in the angle of the cutting edge of the discs with the purpose of sharpening them.

PROCEDURE

1st Step - *Trace the width of the bevel* thus:

OBSERVATION
Consult specifications to obtain the width of the bevel.

a) Measure and mark the width of the bevel (Fig. 1).

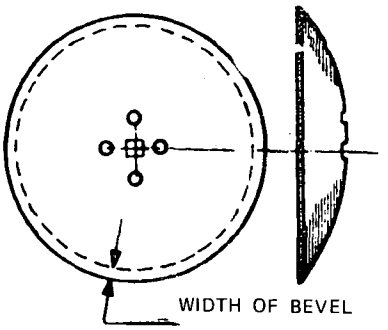


Fig. 1

b) Trace the circumference which determines the width of the bevel.

2nd Step - *Grind* until obtaining the bevel thus:

SAFETY MEASURE
USE PROTECTIVE GLOVES.

a) Mount the disc on the support and tighten it.

b) Place the grinder so that the grinding wheel keeps the cutting angle (Fig. 2).

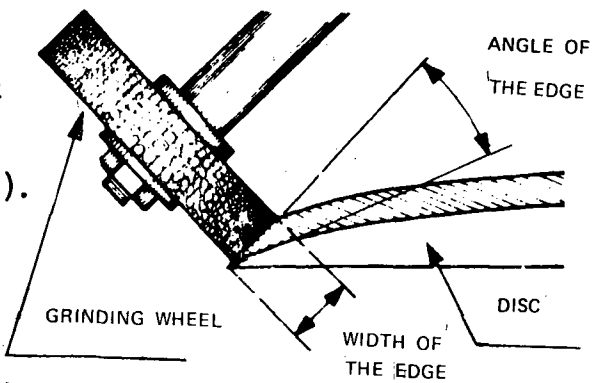


Fig. 2

SAFETY MEASURE
USE SAFETY GLASSES.

c) Start the grinder.

OBSERVATION
Dress the grinding wheel if necessary.

d) Grind the bevel by uniformly turning the disc until obtaining the desired sharpness and width.

OBSERVATION
The sharpening of the notches in a cut away disc is done independently of that of the edges (Fig. 3).

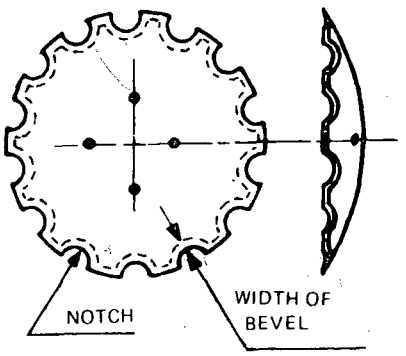


Fig. 3

TECHNICAL VOCABULARY

Scalloped edge disc - Cut-away disc

CBC

OPERATION:
RIVETING

REF. OS.09/AgM | 1/2

Caribbean

This operation consists of flattening the end of a rivet placed in the corresponding hole until it forms a head which holds and secures the assembly. By riveting, two or three pieces (Fig. 1) can be joined in a fixed position.

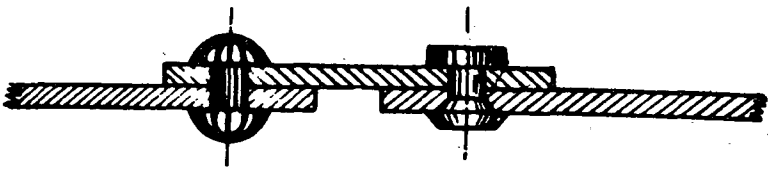


Fig. 1

PROCEDURE

1st Step - *Mark the position of the holes.*

2nd Step - *Drill the parts.*

OBSERVATION
Whenever possible, simultaneously drill the parts to be riveted to ensure the correct position of the holes.

3rd Step - *Countersink the holes.*

OBSERVATION

1) In rivets with flat or snap head, the borders of the holes should be lightly countersunk (Fig. 2). This slight countersink makes the edge not so sharp.

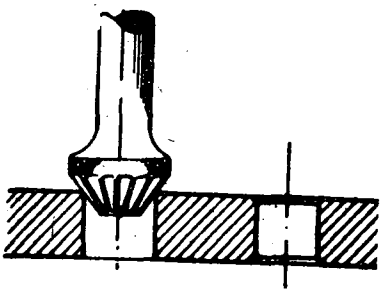


Fig. 2

2) In rivets with countersunk heads a deeper countersink must be made to allow for the placing of the head (Fig. 3).

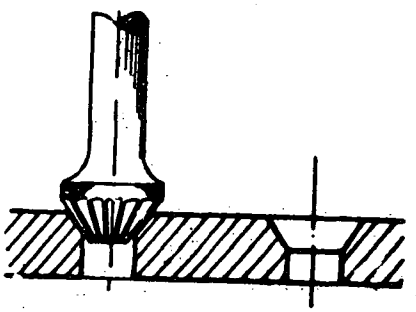


Fig. 3

4th Step - *Hammer the rivet* thus:

a) Insert the rivet in the hole.

b) Place a snap under the head.

c) Bring the parts together by using the set and hammer (Fig. 4).

d) Hold the parts with a vice grip.

e) Gently tap the edges of the rivet to start sharpening the head (Fig. 5)

f) Finish with the aid of a snap and hammer (Fig. 6).

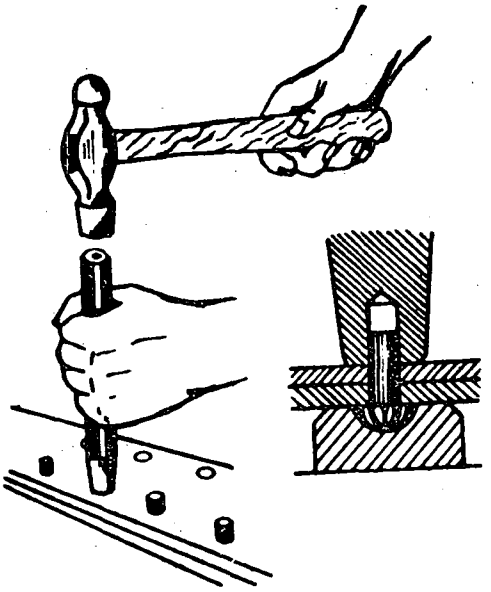


Fig. 4

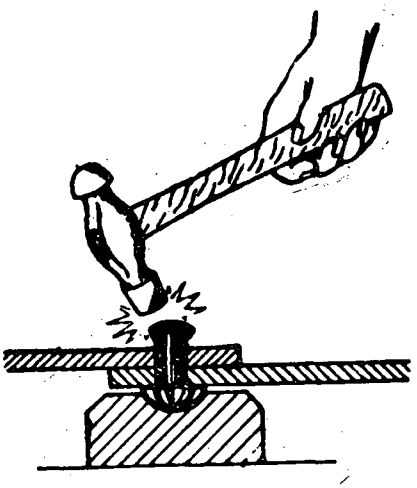


Fig. 5

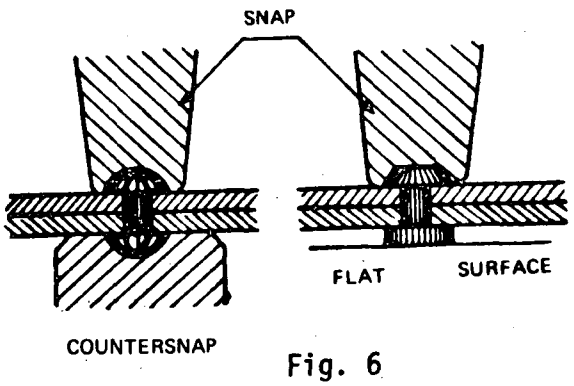


Fig. 6

OBSERVATION

When the end which is to be riveted must be countersunk, a supporting snap is not required.

5th Step - *Hammer the other rivets* following the procedure in Step 4.

CBC

OPERATION:

CHECKING CLYINDRICAL SHAFTS

This operation is done to determine visually and with instruments the wear and distortion of the shafts. Checks are made for pitting, scores, surface cracks, misalignment, taper, free play and ovalness.
The objective of the operation is to determine whether the shafts should be repaired or changed.

PROCEDURE

CASE I - INSPECTING VISUALLY AND BY TOUCH

1st Step - *Check the shaft* and see if there are any surface cracks, pittings or noticeable wear.

OBSERVATION
If damage or wear is very evident it is not necessary to continue checking.

CASE II - CHECKING THE ALIGNMENT

Process I - Checking the alignment on a surface plate

1st Step - *Place the shaft on the surface plate.* See that both are completely clean.

2nd Step - *Roll the shaft* and observe whether it rolls uniformly on the surface plate (Fig. 1).

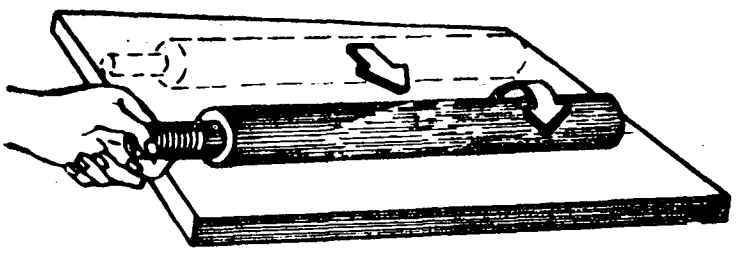


Fig. 1

Process II - Checking the alignment with a precision straight edge

1st Step - *Place the straight edge lengthwise on the shaft* and observe the contact between both (Fig. 2).

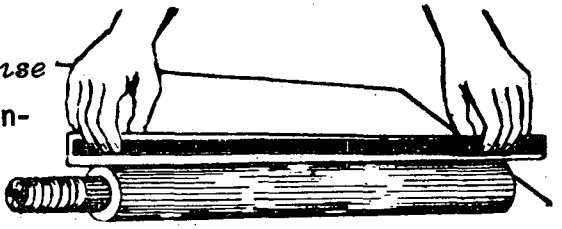


Fig. 2

OBSERVATION

The alignment is right when the straight edge touches the shaft without leaving any light along its entire length.

2nd Step - *Repeat the check in various lengthwise positions* by rotating the shaft.

Process III - Checking the alignment with a surface gauge or dial gauge

1st Step - *Position the axle* for checking thus:

a) Place the "V" blocks on the surface plate.

b) Place the ends of the shaft on the blocks.

2nd Step - *Position the surface gauge* with the point touching the surface of the middle of the shaft (Fig. 3).

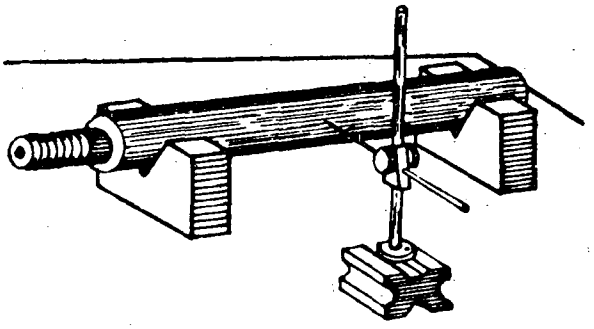


Fig. 3

3rd Step - *Rotate the shaft slowly* and observe the contact between the point of the surface gauge and the shaft

OBSERVATIONS

1) The alignment is right when the point of the gauge constantly touches the surface of the shaft.

2) To find out the degree of misalignment, use the dial gauge applying the same procedure as with the surface gauge.

3) Consult specifications to find out if the shafts are within the manufacturer's tolerances.

CASE III - CHECKING THE WEAR

Process I - Check the taper

1st Step - *Use a micrometer or a vernier caliper* to measure the diameter at one end of the shaft (Fig. 4).

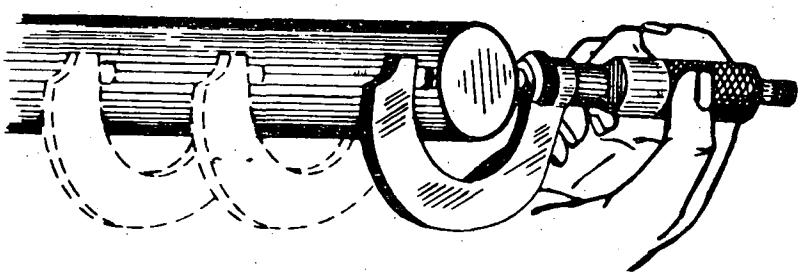


Fig. 4

2nd Step - *Carry out other subsequent measurements* along the length of the shaft.

3rd Step - *Check whether there is taper*. Compare the measurements with the original one.

OBSERVATIONS

1) The original measurement is obtained from specifications or from the parts which have not been subjected to any friction.

2) The shaft is cylindrical when the measurements are equal.

Process II - Check the ovalness

1st Step - *Measure the diameter of the shaft with a micrometer or a vernier caliper.*

Carry out several measurements around the shaft and on the same plane (Fig. 5).

Compare the measurements taken on the shaft.

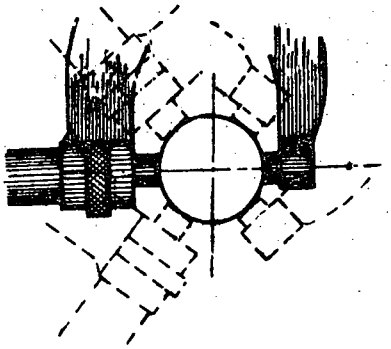


Fig. 5

OBSERVATION

The shaft is cylindrical when all measurements are equal.

CBC

OPERATION:

CHECKING CYLINDERS

REF. OS.11/AgM 1/2

Caribbean

This operation is done to determine visually and with instruments the wear and deformation of the cylinders. Checks are made for pitting, surface cracks, taper, free play and ovalness. The objective of the operation is to determine whether the cylinders should be trued or changed.

CASE I - INSPECTING VISUALLY AND BY TOUCH

1st Step - *Check the cylinder* and see if there are surface cracks, scores, steps or other noticeable wear.

OBSERVATION
If the damage or wear is very evident, it is not necessary to continue checking.

CASE II - USING PRECISION INSTRUMENTS TO CHECK WEAR

Process I - Checking ovalness

1st Step - *Position the dial gauge inside the cylinder (Fig. 1).*

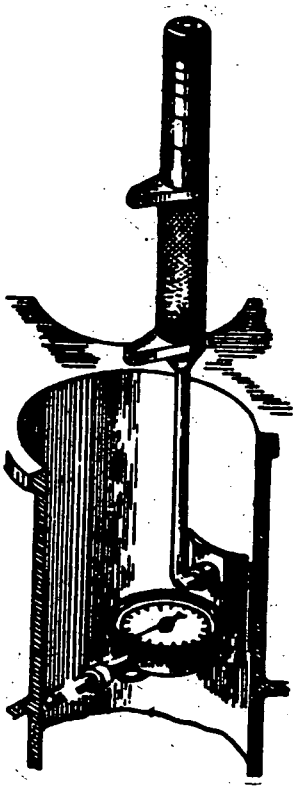


Fig. 1

OBSERVATION
The dial must be perpendicular to the walls of the cylinder.

2nd Step - *Carry out measurements around the cylinder* at the same height or plane and observe the readings on the dial.

OBSERVATIONS

1) Equal readings indicate that the hole is cylindrical. Check the tolerances for ovalness given by the manufacturer.
2) To check ovalness of a cylindrical hole use an inside micrometer. Follow the same procedure as with shafts.

Process II - Checking for taper

1st Step - *Place the dial gauge inside the cylinder.*

2nd Step - *Carry out several lengthwise measurements of the cylinder* and observe the different readings on the dial.

OBSERVATIONS

1) Equal readings indicate that the hole is cylindrical. Consult specifications for tolerances.
2) To check the taper of a cylindrical hole use an inside micrometer. Follow the same procedure as that for shafts.

CBC

OPERATION:
DISASSEMBLING SAFETY MECHANISMS

This operation consists of removing different components of a safety mechanism (discs, springs, nuts and bolts) in order to clean or repair them as well as to allow access to other mechanisms of the machine.

PROCEDURE

Process I - Disassembling the safety mechanism of the sliding friction disc clutch (Fig. 1).

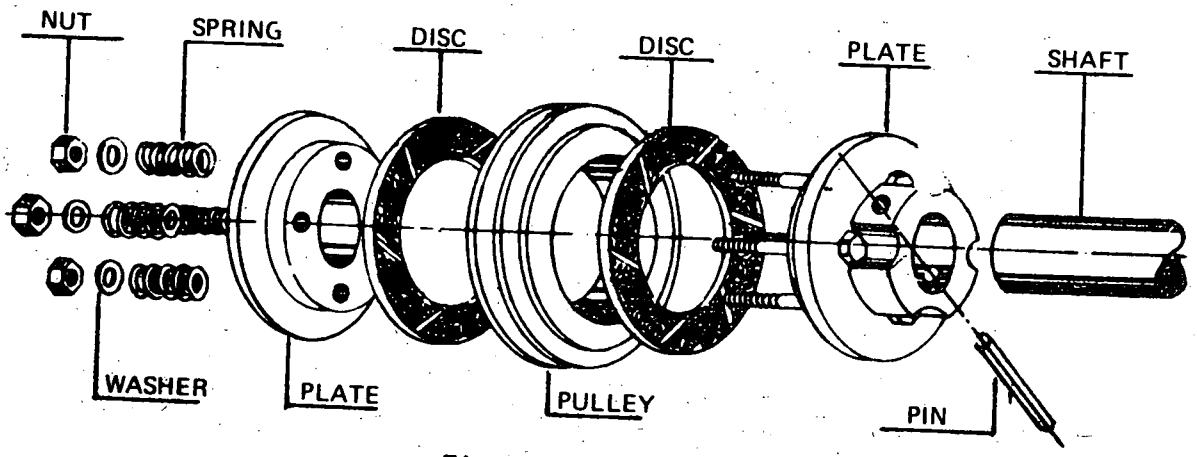


Fig. 1

1st Step - *Disassemble the mechanism* thus:-

a) Slacken the springs, gradually loosening the nuts in an alternate manner.

SAFETY MEASURE

EXERCISE CAUTION WITH THE SPRINGS. IF NECESSARY, USE A COMPRESSOR TO RELIEVE THE TENSION.

OBSERVATION

Use the appropriate spanner and compressor.

b) Remove the nuts.
c) Remove the flat or cop washers.
d) Remove the springs.
e) Remove the pressure plate.
f) Remove the first friction disc.
g) Remove the gear or pulley
h) Remove the second friction disc.

i) Remove the fixed plate by taking out the lock.

2nd Step - *Clean the elements of the safety mechanisms* thus:

a) Wash the elements of the safety mechanism with kerosene.

OBSERVATION

Use a degreaser to clean the friction discs.

b) Use a clean rag or pressurized air to dry the elements of the safety mechanism.

Process II - Disassembling the toothed disc clutch safety mechanism (Fig. 2).

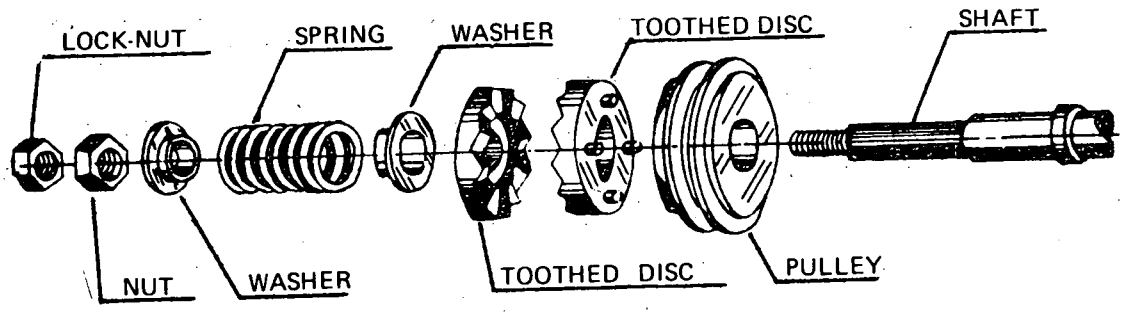


Fig. 2

1st Step - *Disassemble the mechanism* thus:

a) Remove the lock-nut by holding the nut with a spanner.
b) Remove the nut.
c) Remove the top washer.
d) Remove the spring.
e) Remove the second washer.
f) Remove the toothed disc.
g) Remove the disc which is coupled to the pulley or propeller gear.
h) Remove the gear or pulley.

2nd Step - *Clean the parts of the mechanism.*

Process III - Disassembling the sprocket safety mechanism (Fig. 3)

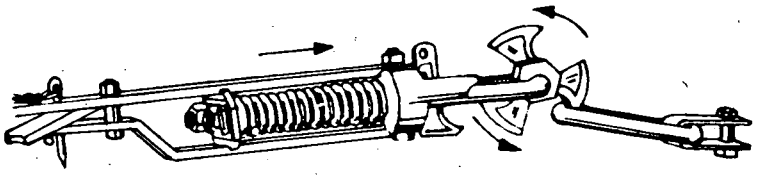


Fig. 3

1st Step - *Disassemble the mechanism* thus:

a) Loosen the nuts alternately so as to release tension from the springs.
b) Remove the clamp with the hook.
c) Remove the spring or springs.

2nd Step - *Clean the parts of the mechanism.*

Process IV - Disassembling safety mechanisms which use shear pins (Fig. 4).

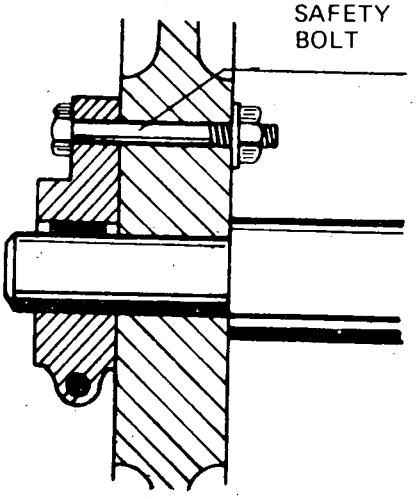


Fig. 4

1st Step - *Disassemble the mechanism* thus:

a) Loosen and remove the nut.
b) Remove the bolts.

OBSERVATION

If the bolt has been cut because of excess load, use a punch to remove it.

2nd Step - *Clean the parts of the mechanism.*

OBSERVATION

There are different types of securing mechanisms. Therefore, consult the manual in each case.

TECHNICAL VOCABULARY

Safety bolt - shear pin

This operation consists of checking, repairing and/or changing the different parts which make up the safety mechanisms (discs, springs, nuts and bolts). It also includes replacing and correctly adjusting them in order to ensure a good functioning of the machine.

PROCEDURE

CASE I - FRICTION DISC CLUTCH

Process I - Repairing the mechanism

1st Step - *Check the linings* thus:

a) Check the wear of the linings.

OBSERVATION

In riveted linings the wear is limited by the rivet heads and in bonded linings, by the grooves which indicate minimum thickness (Figs. 1 and 2).

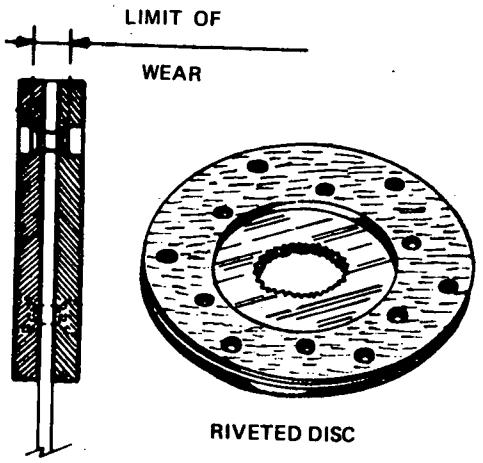


Fig. 1

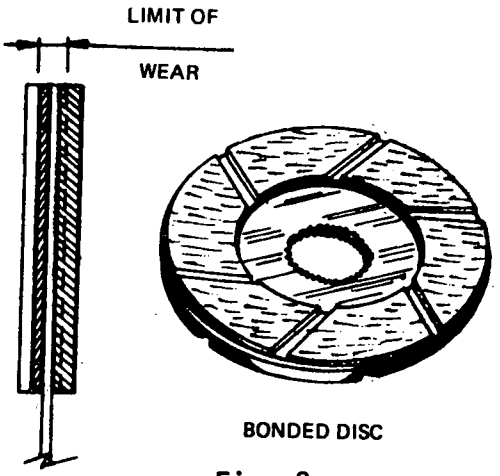


Fig. 2

b) Check for fractures or fissures.

OBSERVATION

The disc should be changed if there are fractures, surface cracks or excessive wear.

2nd Step - *Repair the discs* thus:

a) Remove the worn out linings.

b) Clean the metal discs.

OBSERVATION
When there are chips or surface cracks on the metal discs, change the disc.

c) Be sure the lining and the disc fit correctly (size, holes).
d) Rivet or bond the linings using the appropriate parts.

3rd Step - *Check the springs.*

4th Step - *Check nuts and bolts.*

Process II - Assembling the mechanism

1st Step - *Assemble the mechanism,* reversing the disassembling process.

OBSERVATION
For better functioning it is best to lightly lubricate the shaft (Fig. 3). Take care that oil or grease does not reach the friction surfaces.

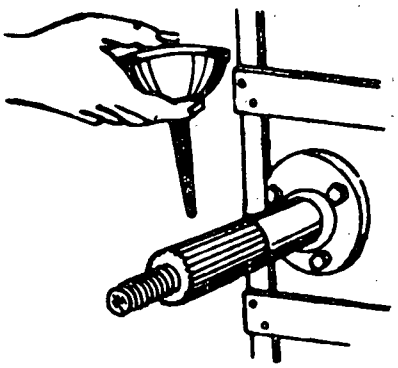


Fig. 3

Process III - Regulating the mechanism

1st Step - *Make the regulating nuts touch the springs.* Do not apply tension (Fig. 4).

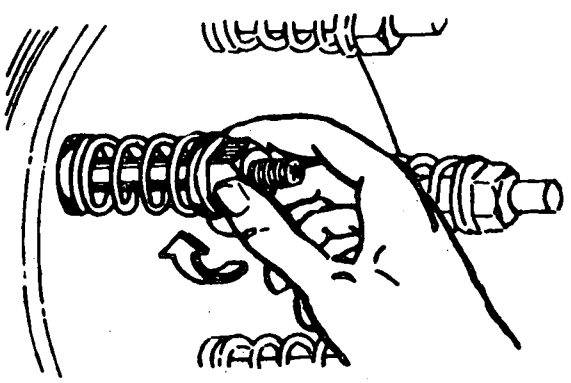


Fig. 4

2nd Step - *Tighten the nuts alternately.* Give an equal number of turns to all nuts on the tension bolts.

3rd Step - *Turn the part of the machine protected by the safety mechanism.* See if the movement is transmitted.

SAFETY MEASURE

BE CAREFUL WITH YOUR HANDS WHILE TURNING THIS PART OF THE MACHINE.

4th Step - *Uniformly regulate the nuts* applying or reducing pressure on the springs until the required tension is achieved.

OBSERVATION

Turn the machine part for each regulation of the nut.

5th Step - *Lock the nuts using the lock-nuts* (Fig. 5).

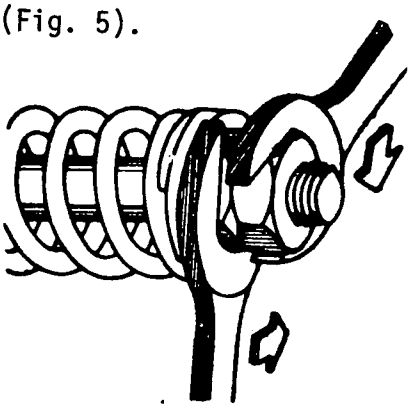


Fig. 5

OBSERVATIONS

1) If the mechanism has only one regulating spring, tighten the corresponding nut.
2) To regulate the different safety clutches, consult manufacturer's specifications.

CASE II - TOOTHED PLATE CLUTCH

Process I - Repairing the mechanism

1st Step - *Verify the discs* thus:

a) Check the wear of the toothed surfaces.

b) Check for surface cracks or fractures.

OBSERVATION
If there are surface cracks, fractures or excessive wear, change the discs.

2nd Step - *Check the state of the springs.*

3rd Step - *Check nuts and bolts.*

Process II - Assembling the mechanism

4th Step - *Assemble the mechanism,* reversing the disassembling process.

Process III - Regulating the mechanism

5th Step - *Uniformly regulate the nuts* until the required tension is achieved.

OBSERVATION
Bear in mind the regulating process used with the friction plate clutch.

CASE III - SPROCKETS

Process I - Repairing the mechanism

1st Step - *Check the mechanism* thus:
a) Check the wear.
b) Check for surface cracks or fractures.
c) Check the tension of the springs.

2nd Step - *Repair the damaged or worn parts.*

OBSERVATION
If there are surface cracks, fractures or excessive wear, change the mechanism or its parts.

Process II - Assembling the mechanism

1st Step - *Assemble the parts.* Prevent the spring from flying out during the operation.

Process III - Regulating the mechanism

1st Step - *Adjust the mechanism* according to manufacturer's specifications.

CASE IV - SAFETY BOLT

1st Step - *Replace the bolt.*

OBSERVATIONS

1) If a part of the bolt is jammed, remove it with a punch and hammer.

2) Warning! These bolts are made of special material and must correctly match the diameter of the hole.

2nd Step - *Check the functioning of the machine.*

CBC

OPERATION:

REMOVING, REPAIRING AND MOUNTING BELTS

The objective of this operation is to remove the belt in order to change it, allow access to other mechanisms or to repair it, if flat. The operation is completed with the mounting of the belt.

PROCEDURE

CASE I - REMOVING THE BELT

1st Step - *Remove the guard.*

SAFETY MEASURE

BEFORE STARTING THE OPERATION, THE MACHINE SHOULD BE COMPLETELY SWITCHED OFF.

2nd Step - *Release tension from the belt* by loosening the belt-tightener or shifting one of the pulleys (Figs. 1 and 2).

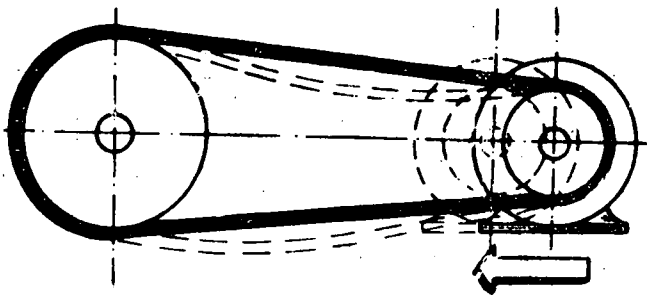


Fig. 1

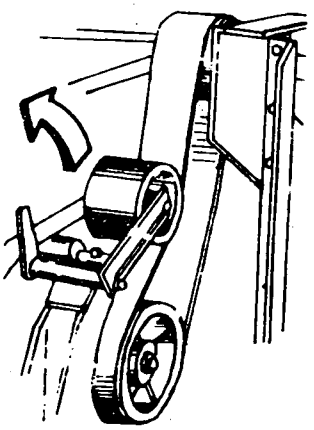


Fig. 2

3rd Step - *Remove the belt.*

CASE II - REPAIRING THE BELT

Process I - Bonded flat belt

1st Step - *Cut the ends of the belt on a board* using a wet knife. The cuttings should be square (Fig. 3).

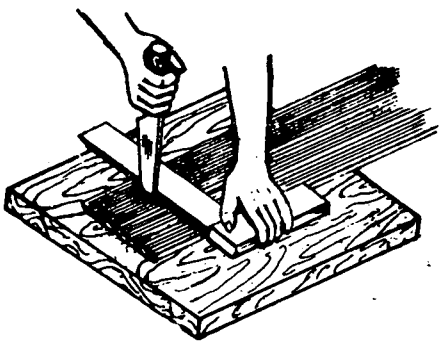


Fig. 3

2nd Step - *Bevel the ends of the belt with the knife* to a length equal to one and one half times the width of the belt (Fig. 4).

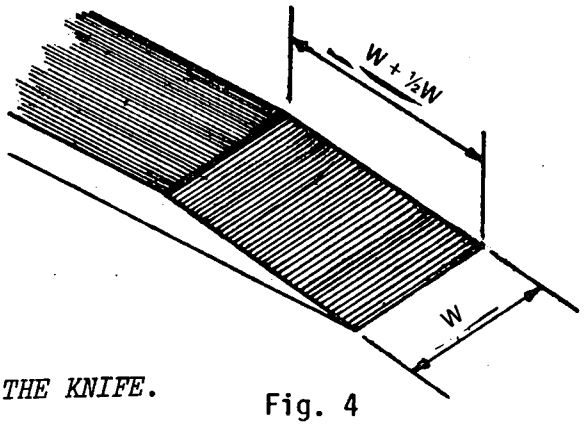


Fig. 4

CAUTION
BE CAREFUL WITH THE BLADE OF THE KNIFE.

3rd Step - *Apply contact cement on both bevels.* Allow the cement to act for the time specified by the manufacturer.

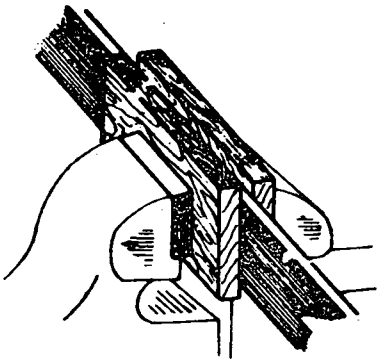


Fig. 5

4th Step - *Place one end on the other and press them* between two boards the width of the belt (Fig. 5).

Process II - Sewn flat belt

1st Step - *Repeat steps 1 and 2 of Process I.*

2nd Step - *Perforate both ends* with a punch of the required diameter (Fig. 6).

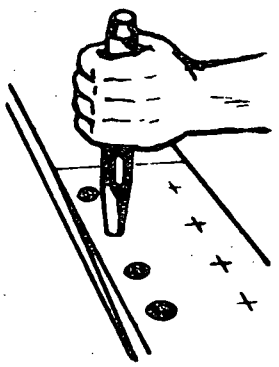


Fig. 6

OBSERVATION
The holes on both ends must fit together.

3rd Step - *Sew with rawhide strips* tensing each stitch well (Fig. 7).

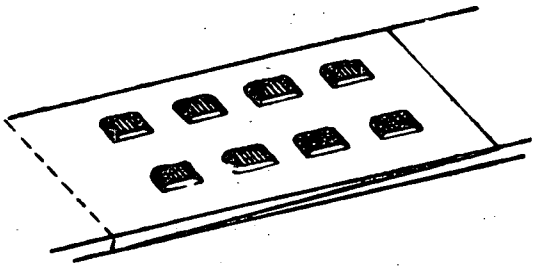


Fig. 7

CBC

OPERATION:

REMOVING, REPAIRING AND MOUNTING BELTS

REF. OS.14/AgM | 3/5

Caribbean

For sewing use a sequence similar to that of figures 8 and 9.

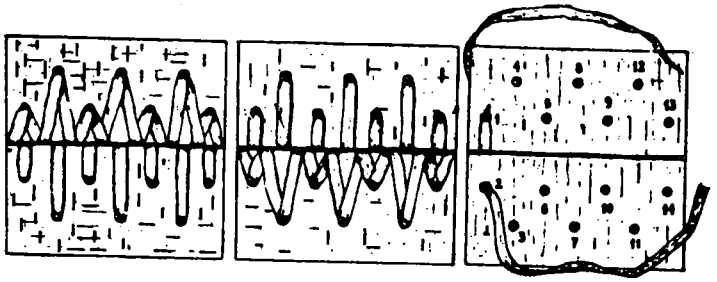


Fig. 8

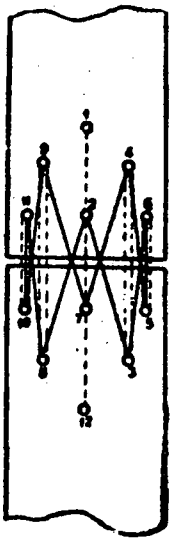


Fig. 9

Process III - Riveted flat belt

1st Step - *Cut the ends of the belt on a board.* Use a wet knife. The cuttings should be square (Fig. 3).

2nd Step - *Bevel the ends of the belt with the knife* to a length equal to one and one half times the width of the belt (Fig. 4).

3rd Step - *Perforate both ends* with a punch of the appropriate diameter (Fig. 6).

4th Step - *Place the rivets.*

5th Step - *Insert the washer and rivet* with the ball of the hammer (Fig. 10).

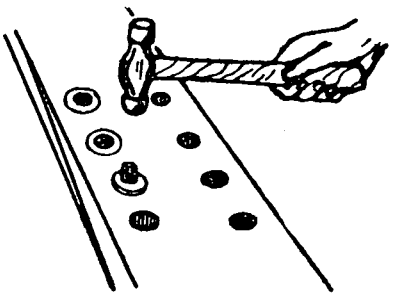


Fig. 10

OBSERVATIONS

1) The heads of the rivets must be on the inside of the belt.
2) Use the appropriate rivets for belts.

Process IV - Clamped Belt

1st Step - *Repeat the 1st step of Process III.*

2nd Step - *Cut the row of clamps* to the width of the belt.

3rd Step - *Mount the clamp squarely* at the end of the belt. Leave space for the pin (Fig. 11).

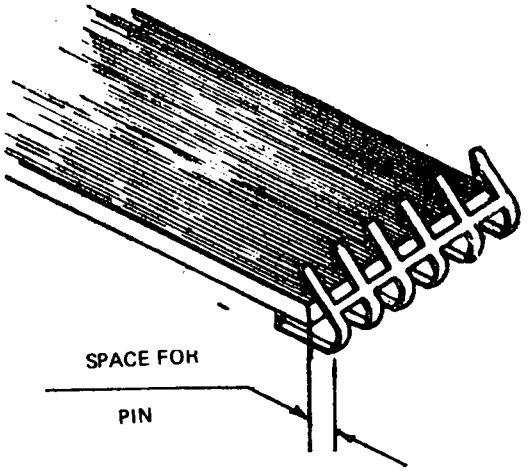


Fig. 11

4th Step - *Hammer the points of the clamps on an anvil* (Fig. 12). You can also press them in the vice (Fig. 13).

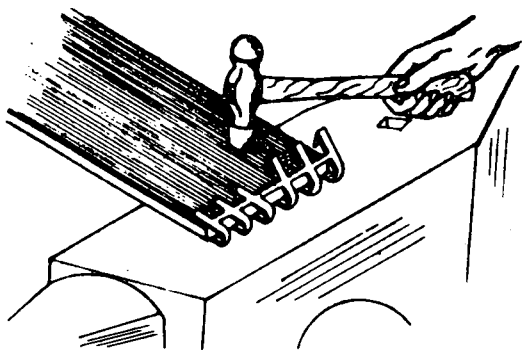


Fig. 12

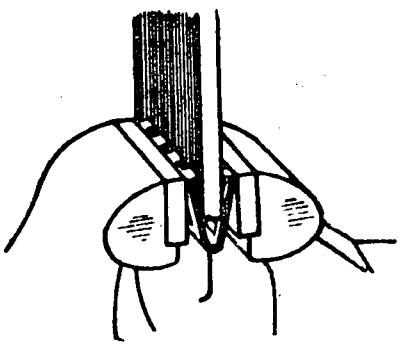


Fig. 13

5th Step - *Repeat the process on the other end of the belt.*

6th Step - *Insert the pin.*

CASE III - MOUNTING THE BELT

1st Step - *Place the belt on the pulleys.*

2nd Step - *Apply adequate tension* according to manufacturer's specifications.

CBC

OPERATION:

REMOVING, REPAIRING AND MOUNTING BELTS

REF. OS.14/AgM | 5/5

Caribbean

OBSERVATIONS

1) Dust, oil and grease on the belts produce loss of power by slipping. The accumulation of these destroys the belts.

2) Adhesives are used on flat belts. Consult manufacturer's specifications.

3) Readjust the tension of new belts after the first forty-eight hours of use.

This operation consists of removing different types of chains with the purpose of cleaning and checking them to find out if they should be repaired by changing links and pins or replaced if such is the case. The operation is completed by mounting the chain.

PROCEDURE

CASE I - REMOVING CHAINS

Process I - Removing flat chains

1st Step - *Release chain tension* (Fig. 1).

2nd Step - ***Remove the chain.***

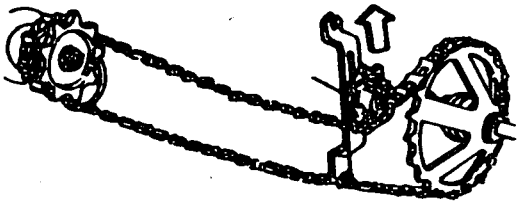


Fig. 1

3rd Step - *Wash the chain* thus:

a) Put the chain in kerosene until the dirt softens, then clean it with a brush and compressed air.
b) Rinse it and apply compressed air.

4th Step - *Check the lengthwise play* thus:

a) Fix the end of the chain on a flat surface (Fig. 2).

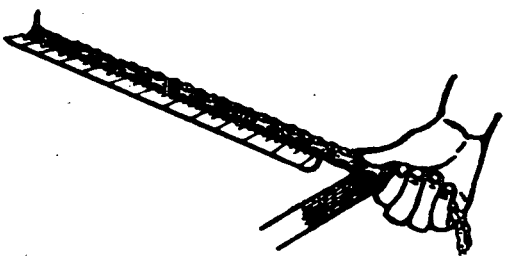


Fig. 2

b) Measure the lengthwise play by comparing the actual length of the pitch of the links with the original. The difference in length determines wether it is in a working condition.

5th Step - *Check the flexion* thus:

a) Hold the chain on edge (Fig. 3).
b) Observe the bending.

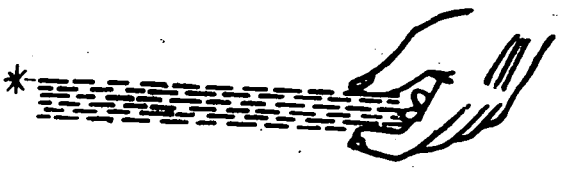


Fig. 3

OBSERVATION

This checking is done on timing chains. It is in good condition when it remains straight.

6th Step - *Check the links* thus:

a) Check for pitting.

b) Check for breaks.

c) Check for bending.

7th Step - *Change links* thus:-

a) Fold the chain at the link to be changed.

b) Slide the link sideways until it comes out (Fig. 4). Gently tap it with a hammer until it is removed.

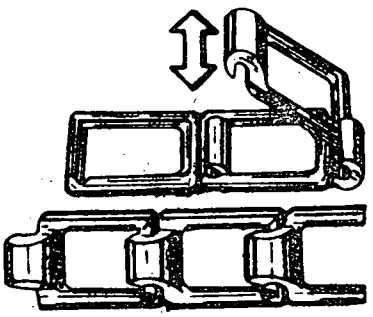


Fig. 4

c) To mount the link, install it in the groove of the other link and slide it into its working position.

Process II - Removing roller chains

1st Step - *Remove the lock from the master pin.*

2nd Step - *Remove the pin*

3rd Step - *Remove the chain.*

4th Step - *Wash the chain.*

5th Step - *Check the chain.*

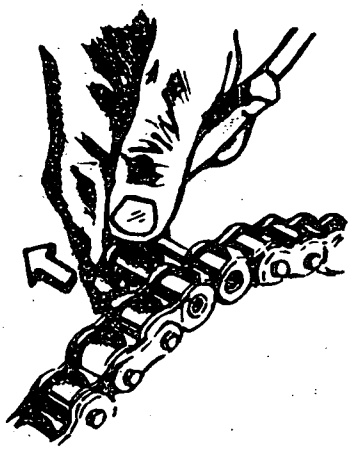


Fig. 5

6th Step - *Check the links.*

7th Step - *Change the links* thus:

a) Remove the securing element.
b) Remove the pin and the link.
c) Mount the new link.
d) Install the pin.
e) Place the securing element.

OBSERVATION
In some chains, the links are riveted.

8th Step - *Lubricate the chain* thus:

a) Put the chain in hot oil until all its parts are soaked (Fig. 6).

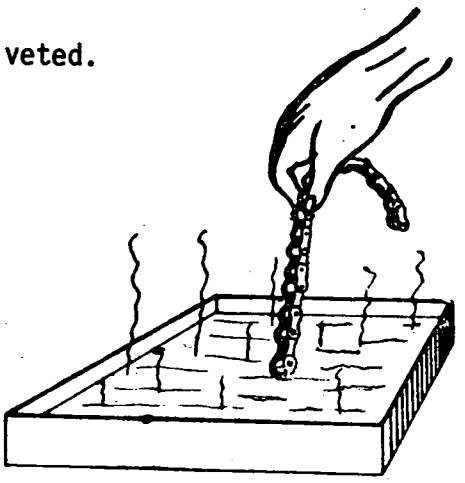


Fig. 6

b) Take out the chain and let it drain.

OBSERVATIONS
1) This step is carried out only on roller chains.
2) Flat chains are not lubricated.

Process III - Removing timing chains

OBSERVATION
This chain is removed by taking out the sprockets (Fig. 7).

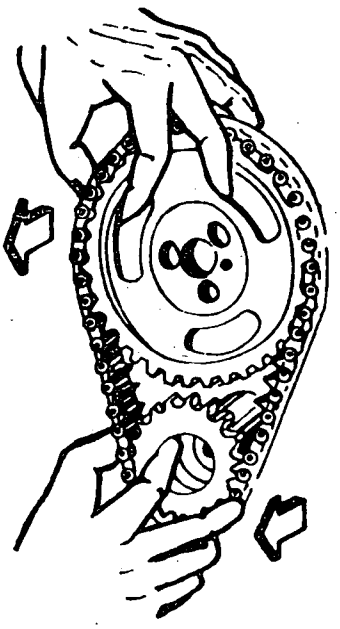


Fig. 7

1st Step - *Remove the securing locks* from the sprockets.
2nd Step - *Remove the pinions progressively and alternately* to avoid tensing the chain.
3rd Step - *Remove the chain and wash it.*
4th Step - *Check the chain.*

OBSERVATION
This type of chain cannot be repaired. If it is in bad condition, discard it.

CASE II - MOUNTING CHAINS

Process I - Mounting flat chains

1st Step - *Clean the gears, tighteners and chains.*
2nd Step - *Place the chain.*
3rd Step - *Tighten the chain*

OBSERVATIONS
1) Before mounting the chains, it is advisable to check the state of the gears.

2) When mounting the flat chain, observe its functioning position.

Process II - Mounting roller chains

1st Step - *Clean the gears and the chain.*
2nd Step - *Place the chain.*
3rd Step - *Place the pin.*
4th Step - *Place the locks of the master pin.*

Process III - Mounting timing chains

1st Step - *Wash chain and sprockets*
2nd Step - *Place the chain on the sprockets.*

3rd Step - *Set sprockets with reference to their shafts.*

4th Step - *Place the sprockets progressively and alternately.*

5th Step - *Place the securing locks of the sprockets.*

CBC

OPERATION:
REMOVING AND MOUNTING GEARS AND PULLEYS

This operation consists of removing gears and pulleys to determine if they should be repaired, or changed or to allow access to other mechanisms. The operation also includes mounting the part.

PROCEDURE

CASE I - REMOVING GEARS OR PULLEYS

Process I - Removing gears or pulleys with the extractor

1st Step - *Remove the fastening device of the gear or pulley.*

2nd Step - *Install the extractor* (Fig. 1). Place it on the edges of the gear. You may also fix it in the extraction holes of the pulley.

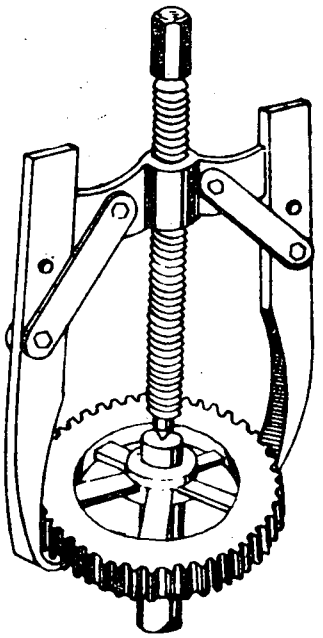


Fig. 1

SAFETY MEASURE

ON TAPERED AXLES DO NOT REMOVE THE FASTENING DEVICE. THIS KEEPS THE GEAR OR PULLEY FROM FLYING OFF.

3rd Step - *Remove the gear or pulley* with the extractor.

OBSERVATION

When using the screw extractor, lightly tap the head of the screw of the extractor. Use a bronze or plastic hammer. These taps will make the removal of the gear or pulley easy.

4th Step - *Remove the key from the shaft.*

PROCESS II - Removing gears or pulleys with the press.

1st Step - *Remove the fastening device* from the gear or pulley.

2nd Step - *Place the shaft with the gear or pulley on the base of the press* (Fig. 2). Add the necessary supports.

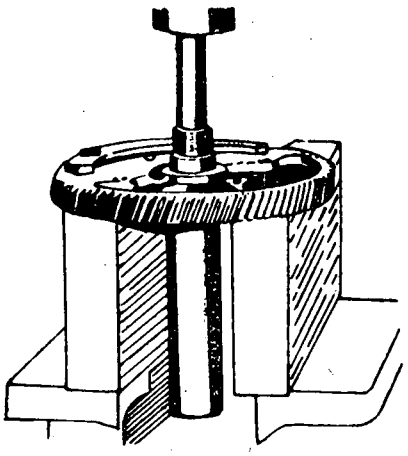


Fig. 2

OBSERVATIONS

1) Plates or supports under and near the centre of the gear or pulley prevent breaks or deformations.

2) The gear or pulley must be level. It must also be aligned with the axis of the ram.

3) Do not hit the axle when it is removed from the gear or pulley.

3rd Step - *Take out the gear or pulley* with the press.

4th Step - *Take out the key.*

CASE II - MOUNTING GEARS AND PULLEYS

1st Step - *Clean the gear or pulley.*

2nd Step - *Clean the shaft.*

3rd Step - *Install the key.*

4th Step - *Place the shaft in the hole of the gear or pulley.* Make the key coincide with the keyway (Fig. 3).

5th Step - *Place the gear or the pulley* so that its centre coincides with the axis of the ram.

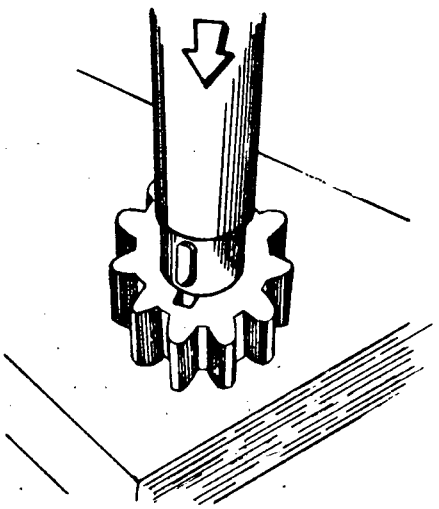


Fig. 3

6th Step - *Insert the shaft* with the press.

7th Step - *Place the fastening element.*

OBSERVATION

If the gear or pulley is not placed by pressure on the shaft, it can be installed by lightly tapping it with a hammer.

CBC

OPERATION:
REMOVING AND MOUNTING RETRACTING AND TORSION SPRINGS

This is the operation which consists of removing and installing springs in order to check their condition, replace them or gain access to other mechanisms.

PROCEDURE

CASE I - REMOVING SPRINGS .

Process I - Removing springs with pliers

1st Step - *Hold the end of the spring with the pliers.* Pull it until the point is removed from its lodging (Fig. 1).

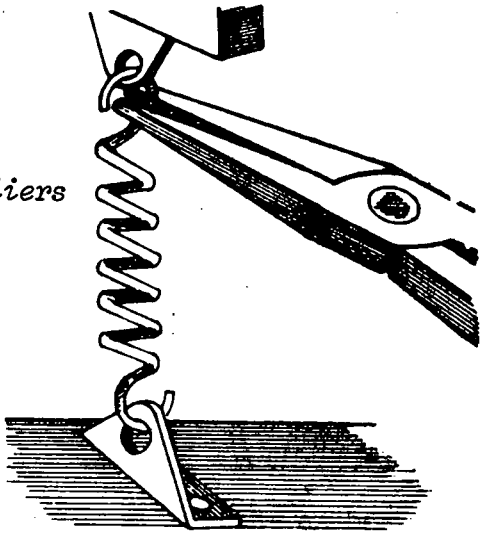


Fig. 1

SAFETY MEASURE
ENSURE THAT THE PLIERS ARE PROPERLY FIXED. WEAR SAFETY GLASSES.

2nd Step - *Gently release tension* and pull out the other end to remove the spring.

Process II - Removing springs with cord or wire tensor.

1st Step - *Pass the cord or wire* through one of the ends of the spring.

2nd Step - *Tie the tensor to a lever* (Fig. 2).

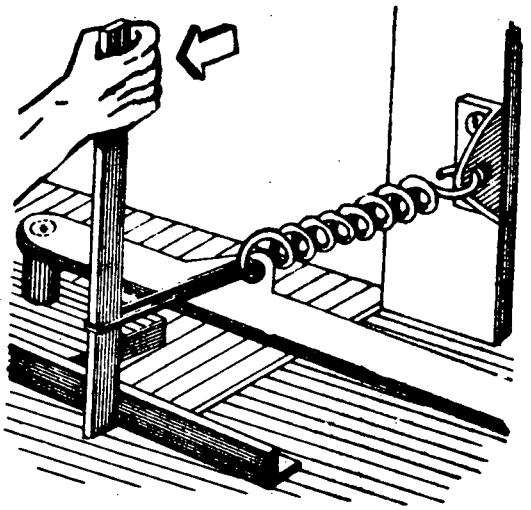


Fig. 2

SAFETY MEASURE
TIE THE TENSOR STRONGLY TO PREVENT IT FROM PULLING.

3rd Step - *Place the lever on a support.*

4th Step - *Pull the lever to stretch the spring* and remove the point from its lodging.

OBSERVATION
Sometimes the help of another person is required to remove the point of the spring.

5th Step - *Follow the 2nd Step of Process I.*

Process III - Removing springs with brake pliers.

1st Step - *Place the smooth part of the pliers on a firm base.*

2nd Step - *Hook one end of the spring* to the other point of the pliers (Fig. 3).

SAFETY MEASURE
ENSURE THAT THE PLIERS ARE WELL SECURED TO PREVENT THE SPRING FROM FLYING OUT OR SLIPPING.

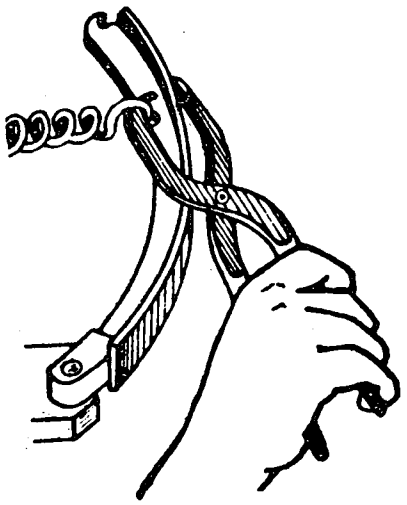


Fig. 3

3rd Step - *Keep a closing grip on the pliers* until the spring is stretched.
4th Step - *Remove the point of the spring* from its lodging.
5th Step - *Gently release tension to remove the spring.*

CASE II - MOUNTING SPRINGS

Process I - Mounting springs with pliers

1st Step - *Install one end of the spring in its lodging.*
2nd Step - *Hold the other end of the spring with the pliers.*
3rd Step - *Pull it until it is set in its lodging.*

Process II - Mounting springs with a cord or wire tensor

1st Step - *Install one end of the spring in its lodging.*
2nd Step - *Pass the cord or wire through the free end of the spring.*
3rd Step - *Hinge the lever to the spring* in order to stretch it.
4th Step - *Put the other end of the spring in its lodging.*

Process III - Mounting springs with brake pliers

1st Step - *Install one end of the spring in its lodging.*
2nd Step *Rest the curved part of the pliers* on a firm base.
3rd Step - *Hook the free end of the spring* to the other end of the pliers.
4th Step - *Keep a closing grip on the pliers* until the spring is stretched.
5th Step - *Put the other end of the spring in its lodging.*

CBC

OPERATION:
CHANGING RETAINERS (Seals)

This operation consists of changing retainers to avoid water, oil and grease leaks or the entry of impurities to the mechanisms of machines.

PROCEDURE

CASE I - REMOVING RETAINERS

Process I - Removing retainers with the press

1st Step - *Place the part on the base of the press.* The retainer must be centered with the axis of the ram.

OBSERVATION
In the case of fragile parts, place adequate supports under them to avoid breakage.

2nd Step - *Place on the retainer* a cylindrical object of a smaller diameter than the housing of the retainer (Fig. 1).

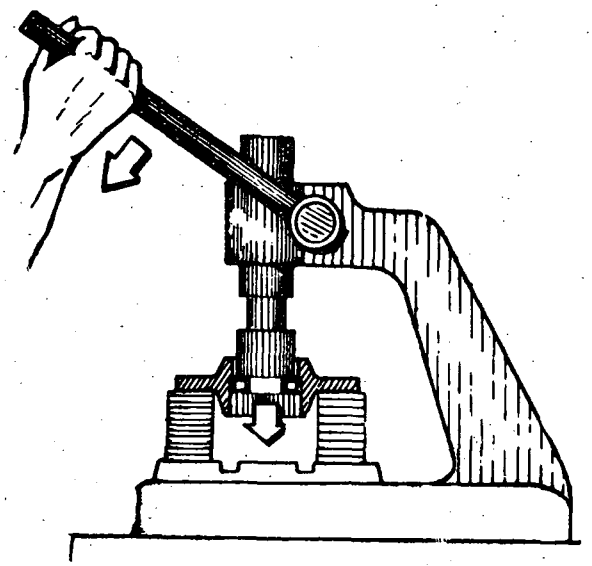


Fig. 1

3rd Step - *Pull the lever of the press* until the retainer is removed.

Process II - Removing retainers with a sliding hammer

1st Step - *Place the extractor* so that the legs are under the retainer (Fig. 2).

2nd Step - *Operate the extractor* until the retainer is removed.

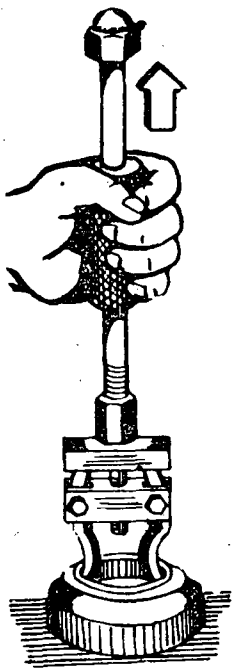


Fig. 2

Process III - Removing retainers by impact

1st Step - *Tap on and around the retainer* until it is removed (Fig. 3).

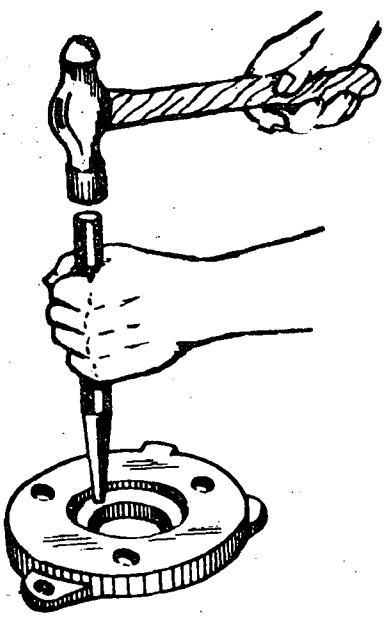


Fig. 3

OBSERVATION

The retainers should be changed each time they are removed from their housing.

If the part is completely flat, place it on supports or blocks to make easy the removal of the retainer.

CASE II - MOUNTING RETAINERS

Process I - Mounting retainers with the press

1st Step - *Prepare the housing* thus:

a) Clean the housing of the retainer.
b) Lubricate the housing of the retainer.

2nd Step - *Install the retainer* thus:

a) Place the part on the base of the press.
b) Centre the housing of the retainer with the axis of the ram.
c) Place the retainer in its housing. See that the lip is in its correct position.
d) Place the cylindrical object on the retainer. Act on the press until the retainer is in place.

Process II - Mounting retainers by impact

1st Step - *Prepare the housing.*

2nd Step - *Install the retainer* thus:

a) Lightly tap on and around the retainer to centre it. Put it in place slightly. Use a plastic hammer.
b) Place a tool which may serve as a ram. Tap lightly until the seal is in place.

CBC

OPERATION: PREPARING SURFACES FOR PAINTING

This operation consists of scraping and cleaning surfaces with the purpose of conditioning them for painting.

PROCEDURE

Process I - Preparing the surface using remover

1st Step - *Remove the paint* thus:

a) Apply the remover with a brush (Fig. 1).

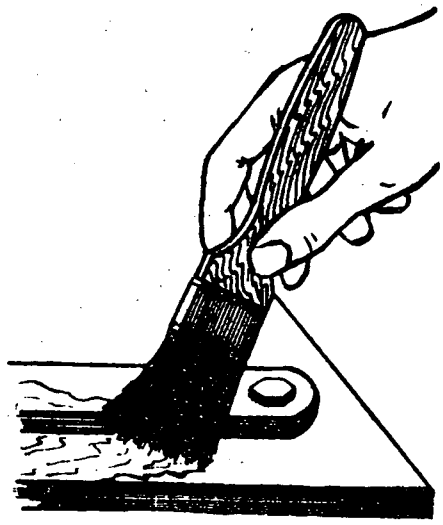


Fig. 1

OBSERVATION
Allow the remover to act during the time specified by the manufacturer.

b) Scrape the paint with a paint scraper (Fig. 2).

c) Wash with water.

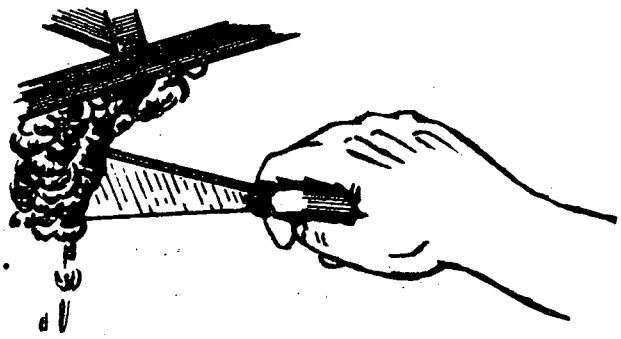


Fig. 2

OBSERVATION

Wash thoroughly to avoid leaving residues of the remover.

CAUTION

THE REMOVER IS CAUSTIC. AVOID DIRECT CONTACT WITH SKIN.

2nd Step - *Finish the surface* thus:

a) Remove small residues of paint or rust. Use sandpaper, scraper or wire brush.

OBSERVATION

In the case of deep rust apply antirust liquid.

b) Apply pressurized air on the surface to be painted.

c) Wipe the surface with a rag damped with thinner.

OBSERVATION

Small dents may be removed with a light hammer.

SAFETY MEASURE

KEEP ALL SOLVENTS AWAY FROM HEAT OR FLAME. THEY ARE INFLAMMABLE.

Process II - Preparing the surface using scrapers or wire brushes

1st Step - *Remove the paint* thus:

a) Rub the paint with a scraper or wire brush (Fig. 3) until it is removed.

b) Clean the surface.

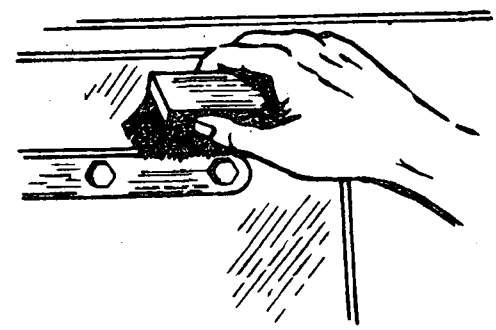


Fig. 3

2nd Step - *Paint the surface.*

CBC

OPERATION:
BRUSH PAINTING

This operation consists of applying paint manually to preserve and give surfaces a good appearance.

PROCEDURE

1st Step - *Prepare the paint* thus:

a) Invert the container and shake it.
b) Carefully remove the lid to avoid deforming it.

OBSERVATION
For big containers stir the paint with a knife.

2nd Step - *Apply the paint* thus:

OBSERVATION
Select a size of brush appropriate to the surface to be painted.

a) Dip the brush in the paint to half the length of the bristles.
b) Drain off the excess paint and invert it rapidly (Fig. 1).
c) Make three strokes of a length 3 times the width of the brush leaving an alternate empty space (Fig. 2).

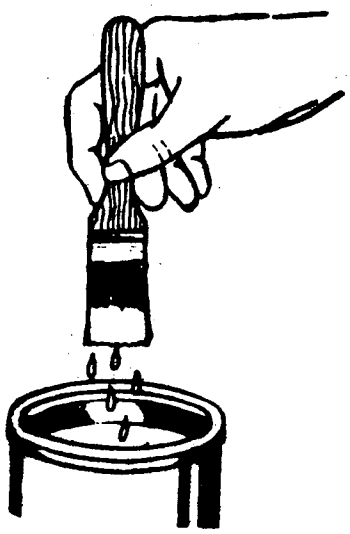


Fig. 1

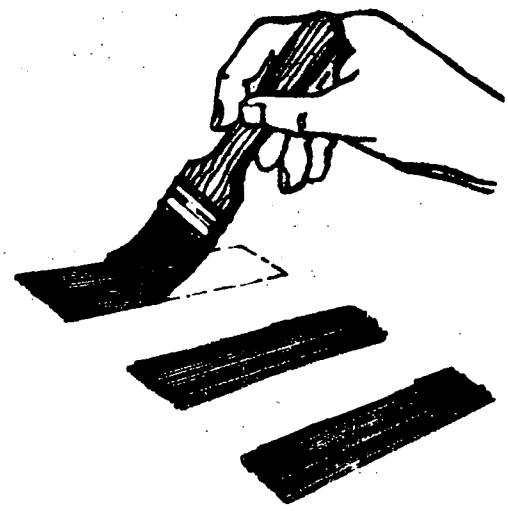


Fig. 2

d) Spread the paint by crossing the first strokes (Fig. 3).

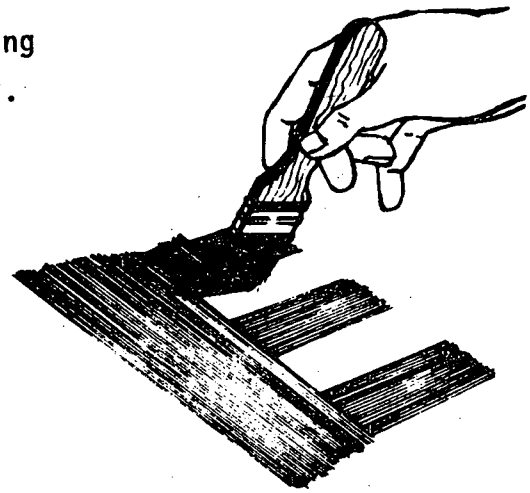


Fig. 3

OBSERVATION

For small and complicated surfaces you cannot use this procedure. In such cases keep in mind these two rules: 1) The paint should be applied uniformly; 2) The surface should be covered with thin coats.

3rd Step - *Cover the container* thus:

a) Clean the edges of the container and lid.
b) Cover the container and press the lid uniformly.

4th Step - *Wash the brush* thus:

a) Dip the brush in thinner.
b) Wash it until completely clean.

CAUTION

PAINTS AND THINNERS ARE INFLAMMABLE.

CBC

OPERATION:

TESTING THE HYDRAULIC SYSTEM (with analyser)

This operation consists of carrying out a set of tests with the hydraulic system analyser to detect the damaged component or components. With this testing apparatus the flow of fluid, pressure and temperature of any hydraulic system may be measured.

1st Step - *Examine the system* thus:

a) Check the level of the fluid.
b) Check for dirty fluid.
c) Check flexible tubes and hoses which might be obstructed. because of excessive bending.
d) Closely examine the components. Look for cracks, breaks, loose bolts and false connections.

OBSERVATIONS

1) Abnormalities found during these checks should be repaired before going on to the second step.
2) Be sure the outside of the system is clean.

2nd Step - *Test the pressure of the pump* thus:

OBSERVATION

To test the hydraulic system you need to know the specifications for both system and analyser.

a) Pull the control lever to release the pressure from the system.
b) Disconnect the tubing which goes from the pump to the distribution valve.
c) Connect this tubing to the intake of the analyser (Fig. 1).

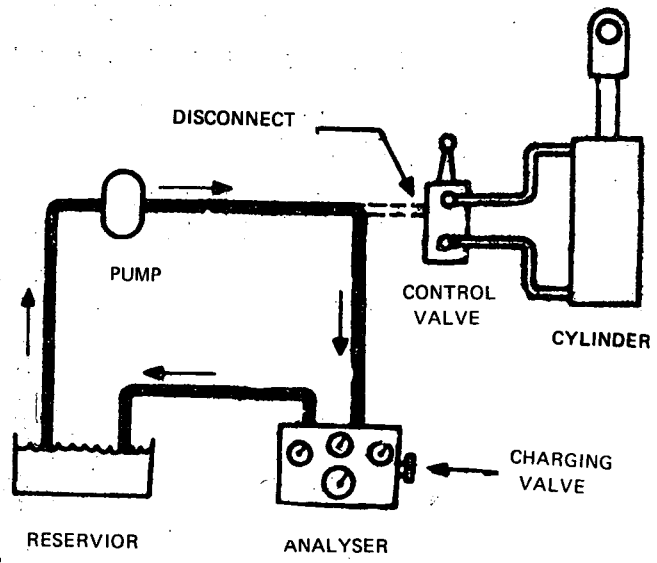


Fig. 1

d) Connect the outlet of the analyser to the fluid reservoir.

OBSERVATION
This connection should be made, whenever possible, with the return pipeline. This will avoid draining the reservoir.

e) Fully open the charging valve of the analyser.
f) Start the engine and allow the fluid to reach normal temperature.
g) Close the charging valve slowly and observe the pressure reading.

OBSERVATION
Do not exceed the maximum pressure which the system can withstand.

3rd Step - *Test the flow volume of the pump* thus:

a) Open the charging valve and check the maximum flow delivered by the pump without pressure.
b) Close the charging valve slowly so as to increase the pressure in the system.
c) Observe and register the flow indicated by the instrument.

4th Step - *Test the components of the system* thus:

a) Install a T fitting on the tubing which leads from the pump to the control valve.

b) Couple the T to the intake of the analyser (Fig. 2).

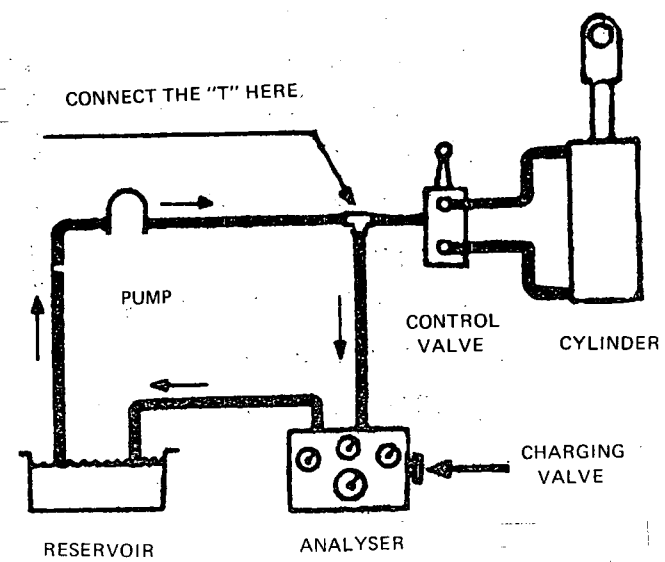


Fig. 2

OBSERVATION
The outlet of the analyser remains connected as in the previous case.

c) Open the charging valve of the analyser.
d) Start the engine and let it run at the speeds indicated for this test by the manufacturer.

OBSERVATIONS
1) The hydraulic circuit should be kept charged until the fluid reaches the normal working temperature.
2) It is convenient to close the charging valve of the analyser while the lubricant is heated.

e) Measure the maximum flow by completely opening the charging valve.
f) Move the control lever in either direction.
g) Register the flows delivered by the pump, varying the pressure in a stepped sequence from zero to the maximum working value.
h) Repeat the test in the other position of the control lever starting from zero pressure.

OBSERVATION
All the tests must be carried out with the fluid at the same temperature so that the results can be compared.

i) Stop the engine.

5th Step - *Compare the results* obtained in the tests with those given by the manufacturer. This comparison will tell if the system is functioning properly.

CBC

OPERATION:

REMOVING AND MOUNTING THE HYDRAULIC SYSTEM HOSES

REF. OS.22/AgM | 1/2

Caribbean

This operation consists of changing high pressure hoses or tubing, changing swivels, cleaning the system, installing control instruments for proper functioning checks and replacing piping and hoses to complete the operation.

PROCEDURE

CASE I - REMOVING HOSES OR PIPES

1st Step - *Hold both swivels* of the fitting with appropriate spanners. Turn one spanner in the correct direction to loosen the connection (Fig. 1).

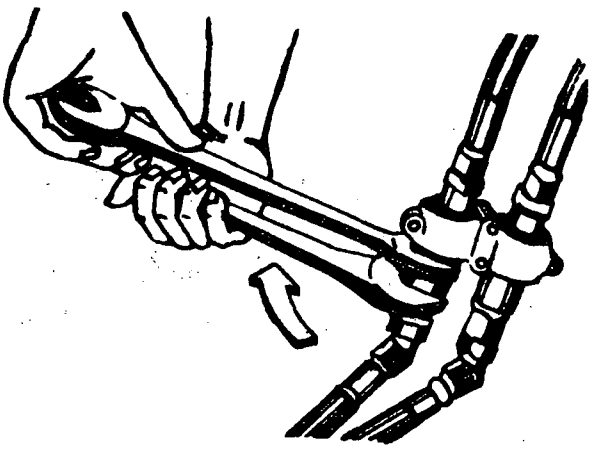


Fig. 1

2nd Step - *Remove the hose* by loosening the fitting at the fixed end.

3rd Step - *Protect the open connections* with plugs or wrap to keep dirt out (Fig. 2).

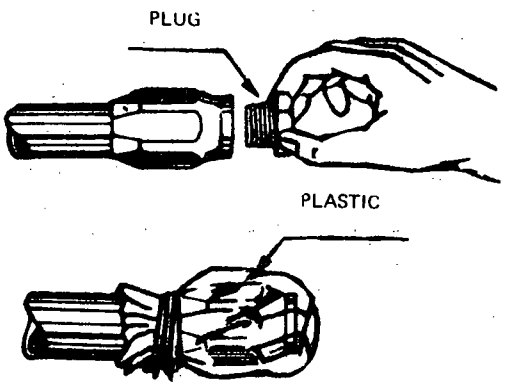


Fig. 2

OBSERVATIONS

1) Always use the appropriate spanner.
2) The plugs should be made of a material which does not shed particles.

CASE II - MOUNTING HOSES OR PIPES

1st Step - *Screw on the rigid end of the hose* and tighten it with a spanner.

2nd Step - *Screw the swivel on the other end* of the fitting and tighten it. Use two spanners and turn them in opposite directions to keep the hose from twisting.

OBSERVATIONS

1) The hoses or piping should remain slack. Hoses or pipes which are under tension, weaken because of pressure.

2) Avoid pronounced sags in hoses and pipes by installing appropriate couplings.

3) Avoid twistings in hoses and pipes. Pipes weaken and the connections slacken during work.

4) Keep pipes and hoses from rubbing against other parts. Install supporting clamps or protect them with a metallic shield.

5) Avoid heating the hoses or pipes. Keep them away from hot surfaces or protect them with a shield, preferably asbestos.

6) Avoid sharp bends which can cause cut of flow. The manufacturer usually indicates the minimum allowable angle.

/) Check for leaks in the connections of hoses and pipes.

CBC

OPERATION:
CHANGING HOSES AND TUBINGS

This operation is done when changing high and low pressure hoses in the hydraulic system.

PROCEDURE

Process I - Changing low pressure hoses

1st Step - *Remove the hose* thus:

a) Put the swivel in a vice
b) Cut the hose to the end of the nipple (Fig. 1).
c) Bend the hose and remove it from the nipple (Fig. 2).

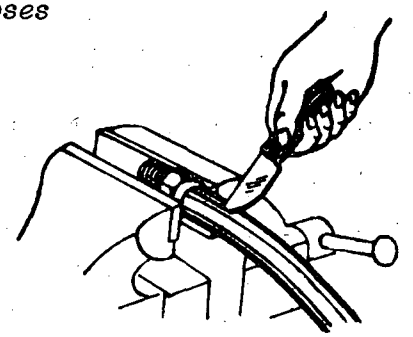


Fig. 1

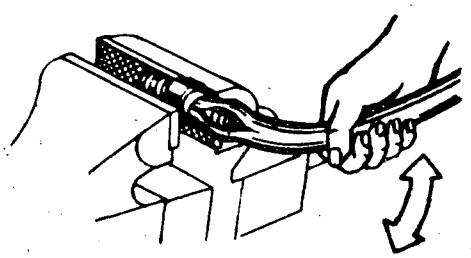


Fig. 2

2nd Step - *Mount the hose* thus:

a) Cut a length of hose. Lubricate the inside of it. Also lubricate the outside of the nipple of the swivel (Fig. 3).

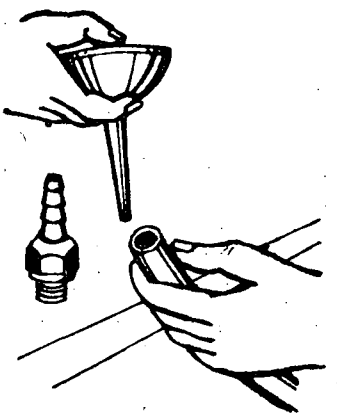


Fig. 3

OBSERVATIONS

1) If there is a hose clamp, mount it before replacing the swivel.

2) When changing the hose be sure that the length is equal to the one replaced.

b) Push the hose on the nipple until it reaches its limit (Fig. 4).

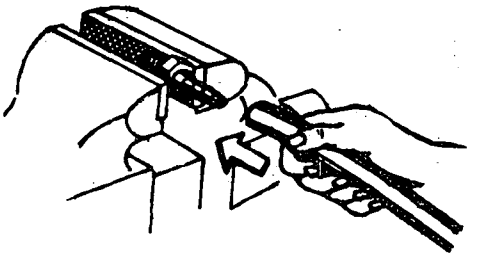


Fig. 4

Process II - Changing high pressure hoses

1st Step - *Remove the hose* thus:

a) Unscrew the nipple and remove the swivel.
b) Unscrew the socket from the hose and remove it.
c) Repeat the procedure on the other end.

2nd Step - *Prepare the hose* thus:

a) With a fine saw, cut the necessary length of hose.
b) Measure with the socket the amount of hose to be inserted at each end (Fig. 5).

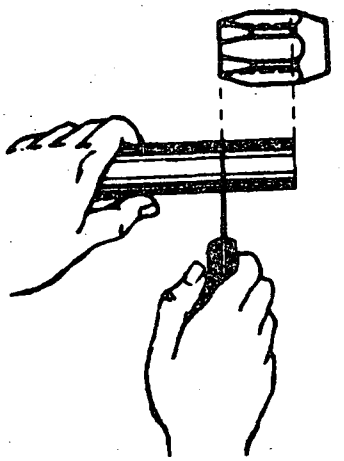


Fig. 5

c) Make a circular cut down to the metallic shield and remove the protective covering.
d) Make a lengthwise cut down to the metallic shield and remove the protective covering.

CAUTION

BE CAREFUL WITH THE POINTS OF THE METALLIC SHIELD

e) Clean the metallic shield (mesh) with a soft wire brush taking care not to pull it apart.

3rd Step - *Mount the hose* thus:-

a) Screw the stripped end of the hose counter-clockwise into the socket to its limit (Fig. 6).

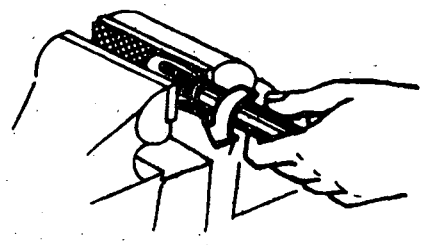
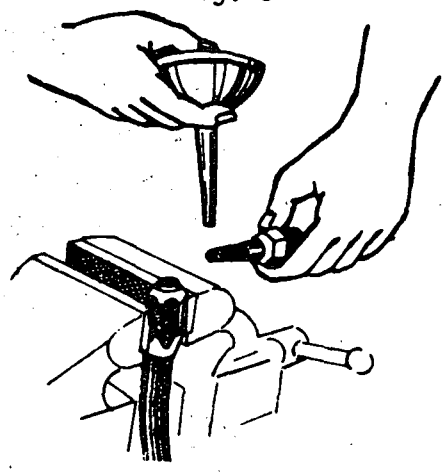
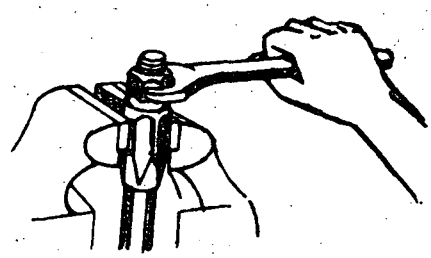


Fig. 6



b) Lubricate the thread of the nipple and the inside of the hose (Fig. 7).

Fig. 7



c) Screw the nipple into the socket of the swivel clockwise (Fig. 8).

Fig. 8

OBSERVATION

Check the tightness of the swivels.

Process III - Changing a tubing

1st Step - *Remove the tubing* thus:

a) Loosen the supporting brackets if any.
b) Unscrew the swivels of both ends.
c) Remove the tubing trying not to deform it.

2nd Step - *Prepare the new tubing* thus:

a) Cut a length of pipe to the appropriate size.

b) Shape it following the outlines of the removed tubing.

c) Put the new tubing in place and adjust its shape.

d) Cut the ends of the old tubing and remove the swivels.

e) Install the swivels on the new tubing and make a flare at each end (Fig. 9).

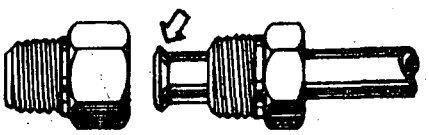


Fig. 9

OBSERVATION
Use the appropriate tools for the material of the tubing.

3rd Step - *Mount the tubing* thus:

a) Put the new tubing in place and secure it with any of its existing clamps.

b) Screw on the swivels at both ends.

OBSERVATION
When connecting the swivels, do not use excessive pressure. When testing the tubing more pressure on the connections may be applied until the leaks stop.

CBC

OPERATION:
REPAIRING HYDRAULIC CYLINDERS

This operation consists of disassembling, checking, changing different parts and assembling the hydraulic cylinder unit with the purpose of conditioning it for proper functioning.

PROCEDURE

CASE I - DISASSEMBLING HYDRAULIC CYLINDERS

Process I - Disassembling the internal cylinder

1st Step - *Remove the accessory parts* thus:

a) Disconnect the intake and outlet pipes.

b) Remove the fastening devices which prevent access to the cylinder.

OBSERVATION

Place a tray before disassembling to avoid spilling the fluid.

2nd Step - *Remove the piston thus (Fig. 1).*

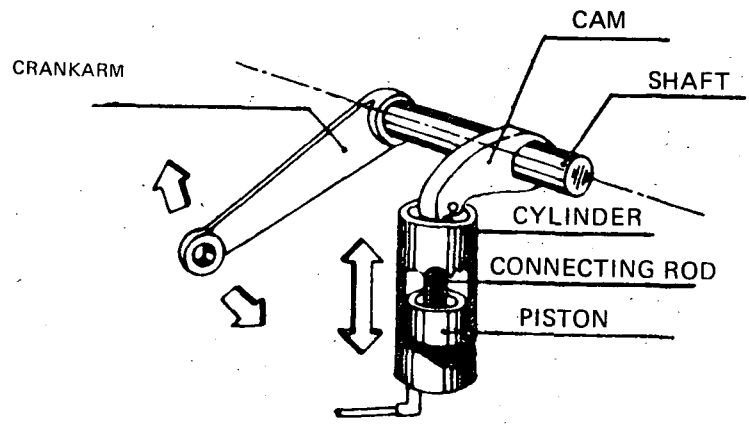


Fig. 1

a) Remove the parts which make the removal of the piston difficult.

b) Push the crank arms upwards to allow pressurized air into the cylinder. Take out the piston.

OBSERVATION

In some tractors it is necessary to disconnect the connecting rod in order to remove the piston.

c) Remove the seals of the piston.

3rd Step - *Clean the parts* with kerosene, brush and pressurized air.

4th Step - *Check visually and with instruments* the state of the parts thus:

a) Check the parts for pitting, scratches, surface cracks and noticeable wear.
b) Check for ovalness.
c) Check for taper.
d) Check alignment.

Process II - Disassembling the external cylinder

1st Step - *Remove the cylinder thus:* *(Fig. 2).*

a) Disconnect the intake and outlet hoses.
b) Disconnect the fastening devices.
c) Remove the cylinder.

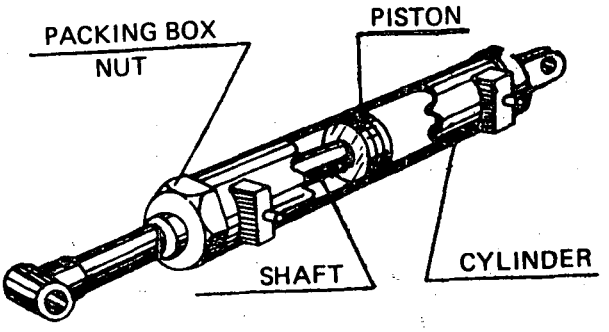


Fig. 2

2nd Step - *Remove the piston* thus:

a) Fix the cylinder in a vice. Use two blocks of wood to avoid damaging it.
b) Completely loosen the packing-box.
c) Pull the piston rod turning it until the piston comes out.

3rd Step - *Disassemble the piston* of the external cylinder thus:

a) Release the lock and remove the nut from the piston.
b) Remove the piston.
c) Remove the packing-box.
d) Remove the piston seals and the packing.

4th Step - *Clean the parts.*

5th Step - *Check visually and with instruments* the state of the parts.

CASE II - ASSEMBLING HYDRAULIC CYLINDERS

Process I - Assembling the internal cylinder

1st Step - *Install the piston* thus:

a) Blow out the lines with pressurized air.
b) Install the piston seals.

OBSERVATION
Metallic seals are installed using pliers for seals (Fig. 3). Rubber seals are mounted manually, lubricating the groove and seal beforehand.

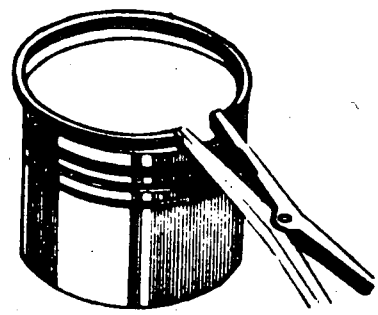


Fig. 3

c) Lubricate the piston and cylinder assembly with hydraulic fluid.
d) Mount the piston inside the cylinder with the seal compressor. Tap it lightly with a rubber mallet (Fig. 4).

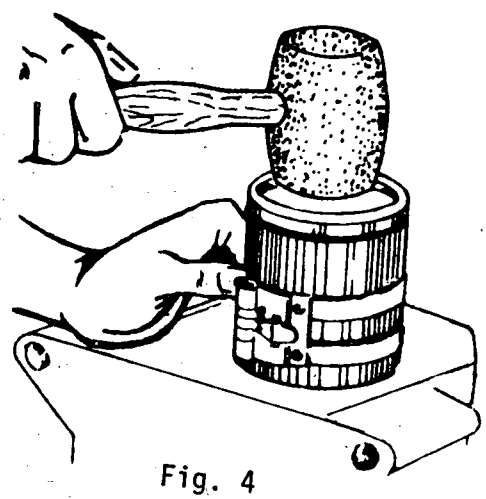


Fig. 4

2nd Step - *Check the cylinder* thus:

a) Install the accessory parts.
b) Install hoses and pipes.
c) Top up with the necessary hydraulic fluid.
d) Bleed the cylinder.
e) Test the cylinder.

f) Correct any oil leak.

IMPORTANT

CHANGE THE OIL IF IT IS DIRTY

Process II - Assembling the external cylinder

1st Step - *Install the piston on the rod* thus:

a) Place the piston rod in a vice.
b) Install the dust cover retainer and the seal in the packing-box.
c) Install the packing-box on the piston rod.
d) Install the seals on the piston.

OBSERVATION

Consult specifications for the thickness of the seal.

e) Install the piston on the rod.
f) Install the nut and secure it (Fig. 5).

OBSERVATION

Tighten as recommended by the manufacturer.

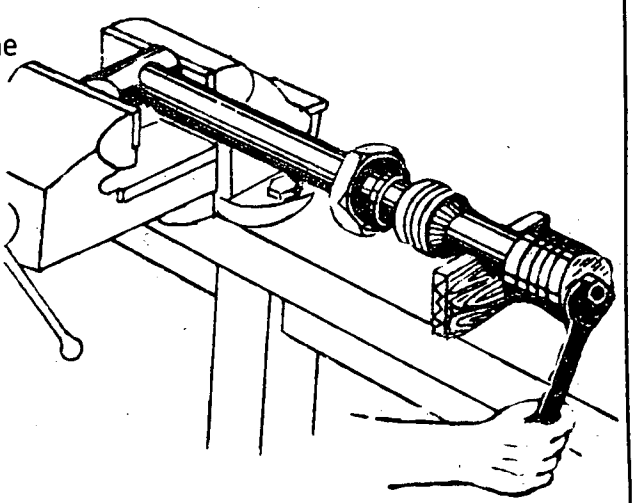


Fig. 5

2nd Step - *Install the piston* in the cylinder thus:

a) Lubricate the assembly of cylinder, piston and packing with hydraulic fluid.
b) Install the piston in the cylinder.
c) Install and adjust the packing-box.

3rd Step - *Install the cylinder in its lodging.* Secure the fastening devices.

4th Step - *Test the cylinder.*

OBSERVATION

The packing-box is adjusted gradually in the external cylinders in order to eliminate oil leaks.

CBC

OPERATION:
REPAIRING HYDRAULIC PUMPS

REF. OS.25/AgM | 1/6

Caribbean

This operation consists of disassembling, checking and changing (if necessary) different parts of the hydraulic pumps so as to condition them for proper functioning. This operation includes reassembling the parts.

PROCEDURE

CASE I - DISASSEMBLING HYDRAULIC PUMPS

Process I - Disassembling the gear pump

1st Step - *Remove the pump* thus:

a) Disconnect the inlet and outlet hoses.

OBSERVATION
Cover the pipings and ducts as soon as they are removed.

b) Uncouple the transmission system of the pump.
c) Take out the bolts or nuts which hold the pump. Remove the pump.

2nd Step - *Remove the pump* thus: (Fig. 1).

a) Mark the position of the parts of the pump.
b) Remove the screws from the pump.
c) Remove the cover.
d) Loosen the gasket and remove it.
e) Take out the oil impelling element.
f) Remove the shaft and its seal.
g) Remove the bearings.

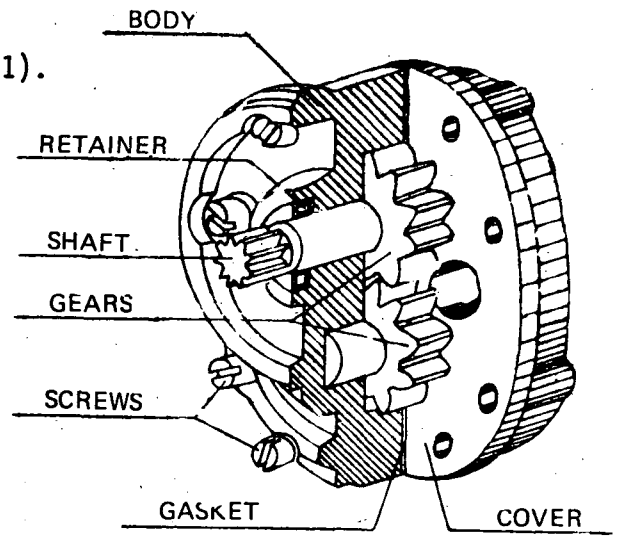


Fig. 1

OBSERVATION
In the gear pump the impelling element is formed by a propelling and a propelled pinion (Fig. 2).

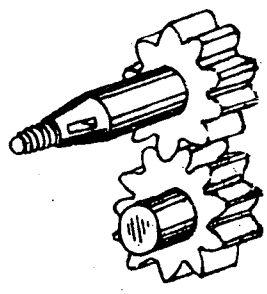


Fig. 2

3rd Step - *Check the condition of the parts* thus:

a) Measure the axial play of the gears (Fig. 3).

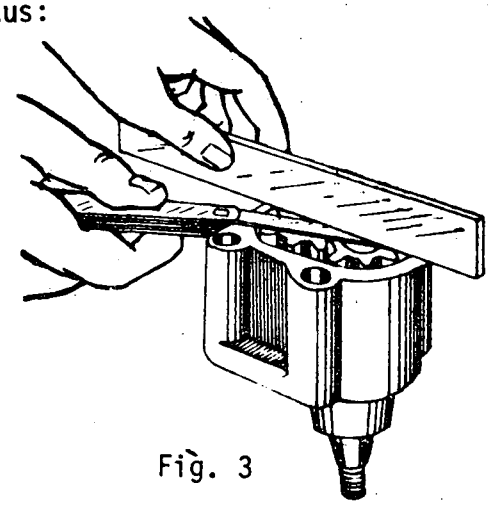


Fig. 3

b) Measure the radial play of the gears (Fig. 4).

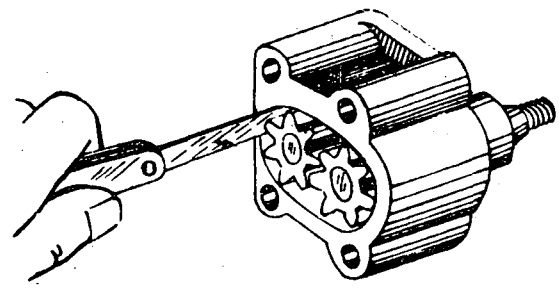


Fig. 4

c) Measure the backlash of the gear (Fig. 5).

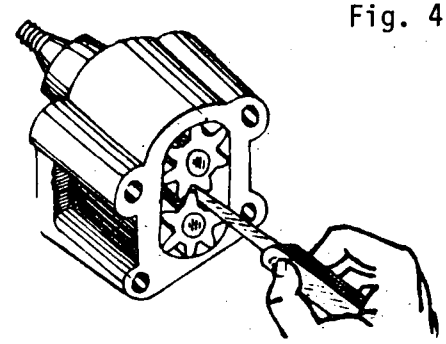


Fig. 5

d) Compare with specifications the play obtained.
e) Verify the alignment of the shaft.
f) Verify the bearings.
g) Check for wear, pitting, fissures or scratches in all the elements.
h) Ensure that the contact surfaces of the cover and the body of the pump are flat.

Process II - Disassembling vane pumps

1st Step - *Remove the pump.*

2nd Step - *Disassemble the pump.*

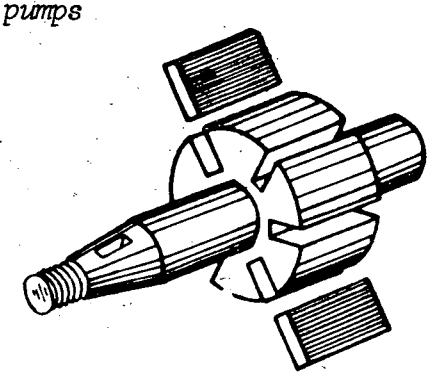
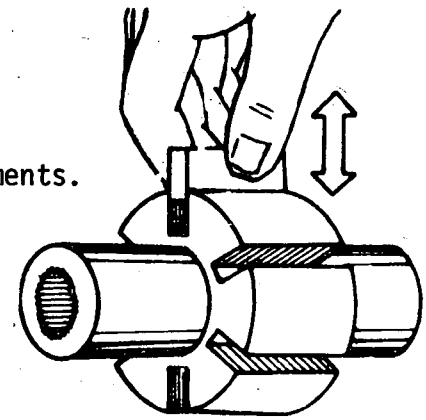


Fig. 6

OBSERVATION
In the vane pump, the impelling element is formed by the rotor and the blades (Fig. 6).

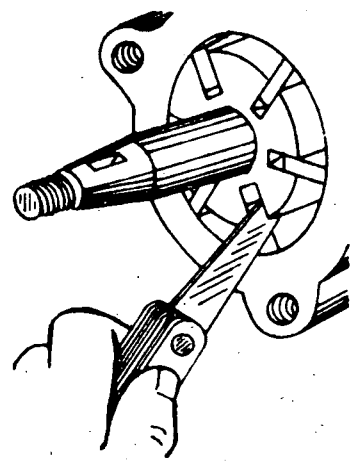
3rd Step - *Check the condition of the parts* thus:

a) Check the alignment of the shafts.
b) Check the bearings.
c) Check for wear, pitting, surface cracks or scratches in all the elements.



d) Be sure the vanes move freely within their guide (Fig. 7).

Fig. 7



e) Measure the clearance between the vane and its guides (Fig. 8).

f) Measure the axial play of the rotor.

g) Check the radial adjustment of the vanes with the housing.

h) Check the state of the springs of the vanes.

i) Be sure the contact surfaces of the cover and the body of the pump are flat.

j) Compare the clearance obtained with the manufacturer's specifications.

Process III - Disassembling the piston pump.

1st Step - *Remove the pump.*

2nd Step - *Disassemble the pump.*

OBSERVATION
In the piston pump, the impeller is formed by the cams and pistons (Fig. 9).

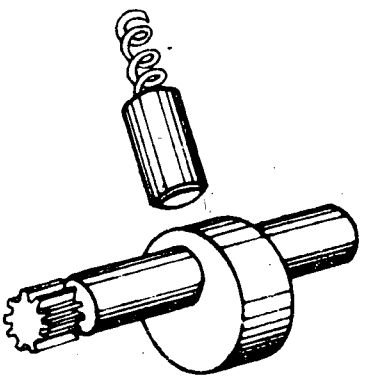


Fig. 9

3rd Step - *Check the condition of the parts* thus:

a) Check the alignment of the shafts.

b) Check the bearings.

c) Check for wear, pitting, surface cracks or scratches on all the elements.

d) Check the condition and functioning of the valves.

e) Be sure the contact surfaces of the cover and body of the pump are flat. If this is not so, rectify them.

OBSERVATION
In processes I, II, and III the damaged parts must be changed.

CASE II - ASSEMBLING HYDRAULIC PUMPS

Process I - Assembling the gear pump

1st Step - *Clean the parts.*

2nd Step - *Install the parts* thus:

a) Mount the new seals.
b) Mount the bearings and lubricate them.
c) Install the shafts and gears.
d) Place the covers and tighten the bolts according to specifications.
e) Test the free turning of the pump.

3rd Step - *Mount the pump* thus:

a) Install the pump in its place coupling the transmission system.
b) Connect the inlet and outlet hoses.
c) Test the pump.

OBSERVATION
All pumps must be primed before they are started.
Consult the instructions manual.

Process II - Assembling the vane

1st Step - *Clean the parts.*

2nd Step - *Install the parts.*

3rd Step - *Mount the pump and test it.*

Process III - Assembling the piston pump

1st Step - *Clean the parts.*

2nd Step - *Install the parts.*

3rd Step - *Mount the pump and test it.*

OBSERVATION
The gaskets and seals must be changed each time the pump is disassembled.

This operation consists of disassembling, checking, repairing, assembling and gauging the valves of a hydraulic system for proper functioning.

PROCEDURE

CASE I - DISASSEMBLING HYDRAULIC SYSTEM VALVES

Process I - Disassembling regulating valves (of flow and pressure) (Figs. 1 and 2).

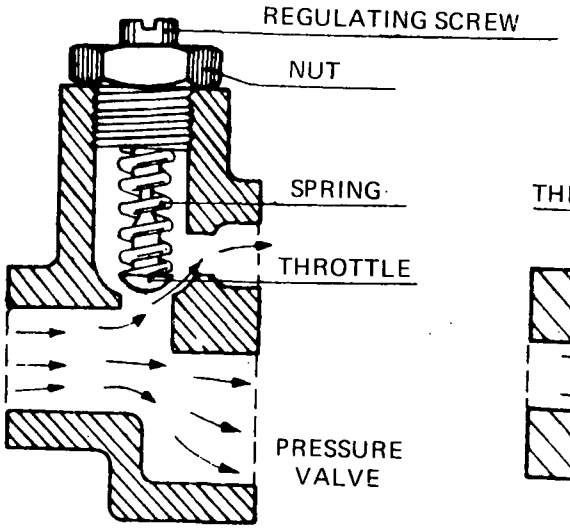


Fig. 1

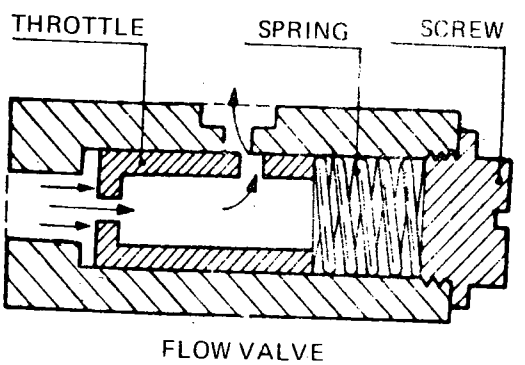


Fig. 2

1st Step - *Remove the parts* thus:

a) Actuate the control lever so as to leave the system without pressure.

OBSERVATIONS

1) The engine must be switched off to avoid circulation of the hydraulic fluid.
2) Place the hydraulically activated units on blocks or on the floor.

b) Clean around the valves ensuring that all connections of hoses and pipes are airtight.
c) Mark or lay out the parts so as to reassemble them in the same position.
d) Disconnect the inlet and outlet pipes of the valves.
e) Place plastic caps on the disconnected ducts.
f) Remove the regulating nut and bolt from the valve.
g) Take out the spring and the throttling element.

2nd Step - *Clean the parts* thus:

a) Wash all the parts in kerosene.

b) Dry the parts using pressurized air. Place them on a clean surface for checking.

3rd Step - *Check the parts* thus:

a) Verify the adjustment of the piston in its cylinder.

OBSERVATION
The oiled piston must slide in slowly on its own weight.

b) Check the pressure of the springs of the valves.

c) Change the valves if flattening is found on the seat or on the throttling element.

OBSERVATIONS
1) Change the springs if they are worn.
2) If necessary, grind the cone valves.
3) Some seats are removable and can be replaced.

d) Clean the mesh and valve openings.

e) Change the seals and gaskets.

f) Saturate the parts in hydraulic fluid to protect them from rusting and to make mounting easier.

g) Keep them in a clean place until they are installed.

Process II - Disassembling piston distribution valves (Fig. 3)

1st Step - *Remove the valve* thus:

a) Remove the hoses.

b) Take out the nuts or bolts and remove the valve.

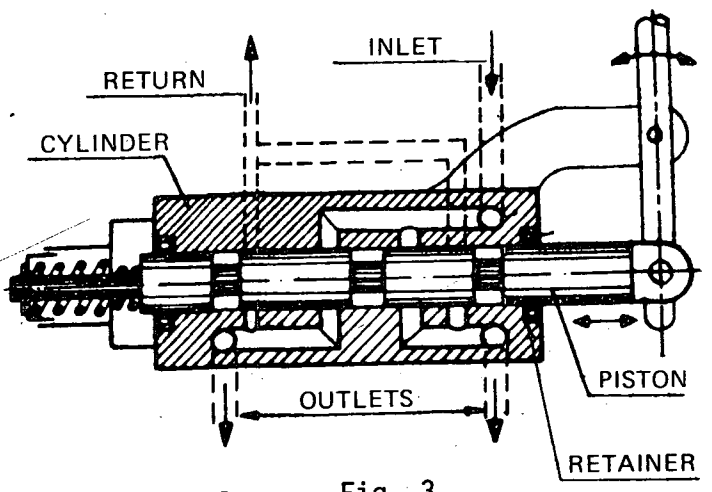


Fig. 3

OBSERVATION
Use a tray to collect the spilt oil.

2nd Step - *Remove the parts* thus:

a) Repeat sub-steps (a), (b), (c), (d), and (e) of the 1st. Step, Case I.
b) Remove the control lever.
c) Take out the fastening element from the piston.
d) Remove the piston, springs and seals.

OBSERVATIONS

1) Valves with high tension spring should be opened with care using an extractor.

2) Sometimes it will be necessary to hold the valve-box in the bench vice. In such cases use copper or lead protectors on the jaws of the vice.

3rd Step - *Clean the parts.*

4th Step - *Check the parts* thus:

a) Follow sub-steps (a), (b), (c), (e), and (g) of the 3rd Step of Case I.
b) Be sure the distribution pistons and the openings do not have burrs, incrustations, scratches, or wear.

OBSERVATIONS

1) The tolerances must be checked with specifications.

2) Change the worn parts.

CASE II - ASSEMBLING THE HYDRAULIC SYSTEM VALVES

Process I - Assembling flow and pressure regulating valves

1st Step - *Install the parts* thus:

a) Clean and lubricate the parts.
b) Install the throttling element.
c) Install the spring.
d) Replace the nut and bolt.

OBSERVATION
The elements must be placed in the position indicated by the marks made when disassembling.

e) Connect the inlet and outlet valves pipings.
f) Fill with fluid of the type specified in the instructions manual.
g) Test the functioning of the valves in the system. Gauge them according to specifications.

Process II - Assembling piston distribution valves

1st Step - *Install the parts* thus:

a) Clean and lubricate the parts.
b) Install the seals.
c) Place the piston in its cylinder.

OBSERVATION
The piston must enter smoothly.

d) Test the displacement of the piston.
e) Replace the fastening element of the piston.
f) Install the springs.
g) Install the control lever.

2nd Step - *Mount the valve* thus:

a) Install the new packing.
b) Put the valve in its place and fix it by tightening the nuts or bolts.
c) Connect the inlet and outlet hoses.
d) Top up the oil level.
e) Test the functioning of the valve.

This operation consists of checking axles visually and with instruments to determine wear and deformation.

PROCEDURE

Process I - Checking axles using the surface plate

1st Step - *Examine the axle* and determine if there are surface cracks or noticeable wear.

2nd Step - *Check the alignment* thus:

a) Place the axle on the surface plate.
b) Determine if the axle is aligned by checking the light visually or with a feeler gauge (Fig. 1).

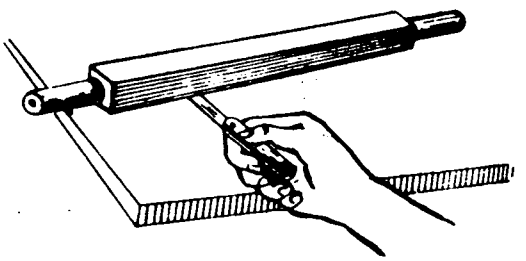


Fig. 1

OBSERVATION
The alignment is determined by the light or separation between the axle and the surface of the instrument or testing tool.

3rd Step - *Check if the axle is twisted.* See if the edges maintain a straight line.

Process II - Checking the axles by means of the precision straight edge.

1st Step - *Examine the axle* and determine if there are noticeable fissures or wear.

2nd Step - *Check the alignment* thus:

a) Place the axle on a table.
b) Place the straight edge lengthwise on the axle (Fig. 2)

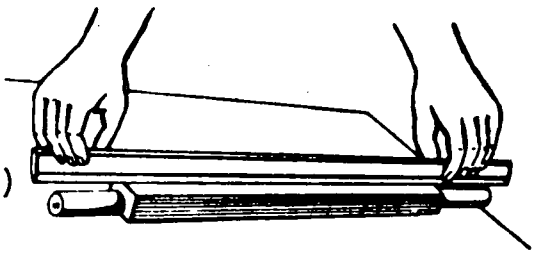


Fig. 2

c) Follow sub-step (b) of Process I.

3rd Step - *Check whether the axle is twisted.*

Process III - Checking the axles by means of a tensed cord

1st Step - *Examine the axle.*

2nd Step - *Check the alignment* thus:

a) Place the axle on a table.

b) Place the cord lengthwise on the axle.

c) Tense the cord (Fig. 3).

d) Determine if the axle is aligned checking the light.

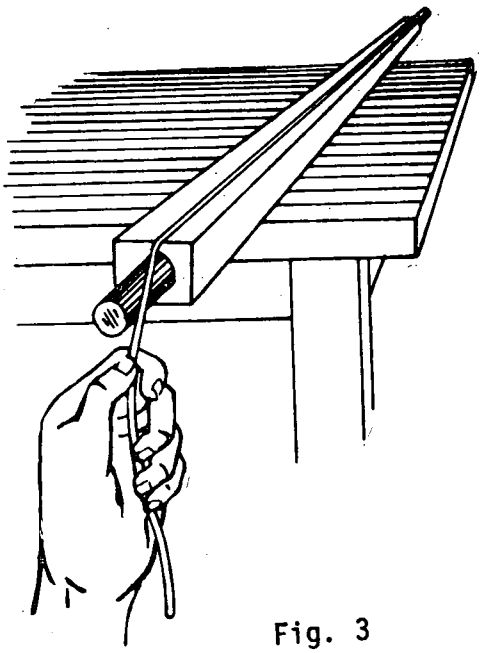


Fig. 3

OBSERVATION
The cord test is used for long axles.

3rd Step - *Check whether the axle is twisted.*

OBSERVATION
Twisting is verified when the aligning is determined. Twisting is noted when the edges are no longer straight.

CBC

OPERATION:
CHECKING GEARS AND PULLEYS

REF. OS.28/AgM 1/3

Caribbean

This operation consists of determining visually and with instruments the wear or deformation of gears and pulleys, checking for pitting, scores, surface cracks, misalignment or play with the purpose of deciding if they are to be repaired or changed.

PROCEDURE

CASE I - CHECKING GEARS

Process I - Checking gears using a feeler gauge

1st Step - *Examine the condition of the gear.* Check for pitting, breakings, scores, or noticeable wear.

2nd Step - *Check the backlash of the pinion gears* thus:

OBSERVATION
In order to measure the backlash, the gears must be installed on their shafts.

a) Turn one of the gears until the flanks of the teeth come into contact.
b) Measure with the feeler gauge the play or light between the teeth (Fig. 1).

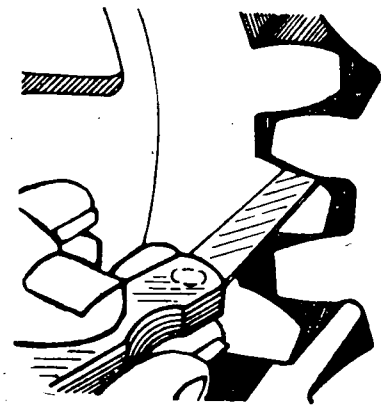


Fig. 1

Process II - Checking gears using a gauging lead.

1st Step - *Examine the condition of the gear.*

2nd Step - *Check the backlash of the gears* thus:

a) Install the lead between the flanks of the teeth thus: (Fig. 2)

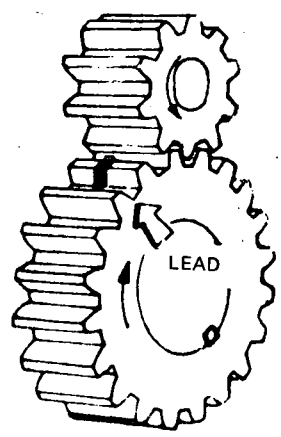


Fig. 2

b) Turn the gears to compress the lead.

c) Remove the lead and gauge it with an outside micrometer.

OBSERVATION

The result of the measurement will be the play or light between the gears.

Process III - Checking gears using a dial gauge.

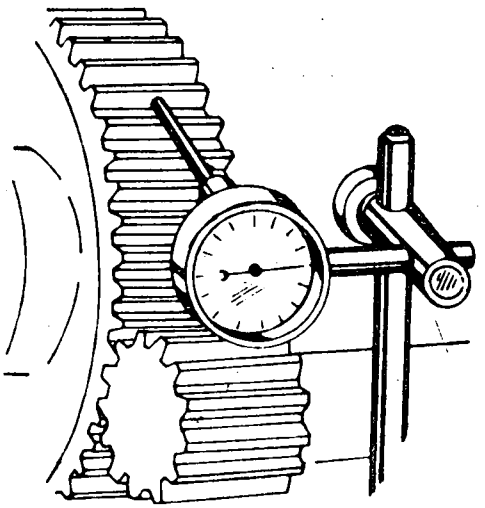


Fig. 3

1st Step - *Examine the condition of the gears.*

2nd Step - *Check the backlash* thus:

a) Install the dial gauge (Fig. 3).

b) Turn one of the gears until the flanks of the teeth come into contact.

c) Place the dial gauge so that the contact rod touches one of the teeth of the gear.

d) Move the gear and observe the reading on the dial of the gauge.

OBSERVATION

To find out if the play between the teeth is correct compare the reading with the manufacturer's specifications.

3rd Step - *Check the alignment of the gear* thus:

OBSERVATION

To check the alignment, the gear must be placed on its shaft.

a) Install the dial gauge.

b) Place the contact rod of the indicator until it touches the side of the gear (Fig. 4).

c) Turn the gear and observe the reading on the dial.

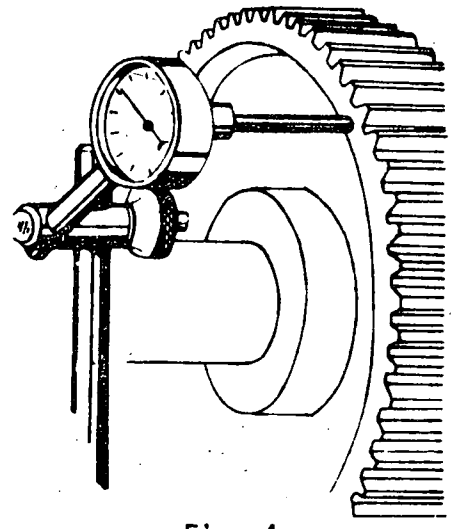


Fig. 4

OBSERVATION

An uneven reading indicates that the gear is misaligned or the shaft bent.

CASE II - CHECKING PULLEYS

1st Step - *Check the general condition of the pulley.* Follow the 1st Step of Process I for checking gears.

2nd Step - *Check the warping of the pulley.* Follow the 3rd Step of Process III for checking gears.

CBC

OPERATION:

TESTING THE HYDRAULIC SYSTEM

This operation consists of carrying out a series of checks which do not require the use of testing devices for checking the hydraulic system. The operation is usually carried out to determine whether there is failure in the components of the system (valves and cylinders).

PROCEDURE

1st Step - *Examine the system* thus:

a) Check the level of the lubricant.
b) Closely examine the components for cracks, breaks, slackened nuts or loose joints.

OBSERVATIONS

1) Abnormalities should be repaired before moving on to the second step.
2) Be sure the outside of the system is clean.

2nd Step - *Test the hydraulic system* thus:

a) Couple an implement to the hydraulic system.
b) Start the engine and bring it to the speed indicated by the testing manual.
c) Lift the implement by actuating the control lever and control the lifting time.
d) Lower the implement and control the lowering time.

OBSERVATION

Compare the lifting and lowering times with specifications. The difference shows there are failures in the system.

e) Lift the implement again.
f) Leave the lever in a neutral position.
g) Switch off the engine.
h) Observe whether the implement remains hoisted. If it slips, there are fluid leaks.

3rd Step - *Test the distribution valve* thus:

OBSERVATION
Check all the outside and inside valves.

a) Support the implement on wooden blocks.
b) Be sure the control lever is in the neutral position.

c) Disconnect the return tubing which goes from the distribution valve to the reservoir (Fig. 1).

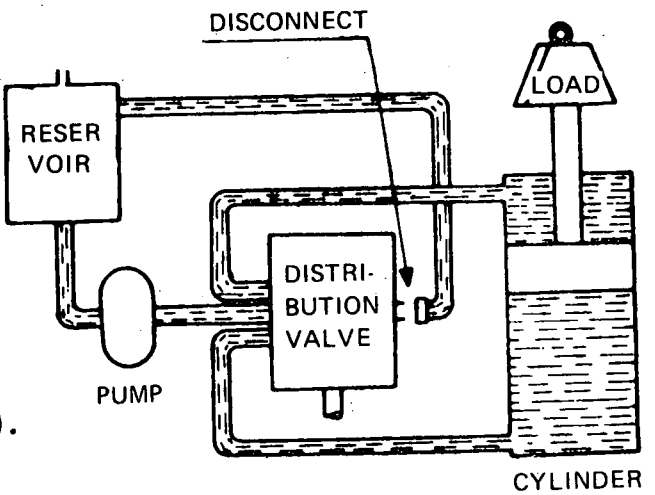


Fig. 1

d) Cover the duct of the return tubing.
e) Remove the support from the implement.
f) Examine the open duct of the valve while the implement descends.

OBSERVATION
1) Fluid leaks through this duct indicate leaks in the valve.

2) If no fluid comes from the duct of the distribution valve, check the hydraulic cylinder coupling beforehand the return tubing.

4th Step - *Test the cylinder* (external) thus:
a) Start the engine.
b) Actuate the control lever until the piston rod comes out completely.
c) Block the raised implement.

d) Switch off the engine.

e) Disconnect the flexible tube or hose from the cylinder. This tube has no pressure (Fig. 2).

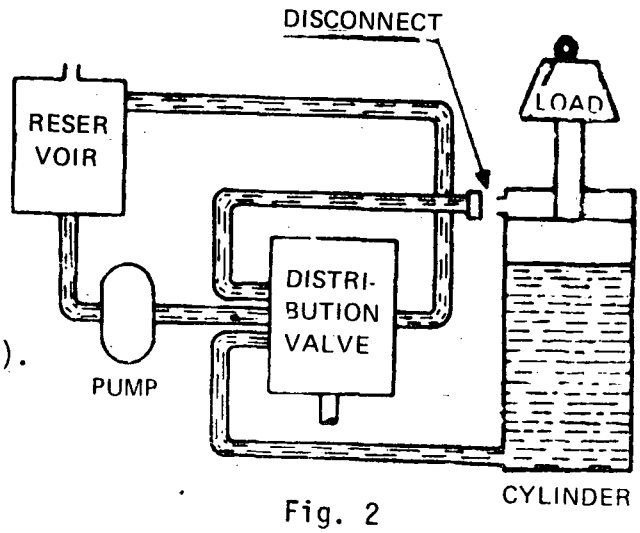


Fig. 2

f) Cover the end of the tubing.
g) Start the engine.
h) Actuate again the control lever for lifting.
i) Check the open cylinder mouth.

OBSERVATION
If the fluid is lost through the open mouth, check the cylinder components.

j) Switch off the engine.

TECHNICAL VOCABULARY

Duct - port

CBC

OPERATION:

CHANGING SECTIONS AND LEDGER PLATES OF MOWERS

This operation consists of changing broken or worn sections and ledger plates in order to obtain a good functioning of the mower and less strain on the mechanism of the machine.

PROCEDURE

CASE I - CHANGING THE SECTIONS

1st Step - *Remove the sections* thus:

a) Remove the section bearing bar from the cutter bar.

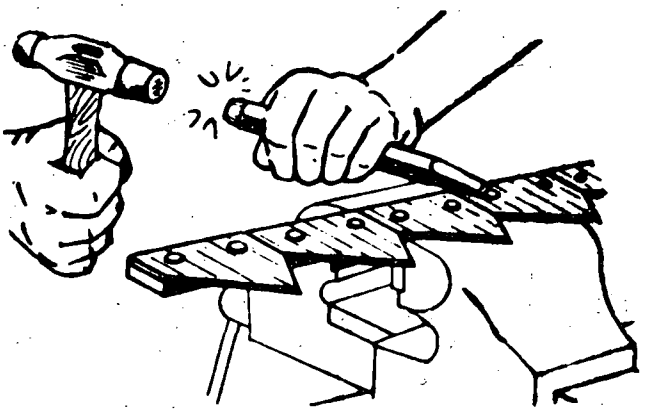


Fig. 1

CAUTION

THE BLADES ARE SHARP. TAKE CARE NOT TO CUT YOURSELF WHEN HANDLING THEM.

b) Secure the cutter bar in a vice.

c) Remove the heads of the rivets with a chisel (Fig. 1).

d) Remove the rivets with a punch (Fig. 2).

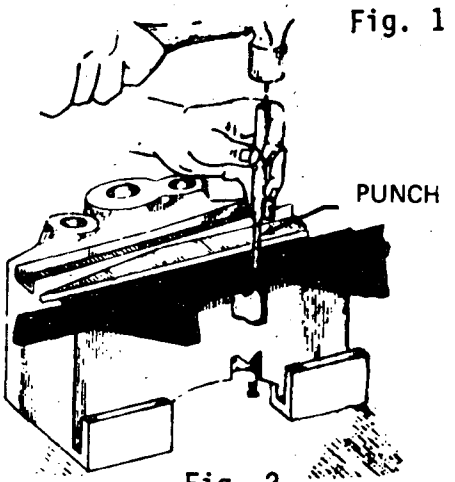


Fig. 2

2nd Step - *Mount the sections* thus:

a) Be sure the holes of the sections correspond with those of the bar.

b) Mount the sections with the rivets and rivet them. See Fig. 3.

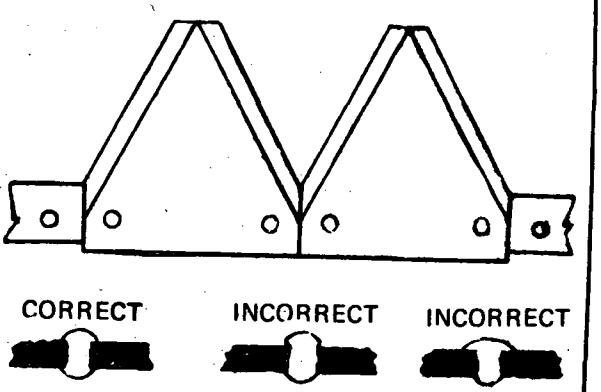


Fig. 3

OBSERVATION

This operation is the same for both types of sections: smooth and serrated.

CASE II - CHANGING THE LEDGER PLATES

1st Step - *Remove the ledger plates* thus:

a) Remove the guards from the cutter bar.

b) Place the guard on a firm base.

c) Remove the rivet (Fig. 4).

d) Remove the ledger plates.

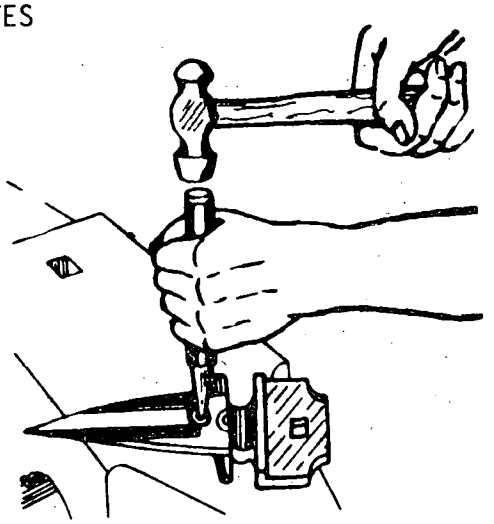


Fig. 4

2nd Step - *Mount the ledger plates* thus:

a) Be sure the ledger plates are properly placed on the guard.

b) Place the rivet. Rivet it in the position shown in Fig. 5.

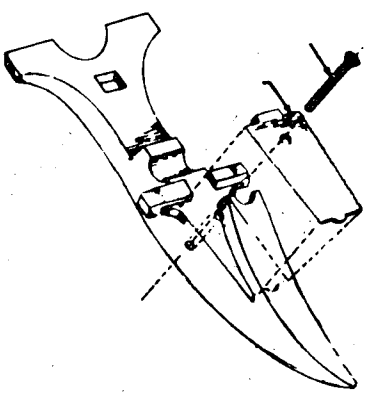


Fig. 5

OBSERVATIONS

1) Be sure the head of the rivet is not above the surface.

2) This operation is the same for both types of ledger plates: smooth and serrated.

3rd Step - *Replace the section bearing bar* thus:

a) Install the cutter bar.
b) Check the displacement of the sections.
c) Check the clearance between the section and the lip of the guard (Fig. 6).
d) Adjust the displacement of the section according to specifications.

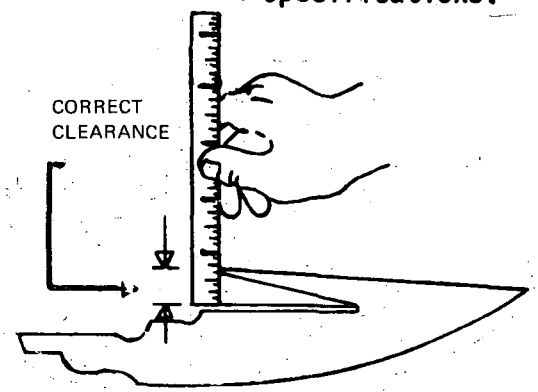


Fig. 6a
Measuring the clearance between the ledger plate and the knife.
Correct reading between 3/8" and 1/2"

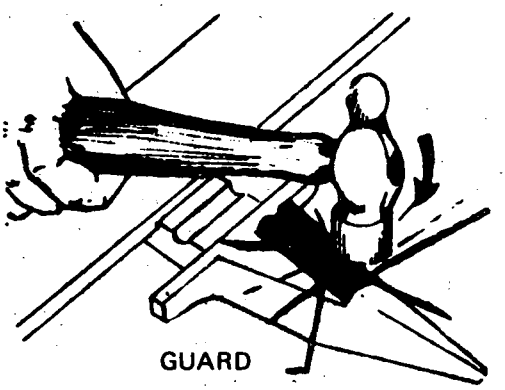


Fig. 6b
How to reduce the clearance

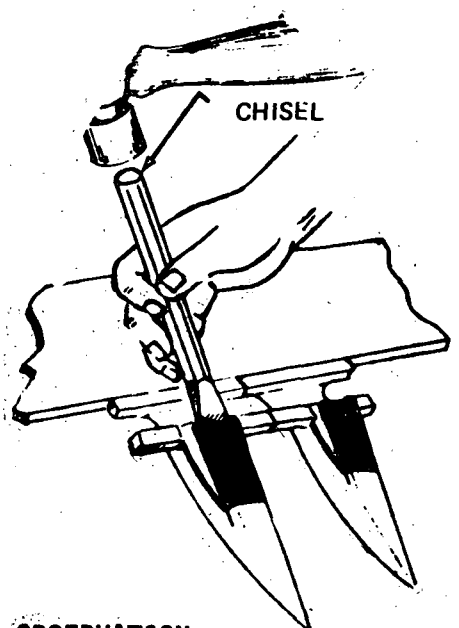


Fig. 6c
How to increase the clearance

OBSERVATION
Before replacing the section bearing bar check its alignment (Fig. 7).

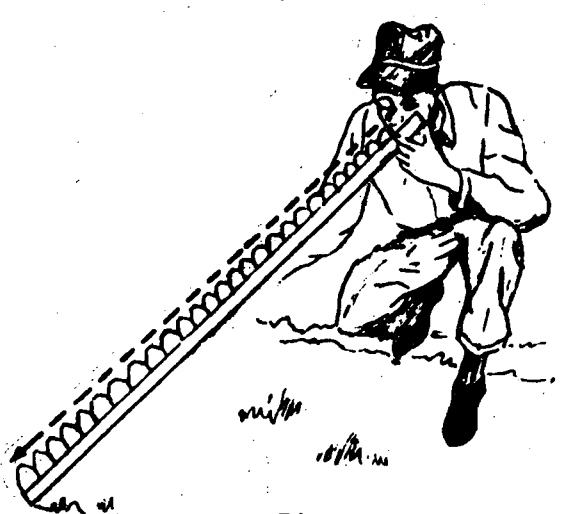


Fig. 7

CBC

OPERATION:

SHARPENING SECTIONS AND LEDGER PLATES OF MOWERS

This is the operation which consists of conditioning the cutting bevel and angle of the sections and ledger plates so that they may make an even cut thereby reducing the strain on the mechanism of the machine.

PROCEDURE

CASE I - SHARPENING SECTIONS

Process I - Sharpening the sections with a special grinder

1st Step - *Sharpen the sections* thus:-

a) Place the cutter bar on the grinder and secure it.

b) Make the union of the sections coincide with the vertex of the grindstone (Fig. 1).

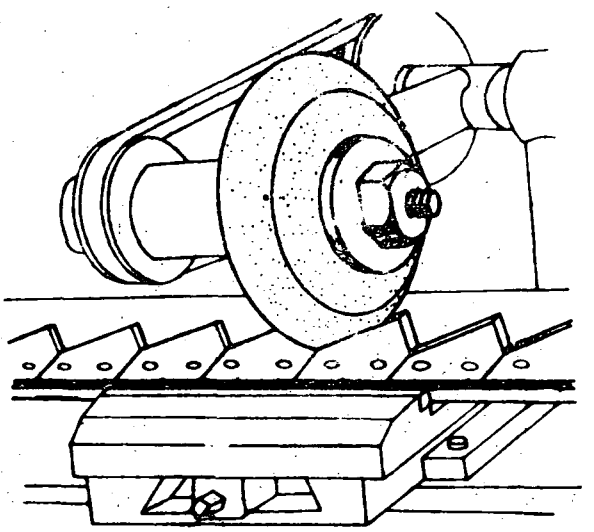


Fig. 1

SAFETY MEASURE

WEAR SAFETY GLASSES WHEN GRINDING

c) Sharpen until the bevel and cutting angle match the original When the apex is equal to a point the section should be changed (Fig. 2).

Process II - Sharpening the sections with a portable grinder

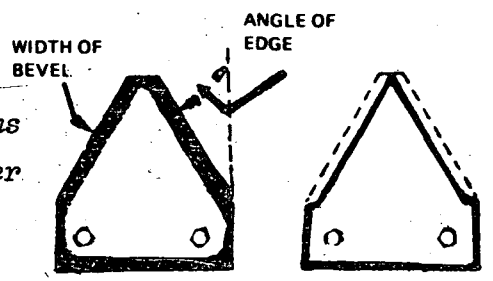


Fig. 2

1st Step - *Sharpen the sections* thus:

a) Secure the bar in a vice.

b) Sharpen the sections maintaining the cutting angle and bevel (Fig. 2).

Process III - Sharpening the sections with the fixed grinder

1st Step - *Sharpen the sections* thus:

a) Remove the sections from their cutter bar.
b) Sharpen the sections on the fixed grinder. Maintain the original cutting angle and bevel (Fig. 3).
c) Place the sections on the cutter bar and rivet them.

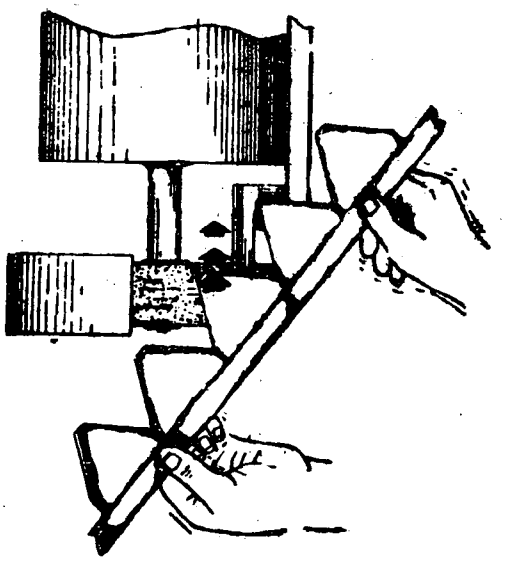


Fig. 3

OBSERVATION
Worn serrated type sections must be changed.

CASE II - SHARPENING LEDGER PLATES

1st Step - *Sharpen the ledger plates* thus:-

a) Remove the ledger plates from the cutter bar.

b) Sharpen the ledger plates with the fixed grinder without removing them from their guards. Maintain the angle of the original bevel (Fig. 4).

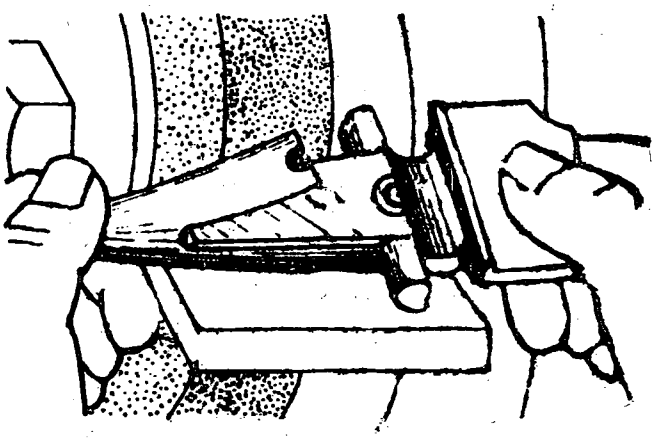


Fig. 4

OBSERVATIONS
1) The ledger plates can only be sharpened once.
2) Worm serrated-type ledger plates must be changed.

CBC

OPERATION:
DISASSEMBLING AND ASSEMBLING THE BRAKE UNIT
(Mechanically activated shoe system)

The preventive maintenance of the braking system is very important for safe driving. It calls for periodic removal of all the components of the braking unit. After checks, cleaning and repair of the components, the unit must be reassembled.

PROCEDURE

CASE I - DISASSEMBLING THE BRAKE UNIT

Process I - Braking group with drum installed outside the semi-axle (Fig. 1)

1st Step - *Remove the drum* thus:

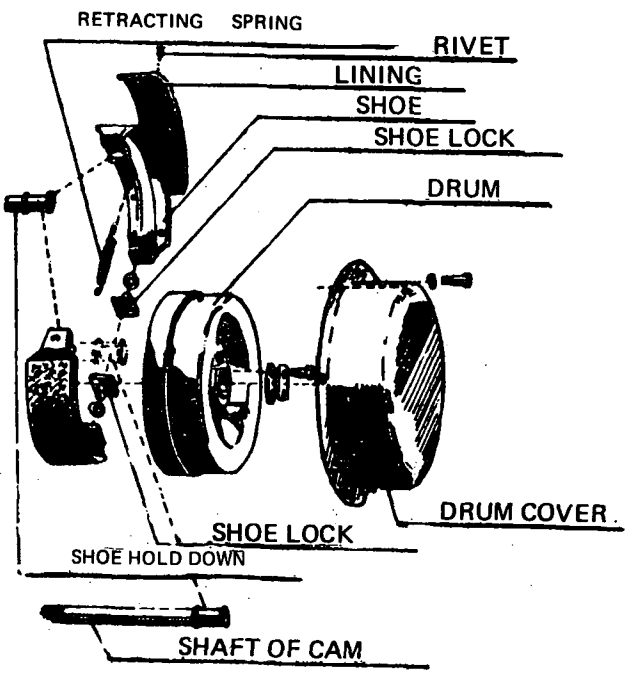


Fig. 1

a) Loosen the adjusting nut or screw. This will relieve all tension from the braking system (Fig. 2).

b) Remove the drum guard.

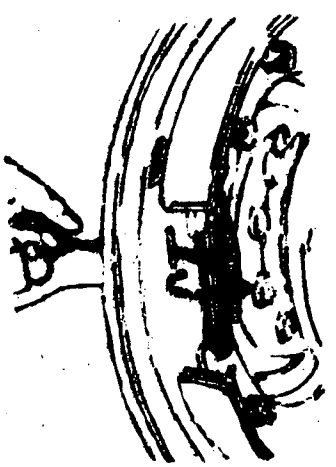


Fig. 2

c) Remove the fastening system (nuts, bolts, etc) from the drum.

d) Remove the drum.

OBSERVATIONS

1) Tap the drum with a rubber hammer to loosen it. If necessary, use an extractor.

2) Be careful with the drum. It is made of cast iron and breaks easily.

2nd Step - *Remove the brake shoes* thus:

a) Remove the retracting spring from the shoes.

CAUTION

BE CAREFUL: THE SPRING MAY FLY OFF.

b) Remove the brake shoe hold downs.

c) Remove the shoes.

3rd Step - *Remove the brake shoe mechanism (cam)* thus:

a) Remove the lock from the shaft of the cam.

b) Remove the cam.

4th Step - *Clean the elements* thus:

a) Wash the parts with kerosene and a brush.

b) Dry the parts with a clean rag and pressurized air.

OBSERVATION

Shoes should be free of grease. Use gasolene or alcohol.

5th Step - *Verify the elements* thus:

a) Check for scratches, fissures and the general state of the drum.

b) Check the working surface of the lining of the shoes (surface cracks, cracks, rough edges and wear).

c) Check the brake shoes for cracks, surface cracks, or wear.

d Check the state and tension of the retracting spring of the shoes.

e) Check the state of the hold downs of the shoes (twist, wear, etc).
f) Check the wear and alignment of the shaft of the cam and also its lodging.
g) Check the state of the nuts, bolts and washers.
h) Check that rivets are well below the working surface of the linings.

OBSERVATIONS

1) Rectify the drum or have it rectified if necessary.

2) Weak springs, worn cams, bolts, screws, etc., should be changed.

3) Worn linings should be changed.

Process II - Brake group with the drum installed on the semi-axle.

1st Step - *Remove the drum* thus:

a) Chock the front wheels.
b) Jack up the back of the tractor.
c) Remove the back wheels.
d) Release all tension from the braking system.
e) Remove the reduction mechanism if necessary (Fig. 3).

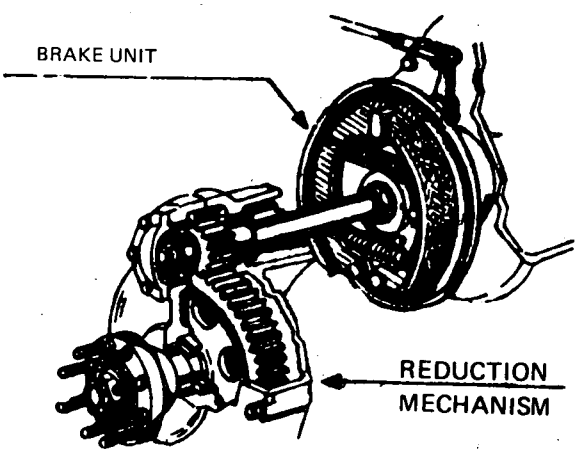


Fig. 3

OBSERVATIONS

1) When the reduction mechanism is removed its drum also comes off with it.

2) To remove this mechanism, support it with a crane.

2nd Step - *Remove the shoes.*

3rd Step - *Remove the brake-shoe mechanism.*

4th Step - *Clean the parts.*

5th Step - *Check the parts.*

CASE II - ASSEMBLING THE BRAKE UNIT

Process I - Brake group with drum installed outside the semi-axle

1st Step - *Install the brake shoe mechanism* thus:

a) Install the shaft of the cam in its lodging.
b) Install the lock of the shaft of the cam.

2nd Step - *Mount the shoes* thus:

a) Install the shoes in their place. Be sure the adjusting screw is at its minimum adjustment.
b) Mount the brake shoes hold downs.
c) Mount the retracting spring.

3rd Step - *Install the drum* thus:

a) Mount the brake drum.
b) Install the securing system of the drum.
c) Mount the guard of the drum.

4th Step - *Adjust the mechanism of the brakes* thus:

a) Adjust the shoes until the wheel is completely braked.
b) Gradually reduce adjustment until the wheel turns freely.

OBSERVATIONS

1) Check the free play of the pedals. Follow specifications.
2) Be sure the wheels brake uniformly.

CBC

OPERATION:
DISASSEMBLING AND ASSEMBLING OF THE BRAKE UNIT
(Mechanically activated shoe system)

REF. OS.32/AgM | 5/5

Caribbean

Process II - Brake unit with drum installed on the semi-axle

1st Step - *Install the brake mechanism.*

2nd Step - *Mount the shoes.*

3rd Step - *Install the drum.*

4th Step - *Adjust the brake mechanism.*

TECHNICAL VOCABULARY

Hold down - retainer
Semi-axle - half-axle shaft, half shaft

The preventive maintenance of the braking system is very important for safe driving. It calls for periodic checks, cleaning and repair of the components. To enable this it is necessary to remove the components of the wheel brake unit and mount them again.

PROCEDURE

CASE I - DISASSEMBLING THE BRAKE UNIT

Process I - Removing the brake unit installed outside the semi-axle (Fig. 1).

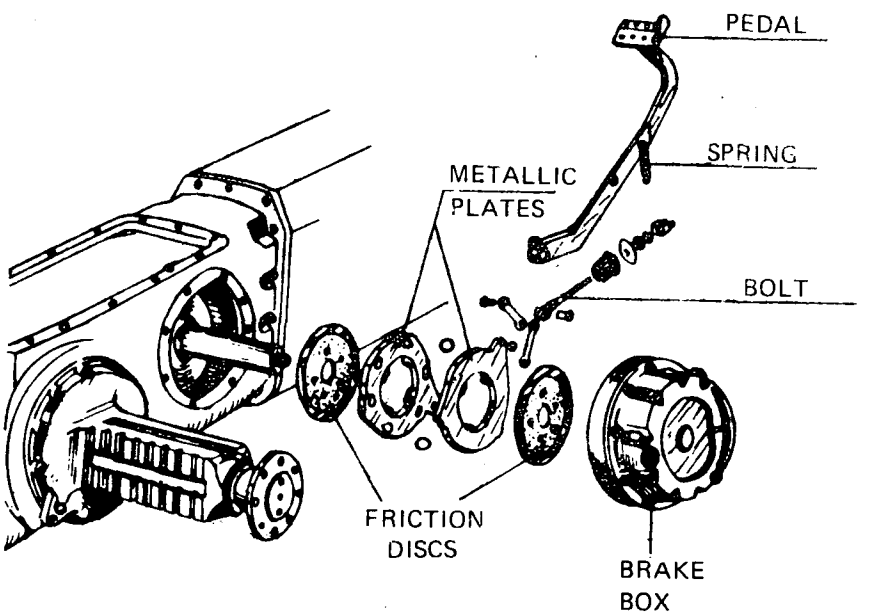


Fig. 1

1st Step - *Remove the brake group* thus:

a) Remove the spring to relieve tension from the brake pedal.
b) Unscrew the bolt which joins the pedal to the box and remove it.
c) Remove the bolts which secure the housing to the gearbox.
d) Remove the brake housing with the whole disc mechanism included.
e) Repeat the above sub-steps for the brake on the other side.

CINTERFOR 1st. Edition

2nd Step - *Disassemble the mechanism* thus:

a) Remove the friction disc or discs.

b) Remove the group of metallic pressure plates.

c) Remove the pins which join the metallic plates to the screw of the pedal. Separate the metallic plates.

d) Remove the friction disc or discs.

OBSERVATION

Before assembling or repairing the components of the brake, thoroughly wash them with a brush and gasolene.

3rd Step - *Check the parts* thus:

a) Check for scratches, surface cracks or deformation of the metallic discs.

b) Verify the wear of the working surface of the friction linings.

OBSERVATIONS

On riveted linings, the wear is limited by the heads of the rivets.

c) Check the state and tension of the springs.

d) Check the state of the nuts, bolts and washers. Change them if they are worn.

4th Step - *Change the linings of the discs if necessary.*

OBSERVATION

Rectify the metallic friction plates or have them rectified.

CBC

OPERATION:

DISASSEMBLING AND ASSEMBLING THE WHEEL BRAKE UNIT (Mechanically activated disc system)

REF. OS.33/AgM | 3/5

Caribbean

Process II - Brake group installed on the semi-axle (Fig. 2)

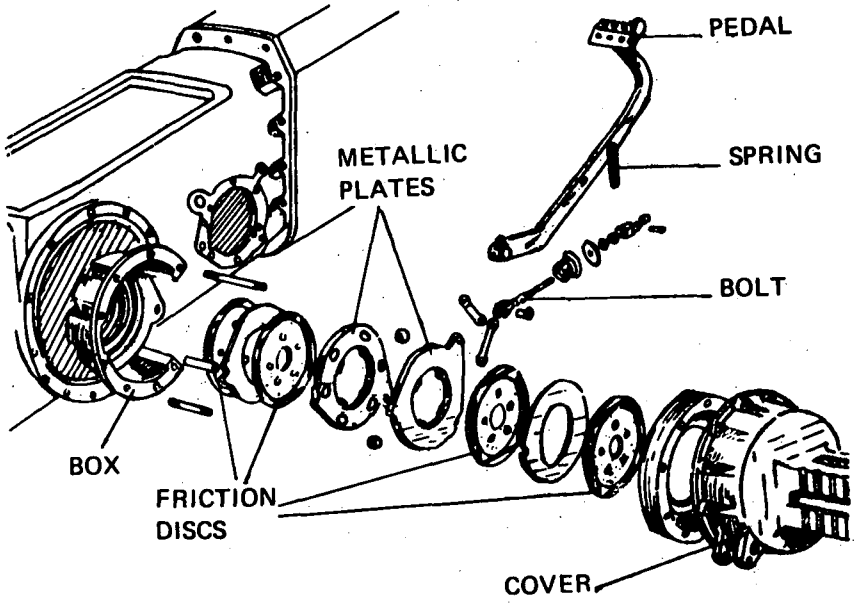


Fig. 2

1st Step - *Jack up the rear of the tractor.*

2nd Step - *Release all tension from* the brake pedal by removing the spring. Take out the pin which joins the pedal with the brake unit.

3rd Step - *Remove the wheel from its housing.*

4th Step - *Remove the rear light electrical circuit.*

5th Step - *Remove the mud guard.*

6th Step - *Tie the assembly cover with a rope,* cable or chain. Connect the rope, cable or chain to a crane and take up the slack.

7th Step - *Loosen and remove the bolts* which hold the cover to the gearbox.

SAFETY MEASURE

REPAIRS MAY BE NECESSARY ON BOTH SEMI-AXLES. IN THIS CASE, BE SURE TO STABILIZE THE TRACTOR WITH SUPPORTS. THIS WILL KEEP THE BALLAST FROM OVERTURNING IT.

8th Step - *Remove the cover* with the complete reduction group and brake.

9th Step - *Take out the screws and remove the brake housing.*

10th Step - *Disassemble the brake mechanism*

OBSERVATION

Repeat the above steps for the brake on the other side.

11th Step - *Check the parts.*

12th Step - *Change the linings of the discs* if necessary.

CASE II - ASSEMBLING THE BRAKE UNIT

Process I - Brake unit installed on the outside of the semi-axle.

1st Step - *Assemble the brake mechanism.*

2nd Step - *Mount the brake housing.*

3rd Step - *Adjust the mechanism* thus:

a) Turn the adjusting screw to apply tension on the brakes until the wheel is completely braked (Fig. 3).

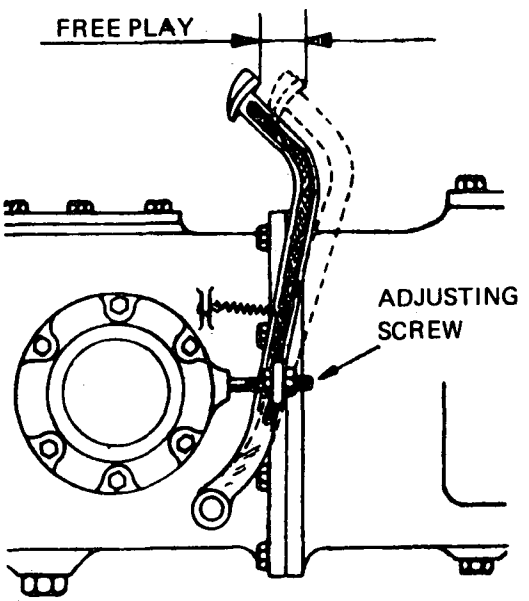


Fig. 3

b) Gradually reduce tension unscrewing the adjusting screw until the wheel turns freely.

OBSERVATIONS

1) Check the free play of the pedals. Follow specifications (Fig. 3).

2) Check both wheel brakes at the same time when the pedal is pressed.

Process II - Brake unit installed on the semi-axle

1st Step - *Install the brake mechanism* in the cover.

2nd Step - *Mount the cover* with the brake mechanism.

3rd Step - *Mount the mud guard.*

4th Step - *Install the electrical circuit.*

5th Step - *Install the wheel.*

6th Step - *Mount the pin and spring* on the brake pedal.

7th Step - *Adjust the brake mechanism.*

8th Step - *Remove the jacks or supports from the tractor.*

CBC

OPERATION:

REMOVING THE STEERING UNIT (tractors)

This operation consists of removing the steering unit for check and repair with the purpose of correcting failures in its functioning or to allow access to other mechanisms which require checking or repair.

PROCEDURE

1st Step - *Remove the steering wheel* thus:

a) Remove the nut from the steering shaft.

b) Set the extractor and remove the steering wheel (Fig. 1).

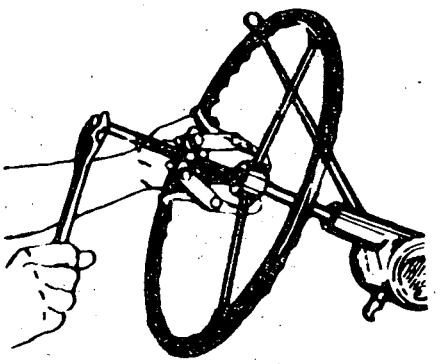


Fig. 1

OBSERVATION
While tightening the extractor, tap the head of the screw with a hammer.

2nd Step - *Remove the steering column* thus:

a) Remove parts that allow the dismounting of the steering column.

b) Remove the nut. Set the extractor. Remove the steering arm from the pitman arm.

c) Remove the nut from the pitman arm. Set the extractor. Remove the arm (Fig. 2).

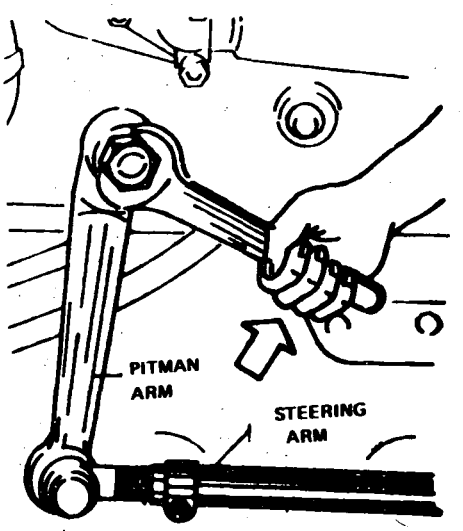


Fig. 2

OBSERVATION
The pitman arm may have no reference mark with regard to the sector. In this case, mark it before removing it.

d) Take out the nuts and remove the steering column (Fig. 3).

e) Loosen the bolts which secure the steering box. Remove the steering box.

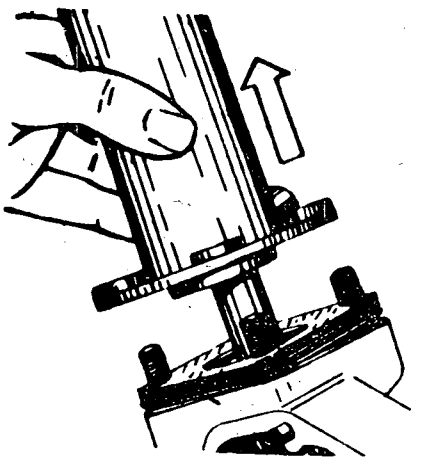


Fig. 3

3rd Step - *Remove the steering track rod bars* thus:

a) Remove the steering arm.

b) Remove the tie rods from the ends of the axles.

c) Loosen the anchoring bolts and nuts and remove the control arms.

CBC

OPERATION:
MOUNTING THE STEERING UNIT (tractors)

This operation consists of mounting the parts which make up the mechanical steering unit so as to conclude the reassembly of the steering system of the tractor.

PROCEDURE

1st Step - *Replace the steering box* thus:

a) Place the bolts which secure the box and tightem them.

b) Install the gears (Fig. 1).

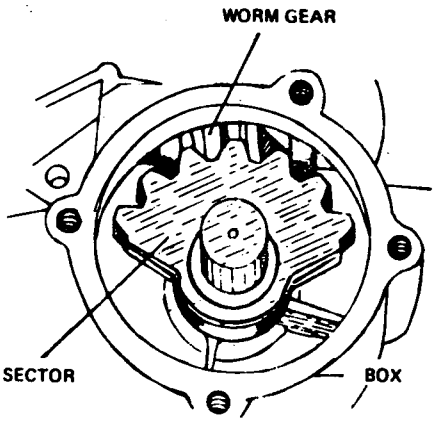


Fig. 1

c) Install the shims of the steering column (Fig. 2).

d) Place the steering column on the box. Tighten the securing bolts (Fig. 2).

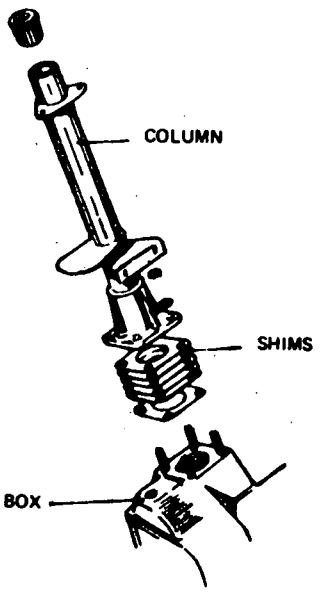


Fig. 2

e) Install the parts related to the steering column (instrument panel, accelerator, etc.).

2nd Step - *Mount the tie rod* thus:

a) Install the tie rod. Use the reference marks as a guide (Fig. 3).

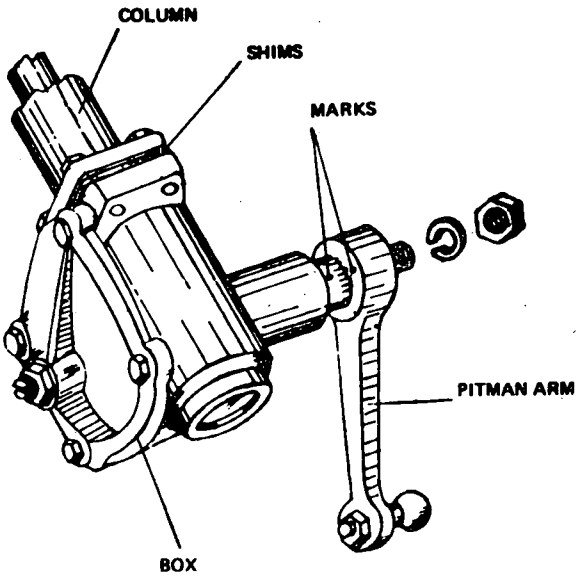


Fig. 3

3rd Step - *Mount the steering wheel.*

4th Step - *Mount the steering bars and arm* thus:

a) Mount the steering arms.
b) Mount the track rod.
c) Install the intermediate steering arm.

OBSERVATION
Each time this step is done, the convergence of the wheels must be adjusted (toe-in).

5th Step - *Adjust the play of the sector and worm gear.*

6th Step - *Lubricate the steering system* according to specifications.

CBC

OPERATION:

ALIGNING THE STEERING (tractors)

REF. OS.36/AgM | 1/3

Caribbean

This operation is done to check and adjust the argles of convergence and divergence of the steering system each time it is repaired or the track width is changed. This is done to prevent premature wear of the parts.

1st Step - *Place the tractor* thus:

a) Place the tractor on a flat surface.
b) Check pressure of the tyres according to specifications. It must be the same in both tyres.

2nd Step - *Check the wear of the front end* thus:

a) Lift the front end with a jack.

b) Move the wheel in and out and check the play of the front wheel bearing. Hold the wheel at top and bottom as shown (Fig. 1).

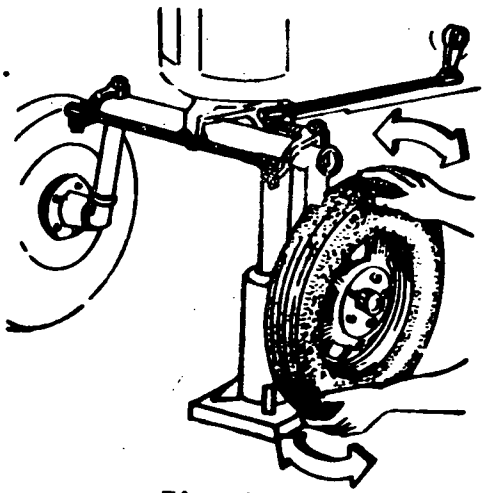


Fig. 1

c) Check the wear in the steering arms and joints.

OBSERVATION
To check the wear turn the steering in both directions and observe the free play.

3rd Step - *Inspect the steering unit.*

4th Step - *Be sure the wheels are aligned* thus: (Fig. 2).

a) Lock the steering wheel to one side.

b) Count the turns when locking the wheel in the other direction.

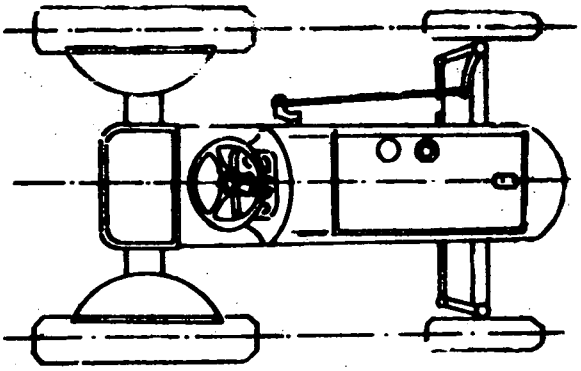


Fig. 2

c) Return the steering wheel to a position equal to half of its turns and secure it in place.

OBSERVATION
The wheels should be aligned in this position.

d) Align the wheels with the help of the steering bars.

5th Step - *Check the toe-in* thus:

a) Place the toe gauge. Measure the distance between the front tyres (Fig. 3).

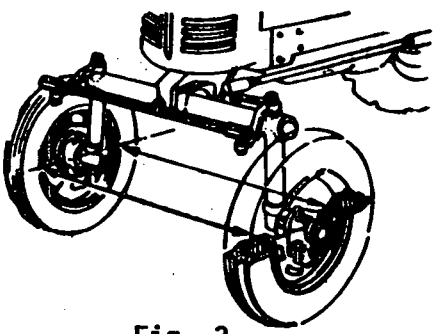


Fig. 3

b) Measure the back of the tyres. See if the difference in reading agrees with specifications.

6th Step - *Adjust the toe-in* thus:

OBSERVATION
This step is carried out when the toe-in is incorrect.

a) Loosen the clamps or pins at the ends of the tie rod.

b) Turn the tie rod to screw or unscrew it from its end (Fig. 4). Turn it until the specified measurement is reached.

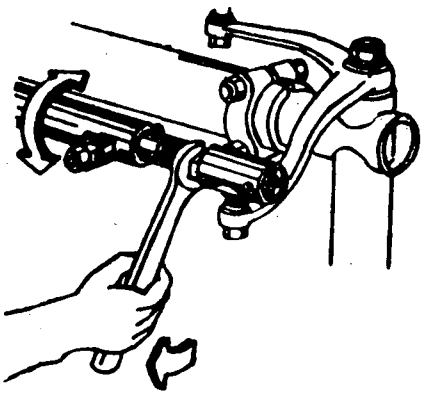


Fig. 4

c) Tighten the securing elements at the ends of the tie rod.

d) Check the toe-in.

CBC

OPERATION:

CHANGING THE UNIVERSAL JOINTS OF THE PROPELLER SHAFT (tractors)

REF. OS.37/AgM | 1/3

Caribbean

This operation consists of changing the universal joints of the propeller shaft when they are worn with the purpose of obtaining a uniform rotary movement and eliminating noises and vibrations.

PROCEDURE

1st Step - *Remove the propeller shaft* thus:

SAFETY MEASURES

1) *CHOCK THE WHEELS TO KEEP THE TRACTOR FROM MOVING.*

2) *DO NOT START THE ENGINE WHEN WORKING ON THE PROPELLER SHAFT.*

a) Take out the securing bolts from the propeller shaft.
b) Pull and lower the propeller shaft to uncouple it.

OBSERVATION

If necessary, use a lever to pry the propeller shaft loose.

2nd Step - *Remove the universal joint* thus:

b) Remove the circlips (Fig. 1). Use a pair or circlip pliers.

SAFETY MEASURE

USE SAFETY GLASSES WHEN REMOVING THE CIRCLIPS. THEY USUALLY FLY OFF.

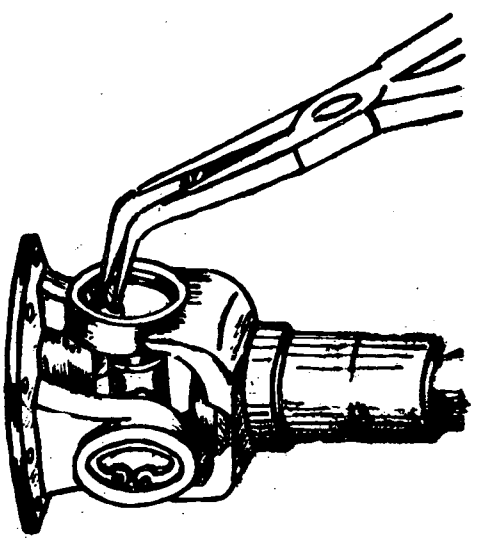


Fig. 1

c) Remove the bearings. Use a press or extractor (Fig. 2).

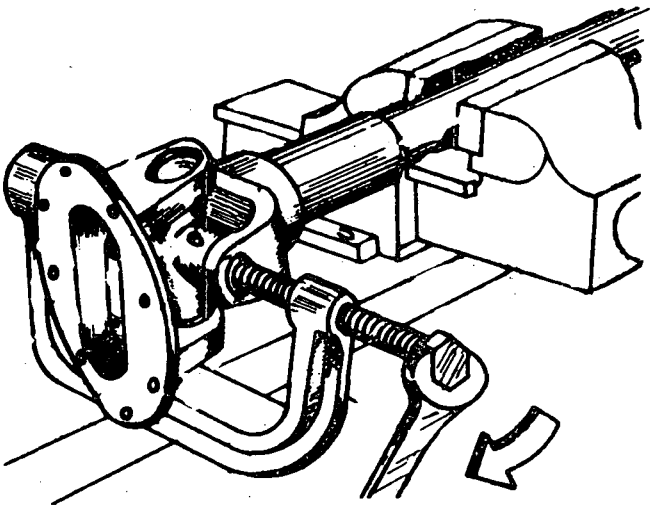


Fig. 2

d) Remove the cross (Fig. 3).

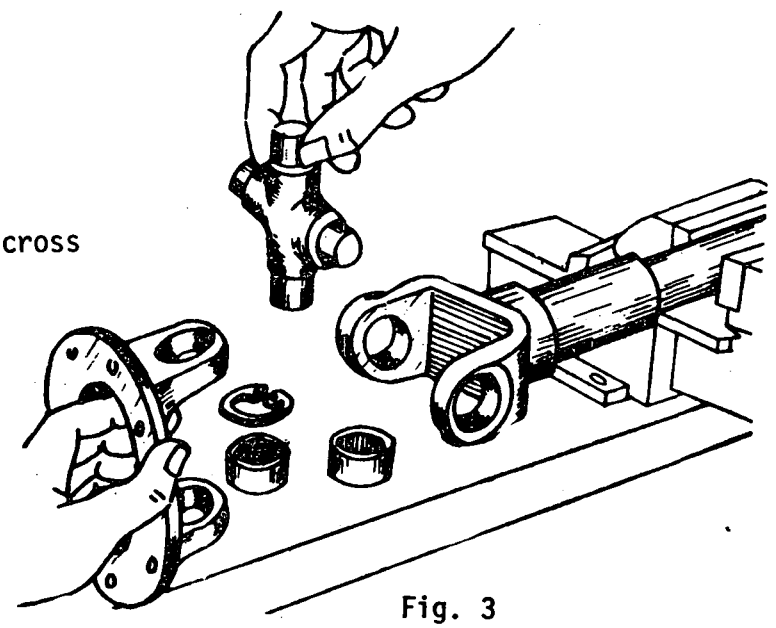


Fig. 3

OBSERVATION

Remove the grease nipple if it makes the removal of the cross difficult.

c) Check the state of the propeller shaft.

3rd Step - *Mount the new universal joints* thus:

OBSERVATION

Put a small amount of fibrous grease in the bearings to prevent the needles from falling from the side.

a) Position the cross in the shaft.

b) Let one end of the cross extend outwards and install the bearing.

OBSERVATION
Be sure the needles in the bearings keep their position.
Be sure they are centred.

c) Using a press, insert the bearing in the bore of the yoke until the groove of the circlip appears.
d) Install the circlip.
e) Put on the other bearing and repeat sub-steps (c) and (d).

OBSERVATION
While applying pressure on the bearings, check on the free movement of the cross.

4th Step - *Mount the propeller shaft* thus:

a) Couple the propeller shaft.
b) Place and tighten the bolts which hold the propeller shaft.

5th Step - *Lubricate the Universal Joints.*

CBC

OPERATION:

REMOVING THE CLUTCH (tractors)

REF. OS.38/AgM | 1/2

Caribbean

This operation consists of removing the parts of the system with the purpose or repairing the clutch unit and other parts such as the flywheel and the ring gear.

PROCEDURE

1st Step - *Separate the engine section from the transmission section.*

2nd Step - *Remove the clutch* thus: (Fig. 1).

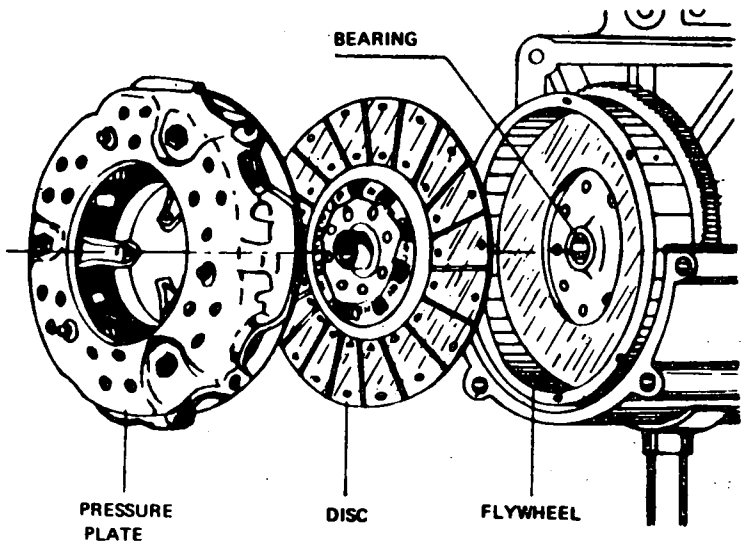


Fig. 1

a) Gradually remove the screws which hold the pressure plate. Leave one or two screws holding the clutch.

b) Hold the clutch and remove the last two screws. Then remove the clutch disc and pressure plate.

OBSERVATION

Sometimes help of another person is required to remove the clutch.

c) Remove the pilot bearing from the flywheel.

3rd Step - *Remove the control group* thus: (Fig. 2)

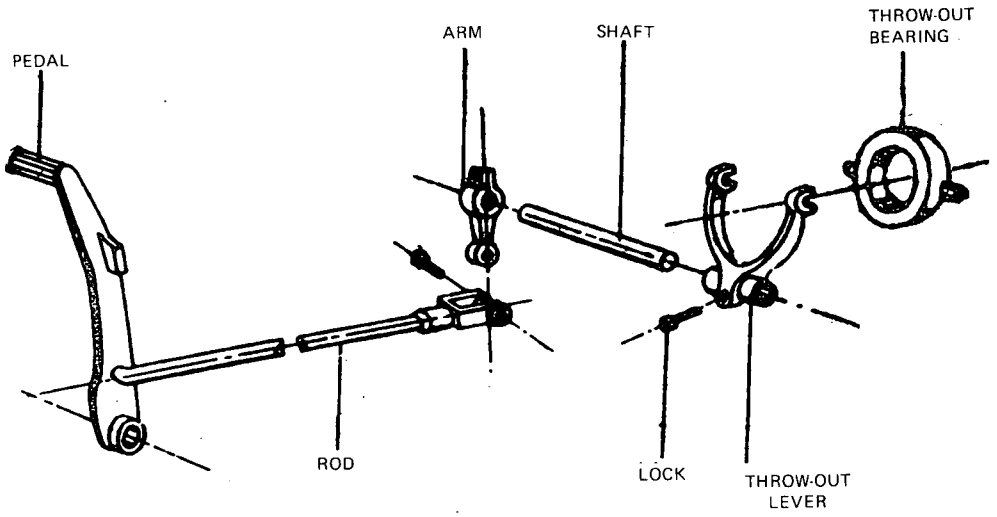


Fig. 2

a) Disconnect the pedal from the throw-out lever shaft.
b) Remove the pin from the throw-out lever.
c) Remove the shaft of the throw-out lever.
d) Remove the throw-out lever and the throw-out bearing.

OBSERVATIONS

1) Sealed type throw-out bearings should not come in contact with solvents.

2) Store the parts in a suitable place.

CBC

OPERATION:
CHECKING THE CLUTCH COMPONENTS

This operation consists of determining visually or with instruments the wear or deformation of the components of the clutch. The objective is to determine whether the components require repair or change.

PROCEDURE

1st Step - *Clean all the parts.*

2nd Step - *Check the wear of the disc* thus:

a) Check the wear of the linings.

OBSERVATION
The wear of riveted linings is limited by the head of the rivets and on bonded linings, by the grooves which indicate the minimum thickness.

b) Check if the splines of the hub are deformed or worn.
c) Check whether the damper springs are broken or slack in their lodging.
d) Check for oil or grease-soaked linings.
e) Check for burnt or glazed linings.

OBSERVATION
If the linings are glazed, burnt, oil-soaked or worn out they should be changed.

f) Install the disc on the input shaft. See that it slides freely or if it has play (Fig. 1).

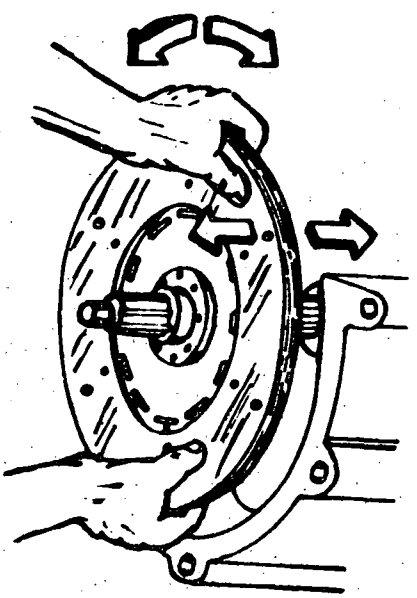


Fig. 1

OBSERVATIONS
1) Radial play or movement of the shaft when tilted indicates that

splines of the hub are worn. In this case one or both parts must be changed.

2) The new disc is tested in the same way. If it has the same play, the splines on the shaft are worn.

3rd Step - *Check the alignmenttof the disc* thus:

a) Install the disc on an adjustable axle or chuck.

b) Place the axle or chuck on two "V" blocks.

c) Position the dial gauge (Fig. 2).

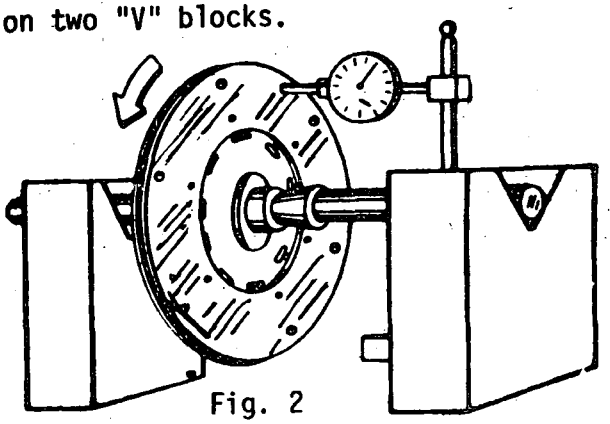


Fig. 2

d) Place the contact point of the indicator on the face of the disc.

e) Turn the disc and observe the reading on the indicator.

OBSERVATIONS

1) An even reading means that the disc is aligned.

2) Change the disc if the misalignment surpasses the limits specified by the manufacturer.

4th Step - *Check the tension and height of the springs.*

5th Step - *Check the surface of the pressure plate* thus:

a) Check whether the surface is scratched, cracked or burnt.

OBSERVATION

If the pressure plate is scratched or burnt, it can be rectified. If it is cracked, it should be changed.

b) Check if the surface of the pressure plate is flat (Fig. 3).

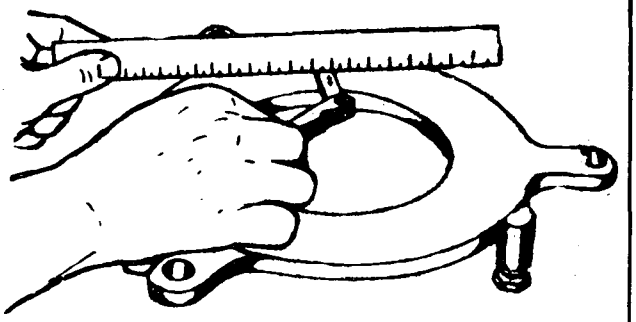


Fig. 3

OBSERVATIONS

1) The surface is flat when there is no light between the straight edge and the plate.
2) Change or rectify the plate if the light exceeds the tolerance indicated by the manufacturer.

6th Step - *Check the throw-out bearing.*

a) Spin the bearing. The sound will tell if it is in a bad state.
b) Check the play of the shaft of the throw-out lever.

7th Step - *Check the flywheel* thus:

a) Check if the surface is scratched, cracked or burnt.

OBSERVATION

If the surface is scratched or superficially burnt, it may be rectified. If it is cracked, the flywheel must be changed.

b) Check if the surface of the flywheel is flat (Fig. 4).

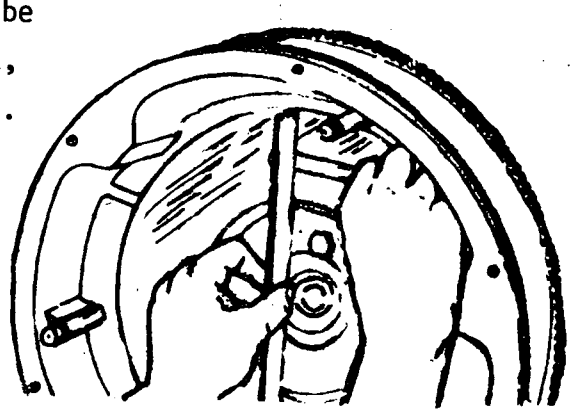


Fig. 4

CBC

OPERATION:
MOUNTING THE CLUTCH (tractors)

This operation consists of installing the clutch unit on the flywheel of the engine after having it repaired or checked.

PROCEDURE

1st Step - *Mount the throw-out bearing* thus:

a) Place the throw-out bearing on its guide.

b) Place the throw-out lever. The prongs must coincide with the ends of the throw-out bearing (Fig. 1).

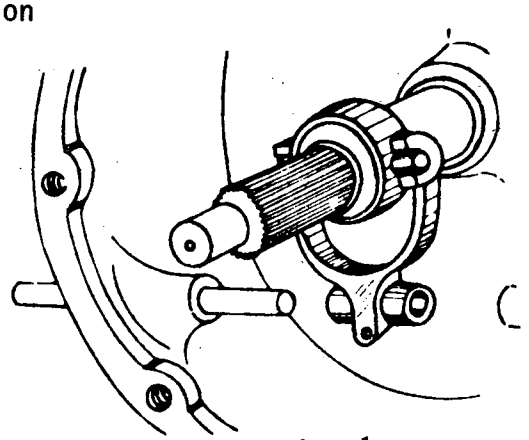


Fig. 1

c) Install the shaft and secure the throw-out lever.

2nd Step - *Mount the clutch* thus:

OBSERVATION
Clean the flywheel.

a) Install the pilot bearing in the flywheel.

b) Place the clutch disc and the pressure plate on the flywheel. Centre the disc with a clutch arbor (Fig. 2).

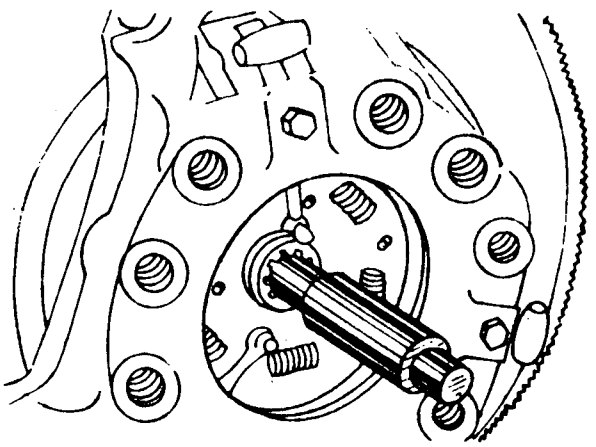


Fig. 2

c) Align the holes of the pressure-plate and flywheel.

d) Place the screw and tighten them following the correct sequence. Stop when you get to the specified torque.

e) Remove the clutch arbor.

3rd Step - *Join the engine section* to the transmission section of the tractor.

4th Step - *Install and adjust the clutch rod* thus:

a) Place the rod on the end of the throw-out lever.
b) Install the retracting spring.
c) Adjust the free play of the pedal to specifications.
d) Test the clutch.

TECHNICAL VOCABULARY

Clutch arbor - dummy shaft

CBC

OPERATION:
REMOVING THE DIFFERENTIAL (tractors)

REF. OS.41/AgM | 1/2

Caribbean

This operation consists of removing different parts of the tractor with the purpose of taking out the components of the differential for checks, repairs or change.

PROCEDURE

1st Step - *Drain the lubricant* from the gearbox, differential and terminal controls.

2nd Step - *Separate the engine section* from the transmission section.

SAFETY MEASURE
BOTH SECTIONS OF THE TRACTOR MUST BE SECURED TO AVOID ACCIDENTS.

3rd Step - *Remove the rear wheels.*

4th Step - *Remove the gearbox.*

5th Step - *Remove the differential cover* thus: (Fig. 1)

a) Dismount parts which make removal difficult.
b) Loosen and remove the bolts from the cover.
c) Remove the cover.

OBSERVATION
Use a crane to lift the cover if it is very heavy.

d) Remove the gasket.

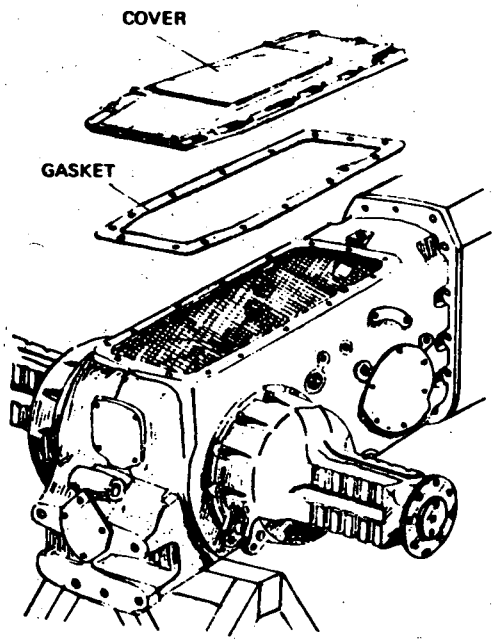


Fig. 1

6th Step - *Remove the semi-axles* thus:

SAFETY MEASURE
BEFORE REMOVING THE FIRST SEMI-AXLE, BE SURE TO STABILIZE THE TRACTOR. IT WILL KEEP THE BALLAST FROM OVERTURNING IT.

a) Remove the brake system if it is installed on the semi-axles.
b) Remove the reduction gears if any.
c) Loosen the bolts of the housing.
d) Tie the housing with a rope, chain or steel cable to support it.
e) Apply tension to the rope, chain or cable with a crane.
f) Remove the bolts from the housing.
g) Remove the semi-axle. Place a lever between the base of the housing and the differential, if necessary (Fig. 2).
h) Use the same procedure on the other semi-axle.

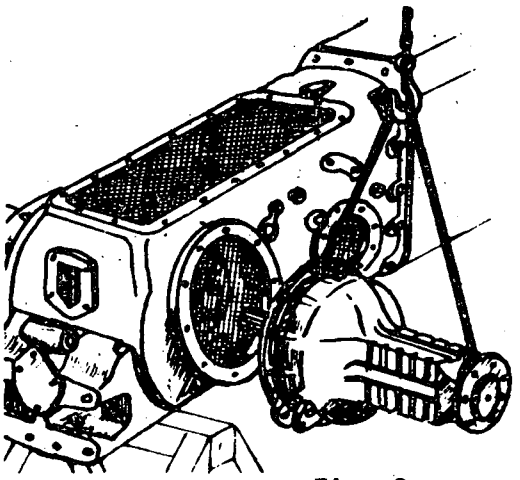


Fig. 2

7th Step - *Remove the ring gear* and the differential case thus:

a) Remove the hydraulic pump if placed on the rear end.
b) Remove the locking device from the differential.
c) Loosen and remove the covers which hold the ring gear.
d) Remove the ring gear and differential cage (Fig. 3).

OBSERVATION
Keep the disassembled parts in a suitable place.

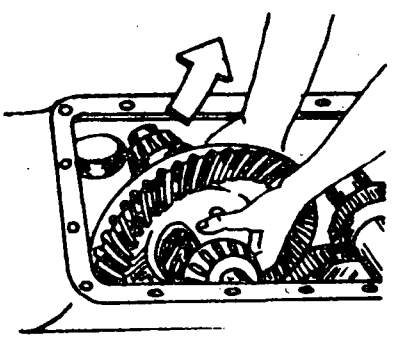


Fig. 3

TECHNICAL VOCABULARY

Ring gear - crown wheel

CBC

OPERATION:

DISASSEMBLING THE DIFFERENTIAL UNIT

This operation consists of removing components of the differential unit to check their condition and determine if they need to be changed.

PROCEDURE

Process I - Disassembling the non-separable differential cage.

1st Step - *Remove the bearings.*

2nd Step - *Remove the ring gear* thus:

a) Place the group in a bench vice.

b) Mark the position of the ring gear.

c) Remove the bolts from the ring gear (Fig. 1). Release the tension from the bolts in a gradual and alternate manner.

d) Tap the ring gear with a plastic hammer until it comes out.

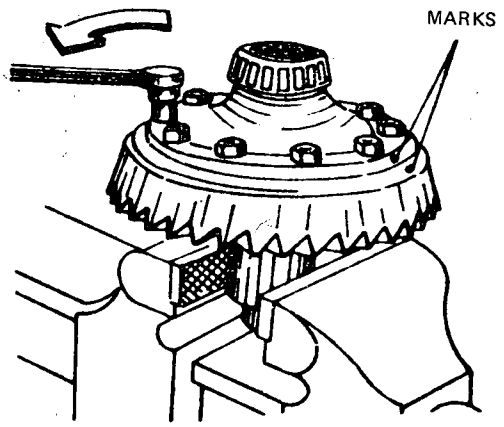


Fig. 1

3rd Step - *Remove the pinions* thus (Fig. 2).

a) Remove the pin from the shaft of the pinions.

b) Remove the shaft of the pinions.

c) Remove the pinions and their washers.

d) Remove the side gears and their washers.

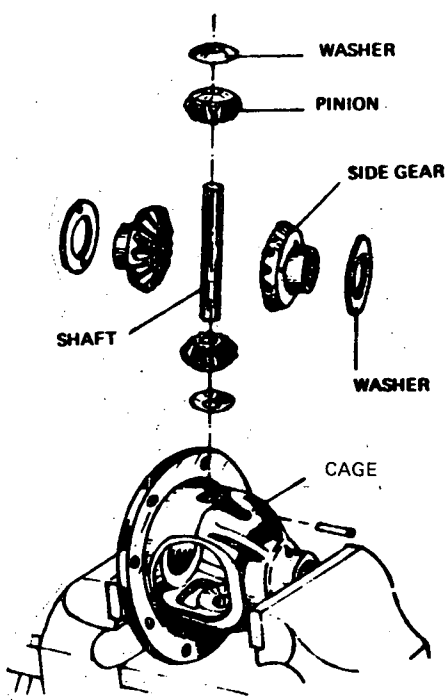


Fig. 2

Process II - Disassembling the separable differential cage

1st Step - *Remove the bearings.*

2nd Step - *Remove the ring gear.*

3rd Step - *Remove the pinions* thus: (Fig. 3).

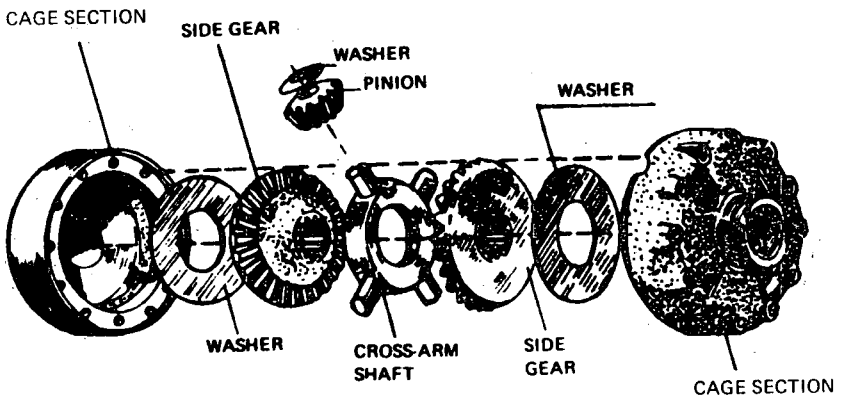


Fig. 3

a) Mark the position of the cage section of the differential cage.
b) Loosen and remove the bolts of the differential cage.
c) Tap the cage sections with a plastic hammer until they are separated.
d) Remove the group of pinions, axles, side gears and washers.

OBSERVATION
In many cases, the ring gear is secured by the same bolts which join the cage sections of the differential cage.

CBC

OPERATION:
REASSEMBLING THE DIFFERENTIAL UNIT

REF. OS.43/AgM | 1/3

Caribbean

This operation consists of reassembling the components of the differential unit which can then be installed in the differential carrier.

PROCEDURE

Process I - Assembling the non-separable differential cage

1st Step - *Clean the parts.*

2nd Step - *Mount the ring gear* thus:

a) Install the ring gear on the cage. Make the holes match and thus align the positioning marks.

b) Place the bolts in the ring gear.

c) Tighten the bolts alternately and at the recommended torque (Fig. 1).

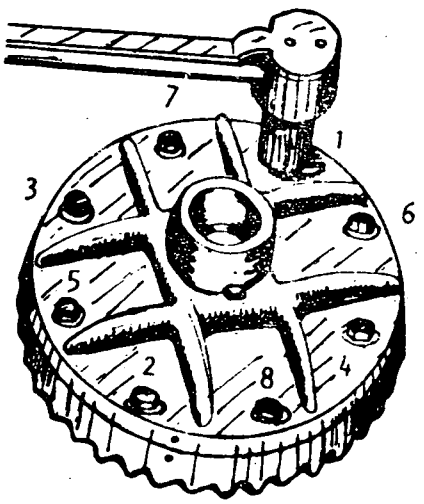


Fig. 1

OBSERVATION
In some separable differential cages it is necessary to assemble the pinions together with the ring gear. This is so because the same bolts keep the ring gear and cage sections of the cage in place.

3rd Step - *Mount the pinions and side gears thus: (Fig. 2).*

a) Install the washer of the side gears.

b) Install the side gears.

c) Install the washers of the pinions.

d) Install the pinions so that they match with the side gears. Also their centres should be aligned with the hole in which the shaft is to be placed.

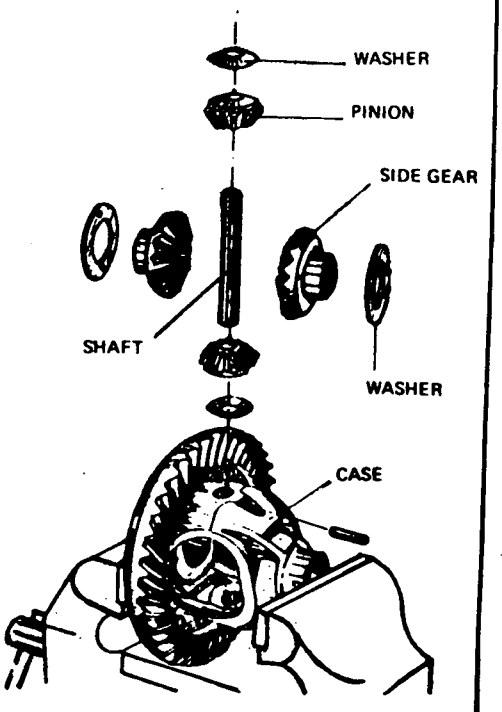


Fig. 2

OBSERVATION

To put the pinions in place it is necessary to turn the side gears.

e) Place the shaft which holds the pinions so that its hole coincides with the hole of the pin.

f) Install the pin.

Process II - Assembling the separable differential cage.

1st Step - *Clean the parts.*

2nd Step - *Install the ring gear.*

3rd Step - *Install the pinions and side gears* thus:

a) Place one of the cage sections on a table, so that the lodging of the side gear faces upwards.

b) Install the washer of the side gear.

c) Install the side gear.

d) Install the pinions on the cross arm shaft.

e) Place the washers of the pinions.

f) Mount the group of pinions on the side gear which is installed in the cage. Be sure the pinions match with the side gear.

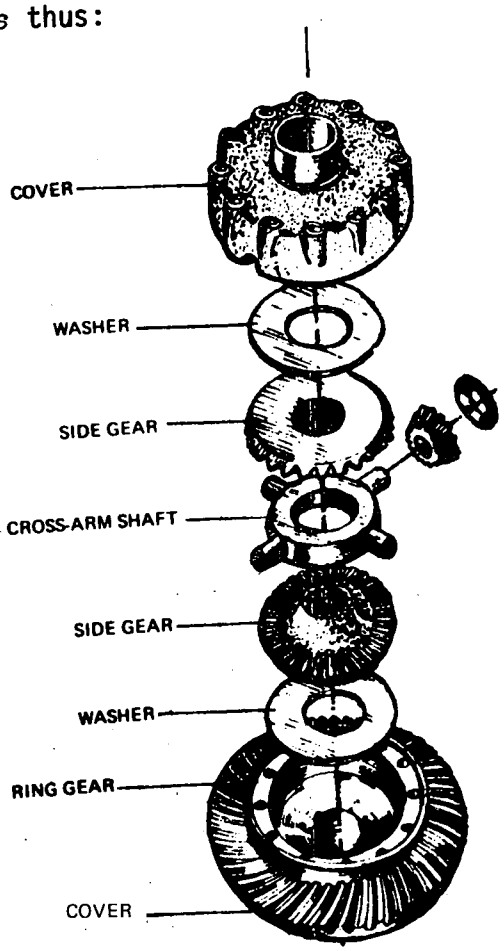


Fig. 3

g) Install the washer of the other side gear in the other cage section.

h) Install the other side gear.

i) Place the cage section with the side gear on the other cage section of the pinions. Align the positioning marks and make the holes match.

j) Tap the cage sections lightly to join them.

OBSERVATION

The cage sections must join easily and without resistance.

k) Place the bolts and tighten to the recommended torque.

OBSERVATIONS

1) Ring gears with cage sections held in place by the same bolts should be installed simultaneously.

2) The bolts generally carry a lock to prevent them from loosening.

4th Step - *Install and lubricate the bearings.*

CBC

OPERATION:

ADJUSTING THE DIFFERENTIAL UNIT

This operation consists of adjusting the differential unit with the clearances recommended by the manufacturer. The objective is to obtain the correct coupling of the components and avoid premature wear of the parts due to lack of adjustment (Fig. 1).

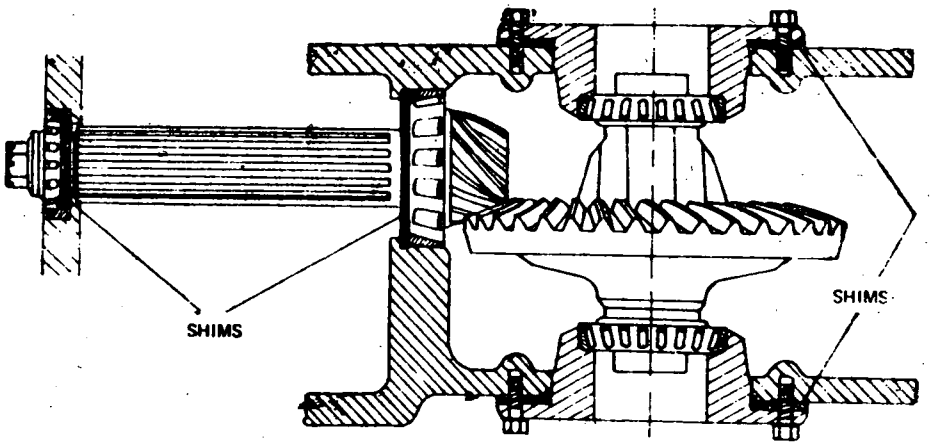


Fig. 1

PROCEDURE

1st Step - *Adjust the axial play of the drive pinion* thus:

a) Install the drive pinion in the case.

b) Place the dial gauge at the end of the drive pinion (Fig. 2).

c) Measure the axial play with the dial gauge.

d) Remove the drive pinion and place the shims needed to eliminate axial play.

e) Replace the drive pinion and check the axial play.

f) Remove and replace the drive pinion as many times as necessary. Place or remove shims until the axial play is eliminated.

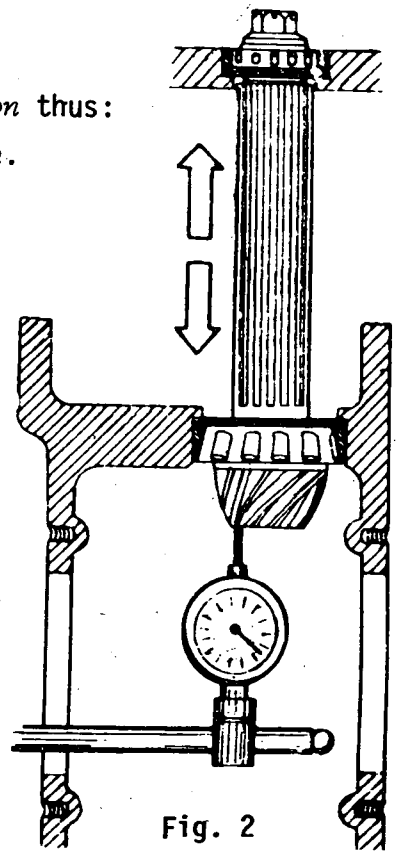


Fig. 2

OBSERVATIONS

1) The axial play is eliminated when the drive pinion cannot move lengthwise and the indicator remains at zero. Check the specifications.

2) The bolts should be tightened to the torque recommended by the manufacturer.

3) To eliminate axial play, sometimes it is necessary to remove shims instead of adding them.

2nd Step - *Adjust the load of the bearings* of the drive pinion thus:

OBSERVATION
Consult the manual to find out the load of the bearings.

a) Place a torque wrench or a dynamometer on the end of the drive pinion (Fig. 3).

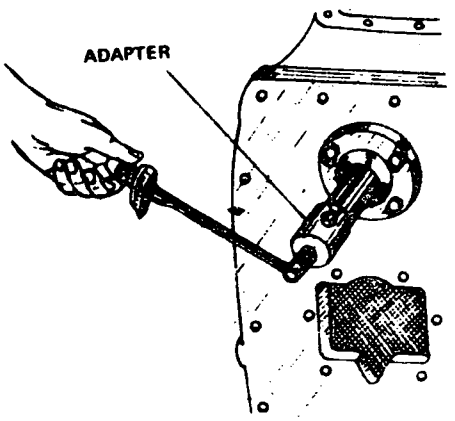


Fig. 3

b) Use the torque wrench or the dynamometer to turn the pinion. Check the reading.

c) Compare the reading with the torque indicated by the manufacturer.

OBSERVATIONS

1) Add or remove shims to correct any vibration of the established load.

2) To adjust the load of the bearings the drive pinion should not be connected to the ring gear.

3rd Step - *Adjust the axial play* of the ring gear thus:

OBSERVATION
To avoid possible errors in the adjustments, the ring gear should not be connected to the pinion.

a) Install the ring gear in the case. Place several additional shims to provide the ring gear with lengthwise play.

b) Place the dial guage.

c) Measure the axial play with the dial gauge (Fig. 4).

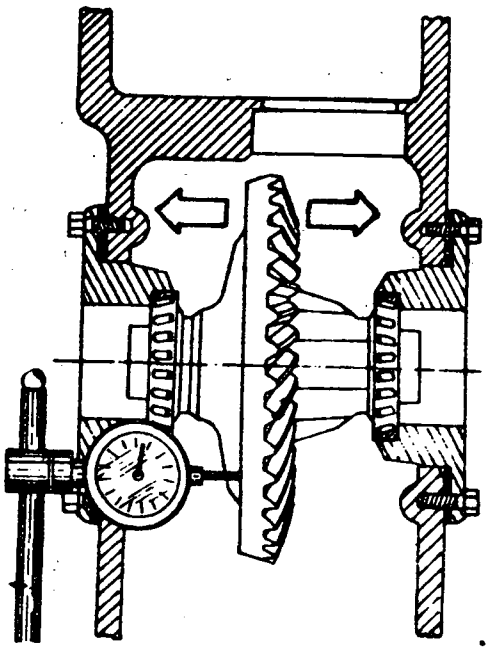


Fig. 4

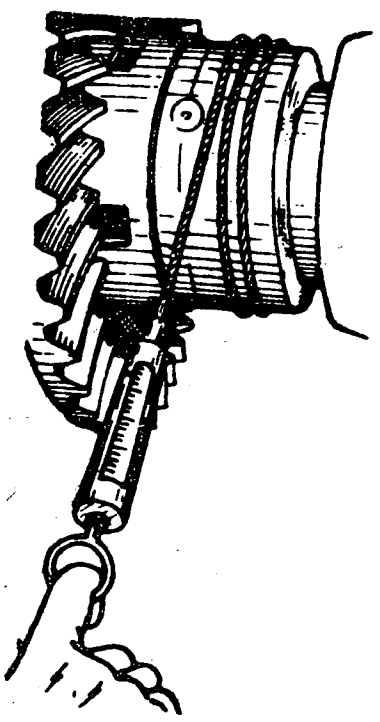
d) Remove and replace the covers of the ring gear as many times as necessary and remove shims until the axial play is eliminated.

4th Step - *Adjust the load* of the bearings of the ring gear.

OBSERVATIONS

1) To adjust the load of the bearings the ring gear should not be connected to the pinion.

2) Consult specifications to find out the load of the bearings.



a) Place a dynamometer on the differential case (Fig. 5).

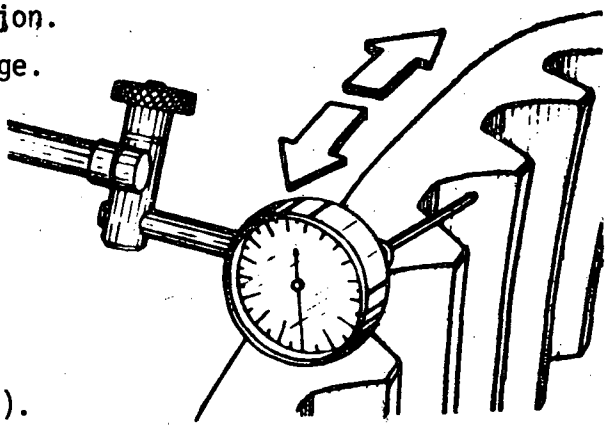
Fig. 5

b) Follow the same procedure used to adjust the load of the bearings of the drive pinion.

5th Step - *Adjust the clearance between the teeth* of the ring gear and the pinion (backlash) thus:

a) Install the drive pinion.

b) Position the dial gauge.



c) Measure the clearance between the teeth at various points around the ring gear (Fig. 6).

Fig. 6

d) Pass shims from one side of the ring gear to another until you get the specified clearance.

OBSERVATIONS

1) Each time that the shims are changed from one side to another, the bolts of the covers should be tightened to the recommended torque and a new measurement taken.

2) The same amount of shims which are removed from one side should be placed on the other.

6th Step - *Check the contact pattern* thus:

a) Thoroughly clean the teeth of the ring gear and the pinion.

b) Paint the pinion teeth with a thin film of Prussian blue or a similar colouring.

c) Rotate the ring gear and the pinion in both directions.

d) Observe the marks of the colouring on the teeth of the ring gear. These will show if the contact between teeth is correct (Fig. 7).

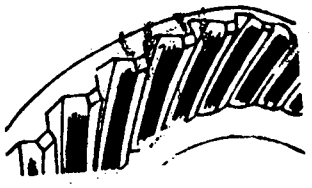


Fig. 7

OBSERVATIONS

1) When the colouring covers the flank of both teeth, the contact is correct.

2) After adjusting the ring gear and pinion, the contact pattern should be correct.

3) It may be necessary to remove the ring gear or the drive pinion after they have been adjusted. So, keep the shims in their respective covers. Then, install them in the same place without changing their number.

TECHNICAL VOCABULARY

Dynamometer - spring balance
Prussian blue - mechanic's blue, impression blue

This operation consists of installing various tractor parts after completing repairs of the component units which make up the final drive.

PROCEDURE

1st Step - *Assemble the gearbox.*

2nd Step - *Install the semi-axles* thus:

OBSERVATIONS
The ring gear and the differential case are installed when the differential unit is adjusted.

a) Install the differential locking mechanism.
b) Replace the hydraulic pump if it is installed in the casing of the differential.
c) Tie the housing with a rope, chain or cable.
d) Lift the housing with a crane.
e) Install the new gasket.
f) Couple the housing to the transmission box. Tighten the bolts.
g) Install the brake system if this is installed on the semi-axles.
h) Mount the reduction gears if there are any, or if they have been removed.
i) Proceed in the same way with the other semi-axle.

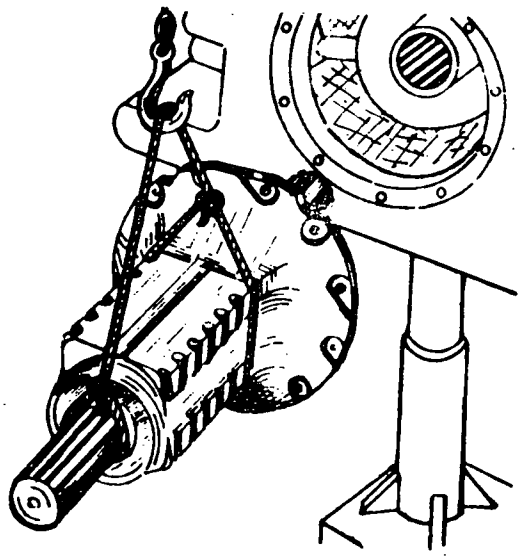


Fig. 1

3rd Step - *Replace the differential cover* thus: (Fig. 2).

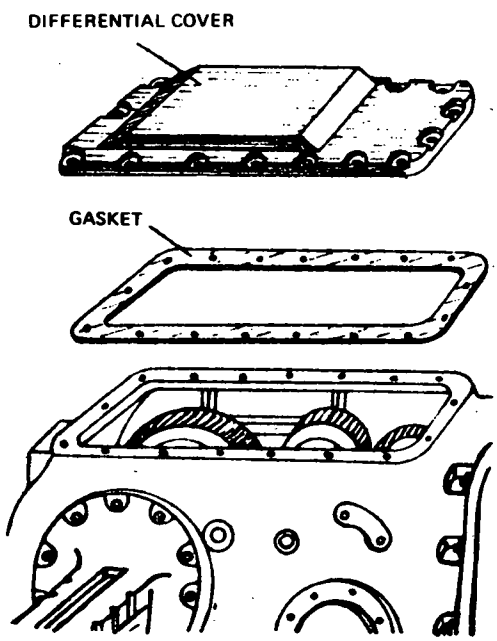


Fig. 2

a) Install the new gasket.
b) Place the cover.

OBSERVATION
Use a crane to lift the cover if it is very heavy.

c) Place and tighten the nuts.
d) Install the accessories on the cover, if there are any.

4th Step - *Join the engine section with the transmission section.*

5th Step - *Mount the rear wheels.*

6th Step - *Fill* the transmission case, final drive and terminal controls with oil.

OBSERVATION
Some tractors use different types of lubricating oils in the differential, gearbox and terminal controls. Consult the corresponding manual.

7th Step - *Test the tractor* thus:
a) Test the differential.
b) Test the gearbox.
c) Test the hydraulic system.
d) Test the brakes.

CBC

OPERATION:

DISASSEMBLING THE MECHANICAL GEARBOX

REF. OS.46/AgM | 1/5

Caribbean

This operation consists of removing the components from the gearbox with the purpose of checking, repairing or changing defective parts. This operation can also be done to gain access to other parts of the tractor.

PROCEDURE

Process I - Disassembling the gearbox with multiple-gear shaft

1st Step - *Remove the drain plug from the box and empty the lubricating oil* into a container.

2nd Step - *Separate the engine section from the transmission.*

3rd Step - *Remove the cover from the box.*

4th Step - *Remove the shifter forks* (Fig. 1) thus:

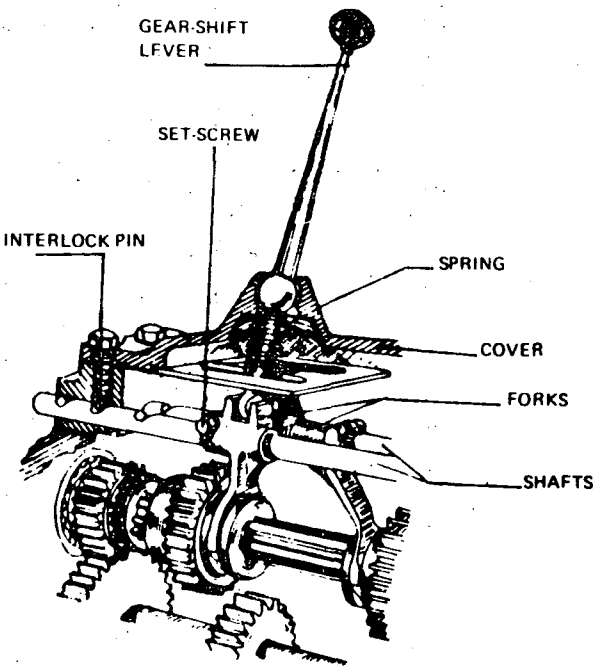


Fig. 1

a) Mark the position of the forks and shifter rails.
b) Release the tension of the spring and remove the gearshift lever.
c) Remove the setscrews which hold the forks to the shifter rails.
d) Remove the shifter rails, interlock pins and springs.
e) Remove the forks.

OBSERVATION

In some cases, the forks and rails form part of the body of the box.

5th Step - *Remove the input shaft* (Fig. 2).

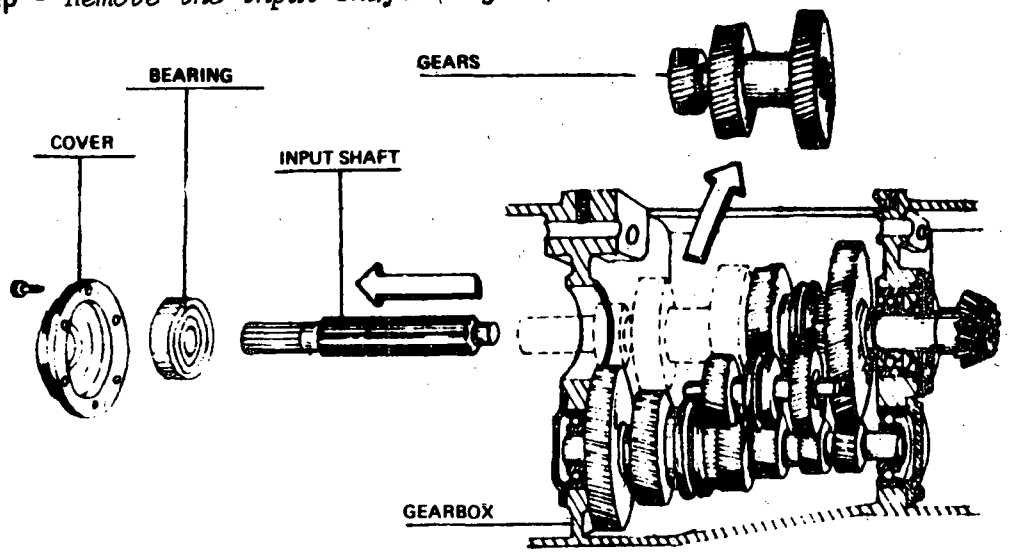
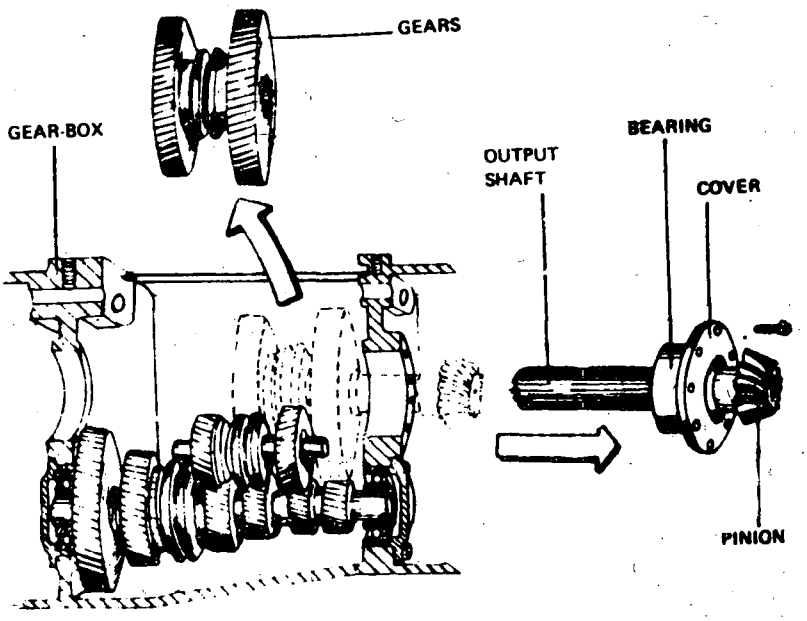


Fig. 2

a) Remove the covers of the shaft bearings.
b) Remove the snap rings of the bearings if there are any.
c) Use a soft hammer to tap the shaft so that it moves with the bearing.
d) Remove the shaft and its gears.

OBSERVATION
Mark the position of the gears with relation to their shafts.

e) Remove gears and thrust washers from the shaft.
f) Remove the bearings from the shaft.



6th Step - *Remove the output shaft* (Fig. 3).

Fig. 3

a) Remove the differential unit, if necessary.
b) Loosen the adjusting cover from the drive pinion.
c) Remove the shaft by tapping it gently until it comes out.
d) Remove the gears from the box.
e) Remove the bearing from the drive pinion.
f) Remove the adjusting cover of the drive pinion. Keep the thrust washers.

7th Step - *Remove the reverse idler gear* thus; (Fig. 4)

OBSERVATION
This gear is only used in boxes with two gear shafts.

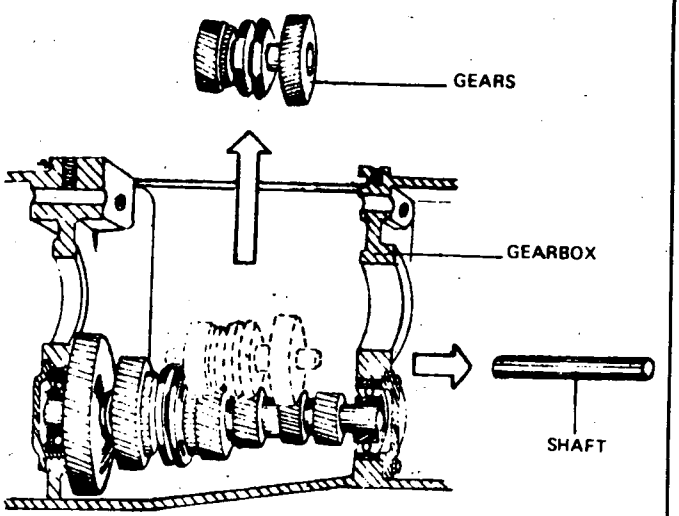


Fig. 4

a) Remove the lock from the shaft.
b) Push the shaft and remove it.
c) Remove the gear.
d) Remove the needles from the bearing of the gear, if there are any.

8th Step - *Remove the countershaft (Fig. 5).*

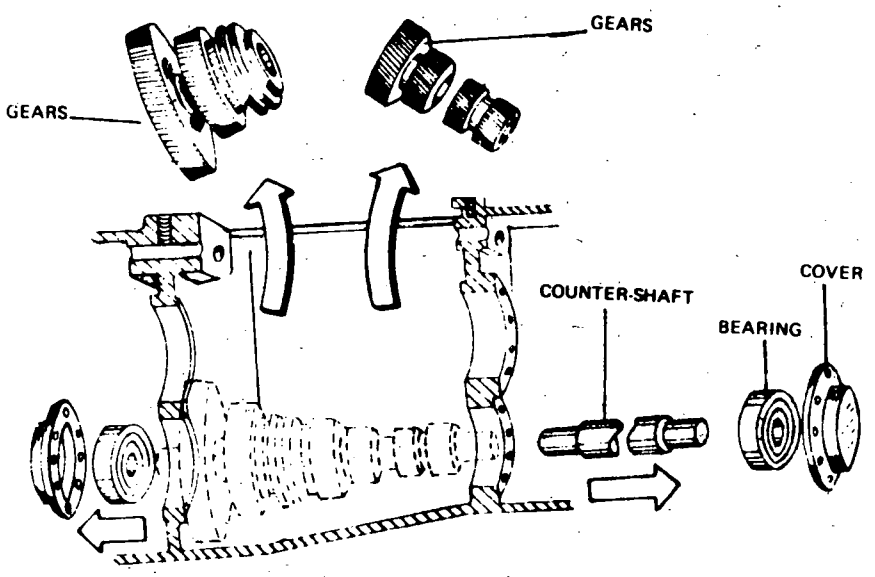


Fig. 5

a) Remove the snap rings which hold the bearings of the shaft.
b) Drive out the shaft using another shaft of a smaller diameter as a drift.
c) Remove the countershaft.
d) Remove the gears and thrust washers.

9th Step - *Wash the parts of the gearbox and dry them with compressed air.*

10th Step - *Check the parts of the box.*

Process II - Disassembling the gearbox with integral cluster gear

1st Step - *Remove the drain plug and let out the oil.*
2nd Step - *Separate the engine section from the transmission.*
3rd Step - *Remove the cover of the gearbox.*
4th Step - *Remove the set of shifter forks.*
5th Step - *Remove the input shaft.*
6th Step - *Remove the output shaft.*
7th Step - *Remove the reverse idler gear.*
8th Step - *Remove the countershaft* (Fig. 6).

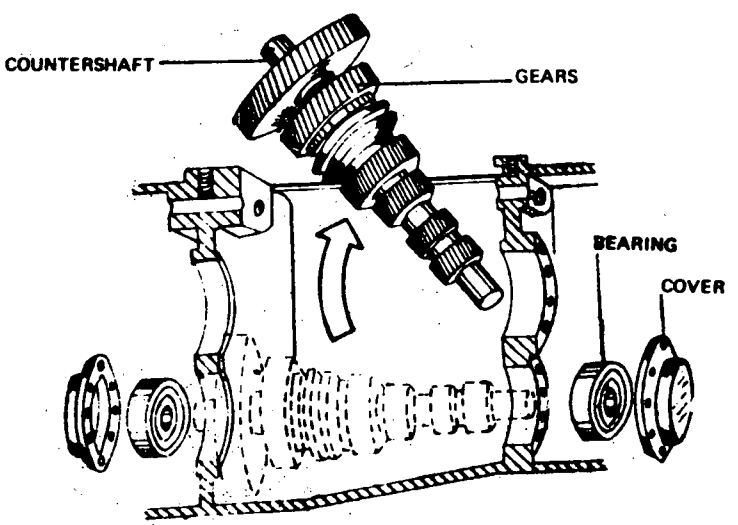


Fig. 6

a) Remove the covers which hold the bearings.
b) Lightly tap along the ends of the shaft with a soft hammer. The cups of the tapered bearings will slide out.
c) Tilt the shaft and remove the train of gear.
d) Remove the bearings from the shaft.

9th Step - *Wash the parts of the gearbox and use compressed air to dry them.*

10th Step - *Check the parts of the box.*

TECHNICAL VOCABULARY

Cluster gear - countershaft gear, lay shaft gear

CBC

OPERATION:
ASSEMBLING THE MECHANICAL GEARBOX

REF. OS.47/AgM | 1/5

Caribbean

This operation consists of installing gears, bearings and other parts in an orderly manner after changing the defective parts and making the adjustments recommended by the manufacturer.

PROCEDURE

Process I - Assembling the gearbox with multiple-gear shaft

1st Step - *Place the countershaft* thus: (Fig. 1).

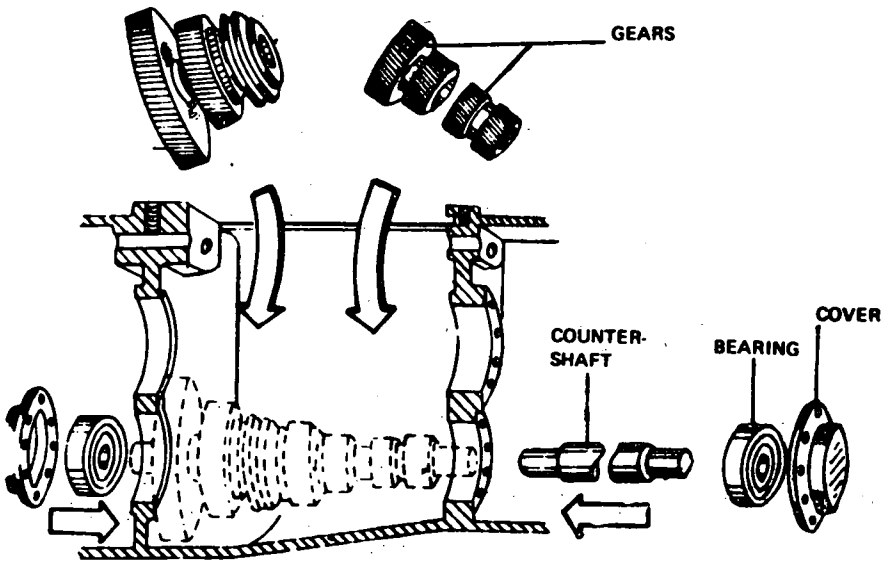


Fig. 1

a) Install the gears on the shaft.

b) Place the thrust washers.

c) Tilt the shaft and gears. Place the shaft in its lodging.

d) Install and lubricate the shaft bearings.

e) Install the snap rings which hold the shaft bearings.

f) Place the retainer and the gasket on the covers of the bearings.

g) Place the covers.

h) Ensure that the shaft turns freely.

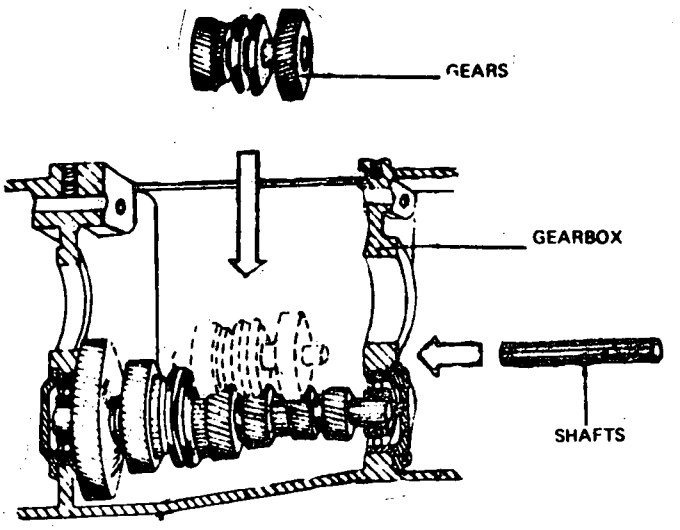


Fig. 2

2nd Step - *Install the reverse idle gear* thus: (Fig. 2).

a) Install and lubricate the needle bearings of the gear.
b) Place the gear in its appropriate position.
c) Align the holes of the gear with those of the box and insert the shaft.
d) Place the lock pin which holds the shaft.
e) Ensure that the gear turns freely.

3rd Step - *Place the output shaft* thus: (Fig. 3).

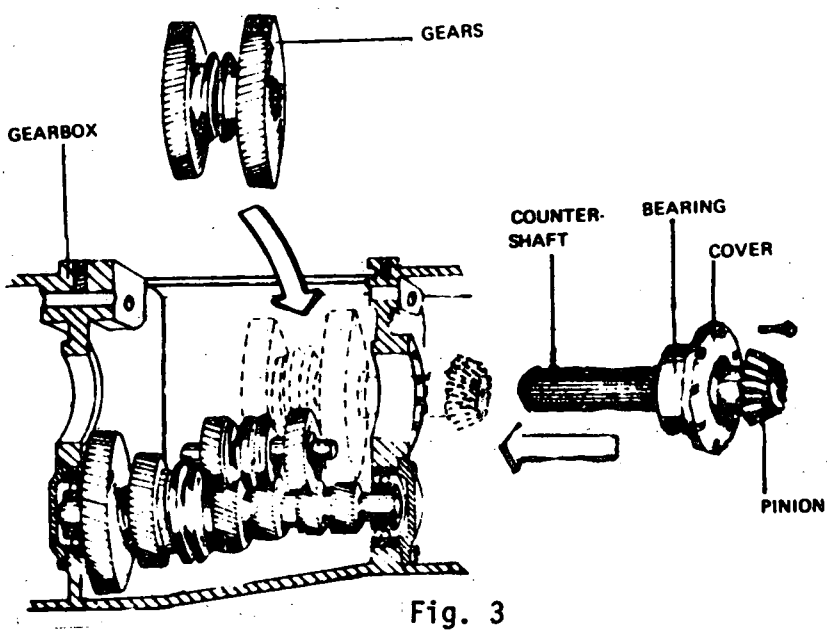


Fig. 3

a) Install the adjusting cover on the shaft.
b) Install and lubricate the rear bearings.
c) Put the shaft in and at the same time slide the gears to their correct position on it.
d) Install the front bearings on the shaft and lubricate it.
e) Adjust the cover of the drive pinion.
f) Ensure that the shaft turns freely.

4th Step - *Mount the input shaft* thus: (Fig. 4).

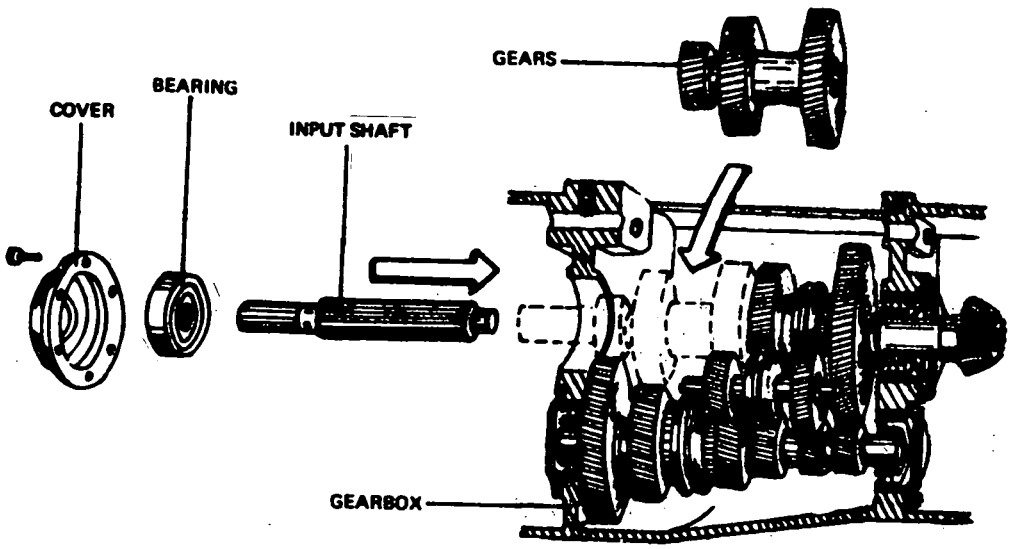


Fig. 4

a) Install the bearing of the shaft and lubricate it.
b) Put in the shaft correctly coupling the gears.
c) Centre and couple the shaft with the front bearing of the output shaft.
d) Install the snap ring which holds the bearing.
e) Place the retainer and the gaskets on the covers of the bearing.
f) Place the covers.
g) Ensure that the shaft turns freely.

5th Step - *Replace the shifter forks* thus: *(Fig. 5)*

a) Gradually put in the rails placing the interlock pins and the forks.
b) Check the correct position of the fork and rails.
c) Secure the forks with the rail setscrew.
d) Install the spring and gearshift lever.

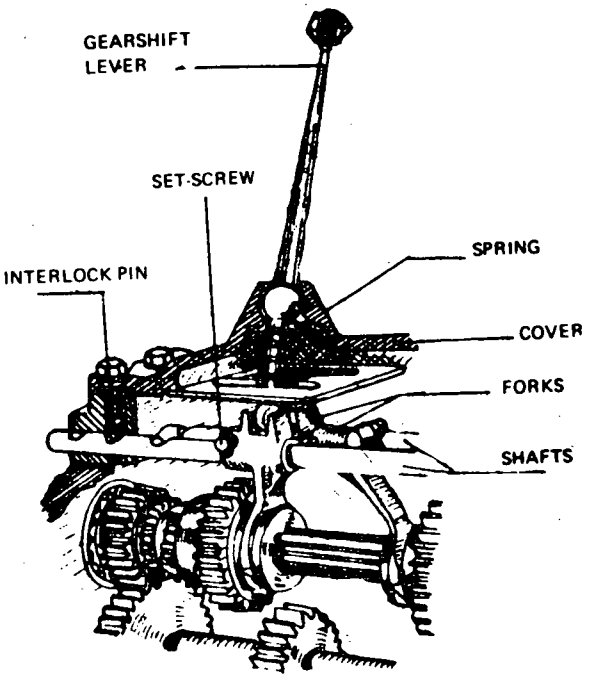


Fig. 5

6th Step - *Place cover* on the box thus:

OBSERVATION
Put the gears and forks of the box in neutral.

a) Place the cover, matching the forks with the guides on the gears.
b) Secure the cover.
c) Check the different gear combinations.
d) Fill the box with the specified oil.

7th Step - *Join the section of the engine* with the transmission.

Process II - Reassembling the gearbox with integral cluster gear

1st Step - *Place the countershaft* thus: (Fig. 6).

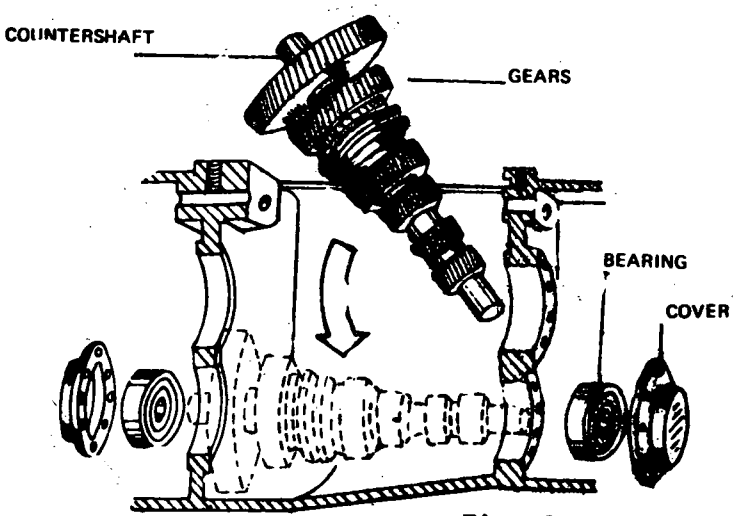


Fig. 6

a) Install the bearings on the cluster gear shaft.
b) Tilt the shaft and place it in its lodging.
c) Lubricate the bearings.
d) Install the cups of the bearings.
e) Place the gasket on the covers of the bearings and mount them.
f) Ensure that the shaft turns freely.

2nd Step - *Install the reverse idler gear.*

3rd Step - *Install the output shaft.*

4th Step - *Install the input shaft.*

5th Step - *Assemble the unit of shifter forks.*

6th Step - *Place the cover* on the box.

7th Step - *Join the section of the engine* with the transmission.

TECHNICAL VOCABULARY

Cluster gear - counter-shaft gear, lay shaft gear

CBC

OPERATION:

REMOVING THE ENGINE (tractors)

This operation consists of removing the tractor engine with the help of hoisting equipment in order to adjust all its parts.

PROCEDURE

1st Step - *Place the tractor* where the repair will be done.

2nd Step - *Remove the engine cover.*

3rd Step - *Drain the cooling, lubricating and fuel systems.*

4th Step - *Remove the fuel tank.*

5th Step - *Disconnect the radiator hoses.*

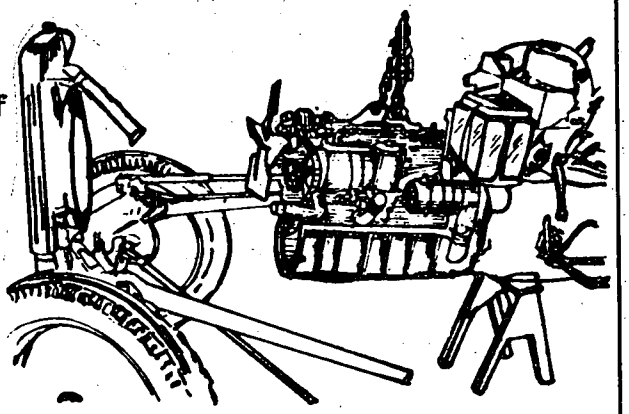
6th Step - *Disconnect the cables leading to the battery, generator, ignition, starter motor and lights.*

7th Step - *Disconnect the accessories of the engine* thus:

a) Remove the sending unit of the temperature gauge, and the cable or piping of the oil pressure gauge.
b) Disconnect all piping which might make it difficult to remove the engine.
c) Disconnect the accelerator.
d) Disconnect the choke.
e) Disconnect the fuel system.
f) Disconnect the distributor (Gasolene engines).
g) Disconnect the tachometer.
h) Disconnect the exhaust pipe.

8th Step - *Disconnect the steering rod* from the control arm, if necessary.

9th Step - *Remove the engine* thus:
(See figure)



a) Place chocks in front of and behind traction wheels.
b) Place a jack or support under the gearbox.

OBSERVATION
The jack or support must be centered.

c) Place the crane to lift the engine. Fasten the sling to the engine.
d) Remove the engine mount bolts from the chassis.
e) Remove the bolts which join the engine to the clutch housing.
f) Slowly lift and move the engine forward until it leaves the input shaft of the gearbox.

OBSERVATIONS
1) Use a lever to loosen the engine, if necessary.

2) Avoid damaging other parts of the tractor when the engine is removed.

g) Remove the engine from the tractor and place it on a bench support.

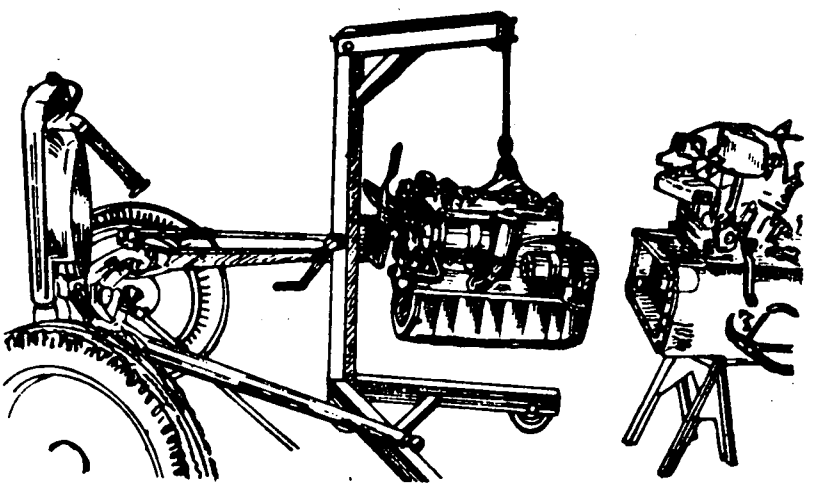
CAUTION
AVOID GOING UNDERNEATH THE SUSPENDED ENGINE.

This operation consists of mounting the engine on the tractor after its partial or total repair. This operation is done with the aid of hoisting equipment.

PROCEDURE

1st Step - *Clean the surface on which the engine is to be mounted* with a brush, a scraper and pressurized air.

2nd Step - *Mount the engine* thus: (See figure)



a) Chock the rear wheels.
b) Place the crane and fasten the sling in place. Lift the engine.

OBSERVATION
The sling must be centered.

c) Align the engine with relation to the input shaft of the gearbox.
d) Slide the engine until it couples with the gearbox.
e) Place and tighten the fastening bolts of the engine to the clutch housing.
f) Mount the front end.

3rd Step - *Connect the control arm* to the steering rod, if necessary.

4th Step - *Connect the accessories of the engine* thus:

a) Connect the exhaust pipe.
b) Connect the tachometer.
c) Connect the distributor (Gasolene engine)
d) Connect the fuel system.
e) Connect the choke.
f) Connect the accelerator.
g) Connect the piping of the system.
h) Connect the temperature and oil pressure gauges.

5th Step - *Connect the cables of the generator, ignition, starter motor, lights and battery.*

6th Step - *Connect the radiator tubing.*

7th Step - *Connect the fuel tank.*

8th Step - *Put oil in the crankcase of the engine.*

9th Step - *Pour water in the radiator.*

10th Step - *Put fuel in the tank.*

11th Step - *Mount the engine cover.*

12th Step - *Install air filter system.*

CBC

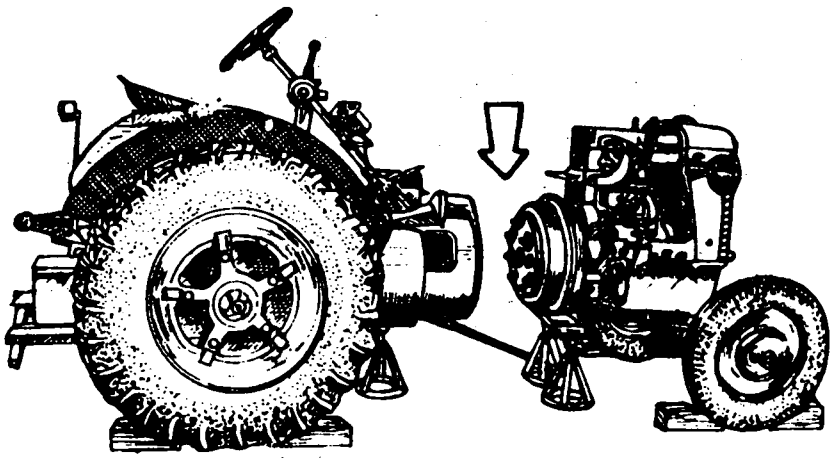
OPERATION:

SEPARATING AND JOINING THE TRACTOR ENGINE AND TRANSMISSION

REF. OS.50/AgM | 1/2

Caribbean

This operation consists of separating the front part of the tractor (engine and front end) from the rear part (transmission and rear end) in order to remove or repair the engine, gearbox or final drive.



PROCEDURE

1st Step - *Place chocks* in front of and behind traction wheels.

2nd Step - *Remove the engine cover,* if necessary.

3rd Step - *Disconnect the battery and remove it.*

4th Step - *Disconnect and remove the piping of the hydraulic and fuel systems.*

5th Step - *Disconnect the fuel tank.*

6th Step - *Disconnect the instruments from the control panel.*

7th Step - *Loosen any wiring* which makes the separation of the sections difficult.

8th Step - *Disconnect the accelerator.*

9th Step - *Disconnect the steering rod from the control arm.*

10th Step - *Remove the steering box* along with the control panel, if necessary.

11th Step - *Place a jack or support* under the gearbox

CAUTION

THE BOTTOM OF THE BOX IS GENERALLY CURVED. THEREFORE, THE JACK SHOULD BE PROPERLY CENTERED.

12th Step - *Use a crane* to hold the rear part of the engine. *Take up the slack of the sling.*

13th Step - *Remove the bolts* which hold the engine to the transmission box.

14th Step - *Slide the engine slowly forward* until it leaves the input shaft of the gearbox

OBSERVATIONS

1) When sliding the engine the front wheels must remain aligned in a forward position.
2) Use a lever to loosen the engine, if necessary.
3) After the engine has been removed, rest it on an appropriate support and chock the front wheels.

15th Step - *Join the engine to the transmission box.* Reverse the steps for separating it.

OBSERVATION

When coupling both sections of the tractor, place guides between the transmission and the engine. These guides will show the correct alignment between the input shaft of the gearbox and the engine.

TECHNOLOGICAL INFORMATION SHEETS

CBC

TECHNOLOGICAL INFORMATION
FLAT BELTS
(Splices)

Splices are joints made on flat belts. Several procedures are used in splicing. These procedures are: bonding, lacing and clamping. These are done when it is necessary to repair a belt or to adapt a new belt to the dimensions required by any given machine.

The joint is the weakest part of the belt. For this reason, joints require the greatest attention.

JOINING THE BELTS

The figures show the systems most used in splicing. Depending on the case, one of these will be used.

Clamp or "Marris" metallic clasp (Fig. 1)

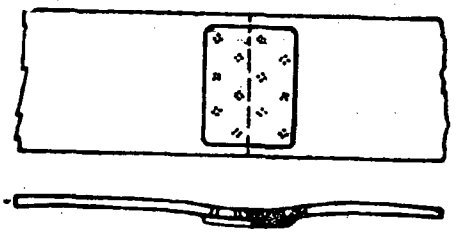
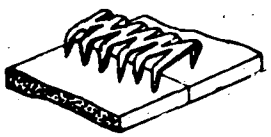


Fig. 1



Clamp or Bristol metallic clamp (Fig. 2).

Clamp or metallic clasp (Fig. 3).

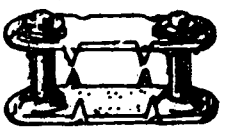


Fig. 3

"Alligator" clamp (Fig. 4).

Fig. 4

Bar-type clamp (Fig. 5).

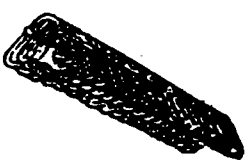
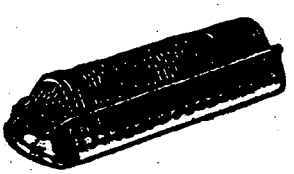


Fig. 5

"Hinged" clamp (Fig. 6).

Fig. 6



"Hook-type" clamps (Fig. 7).

Fig. 7

End to end lacing (Fig. 8)
(For belts up to 5 cm wide)

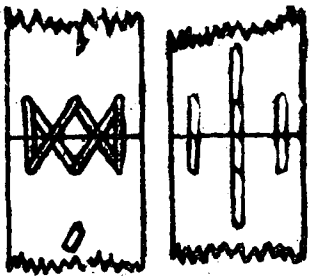


Fig. 8

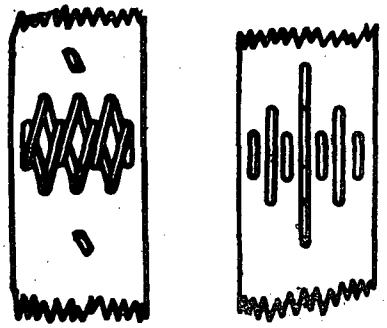
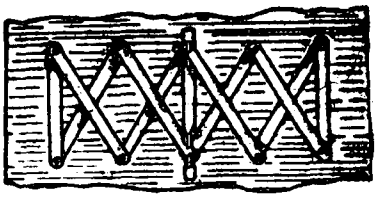


Fig. 9

End to end lacing (Fig. 9).
(For belts over 8 cm wide)



End to end lacing (Fig. 10).
(For belts over 8 cm wide)

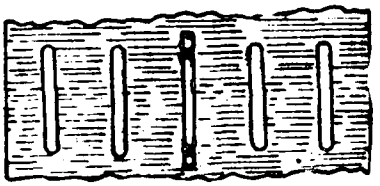
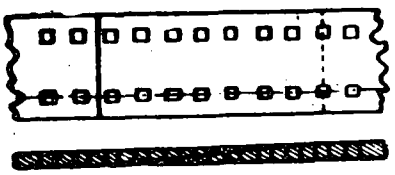


Fig. 10



Overlap lacing (Fig. 11).

Fig. 11

Alligator clamp with projecting nut (Fig. 12).

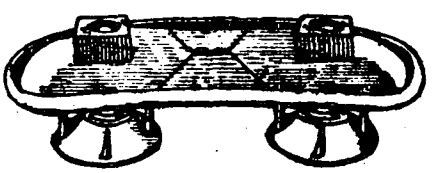


Fig. 12

Button-type clamp with cleaved edges (Fig. 13).

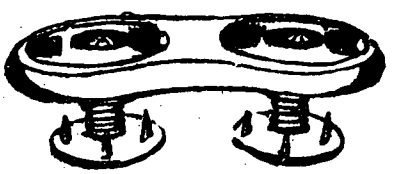


Fig. 13

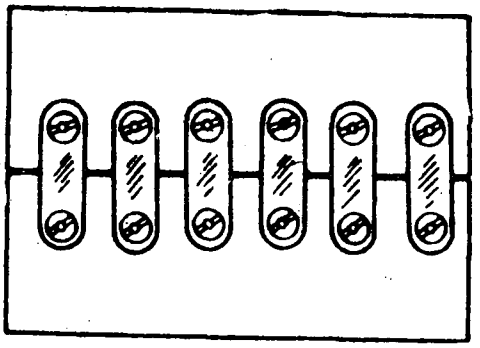


Fig. 14

Splices of a flat belt using button type clamps (Fig. 14).

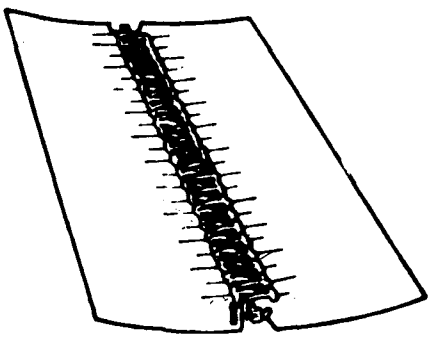


Fig. 15

Splices of a flat belt using metal lacing with hinge pin (Fig. 15).

SAFETY MEASURE

BE VERY CAREFUL WHEN DEALING WITH METALLIC SPLICES. YOU MIGHT INJURE YOUR HANDS.

These are mechanical assemblies used in automatic engaging and disengaging of movement in different types of machines.
Safety mechanisms protect mechanical elements in case of seizures.

TYPES

- *sliding friction disc clutch*
- *sliding toothed disc clutch*
- *safety catch*
- *safety bolt*

SLIDING FRICTION DISC CLUTCH

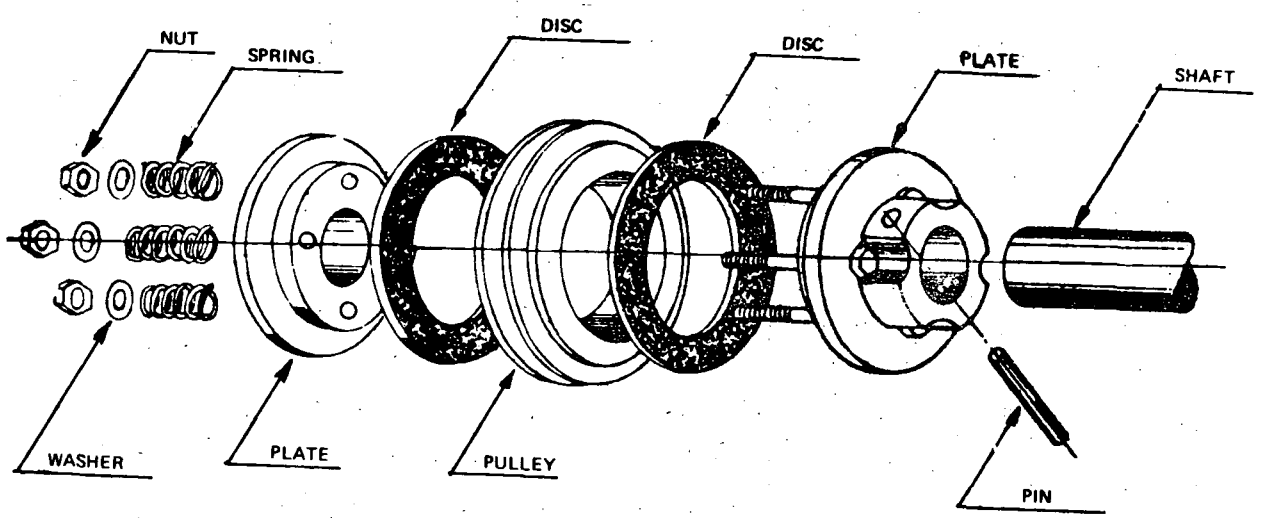


Fig. 1

OPERATION

The pressure of the springs keeps together the parts which make up the system. Under these conditions the movement can be transmitted.
The part of the machine protected by the safety mechanism may be obstructed by an unknown cause. In this case, the pressure of the springs is overcome leaving the gear or drive pulley free to turn.
These mechanisms are widely used in farm equipment moved by universal joint shafts and drive shafts.

OBSERVATIONS

1) If the gear or pulley runs idle, switch off the machine at once and investigate the cause.
2) The operator's manual indicates the tension which must be applied to the springs of the plate.

SLIDING TOOTHED-DISC CLUTCH

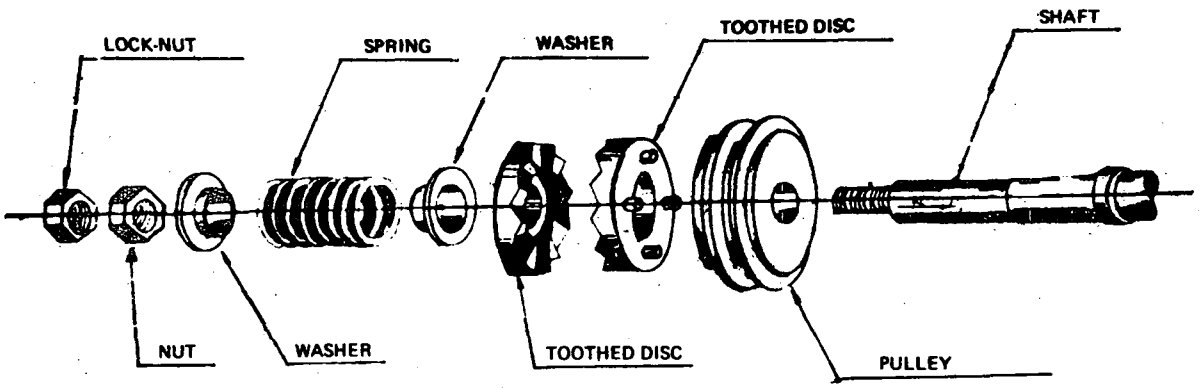


Fig. 2

OPERATION

The toothed disc connected to the pulley or gear is idle. The toothed disc connected to the movable part, is joined to the other toothed disc by the action of the spring or springs. If there is no overload in the mechanism of the machine, the clutch remains coupled and the unit works correctly. When the system is overloaded, the toothed disc, which is fixed to it, stops and only the idler disc turns making a characteristic noise.
This device is used in the transmission chains of agricultural machinery. Such is the case, for example, of the rotary fodder harvesters with double cutters.
Adjustments: Consult the operator's Manual to determine the tension which should be applied to the spring by means of the nut.

SAFETY CATCH

This system is generally found in farm equipment coupled to the drawbar of the tractor.

Some ploughs are protected by a catch system. They are specially recommended for use on soils with buried obstacles (tree trunks, rocks, etc.).

OPERATION

The traction tension is carried by heavy spiral springs which are compressed when the load is too great. This forces the hook to free itself when it comes across obstacles in the soil (Fig. 3).

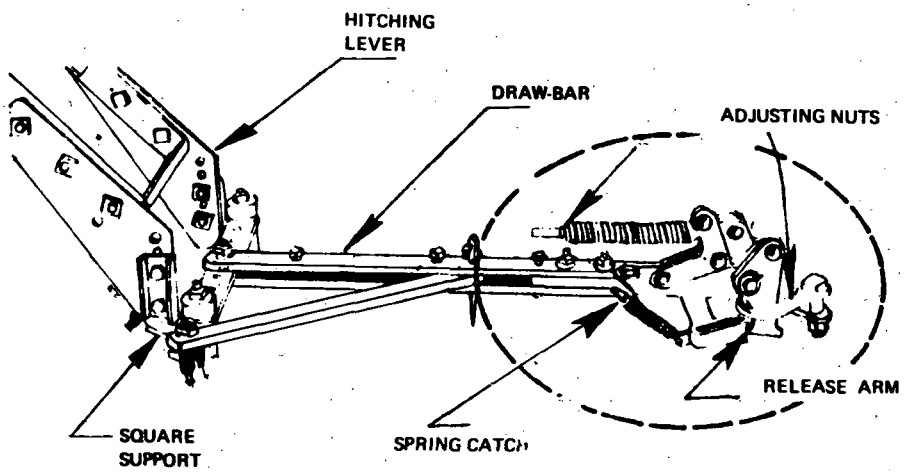


Fig. 3

OBSERVATIONS

1) The catch or hook must be adjusted to the appropriate tension in order to fulfil the traction requirements. These are obtained by testing the catch, using the machine on the land to be worked.

2) The safety catch requires periodic lubrication of the swivel hook or the trigger.

SAFETY BOLT

OPERATION

Generally it is a bolt which bears the load stress. It breaks when there is an overload.

The size and hardness of the bolt vary with the force to be transmitted and the expected magnitude of the overload (Figs. 4 and 5).

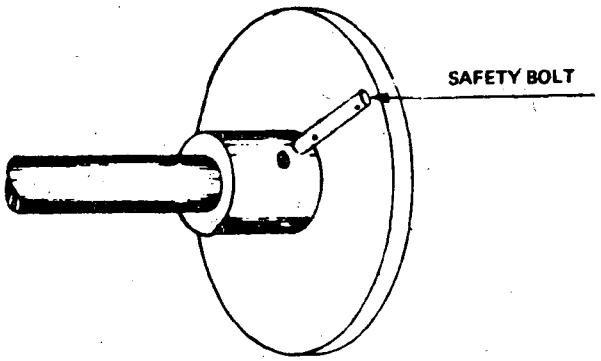


Fig. 4

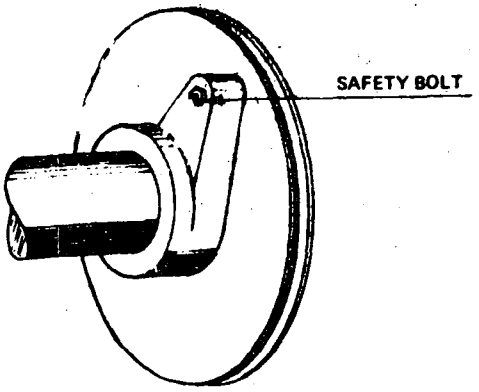


Fig. 5

TECHNOLOGICAL VOCABULARY

Safety bolt - Shear pin

CBC

TECHNOLOGICAL INFORMATION

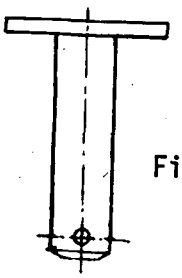
PINS

These are elements used to keep the parts of a mechanism from shifting. They are usually made of case-hardened steel.
The pins are generally fixed to the shaft or to the part with cotter pins, circlips or set screws. Exception is made of expansion pins which are self-fixing.

TYPES

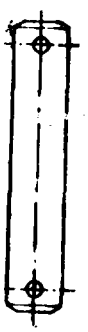
- *Roll pins*
- *Expansion pins*

ROLL PINS (Figs. 1, 2, and 3)



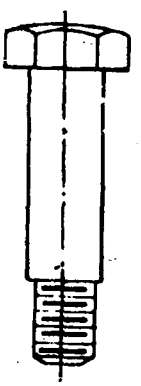
ROLL PIN WITH HEAD

Fig. 1



STRAIGHT ROLL PIN

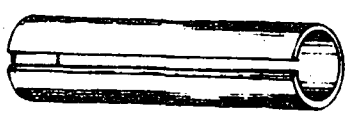
Fig. 2



SCREW-ON ROLL PIN

Fig. 3

EXPANSION PINS (Figs. 4 and 5)



SIMPLE EXPANSION PIN

Fig. 4

DOUBLE EXPANSION PIN

Fig. 5

The double expansion pin consists of two pressure pins, open and fitted one into the other.

These are parts used only for cutting plants. They are used on mowers and in some types of harvesting machines.

TYPES

There are two types of sections: smooth edge and serrated edge (Figs. 1 and 2).

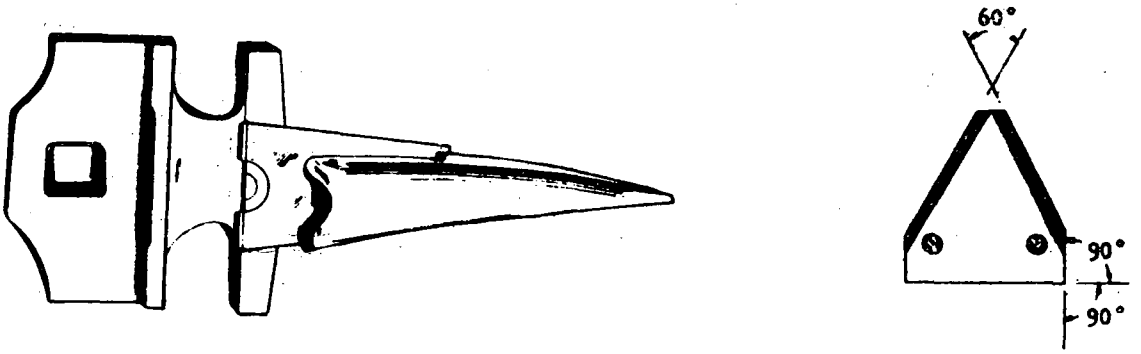


Fig. 1 Smooth-edged Ledger Plate

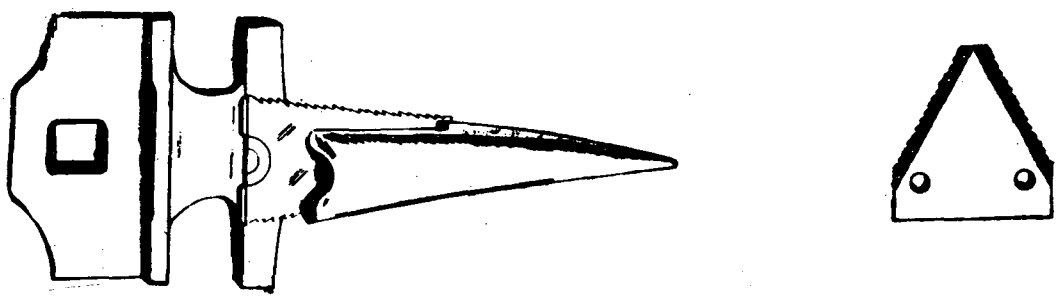


Fig 2 Serrated Ledger Plate

STRUCTURE

The sections are made of hardened steel on the cutting edges and mild steel in the centre to provide resistance to vibrations. On the ledger plates the edges and the centre are made with the same hardness.

SHAPE

The sections are triangular with an angle of 60 degrees. The rear angles are 90^{o} so that each section joins properly with the next. The ledger plates are slightly broader at the rear, where they have the hole for the rivet and a guide notch. On the front they have a rim for fixing them on the guard.

ADVANTAGES AND DISADVANTAGES

The advantage of the serrated sections and ledger plates over the smooth ones is that they are used for cutting green or dry plants. The smooth ones are only used for cutting green plants. However, serrated sections and ledger plates cannot be sharpened while the smooth ones can be sharpened many times.

A section can be sharpened provided:

- the width of the edge is not changed.
- its angles remain constant.
- its total height is not changed nor its end turned into a point.

See these aspects in Fig. 3

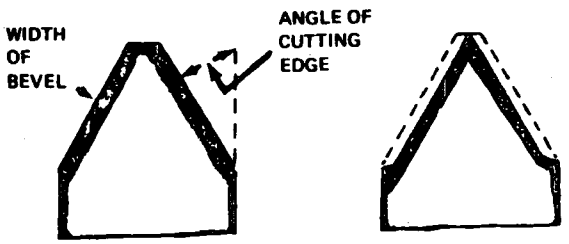


Fig. 3

MAINTENANCE

The sections and ledger plates must be washed and lubricated as indicated in the operator's manual.

TECHNICAL VOCABULARY

Guard - finger

CBC

TECHNOLOGICAL INFORMATION
HYDRAULIC PUMPS
(Characteristics)

These are mechanical elements used in hydraulic systems. These systems change mechanical energy into hydraulic energy. They make a flow of liquid pass through the different ducts and elements of the system.
The movement of the pump is directly or indirectly obtained from the engine by means of shafts, pulleys or gears.

TYPES

Gear pumps
- external gears.
- internal vane pumps.

Rotary pumps
- crescent pumps.
- sliding vane pumps.

Piston pumps
- axial pistons (Pistons parallel to the drive shaft).
- radial pistons (Pistons mounted at right angles to the drive shaft).

CHARACTERISTICS OF THE HYDRAULIC PUMPS

All pumps produce a flow or current of liquid.

The hydraulic pump does not create pressure; it only delivers a liquid flow. The pressure rises as a result of the resistance to the circulation of liquid.

The flow is the volume of liquid which the pump delivers in a unit of time. By the flow they deliver, pumps are divided into two categories:

- *Fixed flow pumps* = constant flow.
- *Variable flow pumps* = variable flow.

Fixed or constant flow pumps, always deliver the same volume of liquid per time unit. The volume varies only when the speed of rotation of the pump varies.

Variable flow pumps are capable of varying the volume of fluid in the unit of time although its speed or rotation does not vary.

OUTPUT OF THE HYDRAULIC PUMPS

The flow is different for the three types of pumps. The piston types deliver greater flow at greater pressure and work at greater speeds. The vane pumps are next in line followed by the gear pumps.

Let us look at the following comparative chart:

Types of Pumps	Flow in 1 per minute		Pressure in Kg per sq. cm		Speed in R.P.M.	
	FROM	TO	FROM	TO	FROM	TO
Gears	1	600	15	175	800	3,500
Vanes	2	950	15	175	1,200	1,400
Pistons	2	1,700	50	350	600	6,000

The efficiency of gear pumps, vane pumps, and piston pumps ranges from 75% to 95%.

Piston pumps usually deliver the highest output. The output of vane pumps is lower than the output of piston pumps. Gear pumps deliver the lowest output.

These are mechanisms used in hydraulic systems to convert mechanical energy into hydraulic energy. This conversion of energy occurs when the oil, fluid or another liquid passes through the ducts, tubings, valves and other parts of the system. The mechanical energy is generally produced by a heat engine which transmits it to the pump by means of shafts, pulleys or gears.

TYPES

Two types of gear pumps are used:

EXTERNAL GEAR PUMP (Fig. 1)

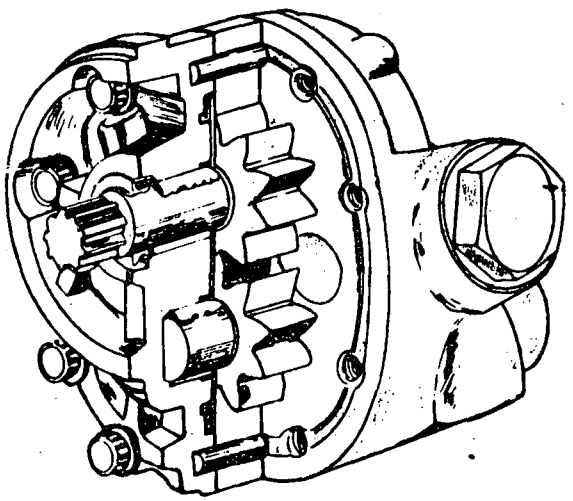


Fig. 1

STRUCTURE

It consists of two gears meshed together, two shafts (one for each gear), a watertight chamber, an inlet port and outlet port. This pump has a constant flow.

ADVANTAGES

It has the advantage of being able to withstand high pressure; besides, the fluid leaks are minimal.

It is primarily used to work at low pressures and where the space is limited. The initial cost is relatively low.

DISADVANTAGES

It is noisy and has a low mechanical efficiency when operated at high speeds.

OPERATION (Fig. 2)

One of the gears is moved by a shaft. It then transmits the movement to a second gear called the idler gear. When the two gears rotate at high speed they produce a vacuum. This allows the intake of the liquid, which is sucked in by the spaces between the teeth of the gear and the wall of the chamber. Later the liquid is forced out the outlet port.

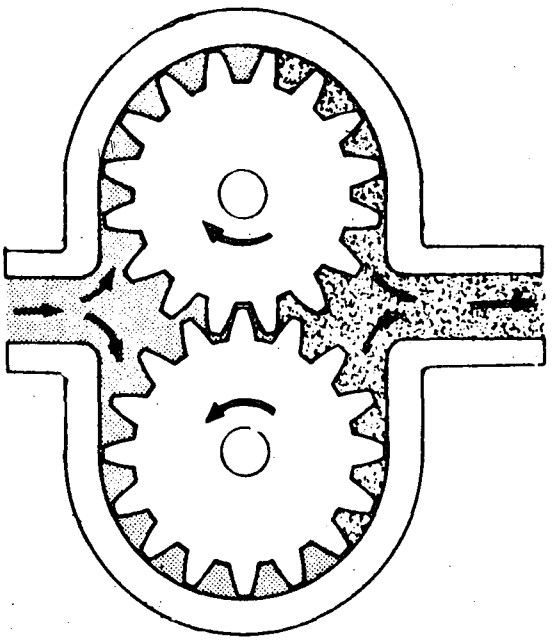


Fig. 2

INTERNAL GEAR PUMP (Fig. 3)

STRUCTURE

It consists of two gears (one with external teeth and the other with internal teeth), an eccentrically placed shaft, a pump case, one inlet port and one outlet port.

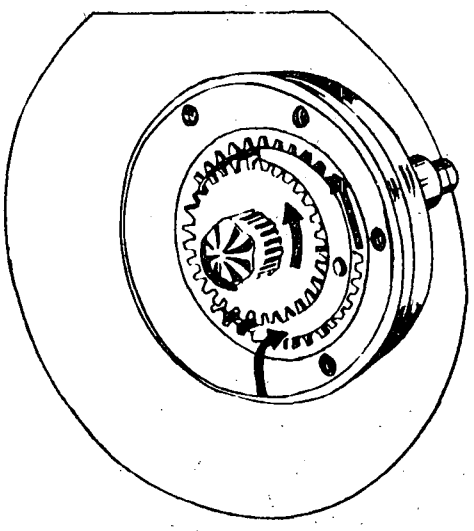


Fig. 3

ADVANTAGES

Because of its structure and its operation it can perform at high speeds. This implies greater output.

DISADVANTAGES

Bearings of the rotor shaft wear faster because of the eccentric movement. Also liquid is lost at the apex of the teeth when they mesh.

OPERATION (Fig. 4)

The rotor turns eccentrically inside the fixed rotor ring. This movement compresses the liquid and forces it through the inside walls of the fixed pinion. The liquid is finally discharged through the outlet at a given pressure. In these types of pumps a difference of one or two teeth can be found between the rotary and the stationary gear.

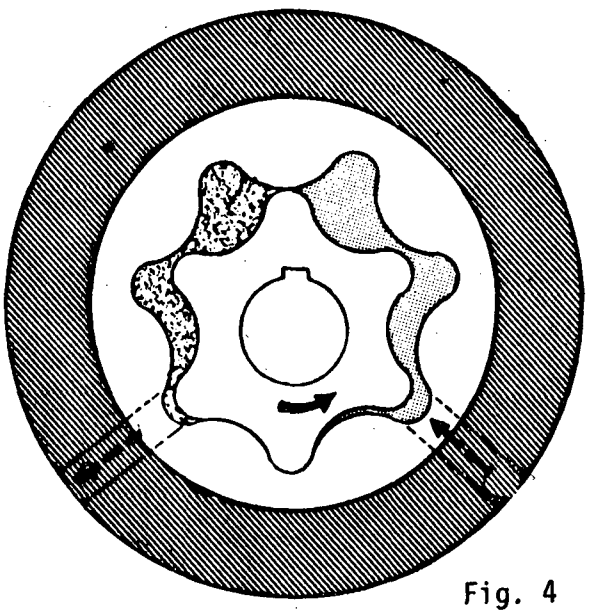


Fig. 4

When the difference is of two teeth, there is a lateral plate which partially prevents loss. This type is used for low speeds and low pressures (Figs. 5 and 6).

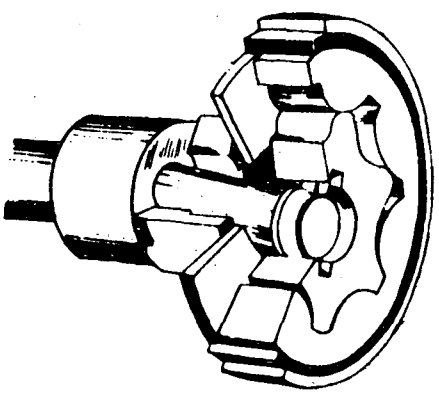


Fig. 5

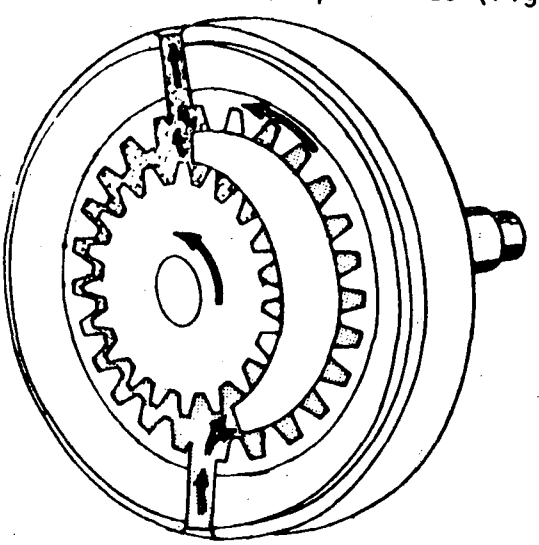


Fig. 6

CBC

TECHNOLOGICAL INFORMATION
VANE PUMPS

These are mechanical devices used in hydraulic systems. They convert mechanical energy into hydraulic energy. Rotor pumps push a liquid current through passages and other elements of the system. Rotor pumps are moved by a motor. The movement is transmitted by shafts, pulleys or gears.

TYPES

Two types of rotor pumps are used:

CRESCENT PUMPS (Fig. 1).

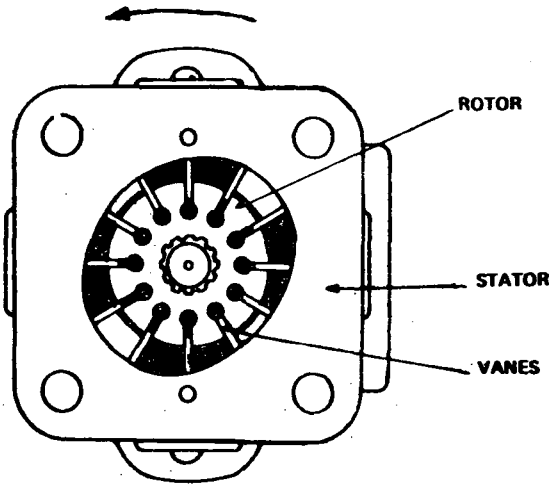


Fig. 1

STRUCTURE

Its main parts are: Rotor, vanes stator and body. The rotor is moved by a shaft. The vanes are housed in the grooves of the rotor. The stator has an oval shape inside. The body encloses all the parts.

ADVANTAGES

Crescent pumps have several advantages:

1) They suffer less wear because the forces which move the mechanism are constant and balanced.
2) They deliver great flows at moderately high pressures.
3) The wear on vanes does not reduce efficiency since these are driven towards the outside by centrifugal force and maintain contact with the body.

DISADVANTAGES

They are of fixed-flow, only.

OPERATION

The pump is balanced by the position of the ports through which the oil enters and leaves.

When the rotor turns, the centrifugal force displaces the vanes pushing them against the inside of the stator.

Two chambers subdivided by vanes into smaller ones are formed between the rotor and the stator. These pockets restricted by the vanes increase and reduce the volume twice for each complete turn of the rotor. The inlets are situated at points where these chambers begin to increase in volume and the outlets are situated where they begin to decrease.
When the volume of the chambers is increased, they draw in oil which the vanes push, forcing it out of the pump when the volume of the chamber which they restrict is reduced. In the second half of the turn of the rotor the same process is repeated through the ducts which are situated at opposite points.

SLIDING VANE TYPE PUMPS (Fig. 2)

STRUCTURE

Sliding vane pumps consist of:

1) A rotor moved by a shaft.
2) Vanes which are housed in the grooves of the rotor.
3) A body which encloses all the parts.

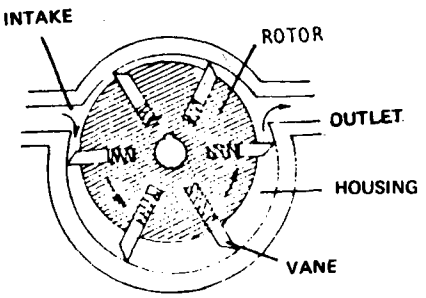


Fig. 2

ADVANTAGES

Its advantage over the crescent pumps is that its flow can be fixed or variable.

DISADVANTAGES

They suffer wear on the bearing of the rotor shaft. This wear is caused by the constant pressure exerted on the same side.

OPERATION

The operational principle of the sliding vane pump is the same as for the crescent pump.
However, on this pump there is only one work cycle for each turn of the rotor.
Because of this the pump has only one intake port and one outlet. Also, the rotor is off centre with relation to the body.
The chamber formed by the vanes increases in volume starting at the oil intake port. The volume is again reduced and compressed as it nears the outlet port.

These are mechanical devices used in hydraulic systems to change mechanical energy into hydraulic energy.

The pump is moved by an engine and delivers a flow of liquid. The engine which moves the pump can be directly coupled to it in a rigid or flexible manner. It can also be coupled by any means of transmission such as shafts, pulleys and belts or gears and chains.

OPERATION

In this type of pump the fluid is impelled by the alternate movement of the piston or pistons in their respective cylinders. They are compact and efficient mechanisms capable of producing a great flow of fluid and high pressures.

TYPES

The rotary hydraulic pumps can be grouped into two types. This grouping depends on how the axis of the pistons relates to the axis of the shaft of the pump.

The two types of rotating piston pumps are:

- *axial piston pumps, and*
- *radial piston pumps.*

Figure 1 shows the parts of a pump fitted with six axial pistons. These are driven when placed on an oscillating plate.

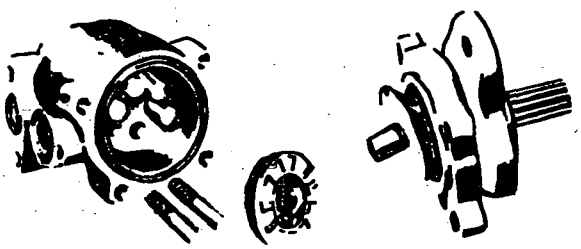


Fig. 1

Figure 2 shows an eight piston radial pump. These are moved by a cam on the drive shaft.

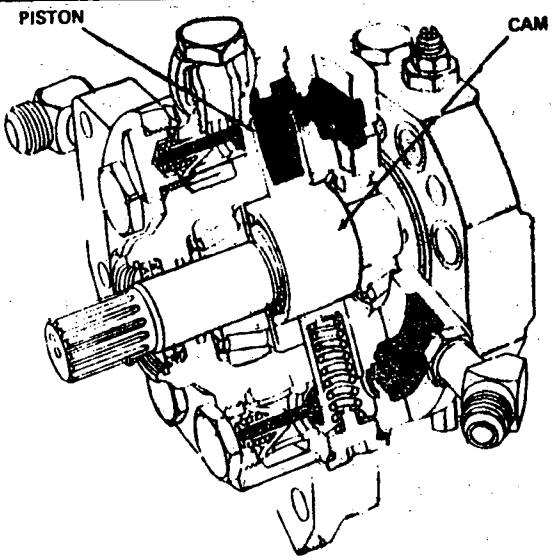


Fig. 2

AXIAL PISTON PUMPS

Structure. They consist of a *cylinder block* in which the pistons move in an alternate or forward and backward manner. This movement is produced by an *oscillating plate* which is mounted on the drive shaft of the pump (Fig. 3).

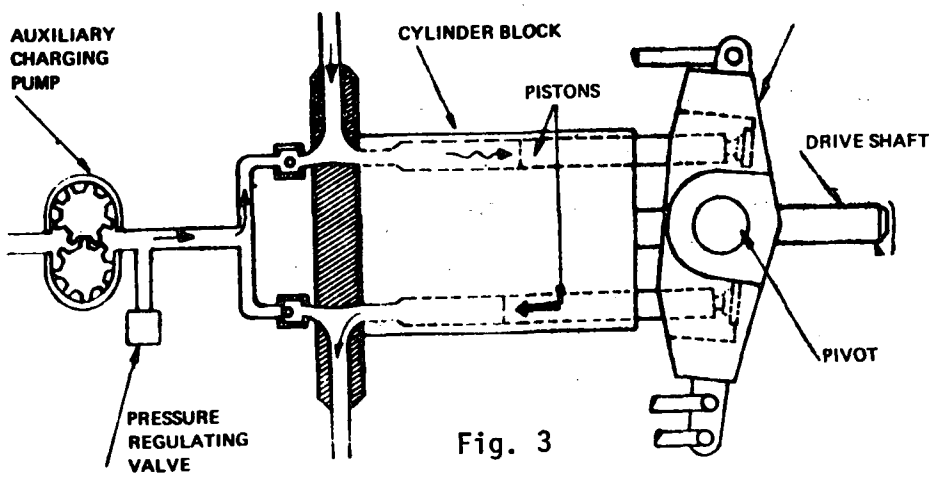


Fig. 3

They are usually in series with an auxiliary charging pump of the gear type which allows complete filling of the cylinders.

Operation. The movable parts of the pump are: the cylinder block which rotates inside the body provided with ports, and pistons which move alternately inside their respective cylinders.

The fixed parts are: the pump case and the oscillating plate which tilts alternately, hence its name, in order to vary the delivery flow of the pump.

When the cylinder block rotates, these successively face the intake ports (A of Fig. 3), receiving the oil sent by the auxiliary pump. Note that the oscillating plate allows maximum displacement of the piston when it faces the intake port.

Once a cylinder is full, when the block continues to rotate it faces several outlet ports of different sizes in an increasing order through which the oil is discharged. In turn the cylinder head of the piston leans on sections of the oscillating plate which forces it to shift to the left (Fig. 3) thus pushing the oil and making it discharge into the ports.

The high rotation speed of the pump, the action of several pistons and the outlet ports of increasing sizes produce a continuous flow of oil.

Types. Some axial pumps have cylinders and pistons arranged on axes parallel to the drive shaft and are called *in line axial piston pumps.*

In other pumps the body of the cylinders forms an angle of approximately 120° with the plane of the drive shaft. These are called *angular axial piston pumps.*

RADIAL PISTON PUMPS

STRUCTURE. These consist of a case (1 in Fig. 4) fitted with ports (2) which constitutes the cylinder block, their corresponding pistons (3) and a drive shaft (4) fitted with a cam which drives the above mentioned parts.

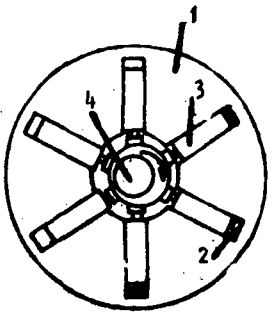


Fig. 4

The pistons are pushed towards the axis or centre of the pump by *springs*. (Fig. 5).

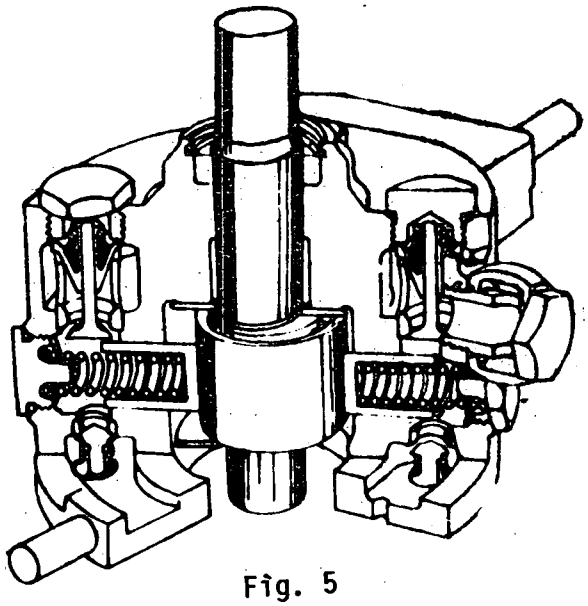


Fig. 5

Operation. Each piston is pushed towards the centre of the pump. The displacement of the piston produces a vacuum which causes the suction or admission of fluid to the cylinder. When the cam pushes the piston into the cylinder, the piston forces the liquid out.

Thus a cycle is completed when the cam rotates. One cycle consists of intake and outlet in each of the cylinders. A high number of revolutions per minute of the drive shaft or cam produces a continuous flow.

TECHNICAL VOCABULARY

Oscillating plate - swash plate

CBC

TECHNOLOGICAL INFORMATION
AIR-TIGHT GASKETS

These are sealing materials placed between two surfaces. They provide a tight fit to avoid fluid leaks and to keep impurities out of mechanical systems.

TYPES

Air-tight gaskets are classified by their use. They can be static or dynamic.

Static gaskets are used to obtain a tight fit between parts that remain fixed.

Dynamic gaskets are used to obtain a tight fit between surfaces of moving parts.

"O" RINGS (Fig. 1)
These are rings of toric form used as static or dynamic gaskets. They are made of a special synthetic rubber. These gaskets are seated in circular grooves and are compressed by approximately ten per cent between the two surfaces they seal.

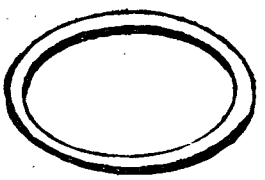


Fig. 1

When they are used as dynamic gaskets they should work lengthwise and on polished surfaces. They are not used on revolving shafts because of the wear they undergo, neither on surfaces at an angle or with holes.

Static gaskets submitted to great pressures are generally reinforced with a supporting rim. This keeps it from being pushed out.

"U" and "V" GASKETS (Fig. 2)

This type of gasket with a "U" or "V" section is used for the air-tight fitting of pistons and rods in hydraulic cylinders. They are also used on pump shafts or on the shafts of the control valves system and on revolving shafts. They are made of several different materials. The ones more commonly used are leather, special synthetic rubber and plastic.

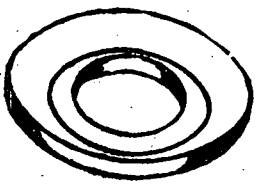


Fig. 2

To place these gaskets care should be taken that the working flange faces the pressure side. The pressure will force the flange against the polished surface to obtain an air-tight fit.

SEALING RINGS (Fig. 3)

This type of dynamic gaskets is used on pistons and rods in hydraulic cylinders. It operates by the expansion of a retainer flange. They are made of leather, special synthetic rubber, plastic and other materials.

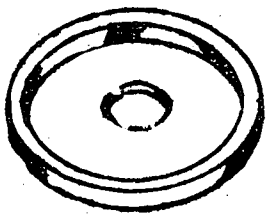


Fig. 3

PACKING (Fig. 4)

This type of dynamic gasket is compressed and is used for low pressure. It is made of plastic, asbestos or cotton strand. These gaskets should be lubricated to avoid friction-caused wear.

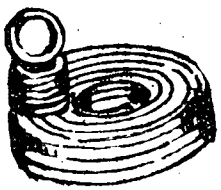


Fig. 4

METAL-PLASTIC GASKETS (Figs. 5 and 6)

Its application is only static. When compressed between two parts it should mould itself to them. It should adjust itself equally in all its points, in order to have an air-tight fit.

They are made of different materials: cork, special paper or rubber. Some are made up by more than one material. For example, copper gaskets with an asbestos core (Fig. 6), resist high temperatures.

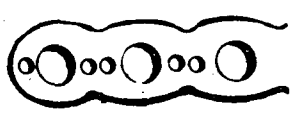


Fig. 5

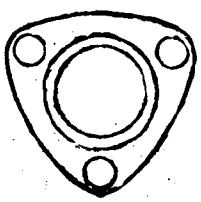


Fig. 6

CBC

TECHNOLOGICAL INFORMATION
CLAMPS
(Different types)

These are ring-shaped parts. They are used to hold hoses, pipes and other elements.

They are made up by a ring or metallic band and a mechanism for tightening or loosening the ring.

The main characteristic is its closing and adjusting device.

TYPES

They are made in different types like those shown in the following figures.

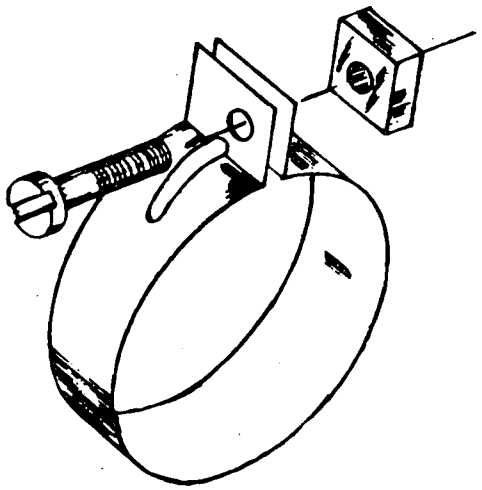


Fig. 1

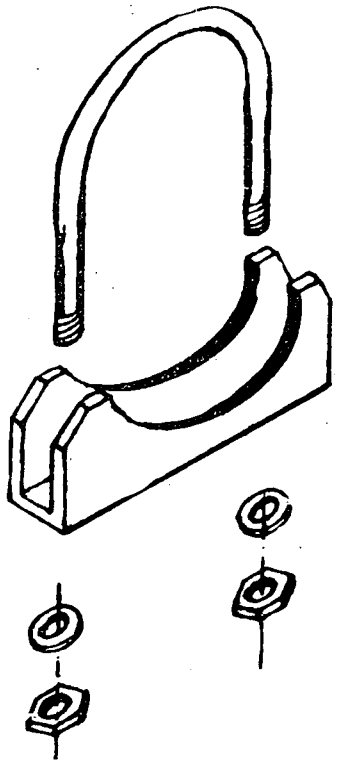


Fig. 2

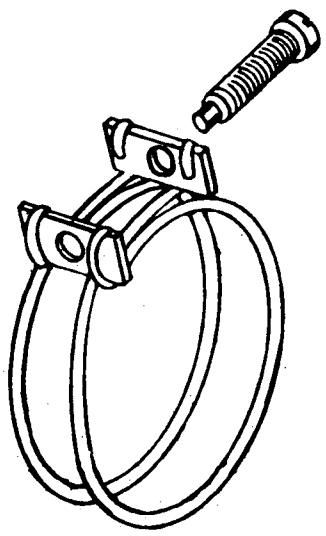


Fig. 3

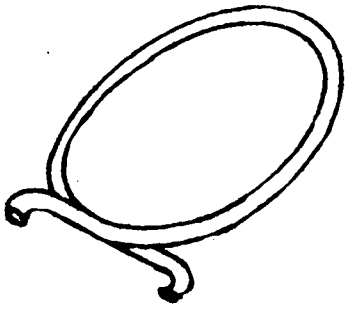


Fig. 4

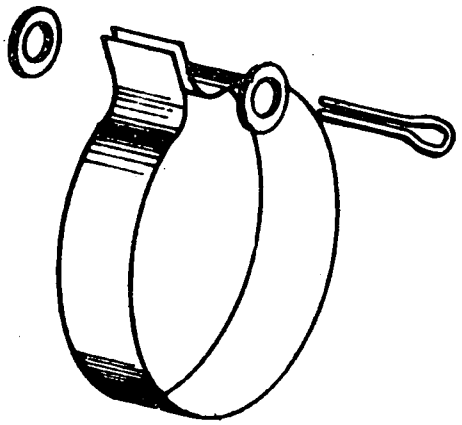


Fig. 5

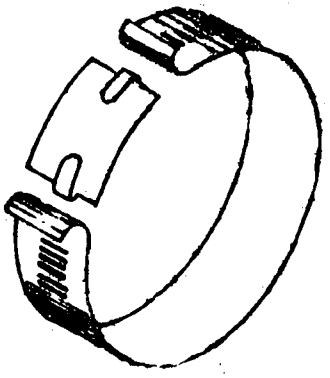


Fig. 6

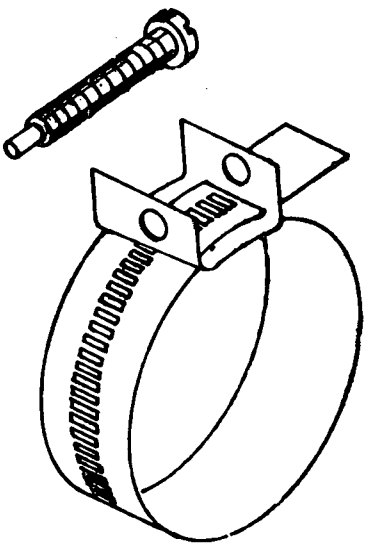


Fig. 7

The most commonly used are the 10 to 100 milimeters in diameter. They come in adjustable diameters, fixed diameters and special measurements. The adjustable diameter clamps open or close to adapt themselves to a given size and have a minimum and maximum opening limit.

These are toothed wheels used to transmit power and movement from one shaft to another.

The shafts can be parallel or at angles to each other.

Almost all conventional-type transmissions are mainly made up of gears.

There are different types of gears adapted to the needs of power and speed of the transmissions.

Gears are classified taking into consideration the following criteria:

Type of teeth (Figs. 1 and 2).

STRAIGHT TOOTH GEAR

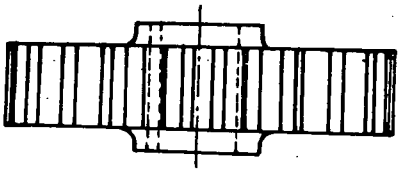


Fig. 1

HELICAL TOOTH GEAR

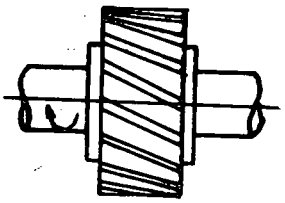


Fig. 2

Type of contact between teeth (Figs. 3 and 4)

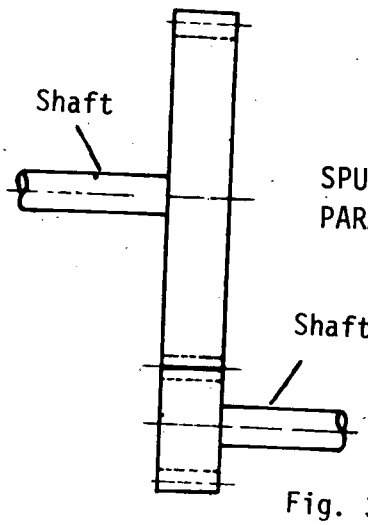


Fig. 3

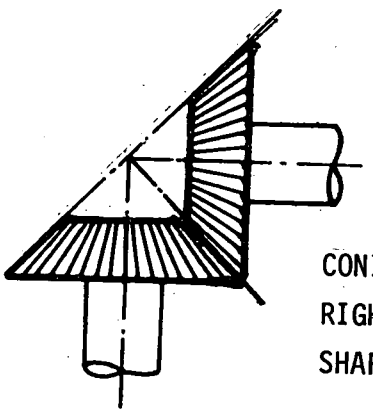


Fig. 4

Gears are made on the basis of the different types of teeth and surface forms.

SPUR GEARS

These gears have straight teeth parallel to the axis of rotation.

They generally have one or two pairs of teeth constantly in contact. They are characterized by their noisy functioning. For this reason they are only used for low speeds.

They are used in mechanisms like capstans and slow transmissions (Fig. 5).

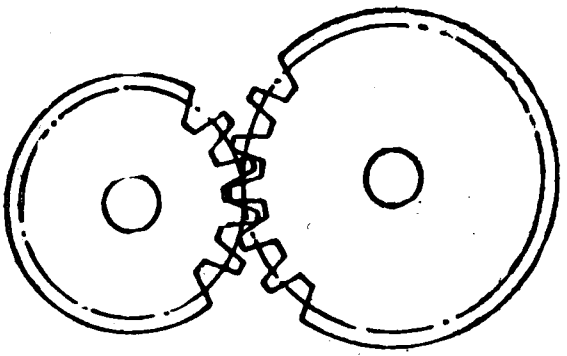


Fig. 5
STRAIGHT TOOTH GEAR

HELICAL GEARS (Fig. 6)

The teeth of the helical gears form an oblique angle with the axis of rotation. The teeth mesh at one end and separate at the opposite end. This angular contact causes a lateral thrust supported by the bearings. They are less noisy. They are sturdier and last longer then the spur gears because the contact surface of the teeth is greater for gears of the same size. They are used for tractor and automobile transmissions because they are less noisy and last longer than spur gears.

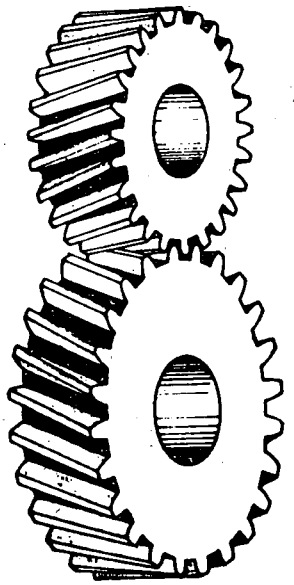


Fig. 6
HELICAL GEARS

DOUBLE-HELICAL GEARS (Fig. 7)

Double-helical or herringbone gears have their teeth forming an oblique angle with the vertex at the centre. This way it is possible for the lateral thrust of half of the tooth to be counteracted by the lateral thrust in the opposite direction of the other half of the same tooth.

The two halves of the tooth are generally separated by a groove at the vertex of the angle they form. This groove makes gear alignment easy. It also avoids the blocking effect of a small portion of oil at the vertex of the tooth during operation.

The gears work silently at high speeds and do not cause lateral thrusts with large loads. For this reason they are used in large turbines and alternators which require long-lasting gears.

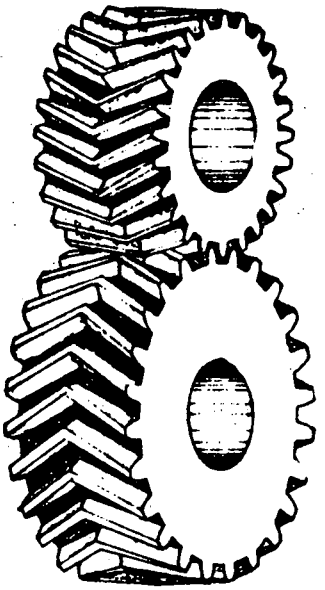


Fig. 7
BI-HELICAL GEARS

STRAIGHT TOOTH-BEVEL GEARS

This type of gear allows the transmission of power at an angle. The teeth are oriented towards the centre of the axis and form an angle with the latter. The smallest gear is often called pinion and the larger is called ring. Straight-tooth bevel gears are only used for low speeds, just like straight-tooth-cylindrical gears.

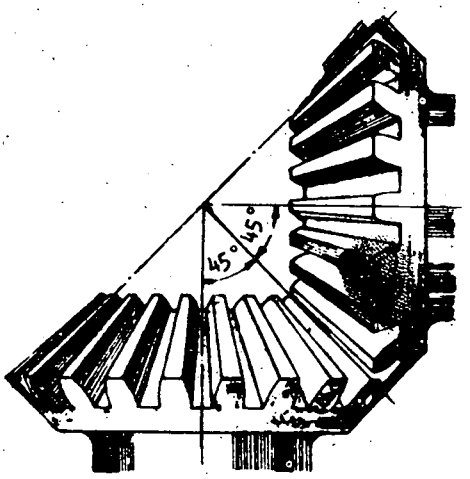


Fig. 8
BEVEL GEARS

HELICAL-TOOTH-BEVEL GEARS (Fig. 9)

These gears are used at higher speeds and when it is necessary to transmit greater power at an angle.

Their teeth converge obliquely on the angular surface of the gear.
Agricultural and industrial machines use this type of gears for the pinion and ring of the differential.
Besides transmitting power at a right angle, a reduction is obtained which lowers the speed or rotation and increases torque.

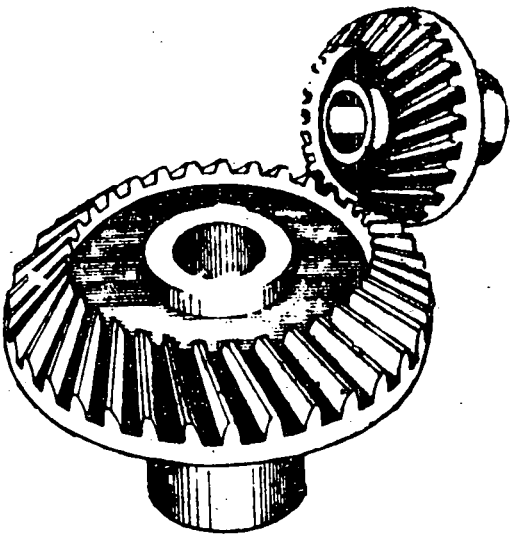


Fig. 9
HELICAL TOOTH BEVEL GEAR

HYPOID GEARS (Fig. 10)
The hypoid gear is similar to the helical-tooth bevel gear. The only difference is that the pinion engages in the ring at a point located below the central axis of the ring.
They are used for the differentials of automotive vehicles.

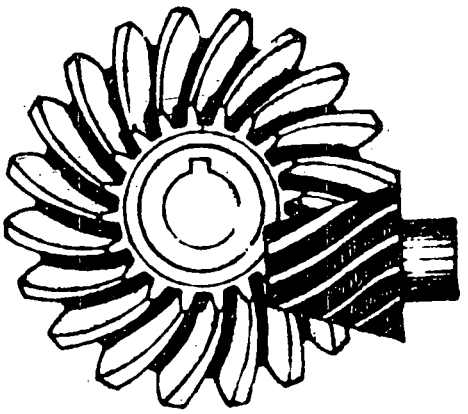


Fig. 10
HYPOID GEARS

WORM AND WHEEL GEARS (Fig. 11)
This gear is similar to a slanted-thread screw. It allows large reductions within small spaces. It also allows the transmission of power at an angle. The gear connected to the worm gear has curved teeth, adapted to the threads of the worm gear, to increase surface contact. The active part is the worm gear. This combination is used whenever power and a high speed of rotation are available and low speed and high torque are needed.

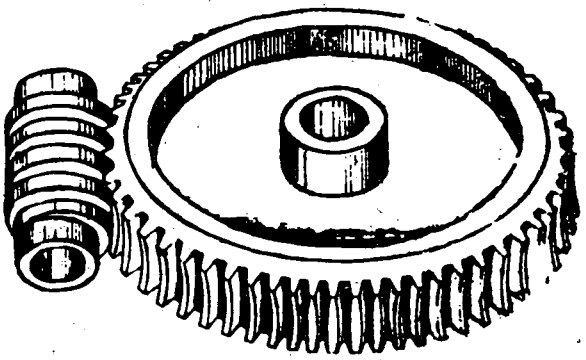


Fig. 11
WORM AND WHEEL GEARS

RACK AND PINION GEARS (Fig. 12
With this combination, rotation is transformed in rectilinear movement and vice versa. The teeth of the rack and of the pinion can be straight or oblique. Rack and pinion gears are used to obtain very slow movement and a great increase in power.

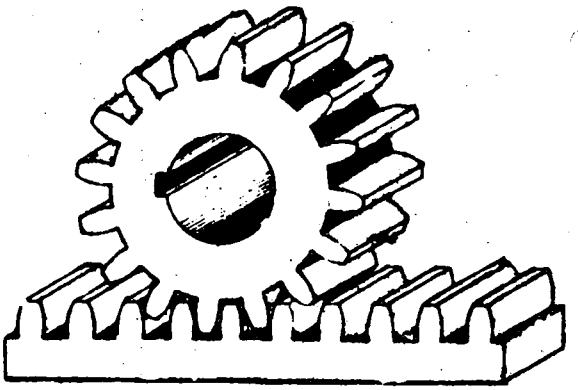


Fig. 12
RACK AND PINION GEARS

EPICYCLIC GEARS (Fig. 13)
These consist of a set of gears formed by an internally toothed ring gear and planetary gears of a smaller diameter.
These gears are often used in transmissions because they allow several speeds without shifting gears.

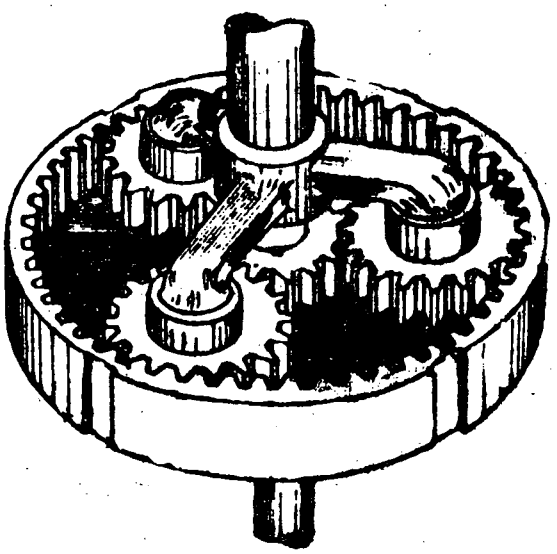


Fig. 13
EPICYCLIC GEARS

CBC

TECHNOLOGICAL INFORMATION

GEARS
(Contact Pattern)

The contact pattern is a check performed with colouring matter to determine if two engaged gears are coupled correctly. Coupling is checked whenever the gears are assembled to ensure correct contact between teeth.

Correct contact (Fig. 1) is the one suitable for silent mesh and smooth operation

Fig. 1

Toe contact (Fig. 2) indicates insufficient clearance. To correct it the ring is separated from the pinion.

Fig. 2

Heel contact (Fig. 3) indicates excessive clearance. To correct it the ring is brought closer to the pinion.

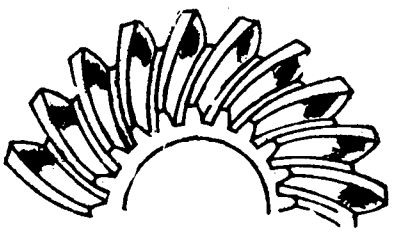


Fig. 3

Side contact (Fig. 4) indicates that the pinion is too far out. In other words, the tooth is not meshed in all its length.

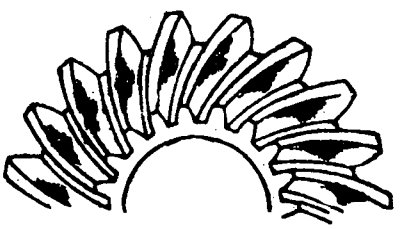


Fig. 4

Flank contact (Fig. 5) indicates that the pinion meshes too deep.

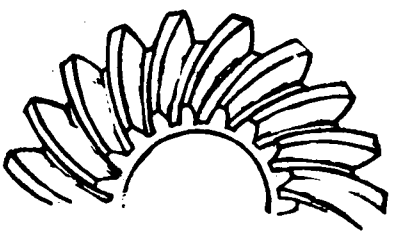


Fig. 5

Contact surfaces of the teeth of new gears present minor defects. These normally disappear with the smoothing-out after the first hours of work. This smoothing-out is produced by the lubricant and the polishing effect. After this smoothing-out the teeth should bear many hours of work without any sifnificant wear. However, the lack of lubrication, the presence of abrasive impurities and other causes can produce early wear in the gears. The most common types of gear wear are presented below.

NORMAL WEAR

It polishes the contact surface of the teeth. The polished surface should cover the entire height and width of the tooth from pitch diameter to the top. A well machined gear, well assembled, lubricated and not overloaded will have polished teeth only after many hours of work.

Figure 1 shows the lines of contact between teeth of spur gears and helical gears working correctly.

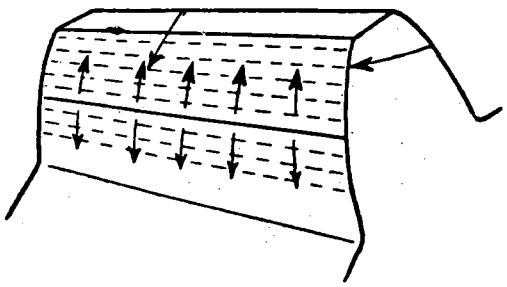


Fig. 1

When the teeth of hypoid gears or worm gears are suitably paired they make contact with each other as shown in Figure 2.

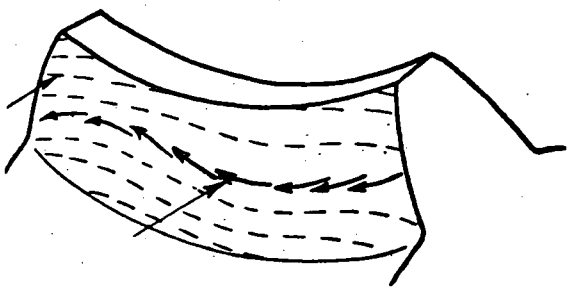


Fig. 2

The polish on the teeth of normally worn gears is similar to the lines of contact shown in (Figs. 1 and 2).
Figure 3 shows normal wear.

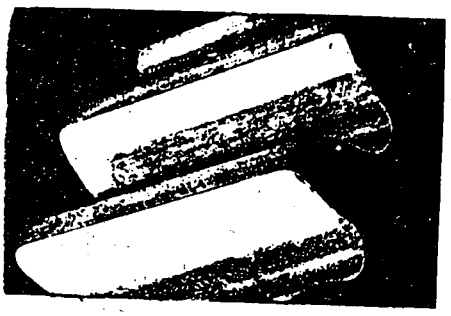


Fig. 3

ABRASIVE WEAR

It is caused by minute abrasive particles. These can come in the oil or might have been embedded in the contact surface of the teeth. These abrasive particles come from gear metals, from the abrasive that remained in the gearbox or from the sand of the foundry.

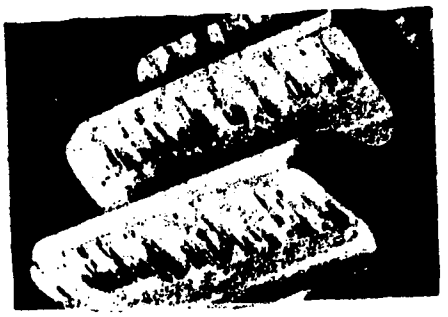


Fig. 4

SCRATCH WEAR

These marks are often found on gears which work at low speeds and with large loads. Thev are caused by metal particles larger than the abrasive ones that break off from gear teeth. The scratches on the teeth often indicate that the gear has not been correctly proportioned to the load it bears (do not mistake with fluting).

Fig. 5

OVERLOAD WEAR

When the contact surface of the teeth is polished and very worn, it is an indication that they have been over-loaded. As a consequence of this wear, play between the flanks of the teeth increases and a hammering effect is caused.

Fig. 6

HAMMERING WEAR

The impact of one tooth on another expels oil and causes metal to metal contact which produces a rough edge on the teeth. They are generally seen on gears of soft metal or which work on bearings of unsuitable proportions.

Fig. 7

FOLDS

Lack of lubrication, excess load and vibrations deform the tooth surface. This deformation produces folds in the tooth surface perpendicular to the direction in which it moves.

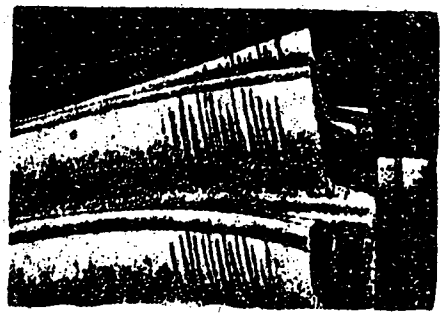


Fig. 8

SCORING

It is produced by the rise in temperature and subsequent thinning of the oil, until the lubricating film breaks due to excess load. Pressure and friction heat the metal and cause the heat to transfer from one tooth to another. As this process goes on pieces of metal fall off leaving deep grooves in the same direction in which the tooth is working. In this case, the rise in temperature of the gear is not so intense as to burn it.

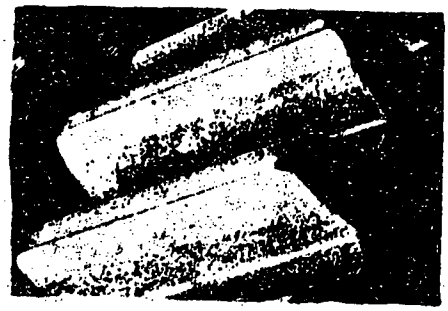


Fig. 9

PITTING

All gears are somewhat pitted when new. However, this pitting completely disappears in the smoothing process. But when gears are not well machined or are working forcibly, pitting increases. Finally, pieces of metal fall off. In this case, a fracture of the tooth can occur.

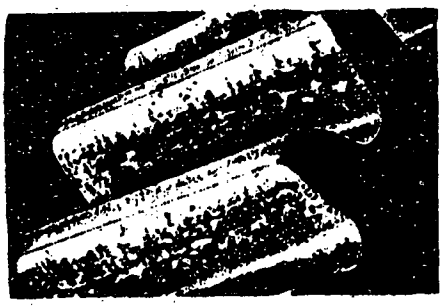


Fig. 10

SPALLING (or FLAKING)

Initally small cracks are produced in the teeth. These cracks finally cause small flakes to fall off the metal. Teeth tempered by heat are the most likely ones to suffer this type of damage because the surface of the metal

is more brittle. The flaking can occur in a single tooth, but the pieces of metal can damage the teeth of the gear in different ways.

Fig. 11

CORROSION

Corrosion occurs when the tooth is acted upon by acids formed in the lubricant. In fact, the humidity of the lubricant combines with its impurities and other atmospheric pollutants to form acids. As a general rule, the surface is pitted and becomes uneven causing some points of the tooth to work more than others. This causes the flaking of pieces of metal.

Fig. 12

BURNING

Gear teeth suffer burning from lack of lubrication. Friction during work with a heavy load causes the teeth to reach a temperature higher than their maximum tolerance. Teeth of the over-heated gear become brittle and break easily.

GROOVES

These are deep scores which only appear on one end of the tooth, particularly on hypoid pinions. They can be caused by excess load, lack of lubrication or because the steel was not well tempered.

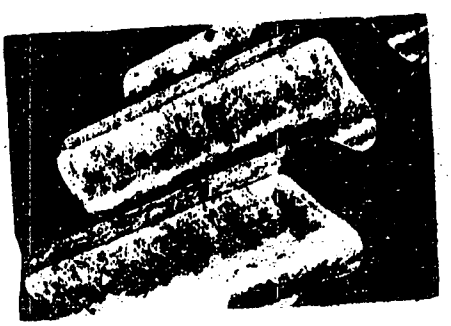


Fig. 13

FRACTURE

The fracture of a tooth is due to numerous causes. To discover these, all gear teeth have to be thoroughly examined. The fracture can occur because of violent impacts or because of factory defects of the gear. To determine if the fracture was caused by overload or fatigue, the fracture surface should be carefully examined.

When the fracture surface appears bright because it is recent, the cause of the fracture was an overload impact (Fig. 14). When the surface presents a bright zone at the centre surrounded by another somewhat darker one, the cause for the fracture of the tooth was mechanical stress, which began by a small crack on the surface (Fig. 15).

Fig. 14

Fig. 15

CRACKS

Cracks on gear teeth often occur when they have not been tempered by heat during the manufacturing process. They can also appear throughout the teeth when their base is too weak. Almost all cracks caused by poor tempering are very fine and are not visible until after the gear has worked for some time.

Fig. 16

Epicyclic gears are also known as planet gears. They rotate around their shafts while rotating around a central pinion. The set of planetary pinions revolve by means of these, inside an internally toothed ring. Observe that the sun gear, the planet gears and the ring are constantly meshed (Fig. 1).

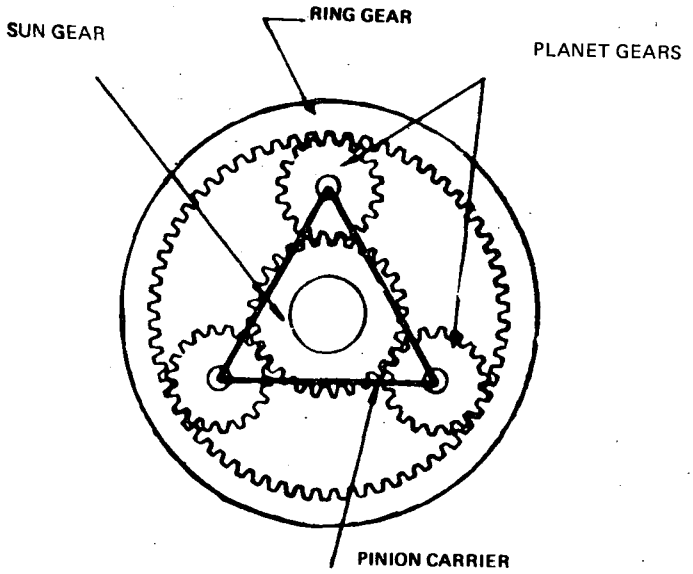


Fig. 1

OPERATION

The planet gears revolve on a shaft fixed to the planet pinion carrier, moving around whichever is fixed, the sun gear or the ring. If torque is applied on the sun gear or on the planet pinion carrier, the system will rotate as if it were a single unit, that is, if a brake is not applied to one of the other two members of the system. By applying torque to one member of the system and a brake to another member, the third becomes the output point for the applied force. The combinations that can be made are shown here through a few examples.

When the sun gear (Fig. 2) is made to rotate and the ring is maintained fixed, the planet gears revolve around the ring carrying the planet pinion carrier with them. The latter revolves in the same direction in which the sun gear does, but slower.

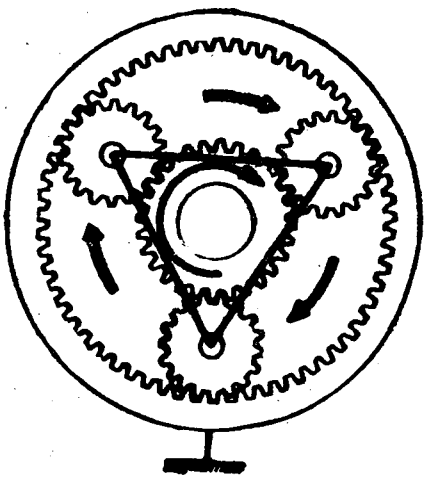


Fig. 2

When the ring gear (Fig. 3) is made to rotate and the planet pinion carrier is held, the planet gears revolve on their shafts and transmit the movement to the sun gear which revolves in an opposite direction to the ring gear and at a higher speed.

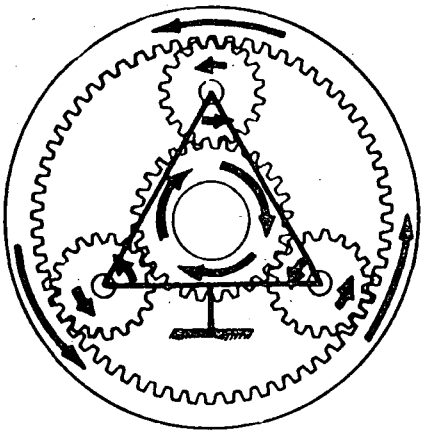


Fig. 3

In the former two cases, one of the members of the set is made to rotate, another is held still and the force of the third is used.

Depending on the member that is moved and on the one held, several reductions can be obtained with the same set of gears.

DOUBLE-PLANET GEARS

When a planet gear is coupled to a sun gear through a second planet gear, a reversal in the direction of rotation is obtained (Fig. 4).
With this combination, torque is applied to the planet pinion carrier. By braking the ring gear, the planet gears engaged with the ring gear are forced to revolve on their shafts. Movement is then transmitted to the sun gear through the second planet gears, thus obtaining a reversal in the direction of rotation with respect to the planet pinion carrier.

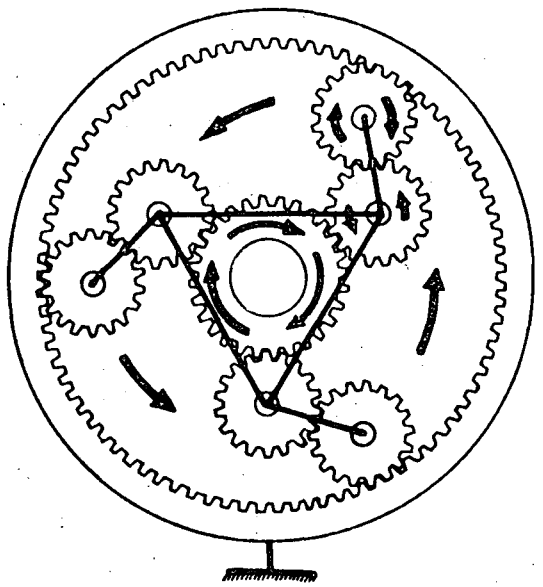


Fig. 4

With this epicyclic system we can obtain high and low speeds and reversing.

CBC

TECHNOLOGICAL INFORMATION
PULLERS FOR GEARS, PULLEYS AND BEARINGS
(Nomenclature and Use)

These are tools used to remove pulleys, gears, bearings and other press-fitted parts.

They are made of special high stress-resisting steel.

The main characteristics are shown in figures 1 and 2.

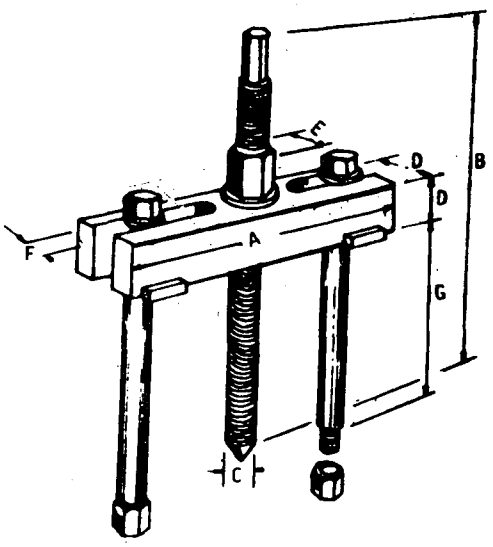


Fig. 1

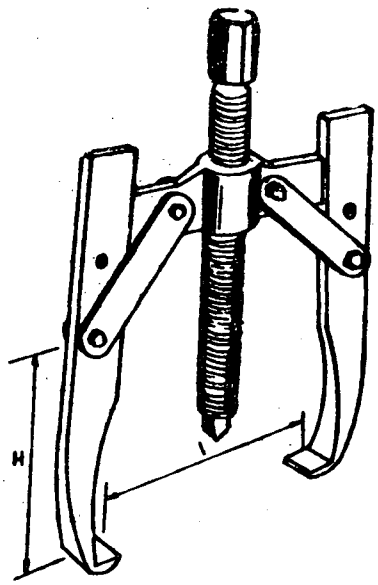


Fig. 2

A Length of head.
B Length of forcing screw.
C Diameter of forcing screw.
D Type and width of head.
E Size of screw nut.
F Head slot.
G Length of legs.
H Maximum reach of legs.
I Maximum opening of legs.

Classification: hydraulic (Fig. 3) and mechanical (Fig. 4).

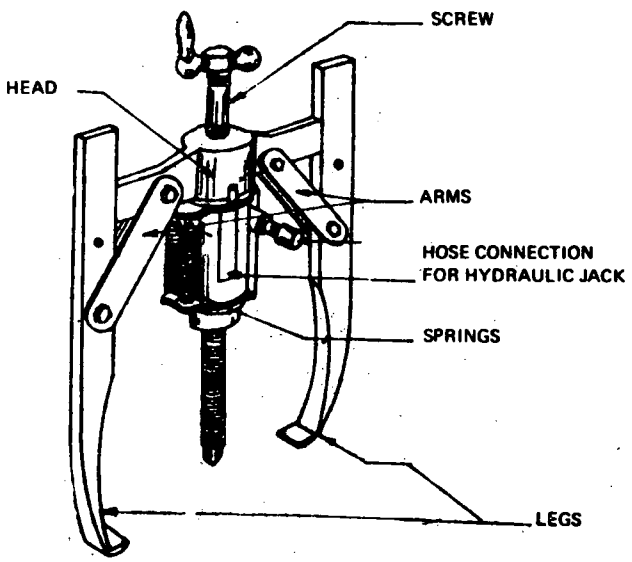


Fig. 3

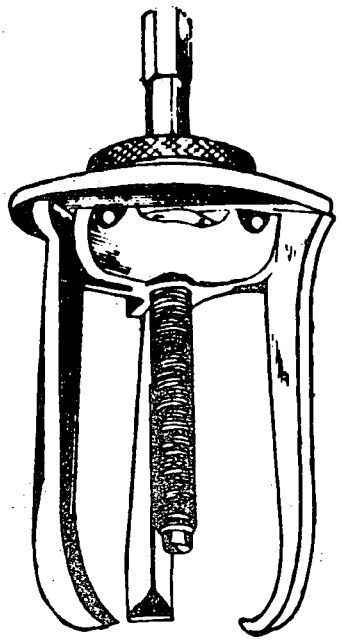


Fig. 4

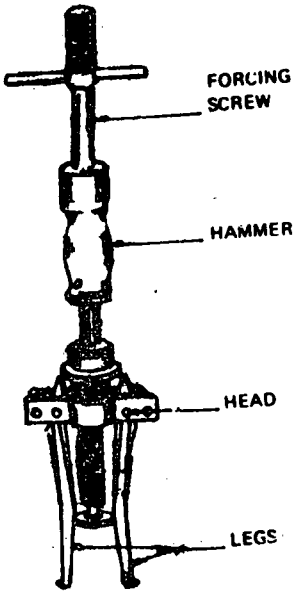


Fig. 5

Mechanical pullers are divided into two classes:

Screw (Figs. 1, 2 and 4) and *impact* (Fig. 5) pullers.

Depending on how they hold the parts they are called *double* and *triple grip* pullers.

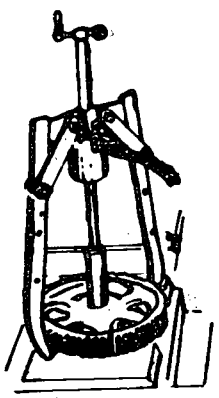


Fig. 6

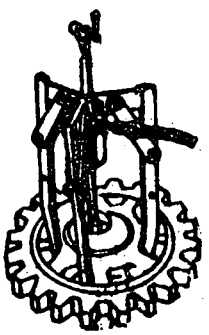


Fig. 7

These are made in different types and sizes according to the working needs and to the specific working pressure.
When working with pullers be sure they are in the best condition.

MAINTENANCE

Keep pullers clean, with the forcing screw lubricated and the head in good condition. Correct fluid leaks in hydraulic pullers.

FITTINGS

Male and female thread adapter (Fig. 8). It serves as an extension piece for the forcing screw or for the arms. It is used when bearings and pulleys are to be pulled out.

Fig. 8

Female thread adapter (Fig. 9). It is used as an extension piece for the forcing screw or for the arms. It is used when bushings or shafts are to be removed.

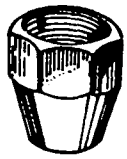


Fig. 9

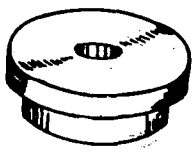


Fig. 10

Adapter for guiding the forcing screw (Figs. 10 and 11). These are used to protect axles and as an aid for centering the forcing screw.

Discs are used to remove pulleys, gears and bearings and as shims in hydraulic presses.

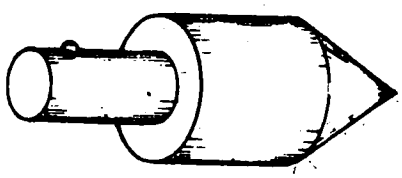


Fig. 11

Double-end legs (Fig. 12). These legs have double-ends, one opposite to the other. They are used for pulling out internal or external parts.

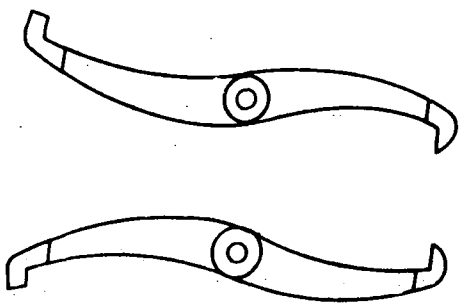


Fig. 12

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TECHNOLOGICAL INFORMATION
GEARBOX
(Diagnosis of failures)

The following table will help in diagnosing and correcting some failures which occur in the mechanical gearbox.
The most frequently observed gearbox failures are listed below. The list, which may serve for orientation, indicates the probable cause and the way to correct it.

NOISY GEARBOX IN NEUTRAL

Possible cause	*Correction*
Dry, worn or broken bearings.	Lubricate or change the bearings.
Low level of lubricant.	Top up with lubricant.
Worn or broken gears.	Change the gears.
Worn or broken countershaft.	Change the countershaft.
Excessive axial play of the countershaft.	Adjust the clearance or change the worn parts of the countershaft.

NOISY GEARBOX IN GEAR

Possible cause	*Correction*
The same causes as above.	The same corrections as above.
The bearing of the output shaft is worn or broken.	Change the bearing.
Worn teeth on gears.	Change the gears.
Worn speedometer gears.	Change the speedometer gears.

Play between gears at the output shaft.	Change the worn parts.

STIFFNESS IN GEAR CHANGE

Possible cause	*Correction*
Clutch not releasing.	Adjust or repair the clutch.
Seized shifting gear.	Clean the splines or change the shaft and gear.
Improperly adjusted gearshift mechanism.	Adjust the gearshift mechanism.
Deformed splines on the output shaft.	Change the shaft.
Damaged synchronizer.	Change the synchronizer.
Broken teeth on shifting gears.	Change the gears.

GEARS GRATE WHEN SHIFTING

Possible cause	*Correction*
Clutch not releasing.	Adjust or repair the clutch.
Defective synchronizer.	Change the synchronizer.
Seized gears on the output shaft.	Clean the gears and the shaft. This allows them to turn freely. Change the damaged parts.

STICKS IN GEAR

Possible cause	*Correction*
Clutch not releasing.	Adjust or repair the clutch.
Interlock pin or balls of the shifting mechanism stuck.	Free the interlock pins or balls.
Improperly adjusted and dry shifting mechanism.	Adjust and lubricate the mechanism.
Seized shifting gears.	Clean the splines or change the gear and shaft.

JUMPS OUT OF GEAR

Possible cause	*Correction*
Improperly adjusted shifting mechanism.	Adjust the shifting mechanism.
Gear with excessive play at shaft's end.	Change the shaft and gears.
Worn teeth on gears.	Change the gears.
Excessive axial play in gears.	Change the worn parts.
Weak interlock spring on the shifting mechanism.	Change the spring.
Worn bearing.	Change the bearings.

LOSS OF LUBRICANT

Possible cause	*Correction*
Level of lubricant too high.	Drain off the excess lubricant.
Missing or defective gaskets.	Install new gaskets.
Damaged or wrongly installed seals.	Correctly install new seals.
Loose drain-plug.	Tighten the plug.
Loose, and missing bolts or worn thread.	Repair or change the box.
The lubricant foams.	Change to the recommended lubricant.

CBC

TECHNOLOGICAL INFORMATION
TOOLS FOR REMOVING AND MOUNTING SPRINGS (Compressors)

These are tools used for removing and mounting different types of springs

TYPES OF COMPRESSORS

There are three types of compressors-expanders: "C" compressor, plate compressor and lever compressor.

"C" COMPRESSOR (Fig. 1)

It consists of an arc, a fixed base and an adjustable mechanism which allows it to be adapted to different sizes of springs.

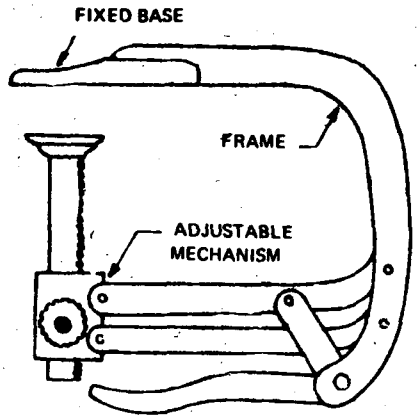
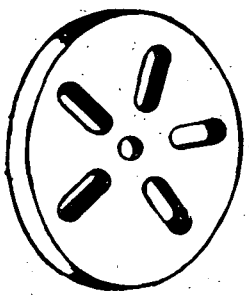


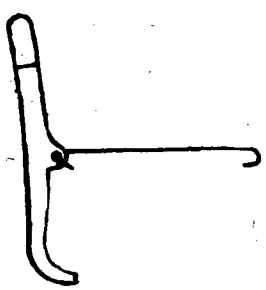
PLATE COMPRESSOR (Fig. 2)



This is a metal disc with holes for lodging various springs. The springs are mounted or removed by means of a forcing screw or a vertical press.

LEVER COMPRESSOR (Fig. 3)

This is a bar with two holes. One supports the end of the lever and the other lodges the spring. The other end is used for applying pressure on the lever when compressing and relieving tension from the spring.



MAINTENANCE

After using these tools, clean them and oil their moving parts.

CBC

TECHNOLOGICAL INFORMATION
CLUTCH
(Diagnosis of failures)

The following table will help in diagnosing and correcting some failures which occur in clutches.

THE CLUTCH VIBRATES

Possible cause	*Correction*
Greasy or oily disc linings.	Wash or change the linings.
Worn or glazed linings.	Change the linings.
Loose or worn engine mounts.	Tighten or change the mounts.
Worn splines on the disc hub or on the input shaft.	Change the disc and/or the input shaft.
Worn Universal Joints, differential or leaf springs.	Change the Universal Joints or correct the wear of the differential and/or of the leaf springs.
The disc is seized on the splines of the input shaft.	Clean the splines on the shaft and hub to ensure a smooth slide or change the disc and the output shaft.
Roughness or cracks on the friction surface of the pressure plate or flywheel of the engine.	Rectify or change the pressure plate and/or the flywheel.
Warped clutch disc.	Change the disc.
Warped pressure plate.	Change the pressure plate.
Pressure plate seized on its lugs.	Free and lubricate the lug or change the pressure plate.

Seized clutch release levers.	Correct seizure.
Unevenly adjusted clutch release levers.	Adjust the levers correctly.
Springs with uneven tension and length.	Change the springs.
Twisted input shaft.	Change the shaft.
Improperly adjusted transmission.	Adjust the transmission correctly.

THE CLUTCH GRABS

Possible cause	*Correction*
Oil or grease on the clutch.	Wash the clutch.
Warped clutch disc.	Change the disc.
Disc seized on the splines of the input shaft.	Clean the splines of the shaft and hub to ensure a smooth sliding or change the disc and the input shaft.
Seized pilot bearing.	Change the bearing.
Warped pressure plate.	Change the pressure plate.
Broken disc linings.	Change the linings or the disc.
Dust in the clutch.	Clean the clutch.
Improper adjustment of the pedal or the clutch.	Adjust the pedal and the clutch correctly.

CLUTCH NOISY

Possible cause	*Correction*
Dry throw-out bearing.	Grease or change the bearing.
Dry pilot bearing.	Grease the bearing.

CLUTCH CHATTERS

Possible cause	*Correction*
Loose clutch disc hub.	Change the disc.
Worn throw-out bearing.	Change the bearing.
Worn clutching mechanism.	Change the mechanism.
Worn pilot bearing.	Change the bearing.
Worn splines on hub or input shaft.	Change the disc or the input shaft.
Improperly adjusted clutch release levers.	Adjust the clutch release levers correctly.
Worn pressure plate guides.	Repair or change the pressure plate.
Excessive transmission end play.	Repair or adjust the transmission.
Twisted input shaft.	Change the shaft.

CLUTCH GRABS SUDDENLY

Possible cause	*Correction*
Disc linings grease-or oil-soaked.	Wash or change the linings.
Disc seized on input shaft splines.	Clean the splines on the shaft and hub to ensure a smooth slide or change the disc and input shaft.
Pressure plate seized on the drive lugs.	Correct seizure or change the pressure plate.
Glazed or worn disc linings.	Change the linings or the disc.
Seized release levers.	Correct seizure.

CLUTCH SLIPS.

Possible cause	*Correction*
Worn linings.	Change the linings.
Broken or worn springs.	Change the springs.
Improper clutch pedal adjustment.	Adjust the clutch pedal correctly.
Disc linings oil or grease-soaked.	Wash or change the linings.
Warped disc.	Change the disc.

Warped pressure plate.	Change the pressure plate.
Seized release levers.	Correct seizure.
Pressure plate seized on drive lugs.	Correct seizure or change the pressure plate.

WILL NOT HOLD

Possible cause	*Correction*
Torn off or totally worn linings.	Change the linings or the disc.
Broken springs.	Change the springs.
Improper clutch adjustment.	Adjust the clutch correctly.
Disc seized on the splines of the input shaft.	Clean the splines on the shaft and the hub to ensure a smooth slide or change the disc and the input shaft.

The present table serves only as a guide and should only be used for orientation. To solve each specific case in the repair of a clutch, always consult the service manual.

The causes and corrections have not been set out in a determined order of growing difficulty. Begin checking in order of growing difficulty, that is, from the simplest to the most complex.

CBC

TECHNOLOGICAL INFORMATION
DIFFERENTIAL
(Diagnosis of failures)

The following table will help in diagnosing and correcting some failures which occur in differentials.

CONSTANT NOISE

Possible cause	*Correction*
Insufficient lubricant.	Top up with the recommended lubricant.
Damaged bearings.	Replace the bearings.
Damaged drive pinion and ring.	Replace drive pinion and ring.
Improper adjustment of pinion and ring.	Adjust the pinion and ring correctly.
Damaged differential pinions or side gears.	Change the pinions or the side gears.

DIFFERENTIAL DOES NOT WORK FREELY WHEN ROUNDING A CURVE

Possible cause	*Correction*
Rough pinion bushings.	Change the bushings.
Rough side gear bushings.	Change the bushings.
Rough or damaged pinions.	Change the pinions and their axles.
Rough or damaged side gears.	Change the side gears.
Engaged differential locking device.	Disengage the locking device.

THE MECHANICAL LOCKING DEVICE SLIPS OUT

Possible cause	*Correction*
Broken or improperly adjusted control rods.	Repair, change or adjust the rods.
Damaged throw-out bearing.	Change the throw-out bearing.
Mechanism seized on the splines of the shaft.	Clean the splines or change the shaft if necessary.

LOSS OF LUBRICANT

Possible cause	*Correction*
Damaged gaskets.	Change the gaskets.
Damaged seals.	Change the seals.
Broken or cracked housing.	Repair or change the housing.
Loose and missing bolts. Worn thread.	Tighten or replace the bolts. Rethread to oversize.

OBSERVATION
To find out the cause of a problem begin with the simpler checks and proceed to the more complex.

CBC

TECHNOLOGICAL INFORMATION

CIRCLIPS

These are elements generally of cylindrical form, made of tempered steel. Their elasticity makes it easier to remove and mount them. Their purpose is to limit movement and hold parts, shafts and pins.

TYPES OF CIRCLIPS

With holes for inside use.
Flat surface (Fig. 1).

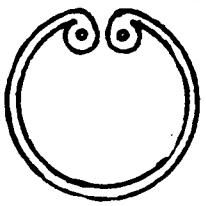


Fig. 1

With holes for outside use.
Flat surface (Fig. 2).

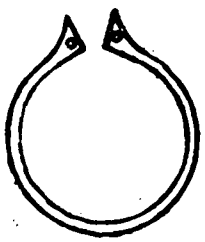


Fig. 2

Without holes for inside use. Circular surface (Fig. 3).

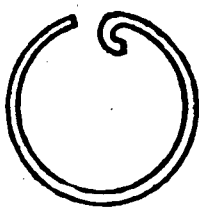


Fig. 3

Without holes for outside use.
Circular surface (Fig. 4).

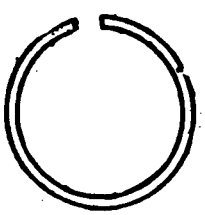


Fig. 4

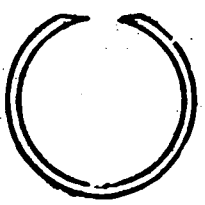


Fig. 5

Without holes for inside use.
Flat surface (Fig. 5).

Without holes for outside use.
Flat surface (Fig. 6).

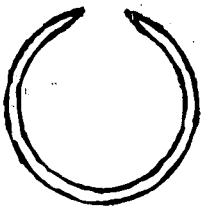


Fig. 6

Roller chain circlips
(Fig. 7).

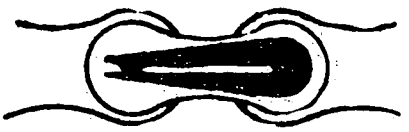


Fig. 7

Outside circlips
(Fig. 8).

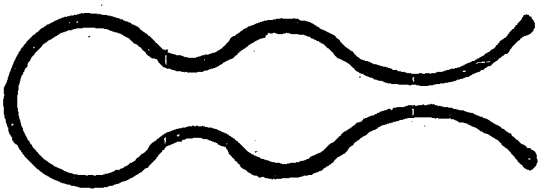


Fig. 8

CBC

TECHNOLOGICAL INFORMATION

RIVETS

Rivets are cylindrical bodies with heads of various forms and of different diameters and lengths. They are used to join or hold two or more parts.

STRUCTURE

Rivets consist of two parts: head and body (Fig. 1). They are made of steel, copper, aluminium or brass.

TYPES OF RIVETS

By the shapes of the heads they may be classified thus:

SNAP-HEAD RIVET (Fig. 1)

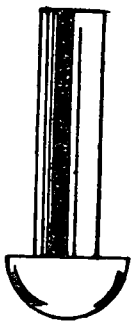


Fig. 1

COUNTERSUNK-HEAD RIVET (Fig. 2)

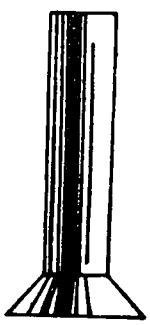


Fig. 2

FLAT-HEAD RIVET (Fig. 3)

Fig. 3

CALCULATING THE LENGTH OF RIVETS

The following formulae are applied when calculating the length of rivets:

- For snap and flat head rivets:

$$L = e + (1.5 \times d)$$

L = Total length of rivet.
e = Thickness of sheets.
d = Diameter of rivet.

EXAMPLE
Calculate the length of a snap head rivet of 4 mm in diameter used for riveting two sheets 5 mm thick each.

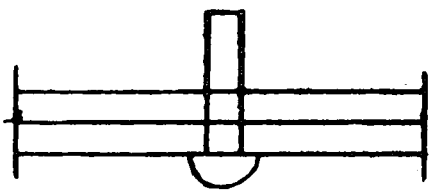


Fig. 4

L = 5 + 5 + (1.5 x 4)
L = 10 + 6
L = 16 mm = total length of rivet (Fig. 4).

- For countersunk head rivets

$$L = e + (0.7 \times d)$$

CALCULATING THE DIAMETER OF THE RIVET AND ITS HOLE

For this calculation use the following table:

THICKNESS OF THE SHEET (e)	1	1.5	2	3	5
DIAMETER OF THE RIVET (d)	3	4	6	8	10
DIAMETER OF THE HOLE (D)	3.1	4.2	6.2	8.2	10.5

These are tools of cylindrical or prismatic form. They are made of hardened steel, and are used to join the parts to be riveted, and to finish the heads of the rivets. In some cases the set and snap are found in a single tool.

The most important riveting tools are:

THE SET (Fig. 1)

The set joins and seats the parts to be riveted. The depth and diameter of the hole of this tool should be slightly larger than the length and diameter of the rivet so as to allow its easy entry.

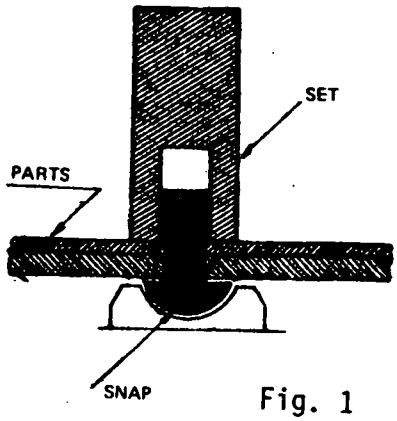


Fig. 1

BACKING SNAP (Fig. 1)

This is used to support the head of the rivet. Its size and shape should match the head of the rivet and support it completely so that it suffers no deformation during riveting.

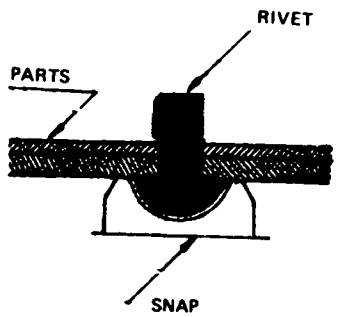


Fig. 2

SNAP (Fig. 3)

The snap is used to form the other end of the rivet. One of its faces is provided with a concave recess with the shape of the rivet head. This recess is used to finish the new head.

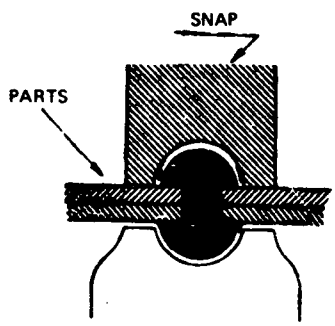


Fig. 3

CONDITIONS OF USE

The heads of these tools should be flat and free of burrs so as to avoid accidents when they are struck with a hammer.

These are elements made of hard steel in different types and sizes. They are used to transmit movement and power from one sprocket to another. They consist of "links" which mesh with the teeth of the pinions thus transmitting the circular movement.

ADVANTAGES

- They do not slip.
- They are sufficiently flexible and compact.
- They maintain the speed ratio.
- They are heat resistant.
- They accept heavier loads than belts.

TYPES

Flat chain (Fig. 1)
They consist of a series of open or closed links which can be separated. They are used in low speed transmissions. They are made of wrought iron and mild steel.

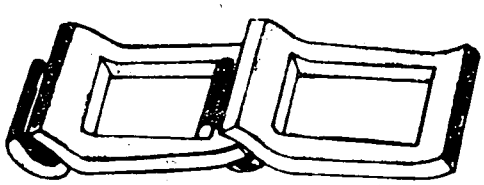


Fig. 1

Pin chains (Fig. 2)
They are made of wrought iron and their form and assembly are shown in figure 3.

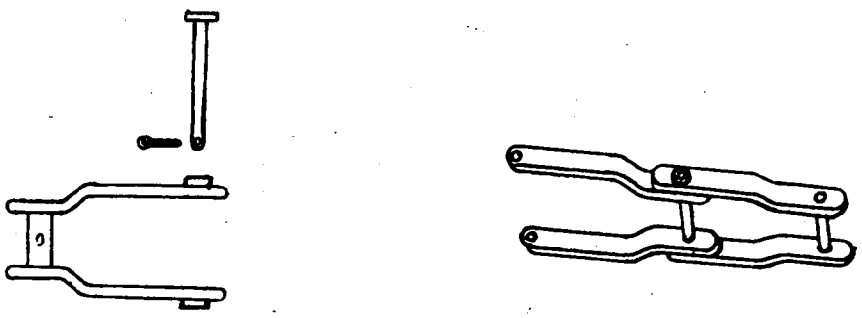


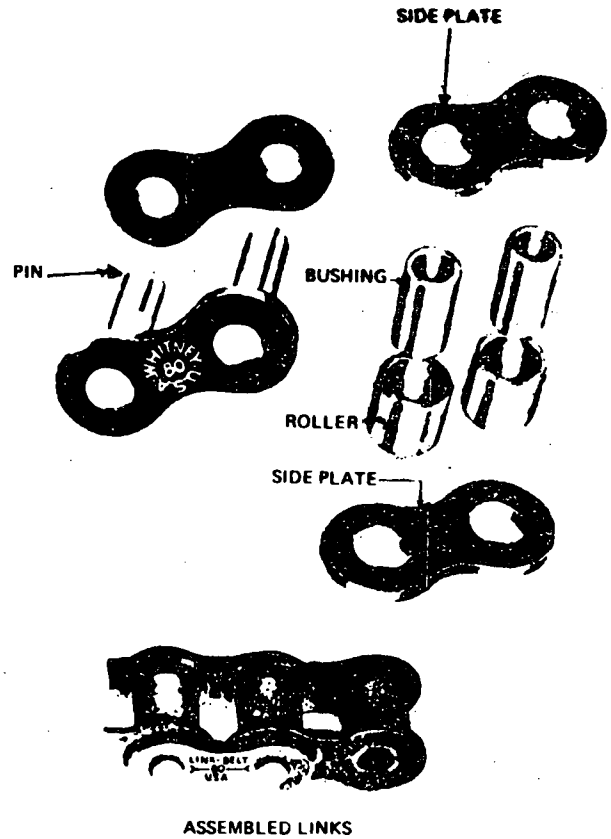
Fig. 2

Roller chains

The roller chains consist of links, pins and bushings or floating rollers (Fig. 3). They are mostly used for working with heavy loads at low or medium speeds, between close or very separated shafts. They should not be exposed to dust.

Timing chain

They consist of a set of link plates finished in gear-tooth form and joined by pins.
These chains have a very low vibration and can be used at high speeds. They are used in the distribution systems of engines.



ASSEMBLED LINKS

Fig. 3

CAPACITY OF CHAINS

The pitch of the chain is determined by each manufacturer according to the transmissible speed and power.

The following table is only used as an example. Always consult those supplied by the manufacturers.

Table for Diamond roller chains with single links and multiple rows.

Pitch of the Chain	Power H. P.	Speed R.P.M.
1/4"	25	8,000 RPM
3/8"	120	4,500 RPM
1/2"	220	3,370 RPM
5/8"	375	2,400 RPM
3/4"	480	1,800 RPM
1"	950	1,160 RPM
1 1/4"	1,440	800 RPM
1 1/2"	1,200	650 RPM
1 3/4"	1,540	475 RPM
2"	2,300	400 RPM
2 1/2"	2,800	280 RPM

CALCULATION OF THE LENGTH OF CHAINS (Fig. 4)

When it is necessary to calculate the exact length of a chain to join two sprockets which axes are situated at a known distance (Fig. 4), the following formula is applied:

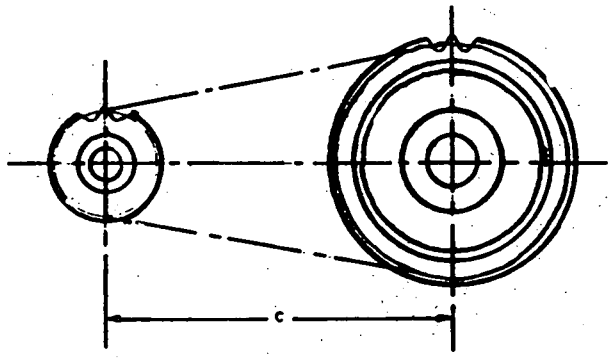


Fig. 4

$$L = \frac{3.14}{2} (D + d) + 2C \frac{(D - d)^2}{4C}$$

L = Length of chain
D = Diameter of the drive gear
d = Diameter of the driven gear
C = distance between centres of the shafts

EXAMPLE

Calculate the length of a chain to join 2 sprockets of 16 and 8 centimeters in diameter respectively and the distance between shafts is 40 centimeters.

SOLUTION

$$L = \frac{3.14}{2} (16 + 8) + 2 \times 40 + \frac{(16 - 8)^2}{4 \times 40}$$

$$L = 1.57 (24) + 80 + \frac{64}{160}$$

$$L = 37.68 + 80 + 0.4$$

L = 118.08 cm length of the chain

Testing and control instruments measure the pressure flow and temperature of fluids. They are used to detect failures and to check the operation of the different components of the hydraulic systems.

TYPES OF INSTRUMENTS

The testing instruments are:

PRESSURE INDICATORS (Fig. 1)

This indicator is used for measuring the pressure of the system at different points (pump outlet, inlet and outlet of valves, cylinders, etc.).

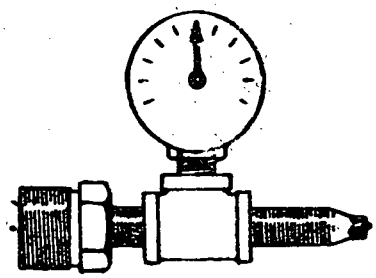


Fig. 1

CHARACTERISTICS

The pressures registered by this instrument may be expressed in kilograms per square centimeter (kg/cm^2), pounds per square inch (lbs/in^2), or atmospheres (atm).

There are combined indicators which simultaneously indicate pressure in pounds per square inch and kilograms per square centimeter.

In this instrument the pressure is shown by a pointer on a graduated scale.

TABLES

1 atmosphere = 1.033 kg/cm^2 = 14.22 lb/in^2

To convert atmospheres to kg/cm^2 multiply by 1.033

To convert kg/cm^2 to lbs/in^2 multiply by 14.22

CONDITIONS OF USE

The connections of this instrument must be airtight to avoid loss of pressure.

OBSERVATION

The capacity of the instrument should be greater than the pressure to be measured.

FLOW INDICATORS

These are used for measuring the flow which is delivered or carried by a

hydraulic line in a given unit of time.

The flow is measured in litres per minute or gallons per minute.

1 litre	= 1,000 cm^3
1 gallon	= 3,785 cm^3
1 gallon	= 231 in^3
1 cubic in.	= 16.39 cm^3

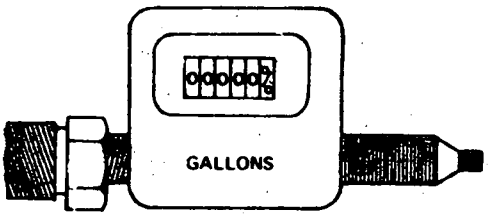


Fig. 2

To convert cubic inches to cubic centimetres, multiply by 16.39.

TEMPERATURE INDICATORS (Fig. 3)

These instruments measure the temperature of fluid in a hydraulic system.

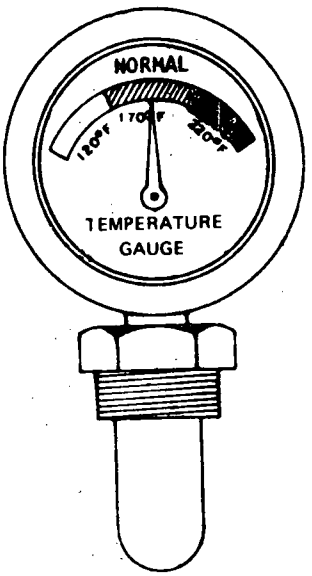


Fig. 3

CHARACTERISTICS

The temperature shown by these instruments may be read in degrees centigrade or degrees fahrenheit.

FORMULAE

To convert centigrade to fahrenheit, multiply tne degrees centigrade by nine, divide by five and add 32 to this quotient.

$$\text{Degrees Fahrenheit} = \frac{(\text{Degrees Cent.}) \times 9}{5} + 32$$

To convert degrees Fahrenheit to centigrade subtract 32 from the degrees Fahrenheit, multiply the rest by 5, then devide the product by 9.

$$\text{Degrees Centigrade} = \frac{(\text{Degrees F.} - 32) \times 5}{9}$$

The following table will help diagnose and correct some failures in hydraulic pumps.

PUMP NOT DELIVERING FLUID

Possible cause	*Correction*
Reservoir below level.	Fill the reservoir with the recommended fluid. Check for possible leaks.
Unprimed pump.	Prime the pump.
Clogged pump intake.	Remove and clean. Check filters and reservoirs.
Takes in air.	Check fittings, pipings, hoses and gaskets. Prime and bleed the pump.
Turning slowly.	Speed up to specifications. If belt-driven, check tension.
Mud or dirt in pump.	Disassemble and clean the pump. Clean the entire system and refill with fresh fluid.
Fluid too viscous.	Consult the manufacturer's recommendations and refill with appropriate fluid.
Improperly adjusted flow regulator (variable flow pump)	Adjust following manufacturer's specifications.
Broken or worn parts inside pump.	Correct the causes of damage. Repair or replace the parts following the manufacturer's specifications.

LOW PRESSURE

Possible cause	*Correction*
Pump does not deliver fluid.	Refer to corrections in section 1.
Vanes seized in groove.	Check for burrs or metallic particles which seize vane in the groove. Clean, repair or change the rotor and stator.
Broken pump valve or piston seized in open position allowing the fluid to flow to the return section.	Disassemble the pump, find the cause and correct it. Repair following the manufacturer's specifications.

LOW OR FLUCTUATING PRESSURE

Possible cause	*Correction*
Seized parts.	Disassemble the pump following the technical manual. Check for burrs or metalic particles in the liquid. Clean the whole system if foreign matter is found.
Excess clearance between the parts of the pump.	Disassemble and repair the pump. If wear is not normal, find the cause.
Pump slow.	Speed up as specified.

PUMP NOISY

Possible cause	*Correction*
Inlet tubing flattened or partially obstructed.	Clean and repair.
Air entering through fluid intake.	Repair or ensure that the intake pipe is below the fluid level.
Low fluid level.	Fill up with the appropriate fluid.
Air in system.	Find and correct the leaks. Bleed system.
High viscosity.	Refill with fluid of the recommended density.
Seized parts of the pump.	Search for foreign matter in the fluid or burrs on the parts of the pump. Clean and refill the system if found dirty. Repair or change parts following the manufacturer's specifications.
Worn or broken parts.	Check and correct the cause of failure. Repair or change the damaged parts.

EXCESSIVE WEAR

Possible cause	*Correction*
Abrasives or sediments in	Search for the cause.

the liquid.	Install or change the filter. Repair or change the worn out parts following the manufacturer's specifications. Change the liquid.
High or low lubricant viscosity.	Change the fluid for one with the recommended characteristics.
Pump with too high working pressure.	Check the pressure discharge limiting valve or relief valve.
Air entry or choking which produces vibrations.	Correct the cause. Check the wear of the parts. Change those which are worn.
Misaligned pump shaft.	Check, correct or change the shaft.

EXCESSIVE LOSS OF FLUID

Possible cause	*Correction*
Defective seals and gaskets.	Check and change. Ensure that the fluid does not attack the gaskets and seals. Use the fluid recommended by the manufacturer.

BREAKING INTERNAL PARTS

Possible cause	*Correction*
Excessive work pressure.	Find the cause of improper working. Repair following the manufacturer's specifications.

Seizure because of lack of fluid.	Check the level of the liquid in the reservoir, the permeability of the suction tube and the liquid filter tube.
Abrasives which are not retained in the filter.	Check the liquid filter.

These mechanical elements of a hydraulic system distribute and regulate the flow and pressure of the fluid. Valves are used for different operations.

TYPES

The valves of a hydraulic system can be grouped according to their function:

- *distribution valves.* Lead or guide the fluid through different circuits of the hydraulic system.
- *flow-regulating valves.* They determine or measure the quantity of fluid which goes through a circuit or part of a given system.
- *pressure-regulating valves.* They regulate the pressure of the fluid in the system. They also limit or reduce pressure in a given circuit of the system.

DISTRIBUTION VALVES

There are different types of mechanical devices which distribute or direct the hydraulic liquid of a system through different circuits. Among those used are:

- *the spool valves, and*
- *the rotary valves.*

Spool valves. These consist of a piston. When this piston moves inside a body through which different circuits pass, it closes or opens ports or holes. Closed ports avoid communication between circuits. Open ports allow communication between them.

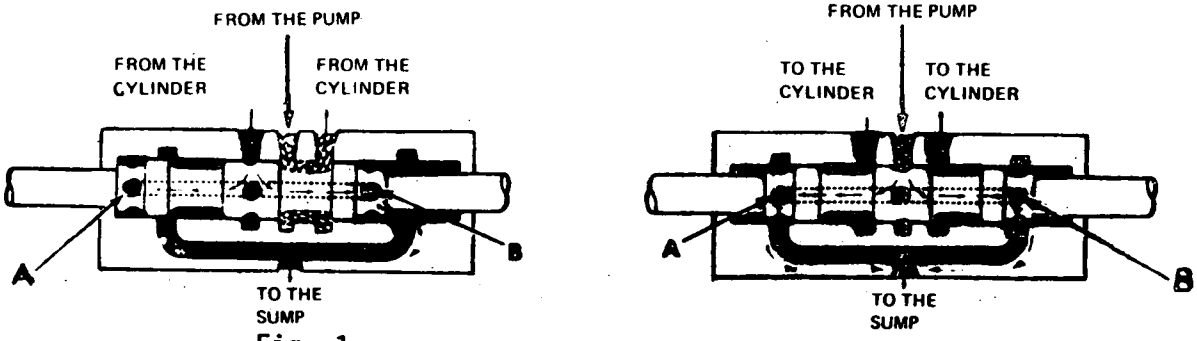


Fig. 1

The piston distributes the fluid through one circuit or another when the fluid follows a longitudinal path. This distribution valve is called the control valve and allows control of different units in the hydraulic system.

The parts, piston and body are built with great precision. Surfaces are finely polished to avoid leaks of fluid. A single piston valve is able to control two, four or six different circuits.

Rotary valves. These consist of a body and an interior rotor. Through the body different circuits pass. The rotor has an excellent mechanical adjustment. When the rotor is turned it opens and closes ports and holes. Open ports allow communication between the circuits. Closed ports avoid communication between them.

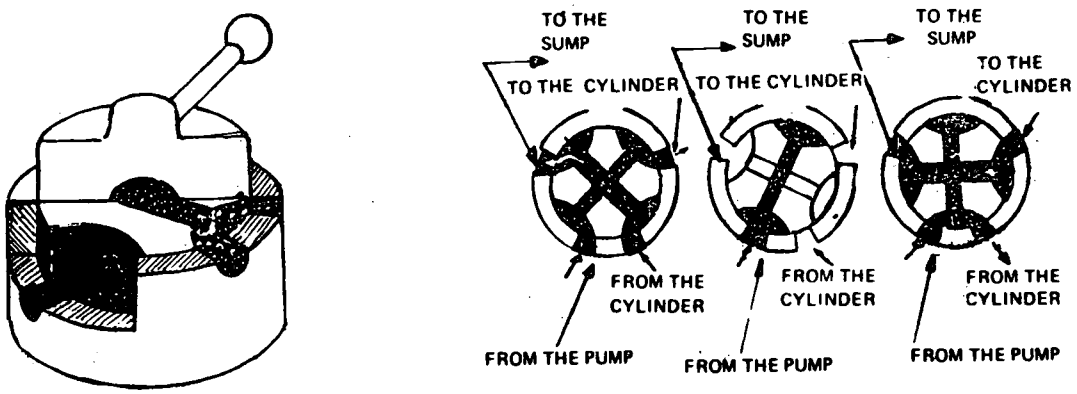


Fig. 2

Rotary valves are used to drive or control the different units of the hydraulic system. For example, lifting the complete hydraulic system or activating remote control cylinders.

A single rotary valve is capable of controlling, two, three or four different circuits.

FLOW REGULATING VALVES

These control and/or modify the amount of hydraulic fluid which reaches a circuit or part of it in a given time. The amount of fluid is generally expressed in gallons or quarts per minute.

To regulate the flow throttle or partially block the outflow of fluid. Flow can also be regulated by diverting the excess fluid to the crankcase or reservoir.

This type of valve can either be balanced or unbalanced. The balanced valves keep a constant flow at the valve's outlet regardless of fluid pressure. If the pressure increases in them the outlet partially closes to maintain the same delivery flow.

The unbalanced flow-regulating valves modify the delivered flow if the pressure of the system varies. The valves which divert part of the fluid towards the crankcase to regulate the flow are balanced. If the pressure increases, a spring is compressed and greater flow of the liquid goes towards the tank. This way the flow remains constant.

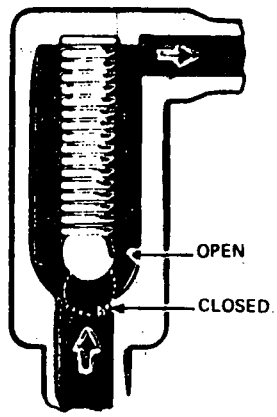


Fig. 3

PRESSURE REGULATING VALVES

These limit or reduce the pressure of the liquid in a system or curcuit. They are used for different purposes and can be grouped thus:

- *relief valves.*
- *reducers.*
- *discharge valves.*

Relief valves are usually installed at the outlet of the hydraulic pump. When the pressure reaches a given level for the system, the valve overcomes the force of the spring and opens. Through the open valve the excess fluid is discharged into the crankcase.

Reducers are used to reduce the pressure within a given circuit. A spring balances the pressure in the circuit. If this pressure exceeds the force of the spring, the passage of the liquid is blocked The force of the spring can be modified with an adjusting screw (Fig. 4). This adjustment modifies the pressure of the given circuit.

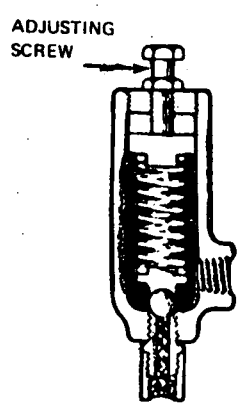


Fig. 4

Discharge valves protect hydraulic systems or parts of them from excessive pressure and/or flow.

In cases of increased pressure or flow the valve opens. When open it diverts the excess flow until it falls to normal limits to which the valves have been adjusted.

The following table will help to correct some of the failures in hydraulic valves.

PRESSURE REGULATING VALVE NOT FUNCTIONING (NO PRESSURE IN THE CIRCUIT)

Possible Cause	*Correction*
Improper adjustment of valve.	Adjust according to manufacturer's specifications.
Particles of dirt preventing valve from closing properly.	Wash and clean the system. Change fluid.
Worn or deteriorated cones or seats.	Rectify or change seats and balls.
Piston seizes in valve body.	Clean system. Change fluid as recommended. Test temperature of fluid.
Weak spring.	Change it.
Ends of spring in bad condition.	Change spring.
Body or seat of valve in bad condition.	Change body or rectify both.
Clogged compensating passage.	Clean system and change lubricant.

NOISY PRESSURE REGULATING VALVE

Possible cause	*Correction*
Fluid too viscous or cold.	Change it according to the manufacturer's specification.

Defective cone or seats.	Rectify or change cone and/or seats.
Excessive return pressure.	Adjust valve according to manufacturer's specification.
Opening adjustment too near to other circuit.	Adjust the valve according to manufacturer's specifications.

IRREGULAR PRESSURE DUE TO DISTRIBUTION VALVES

Possible cause	*Correction*
Dirt in the fluid.	Wash system. Change fluid.
Worn cone or seats.	Rectify or change.
Clogged compensating passage.	Clean system. Open passage.
Piston seized in body of valve.	Clean system. Change fluid as recommended. Check fluid temperature.
Return reservoir tubing clogged.	Open and wash.
Plane cf spring ends not normal to "axis".	Change.
Wrong spring.	Change.
Worn spring.	Change.
Improperly adjusted valve.	Adjust according to manufacturer's specification.

Wear of cylinder.	Change the valve.
Loose connections between tubing and valve case.	Check and tighten connections.
Leaks in valve seat.	Rectify or change seats.
Defective check valve spring.	Change spring.

INCOMPLETE OR DEFECTIVE FLUID DISTRIBUTION (REGULATING VLAVES)

Possible cause	*Correction*
Control rods with play or seized.	Clean the rod and change the bushing.
Defective or off-centre spring.	Center or change spring.
Distribution piston not running full course.	Adjust piston run.
Broken block spring.	Change.

FLOW VARIES (FLOW REGULATING VALVE)

Possible cause	*Correction*
Seized piston in the body of valve.	Clean the system. Change fluid as recommended. Check fluid temperature.
Fluid too viscous.	Change as recommended.
Dirt in fluid.	Wash the system and change fluid as recommended.

Worn cone or valve seats.	Rectify or change.
Improperly adjusted valve.	Adjust according to manufacturer's specification.
Short piston run.	Clean and wash system or change valve.
Clogged passages or ducts.	Clean and wash system.
Deformed valve piston.	Change.
Fluid too hot.	Change it for the recommended fluid.

CBC

TECHNOLOGICAL INFORMATION
HYDRAULIC CYLINDERS

These elements of a hydraulic system transform the hydraulic flow into mechanical power.
They are used for agricultural and industrial works such as lifting and lowering platforms and regulating and adjusting implements and machines while moving.

TYPES OF CYLINDERS

According to their mechanical action, cylinders may be divided into single acting and double acting cylinders.

SINGLE ACTING (Fig. 1)

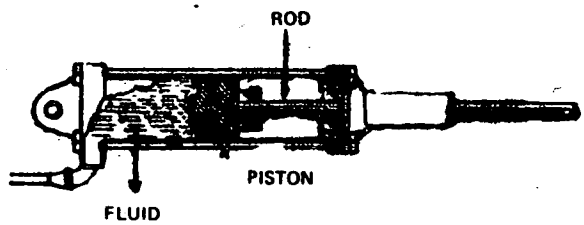


Fig. 1

OPERATION

In this cylinder the fluid reaches and leaves the reservoir through the same passage. The fluid delivered by the pump pushes the piston in one direction. When the operator opens the retaining valve, the weight of the load pushes the piston back to its place, and drains the fluid from the cylinder.

DOUBLE ACTING (Fig. 2).

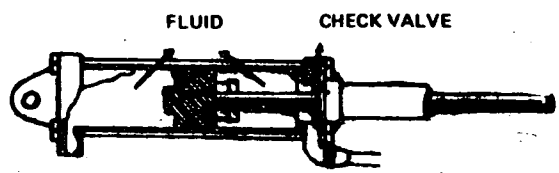


Fig. 2

OPERATION

In this cylinder the fluid enters alternately through each end of the cylinder. This alternate flow provides the forward or backward movement of the piston.

CBC

TECHNOLOGICAL INFORMATION
HYDRAULIC CYLINDERS
(Diagnosis of failures)

The following table will help to diagnose and correct some failures in hydraulic cylinders.

EXTERNAL LEAKS

Possible cause	*Correction*
Loose cylinder cover.	Tighten the bolts following technical specifications.
Damaged gaskets.	Change the gaskets.
Damaged or improperly installed piston rod seals.	Reinstall or change the seals.
Scoring or burrs on the rod.	Rectify the piston rod.
Misaligned piston rod.	Align or change piston rod.

INTERNAL LEAKS

Possible cause	*Correction*
Worn seals.	Change the seals.
Worn cylinder walls.	Rectify or change the parts.

CYLINDER DOES NOT SUSTAIN LOAD

Possible cause	*Correction*
Internal leaks.	See "Internal Leaks" section above.
Leaks because of wear or dirt in the distribution valve.	Clean and/or change the distribution valve.

VERY SLOW OPERATION

Possible cause	*Correction*
Air in the cylinder.	Bleed the cylinder.
Internal leaks.	See "Internal Leaks" section above.
Very viscous fluid.	Change the fluid to the one indicated in the manufacturer's manual.
Damaged system parts.	Check the hydraulic system.

LOOSE CYLINDER JOINTS

Possible cause	*Correction*
Loose or worn bolts or pins.	Tighten or change the bolts and pins.