INSTRUCTIONS for LINDE
TRADE MARK
CM-15-18 & CM-15-36
OXY-ACETYLENE
SHAPE-CUTTING MACHINES

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Be sure this information reaches the operator. You can get extra copies through your supplier.
NOTE: Drive unit maintenance instructions covering those CM-15-18 and CM-15-36 Cutting Machines using an automatic tracer or a photocell tracer instead of a Line and Strip Templet Tracer will be found in either Form 5437, "Operating and Maintenance Instructions for the OXWELD Automatic Tracer," or Form 922, "Instructions and Parts List for the LINDE Photocell Tracer." The portions of this booklet which do not refer to the drive unit and tracer assembly are equally applicable to all CM-15-18 and CM-15-36 machines.

Introduction

In the instructions to follow it is assumed that the torch and nozzle are being operated in accordance with the instructions and tables supplied with the torch. For this reason the adjustments given pertain only to the mechanical operation of the machine. Before looking for mechanical causes of unsatisfactory cuts, make certain that the instructions for the torch and nozzle are being carefully followed.

To expedite locating worn, broken, or misadjusted parts that may be causing the machine to operate improperly, an operating check list and adjustment guide is provided.

I. Preliminary Checks

Most malfunctions manifest themselves in faulty cuts by interrupting the smooth travel of the machine. To help isolate the trouble there are two simple preliminary checks which can be made:

A. Lock the tracer assembly in the raised position.
   Lock the transverse arms in position by means of the lock on the carriage body. Move the machine slowly back and forth on the rails by hand. Note: Some stiffness will result from the tracer being in the raised position, but this is a normal condition and should not be confused with erratic or jumpy movement. If the carriage does not move uniformly, the trouble is probably in the alignment or surface condition of the wheels and rails. Hose drag is another possibility.

B. Unlock the transverse arms. Holding the machine carriage in position, swing the transverse arm group slowly from side to side, to detect any unevenness in its motion. If the motion is not smooth and steady, examine the transverse arm bearings.

If the above tests do not reveal the trouble, it is probable that the drive unit assembly is at fault.

To test the machine's circle-cutting accuracy, without actually making a cut, attach a stylus to the blowpipe and make a trace on a sheet of paper. If a stylus is not available, insert a pointed piece of pencil lead in the cutting oxygen orifice of the nozzle. Open the cutting oxygen valve to provide pressure behind the lead, then proceed to make the trace.

Before cutting shapes requiring close tolerances, make a test cut. This will enable you to make sure that the correct kerf allowance has been made, and that the machine, torch and nozzle are operating at top efficiency.

II. Operating Check List and Adjustment Guide

A. If Machine Travel Is Jumpy:

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Table rail surfaces may be dirty.</td>
<td>1. Clean as instructed in Periodic Servicing Schedule (last page in Operating Instruction book).</td>
</tr>
<tr>
<td>2. Carriage wheels may be dirty.</td>
<td>2. Clean as instructed in Periodic Servicing Schedule (last page in Operating Instruction book).</td>
</tr>
<tr>
<td>4. Governor contacts may be dirty or worn.</td>
<td>4. Replace contacts.</td>
</tr>
<tr>
<td>5. Travel of machine is jumpy only at low speeds.</td>
<td>5. Adjustable resistor may be incorrectly set. See Page 13.</td>
</tr>
<tr>
<td>6. Wheels or rollers do not turn freely and smoothly.</td>
<td>6. Replace wheel bearings or rollers.</td>
</tr>
<tr>
<td>7. Carriage wheels may be pitted, nicked, loose, eccentric, or wobbly.</td>
<td>7. Tighten or replace.</td>
</tr>
<tr>
<td>8. Rail surfaces may be nicked, or have worn sections.</td>
<td>8. Redress or replace rails.</td>
</tr>
<tr>
<td>9. Rails may be misaligned.</td>
<td>9. Although the rail sections are perfectly straight and level when installed, settling of the foundation, distortion due to heat or cold, or movement of the supports may result in misalignment. Shimming or repositioning the supports may be necessary. Check alignment of rails.</td>
</tr>
<tr>
<td>Tracer wheel teeth may be worn.</td>
<td>10. Replace tracer wheel.</td>
</tr>
<tr>
<td>Hose may be hose drag.</td>
<td>11. Relocate hose, or support it.</td>
</tr>
<tr>
<td>Drive assembly mounting bracket may be (CM-15-36 only).</td>
<td>12. Tighten mounting bolts securely.</td>
</tr>
</tbody>
</table>

(Continued on next page.)
A. If Machine Travel Is Jumpy:

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>13. Drive barrel has too much side play.</td>
<td>13. Adjust the bearing lock rings on the lower end of the drive barrel sleeve to hold the sleeve bearings as firmly as is consistent with smooth, free, rotation of the drive head. Replace worn or defective sleeve bearings, drive barrel sleeve, or drive barrel.</td>
</tr>
<tr>
<td>14. Transverse arm bearing shafts may be bent.</td>
<td>14. Straighten or replace.</td>
</tr>
<tr>
<td>15. Drive unit rotational lock screw may not be loosened.</td>
<td>15. Loosen.</td>
</tr>
<tr>
<td>16. Stop plunger may not be released.</td>
<td>16. Withdraw plunger knob and turn knob to hold it in the withdrawn position.</td>
</tr>
<tr>
<td>17. Templet may have wide sections or may have irregularities along sides.</td>
<td>17. Check width with templet gauge. File sides to smooth contour.</td>
</tr>
<tr>
<td>18. Drive barrel may stick in sleeve so that tracing wheel does not float freely up and down.</td>
<td>18. Clean high spots or burrs from the drive barrel. See that stop plunger disengages completely.</td>
</tr>
</tbody>
</table>

B. If Line of Cut Is Uneven:

Check possible causes under II, A, Items 7 through 18.

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Line tracer wheel may be sideslipping.</td>
<td>1. Check carriage travel and Transverse Arm Assembly for sluggishness. Replace tracing wheel if teeth are worn.</td>
</tr>
<tr>
<td>2. Templet strips may be worn, nicked, or otherwise in bad condition.</td>
<td>2. Replace templet strip.</td>
</tr>
<tr>
<td>3. Templet may have wide sections or may have irregularities along sides.</td>
<td>3. Check width with templet gauge. File sides to smooth contour.</td>
</tr>
<tr>
<td>4. Rollers may be loose, worn, or damaged.</td>
<td>4. Tighten studs, or replace.</td>
</tr>
<tr>
<td>5. Roller stud may be bent.</td>
<td>5. Straighten or replace studs.</td>
</tr>
<tr>
<td>6. Guide wheels or rollers may not be maintaining constant, firm, rolling contact on the guide rail (V-rail on the CM-15-36 machine).</td>
<td>6. Adjust the eccentric wheel of the CM-15-18 machine. See Section III, H. Level the rails to bring all rollers into contact.</td>
</tr>
</tbody>
</table>

C. If a True Shape Cannot Be Traced with Templet Tracer Assembly:

Check possible causes under II, A, Items 7 through 18, and under II, B, Items 2 through 5.

D. If a True Circle Cannot Be Traced with Circle-Cutting Attachment:

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Tracer wheel shaft may be loose.</td>
<td>1. Tighten setscrews.</td>
</tr>
<tr>
<td>2. Tracer wheel may have side play.</td>
<td>2. Shim at bevel gear hub.</td>
</tr>
<tr>
<td>3. Center swivel attachment may be incorrectly adjusted.</td>
<td>3. See Operating Instructions.</td>
</tr>
<tr>
<td>4. Radius bar may be loose.</td>
<td>4. Tighten clamping screw.</td>
</tr>
<tr>
<td>5. V-wheels may be loose, eccentric, or wobbly. (CM-15-18)</td>
<td>5. Tighten nut or replace wheel.</td>
</tr>
<tr>
<td>6. Plain wheels may be eccentric. (CM-15-18)</td>
<td>6. Replace wheel and bearing assembly.</td>
</tr>
<tr>
<td>7. Rails may be misaligned.</td>
<td>7. Although the rail sections are perfectly straight and level when installed, settling of the foundation, distortion due to heat or cold, or movement of the supports by being struck by cranes or work may result in misalignment. Shimming or repositioning the supports may be necessary. Check alignment of rails.</td>
</tr>
</tbody>
</table>

(Continued on next page.)
### E. If Torch Motion Stops When Using Circle-Cutting Attachment or Hand-Tracing a Shape:

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. There may be hard surface spots on which the tracer assembly is operating.</td>
<td>1. Remove hard spots by scraping or filing.</td>
</tr>
<tr>
<td>2. Tracer wheel teeth may be worn.</td>
<td>2. Replace tracer wheel.</td>
</tr>
<tr>
<td>3. Tension on tracer assembly may not be sufficient, causing tracer wheel to slip.</td>
<td>3. Replace spring.</td>
</tr>
<tr>
<td>4. Drive barrel assembly may stick in sleeve, so that tracer wheel does not float freely up and down.</td>
<td>4. Clean high spots or burrs from barrel. See that stop plunger disengages completely.</td>
</tr>
<tr>
<td>5. Governor contacts may be pitted or worn.</td>
<td>5. Replace contacts.</td>
</tr>
<tr>
<td>6. Motor may be damaged.</td>
<td>6. Repair or replace motor.</td>
</tr>
<tr>
<td>7. There may be hose drag.</td>
<td>7. Relocate hose or support it.</td>
</tr>
<tr>
<td>8. Rails may be misaligned.</td>
<td>8. Although the rail sections are perfectly straight and level when installed, settling of the foundation, distortion due to heat or cold, or movement of the supports by being struck by cranes or work may result in misalignment. Shimming or repositioning supports may be necessary. Check alignment of rails.</td>
</tr>
<tr>
<td>9. Drive unit lock screw may not be released.</td>
<td>9. Loosen.</td>
</tr>
<tr>
<td>10. Stop plunger may not be released.</td>
<td>10. Withdraw plunger knob and turn knob to hold it in the withdrawn position.</td>
</tr>
</tbody>
</table>

### F. If Torch Motion Stops When Using Templet Assembly:

Check possible causes under II, E, Items 5 through 10.

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Templet strips may be worn, nicked, or otherwise in bad condition.</td>
<td>1. Replace strip.</td>
</tr>
<tr>
<td>2. Templet may have wide sections, or may have irregularities along sides.</td>
<td>2. Check width with templet gauge. File sides to smooth contour.</td>
</tr>
<tr>
<td>3. Rollers may be loose, worn, or damaged.</td>
<td>3. Replace or tighten studs.</td>
</tr>
<tr>
<td>4. Templet tracer assembly may stick in sleeve.</td>
<td>4. This may be due to weakness of traction spring, which must then be replaced. High spots or nicks must be removed by draw filing.</td>
</tr>
<tr>
<td>5. The templet strip may have too small a radius or the strip may be too low.</td>
<td>5. Make new templet.</td>
</tr>
</tbody>
</table>

### G. If Motor Does Not Run:

Make sure that there is power to the switch.

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Electric leads may be unserviceable or connections may be loose.</td>
<td>1. Check power supply and electric leads.</td>
</tr>
<tr>
<td>2. Motor brushes may be worn or broken.</td>
<td>2. Replace.</td>
</tr>
<tr>
<td>3. Motor commutator may be dirty.</td>
<td>3. Clean.</td>
</tr>
<tr>
<td>4. Governor contacts may be pitted or worn.</td>
<td>4. Replace.</td>
</tr>
<tr>
<td>5. Motor may be damaged or burned out.</td>
<td>5. Repair or replace motor.</td>
</tr>
</tbody>
</table>

### H. If High Speeds Cannot Be Obtained:

<table>
<thead>
<tr>
<th>POSSIBLE CAUSES</th>
<th>ADJUSTMENTS AND REFERENCES</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The control dial may be incorrectly set.</td>
<td>1. See Section III, A, 4.</td>
</tr>
<tr>
<td>2. Adjustment may be incorrectly set.</td>
<td>2. Adjustment for high speed operation (see p. 13).</td>
</tr>
<tr>
<td>3. Governor contacts may be pitted or worn.</td>
<td>3. Replace.</td>
</tr>
<tr>
<td>4. Motor brushes may be worn or broken.</td>
<td>4. Replace.</td>
</tr>
<tr>
<td>5. Motor commutator may be dirty.</td>
<td>5. Clean.</td>
</tr>
</tbody>
</table>

### I. If Preheat or Cutting Valves Do Not Work Properly:

See Section III, D.
III. Disassembly and Maintenance

A. Motor-Governor Gear Reduction Unit

Assembly:
1. TO TEST THE ELECTRICAL SYSTEM:

   Caution: Always disconnect the machine power cable from the power line while making adjustments or repairs to the electrical system.

In order to check the electrical system a test lamp will be required. This will consist of a 15-watt light bulb mounted in a portable socket. The socket leads must be insulated and should be about a foot long.

   It is not necessary to remove the motor assembly from the machine when testing the electrical system.
Prior to testing the system check the 115-volt A.C. power line for voltage by inserting the test lamp leads into the power receptacle.

Figures 1, 2, and 3 are schematic-wiring diagrams for the machines.

**TEST PROCEDURE**

(a) **General Inspection:**

1. Remove the screen which covers the resistor and terminal block on the side of the motor. (This screen is held by the round head machine screw at its center.) Do not lose the fibre insulating spacer on the retaining screw.

2. Remove the cover plate from the end of the governor by withdrawing the round head screws which secure it.

3. Remove the governor top cover by withdrawing the two screws which hold it to the housing.

4. Lift off the control dial.

5. Examine the electrical system for obvious faults such as broken wires, loose connections, burnt resistors. Examine the wires closely for worn or broken insulation—possible locations for a short or open circuit. Inspect the inside of governor for loose connections, short circuit, burnt or pitted contacts. Check the governor yoke and cup to see that it swings freely on its pivots.

**Caution:** Do not attempt to adjust the yoke and cup bearings to eliminate end play. Drawing these jewel bearings up snug is liable to crack them. However, end play should not be excessive. If adjustment appears to be necessary, refer to Section III, A, 3-j, for the correct procedure to be followed.

Make sure the adjustable resistor is set correctly (see Page 13) for adjustment according to speed range.

(b) Connect the machine power cable to the 115-volt power line.

(c) Make sure that power is reaching the motor:

1. Turn the tracer lamp switch to the ON position. (This switch is located on top of the carriage chassis, near the fuse receptacles.) If the tracer lamp lights, this indicates that power is reaching the machine, and that the fuses are not blown. If the lamp fails to light, this indicates that there is trouble in the power supply, fuses, or machine wiring, or that the tracer lamp itself is burnt out.

2. Turn the motor control switch to the "on" position.

3. Rotate the governor speed adjusting screw (27W04) counter-clockwise until the governor contacts separate.

4. Touch the test lamp leads to terminals L1 and L2 (See Figure 4). The lamp should burn at full brilliance and should go out when the motor switch is turned off. If it does not, check the wiring at successive points back to the power line, to isolate the point of open circuit. Possible causes of trouble are: plugs or fuse not fully inserted, broken wiring, defective switch.
(d) To test the motor:

(1) Remove the machine power cable plug from the power outlet.

(2) Disconnect the lead (L1) that runs into the gear box (to the slip rings) and fasten it to terminal 2.

(3) Replace the plug in the power outlet and turn on the motor switch. The motor should now run at top speed. If it does not, the motor should be examined and repaired or replaced.

(4) Disconnect the machine power cable and replace the lead to terminal L1.

(e) To test the 50 ohm adjustable resistor:

Follow steps C(1), C(2), and C(3), on page 6. Then test the resistor by touching the test lamp leads to terminals 1 and L2. If the wiring checked in step C(4) on page 6 is in good order the lamp should light but will be slightly less bright than in step C(4). If it does not light this will indicate that the resistor (or its lead wires) is defective and should be replaced.

(f) To test the 600 ohm resistor:

(1) Disconnect the machine power cable.

(2) Remove the motor lead and the jumper from one of the terminals marked 2 in Figure 4.

(3) Replace the machine power cable plug in the power outlet.

(4) Follow steps C(1), C(2), and C(3) on page 6.

(5) Touch one test lamp lead to terminal L2. Touch the other test lamp lead to terminal 2 (the one to which is connected a lead from the 600 ohm resistor). The lamp should light, but quite dimly. If it does not light the resistor is unserviceable and should be replaced.

(6) Disconnect the machine power cable and reconnect the leads to terminal 2.

(g) To test the condenser:

(1) Follow steps f(1), f(2), and f(3) above.

(2) Turn the motor switch to the ON position.

(3) Touch one test lamp lead to terminal L2, and the other to terminal 2 (the one to which a lead from the condenser is connected. If the lamp lights, the condenser is shorted and should be replaced.

After testing the electrical system check to make sure that the leads are correctly connected to the terminal block as shown in Figure 4. Leads and terminals should be pressed down to make sure that they do not short circuit against the cover screen when it is installed. Replace the cover screen with its mounting screw and fibre spacer.

2. TO DISASSEMBLE THE GEAR REDUCTION UNIT:

(a) Loosen the setscrew in the neck of the speedometer (Figure 5). Remove the speedometer, being careful not to lose the connecting key (Figure 5).
(b) Remove the three fillister head screws which hold the gear reduction unit to the motor housing (Figure 6).

(c) Remove the unit (Figure 7). If the unit does not dismount readily, tapping on several sides with a rawhide mallet will loosen the seal to permit removal. Do not lose the coupling block (shown in the figure).

(d) Unscrew and remove the countershaft thrust screw and the group of parts which lie underneath it, namely the gasket, pad, plates and ball (refer to Figure 8).

(e) Remove the grease which fills the gear unit housing.

(f) Drive out the pin which holds the worm gear and worm to the countershaft (Figure 9).

(g) Using a drift, drive out the countershaft through the opening from which the thrust screw was removed. The worm, worm gear and spacer will fall free and can be removed (Figure 10). When driving out shafts, take care not to burr or deform the bearings.

(h) Remove the extension shaft in the same manner, following steps d, e, and f.

(i) If bearings or oil retaining washers require replacement, carefully drive out the defective parts. The replacement part is then pressed into position.

(j) To reassemble the unit, follow the above steps in reverse order. Refer to Figure 11 for correct relationship of parts, particularly placement of gears and worms on the shafts. When reassembled repack the housing with ROYCO No. 8-A grease.

3. TO DISASSEMBLE THE GOVERNOR:

(a) Remove the front cover (27W16) by withdrawing the four screws which hold it on the governor housing (Figure 12).
(b) Remove the top cover (31W32) by withdrawing the two screws which hold it on the governor housing.

(c) Lift off the Control Dial Assembly (27W15) as in Figure 13.

(d) Remove the two fillister head screws which hold the contact spring block (45N87) as shown in Figure 14 and pull the collar forward until it hangs free.

(e) Remove the three round head screws which hold the Contact Unit Assembly (18V64) on the top of the governor housing, then lift the Contact Unit Assembly as in Figure 15. It cannot be removed completely since, as the figure shows, the two governor leads are attached to its terminals. As the assembly is lifted, the block and chains should be guided through the governor housing by hand to avoid damage to the parts. The contacts may now be conveniently cleaned or dressed. For replacement of contacts see below.

(f) Make a note of the color (or number) of the wire which is attached to each terminal. Withdraw the two terminal screws. Detach the wires and remove the Contact Unit Assembly.

(g) To disassemble the Contact Unit Assembly remove the two long machine screws as shown in Figure 16. The individual contact springs, spacers and terminals will then separate. The contacts may now be unscrewed and replaced if required (see Figure 24). (Contacts should always be replaced in pairs.)

(h) Remove the three small screws which hold the spider (25W03) in the governor housing. Remove the spider (See Figure 17).
(i) The yoke and cup (13V35) which is mounted in the spider is removed by first loosening the small round head screw (Figure 18) which holds the large pivot bearing (13V22). Then unscrew both bearings (13V21 and 13V22) from the yoke. Loosen the round head set screw in the spider. Remove the bearing shaft (26W52). Then lift out the spider. The disassembled parts are shown in Figure 19.

(j) To reassemble the yoke and cup in the spider follow the procedure in step i in reverse.

The small pivot bearing (which fits into the open end of the cup) screws in tight against a shoulder. Adjustment of engagement of the pivot bearings is made by screwing in on the large pivot bearing. After reassembly try
FIG. 16 – Disassembling Contact Unit Assembly

the spider and cup assembly for free pivoting of the cup on its bearing without excessive end play. It is not practicable to eliminate end play all together. If readjustment of the bearings is necessary, adjust for a barely perceptible amount of end play by turning the slotted end of the bearing in the outer end of the cup yoke. Make this adjustment carefully, trying the end play frequently as the position of the bearing is changed. Care must be taken not to draw the bearings up snug as this might crack the jewels or blunt the pivot points. There is a setscrew on the lower side of the cup yoke opposite the contact lever arm which must be loosened before the bearings can be adjusted. Tighten this setscrew after adjustment is completed. There must be clearance between the back of the cup and the face of the spider. This clearance must not exceed 1/32 of an inch. If adequate clearance is not present or if the clearance is excessive, loosen the round head setscrew at the top of the bracket in the center of the spider. Place a 1/32-in. shim between the back of the cup and the face of the spider and, holding the cup and spider against the shim, tighten the setscrew. Then remove the shim.

(k) Remove the screw plug (26W80) from the side of the governor housing (See Figure 20). Looking into the hole, rotate the magnet (26W84) until the magnet setscrew (81W33) on the magnet hub lines up with the hole. Loosen, but

FIG. 17 – Withdrawing Spider

FIG. 18 – Loosening Bearing Setscrew

FIG. 19 – Disassembled Spider Group
FIG. 20 - Loosening Magnet Setscrew

do not remove, the setscrew. The magnet
can then be removed by inserting a screw-
driver through the plug opening and prying
against the magnet hub (Figure 21). Do not
pry against the magnet itself.

(1) After removal of the magnet you will see four
fillister head screws in the back of the gov-
ernor housing. Withdrawing these screws
will remove the governor housing from the
motor.

(m) To reassemble the governor, follow the pro-
cedure in steps a through 1 in the reverse
order, noting the following:

(1) To reassemble the magnet in the governor,
rotate the armature shaft until the flat
surface on the shaft is opposite the hous-
ing plug opening. Be sure the magnet spacer
is in place on the shaft. The magnet should
then be inserted so that the hub extends
inward and the setscrew is in line with the

FIG. 21 - Prying Magnet Off Armature Shaft

FIG. 22 - Exploded View of Contact Unit Assembly

flat surface on the shaft. Next, remove the
fillister head screw in the end of the gear
reduction unit and insert a screwdriver
until it bears against the end of the arma-
ture shaft within the gear unit housing.
Holding the screwdriver firmly against
the end of the armature shaft with the right

FIG. 23 - Speed Range Adjustment
hand, press the magnet on to the shaft with the left hand as far as it will go, then tighten the magnet setscrew. This operation will take up residual end play in the armature shaft.

(2) When inserting the spider assembly the flat surface on the spider frame should be at the top and the finished face should be seated evenly in the bore of the governor housing.

(3) As an aid in reassembly of the Contact Unit Assembly, Figure 22 shows an exploded view of the assembly. Be sure the contact chain is free of kinks.

4. ADJUSTMENT FOR SPEED RANGE:
(a) The adjustable resistor is the one farthest from the motor. Moving the resistor's movable contact towards the right increases the resistance in series with the motor. Movement towards the left decreases the resistance. For operation at predominantly low speeds, set the movable contact for maximum or near maximum resistance. For operation at predominantly high speeds, set the movable contact for minimum resistance. If operation will be at intermediate speeds generally, set the movable contact at about the center of the resistor.

After locating the movable contact in the desired position, tighten the clamping screw securely.

When once set to suit the general speed requirements of the machine, the resistor should need readjustment only if a change-over is made from extreme high speeds to extreme low speeds, or vice versa.

(b) When installing a new governor control dial assembly, the dial stop adjustment may be such that the dial cannot be rotated sufficiently to cover the full speed range. To adjust for correct coverage of the range, proceed as follows:
(c) Remove the governor top cover by withdrawing the two screws which hold it on the governor housing.
(d) Loosen but do not remove the two screws in the control dial cap (31W31) on the control dial.
(e) Hold the control dial with one hand to keep it from rotating and rotate the central portion of the dial (Part No. 13V34), as shown in Figure 23. This is the raised portion containing the ball bearing in its center. Rotation in a clockwise direction raises the speed range while counter-clockwise rotation lowers the range.

When properly adjusted, the machine speed can be varied from minimum to maximum over the entire graduated scale on the speedometer.

(f) After the correct adjustment is achieved, tighten the two screws in the control dial cap and replace the governor top cover.

(g) If the adjustment made in step (d) is not sufficient to permit the governor to cover the full speed range, further adjustment can be made by varying the length of the contact levers (Figure 14). To do this, loosen the setscrews holding the levers in place, and slide them in or out to get the required speed change. For a higher speed slide the levers out (away from the block). For a lower speed slide the levers in (toward the block). Tighten the setscrews and recheck the high speed range, then the low speed range. If further adjustment is necessary, slide the levers in or out as before.

5. TO INSTALL A NEW LOWER CONTACT OR CONTACT ASSEMBLY:
(a) Remove the old contact as shown in Figure 24. It is recommended that when a contact has to be replaced both the upper and lower contact be replaced at the same time.
(b) To replace the lower contact assembly, remove and disassemble the Contact Unit Assembly as explained in Section 3-g on page 9.
(c) Straighten the ends of the chain clamp (Part No. 26W55 - refer to View A of Figure 22) and remove the washer (26W67).
(d) Withdraw the clamp from the bushing (81W91).
(e) Insert the chain clamp through the hole in the new contact and spring assembly, while holding the eye of the chain clamp against the lower end of the bushing, place the washer (26W67) over the end of the clamp on top of the upper end of the bushing and spread the ends of the clamp.
(f) Reassemble the Contact Unit Assembly (refer to Figure 22 for correct order of parts).

6. TO INSTALL A NEW CONTACT CHAIN
(a) Detach the chain (81W40) from the lower contact and spring assembly as explained in Section 5 above.
(b) Loosen the setscrews on the contact spring block and remove the lever from the block (the exposed length of the lever should be measured and when replaced should be adjusted until this original length is attained).
(c) Cut off the flat end of the chain pin at the bottom of the lever and withdraw the chain pin.
(d) Cut the new chain to exactly the same length as the one removed (41 links).
(e) Insert a new chain pin through each end link of the new chain.
(f) Insert the chain pins in the levers.
(g) Press the head of the chain pin against the top of the lever and cut off the other end of the chain pin at approximately 1/16 in. below the bottom of the lever.
(h) Flatten the cut end of the chain pin so that it cannot be removed from the lever. The chain
pin should be free to move about 1/32-in. up or down in the lever.

(i) Replace the levers and setscrews in the contact spring block. Adjust the governor speed as described in section 4-g on page 13.

(j) Insert the clamp (26W55) through the center link of the chain then insert the clamp through the bushing (81W91) in the lower contact and spring assembly.

(k) Slip the washer (26W67) over the ends of the clamp on top of the upper end of the bushing and spread the ends of the clamp.

7. TO DISASSEMBLE THE MOTOR:

(a) Disconnect the machine power cable from the power line.

(b) Remove the gear reduction unit by withdrawing the three fillister head screws which hold it to the motor housing (Figure 6). If the unit does not lift off readily, tap on several sides with a rawhide mallet to loosen the seal.

(c) Remove the governor by disassembling as explained in Section 3 on page 8. It is not necessary to remove the governor housing from the motor.

(d) Remove the screen from the resistor case on the motor. This screen is held by a round head machine screw in its center.

(e) Disconnect the two power leads from the terminal strip. These leads are the two wires which enter the right-hand end of the resistor case.

(f) Withdraw the two round head brass machine screws which hold the resistor case to the motor housing (Figure 25). Lift off the resistor case. (The case will not be detached completely, since it is still connected, by wiring, to the motor.)

(g) Withdraw the four socket head cap screws which hold the motor base plate to the top of the drive unit (Figure 26). Lift off the motor assembly.

(h) Remove the locknut from the end of the motor shaft.

(i) Remove the worm from the shaft.

(j) Drive out the worm pin (Figure 27) and remove the washer from the shaft.

(k) Unscrew the two motor housing screws (See Figure 28).
(l) Withdraw the motor end housing (Figure 29).

(m) Unscrew the motor brush plugs and remove the brushes (Figure 30). When removing the brushes mark each one so that it can be returned to its original holder, in its original position.

(n) Remove the armature by tapping with a mallet or wooden stick on the extension shaft at the governor end of the armature (See Figure 31).

(o) Further disassembly of the motor is as shown in Figure 32.

8. MOTOR BRUSH AND COMMUTATOR MAINTENANCE

Examine the motor brushes. Make sure that each brush surface in contact with the commutator has the polished finish that indicates good contact.

This polish should cover essentially all of the contacting surface of the brush.

When reinserting a brush be sure to put it back in the same brush holder and in its original position. After insertion make sure that the brush moves freely up and down in the holder. The brush must have free movement for correct operation.

New brushes should be approximately ¾ of an inch long. When they have worn down to about 1/2-in. in length they should be replaced with new brushes.

Inspect the surface of the commutator. This surface should appear clean and smooth with a polished brown color where the brushes ride it. If the surface of the commutator appears to be rough, remove the armature from the motor. Polish the commutator surface with No. 00 sandpaper. When possible the armature should be rotated in a lathe for this operation.
CAUTION: Never use emery cloth or any emery stone for this polishing. Emery is a conductor of electricity, and any residual powder will short circuit the commutator segments during operation.

Brush replacement and commutator maintenance should be performed only by an experienced electrician.

B. Drive Unit Assembly:
1. Remove the line tracer unit as follows:
   (a) Pull out the Drive Barrel Stop Assembly and lower the tracer unit until it rests on the table.
   (b) Raise the leather boot on the drive barrel and remove the three screws which secure the line tracer (See Figure 33).
   (c) Raise the drive barrel, allowing the tracer unit to slip off the barrel.
   (d) Remove the leather boot by pulling downward.
2. Remove the Woodruff key from the side of the drive barrel.
3. Unscrew and remove the two bearing lock rings which hold the drive unit in its bracket (Figure 34).
4. Remove the speedometer from the gear reduction unit by loosening the setscrew in the neck of the speedometer. When pulling off the speedometer, be careful not to lose the drive key which connects it to the gear reduction unit (Figure 5).
5. Lift the drive unit out of its bracket. Be careful not to lose the two carbon brushes which project from the underside of the brush block (20V24). The upper and lower bearings remain in their places in the bracket. By exerting a slight pressure each bearing may be removed for inspection and replacement if necessary.
6. Withdraw the four fillister head screws which hold the cover on the gear box (Figure 35). The cover is keyed to the gear box by two dowel pins. Lift the cover evenly until these pins are cleared (Figure 36).

NOTE: The illustrations for this part of the procedure show the Motor-Governor-Gear Re-
11. To remove the brush block, unscrew the flat head screw which holds it to the gear box (Figure 41).

12. The wire leads can be disconnected by loosening the retaining setscrews (Figure 41).

13. To reassemble the Drive Unit Assembly, follow the above steps in reverse order.

When replacing the wires in the brush block, first remove the brush block. Then remove the setscrews from the brush block. This makes it easier to correctly and completely insert the wires in the brush block holes, by observation through the setscrew openings. Make certain that a good solid electrical connection is made. Then fasten the brush block in place on the gear box, using its flat-headed screw to secure it firmly.

When replacing the gear on the Drive Barrel Assembly the gear hub should face upward and the washer should be placed on the shaft before the gear is installed. If a new drive barrel shaft is to be installed, it must be spot-drilled to accommodate the gear setscrew. Also, make certain that the carbon brushes are fully seated in the brush block before installing the drive unit in its bracket.

7. To remove the pinion and shaft from the cover, drive out the pin which holds the coupling to the top of the pinion shaft (Figure 37). The pinion and shaft can then be withdrawn. Do not lose the washer which is mounted on the shaft below the pinion.

8. Pull forward on the stop assembly knob, then lift out the drive barrel assembly (Figure 38). Be careful not to lose the Woodruff key in the side of the drive barrel near its top (See Figure 39).

9. To disassemble the Drive Barrel Assembly:
   (a) Loosen the setscrew in the hub of the gear (Figure 39).
   (b) Withdraw the gear and the washer beneath it.
   (c) Remove the Woodruff key which keys the gear to its shaft.
   (d) Withdraw the shaft through the bottom of the drive barrel. Figure 40 shows the disassembled parts.

10. The drive barrel sleeve can be removed by withdrawing the four screws which hold it to the bracket.
C. Line Tracer Head:

1. Remove the tracer wheel guard (33W44) by withdrawing the two screws which hold it (Figure 42).

2. Remove the setscrews which hold the tracer wheel shaft (33W57). (See Figure 43.)

3. Withdraw the tracer wheel shaft. This will release the tracer wheel assembly and its washers, which can then be removed (Figure 44).

4. The wheel, gear, and hub are held together by three filler head screws. Removing these screws will permit separation of the parts.

5. Withdraw the two cap screws which hold the adaptor assembly in the tracer head (Figure 45). Then lift out the Assembly (Figure 46). Do not lose the Woodruff key which is in the side of the adaptor body (Figure 47).

6. Drive out the adaptor coupling pin (34W30).

7. Drive out the taper pin which secures the collar (34W31) to the pinion shaft (21W49), as shown in Figure 47.

8. Remove the collar and washer from the pinion shaft.

9. Withdraw the pinion through the bottom of the adaptor body.
FIG. 45 – Withdrawing Adaptor Assembly Screws

10. To reassemble the tracer head, follow the above steps in reverse order.

11. Screw on the upper locking ring tight enough to remove play in the unit, but not so tight as to prevent free rotation of the drive head.

12. Holding the first ring in position, screw on the second ring to lock it.

D. Valve Block Assembly

1. If a valve leaks around the valve stem, tighten the guide (also known as a packing nut). (To tighten the guide on the oxygen preheat section it is necessary to remove the Cutting Oxygen Valve Stem Assembly. This will provide access for the wrench.) If the tightening of the guide fails to stop the leak, replace the packing washers or the Valve Stem Assembly. If gas leaks through a valve when it is closed, inspect the valve seat to see if it is worn or marred and make replacement if necessary. Make sure that the valve seat and the interior of the valve body are clean.

FIG. 46 – Adaptor Assembly Removed

FIG. 47 – Driving Out Collar Pin

2. To Disassemble The Cutting Oxygen Valve:

(a) Place the valve handle in “open” position, then unscrew the Assembly from the Block (See Figure 48).

(b) Remove the lever (25Z22) by removing the pin clip (81W53), pin (38Z34) and washer (53Z64) (Figure 49).

(c) Remove the fiber washer from the valve stem.

(d) Remove the guide.

(e) Tap out the pin (38Z36). See Figure 50.

(f) Slip the bushing, lock ring, washers, and spring off the stem. Figure 51 shows the stem assembly partially disassembled. The order of the washers (reading from left to right is: 1 leather, 2 plastic, 1 leather, 1 metal and 1 plastic.

FIG. 48 – Cutting-Oxygen Valve Unscrewed
FIG. 49 – Partial Disassembly of Valve

(g) The valve seat (32Y07) can be removed by withdrawing the screw which holds it to the stem (Figure 51).

3. To Disassemble The Preheat Gas Valves:

(a) Remove the cutting oxygen valve as directed in Paragraph b above.

(b) Place the handle of the preheat gas valves in the "open" position. Then loosen the guides by unscrewing each one alternately a few turns at a time.

(c) Carefully withdraw the Valve Stem Assemblies from the block.

FIG. 51 – Valve Stem Group Disassembled

(d) Rotate the inserts (70Z07) and valve stems (33Z49) a quarter turn.

(e) Tap out the pins (38Z44) as shown in Figure 52, then lift off the lever (25Z30) and inserts.

(f) Remove the inserts from the lever, first making them so that each can be returned to its original location.

(g) Further disassembly of the Valve Stem Assemblies is as described in Section 2, steps c to g on page 20.

4. Reassembly of the valves can be accomplished by following the procedure of Sections 3 and 4, referring to Figure 51 for correct relationship to parts. Reassemble the preheat section before the cutting oxygen section.

NOTE: As originally assembled at the factory, the nuts on the inserts (70Z07) are so adjusted as to cause the acetylene valve to open slightly before the oxygen valve opens. It is possible to readjust the sequence of operation if it is desired to have the valves simultaneously, or in inverse order.

FIG. 50 – Driving Out Retaining Pin

FIG. 52 – Driving Out Preheat Valve Pins
E. PART 1 Torch Holder Assembly (CM-15-18 Machine Only)
NOTE: Two styles of torch holders have been used with this machine. Though their appearances differ, the disassembly procedure is the same for both. When ordering replacement parts, use the parts list supplied with your machine.

1. Drive out the taper pin which holds each knob to its pinion gear shaft (Figure 53).
2. Remove the knob. The pinion gear shaft can then be withdrawn (Figure 54).
3. The clamps can be removed from the bracket after removing the two retaining nuts (Figure 55).

E. PART 2 Torch Holder Assembly (CM-15-36 Machine Only)
NOTE: Two different torch holders are now in use with the CM-15-36 Machine. The latest holder is easily disassembled using standard procedures. The disassembly method for the early model (shown in following illustrations) is as follows:

1. Drive out the taper pin which holds the collar to the handwheel shaft (See Figure 56).
2. Remove the collar and withdraw the handwheel.
3. Loosen the setscrew shown in Figure 57.
4. Insert two 10-32 filler head screws in the tapped holes in the end bearing and lift out the bearing as shown.
5. Withdraw the pinion gear from the shaft. It may be necessary to tap the holder with a rawhide mallet to jar the gear off the shaft.
6. Remove the setscrew and unscrew the thrust plug indicated in Figure 56.
7. Remove the pin key and withdraw the gear shaft as shown in Figure 58. Note that the pin key has one square end and can therefore be removed in only one direction. Do not mistake it for a key riding in a Keyway.
In reassembling, the pin key must line up exactly square with the Keyway in the pinion gear (See Figure 58). This will permit the key to engage properly as the pinion gear is slipped on to the shaft. To remove the end play in the handwheel, place the proper thickness of shim washers on the shaft before replacing the shaft collar.

F. PART 1 Transverse Arm Assembly (CM-15-18 Machine Only)

1. Loosen the two clamping bolts which secure the torch mounting tube. Then withdraw the tube.

2. Remove the drive unit as explained in Section III B.

3. Remove the valve block by withdrawing the two screws which hold it on the top of the Transverse Arm.

4. If the Transverse Arm is to be moved away from the machine location, it will be necessary to disconnect the electric cable. This is done as follows: (Note: it is advisable to mark each wire as removed, as an aid in reassembly.)

(a) Remove the switch plate by withdrawing the four screws which hold it to the side of the Transverse Arm (Figure 59).

(b) Disconnect from the switch the wires which connect to the machine chassis (Figure 60).

(c) Disconnect the ground wire terminal. This terminal is adjacent to the switch.

(d) Carefully withdraw the cable and wiring from the Transverse Arm.

5. Unscrew the two dust caps which cover the pivot bearings.
6. Remove the locknuts and washers from the pivot shafts (Figure 61).

7. Two setscrews are used to hold each pivot shaft in place in the Transverse Arm. Loosen these setscrews, using a 1/8-inch hex wrench (Figure 62).

8. Using a mallet drive the pivot shafts out through the bottom of the Transverse Arm (Figure 63). The Arm can then be removed by pulling it forward.

9. The roller bearings can now be lifted out for examination.

10. To remove the pivot arms, unscrew the dust caps and retaining nuts. The arms can then be lifted off as shown in Figure 64.

11. To reassemble the Transverse Arm Assembly, follow the above steps in reverse order. Before tightening the setscrews (See Step 7), position the Transverse Arm so that there is a slight clearance at top and bottom of the joint between it and the pivot arm. There should be no friction between the two members when the assembly swings from side to side. When replacing the locknuts on the pivot shafts, care must be exercised to avoid damage to the roller bearings. The nuts should be tightened sufficiently to pro-

F. PART 2 Transverse Arm Assembly (CM-15-36 Machine Only)

1. Remove the Extension Arm Assembly by removing the four bolts which hold it to the Transverse Arm (Figure 65).

2. Remove the counterweight (or Extension Arm Assembly if used) from the opposite end of the Transverse Arm.

3. Remove the drive unit as explained in Section III.B.

4. Remove the valve block by withdrawing the two screws which hold it on the top of the Transverse Arm.

5. If the Transverse Arm is to be moved away from the machine, location, it will be necessary to disconnect the electric cable. This is done as follows: (Note: It is advisable to mark each wire as removed, as an aid in reassembly.)
FIG. 65 - Dismounting Extension Arm

(a) Remove the right hand switch plate by withdrawing the four screws which hold the plate to the side of the Transverse Arm.

(b) Disconnect the two power leads from the right-hand switch (Figure 66). These are the leads which enter the top of the Transverse Arm through the strain-relief bushing (Figure 67).

(c) Disconnect the ground wire terminal. This terminal is on the underside of the Transverse Arm, near the V-rail end.

(d) Unscrew the knurled ring on the strain-relief bushing. This is the bushing through which the electric cable enters the top of the Transverse Arm. (See Figure 67.)

(e) Carefully withdraw the cable and wiring from the Transverse Arm.

6. Unscrew the two conical dust caps which cover the pivot bearings.

7. Remove the locknuts and washers from the pivot shafts. (See Figure 68.)

FIG. 66 - Detaching Wiring from Switch

FIG. 67 - Releasing Strain-Relief Bushing

8. Support the Transverse Arm to relieve the weight on the pivot joints.

9. Two setscrews are used to hold each pivot shaft in place in the Transverse Arm. These setscrews are in turn held in position by lock screws. Remove the four lock screws, then loosen the four setscrews, using a 3/16-in. hex wrench (Figure 68).

10. Using a mallet drive the pivot shafts out through the bottom of the Transverse Arm (Figure 69). The Arm can then be removed by pulling it forward.

11. The four roller bearings can now be lifted out for examination.

12. To reassemble the Transverse Arm Assembly, follow the above steps in reverse order. See that the pivot shafts are turned so that the setscrews will seat on the flats on the shafts. Before tightening the setscrews (See Step 9), position the Transverse Arm so that there is a slight clearance at top and bottom of the joint, between it and the pivot arm. There should be no fric-
tion between the two members when the assembly swings from side to side.

When replacing the locknuts on the pivot shafts, care must be exercised to avoid damage to the roller bearings. The nuts should be tightened sufficiently to provide a firm joint, yet avoiding undue pressure on the bearings. The arms should swing smoothly, without detectable binding.

G. Pivot Arm Assembly

1. Remove the Transverse Arm Assembly as directed in Section F page 23 (or 24).
2. Unscrew the dust cap which covers the pivot joint.
3. Remove the locking nuts and washer from the pivot shaft.
4. The Pivot Arm can then be removed by lifting it upward off the shaft.
5. The roller bearings can now be lifted out of the arm for inspection.

FIG. 69 – Driving Out Pivot Shaft

FIG. 70 – Leveling Carriage

FIG. 71 – Removing Wheel Assembly Retaining Nut

6. The pivot shaft is held in position in the lower carriage by a hex nut and washer. Removing these from the underside of the carriage will permit the pivot shaft to be withdrawn.

7. To reassemble the Pivot Arm Assembly follow the above steps in the reverse order. When replacing the locking nuts on the pivot shaft (See Step 3) care must be exercised to avoid damage to the tapered roller bearings. The nuts should be tightened sufficiently to provide a firm joint, yet avoiding undue pressure on the bearings. The arms should swing smoothly without detectable binding.

H. PART 1 Wheel (or Roller Block) Assembly

(CM-15-18 Machine Only)

Three different wheel assemblies are used on the CM-15-18 machine. Assembly 20V09, the grooved wheel assembly, is used at front and rear on the right side of the machine. Assembly 20V07 is used at the left rear and assembly 20V10 is used at the
left front of the machine. 20V07 and 20V10 are flanged wheel assemblies.

Assembly 20V10 has an eccentric shaft with a slotted extension. Loosening the jam nut N-HJ-2 (Figure 70) allows the shaft to be rotated, using a screwdriver inserted in the slot. This arrangement permits repositioning this wheel so that all four wheels are in equal contact with the rails.

Four wheel contact prevents rocking of the carriage, provides smooth travel during operation.

Disassembly is as follows:

1. Remove the nut and washers which hold the wheel assembly to the carriage (Figure 71).

2. Carefully withdraw the wheel assembly. Each wheel assembly is pinned to the carriage by a dowel pin to maintain correct alignment. (See Figure 72.) The assembly must be pulled clear of this pin before it can be removed.

3. Remove the jam nut from the wheel shaft.

4. Drive out the wheel shaft.

5. The wheel is then free and can be removed.

6. To remove the wheel bearing, first remove the bearing retaining plate. This is done by withdrawing the four flat head screws which hold the plate on the wheel. The bearing can then be pressed out. A disassembled view is shown in Figure 73.

7. To replace the wheel assembly, follow the above steps in reverse order. After reassembly to the machine, readjust the eccentric shaft of wheel assembly 20V10 so that four-wheel contact with the rails is attained.

H. PART 2 Wheel (or Roller Block) Assembly
(CM-15-36 Machine Only)

The CM-15-36 has two V-roller blocks (1 front, 1 rear) on the right-hand side, and two flat-roller blocks on the left-hand side of the machine. To disassemble the V-roller block, proceed as follows:

1. Remove the cover:
   (a) Withdraw the cotter pin which retains the cover pivot pin.
   (b) Withdraw the cover pivot pin.

2. Remove the Roller Block Assembly by withdrawing the four socket head cap screws which hold it to the carriage (Figure 74). It will be necessary to pry the assembly off evenly since it is mounted on two dowel pins for correct alignment (Figure 75).

3. Drive out the taper pin which holds the wheel shaft in the block (Figure 76).

4. Drive out the wheel shaft. The wheel will then fall free (Figure 77).

5. Disassembly of the flat rail Roller Block Assembly is similar to the above except that the wheel shaft is held in place by a setscrew instead of a taper pin; this setscrew must be loosened to permit removal of the shaft.
6. To reassemble the Roller Block Assembly, follow the above steps in reverse order.

1. **Extension Arm Assembly (Used Only on CM-15-36 Machine)**
   
   **Note:** To remove the extension rack and bracket assembly in its entirety, see step 6 below.

   1. Remove the torch holder by loosening the clamping screw and sliding the holder off the bracket.
   2. Remove the torch holder bracket by loosening the locking screw and tapping the bracket out of the racking assembly.

   ![Figure 78 - Dismounting Extension Rack Adjusting Assembly](image)

   ![Figure 79 - Disassembly of Extension Arm](image)

   3. Remove the seven screws on the underside of the extension rack adjusting assembly.
   4. Loosen the lock screw and lift off the assembly as in Figure 78.
   5. The rack can now be withdrawn from the extension tube.
   6. To dismantle the assembly, drive out the taper pin which holds the collar on the handwheel shaft. Then withdraw the shaft.
   7. To Disassemble the Extension Arm Housing:
      
      (a) Remove the six screws which hold the cover to the housing. Lift off the cover (Figure 79).
      
      (b) The clamp plates can now be lifted off the extension tube and the extension tube removed.
      
      (c) Remove the screws from the underside of the side roller.
      
      (d) Carefully drive out the roller.
      
      (e) Remove the bottom roller by removing the setscrew indicated and driving out the shaft from the opposite end.

   In replacing the Extension Arm cover, the two clamp plates shown in the figure must fit over the lugs in the Extension Arm cover. If the cover does not fit down snugly, it may be that one of these plates has been inverted. When the plates are properly positioned the cover will fit tightly.