

CDR HAM ROTOR

(antenna rotators)

MODEL HAM-M

Series 1, 2, 3, 4, 5

precursor to HAM-IV

CLASS 252-50

OWNERS MANUAL REPAIR PARTS MANUAL SCHEMATICS

50137-00 ISSUE G
DECEMBER 1972

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CLASS 252-50



CDR HAM ROTOR

Owner's Manual

**MODEL
HAM-M[®]**



CORNELL-DUBILIER ELECTRONICS

A DIVISION OF FEDERAL PACIFIC ELECTRIC COMPANY

Rotor Department

Fuquay-Varina, North Carolina

Owner's Manual FOR CDR HAM ROTOR

MODEL HAM-M

Foreword On the following pages, you will find information obtained from the Engineering Staff where the Ham Rotors are built, the Service Engineering Group, and from amateurs who have Ham Rotors installed. No attempt has been made to detail every possible installation or suggest every maintenance procedure that may be necessary to cover many years of operation.

Please feel free to communicate with us at any time that we may be of assistance. Write to:

CORNELL-DUBILIER ELECTRONICS

DIVISION OF FEDERAL PACIFIC ELECTRIC COMPANY

CDR Rotor Department

118 E. Jones Street

Fuquay-Varina, North Carolina 27526

General The Ham rotor is designed to support exceptionally heavy antenna arrangements used by amateur radio operators, and provide for rotation of such antennas through a complete 360 degree range. Position of the antenna is indicated on a meter in the control box.

This rotor is built along the general lines of the original Bell rotors which have been used extensively for television reception for many years. The weight of the upper mast and antenna is carried directly in line with the supporting mast. The rotor, radial and thrust bearings, electrically operated brake, gear train and indicating mechanism are specially built into an elongated bell shaped housing made of aluminum.

Specifications

Input voltage	115 VAC 60 Cycles (105-125)
Motor	24 V., 2 1/4 Amp., Split phase 10% duty
Capacitor	130 MFD—Electrolytic 10% duty
Brake Solenoid	24 V., 3 1/2 Amp., Continuous duty
Power Transformer	115/26 VAC, 10% duty, Thermal cutout
Instrument Transformer	115/23 VAC Continuous duty
Meter	DC Voltmeter, 1000 Ohms/Volt
Meter Scale	Direct reading in degree from North (5 degree increments)
Recommended cable	Belden #8448 or equivalent. 2 wires #18, 6 wires #22
Max. cable resistance for proper operation	Not over 1 Ohm, conductors #1 and #2 Not over 2 1/2 Ohms, Conductors #3 to #8 (This is about 150 ft. #8448 cable)
Indicating Accuracy	Within 5 degrees of true compass direction when exactly calibrated
360° rotation time	Approximately 50 seconds
Brake mechanism	Positive lock into one of 96 segments (Spaced 3°45'). Electrically retracted
Control Box Size	5 1/8" wide, 6" deep, 5 1/4" high
Rotator Dimensions	8" max. dia. x 20" high with top and bottom mast supports. Less lower mast—13 3/4" high
Weight (Pounds)	Rotator with top mast support—13 1/2. Lower mast support only—2 1/2. Control box complete—6. Total shipping weight—26 lbs.
Permissible Mast Size	From 1 3/8" to 2 1/8" diameter
Mounting Hardware	1/4" Stainless steel "U" bolts and nuts.

Checking Control Unit

It is recommended that a preliminary check be made on the control unit and the rotor itself before actual installation to detect possible shipping damage.

To check the control unit, plug it into 110 volt AC power. With no connections to the terminals, operate the control lever to the left slightly until the pilot lights are illuminated. The meter should deflect to about 3/4 scale. Turning the adjusting control

on the rear of the unit should cause some change in the meter deflection. Check for similar operation with the control lever pushed slightly to the right.

To check the power circuit, connect an AC voltmeter between terminals 1 and 2 on the rear panel and see that approximately 30 volts is indicated when the control lever is shifted to the extreme left or right. Connect the same meter between terminals 1 and 5 and see that approximately 30 volts is indicated as the control lever is moved to the extreme right only. Connect the meter from terminal 1 to terminal 6 and see that approximately 30 volts is indicated when the control lever is moved to the extreme left only.

Checking Rotator

Connect all 8 terminals of the control box to the corresponding 8 terminals of the rotor using the coil of cable obtained for the installation. The 2 heavy wires in the cable should be used for terminals 1 and 2 (Refer to Schematic). CAUTION — SHORTS BETWEEN TERMINALS OR GROUNDED LEADS MAY BURN UP THE POT STRIP IN ROTATOR.

With the rotor in an upright position without the lower mast support assembled, operate rotator by means of control unit lever in both directions. The operation of control unit lever on and off, releases the brake mechanism in rotator. This is audible to the operator.

Meter Calibration

Run rotator to full left extreme and use zero-center screw to put needle exactly on left limit while holding lever operated. Then run to right extreme and adjust calibrate control on rear to put needle exactly on right limit. If this cannot be done, turn the compensating control inside control box so that the external control is able to cover the range properly. Left end adjustment depends only on installation. Right hand adjustment varies with line voltage and must be rechecked periodically if extreme accuracy of indication is desired. When power is off, the meter will come to rest slightly to left of left end of scale.

Recheck of calibration requires rotation of antenna to right hand extreme. Where it is desirable to check accuracy quickly without rotating the beam, a field modification kit, AK-120, is available. This contains special controls which may be added to Series 2 or Series 3 rotors. See Field Modification 4, page 12.

Rotor Installation

The HAM rotor is engineered to handle heavy antennas with relatively high wind resistance, including multi-band arrays having traps at the extreme of the elements. Long and trouble-free performance of the rotor with amateur antennas of different types, depends upon making an installation to properly handle the stresses involved.

Balanced Weight

produces only down-thrust on the rotor. With 98 ball bearings operating in accurately machined races, the rotor is capable of handling as much as a thousand pounds downward pressure in line with the axis of rotation.

Unbalanced Weight

creates a bending moment of force which is concentrated on the mast at the point where it is clamped to the top of the rotor. This moment tends to strain the mast at that point and also to bind the ball bearings by creating excessive downward pressure on one side and upward pressure on the other. Such

unbalance places additional stresses on the motor and gear train. Unbalanced weight becomes critical as the distance from the antenna boom to the clamping point at the rotor is increased.

Wind Pressure against the boom and elements usually produces a bending force on the mast which causes the same stresses as unbalanced weight. To strengthen the installation to withstand unbalanced weight and wind pressure, the top mast should be as short as possible. In multiple arrays the heaviest sections should be closest to the rotator. In order to distribute the bending stress and prevent fracture of the mast, the HAM rotor includes two long, heavy, specially designed steel clamping plates. These are grooved to grip the mast securely. It is recommended that the mast be reinforced in the area where it is clamped by driving a hardwood dowel of proper size into the end of the mast.

Start-Stop Torsion Torsional or twisting forces must be given special considerations when using the HAM Rotor. Although the acceleration of the antenna array is gradual as the motor picks up the load, the stopping is instantaneous. When the brake wedge is pulled into the groove in the outer casing, the top and bottom masts are locked rigidly together.

The rotating inertia of the antenna in motion must be safely absorbed at the instant of stop by the momentary flexing and subsequent return of the antenna elements, boom, masts, and tower. It is absolutely essential that all mechanical assemblies making up the antenna array be solidly clamped so that no slipping occurs even under heavy icing conditions. Particular attention must be given to clamping of the boom to the mast, and the masts to the rotor, as the greatest leverage occurs at these points.

Torsional Guying of Tower Average height, well built towers, properly erected, carrying average antennas, are able to absorb the heavy twisting strain at the moment of stopping. Where the antenna is large or heavy, or the tower is tall or of light weight construction, a torsion bar or sway brace (as shown in Fig. 2 on the next page) should be rigidly attached near the top of the tower. Such an arrangement allows the double guy wires to absorb the shock of stopping, which would otherwise tend only to twist the tower on its base.

Mechanical Description The motor drives a train of stainless steel spur and pinion speed reduction gears which in turn drive the ring gear. The ring gear drives the bell shaped upper mast support, into which the antenna mast is mounted in rigid central alignment.

A boss is cast on the under side and in the center of the cavity of the upper mast support, which engages the serrated edge of the potentiometer arm which is mounted on the top of the inner mechanism.

Maximum support and low frictional loss between the rotating upper mast support and the inner mechanism is assured by the use of two groups of 49 steel balls each riding in the bearing races between the two assemblies, and held in special nylon retainers.

Mechanical stops along with electrical limit switches are built into the rotor mechanism to provide accurate and complete 360 degree rotation.

The brake assembly is released by a 24 volt AC solenoid, the plunger of which is mechanically attached to the wedge. When the wedge is positioned for braking, a cam latch locks the wedge in the teeth of the lower housing. To release the brake, the solenoid is energized. This unlocks the latch automatically and retracts the wedge from the gear teeth in the housing.

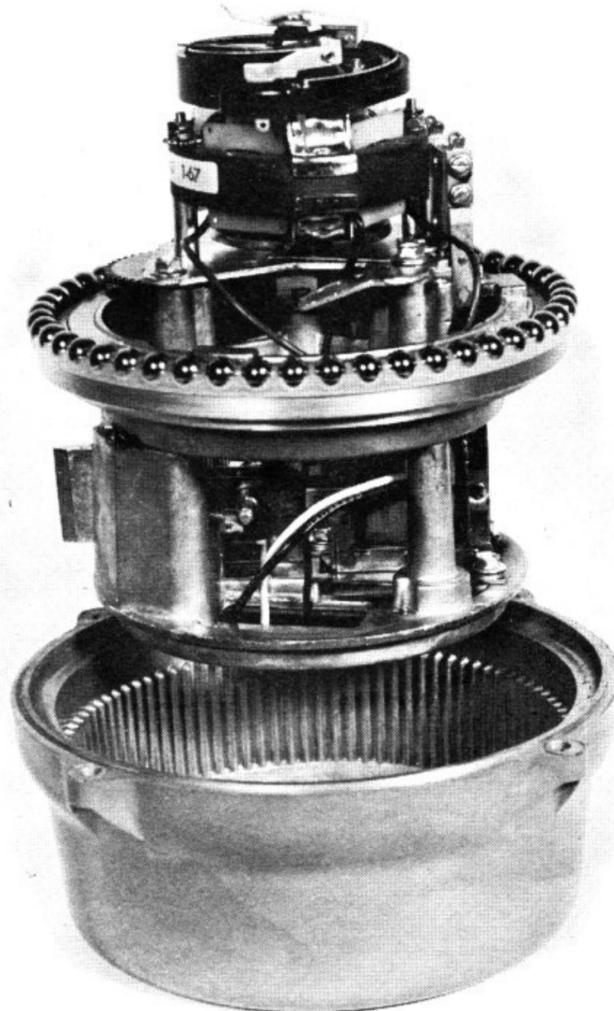


Fig. 1—Rotator Mechanism

Circuit Description Two transformers are mounted in the control unit. The power transformer supplies approximately 30V. AC for releasing the brake and operating the motor when the control lever is moved completely to the left or right of the mid-position. Overheating of the transformer from prolonged operation or possible short circuit is prevented by a thermal cut-out switch in the primary winding.

The motor is a two-phase device, the first winding is supplied AC direct from the transformer, while the second has a 130 mfd. capacitor in series in order to shift the phase and provide forward rotational torque. To reverse, the capacitor is switched in series with the first winding, while the second is directly supplied from the transformer. This switching is done by simply moving the control lever from side to side, the center position is off, and cuts the line voltage off the entire unit.

The solenoid which releases the brake operates from the same transformer that supplies power to the motor.

The instrument transformer is energized as the control lever is moved slightly to the left or right of mid-position. It illuminates the meter dial and supplies approximately 21 VDC through a 100 PIV Diode to the 500 ohm potentiometer in the rotator.

The meter is a high quality DC instrument requiring 1 MA for full scale deflection. It is connected with plus side through the 18K multiplier to the plus side of the pot. The meter circuit is completed through the 5K compensating control inside the cabinet and the 5K calibrating control on the rear to the pot arm which is grounded. With nominal components and 115 VAC line, both controls should be in center thereby adding 5K ohms to the 18K resistor so that the meter multiplier totals 23K for 21 VDC to give 1 MA full scale deflection. The 20K resistor, from center of pot to negative, balances the shunting effect of the meter on a portion of the 500 ohm pot and reduces by half the maximum error. Deflection increases as pot arm moves to negative end.

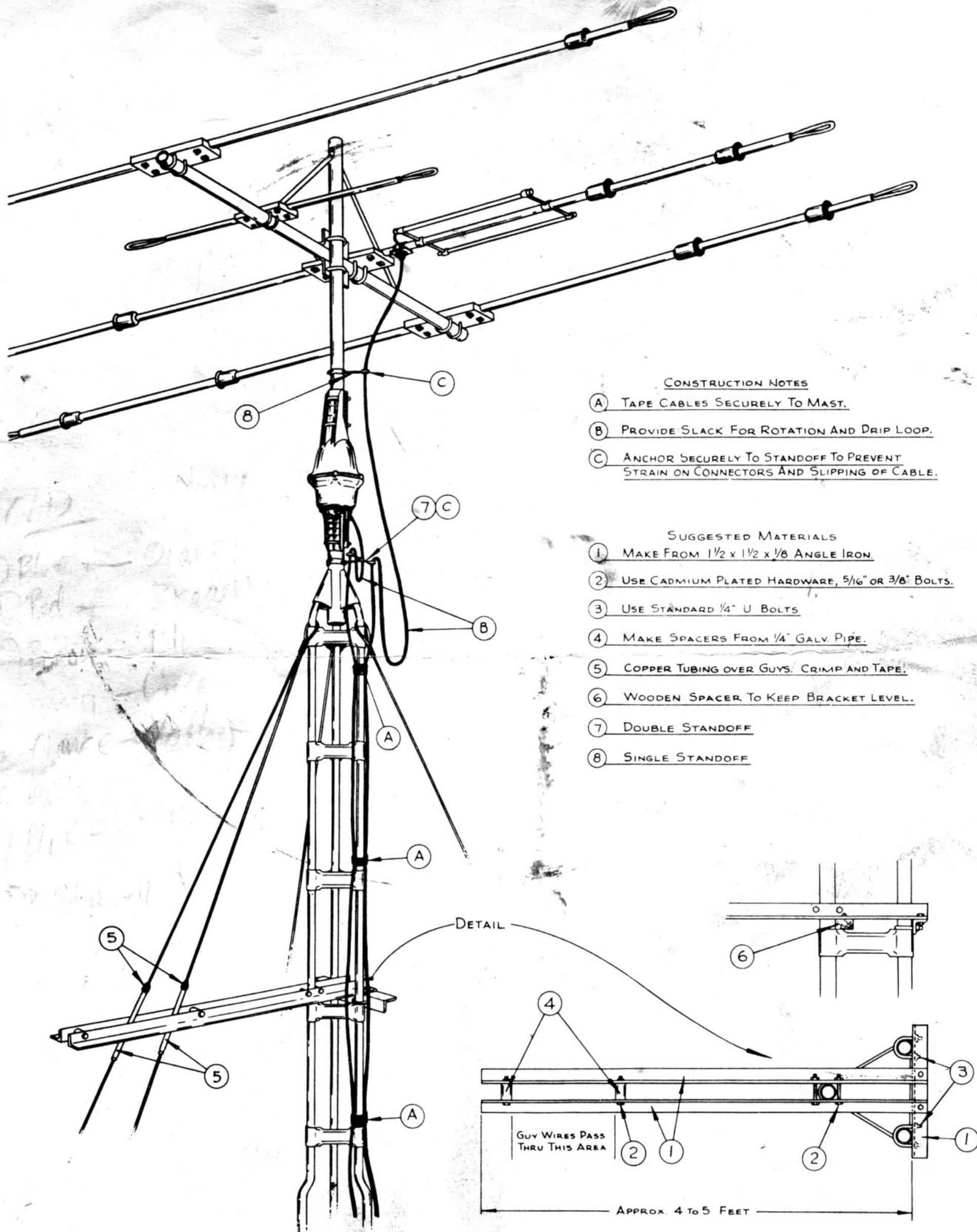


Fig. 2—Top Tower Installation with Torsion Bar
 (See Page 12, Paragraph 5 for Inside Tower Mount)

Two electrical limit switches in the rotator cut the motor power just before the rotation reaches the extremes. A fuse is included on one side of the supply line. The calibrating control, accessible from the rear, is used to establish exact readings for the particular line voltage present. Full scale value will be directly proportional to line voltage. If the line goes up 5% (6 volts) the high reading will go up 18°. The center reading will go up 9°.

A number of variations of the circuit are possible—depending upon individual operators desires. These are discussed as "Possible Field Modifications" on Page 12. Series 3 circuit modification should be studied carefully. It is shown as Alternate B in the schematic diagram below.

Servicing the Control Unit

Disconnect the AC power source and remove the eight-wire cable. Tag each wire with its number.

The control box can be checked without removing the cover using an ohmmeter and voltmeter to check values across terminals. Resistance from terminals #1-2 should be .4 ohms with switch in any position. Read same value #1-5 switch right and #1-6 with switch left. Resistance across input line cord should be 3.8 ohms.

With power cord connected, read approximately 30 VAC terminals #1-2 and 31 VDC across terminals #3-7 with switch operated in either direction.

The electrolytic motor capacitor must be of proper value to give adequate motor torque. If a new capacitor is not available for check by substitution, a quite reliable check may be made using the power transformer in the control box and an auxiliary 1 ohm 10 watt resistor.

To make this capacitor check, remove cable from terminals. For Series 1, 2 or 3, tie terminal #2 to #4. Connect one end of resistor to #1. On Series 1 or 2, return resistor to #3. On Series 3 return it to #8.

Move lever to L or R to apply power. If capacitor is OK, it will draw sufficient current to cause a voltage drop of 1.4 to 1.6 volts to be present across the resistor. Measure with an AC voltmeter.

Checking the Rotator from the Ground

One may possibly avoid bringing the rotator down from the mast by making electrical checks from the position of the control box. This is done by disconnecting the eight wires from the screw terminals and tagging them carefully #1 through #8 to correspond with the terminal numbers from which they are removed. From the schematic diagram it is apparent that the resistance of the lead wires will be added to the resistance of the motor windings and potentiometer strip in making the resistance checks.

Leads #1 and #2 of #18 AWG have approximately 0.64 ohm resistance per 100 feet and leads #3 through #8 of #22 AWG have approximately 1.6 ohms resistance per 100 feet. Use a low resistance ohmmeter to check the values shown in the table below to an accuracy of 10 percent after adding the resistance of the leads involved.

To Check	Read Resistance	Between Terminals	
		Series 1 or 2	Series 3
Brake Solenoid	.75 ohms + leads	1-2	1-2
1/2 Motor Winding	2.5 ohms + leads	1-3	1-8
1/2 Motor Winding	2.5 ohms + leads	1-4	1-4
1/2 Motor + Switch	2.5 ohms + leads	1-5	1-5
1/2 Motor + Switch	2.5 ohms + leads	1-6	1-6
Entire Motor	5 ohms + leads	3-4	8-4
Right Limit Switch	0 ohms + leads	3-5	8-5
Left Limit Switch	0 ohms + leads	4-6	4-6
Entire Pot Strip	500 ohms	3-7	3-7
Pot Arm to + End	0 to 500 ohms	3-8	3-1
Pot Arm to - End	0 to 500 ohms	8-7	1-7

Disassembly of Rotator

1. Remove the bottom mast support to permit the rotator to be set on a flat bench.
2. Remove four screws and carefully raise top casting to expose potentiometer and drive mechanism.
3. Carefully remove upper ball retaining ring. Keep it circular, and lay it on clean paper.
4. Inspect inside of top housing for small scratches or burned spots on the ribs. These are an indication that a switch blade or connection is rubbing during rotation. See that the pot strip is clean and not burned at either end. See that pot body

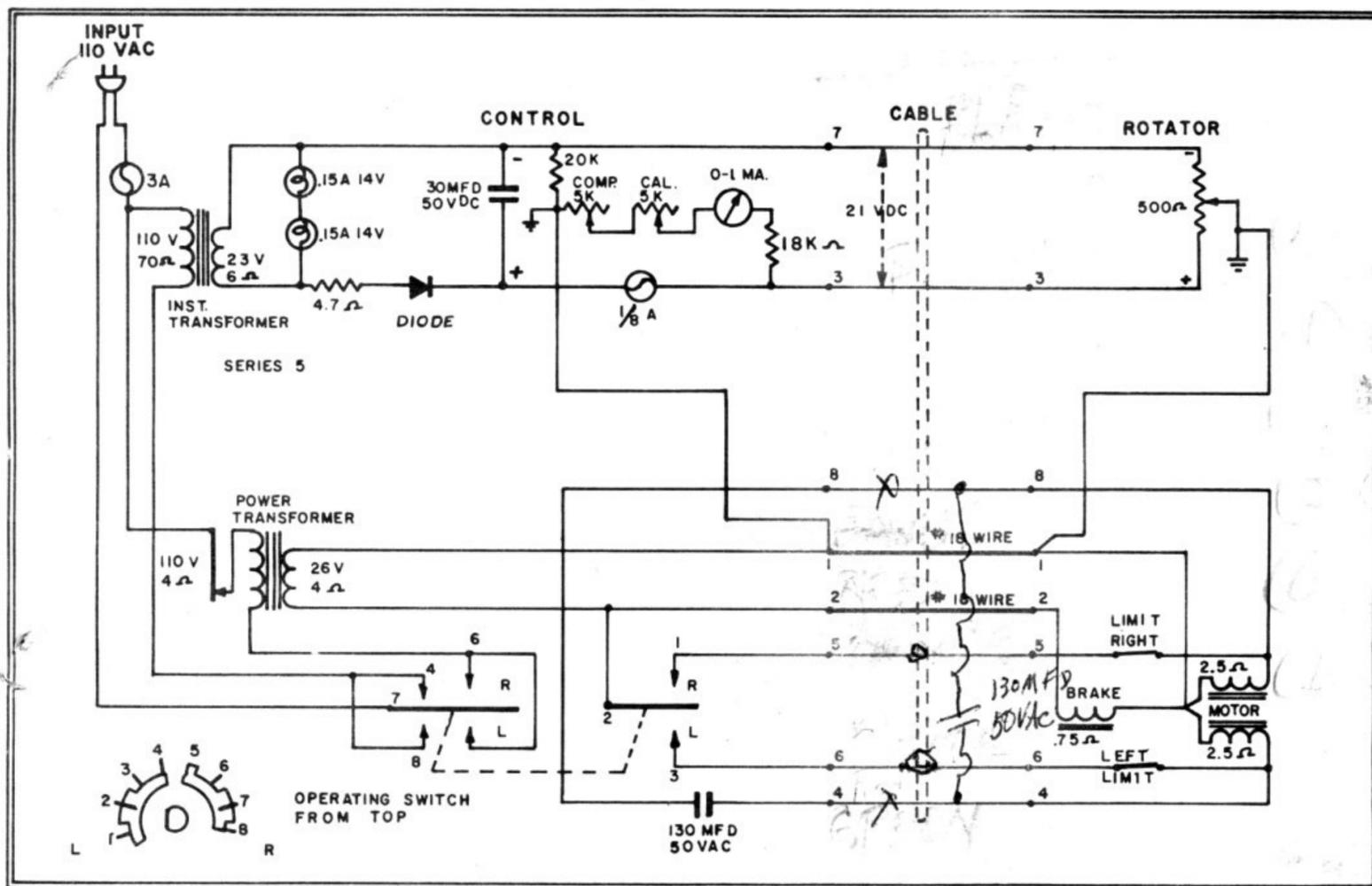


Fig. 3 — Schematic Diagram — Series 5

is secure and that pot arm is clean at the point of contact. Use only fine rouge cloth to polish contact arm. Check limit switch to see if wires are secure and insulation is undamaged. Contacts should be clean. Check for $\frac{1}{32}$ " clearance between switch blades and motor—particularly alongside of lock-washer under motor fastening. Greater clearance gets switch too close to top bell housing ribs.

5. If the drive ring happens to be near end of rotation, operate the top spur gear to rotate the mechanical stop on the drive ring away from the area of the limit switch. See that the mechanical stop lever (which is positioned between the two limit switches) will open each electrical contact before it hits the corresponding mechanical stop. Also see that the stop lever has not been deformed and that the electrical contacts are clean and uncorroded.
6. Rotate the top spur gear several revolutions to determine that the motor and its bearings are operating freely. Look for broken teeth in any of the gears.
7. Lift the motor and brake mechanism out of the brake housing. Carefully remove the lower ball bearing retainer and place it on a clean piece of paper.
8. Remove the drive ring gear from the base housing. This is accomplished by first pulling up on the side opposite the gear train. Then raise the entire ring slightly upward with the side away from the gear train higher so that it will slide out from under the gears. Examine closely for evidence of broken or worn teeth.
9. Examine the inside of the screw terminal strip to see that there is proper clearance between the solid lugs and frame and that there are no faults in the insulation. Pay particular attention to the insulation at the point where the wires are held in metal clips.
10. Examine the teeth in the brake casting.
11. To separate motor, pot, and gear assembly from the brake assembly, unsolder the solenoid leads from terminals 1 and 2. Remove screws holding terminal board to casting. Then remove four large screws in the base. Be careful to clear wires and terminal strip through opening.
12. The latch mechanism, accessible only after step 11 disassembly, slides down into grooves in the casting and provides the top bearing surface for the brake wedge. The latch itself, which is held down by the compression springs, should prevent the brake wedge from being pushed into the casting from the outside. When the plunger is pushed into the solenoid by pressure applied on the latch pin, where the retracting springs are attached, the wedge is withdrawn and may then be pushed clear into the casting.
13. To remove potentiometer, pry the spring fasteners of Series 1 loose with a sharp instrument. On Series 2 or 3, remove hex nuts. Unsolder leads. Mounting studs are welded to the motor frame. Be sure that the pot strip is clean and that pot arm is not corroded. Use only fine rouge cloth as an abrasive. In replacing the pot be sure the connections are on the side which overhangs the motor.
14. To replace the motor, first remove the pot per Paragraph 13, then unsolder black motor lead from screw terminal 1, the red lead from inside left limit switch lug, and the blue lead from inside right limit switch lug. Fastenings holding motor on studs may then be removed and the motor pulled up and out. In replacing a motor, be sure to see that the round hole in the motor is next to the limit switch. Use a double lock nut on this stud near the limit switch, to provide clearance with the leads. Use special internal-external lockwasher over the stud that works in the slotted hole in the motor. Be sure that the pinion is snug against the spur gear before tightening this fastening over the slot.
15. When it is necessary to closely inspect or replace gears, it is possible to remove motor, limit switch, pot, and terminal strip without unsoldering more than the solenoid leads from terminals 1 and 2. Remove motor fastenings from the mounting studs. Work motor up and out, exercising care in

pulling leads and terminal strip through the window in the gear housing. Remove plate to expose gears. Carefully note positions for proper replacement.

Final Reassembly of Rotator

It is assumed in the following instructions that the brake mechanism is assembled and operative. The motor and gear train along with potentiometer and limit switch are likewise assembled and wired and operative.

It is not likely that the brake wedge will be exactly positioned in relation to the teeth in the brake housing to permit proper assembly unless the brake mechanism is retracted. For this reason it is necessary to operate the brake mechanism electrically during step 8 of the assembly of the rotator unit.

1. See that a small amount of low temperature, high quality, light weight grease is conservatively distributed around the ball bearings, ring gear, and spur gears. Only an even film of grease is desirable (approximately one thimbleful of grease should be used to lubricate a completely dry rotator). Excessive grease will only run out in high temperatures or cause power loss in low temperatures. A few drops of light weight #10 lubricating oil should be applied to the motor bearings.
2. Rotate upper spur gear until the inwardly protruding mechanical stop on the ring gear engages the channel shaped stop lever and pushes it far enough to the right to just open the right hand limit switch contact (it is assumed that the rotator is viewed from the side of the limit switch). This situation represents the extreme counterclockwise end of rotation. The potentiometer arm must then be rotated to its extreme counterclockwise position against the top brass stop.
3. Secure the upper bell housing upside down by the mast support in a vise with the open end of the "V" toward the bench. The boss which drives the potentiometer arm which is located in the bottom part of the ball housing will then be to the left of center.
4. Clean the inner portion of the housing and apply a small amount of grease to the ball race. Then carefully insert one ball bearing assembly with the flanged rim up and against the outer edge of the casting.
5. Grasp the operating mechanism by the flat base, steady the ring gear, invert the mechanism and lower it into the housing. In doing this, note that the serrated portion of the potentiometer arm must engage the driving boss in the housing and that the three driving lugs on the ring gear must engage the mating lugs in the top housing. This situation will result automatically if the previous instructions have been followed.
6. Determine that the top bearing surface is clean and apply a film of grease on the top ball race and the top bearing assembly. Then apply the top bearing assembly to the race with the rim downward.
7. Clean the brake housing and apply a light film of grease to the ball race only. Lower the brake housing into place so that the assembly holes will approximately line up with the threaded holes in the upper housing. **DO NOT MECHANICALLY FORCE AN EXACT ALIGNMENT OF THESE HOLES WITHOUT ELECTRICALLY RELEASING THE BRAKE MECHANISM.**
8. Connect the control terminals #1 and #2 only to the corresponding terminals on the rotator while it remains clamped in the vise. Momentarily operate the lever on the control box in either direction to retract the brake. This will permit the brake housing to be freely rotated for exact alignment of the holes. With the power applied to the brake, insert the 4 assembly screws and run them down to a reasonably tight position. Keep the brake retracted electrically while all 4 screws are being tightened. Release the brake electrically and use a heavy screwdriver with wrench to completely tighten the 4 assembly screws. Torque to 85 inch pounds.
9. It is suggested that all 8 wires be connected from the control box while the rotor is still on the bench and that its complete operation be checked.

TROUBLE SHOOTING SUGGESTIONS

Field experience has shown that most operational difficulties with the HAM rotor are traceable to broken, shorted, or grounded wires—usually at the terminal strips. Time spent in cutting the leads to exact lengths, tinning, forming, and wrapping around terminals, cutting insulation to exact length, and clamping to prevent strain on any single wire, will pay big dividends later in long and trouble-free performance. Put it up right—and leave it up!

Should trouble occur, first follow the suggestion on Page 5 for "Servicing Control Unit" and "Checking Rotor From Ground". Compare resistance values with Schematic Diagram to localize trouble. The following "symptoms" and "treatments" may also be helpful.

Mechanical Play

To prevent binding under adverse operating conditions, a small amount of play is designed into the rotor. Even a degree or so of rotary play will permit several inches movement at the end of a wide antenna boom, or at the tips of the elements. Frequently the slight motion of the antenna array in gusts of wind is due more to the natural flexing of the elements and masts than it is due to actual play in the rotor mechanism.

Antenna Rotates in Heavy Wind

This is usually a matter of the mast slipping in the support. For large arrays it is often necessary to drill a $\frac{3}{8}$ " hole through clamping plate, mast and mast supports and pin them together with a non-corrosive fastening. A false indication of suspected "slipping" can be obtained by comparing meter readings at different times when the beam has not been "rotated officially". Since the indication varies directly with line voltage, a change of 10% will make 36° difference in indicator at full scale of 18° difference at mid-scale. For extreme accuracy and quick checking without rotation of beam, modification 4, page 12 is recommended. If the rotor is actually turning, the brake latch is not engaging properly. Since it is pulled into place by springs and only retracted electrically, it will be necessary to disassemble the rotor per instructions on page 5 and 6 and follow suggestions of step 12 regarding the latch mechanism.

Lack of Power

so that antenna rotation is slow or sluggish. Be sure that the heavy leads in the cable were used for Terminals #1 and #2, as these leads must carry about 5 amps. to handle power for both the brake and motor. Use method on page 5 to check motor from ground. Check the capacitor per paragraph 4, page 5. Check transformer for AC output.

If the electrical circuit is OK, then check for mechanical binding. Pay particular attention to bearings and alignment of shaft on an inside tower mount. As a last resort, dismantle the rotor to check gears, bearings, etc.

No Meter Indication

The brake and motor operate independent of the indicating system. If the pilot lights burn at proper brilliancy, the instrument transformer is OK and output is not shorted. Check for about 21 VDC across terminals #3 and #7 with switch operated. If this is present, check for 500 ohms across these leads to rotor (disconnected at control box). If 500 ohms is present from #3 and #7, see if the readings from #3 to ground and #7 to ground total 500 ohms. If this is so, connect an auxiliary meter from terminal #3 to ground and see that voltage runs from zero to about 21 volts as antenna is rotated from left to right extremes.

No Rotation—Indication OK

Either the thermal cutout in the power transformer has opened to protect the motor or capacitor from excessive heat of prolonged operation or there is actually trouble on the motor circuit. After allowing time for the thermal cutout to restore service, proceed with suggestions above for "lack of power".

Grounded Leads

Grounds on cable leads in Series 1 or 2 rotors can cause completely erroneous readings and even burn out the pot strip. On Series 3 grounds will burn out either the line fuses or the small fuse in the DC circuit. For full explanations, refer to Schematic on page 5 and to circuit modification 3, page 12. Note that in Series 1 or 2 a ground on any of the AC leads #1, #2, #4, #5, #6, or #8 is the same as grounding lead #3 which is common to the AC and DC system. If lead #3 is grounded, it shorts out part of the pot, so that as rotation progresses to the other end, the full DC voltage is applied across a decreasing portion until current becomes so high that it burns out. Note also that in Series 3 wiring any grounds either put an overload on the power transformer which causes the line fuse to blow, or overload the rectifier circuit so that the $\frac{1}{16}$ amp. fuse blows.

Meter Fluctuation

An intermittent condition in any component in the rectifier or meter circuits within the control box, as well as in the cable or potentiometer circuit in the rotator itself can cause meter fluctuation or error. Possible causes of such trouble may be localized by placing a test DC meter across terminals #3 and #7 and comparing the action of the test meter with the panel meter.

If the test meter fluctuates along with the panel meter, either a component in the rectifier circuit is intermittently defective, or an intermittent trouble-ground is drawing excessive current. To further localize such a condition, leave the test meter on terminals #3-#7 and remove the corresponding leads to the rotator. This removes the load from the DC circuit so the test meter will show about 32 volts. The panel meter sensitivity will be cut about in half, so it will show about $\frac{3}{4}$ scale. Fluctuation of the test panel meters will now point to trouble in the DC rectifier circuit. Fluctuation of panel meter only, will point to intermittent trouble in the meter, multiplier resistors, or the "comp." or "cal." pots.

Where the meters are steady in preceding tests, and there is fluctuation with rotator leads connected, it indicates trouble in the lead wires or rotator itself. Any break in insulation or corrosion that causes intermittent grounding or electrolytic action on any leads on Series 1 or 2 wiring will cause abnormal voltages to appear on the pot. The resultant fluctuations usually cause the meter to pulse *upward* from a given reading. Any dirt, grease or corrosion that breaks or interferes with the ground return from the potentiometer slide will cause the needle to fluctuate from a true reading toward a center scale point. In such cases it is necessary to open the rotator per instructions on page 5.

In Series 1 and 2, the ground connection from the pot arm is carried to the "bell" housing through the hinge plate that bears against the inside of the housing. On Series 3, the ground connection is carried through the potentiometer pivot directly to the frame. A potentiometer modification kit, RK-10, may be purchased to rework Series 1 or 2 potentiometers to incorporate the revised method of grounding. This will eliminate possible sources of meter flutter within the rotator unit.

PARTS AND PRICE LIST

FOR CONTROL UNIT (Series 1)

NEW PART NO.	OLD PART NO.	NAME	QUANTITY	PRICE EACH
50192-00	MCU-121	Control Unit Complete (Series 3 only)	1	\$55.65
50267-00	MX-82	Control Cabinet (Bakelite Special)	1	4.20
50176-00	MCU-101	Power Transformer, Special—115 VAC Input	1	10.50
50177-00	MCU-102	Instrument Transformer, Special—115 VAC Input	1	5.25
50040-00	ACU-101	Motor Capacitor 130-140 mfd. 50V. AC	1	1.65
50183-00	MCU-109	Filter Capacitor 30 mfd. 50V. DC	1	1.31
50418-00	XD-9	Rectifier, 1/2 wave, 100 MA 2 plate	1	2.10
50178-00	MCU-103	Control Switch, Special	1	2.21
50170-03	MCU-5-3	Control Switch Handle	1	.33
50189-00	MCU-118	Compensating Potentiometer, 5K, Special	1	.74
50182-01	MCU-108-1	Calibrating Potentiometer, 5K W.W. 2 watt	1	1.73
50187-00	MCU-116	Calibrating Potentiometer Knob	1	.26
	W-634	Resistor, 4.7 ohms. 5% 1/2 watt	1	.35
	W-701	Resistor, 18K ohms. 5% 1/2 watt	1	.35
	W-637	Resistor, 20K ohms. 5% 1/2 watt	1	.35
50181-00	MCU-107	Pilot Light, 14 volts GE #1488 or Equal	2	.35
50184-00	MCU-110	Pilot Light Socket Assembly, Special	1	.68
50195-02	MCU-127-2	Meter, 0-1 MA., Special (NORTH center scale)	1	23.10
	FG-303	Fuse—3 amp. 3 AG	1	.18
50185-00	MCU-112	Fuse Holder—Littlefuse #357001 or Equal	1	.42
50196-02	MCU-148-2	Meter Crystal	1	2.63
50399-00	TRA-146	Terminal Board Assembly, Special	1	.40
50301-00	RP-36	Rubber Feet (Bottom) with SS-84-2 Screw	4	.18
50300-00	RP-35	Rubber Bumpers (Panel)	2	.09
50202-00	MCU-159	Instrument Transformer—220 VAC Input	(Option)	5.25
50203-00	MCU-161	Power Transformer—220 VAC Input	(Option)	10.50

Changes Incorporated in CONTROL UNIT (Series 2)

	FG-303	Fuse—3 amp. 3 AG	Add 1	.18
50185-00	MCU-112	Fuse Holder—Littlefuse #357001 or Equal	Add 1	.42
50193-00	MCU-123	Fuse Holder Bracket	Add 1	.18
50157-02	IT-69-2	Terminal Strips	2	.09

Changes Incorporated in CONTROL UNIT (Series 3)

	MCU-128	Fuse—1/16 amp. Pigtail Type (Not shown Fig. 4) (NOTE: DO NOT substitute Slow Blow type fuse.)	Add 1	.25
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Changes Incorporated in CONTROL UNIT (Series 4)

	MCU-128	Fuse—1/16 amp.	Omit	
50563-00	FG-301/8	Fuse—1/8 amp.	Add 1	.29
50185-00	MCU-112	Fuse Holder—Littlefuse #357001 or Equal	Add 1	.42

Changes Incorporated in CONTROL UNIT (Series 5)

50501-00		Diode 100 Piv.	Add 1	.55
10555-00	S-79	Dual Terminal Strip	Add 1	.09
50185-00	MCU-112	Fuse Holder #357001 or Equal	Omit 1	
50193-00	MCU-123	Fuse Holder Bracket	Omit 1	
	FG-303	Fuse 3 amp. 3 Ag.	Omit 1	
50185-00	XD-9	Rectifier, 1/2 wave 100 MA. 2 Plate	Omit	

Accessories for Optional Field Modifications

50697-10	RK-8	North Centered Meter Scale Kit		2.10
50561-10	RK-9	South Centered Meter Scale Kit		2.10
50562-10	AK-120	Front Panel Control Kit		10.50
50559-10	AK-121	Tower Mounting Plate Kit		2.28
50560-10	AK-129	Shim & Wedge Kit		5.50

ORDER PARTS USING COMPLETE NUMBER & DESCRIPTION

To order parts, remit check or money order for total parts cost plus \$.50 for postage and handling to: Cornell-Dubilier Electronics, Department "C", 118 E. Jones Street, Fuquay-Varina, N. C. 27526

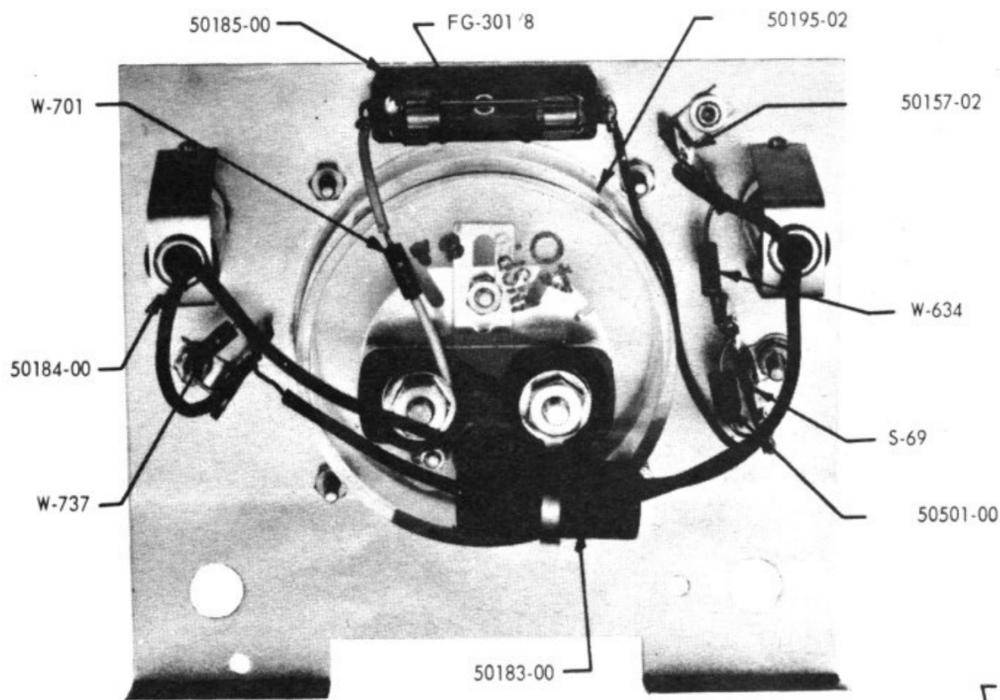


Fig. 4

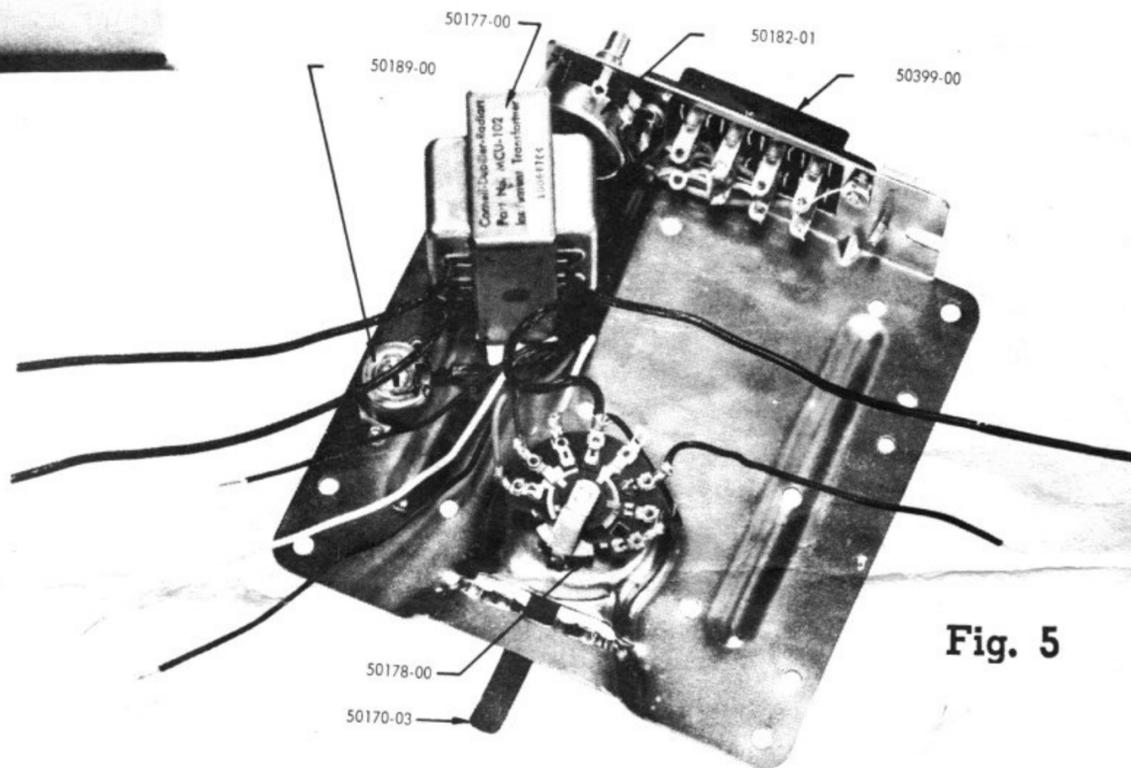
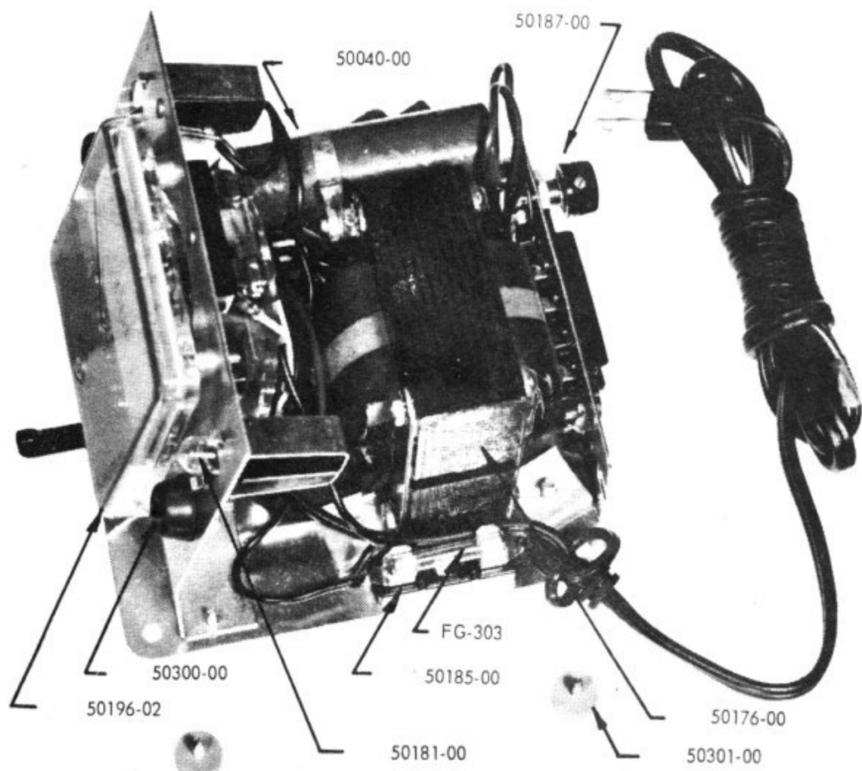


Fig. 5

Fig. 6



WARRANTY

CORNELL-DUBILIER ELECTRONICS warrants each new CORNELL-DUBILIER ROTOR to be free from defect in material arising from normal usage. Its obligation under this warranty is limited to replacing, or at its option repairing the rotor which, after regular installation and under normal usage and service, shall be returned within **ONE (1) YEAR** from date of original consumer purchase of the rotor to **Cornell-Dubilier Electronics, Rotor Service Dept., 118 E. Jones St., Fuquay-Varina, N. C. 27526**, together with satisfactory evidence of such purchase, and which shall be found to have been thus defective in accordance with the policies established by CORNELL-DUBILIER ELECTRONICS.

The obligation of CORNELL-DUBILIER ELECTRONICS does not include either the making or the furnishing of any labor in connection with the installation of such repaired or replacement rotor, nor does it include responsibility for any transportation expense.

CONDITIONS AND EXCLUSIONS

This warranty is expressly in lieu of all other agreements and warranties, expressed or implied, and CORNELL-DUBILIER ELECTRONICS does not authorize any person to assume for it the obligation contained in this warranty and neither assumes nor authorizes any representative or other person to assume for it any other liability in connection with such CORNELL-DUBILIER Rotor.

The warranty herein extends only to the original consumer and is not assignable or transferable, and shall not apply to any rotor which has been subject to alternation, misuse, negligence or accident.

CORNELL-DUBILIER ELECTRONICS
118 E. Jones Street
Fuquay-Varina, N. C. 27526

PARTS AND PRICE LIST

FOR HAM ROTATOR UNIT

[For ordering procedures See Page 8]

NEW PART NO.	OLD PART NO.	NAME	QUANTITY	PRICE EACH
50232-00	MRU-47	Rotator Unit Complete	1	\$82.95
50349-01	TRA-44A	Lower Mast Support Assy.	1	3.51
50339-00	TRA-24	Terminal Cover Plate for Lower Mast	1	.09
50155-00	IG-5	Grommet for Terminal Cover	1	.09
50304-01	TRA-1-2	Upper Mast Support (Bell Casting)	1	7.01
50095-00	ARU-47	Brake Housing (Lower Casting)	1	7.04
50335-01	TRA-20-1	Ball Bearings	98	.09
50113-00	ARU-66	Ball Retainers	2	.88
50097-00	ARU-49	Brake Support Casting	1	5.25
50370-00	TRA-87	Base Casting & Gear Shaft Assy.	1	4.25
50310-00	TRA-12	Motor Pinion (Nylon)	1	.26
50112-00	ARU-65	Gear and Pinion (1st, 2nd, and 3rd from Motor)	3	4.41
50111-00	ARU-64	Gear and Pinion (Thick pinion 4th from Motor)	1	5.25
50107-00	ARU-60	Final Spur Gear	2	2.21
50313-00	TRA-18	Ring Gear (Cast Aluminum)	1	1.40
50341-00	TRA-29-1	Small Gear Spacer (Brass)	1	.09
50378-00	TRA-118	Large Gear Spacer (Steel)	1	.35
50379-00	TRA-119	Bushing for Final Spur Gear	1	.35
50460-00	TRA-127	Motor & Pinion Assy.	1	13.16
50122-00	ARU-78	Motor Mounting Plate with Studs	1	1.75
50231-00	MRU-45	Potentiometer Assembly (Complete)	1	7.88
50090-00	ARU-42	End of Rotation Switch Assembly (Complete)	1	2.16
50338-00	TRA-23	Stop Lever Assembly	1	.26
50099-00	ARU-51	Solenoid Only	1	8.77
50100-00	ARU-52	Solenoid Pin	1	.26
50101-00	ARU-53	Solenoid Pin Spacers	3	.26
50282-06	RCP-29-6	Solenoid Pin Retaining Ring	2	.09
50114-00	ARU-67	Solenoid Retracting Springs	2	.18
50096-00	ARU-48	Retracting Spring Clip	2	.09
50103-00	ARU-55	Brake Wedge (Casehardened Steel) (Order AK-129) (P-8)	1	
50098-00	ARU-50	Connecting Links	2	.35
50102-00	ARU-54	Connecting Link Pin	1	.26
50117-00	ARU-70	Brake Wedge Support	1	.70
50104-00	ARU-56	Brake Latch	1	.88
50106-00	ARU-58	Latch Pins	2	.18
50282-04	RCP-29-4	Latch Pin Retainers	2	.09
50105-00	ARU-57	Latch Springs	2	.18
50399-00	TRA-14-6	Terminal Board Assembly (8 Terminals)	1	.40
50397-00	TRA-143	Shim, Nylon (Sold in AK-129)	1	
	WL-28-7	Retainer for Stop Lever Assembly	3	.09
	WP-54	Washers	3	.09
	SS-64-2	Self-Tap Screw 6-32x $\frac{3}{8}$	2	.09
	SL-5-2	Hex Hd. Screw (Taptite) 12-24x $\frac{3}{4}$	4	.09
50463-00	AK-128	Mounting Kit	1	5.25
	Includes	(2) B14 50115-00 Mast Clamp		
		(4) A08 50382-00 "U" Type Bolt (Stn. Stl.)		
		(4) A14 50502-00 Spacer		
		(6) SM-217-2 Screw, Hex Hd. $\frac{1}{4}$ -20x1 $\frac{1}{4}$		
		(10) NM-68 Hex Nut $\frac{1}{4}$ -20 (Stn. Stl.)		
		(14) WK-11-2 Lockwasher, Split $\frac{1}{4}$ "		

Fig. 7

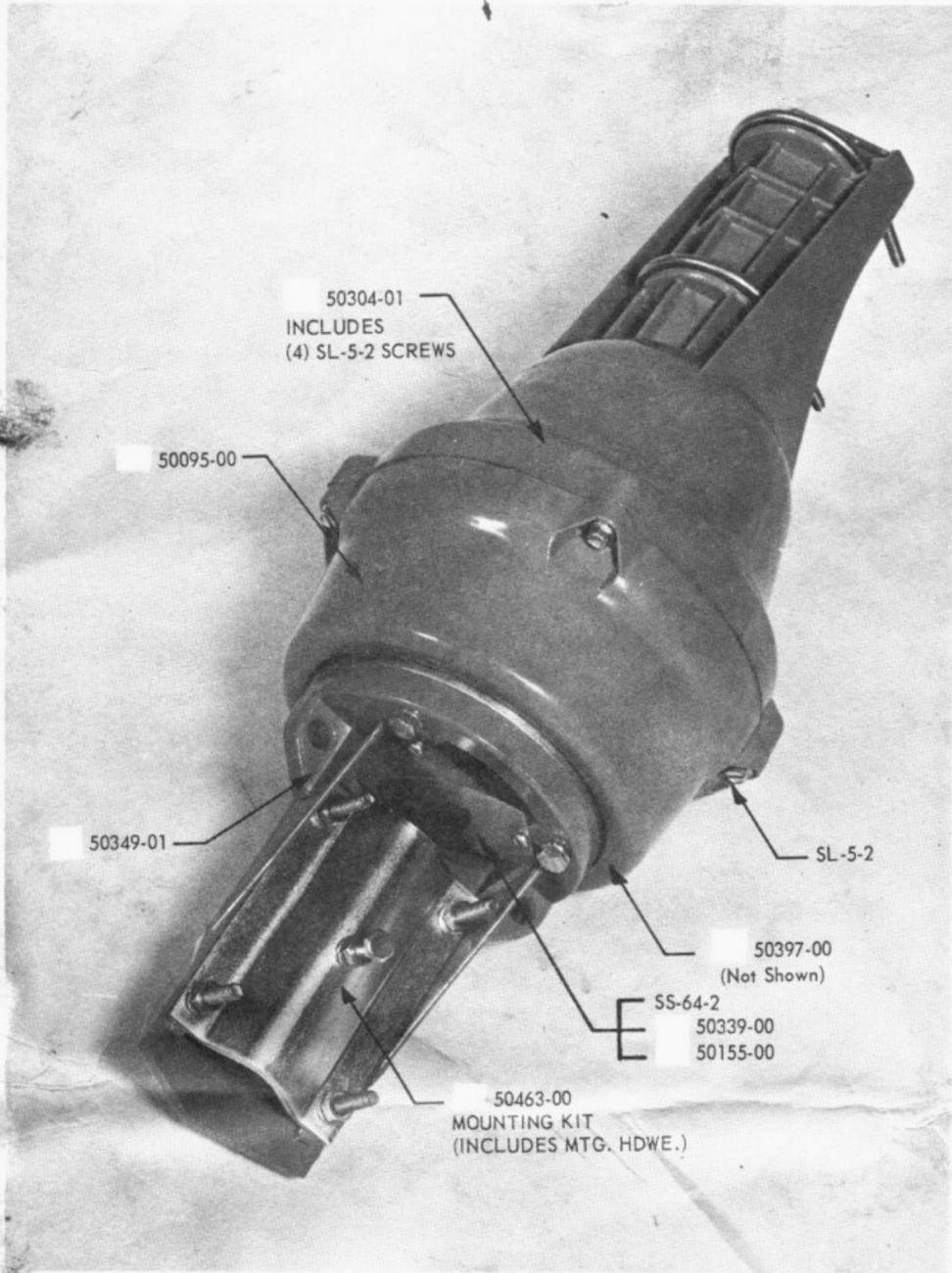
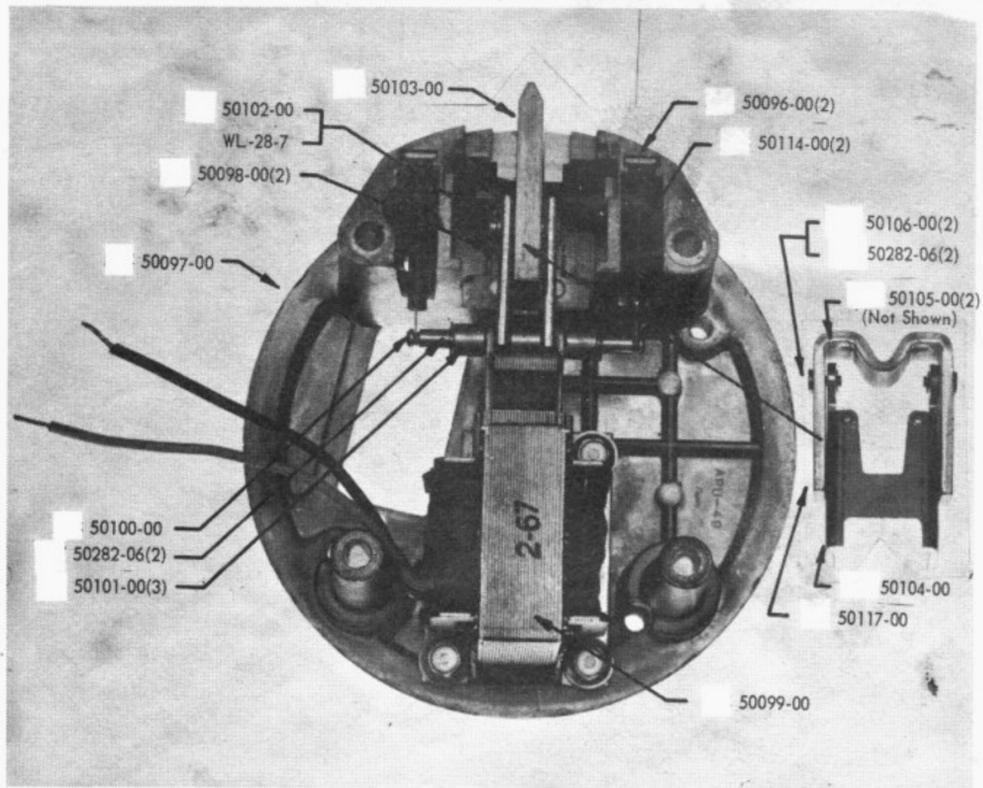


Fig. 9

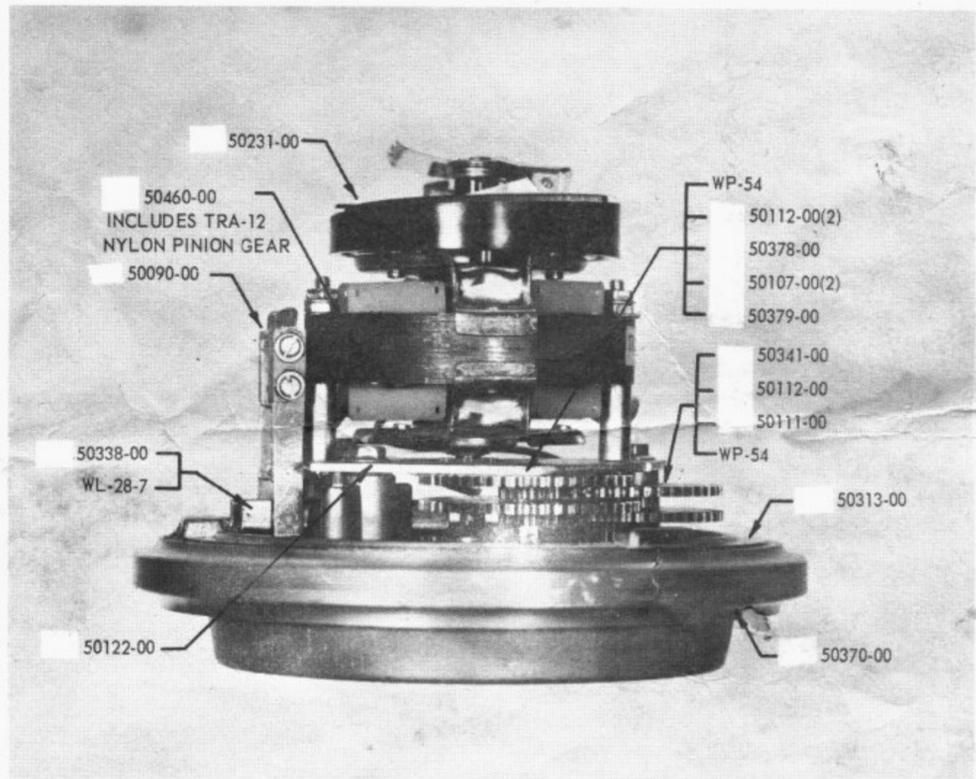
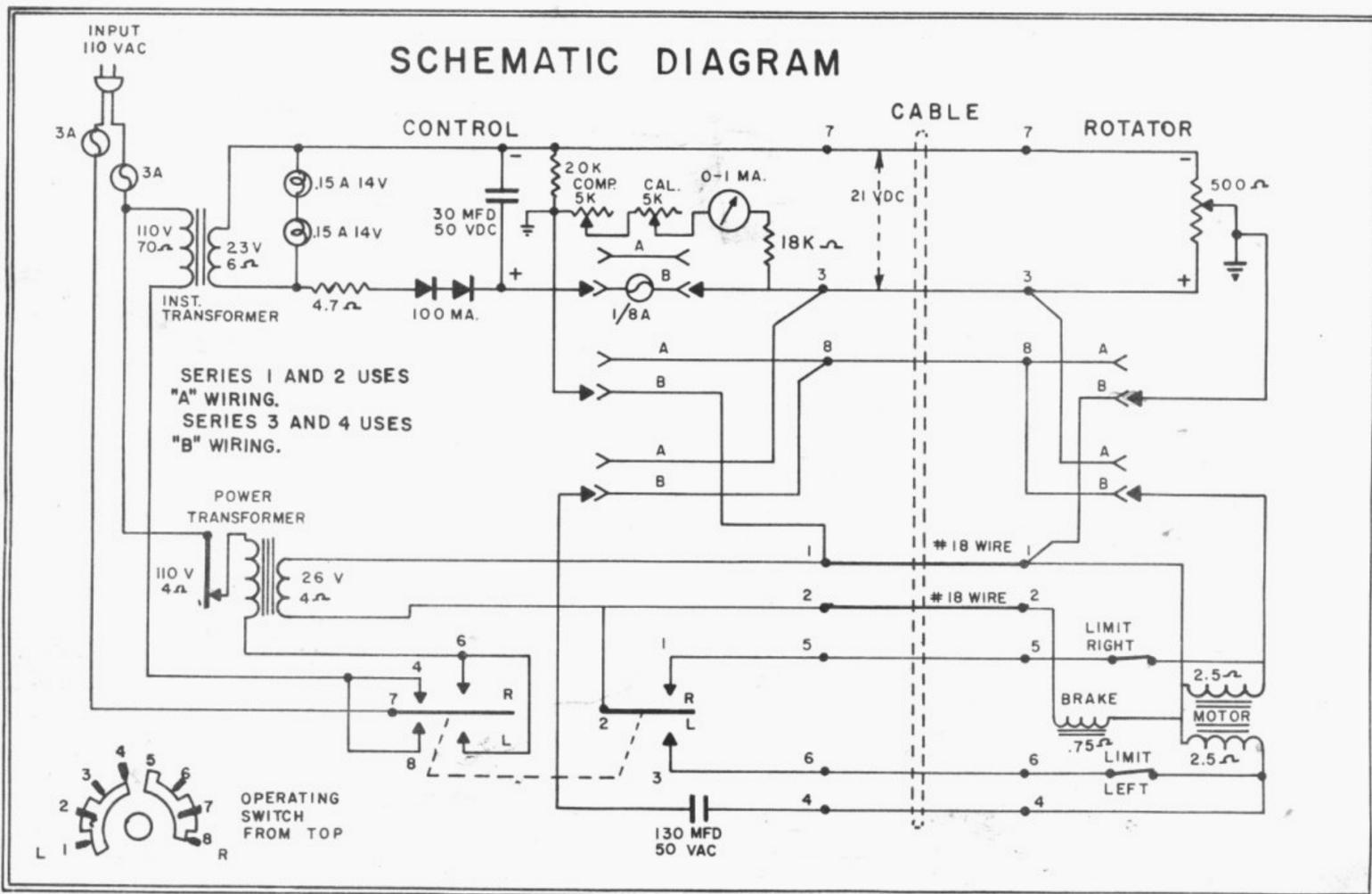


Fig. 8



SERIES 1 THRU 4

FOR
 4-66
 2-14-3

POSSIBLE FIELD MODIFICATIONS

(1) Continuous Meter Indication

may be obtained by providing an auxiliary power "on-off" switch and then placing a jumper between terminals 7 and 8 on the regular operating switch. The instrument transformer and associated circuits are designed for continuous service. A blank position on the control box panel may be used to rotate the power switch if a matching hole is drilled through the case.

(2) Alternate Meter Scales

Series 1, 2 and early Series 3 production used meters having South in the center of the scale. By popular request, regular production was changed to provide meter scales having North in the center. Since some locations will always favor one or the other, two replacement kits with hardware, and instructions are available as RK-8 with North-Centered scale and RK-9 which is South-Centered. See page 8.

(3) Series 3 Circuit Modification

Field experience has shown that occasionally one of the conductors in the cable or a wire in the control box or rotator becomes accidentally grounded. If this occurs on Series 1 or 2 HAM Rotors, it is possible to burn out the pot strip in the rotator unit. The wiring may be changed in both the rotor and control to eliminate such a possibility. Trouble generally is "blow a fuse in the control box" and will not burn the rotator unit. Revised wiring is called as Alternate B in the Schematic Diagram on Page 5.

To change from Series 1 or 2 to Series 3 wiring, make the following changes in the control box: (1) Clip off back portion of terminal 8, leaving 20K resistor connected to ground lead and screw portion of terminal open. (2) Remove motor capacitor lead from terminal 3 and connect to remaining portion of terminal 8. (3) Ground terminal 1 to chassis, leaving present wires in place. (4) Wire $\frac{1}{8}$ amp. pigtail fuse into lead from rectifier positive to terminal 3.

In addition to changes on control box, change rotor as follows after removing outer case per instructions on page 5. (1) Remove three leads from inside blade of left hand switch. (Position rotator mechanism with limit switch toward operator). These leads go to plus side (top) of pot strip, one motor winding, and lead from screw terminal 3. (2) Remove lead from plus side of pot entirely and connect lead from terminal 3 in its place. (3) Clip ground lead from screw terminal 8 and solder to terminal 1 without removing other leads. (4) Run a new lead from terminal 8 to inside blade of left hand limit switch and reconnect motor lead removed in step 1 above. (5) Check position of all wires and protect against sharp edges before reassembly per instructions on page 6.

(4) Instant Meter Calibration

Since power line voltage frequently varies as much as 10% (as from 109 up to 120) a full scale indication may be as much as 10% (36 degrees) in error. To calibrate the meter, the beam is rotated to full scale

limit and the calibrating control on the rear of the control box is used to set the meter exactly accurate.

Should it be desirable to instantly calibrate for exact reading without rotating the mast, and do this with front panel controls, an accessory kit with special switch, control, knobs, metal drilling template and instructions is available as AK-120. (See page 8). Series 2 and 3 control panels are punched, and space is provided for these accessories.

Circuitwise, the special three-position rotary switch gives power "off" on left position, power "on" and regular operation in center. Rotating to right—against a spring return to center—electrically disconnects the meter from the grounded slider and shifts it electrically to the full end of the pot strip. The substitute control, also installed in the front panel, permits instant calibration to the exact line voltage present.

Usually Modification No. 1 is also incorporated to give continuous meter indication when this change is made.

(5) Inside Tower Mounts

A cylindrical space of $8\frac{1}{4}$ " diameter and 15" height will accommodate the HAM Rotor bolted to that plate without lower mast clamp attached. To facilitate such mounting, a heavily plated steel plate, cut out to fit against the bottom of the brake housing and clear the terminals, is available in AK-121 Kit (page 8). This plate carries four heavy bushings drilled to match the screw holes, and hold the rotor $\frac{1}{2}$ " above the tower plate. The mounting plate makes an accurate drill guide. Complete instructions, and also suggestions for thrust bearings for the top mast are included with the Kit.

On any inside tower installation, great care must be exercised to get the top mast shimmed to exact center of the rotor mast support. The geometry is such that a $2\frac{1}{4}$ " diameter will be exactly centered. For each $\frac{1}{16}$ " less diameter used, $\frac{1}{32}$ " thickness of aluminum must be used around the mast or at least on each side of the V support. To center a 2" O.D. mast, use $\frac{1}{32}$ " thick shims.

(6) Potentiometer Arm Modification Kit

Starting with Series 3 the HAM-M Rotor uses a potentiometer assembly having additional grounding straps which provide a direct ground contact for the potentiometer arm circuit. In Series 1 and 2, the ground contact was made from the potentiometer contact hinge to the inside of the bell housing at the point where the mechanical drive takes place. In some cases, dirt, grease, or corrosion may cause an intermittent condition which results in some undesirable meter fluctuation.

Replacement Kit, RK-10, includes a potentiometer arm and bracket assembly with special grounding straps, hardware, and instructions for modifying Series 1 or 2 to make them equivalent to the new Series 3 potentiometer. See listings of kit on page 8.