NOTE
This booklet covers CM-45 Machine Carriages, both Series 1 and Series 2, except where otherwise noted.

The Series 2 carriage differs from the Series 1 in the type of clutching action. On the Series 1 carriage, the drive gear itself is moved in and out of engagement with the output pinion on the motor shaft. On the Series 2 carriage, the drive gear remains in engagement with the output pinion and a sliding clutch gear is moved in and out of engagement with the drive gear. The differences between Series 1 and Series 2 carriages are shown in Figures 27 and 28.

CONTENTS

<table>
<thead>
<tr>
<th>PAGE</th>
<th>CONTENTS</th>
</tr>
</thead>
</table>
| 1    | I. GENERAL INFORMATION..
A. Description
B. Controls
C. Power-Drive
D. Equipment Mounting Setups
E. Heat Shield and Counter-weight |
| 2    | D. Bevel Cutting
E. Circle Cutting |
| 3    | IV. GENERAL MAINTENANCE
A. Lubrication
B. Testing the Electrical System
C. Adjusting the Speed Control Governor |
| 5    | V. DISASSEMBLY AND INSPECTION
A. Motor-Governor-Gear Reduction Assembly
B. Axle-Drive Gear-Wheel Assembly
C. Caster Wheel Assemblies |
| 7    | VI. TROUBLESHOOTER'S CHECK LIST |
| 9    | VII. REPLACEMENT PARTS |

Be sure this information reaches the operator. You can get extra copies through your supplier.
I. General Information

A. Description

The CM-45 Machine Carriage is designed for the controlled movement of equipment used in cutting, flame-treating and welding. It is compact and easily moved from one job to another, since it weighs only 38 pounds when fully equipped with torch and torch rigging. The torch rigging can be located for operation on either side of the carriage.

The carriage is ideally suited to the varied needs of the small metal-working operator, and for supplementing heavier equipment in the larger plants, shipyards, steel mills, etc.

The CM-45 is available in a standard model (01E19) which has a speed range of 4 to 32 inches per minute, and in a special low speed model (301134) which has a speed range of 2-1/4 to 17-1/2 inches per minute.

1. FOR STRAIGHT-LINE APPLICATIONS, the carriage can be operated either directly on the surface of the workpiece or upon a track. The track comes in six-foot lengths. It can be rested on the workpiece or upon a supporting structure alongside the working area. A vee-groove guides one set of carriage wheels during operation. Track edges are machined to accurate alignment with the track vee-groove. This permits the CM-45 to be quickly and easily set up for straight-line cutting by simply placing the track edge parallel to the desired line of cut. Track sections are provided with matching male and female ends to simplify the alignment of sections.

2. FOR CIRCLE-CUTTING, an 18-in. radius rod with a sliding pivot pin is attached to the front of the carriage and extends sideways from it. When the pivot pin is screwed down, it raises the wheels on one side of the carriage, and the machine automatically pivots around the pin. In this manner, the CM-45 will cut circles from 2 to 54 inches in diameter. If it is desired to cut larger circles, a longer radius rod can be readily made from standard bar stock.

3. FOR BEVEL CUTTING, the carriage can be operated upon the workpiece or on the track. Bevels can be made both in straight-line cutting and in circle-cutting. The torch rigging is provided with a scale for approximate setting of the desired bevel angles.

B. Controls (Fig. 1)

A three-position (FORWARD-OFF-REVERSE) motor control switch is located atop the rear end of the carriage on the left-hand side. The direction of carriage travel will be the same as the direction in which the motor control switch is moved. Center position of the switch is the "OFF" position. You may use the motor control switch both to control the direction of carriage movement, and for starting and stopping the machine.

Starting and stopping may also be controlled by use of the shift control levers. These are located at each end of the carriage on the right-hand side. When the position of the shift lever is toward the center of the machine, the clutch is DISENGAGED. When the position of the lever is away from the center, the clutch is ENGAGED.

A speed control dial with lettered settings (A to L) extends from the rear of the carriage. It is rotated in a clockwise direction to increase speed, and in a counter-clockwise direction to decrease speed.

C. Power Drive (Fig. 2)

The machine is powered by a 115-volt motor which operates on a 25- to 60-hertz a.c. power supply. Motor speed is controlled by a centrifugal-type governor.

The carriage is driven through a worm gear reduction unit. Drive force is transmitted to the front axle through the clutching action of two spur gears. These two gears are engaged and disengaged by use of the shift control lever. The clutch is spring loaded to hold it firmly in position when engaged.

The two front wheels of the machine are drive wheels and are knurled to prevent slipping. The left drive wheel is equipped with a friction spring which presses against its inner side, maintaining a light braking action against the rotation of the wheels. This action prevents uneven carriage movements due to back-lash in the gearing.

The terms LINDE and OXWELD are registered trade marks of Union Carbide Corporation.
The two rear wheels or casters are double-locked rigidly into position for straight-line operations by means of two pins located atop the rear end of the carriage and by two thumbscrews which bear against the caster shafts. By backing off the thumbscrews and lifting the pins, you may release the casters for free swiveling during circle cutting.

D. Equipment Mounting Setups

A threaded stud and cap nut are set upon a machined flat at the front of the carriage (Fig. 1) for mounting equipment upon the machine. This mounting accommodates:

1. TORCH RIGGING ASSEMBLY 16V90 - - This rigging is normally used for most CM-45 operations.

2. SPECIAL RACK - - The standard CM-45 Torch Rigging Assembly utilizes a 24-in. long Torch Rack (Part No. 45N43) and is designed to provide maximum utility for normal cutting operations while retaining reasonable compactness. For some uses, however, a shorter rigging rack may be desirable. A 15-in. long Rack (Part No. 45N32) is offered as an accessory.

3. TORCH RIGGING ON VERTICAL POST - - In applications where vertical adjustment of the CM-45 rigging is desired, the rigging may be mounted on a post as shown in Fig. 3-B. The post (Part No. 491620) slips over the mounting stud on top of the carriage. An adaptor rod fits inside of the post and screws onto the stud. A bushing is inserted in the top of the post, and a cap screw passes through the bushing and screws into the upper end of the adaptor rod. The pressure of the bushing against the top of the post prevents the post from turning on the carriage. The adaptor rod, bushing and cap screw are included in adaptor assembly (Part No. 480769). A standard Counterweight (Part No. 45N25) will be required for balancing the torch and rigging, where the torch is to be carried up to 14-1/2-in. away from the carriage side. If the torch is to be racked more than 14-1/2-in. an extra-heavy counterweight must be made up for mounting on the carriage.
mounting bracket (Part No. 491571) slips over the post and can be located at any desired height, it is then locked in place by a thumbscrew. The slide on the standard CM-45 rigging is then attached to the mounting bracket stud with a lock nut supplied with the bracket.

4. **DOUBLE TORCH OPERATION** -- Adaptor Plate 16V89 or Adjustable Slide and Clamp Assembly 16V92 can be used to permit the simultaneous operation of two torches in a variety of positions. Both torches can be used on the same side of the machine, or one torch can be mounted on each side of the carriage.

    Under most conditions, both torches can be operated from one pair of regulators with "Y" connections. In some cases, separate gas supplies for the second torch may be preferred.

    (a) Adaptor Plate 16V89 - The adaptor plate (see Fig. 3-A) can be installed on the mounting stud of the CM-45 machine carriage to permit the simultaneous use of two torches in a variety of positions. studs are provided on the adaptor plate to accommodate two Torch Rigging Assemblies (Part No. 16V90). Each torch can be adjusted individually, or both torches can be rotated around the carriage mounting stud to any desired position after they have been locked in place on the adaptor plate. As shown in Fig. 3-A, both torches can be used on the same side of the machine carriage, or one torch can be mounted on each side, in almost any desired position relative to the carriage or to each other.
you to rest your hand on the cover. The shield is fastened to the side of the machine with the tapered end towards the rear of the carriage. Three screws hold it in place, and spacers are provided to hold it away from the machine.

**F. Counterweight (Figs. 5 and 6)**

An accessory counterweight (Part No. 45N25) may be attached to either side of the carriage to prevent tipping when your machine is carrying heavy, off-center equipment loads. Overbalance may be detected by pressing down lightly on the equipment side of the machine. If it tilts easily, the counterweight should be attached to the opposite side. Like the heat shield, it is fastened with the tapered end towards the rear of the carriage and is held in place by three screws.

**II. Installation**

The CM-45 Machine Carriage is shipped completely assembled. Simply remove it from the packing crate and place it on a flat, clean plate or bench. Never roll the machine by hand unless the gears are first disengaged.

**A. Connection to the Power Line**

The 12-foot power cable is equipped with a two-pronged plug for connection to a 115-volt, 25- to 60-cycle, single-phase power outlet. A green ground lead extends from the side of the plug. Connect the metal terminal of the lead to a suitable ground near the power outlet.

**B. Installation of Track**

For many operations you will find that a single section of CM-45 track is sufficient. Whenever greater length is needed, two or more loose sections of track may be "leap-frogged" along the line of travel as follows: (see Fig. 4).

1. Set up two or more loose sections of track and start carriage operation on first track section.

2. When the carriage has passed from the first section of track to the second section, take up the first section of track and move it to a point beyond the section on which the machine is operating.

3. Rejoin track along the line of travel. Note that track sections are equipped with male and female ends for quick mating of lengths.

A continuous track assembly may be constructed by fastening any desired number of track sections end-to-end. You may use this assembly by resting it directly on the surface of the workpiece or by placing it upon a support alongside the working area. It may be made permanent by fastening it to a rigid supporting structure at the desired operating location. Supporting structures should be checked to see that they provide a firm and level base for track sections. They must be strong enough and rigid enough to maintain that level against vibration and operating load.

NOTE: Track manufactured after 10/72 will be slightly smaller in height. To join a new and old section of track, customer will have to shim the new track to raise it even with the old track.

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![FIG. 4 – "Leap-Frogging" of Track Sections (Part No. 16V82)](image-url)
C. Assembling Torch Rigging 16V81
(Fig. 5; For Complete Breakdown, see Fig. 22)

The rigging consists of four units: (1) TORCH HOLDER SLIDE. This is a slotted fixture with a geared traversing knob for moving the TORCH TRAVERSING RACK in and out. It may be swiveled horizontally to locate the RACK at any desired angle from the side or the front of the machine. (2) TORCH TRAVERSING RACK. A toothed bar which is inserted in the slot of the HOLDER SLIDE. Range of the RACK movement in and out is 8 inches. The RACK can be locked in position by means of a locking thumbscrew on the SLIDE. (3) TORCH HOLDER MOUNTING CLAMP. This is the connecting fixture between the RACK and the TORCH HOLDER ASSEMBLY. The CLAMP slides on to either end of the RACK to permit operations on either side of the carriage. CLAMP angle to the RACK can be adjusted to control torch angle along to line of travel. CLAMP can be locked at the desired angle by thumbscrew provided. When level of work is below level on which carriage is traveling, CLAMP position can be turned 180 degrees from that shown in Fig. 5 to extend the lowering range of the torch. Clamp thumbscrews can be shifted from one side of the clamp to the other to suit the inverted position. (4) TORCH HOLDER ASSEMBLY. This unit holds the torch in operating position. Up-and-down movement of the torch is controlled by turning the geared knob which engages the rack on the torch. The HOLDER ASSEMBLY stud rotates in the MOUNTING CLAMP to adjust torch angle across the line of travel. It can be locked at the desired angle by a thumbscrew provided on the CLAMP. The thumbscrew can be inserted from either side of the clamp to improve clearance. The ASSEMBLY is equipped with a calibrated dial which indicates approximate torch angle settings for bevel cutting. (This dial is to be set by the operator as described in Section III-D-3.)

The Torch Rigging Assembly is assembled in the following manner:

1. Disengage gears by moving the shift lever toward the center of the machine. Lower the caster locking pins to secure the rear wheels to prevent side movement during assembly.

2. Remove cap nut from mounting stud and place the TORCH HOLDER SLIDE atop the carriage. The traversing knob should be towards the front end of the machine. Replace cap nut and tighten.

3. Check to see that the fiber plug under the locking thumbscrew on the SLIDE does not project
into the space to be occupied by the RACK. If it does, remove it by forcing it all the way out with the thumbscrew. Then remove the thumbscrew, re-insert the plug in its proper position, and replace the thumbscrew. NOTE: In assembling and disassembling of the torch rigging, care should always be taken to see that this fiber plug is not damaged or lost.

4. Insert the end of the TORCH RACK into the slot of the TORCH HOLDER SLIDE, with the toothed edge of the RACK facing away from the mounting stud. Turn the SLIDE knob to move RACK in and out. Use the SLIDE locking thumbscrew to lock the RACK in position. NOTE: The thumbscrew will lock only against the square section of the rack, not against the round ends.

5. Slide TORCH HOLDER MOUNTING CLAMP on the end of the rack. Tighten the thumbscrew.

6. Insert protruding stud of TORCH HOLDER ASSEMBLY into TORCH HOLDER MOUNTING CLAMP, with knobbed side of ASSEMBLY facing away from the carriage. Tighten the thumbscrew. The rigging is now ready to receive the torch to be used. Torch angles are adjusted by using the two thumbscrews on the MOUNTING CLAMP.

D. Installing the Torch

1. Loosen the screw on the TORCH HOLDER ASSEMBLY and insert the torch.

2. Slide the torch into the HOLDER ASSEMBLY until the geared knob engages the teeth on the torch rack.

3. Retighten the screws on the HOLDER ASSEMBLY so that the torch will remain at any desired height by friction, but can still be moved smoothly up and down by turning the HOLDER ASSEMBLY knob.

4. Connect the hose to the torch inlet connections in accordance with the directions in the torch instruction book.

5. Set up the oxygen and acetylene supplies and connect the hose leading from the torch in accordance with the directions in the torch instruction book.

6. Arrange the hose and power cable so that they are supported above the machine. They should be well out of the way so that they do not interfere with the operator or the movement of the carriage, yet do not tend to pull the machine off balance. Suspending the hose and cable from the ceiling or other overhead support is usually satisfactory.

III. Operation

A. Preparing for Operation

Brush the track or workpiece clean. Dirt or slag beneath the wheels may cause irregular carriage movement, with resulting flaws in the work being done. Be sure that the workpiece is level, and that there is space beneath it so slag can fall free of the cut.

Disengage clutch (shift control lever toward the center of the machine). Turn motor control switch to FORWARD or REVERSE and allow motor to warm up for about 3 minutes. Rotate the lettered control dial to the carriage speed setting desired (see Section C for setting the carriage speed). Shut the motor control switch OFF and move the carriage to the desired starting point for the operation.

B. Starting the Carriage in Motion

There are two methods of starting the carriage in motion:

**Recommended Method**

Keep the shift control lever in the engaged position and use the motor control switch to start the carriage in motion. This method is recommended because it provides a smoother start, and uses a single control for starting, stopping and reversing the carriage.

**Alternate Method**

Turn the motor control switch to FORWARD or REVERSE and engage the clutch by moving the shift control lever away from the center of the machine.

C. Setting the Carriage Speed

With some practice, you will be able to adjust carriage speeds for general cutting by merely observing the progress of the cut. When performing work that is similar to previous operations, the same approximate settings may be used on the speed control dial. If necessary, finer adjustments can be made as the work progresses.

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**FIG. 6 - Circle Cutting Attachment 16Y84**

Mounted on the CM-45
Where it is desired to set the machine for a definite speed, as when following the instructions packed with the torch or cutting nozzle, it is suggested that you work out a speed table in inches per minute for each of the lettered settings on the speed control dial. You may easily do this as follows:

1. Pick a starting point and place front of carriage in line with it.
2. Set letter "A" on speed control dial beneath metal dot on rear end of carriage.
3. Start carriage in motion and allow it to run for one minute.
4. Stop carriage and measure the exact distance it has traveled.
5. Enter distance in your speed table and follow same procedure for the other lettered settings on the control dial.

D. Bevel Cutting

The CM-45 Machine Carriage can be used for either top or bottom bevel cutting.

1. Place machine either on workpiece or on carriage track.
2. Loosen torch holder thumbscrew on torch holder mounting clamp.
3. Using a spirit level, set the torch directly vertical. The calibrated dial on the torch holder assembly should show an angle reading of zero. If it does not, reset the dial correctly.
4. Turn the torch holder assembly until desired bevel angle on indicator dial is opposite the indicator notch on the mounting clamp. Tighten thumbscrew.
5. When cutting under bevels with the torch angled toward the carriage, it is advantageous to turn the torch holder mounting clamp 180 degrees on the end of the rack, to extend the lowering range of the torch. Clamp thumbscrews can be shifted from one side to the other to suit the inverted position of the clamp. It is also desirable to extend the torch holder rack as far outward as practicable in order to avoid overheating of the machine.

NOTE: In bevel-cutting, the actual depth of the diagonal cut (not the plate thickness) should be used to select the proper nozzle, gas pressures, and cutting speeds.

E. Circle Cutting (Fig. 6)

When equipped with circle-cutting attachment 16V84, the CM-45 Machine Carriage can be used to cut circles within a range of from 2 to 54 inches in diameter. The diameter of a circle determines whether the carriage should be operated outside the circumference or inside the circumference. In cutting circles from 2 inches to 19 inches in diameter, the machine operates outside the circumference. In cutting circles from 19 inches to 54 inches in diameter, the machine operates inside the circumference.

Cutting Circles from 2 Inches to 19 Inches in Diameter:

1. Locate the center of the circle to be cut and mark it with a deep punch mark. A punch with a 60 deg. angle point is recommended for this purpose.
2. Back off the caster locking thumbscrews and lift caster locking pins so casters may pivot freely.
3. There are two holes in the front end of the carriage for the attachment of the long radius rod. Fasten the rod to extend outward on the torch side of the machine. Tighten thumbscrews.

NOTE: In attaching or removing the radius rod, care should be taken to hold the side of the rod back against the thumbscrew heads while turning each screw alternately, a little at a time. This prevents binding of the thumbscrews within the rod.
4. Place the machine on the workpiece with the torch directly over the intended line of cut.
5. Slide the pivot pin bracket over the end of the radius rod so that the pivot pin and the torch are on the same side of the rod.
6. Move the pivot pin bracket along the radius rod until the point of the pivot pin rests in the punch mark that you have made in the center of the circle. Tighten the bracket thumbscrew.
7. Loosen the pivot pin jam nut. Screw in the pivot pin until the near drive wheel has been raised approximately 1/16 inch above the surface of the workpiece. Tighten the jam nut again.

There are now three points of contact; the pivot pin, the far drive wheel, and the far caster. Since the position of the torch is closer to the center of the circle than the position of the drive wheel, the torch nozzle will actually travel slower than the speed for which the carriage is set. The correct speed control setting for the desired nozzle speed may be determined as follows:

1. Measure distance (A) from far drive wheel to pivot pin.
2. Measure distance (B) from torch nozzle to pivot pin.
3. Divide distance (A) by distance (B) and multiply the result by the desired nozzle speed. The answer gives you the correct speed control setting for the carriage.

Example: Suppose that distance (A) is 20 inches and distance (B) is 5 inches. 20 divided by 5 gives an answer of 4. Assuming that the
correct nozzle speed for this operation is 6 inches per minute, 6 times 4 gives a result of 24. Therefore, 24 inches per minute is the adjusted speed control setting in this case, and will produce a speed of 6 inches per minute at the torch nozzle.

Cutting Circles from 19 Inches to 54 Inches in Diameter:
1. Proceed exactly as before EXCEPT: The radius rod is attached to extend outward on the OPPOSITE side of the carriage from the torch.

Since the position of the torch is further from the center of the circle than that of the drive wheel, the torch nozzle will actually travel faster than the speed for which the carriage is set. The correct speed control setting for the desired nozzle speed may be determined as before, (Distance (A) from far drive wheel to pivot pin, divided by distance (B) from torch nozzle to pivot pin, multiplied by desired nozzle speed.)

With the proper cutting speed determined, start cut in the waste part of the workpiece. The starting point will be outside the circle for a disk, inside the circle for a hole. Rack the torch to the line of cut after material has been pierced. Be sure that the section of the workpiece on which the machine travels is well supported.

IV. General Maintenance

A. Lubrication
1. DRIVE GEARS -- When the machine is being used regularly, the drive gears should be lubricated approximately once each month.
   (a) Remove the bottom cover plate.
   (b) Wipe off any excess grease from the sides of the gears.
   (c) Daub the gear teeth with a small amount of light grease.

2. MOTOR-GEAR REDUCTION UNIT -- The gear reduction unit is packed with grease when it is assembled at the factory. During ordinary service, there should be no need for further lubrication. If you disassemble the unit (section V-A-2) the housing should be refilled with Texaco Regar Startak grease.

B. Testing the Electrical System
(For Wiring Diagram, refer to Fig. 32.)

CAUTION: Always disconnect the machine power cable from the power source before making adjustments or repairs in the electrical system.

1. PREPARATION FOR TESTING
   (a) Obtain several short lengths of insulated wire for use as jumpers, and a 15-watt light bulb mounted in a portable socket. Socket leads should be about a foot long and must be insulated. (Testing sockets of this type

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FIG. 7 - Motor-Governor-Gear Reduction Assembly Removed from the Carriage Frame

FIG. 8 - Governor Cap Assembly Removed from the Governor Housing
are generally available at most electrical supply stores.)

(b) Before beginning tests, check the power source by inserting the test lamp leads into the outlet. If the lamp does not light, there is no power available at the outlet. When power is restored, recheck carriage operation.

2. GENERAL INSPECTION

(a) Remove bottom cover plate.

(b) Dismount entire motor-governor-gear reduction assembly (Fig. 7) by removing the four hexagonal socket-head mounting screws located atop the center of the carriage. Disconnect the 4-prong plug on the cable leading to the motor.

(c) Lay the assembly on an insulated surface, with the condenser facing upward.

(d) Loosen the governor cap-assembly stop screw (Fig. 8) and remove the governor cap by unscrewing it in a counter-clockwise direction. Note the number of turns necessary to remove the cap so that it may be replaced in the same position.

(e) Examine the entire electrical system for such obvious faults as broken wires, loose connections, worn or broken insulation, and burnt resistors. Inspect the inside of the governor for loose connections and burnt or pitted contacts. Check the spring contacts to see that they are separated.

(f) Using your finger or the tip of a screwdriver, press down on the friction spring located atop the governor housing (Fig. 8). Replace the governor cap taking care to see that the cap fits properly over the friction spring. Screw the cap in the same number of turns that were necessary to remove it. Tighten the cap assembly stop screw. If the cap assembly wobbles on the threads, remove it and spread the housing slightly on the slits provided for that purpose.

3. TO TEST THE MOTOR CONTROL SWITCH

(a) Disconnect the motor plug and connect the machine power cable to the power source.

(b) Separate the plug shell from the female plug by prying them gently apart with the tip of a small screwdriver (Fig. 9). Locate lead 1 which is connected to the terminal marked "4" on the plug. Insert one lead of the test lamp in the contact opening of this terminal.

(c) Insert the other lead of the test lamp into one of the three remaining openings. Check the motor control switch in each of its three positions. The test lamp should light when the switch is in one of the extreme positions (FORWARD or REVERSE) and should remain out for the other two positions.

(d) Repeat step "c" for each of the two remaining openings in the female plug.

(e) If the test lamp does not react in each case as described in step "c," the motor control switch is defective and should be replaced.

4. TO TEST THE MOTOR

(a) Connect the motor plugs, and connect the power cable to the power source.

(b) Move motor control switch to FORWARD or REVERSE.
5. TO TEST THE CONDENSER

(a) Connect the motor plugs, and disconnect the power cable from the power source.

(b) Remove the governor cap (see Section IV-B-2-d). Check to see that the governor contacts are separated.

(c) Locate lead L3 (see Fig. 11) and disconnect it at the motor control switch.

(d) Connect the power cable to the power source and move the motor control switch to FORWARD or REVERSE.

(e) Locate lead L2 on the motor switch (see Fig. 11). Touch one lead of the test lamp to L2 on the motor control switch. Touch the other lead of the test lamp to terminal 1 on the condenser (Fig. 8). The lamp should light, indicating power in the circuit.

(f) Change the test lamp lead from terminal 1 on the condenser to terminal 2 on the condenser. If the test lamp does not light, the condenser is good. If the test lamp lights, the condenser is shorted and must be replaced.

(g) Reconnect lead L3 at the motor control switch.

(h) Replace the governor cap (see Section IV-B-2-f).

6. TO TEST THE 50-OHM RESISTOR

(a) Disconnect the motor plugs, and connect the power cable to the power source.

(b) Set the motor control switch at any one of the three positions.

(c) Test the resistor by touching the test lamp leads to 1 at the resistor (Fig. 10), and L2 at the motor control switch (Fig. 11). The lamp should light, but will be slightly less bright than in other tests.

(d) If the test lamp does not light, check the lead wires to the resistor. If wiring is in good condition and lamp still does not light, the resistor is defective and should be replaced.

(e) This resistor is set for approximately 35 ohms at the factory. It is not necessary to change this setting during routine maintenance. If the resistor is replaced, the slide on the replacement should be set in approximately the same position (about 1/3 along the resistor length AWAY from the end of the resistor to which the shunting lead is attached, as shown in Fig. 10).

7. MOTOR BRUSH AND COMMUTATOR MAINTENANCE (see Section V-A-4)

C. Adjusting the Speed Control Governor

Using the speed control dial, test the carriage for minimum and maximum speed, i.e., measure the exact distance that it travels in one minute. Maximum speed of the standard carriage (01E19) should be approximately 32 inches per minute; minimum speed should be approximately 4 inches per minute. Maximum speed of the low speed carriage (301134) should be approximately 17-1/2 inches per minute; minimum speed should be approximately 2-1/4 inches per minute. If you are unable to obtain the appropriate speed range by use of the speed control dial, it will be necessary to adjust the governor. Before beginning adjustment, however, examine the axle-drive gear-wheel assembly to see whether friction or binding may be preventing the carriage from operating within the proper speed range.
TO ADJUST FOR MINIMUM SPEED

1. Connect the power cable to the power source.

2. Rotate the speed control dial in a counterclockwise direction as far as it will go.

3. With the clutch disengaged, move the motor control switch to FORWARD or REVERSE. Loosen the locknut on the governor adjusting screw (Fig. 8) and unscrew the adjusting-screw until the motor stops.

4. Slowly, screw the governor adjusting-screw back into the governor cap until the motor just starts. Tighten the adjusting-screw locknut.

NOTE: The governor is now properly adjusted for the minimum speed setting. If you are still unable to obtain the minimum speed, check the following points.

5. Inspect the governor contact assembly to see that it is properly positioned, as described in Section V-A-3-a.

6. Inspect the governor rotor assembly for proper clearance between the rotor bow spring and the washer on the rotor coil spring, as described in Section V-A-3-b.

TO ADJUST FOR MAXIMUM SPEED

1. After completing the adjustment for minimum speed, rotate the speed control dial in a clockwise direction as far as it will go and test the carriage for maximum speed. If you are unable to obtain maximum speed with this setting, proceed with step 2.

2. Loosen the governor cap-assembly stop screw (Fig. 13) and rotate the speed control in a clockwise direction for an additional one-quarter turn. Recheck carriage speed. If there has been no appreciable increase over step 1, the trouble may be due to low voltage at the power source (should be 115 volts), or to dirty commutator or meter brushes (Section V-A-4). If there has been an increase in speed over step 1, proceed with steps 3 through 5.

3. Remove the governor cap (see Section IV-B-2-d).

4. Loosen the nut which locks the contact button in position (Fig. 15). Slide the contact button 1/8 in. to 1/4 in. along the slot TOWARD the attached end of the bar. Retighten the locking nut.

5. Replace the governor cap (see Section IV-B-2-f). If further adjustment is necessary, repeat steps 3 through 5.

6. After adjusting for maximum speed, recheck the minimum speed adjustment.

NOTE: If the carriage reaches maximum speed considerably before the control dial has been rotated, FULLY clockwise, fine adjustments in speed will be more difficult to obtain. To correct for this condition:

1. Remove the governor cap (see Section IV-B-2-d).

2. Loosen the nut which locks the contact button in position (Fig. 15). Slide the contact button 1/8 in. to 1/4 in. along the slot AWAY from the attached end of the bar. Retighten the locking nut.

3. Replace the governor cap (see Section IV-B-2-f). If further adjustment is necessary, repeat these 3 steps.

4. After adjusting for maximum speed, recheck the minimum speed adjustment.

V. Disassembly and Inspection

A. Motor-Governor-Gear Reduction Assembly

1. THE GENERAL ASSEMBLY

(a) Lay the machine on its side and remove bottom cover plate. The plate is held on by 6 screws.

(b) Dismount the entire assembly by removing the four hexagonal socket-head mounting screws located atop the center of the carriage.

(c) Disconnect the four-prong plug on the electric cable leading to the motor. The entire assembly can then be lifted free of the carriage.

(d) To remount assembly, reverse the preceding steps.

2. THE GEAR REDUCTION UNIT (For Complete Breakdown, see Figure 31)

(a) Dismount the gear reduction unit from the motor housing by removing the three numbered screws indicated (Fig. 12). If the gear housing does not lift off readily after the screws are removed, tap it lightly around the sides to loosen the seal.

FIG. 12 – Gear Reduction Unit
(b) Unscrew and remove countershaft thrust screws (Fig. 12). Remove screw-head gaskets.

(c) A group of parts consisting of pad, plates and ball lies beneath each thrust screw. To loosen these parts, take the gear between your fingers and jiggle it gently from side to side. Lift out pad and plates, and remove ball.

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

(e) Drive out the pin which holds the worm gear and worm to the countershaft.

(f) Using a drift, drive the countershaft out through one of the thrust screw openings. BE CAREFUL NOT TO DAMAGE BEARINGS. The worm and worm gear will fall free of the shaft and can be removed.

(g) Remove extension-shaft thrust screw (Fig. 12). Remove gasket, pad, plates and ball as before. Drive out the pin which holds the worm gear to the extension shaft. Carefully drive out extension shaft.

(h) The pinion gear may be removed from the end of the extension shaft by driving out the tapered pin with a center punch.

(i) If bearings or oil retaining washers require replacement, drive them out carefully. Tap replacement parts gently into position with the wooden handle of a screwdriver.

(j) To remount gear reduction unit, reverse the preceding steps. For correct relationship of parts, particularly in replacing gears and worms on the shafts, see Fig. 29. Use ROYCO No. 6-A Grease to repack the housing.

3. THE GOVERNOR ASSEMBLY (Fig. 13)
(For Complete Breakdown, see Fig. 30)
(a) The Contact Assembly

(1) Dismount the motor-governor-gear assembly from the carriage (see Section V-A-1).

(2) Remove the governor cap (see Section IV-B-2-d).

(3) Check the position of the contact assembly (see Fig. 14). There should be a gap of from 1/32 in. to 1/16 in. between the contact points. The assembly insulator should ride on a line with the center of the rotor, and there should be a clearance of from 1/64 in. to 1/16 in. between this insulator and the rotor bow spring. The contact assembly should stand ap-
proximately vertical, with not more than a few degrees of inward or outward tilt.

4. If the contact assembly is not properly positioned, it can be shifted by moving the conductor strips (Fig. 15) to which it is attached. These strips are clamped in place by a curved plate which is fastened to the governor housing by two flat-head screws. Loosen the screws and shift the conductor strips to properly position the contact assembly. Retighten the screws, making sure that the conductor strips are insulated from the curved plate and housing at all points by the insulating sleeves.

5. Remove the two nuts indicated (Fig. 15) and lift out the contact assembly.

6. To renew a contact point, remove the nut which holds the contact spring to the assembly (Fig. 15). Replace the contact spring and point.

7. To remount, set the contact assembly in place and tighten the nuts which hold it (Fig. 15).

8. Replace the governor cap (see Section IV-B-2-f).
(b) The Governor Rotor

(1) Dismount the motor-governor-gear assembly from the carriage (see Section V-A-1).

(2) Remove the governor cap (see Section IV-B-2-d).

(3) Remove the two nuts indicated (Fig. 15) and lift out the contact assembly.

(4) A setscrew holds the governor rotor on the motor shaft. Rotate the shaft until the setscrew is beneath the hole in the top center of the governor housing. Insert a 1/8-in. hex wrench and loosen the setscrew (Fig. 16).

(5) Slide the rotor free of the motor shaft. If the rotor does not slide readily, insert a screwdriver in the semi-circular opening atop the governor housing and pry gently.

(6) Inspect the rotor assembly. The balls should be free rolling. When the rotor is held in a horizontal plane, it should be possible to see light (approximately .010 in.) between the bow spring and the washer on the coil spring (Fig. 17). The washer or, if necessary, the end of the coil spring may be ground down to obtain the required clearance. To remove the washer, press in on the sides of the bow spring and depress the coil spring. Invert the rotor and washer will fall out. The coil spring may be removed by threading the top loop over the bow spring and screwing it out. Replace the coil spring and washer by reversing these procedures.

(7) To remount the rotor, line up the rotor setscrew with the flat side of the motor shaft. Slide the rotor on to the shaft, tapping it with the wooden handle of a screwdriver if necessary.

(8) Remove the center screw in the end of the gear reduction unit and insert a screwdriver tip against that end of the motor shaft. Holding the screwdriver firmly, press the rotor as far down the shaft as it will go. (This removes end play in the motor armature.) Tighten the rotor setscrew. Replace center screw in the end of the gear reduction unit.

(9) Set the contact assembly in place and tighten the nuts which hold it.

(10) Replace the governor cap (see Section IV-B-2-f).

4. THE ELECTRIC MOTOR
(For Complete Breakdown, see Fig. 31)

(a) Dismount the motor-governor-gear assembly (see Section V-A-1).

(b) Remove the gear reduction unit (see Section V-A-2-a).

(c) Remove the governor cap (see Section IV-B-2-d).

(d) Remove the contact assembly and the rotor (see steps (3) through (5), Section V-A-3-b).

(e) Remove the locknut from the end of the motor shaft, and slide the worm from the shaft.

(f) Drive out the worm pin.

(g) Unscrew the two motor housing screws.

(h) Withdraw the motor end housing (Fig. 18).

(i) Before removing motor brushes, mark each brush so that it can be returned to its original holder in its original position. Remove brushes by unscrewing the motor brush plugs (Fig. 19).
FIG. 18 – Removing the Motor End Housing

(j) Remove the armature by tapping with a mallet or wooden stick on the extension shaft at the governor end of the motor (Fig. 20).

(k) To remount the electric motor, reverse the preceding steps.

CAUTION: Motor brush and commutator maintenance should be performed by an experienced electrician. If you feel that you are not qualified to make the following repairs, you should take the motor to any good local motor-service store.

(l) Examine the motor brushes. The ends that contact the commutator should have a polished surface. This indicates good contact.

(m) New brushes should be approximately 3/4 in. long. When they have worn down to about 1/2 in. in length, they should be replaced. After insertion, check to see that the brush moves freely up and down in the holder.

(n) Examine the commutator. The surface where the motor brushes make contact should appear clean and smooth, with a polished brown or copper color. If this surface appears rough, it should be polished with No. 00 sandpaper. NEVER USE EMERY FOR THIS PURPOSE. (Emery particles are electrical conductors and will short-circuit the commutator segments during operation.) If possible, rotate the armature in a lathe while sanding.

(o) Examine the mica segments between the commutator bars. The edges of these segments should be slightly below the edges of the bars. If they are not, they should be undercut.

B. Axle-Drive Gear-Wheel Assembly

(For Complete Breakdown, see Fig. 27 for Series 1 machines, Fig. 28 for Series 2 machines.)

1. Remove bottom cover plate. On Series 2 machines, check clearance between drive gear and sliding clutch gear (Step 2, below). On all machines, check alignment of output pinion and drive gear (Step 9).

2. With the clutch in the disengaged position, there should be a clearance of 1/32-in. between the faces of the sliding clutch gear and the drive gear. If necessary, clearance may be adjusted as follows:
   a. With the clutch in the disengaged position, loosen the machine screw and nut which hold the adjusting bar (47N18) to the carriage frame.
   b. Rotate the adjusting bar clockwise or counterclockwise, as necessary to obtain the proper clearance.
   c. Retighten the machine screw and nut.

3. Remove the snap ring from the axle. Slide the drive gear along the axle and remove the second snap ring by gently pressing against the ends, on the open side of the ring with a screwdriver.

4. Using a 1/8-in. hex wrench, loosen the two setscrews in the outer hub of the drive wheel opposite the clutch side of the carriage.

5. Remove the drive wheel. If the wheel does not slide readily from the axle, place a drift against the axle-end and tap gently with a hammer. Remove the other drive wheel.

6. Remove the axle. If it is snug, tap it out gently with the drift and hammer. The drive gear (and sliding clutch gear on Series 2 machines) will slip off easily.

7. Examine the porous bronze bushings. Inner surfaces should be smooth, bright and free of all dirt or metal particles.

8. If a bushing is to be replaced, use a broad-faced bronze or soft metal drift to drive it out gently, working from the INNER side of the carriage chassis. Insert replacement bushings carefully by gently tapping into place.

9. To remount the axle-drive gear-wheel assembly, reverse steps 1 through 5. Be sure that the clutch drive gear and the motor pinion gear are

FIG. 19 – Motor Brush Assembly

FIG. 20 – Removing the Armature
properly aligned. This may be done as follows:
(a) With the clutch drive gear in position against the axle snap ring, slide the axle so that the two gears mesh along their full width.
(b) Set the drive wheel and washer on the clutch side of the machine snugly against the bushing. Tighten the hub setscrews.
(c) Set the second drive wheel so that the centers of the two wheel-treads are exactly 6 inches apart. There should be at least .020-in. clearance between the wheel and the bushing. Tighten the hub setscrews.
(d) Daub the gear teeth with a small amount of light grease.

(b) Examine the caster shaft and inner surfaces of the bushing. These should be smooth, bright and free of all dirt or metal particles.
(c) Wheels may be removed from the caster body by releasing one of the axle snap rings and pushing out the axle. Check to see that no dirt or metal particles have lodged between the wheel and the caster body.
(d) To remount, reverse the preceding steps.

2. CASTER LOCKING PINS
(a) Remove locking pins by releasing the snap ring on the lower end of the pin and pulling up firmly.
(b) Locking pins are provided with a snug sliding fit by a rubber ring which is set into a groove about half-way along the pin. If a locking pin becomes too loose and will not remain in a raised position, replace the rubber ring.
(c) To remount, push pin back into place and return snap ring to its position on the lower end of the pin.

### VI. Troubleshooter's Check List

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible Causes</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Motor does not run, or runs erratically.</td>
<td>1. Failure of power source.</td>
<td>1. Check for voltage at the power source. (Section IV-B-1)</td>
</tr>
<tr>
<td></td>
<td>2. Defective power cable or plug.</td>
<td>2. Repair or replace.</td>
</tr>
<tr>
<td></td>
<td>3. Defective switch.</td>
<td>3. Test as described in Section IV-B-3. Replace if defective.</td>
</tr>
<tr>
<td></td>
<td>4. Motor brushes sticking in holders.</td>
<td>4. Clean brushes and holders. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>5. Motor brushes broken, or worn too short.</td>
<td>5. Replace. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>6. Dirty governor contacts.</td>
<td>6. Clean or replace. (Section V-A-3-a)</td>
</tr>
<tr>
<td></td>
<td>7. Burned-out resistor.</td>
<td>7. Test as described in Section IV-B-6. Replace if defective.</td>
</tr>
<tr>
<td></td>
<td>8. Dirty commutator.</td>
<td>8. Clean commutator. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>9. Mica segments extending above commutator bars.</td>
<td>9. Undercut mica segments. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>10. Motor burned out.</td>
<td>10. Replace, or have repaired.</td>
</tr>
<tr>
<td>B. High speeds cannot be obtained.</td>
<td>1. Governor contact button incorrectly set.</td>
<td>1. Reset governor contact button. (Section IV-C)</td>
</tr>
<tr>
<td></td>
<td>2. Dirty motor brushes.</td>
<td>2. Clean brushes and holders. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>3. Dirty commutator.</td>
<td>3. Clean commutator. (Section V-A-4)</td>
</tr>
<tr>
<td></td>
<td>4. Friction or binding in gear mechanism.</td>
<td>4. Check alignment of pinion and drive gear. Check drive wheel bushings. Replace if necessary. (Section V-B)</td>
</tr>
<tr>
<td></td>
<td>5. Low voltage at power source.</td>
<td>5. Use a voltmeter to check voltage at power source. Should be 115 volts.</td>
</tr>
</tbody>
</table>

17
<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible Causes</th>
<th>Remedy</th>
</tr>
</thead>
</table>
| C. Low speeds cannot be obtained, or motor does not run smoothly at low speeds. | 1. Governor adjusting screw incorrectly adjusted.  
2. Governor contact assembly improperly positioned.  
3. Bow spring on governor rotor assembly does not have proper clearance over coil-spring washer.  
4. Resistor shorted.  
5. End play in motor armature. | 1. Readjust governor adjusting screw. (Steps 1 through 4, Section IV-C).  
2. Adjust position of contact assembly. (Steps 3 and 4, Section V-A-3-a)  
3. Grind down washer or end of coil spring to obtain proper clearance. (Step 6, Section V-A-3-b)  
4. Test as described in Section IV-B-6. Replace if defective.  
5. Loosen the governor rotor and retighten as described in step 8, Section V-A-3-b. |
| D. Machine travel is uneven. | 1. Friction or binding in gear mechanism.  
2. Binding in caster wheel assemblies.  
3. Motor out of alignment.  
4. Defective governor.  
5. Burned-out condenser.  
6. Dirty or uneven track. | 1. Check alignment of pinion and drive gear. Check drive wheel bushings. Replace if necessary. (Section V-B)  
2. Check for dirt or metal particles between caster wheel and caster body. (Section V-C-1)  
3. Check to see that the motor-governor-gear assembly is correctly positioned in the carriage, and that it is held securely in place by the four mounting screws. (Section V-A-1)  
4. Check governor for loose connections, dirty or pitted contacts, loose screws, dirt in governor cap, interference between cap and contact button, interference between cap and housing. (Section V-A-3)  
5. Test as described in Section IV-B-5. Replace if defective.  
6. Clean and straighten. Replace if necessary. |
| E. Motor runs at one constant speed. | 1. Condenser shorted.  
2. Motor lead grounded.  
3. Governor contacts welded together.  
4. Governor improperly adjusted. | 1. Test as described in Section IV-B-5. Replace if defective.  
2. Examine lead for breaks or loose connections. Replace if defective.  
3. Replace contacts. (Section V-A-3-a)  
4. Readjust governor. (Section IV-C) |
| F. Carriage continues to travel with shift lever to disengaged position | 1. Incorrect clearance between sliding clutch gear and drive gear (Series 2 machines) | 1. Adjust clearance (Section V-B-2) |
| G. Excessive drive gear wear. | 1. Gears dirty or in need of lubrication.  
2. Clutch drive gear and motor pinion gear not properly aligned.  
3. Incorrect clearance between sliding clutch gear and drive gear (Series 2 machines) | 1. Clean and lubricate drive gears. (Section IV-A-2)  
2. Realign clutch drive gear and motor pinion gear. (Section V-B-8)  
3. Adjust clearance (Section V-B-2) |
VII. Replacement Parts

How to Order

1. All replacement parts are keyed on the drawings which follow. Two types of numbers are used on these drawings:
   A. Standard Part Numbers. These are usually formed by two pairs of digits with a letter between (for example: 01N21, 18V69). A few parts may have straight digits sequence (3389) or one letter followed by several digits (A-254221). Each standard part number is accompanied by a descriptive word or words.
   B. Hardware Numbers. These numbers are composed of two four-digit groups. (For example: 6134-0013.) Hardware numbers usually accompany parts on drawings by a one word description.

2. Order standard parts by part number and name, as shown on drawings. DO NOT ORDER BY PART NUMBER ONLY.

3. For hardware, look up the number in hardware list at back of book. You will find there a full description. Hardware items can usually be purchased locally.

4. Parts shown with the symbol [ ] are standard commercial parts and can usually be purchased locally.

5. A complete description of these items will be found in the vendor parts list at the back of the book.

6. When ordering, be sure to state quantity of each part needed.

7. Always state the serial number of the machine on which the parts are to be used. The serial number is stamped on the unit nameplate.

8. Indicate any special shipping instructions.

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FIG. 21 – CM-45 Machine Carriage With Accessories
FIG. 22 - Torch Rigging Assembly _16V90 (24 inch rack)
FIG. 23 - Mounting Bracket (491571), Adaptor Assembly (490769), and Post (491620)
FIG. 26 – Electrical Components and Mounting Hardware
FIG. 27 - Mechanical Components (Series 1 Carriages)
FIG. 28 - Mechanical Components (Series 2 Carriages)
FIG. 29 – Gear Reduction Unit – 44V10 (Low Speed) and 50V70 (Standard Model)
<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
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<tbody>
<tr>
<td>610-1911</td>
<td>No. 10–32 x 1/2&quot; Lg. Round Head, Machine Screw, Brass</td>
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<tr>
<td>610-3881</td>
<td>No. 8–32 x 5/8&quot; Flat Head, Machine Screw, Brass</td>
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<td>6124-0902</td>
<td>No. 10–24 x 1/2&quot; Lg. Socket Head, Cap Screw, Steel</td>
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<tr>
<td>6130-0098</td>
<td>1/4&quot;–28 x 1&quot; Lg. Fillister Head, Machine Screw</td>
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<td>6130-1824</td>
<td>No. 4–40 x 1/4&quot; Lg. Round Head, Machine Screw</td>
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<td>6130-1967</td>
<td>No. 4–36 x 1/2&quot; Lg. Round Head, Machine Screw</td>
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<td>6130-3511</td>
<td>1/4&quot;–20 x 7/8&quot; Lg. Flat Head, Steel Machine Screw</td>
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<td>6130-3850</td>
<td>No. 6–32 x 5/16&quot; Lg. Flat Head, Machine Screw</td>
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<td>No. 8–32 x 1/4&quot; Lg. Flat Head, Machine Screw</td>
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<td>6130-3895</td>
<td>No. 8–32 x 1 1/2&quot; Lg. Flat Head Machine Screw</td>
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<td>6130-5815</td>
<td>No. 2–56 x 1/4&quot; Lg. Binding Head, Machine Screw</td>
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<td>6130-7876</td>
<td>No. 8–32 x 1/4&quot; Lg. Pan Head Machine Screw</td>
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<td>No. 8–32 x 3/8&quot; Lg. Pan Head Machine Screw</td>
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<td>No. 8–32 x 3/8&quot; Lg. Slotted Truss Head Machine Screw, Std.</td>
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<td>No. 00 x 3/32&quot; Lg. Parker Kalon, Type ‘U’ Drive Screw</td>
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<td>No. 00 x 1/8&quot; Lg. Parker Kalon, Type ‘U’ Drive Screw</td>
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<td>No. 6 x 1/4&quot; Lg. Parker Kalon, Round Head, Type ‘U’ Drive Screw</td>
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<td>1/4&quot;–20 x 1/4&quot; Lg. Cup Point, Setscrew</td>
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<td>6133-0806</td>
<td>1/4&quot;–20 x 3/8&quot; Socket, Cup Point Setscrew</td>
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<td>6133-9907</td>
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<td>5/16&quot;–24 x 1&quot; Lg. Thumb Screw</td>
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<td>6225-0022</td>
<td>3/32&quot; Dia. x 3/8&quot; Lg. Roll Pin</td>
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<td>6225-0029</td>
<td>1/8&quot; (.125) x 7/8&quot; Roll Pin, Steel</td>
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<tr>
<td>6225-0346</td>
<td>Roll Pin 5/64&quot; Dia. x 5/8&quot; Lg.</td>
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<tr>
<td>6225-0396</td>
<td>3/32&quot; x .094 x 5/8&quot; Lg. Steel Roll Pin</td>
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<tr>
<td>6225-9395</td>
<td>3/32&quot; (.094) x 5/8&quot; Lg. Roll Pin</td>
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**Vendor Items**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>92W80</td>
<td>Cable Grip - Pyle National Co. - 1/2&quot; Conduit #DB 338, Form 1</td>
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<tr>
<td>92W83</td>
<td>Ring - Crescent Retaining Ring, #5103-50 CM-45</td>
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<tr>
<td>93W48</td>
<td>Ring - Waldes Tru-Arc - Retaining Ring #5130-25</td>
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<tr>
<td>93W77</td>
<td>Lug - Aircraft Marine Prod. Auto-Machine #40834</td>
</tr>
<tr>
<td>96W40</td>
<td>Switch - Cutler Hammer - #8906K132 - DPDT-S Sealed Type, with Long Handle</td>
</tr>
<tr>
<td>98W40</td>
<td>Aircraft-Marine Products Inc. Harrisburg, Pa., Knife-Disconnect Splice Cat. No. 31762</td>
</tr>
<tr>
<td>181W41</td>
<td>Pin, Spring, Groov-Pin Corp., Type 6 Spring Anchor Half Length Taper Groov-Pin 5/32&quot; Dia. x 1-1/4&quot; Lg.</td>
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<td>181W42</td>
<td>Roller, Clutch McGill Mfg. Co., Inc. &quot;Camroll&quot; Bearing Cat. No. CF-1/2-S Pin, Pivot Groov-Pin Corp. Type 24 1/4&quot; Dia. x 1&quot; Lg.</td>
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<td>181W43</td>
<td>1/4&quot; Dia. x 1&quot; Lg.</td>
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Lithographed in U.S.A.
F-9253-K 4-8007 4/74 12C