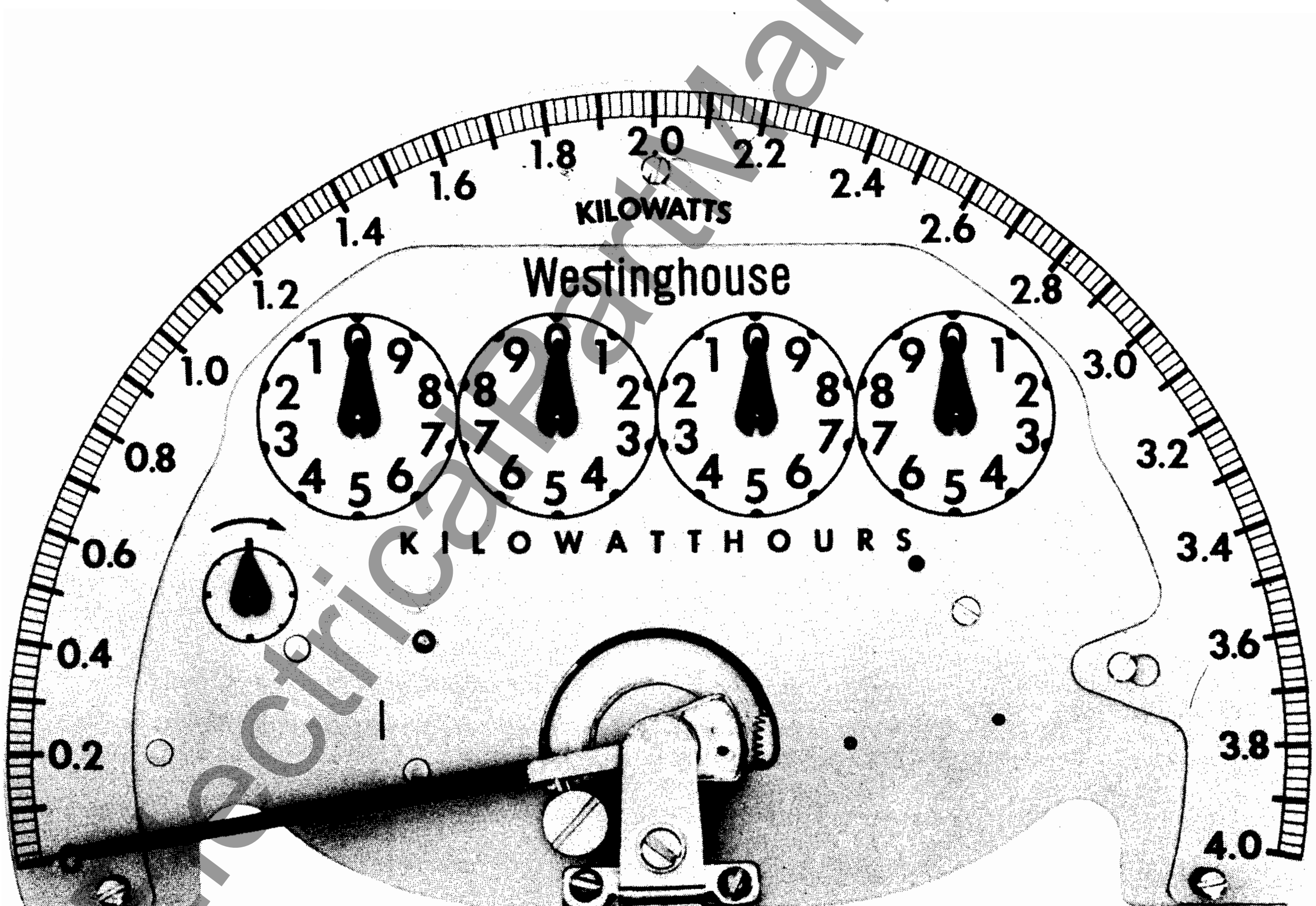
Westinghouse I.L. 42-302.11A

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

MARK 1a DUAL RANGE DEMAND REGISTERS FOR USE ON D-LINE WATTHOUR METERS



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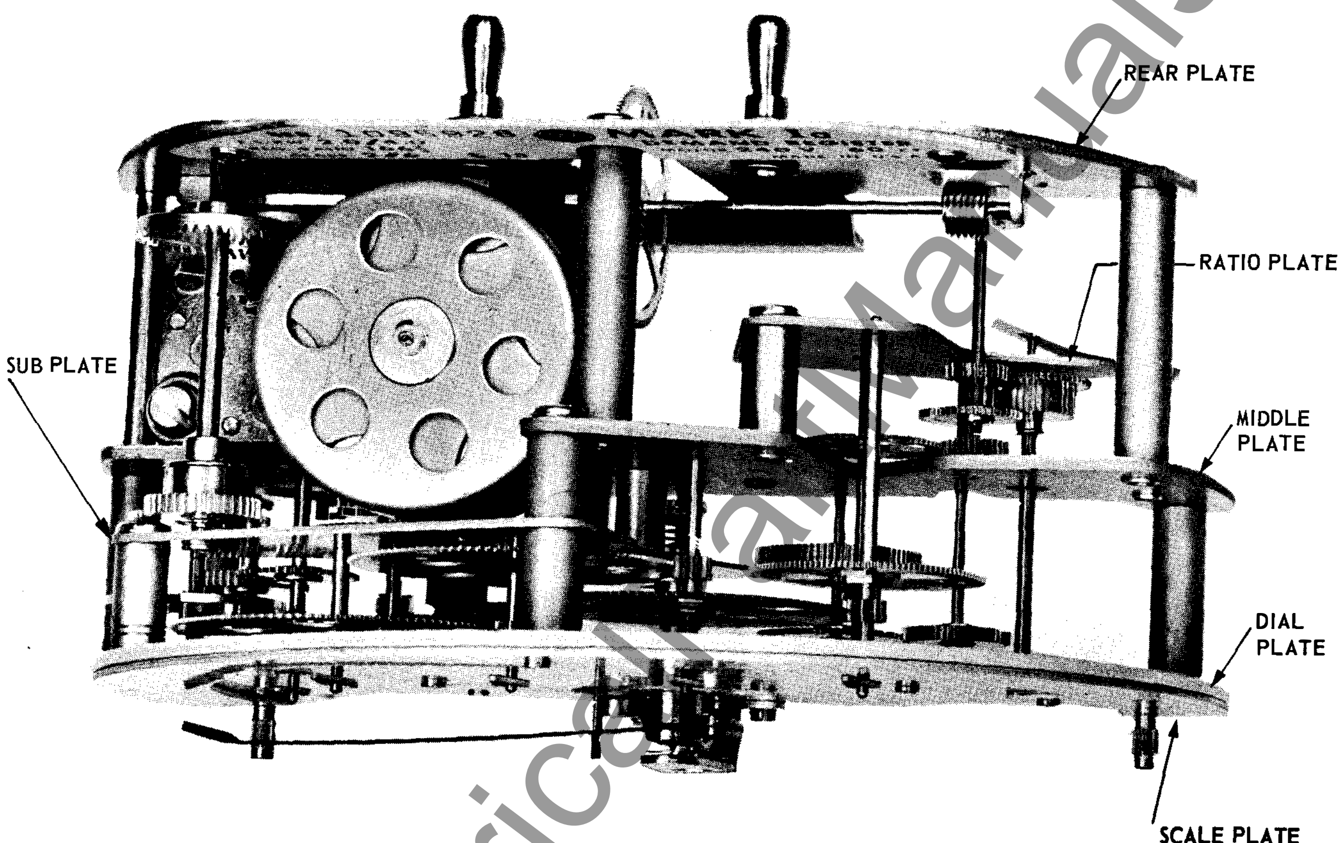
REAR PLATE
RATIO PLATE
SUB PLATE
MIDDLE PLATE
DIAL PLATE
SCALE PLATE

FIG. 1

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INTRODUCTION

The Mark Ia register eliminates the two-pusher design used in the Mark I thereby reducing test time and improving reliability.

The Mark Ia registers convert watthour meters to block interval demand meters. The "watthour demand meters" are identical to watthour meters except for the addition of the demand register and its necessary components: two lead connections for the motor and a glass cover with a mechanical reset. The mechanical demand register gives a combination of the kilowatt hour consumption, just like the standard kilowatt-hour register, and in addition gives the maximum kilowatt demand over a definite time interval by means of a pointer moved over a graduated demand scale.

GENERAL DESCRIPTION

The Mark Ia demand register has a standard kilowatt-hour gear train plus a demand gear train. Both gear trains are driven by the disk shaft.

The interval is accomplished by a synchronous motor and a gear train which turns a cam. The cam pivots an arm which engages a clutch. The clutch when engaged turns a pusher. The pusher contacts a demand pointer. The pointer has enough friction to hold it on any point of the scale to which it is pushed.

During the time interval, the pointer pusher is driven up scale at a rate proportional to the load on the watthour meter. If the demand of the interval exceeds that of the previous interval with the highest demand, the pusher moves the pointer up scale to the point representing the new maximum demand. The pusher is returned to zero at the end of each interval by the action of the cam on a sector gear.

PRINCIPLE OF OPERATION

The following is a description of the operating principle of the Mark Ia demand register (Fig. 2).

The meter disk shaft drives the wormwheel on shaft (1). Shaft (1) turns shaft (2) which turns shaft (10), the kilowatt-hour gear train and the pointer shafts (11) (12) (13) (14) and (15). Shaft (2) also turns shaft (3). Shaft (3) turns the pusher (41) on clutch shaft (6) through shafts (4) and (5).

Both shafts (2) and (3) have two gears and pinions which change mesh when the scale plate is reversed to change class. This gives the dual range feature. As an example to change from Class 2 to Class 6, the scale is reversed and a tab on the scale when placed on the Class 6 side depresses shaft (3) which is then put under spring tension. This action disengages a gear and mating pinion on shafts (2) and (3) and automatically engages a different gear and pinion on these two shafts. This change in ratios corresponds with the scale in use automatically due to the contour of the scale. (Figures 2 and 3).

The time interval is established by the operation of a synchronous motor as it drives thru a gear train to a cam which trips the clutch and returns the pusher to zero by its action on the sector gear (7) and the lever arm (43). The operations are accomplished as follows: crown gear shaft (25) is turned by the output shaft of the synchronous motor. Shaft (25) turns shaft (26), and the driving disk on this shaft turns shaft (27) which turns the time elapsed indicator shaft (30) and also has a driving disk which turns shaft (28). Shaft (28) drives the cam shaft (29). The cam on shaft (29) performs a dual function:

(1) It pivots lever arm (43) which disengages the clutch for the interval reset.

(2) The top outer surface of the cam depresses the spring on the sector gear (7) and drives the pusher (41) on shaft (6) back to zero.

SCALES

The Mark Ia is a dual range register and is available as Class 1 and 2, Class 2 and 6, Class 3 and 5, or Class 4 and 8. The class change is accomplished by reversing the scale which mechanically changes the gear ratios to correspond with the scale in use. (Fig. 3).

A dial multiplier with the words "Multiply all Readings By" is available for meters on which required. A second position is also available on the left hand side of the register for special applications where additional multipliers or information is desired.

In special cases where a customer has standardized on a given demand scale (Example: 0-2.0 KW), the scale plate is not reversed to change the scale class. Instead, a special multiplier tag is reversed which accomplishes the gear shift required and shows the new demand multiplier.

The base speed of the following D-line meters on which these registers are used is either 1000 r.p.h. or 500 r.p.h., and the disk shaft has a single lead worm that meshes with a 100-tooth wormwheel. Listed in the tables (Pg. 7) are some typical register ratios (Rr), watthour constants (Kh), and their corresponding demand scales.

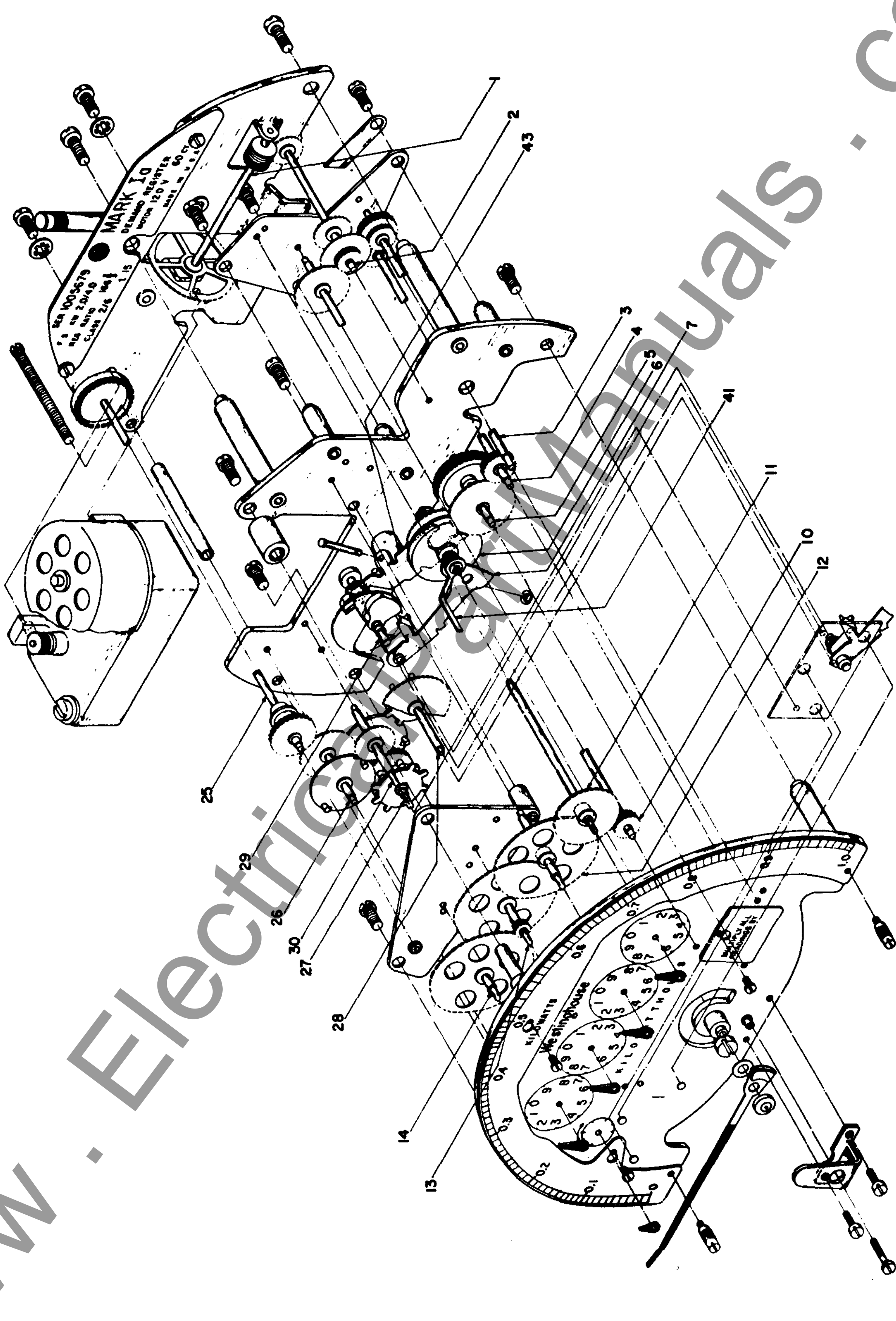


Fig. 2

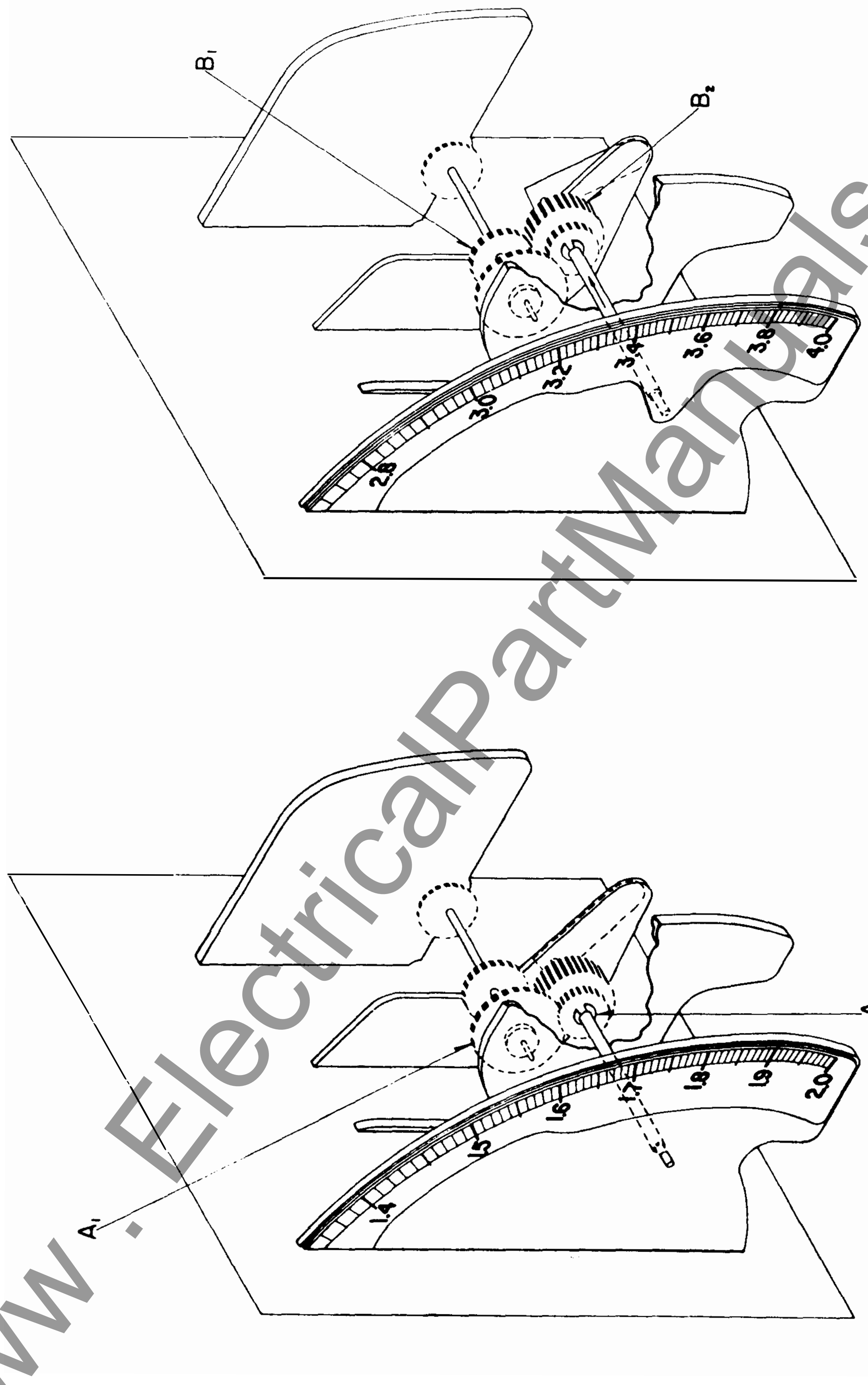


Fig. 3 Dual Range

For Meters with Base Speed 1000 r.p.h.

Volts	Amperes	Stators	Kh	Rr	Full Scale Reading Kilowatts *			
					Class 2	Class 6	Class 3	Class 5
120	2.5	1	.3	333 1/3	1	2	.75	1.5
120	15	1	1.8	55 5/9	6	12	4.5	9
120	2.5	2	.6	166 2/3	2	4	1.5	3
120	15	2	3.6	27 7/9	12	24	9	18

For Meters with Base Speed 500 r.p.h.

Volts	Amperes	Stators	Kh	Rr	Full Scale Reading Kilowatts *			
					Class 2	Class 6	Class 4	Class 8
120	2.5	2	1.2	83 1/3	2	4	2.4	4.8
120	15	2	7.2	13 8/9	12	24	14.4	28.8
120	2.5	3	1.8	55 5/9	3	6	3.6	7.2
120	15	3	10.8	9 7/27	18	36	21.6	43.2

*The Mark Ia register has 2 classes built into one register depending on the scale used.

UNIVERSAL REGISTER FOR METERS WITH BASE SPEED 16 2/3 RPM TYPES DS-DA-D2S-D3S D2A-DSP-2-5-7-8 DAP-2-5-7-8 D2S-2-5-7-8 D2A-2-5-7-8 D4SM SINGLE-PHASE

In order to provide flexibility in application of registers to meters of any KW capacity, the "Universal" demand register is recommended. For self-contained class 100 and 200 meters this is the R-166 2/3 ratio (direct reading on meters with Kh .6) with a class 2/6 demand scale. This register would have a 2 KW or 4 KW scale depending on the class setting.

The 166 2/3 register ratio is chosen because it provides register dial multipliers that are whole numbers (not fractions) on practically every type and rating of self-contained meter. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant (Kh)}}{0.6}$$

In the case of transformer rated class 10 meters, the proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant(Kh)} \times \text{CT ratio} \times \text{PT ratio}}{.6}$$

Since Kh pri = Kh sec X CT ratio X PT ratio, this formula can be used:

$$\text{Multiplier} = \frac{\text{Kh pri}}{.6}$$

UNIVERSAL REGISTERS FOR D4 POLYPHASE METERS WITH BASE SPEED 8 1/3 RPM

With the advent of the D-4 polyphase meters which have a base speed of 500 R.P.H. and a first reduction of 100, a universal register with less gear reduction (twice as fast) should be considered. For self-contained class 200 meters, this is the R_r = 83 1/3 ratio (direct reading on meters with Kh = 1.2) with a full scale of 2 KW or 4 KW depending on the class setting.

The 83 1/3 register ratio is chosen because for the 500 R.P.H. meter it provides register dial multipliers that are whole numbers (not fractions) on practically every type and rating of self-contained meter. The R_r - 83 1/3 is direct reading on a meter with a Kh = 1.2. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant (Kh)}}{1.2}$$

In the case of the transformer rated class 20 meter, the R_r - 83 1/3 ratio (direct reading on meter with K_h = 1.2) register with a class 4/8 full scale is recommended. This register would have a full scale of 2.4 KW or 4.8 KW depending on the class setting. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant(Kh)} \times \text{CT ratio} \times \text{PT ratio}}{1.2}$$

Since Kh pri = Kh sec X CT ratio X PT ratio this formula can be used.

$$\text{Multiplier} = \frac{\text{Kh pri}}{1.2}$$

In all cases the multiplier will apply to both KWH and KW demand readings.

INSTALLATION

These registers are designed for use only on Westinghouse meters. They are designed to be interchangeable with the standard kilowatt-hour register in order to convert from a standard kilowatt-hour meter to a demand meter.

The registers are adjusted and checked for accuracy of registration at the factory and are ready for immediate installation. However, to insure that the register has not been damaged in shipment and that the necessary parts have been received for field conversion, the following procedure should be followed:

1. Unpack the register with care.

2. Inspect the register as follows:
   a. Check the nameplate mounted on top of register back plate to insure that the register is correct for the meter with which it is to be used. Check the meter class vs Register Full Scale to verify that register KW full scale corresponds with the thermal capacity of the meter. For instance, a Class 200-240 volt, 2 stator polyphase meter would have a thermal capacity of 200 x 240 x 2 = 96 KW. The correct matching register for this meter should have a full scale of 96 KW.

   b. Check all shaft assemblies for end play and gear mesh.

   c. If it is desired to check the calibration, proceed as outlined under Testing Watthour Demand Meters and Testing Demand Registers.

3. Remove Kilowatt-hour register and attach leads to meter potential terminals. The leads are furnished with the proper connectors so that any disassembly of the meter proper or soldering is eliminated. This is true for all meters except the 3-wire, single-phase meter which is not recommended for field conversion.

4. On 120-volt meters, the Mark Ia is furnished with a 120-volt motor and on 240-volt meters the Mark Ia is furnished with a 240-volt motor. The 240-volt motor will operate between 200 and 300 volts and is adequate for 277-volt application. On 480-volt meters, a 240-volt motor and 240-volt reactor coil are used.

   Wiring drawings for the installation of leads and reactors are shown in Figures 10 through 25. All A-base polyphase meters above Serial No. 53,980, 000 are shipped equipped with Demand Motor Leads.

5. In the place of the kilowatt-hour register, install the new Mark Ia register. No changes are necessary in the meter proper.

6. Connect the leads to the motor.

7. Apply rated voltage and see that motor functions correctly.

8. Recheck complete meter on full load and light load adjustment. A slight light load adjustment might be necessary to compensate for the additional friction load of the mechanism. While this adjustment is being made, the demand pointer should be up scale so that it is not being driven when calibrating the meter. This corresponds to actual operating conditions as it is very unlikely that maximum demand will occur when the meter is operating at very low loads.

9. Apply demand type cover. For Mark Ia. check to see that reset wire is the proper length.

10. Install complete meter in service as usual for watthour meters.

ADJUSTMENTS AND MAINTENANCE

GENERAL

Mark Ia demand registers are constructed of compatible materials and designed to give maximum trouble-free service. The design is such that preventative maintenance is easily performed and should failure occur, the register can be repaired with minimum difficulty.

CLEANING THE REGISTER

The Mark Ia register can be ultrasonically cleaned. The following procedure is recommended for this cleaning.

1. Remove the motor from the register by removing the two screws in the backplate holding the motor in. The motor is then pushed upward and brought out through the top of the register by rotating slightly around the crown gear shaft No. 25.

2. The register can now be ultrasonically cleaned.

   CAUTION: In order to avoid trapping cleaning solutions in the over-rides and with some cleaning solutions causing corrosive action, the clutch should be propped open and rinsed properly. A toothpick or paper clip can be used to prop the clutch open.

Ultrasonic cleaning is an art and science in itself, and its' success or failure in many cases is related to the understanding of the subject and equipment by those who are responsible for its use. For instance, a knowledge of the following variables is essential: effects of frequency, power density, tank size, holding fixtures or basket design, solution contamination, attitude of parts to be cleaned, type of soil to be removed, cleaning agent concentration and its effects on the particular metals, plastic or fibers in the apparatus, time element to achieve satisfactory cleaning without damaging the components of the apparatus, the number of parts to be cleaned vs. the power level.

It is also important to realize that after the registers have been ultrasonically cleaned the parts are chemically clean and subject to galling; therefore, either a final dip, rinse, or application of a lubricant is recommended. One such lubricant solution for dipping or rinsing which is very satisfactory consists of .373 grms. lithium stearate per liter of denatured alcohol (.031 ounces per gallon). An alternate method of applying a lubricant would be to use powdered lithium stearate and apply to the bearing surfaces with a small artist brush. These materials are available from any chemical supply house.

A typical example of an ultrasonic cleaning process found to be satisfactory for Mark registers by Westinghouse using an ultrasonic cleaner with the following capacity is as follows: Average power output 1000 watts - peak output of 2000 watts - nominal frequency of 20 KC (variable from 18 to 20 KC) and a cleaning tank of 2-gallon capacity.

**

1. Suspend register in a solution of Bendix 25-1 (2 ounces per gallon water) heated to 140 to 150 degrees Fahrenheit and ultrasonically agitate for one minute.
2. Rinse in hot, running tap water for 30 seconds.
3. Ultrasonically rinse in hot, clean tap water 30 seconds.
4. Blow with clean compressed air until all signs of water are removed.
5. Dry in 100 degrees Centigrade (212 degrees Fahrenheit) oven for 5 minutes.
6. Allow to cool to room temperature.
7. Dip in an alcohol-lithium stearate solution 0.373 grams lithium stearate/liter denatured alcohol (0.031 ounces per gallon).
8. Drain over the lithium stearate solution until dripping ceases.
9. Hang to dry at room temperature for 10 to 15 minutes.

**Cleaner Concentrate, Pioneer Central Division, Bendix Aviation, Inc., Davenport, Iowa.

Where the ultrasonic method of cleaning is not used, the following cleaning procedure is recommended.

1. Disassemble the register completely as described under Disassembly of Register.
2. Each component should be cleaned with a good grade of clock cleaning fluid and rinses such as L & R solutions.
3. Dry all parts thoroughly after cleaning.
4. Reassemble the register as described under Reassembly of Register.
5. Apply lubricant as described under Ultrasonic Cleaning.

CHECKING THE MOTOR

Since the motor gear reduction is completely enclosed and running in a good grade of oil, it should not require cleaning. Instead, it is recommended that the motor be tilted so that the oil will drain down under the oil filler screw. Take the syringe Style No. 1340457 used to put oil in the motor and insert it in the oil filler hole. Try to draw out the oil. When the motor contains the recommended 1-1/2 cc of oil, it is only possible to draw 6/10 to 8/10 cc with the syringe. The remainder is trapped in the bearings and lubricating clearances. If oil can be drawn up in the syringe or if it can definitely be established that there is oil in the motor and it is clean, then put this oil back in the motor and replace the oil filler screw. This should be all the service necessary for the motor. If oil is dirty, indicating wear, motor should be replaced.

DISASSEMBLY OF REGISTER

The following procedure is recommended for the disassembly of the Mark Ia register. An assembly block such as shown in Figure 4 facilitates the disassembly of the register.

By placing the register mounting bayonets in a meter, meter frame, or in a block the following parts can be removed (See Fig. 1 for Plates):

1. **Demand Pointer.** Remove the spring tension screw and then the two screws holding the pointer protective bracket and spring. Remove spinner, demand pointer, and fibre washer.
2. **Scale.** Remove the screws holding scale to dial plate.
3. **Pointers.** Using a pointer puller, Style No. 285A555H01, or large screw-driver with paper protecting the dial, remove pointers from ends of shafts being careful not to scratch the dial.
4. **Multiplier Tag.** Remove screw and take off or loosen screw and push tag up and lift off.
5. **Motor — Terminal Block — Back Plate.** Put register face down in assembly block. Remove 5 screws and take back plate, motor and terminal block assembly off. Remove No. 25 shaft assembly.

CAUTION: Place back plate down on bayonet side to prevent damage to the worm wheel.

6. **Worm Wheel (No. 1 Shaft).** Turn screw until flat on screw head allows shaft to be removed.

7. **Nameplate.** Remove two screws.

8. **Ratio Plate – Dual Range Spring.** Remove No. 2 shaft. Remove 3 screws holding ratio plate and dual range spring and lift plate off. The following shafts can now be removed: No. 3, No. 4, No.10, and No. 11 shafts.

9. **Middle Plate.** Remove 4 screws holding middle plate and lift off. The following shaft assemblies can now be removed: (27), (28), (29), (30), (26), (5), and clutch shaft (6).

   The clutch shaft can be completely disassembled by removing the retaining rings on the front, middle, and rear of the shaft.

10. **Sub Plate.** Remove spacer, one screw, and lift plate off. The following kilowatt-hour shafts can now be removed: (11), (12), (13), (14), and (15).

11. **Sector Gear.** Remove the retaining ring and lift off.

REASSEMBLY OF REGISTER

The Mark Ia can be reassembled as follows: Again an assembly block as shown in Figure 4 facilitates this assembly. Applicators, Style No. 1960343, are available for applying retaining rings to shafts (See Fig. 1 for plates).

1. **Front Plate (Dial)**
   Place plate face down in assembly block. Put the sector gear (7) on its front plate pin. It is not necessary to apply retaining ring at this time. Put the following shaft assemblies in their bearing holes in the front plate with the long tapered pivot end thru the plate: (11), (12), (13), (14), and (15).

2. **Sub Plate.**
   Put sub plate on posts and guide shafts into bearing holes. Put screw in and tighten. Put spacer over post.

3. **Clutch Shaft (6)**
   If the clutch shaft was disassembled use the following procedure for reassembly:
   a. Put rear retaining ring into one of the inboard four grooves. Guide the spring centering spacer over the shaft with small diameter to the front.

   b. Place spring over shaft and guide on shoulder of spring centering spacer.

   c. Place rear assembly on shaft, compress spring and apply center retaining ring.

   d. Place front assembly on shaft and apply front retaining ring.

4. **Cam Shaft No. 29**

   Put this shaft in the front plate with the gear toward the rear of the register. Make sure small spring is on front end of shaft.

5. **Interval Gear Train**

   Assemble in the following order (Fig. 2):
   a. No. 26 shaft, put in with the driving disk and pins closest to the front plate.

   b. No. 30 shaft. (Interval Indicator) put in with the long tapered pivot end through the front plate.

   c. No. 27 shaft, put in with the driving disk and pins toward the rear of the register.

   d. No. 28 shaft, put in with the gear toward the rear of the register.

6. Orient disk and pins in neutral position and position cam shaft as shown in Figure 5 (b). This position will facilitate the assembly of the middle plate and trip lever.

7. **Middle Plate.**

   Guide the middle plate assembly into position making sure the prongs of the lever are located between the disk and the gear on the (6) clutch shaft. Put four screws in and tighten down. The cam should be in the second neutral position as shown in Figure 5 (b). The second neutral position facilitates the assembly of the middle plate.

8. **No. 10 Shaft**

   Keep register face down in assembly block and put No. 10 shaft in its front plate bearing hole. The other end of this shaft will have the gear on the outside of the middle plate and the shaft will go thru the cut out section of the plate.

9. **No. 5 Shaft**

   Put this into its bearing hole in the front plate thin gear closest to the front plate.

10. **No. 4 Shaft**

    Put this into its bearing holes in front plate so that large gear is closest to the front plate.

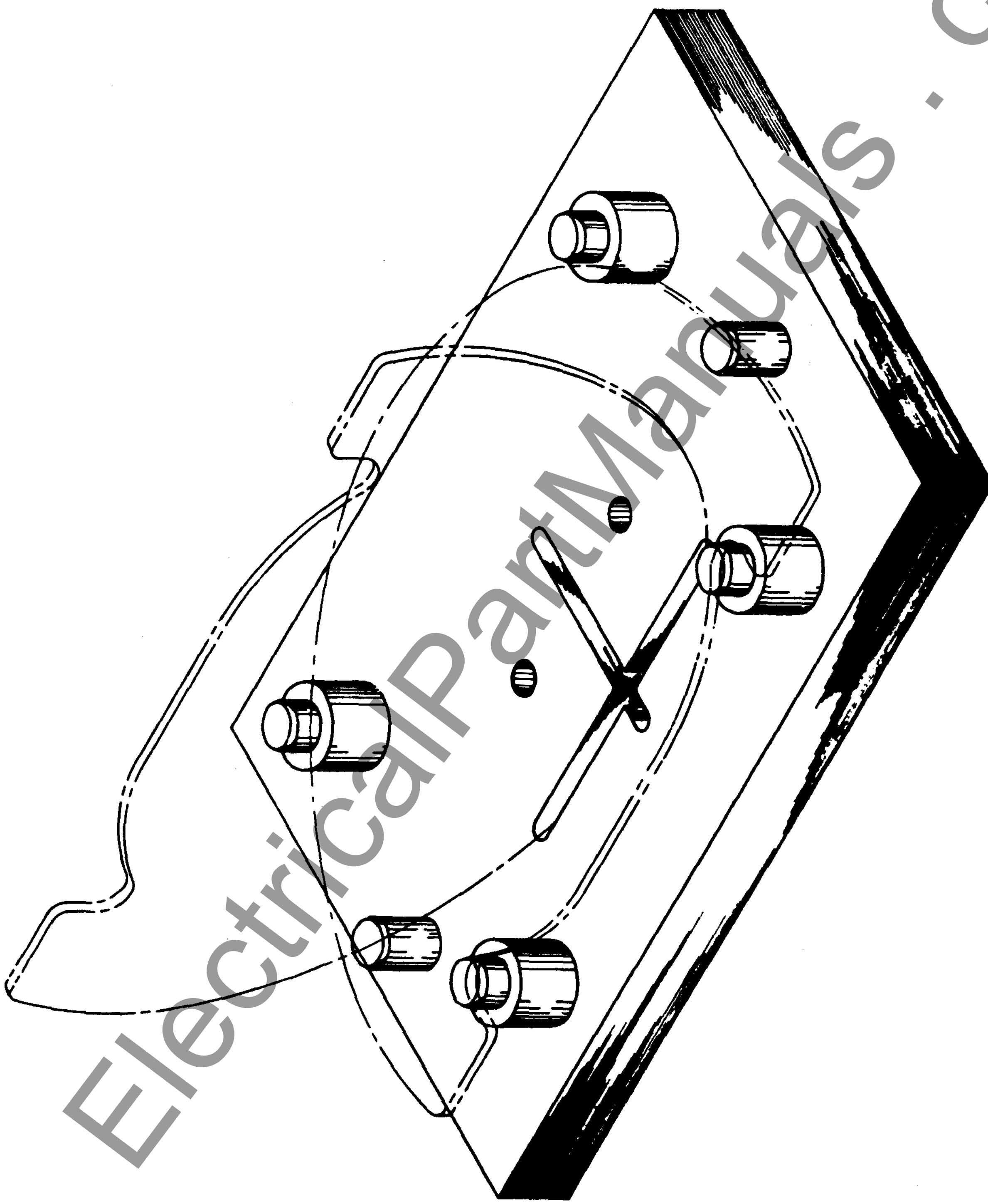
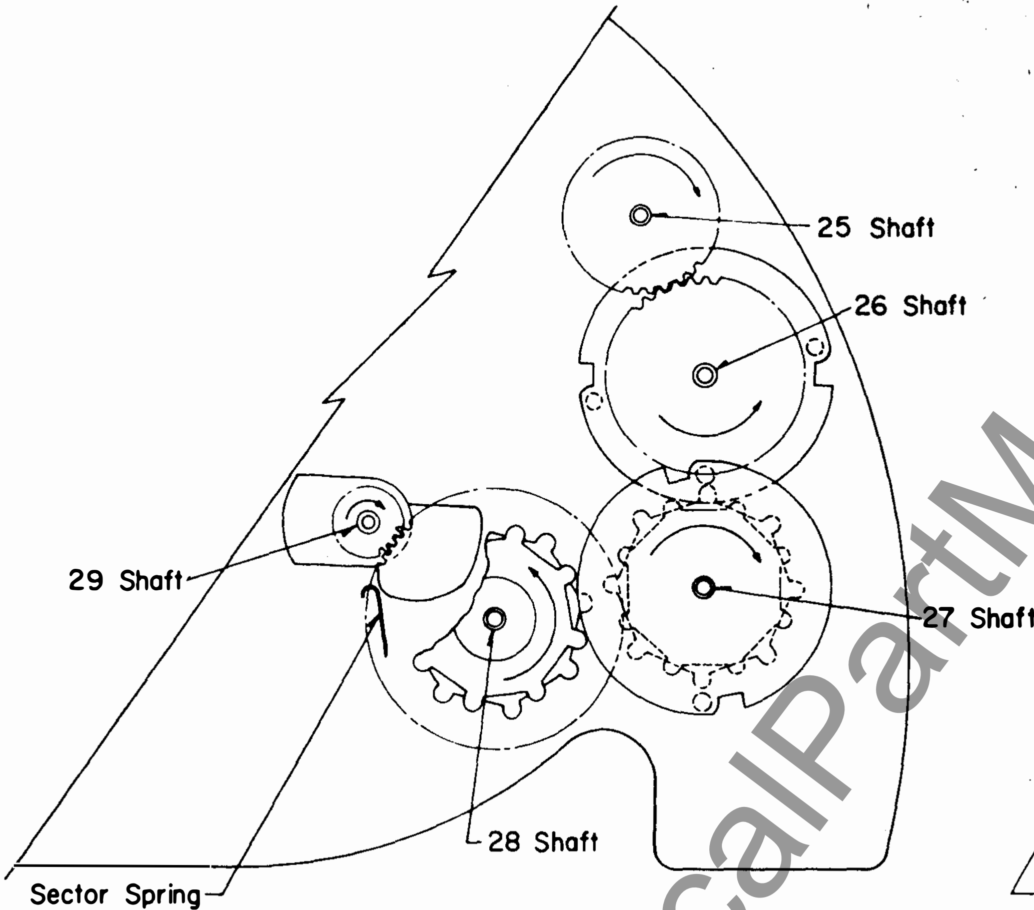
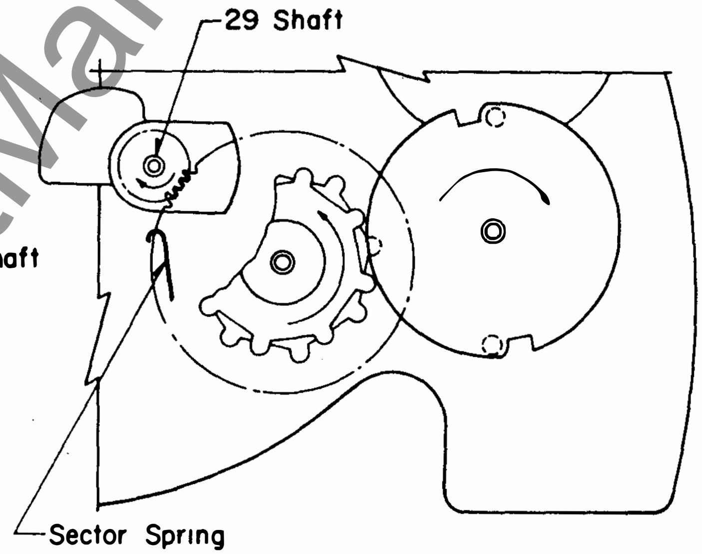


Fig. 4 Assembly Block S# 110C152G01



Cam, Interval Gear Train & Sector Spring Locations (1st Neutral Position)
Fig. 5A



Cam & Interval Gear Train Locations For Reassembly (2nd Neutral Position)
Fig. 5B

Fig. 5a & 5b Cam & Interval Gear Train Locations for Reassembly.

11. **No. 3 Shaft (Dual Range Shaft) (Fig. 3)**

Put the long end of the shaft thru the hole in the middle plate and into the bearing hole in front plate.

12. **No. 11 Shaft**

Put this shaft into its front plate bearing hole with the long tapered pivot end through the front plate.

13. **Ratio Plate**

Put plate in its relative position and put each shaft in its bearing hole. Put 2 screws in right hand side and the flat spring goes under the 3rd screw on the left hand side. Center the spring over pivot of dual range shaft and tighten screw.

14. **No. 2 Shaft**

Put the end of the shaft which has three gears on it in the bearing hole of the middle plate and meshing with gear on dual range shaft. For some ratios it may be necessary to pull back on No. 3 shaft to allow the pivot of the No. 2 shaft to go in its bearing hole.

15. **No. 25 Shaft (Crown Gear)**

Put this shaft in its bearing hole in the sub plate.

16. **Motor Assembly**

Lay the motor in its proper position resting on the middle plate with the output pinion in relative position to mate with crown gear on No. 25 shaft.

17. **Back Plate Assembly**

If No. 1 shaft was removed, put it back in bearings and turn the round edge of the retaining screw toward the back plate.

Place back plate in proper relation to its posts and with worm mating with gear on No. 2 shaft, and seat the crown gear shaft in its bearing hole in the back plate.

Put the 5 screws, spacer, and motor-mounting lockwashers in and tighten down.

18. **Scale Assembly**

Put register on a meter, meter frame or assembly block as shown in Figure 4 with dial up. Put scale in place and put screws in.

19. **Multiplier Tag**

Replace multiplier tag if used by putting keyhole slot over screw and sliding the tag down. Tighten the screw.

20. **Kilowatt-Hour and Interval Pointers**

Put large pointers on kilowatt-hour shafts and the small pointer on interval indicator shaft.

21. **Demand Pointer Assembly**

With register in same position as described in Step 18, assemble as follows:

a. Put fibre washer on demand pointer hub.

b. Put demand pointer on.

c. Put spinner on.

d. Put protective bracket and spring on and tighten two screws down that hold bracket on.

e. Put spring tension screw in and tighten enough to hold spinner on.

22. **Zero Adjustment**

Turn the register dial face up and gently hold demand pointer against the pusher at the zero end of the scale. Rotate the zero adjusting post (Fig. 6) and position the demand pointer in the center of the zero line.

23. **Sector Gear Mesh Adjustment (Fig. 7)**

Put the register in the bottoms up position and insert sector spring adjusting pin Style No. 106R600H01 thru the hole in the middle plate until it rests in the hole provided in the front bearing plate.

a. Gently hold demand pointer against the zero end of the scale as described under Step 22 above.

b. Allow spring on sector gear to rest on adjusting pin and guide teeth of sector into groove in pinion of (6) clutch shaft. Slide sector forward on the shaft so that it can be meshed with pinion on the (6) shaft.

c. Put retaining ring on sector pivot post.

d. Remove spring adjusting pin from middle plate.

24. **Interval Indicator Adjustment**

The interval indicator can be set at 12 o'clock trip position by slipping small pointer on the shaft pivot.

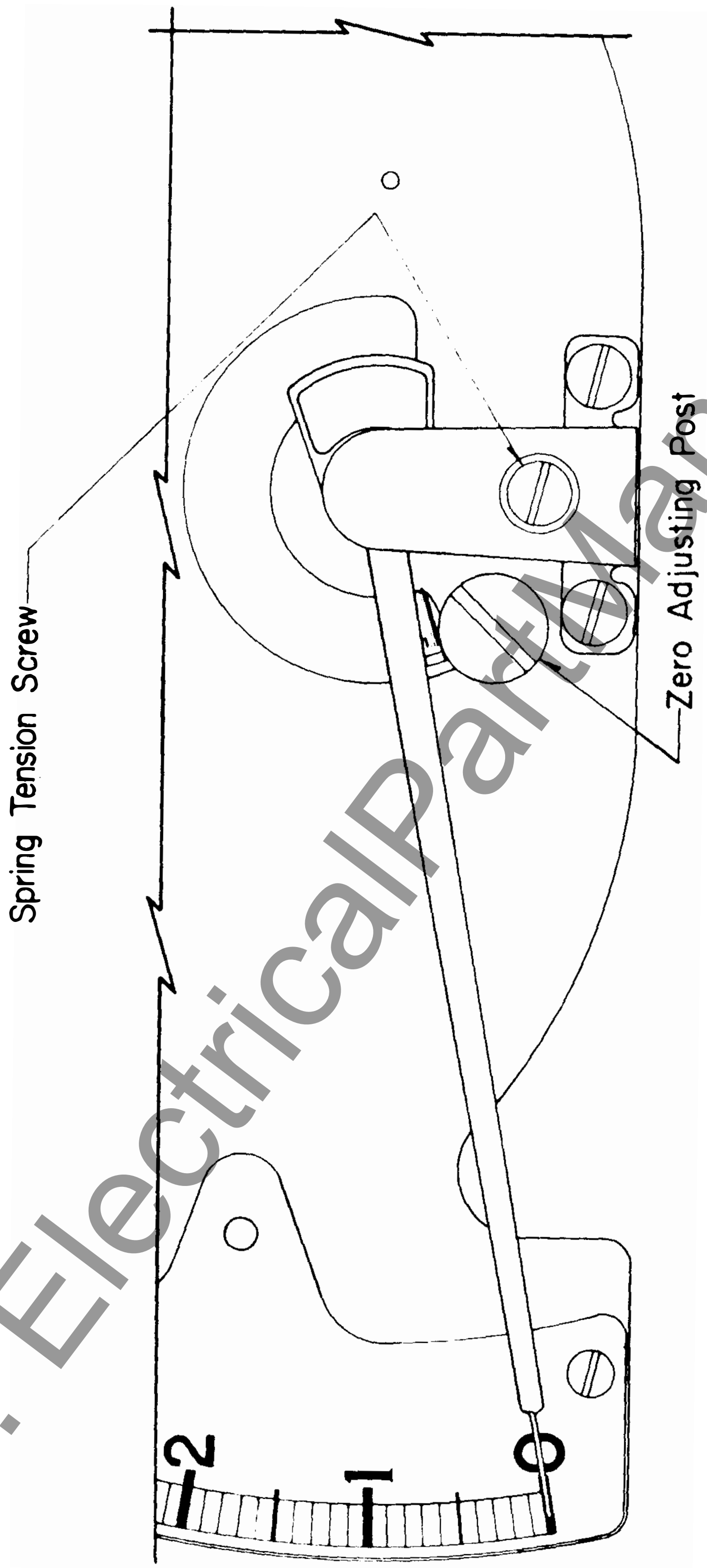


Fig. 6 Zero Adjustment

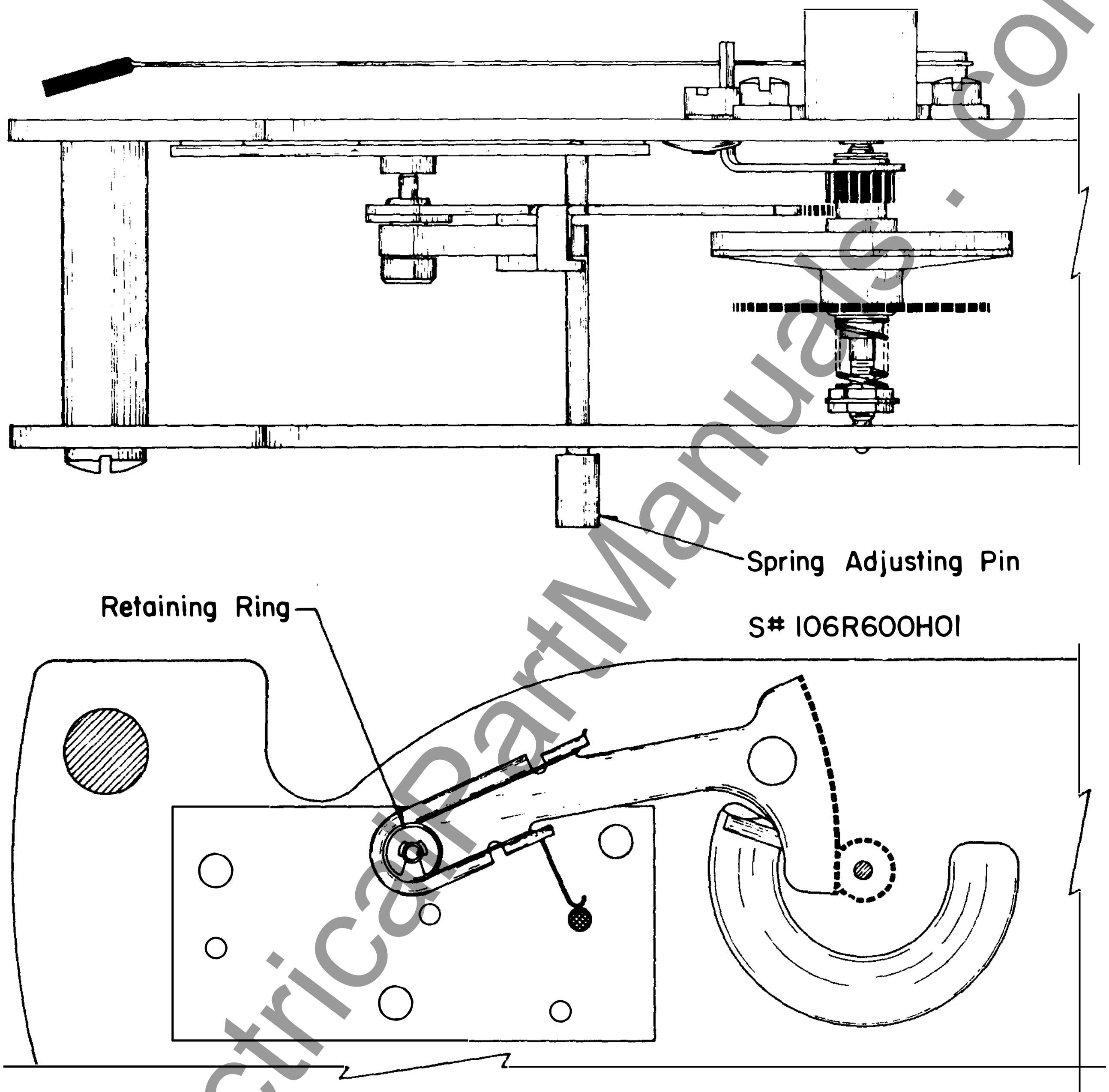


Fig. 7 Sector Adjustment

25. **Checks to be Made After Assembly**

 a. Check all shafts for end play.

 b. Turn the power gear train thru manually by using the slip clutch on the (25) shaft.

 c. Turn the (1) shaft and deflect the demand pointer to full scale making sure the sector spring clears the cam for both neutral positions (Fig. 5).

26. **Final Cam Setting**

Before the middle plate was assembled the interval gear train was positioned so that the cam neutral positions were as shown in Figures 5a and 5b. To insure the best location for smooth tripping action and proper open-time, the following check should be made.

 a. Rotate the (1) shaft until the demand pointer is deflected to the off-scale (pegged) position.

 b. Rotate the (25) shaft until the cam is in the first neutral position as shown in Figure 5a. Check to see that the sector spring is almost in contact but not putting pressure on the forward edge of the cam.

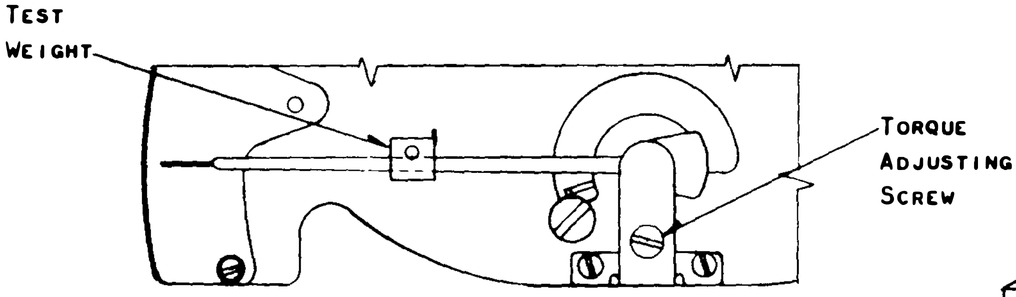
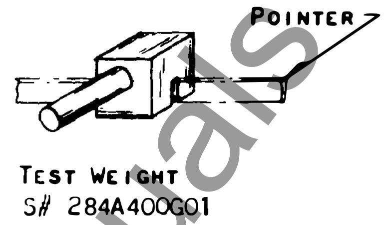


Figure 8A



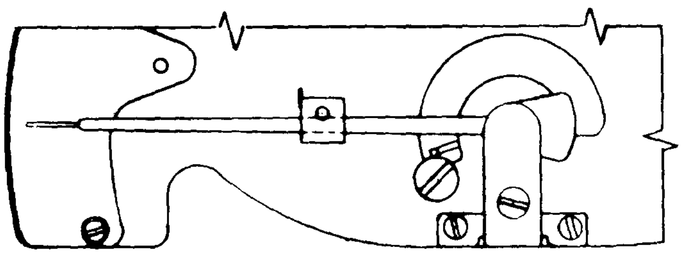


Figure 8B

c. In the event it is necessary to make an adjustment in the neutral position of the cam the following procedure should be followed:

1) Push the cam shaft forward compressing the coil spring until the pinion is demeshed from its mating gear on the (28) shaft.

   CAUTION. When pushing the cam forward in order to demesh make sure the lobe on the cam is not in a position to hit the large gear on the left hand kilowatt hour shaft.

2) With the gearing demeshed, the cam can be rotated in the desired direction.

3) Once the gear teeth are disengaged and rotation has commenced the pressure on the cam shaft can be released. The coil spring will snap the pinion back in mesh on the next tooth thereby insuring only one tooth rotation.

4) After rotating one tooth recheck the clearance between the lobe of the cam shaft and the sector spring per steps a and b, Pg. 15. Check the smoothness of operation by advancing the (25) shaft clutch manually and trip the (6) clutch.

27. **Clutch Open-Time Check**

If the cam has been set as outlined in Step 26 the open-time should be between 2 and 5 seconds. If the open-time is outside the 2 to 5 second range, the cam and sector probably needs to be shifted as outlined in Step 26. The open-time is checked with a stop watch as follows:

a. Turn the first (1) shaft and deflect the pusher (41) up scale.

b. With the motor energized, advance the demand gear train until the clutch is just before tripping as indicated by the interval indicator.

c. The open-time is measured between the time the pusher (41) drops back to zero and the clutch disk on the (6) shaft moves forward.

28. **Demand Pointer Spring Tension Adjustment**

The spring tension on the demand pointer is adjusted by using test weight StyleNo. 284A400G01 in the following manner. See Figure 8A and 8B.

1. Hold register in its normal operating position and make sure pusher is at zero.

2. Mount test weight to demand pointer and locate the right hand edge of weight with the vertical line as shown in Figure 8A. The pointer should slip down scale to a lower reading. (If pointer does not fall then turn counterclockwise on the torque adjusting screw until pointer does fall). This insures that the slip torque is below the maximum allowable.

3. Push demand pointer back to the horizontal position and slide test weight so that the left edge is in line with the vertical line as shown in Figure 8B. This insures that the slip torque is above the minimum requirement. (If pointer slips, it will be necessary to turn clockwise on screw until pointer does not slip and then recheck Step 2.)

29. **Clutch Shaft Safety Check**

The clutch on the (6) shaft can be given a two to one safety check by positioning the test weight as shown in Figure 8a. If by turning the first (1) shaft in the register the pusher will rotate the demand pointer and advance the test weight through the horizontal, then the clutch has at least a two to one safety factor.

30. **Testing Watthour Demand Meters**

The same method of test employed for corresponding watthour meters are used when testing demand meters. However, when calibrating demand meters, the timing motor should be running and the register meshed. The demand pointer should be set at a position such that it will not be advanced by the pointer pusher at any time during the test.

TESTING DEMAND REGISTERS

1. **Mechanical Over-all Test Device Serial No. 110C174G01**

The best way to check the register calibration is by means of a constant speed device such as 110C174G01.

The test device simulates a meter operating under constant load. The register can be driven at a speed corresponding to meter speeds of 16-2/3, 33-1/3, and 66-2/3 rpm. This device has a shaft driven by a synchronous motor and three different worms to give the speeds indicated above.

The device is connected to a 120-volt source and the toggle switch is put in either the 120V or 240V position depending upon the voltage of the register motor. The register is mounted in the desired position and the motor leads coming from the binding posts on the left of the device are connected to the motor terminal block of the register. Varying frequency has no effect since both the test device drive motor and the timing motor in the register will change equally. The three speeds are used to check the full load point and multiples thereof. Therefore, this device will check all classes and three points of the scale.

The actual indication of a Mark II register may be computed by using the following formula.

$$\text{KW Reading} = \frac{6 \times \text{Test Device Setting } (16\text{-}2/3,\ 33\text{-}1/3,\ 66\text{-}2/3)}{\text{Register Ratio}}$$

2. **Portable Gear Checker 111C217G01**

This device shown in Figure 9 is designed for a quick check on the kilowatt demand gear train with respect to the interval timing gear train (exclusive of motor gearing). It is designed to check the full load point of all Mark Ia registers regardless of interval or register ratio.

Operation

Disconnect the motor leads and remove register from meter. Mount register checker bayonets in meter and tighten screws. Mount the register in the checker. This automatically engages the worm wheel of the register with the gear on the checker. Now pull the top of the checker (which is mounted on pivots) down on the register so that gear "A" on checker meshes with the overriding gear on the No. 25 shaft of the register. Push the latch on the front of the register checker under the post on the register to hold the checker in mesh. Turn the handle on the checker clockwise until the interval indicator on the register shows that the clutch is about to trip. Energize the motor and allow the motor to trip the clutch. Reset the demand pointer by hand below the point on the scale which is to be tested. Turn the handle advancing the gear train manually until the interval indicator shows that the clutch is again about to trip. Allow the motor to trip the clutch. Take the existing reading on the KW demand scale. The checker has a high (H) and low (L) deflection and is set by shifting a ratio plate that engages the desired gear train. Two register checkers are available depending on the desired deflection.

111C217G01 Low Range Deflection (Test KW) $= \frac{100}{Rr}$

High Range Deflection (200% Test KW) $= \frac{200}{Rr}$

111C217G04 Low Range Deflection (200% Test KW) $= \frac{200}{Rr}$

High Range Deflection (400% Test KW) $= \frac{400}{Rr}$

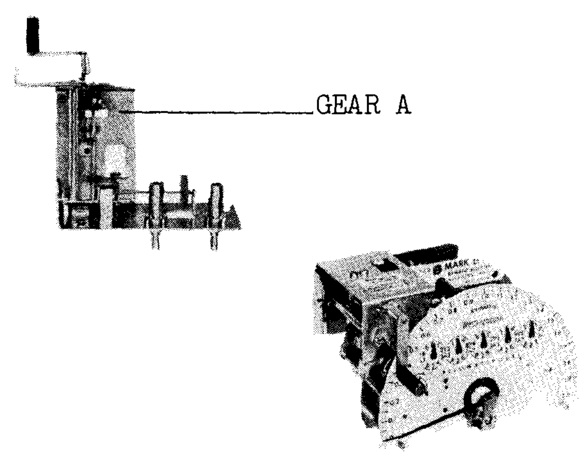


Fig. 9 Gear Checker for Mark Ia Register Style No. 111C217G01

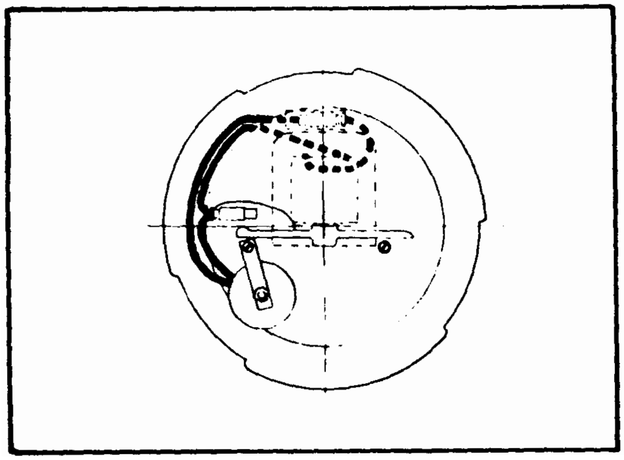


Fig. 10 D4SM-3 Wire Self Contained, 240V. (120V Reg. Motor).

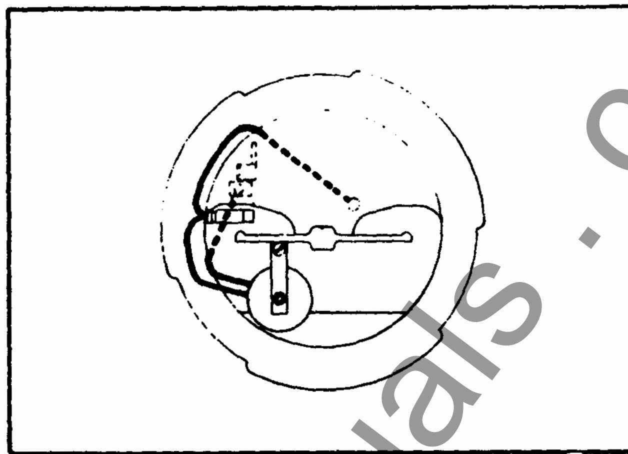


Fig. 11 DSM-D2SM & D3SM-3 Wire Self Contained, 240V. (120V Reg. Motor). DSM-D2SM & D3SM-3 Wire Self Contained, 480V. (240V Reg. Motor).

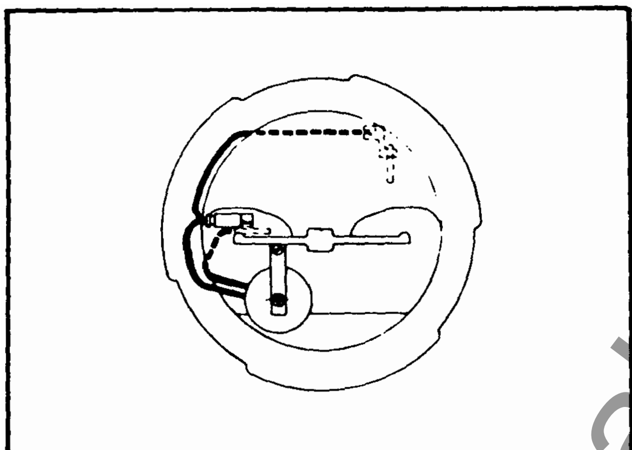


Fig. 12 DSM & D2SM 2 Wire Trans. Type, 240V. (120V Reg. Motor). DSM & D2SM 2 Wire Trans. Type, 480V. (240V Reg. Motor).

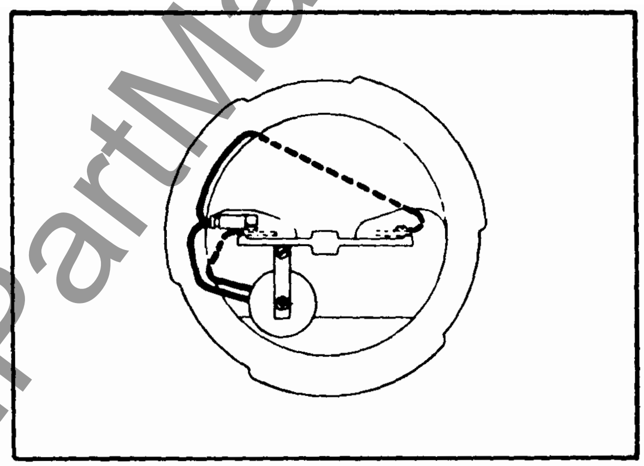


Fig. 13 DSM & D2SM 3 Wire Trans. Type, 240V. (120V Reg. Motor). DSM & D2SM 3 Wire Trans. Type 480V. (240V Reg. Motor).

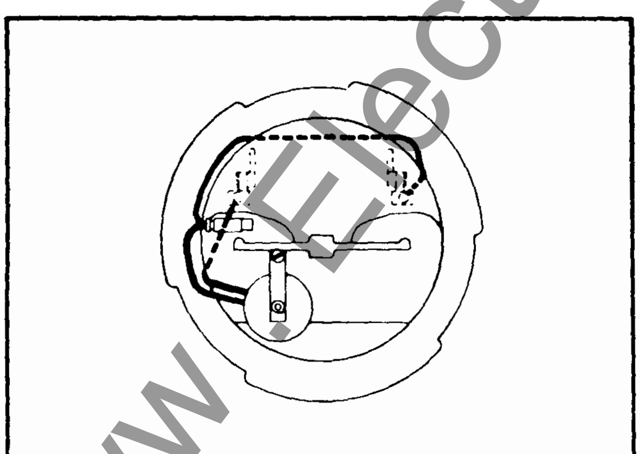


Fig. 14 DSM-D2SM & D3SM 2 Wire Self Contained, 240V. (120V Reg. Motor). DSM-D2SM & D3SM 2 Wire Self Contained, 480V. (240V Reg. Motor).

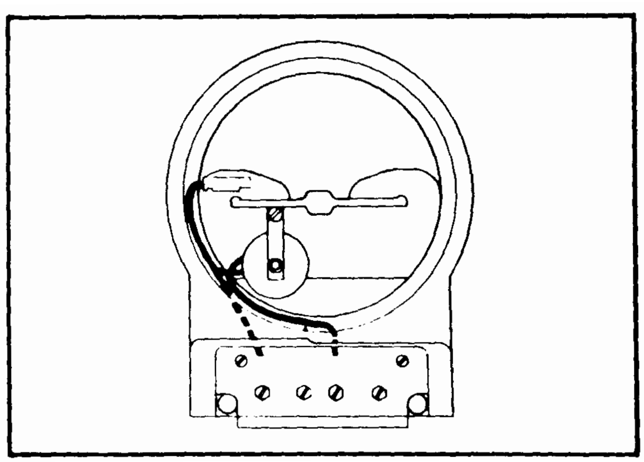


Fig. 15 DAM & D2AM 2 Wire Self Contained, 240V. (120V Reg. Motor). DAM & D2AM 2 Wire Self Contained, 480V. (240V Reg. Motor).

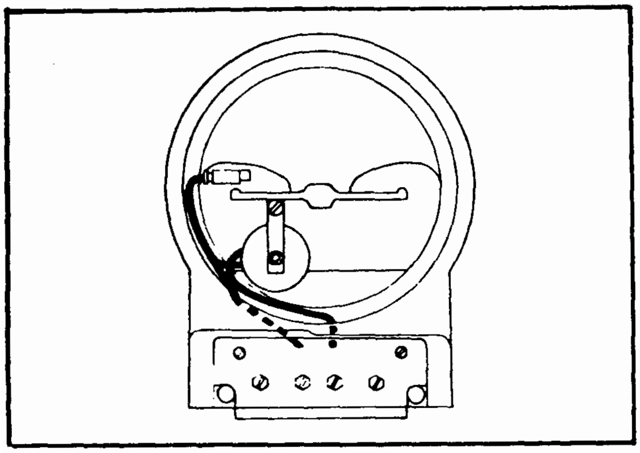


Fig. 16 DAM & D2AM 2 Wire Trans. Type, 240V. (120V Reg. Motor). DAM & D2AM 2 Wire Trans. Type, 480V. (240V Reg. Motor).

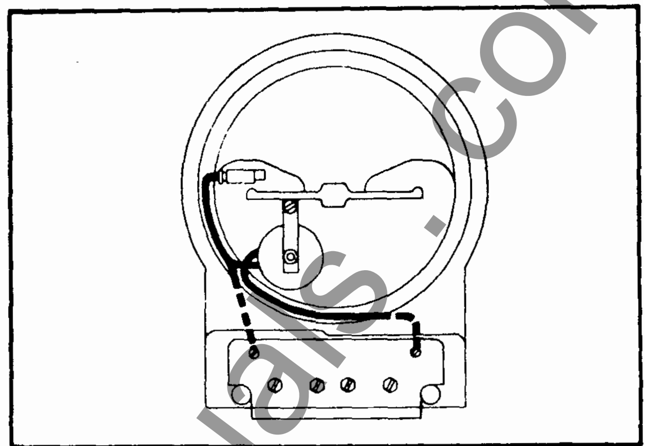


Fig. 17 DAM & D2AM 3 Wire Trans. Type, 240V., DAM & D2AM 3 Wire-4 Terminal Self Contained 240V. (120V Reg. Motor).

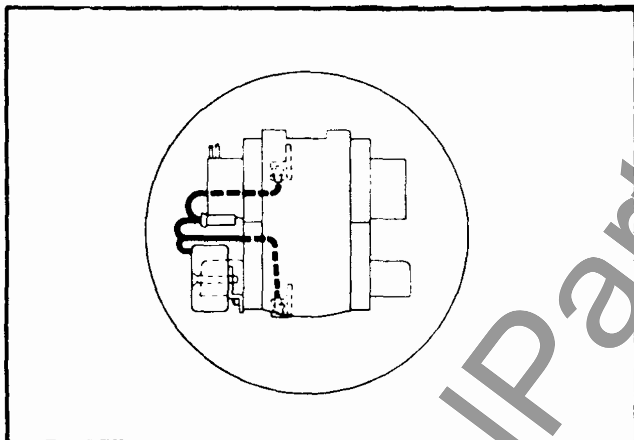


Fig. 18 DSP-2M & D2S-2M Self Cont. & Trans. Type, 240V. (120V. Reg. Motor). DSP-2M & D2S-2M Self Cont. & Trans. Type, 480V. (240V. Reg. Motor).

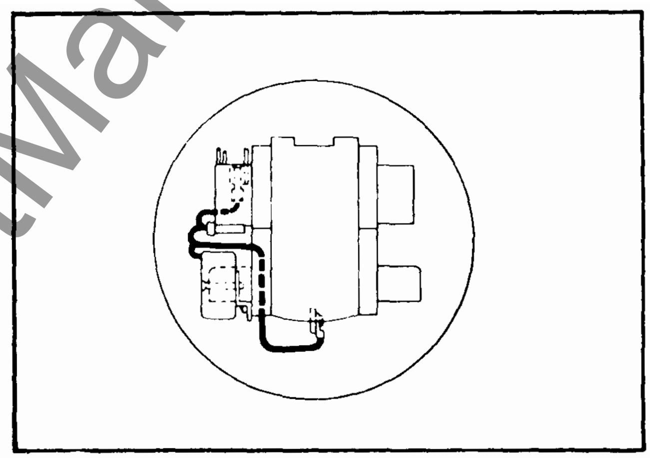


Fig. 19 DS-5M & D2S-5M 240V. (120V Reg. Motor). DS-5M & D2S-5M 480V. (240V Reg. Motor).

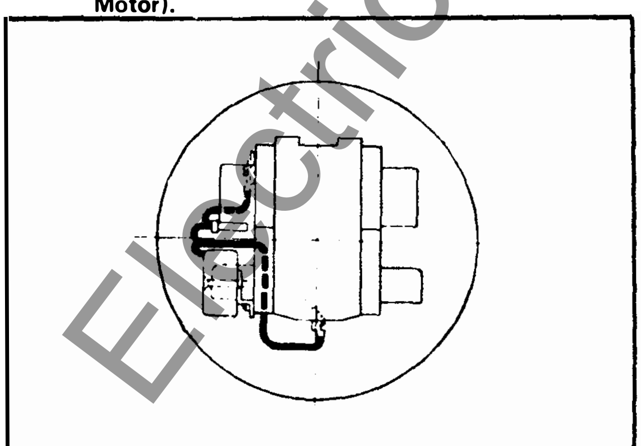


Fig. 20 DS-5M & D2S-5M-30 Amp-480V. (240V Reg. Motor).

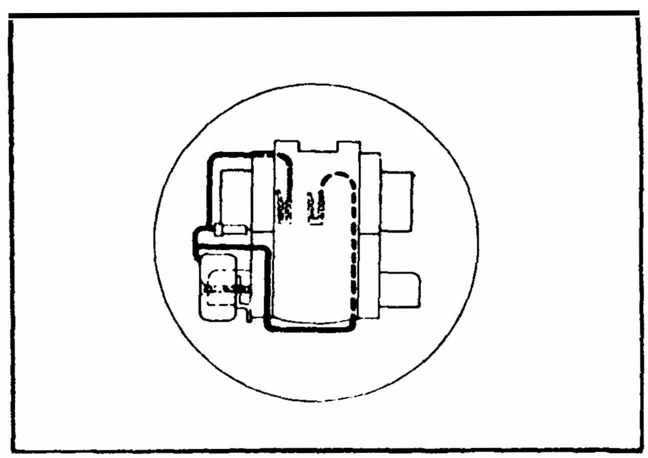


Fig. 21 DSP-7M & D2S-7M Self Contained, 240V. (120V Reg. Motor). DSP-7M & D2S-7M Self Contained, 480V (240V Reg Motor).

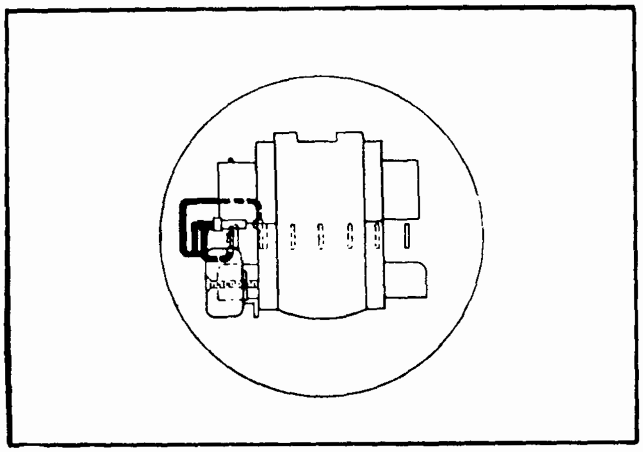


Fig. 22 DSP-7M & D2S-7M Trans. Type, 240V. (120V. Reg. Motor). DSP-7M & D2S-7M Trans. Type, 480V. (240V Reg. Motor).

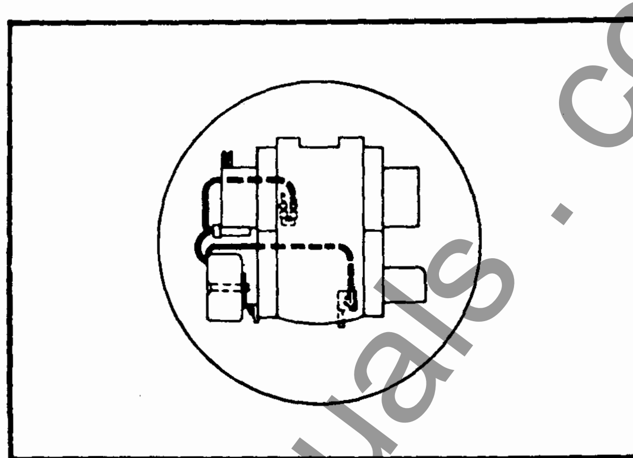


Fig. 23 DSP-8M & D2S-8M Self Contained, 240V. (120V Reg. Motor). DSP-8M & D2S-8M Self Contained, 480V. (240V Reg. Motor).

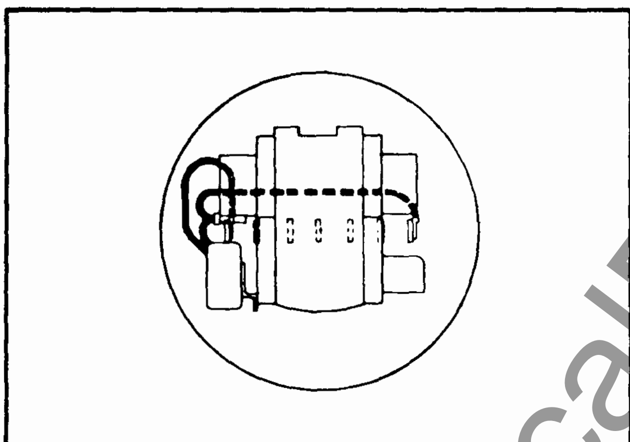


Fig. 24 DSP-8M & D2S-8M Trans. Type, 240V. (120V Reg. Motor). DSP-8M & D2S-8M Trans. Type, 480V. (240V Reg. Motor).

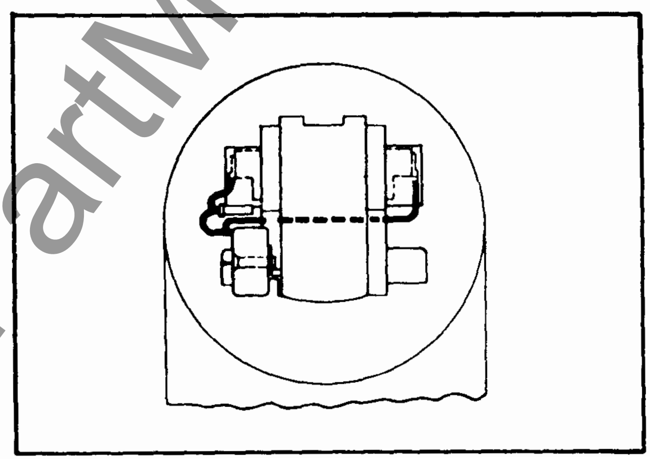


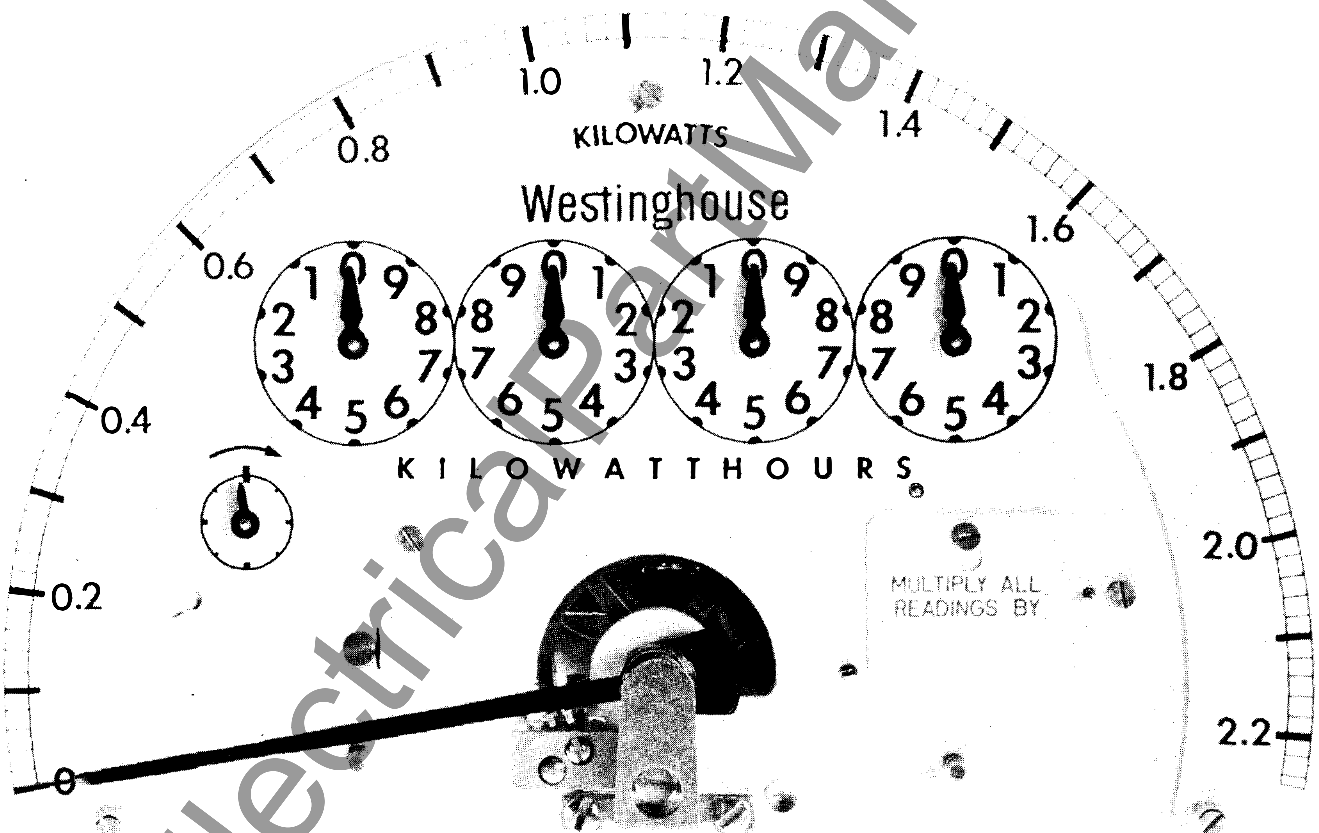
Fig. 25 DAP-2-7-8M & DA-5M & D2A-2-5-7-8M-240V (120V Reg. Motor). DAP-2-7-8M & DA-5M & D2A-2-5-7-8M, 480V. (240V Reg. Motor).

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

MARK I DUAL RANGE DEMAND REGISTERS FOR USE WITH WATTHOUR METERS

TYPES DS-DA-D2S-D2A-DSP-2-5-7-8 DAP-2-5-7-8



SUPERSEDES I.L. 42-302.1A

EFFECTIVE JANUARY 1962

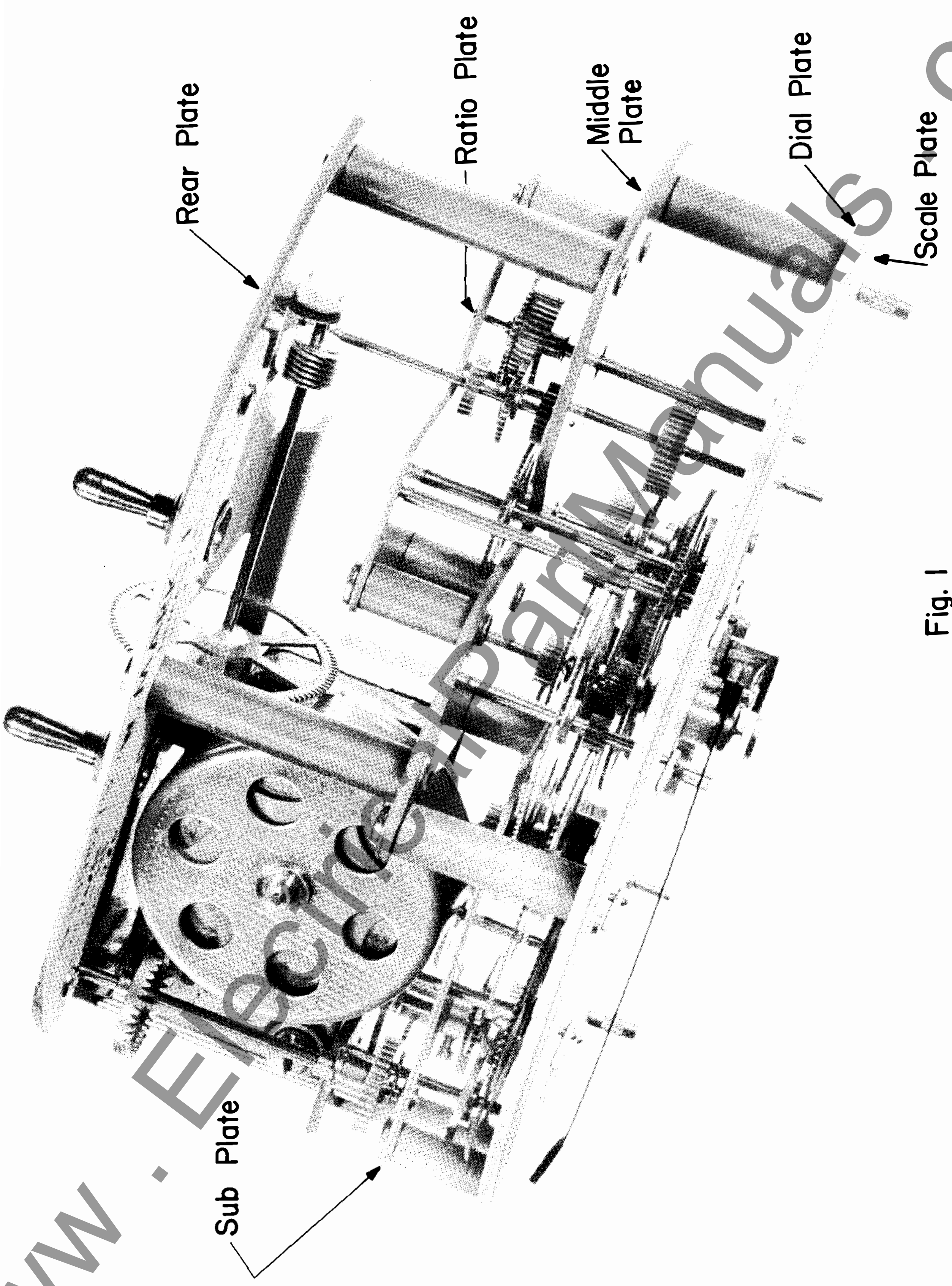
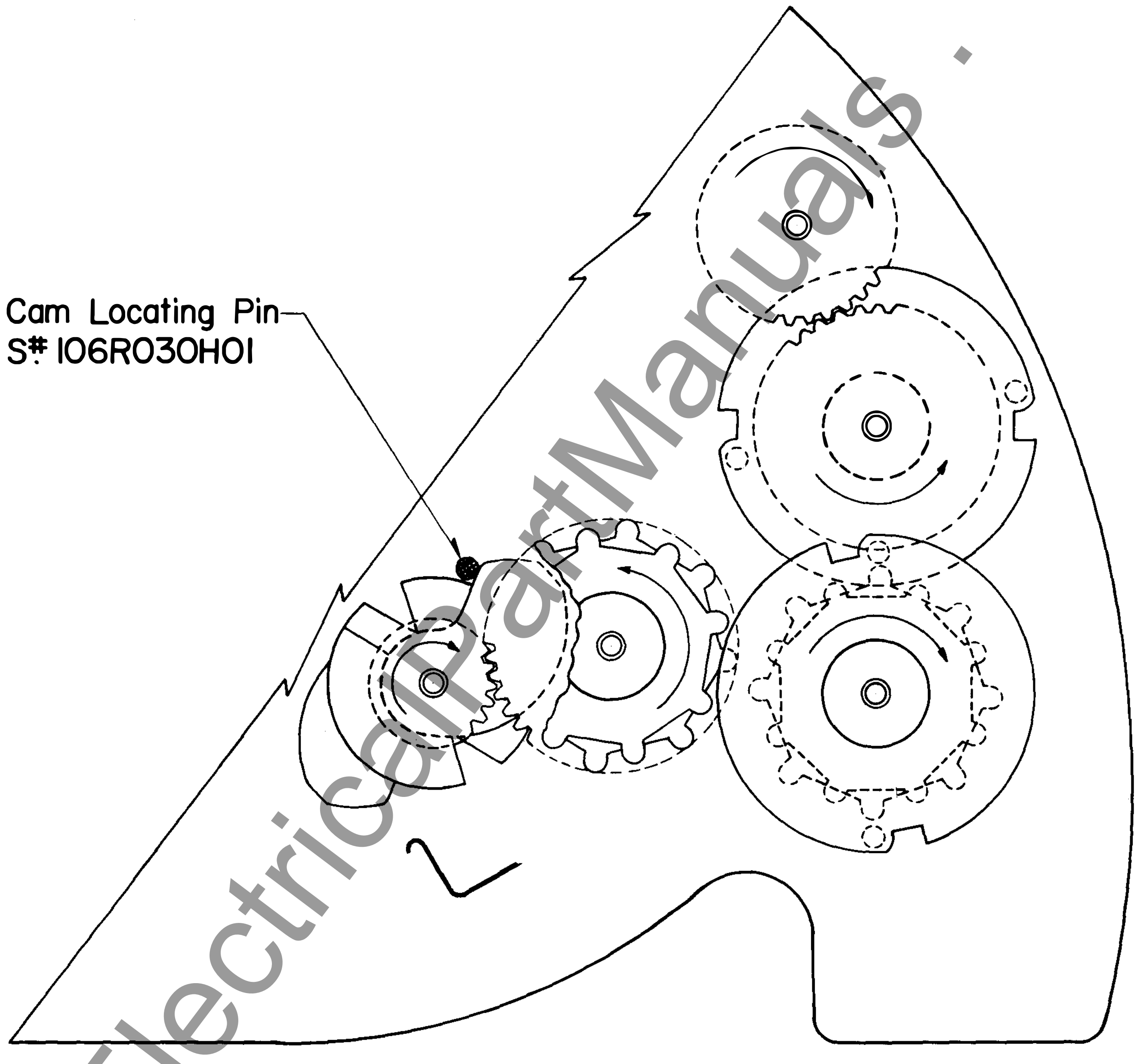

Rear Plate
Ratio Plate
Middle Plate
Dial Plate
Scale Plate
Sub Plate

Fig. I



Cam & Interval Gear Train
Locations For Reassembly
Fig. 5

d. Put the other gear and magnet assembly on the threaded end of the shaft with magnet facing the armature.

e. Put snap ring in the groove provided in the shaft to hold this gear on. Put the #5 shaft assembly in the front plate in its proper position by putting the lever in the groove of the armature and screw driver slotted end of the #5 shaft in the front plate.

CAUTION: Front magnet gear assembly should be resting on the front plate and the armature should be engaged with the back clutch.

4. Cam Shaft #29

Put this shaft in the front plate with the gear towards the rear of the register.

Insert cam locating pin S# 106R030 H01 from the front of the register and screw into left hand multiplier screw hole. (See Figure 5).

Turn cam so that it stops when the top projection of the cam closest to the gear hits the pin. The cam should remain in this position until the middle plate is tightened down.

5. Interval Gear Train

Assemble in the following order: (See Figure 2.)

a. #26 shaft, put in with the driving disc and pins closest to the front plate.

b. #30 shaft. (Interval Indicator) put in with the longest bearing surface in the front plate.

c. #27 shaft, put in with the driving disc and pins towards the rear of the register.

d. #28 shaft, put in with the gear towards the rear of the register.

6. #7 Sector Shaft Assembly

If this shaft was completely disassembled, reassemble as follows:

a. Put snap ring in its groove. (applicators are available for applying snap rings to these shafts.)

b. Put one sector on with the flat side of the sector against snap ring.

c. Put small spacer on.

d. Put the other sector on with flat side against spacer.

Put the assembly in the front plate bearing hole with the end that has no snap ring on it next to the front plate. Do not engage sectors with pusher shaft gears. Let the sectors hang out of the bottom of the register until middle plate is in place and tightened down.

7. Middle Plate

It is very important that the following shafts be placed in the positions described below and as shown in Figure 5. These positions should be maintained until the middle plate is in place and tightened down.

a. Projection of the cam nearest the gear on shaft #29 should be against the locating pin.

b. The disc with pins on shafts #26 and #27 should be located in a neutral position with respect to the driven members with which they mate.

c. With these shafts located as described above, take the middle plate and put in position with respect to its mounting posts. With a slight hand pressure on the left hand side of the plate and working from left to right, put each shaft in its bearing hole. Put 4 screws in and tighten down.

d. Remove cam locating pin from front dial.

8. Clutch Adjustment

Put register in a bottom up position using groove provided in assembly block. Using a small screw driver in the slotted end of clutch shaft #5, turn the threaded portion of the shaft slowly into the hub. Adjust clutch so that lever arm clears the cam when tripped to either clutch position. (See Figure 6). This adjustment should be checked by manually turning the disc on shaft #26 and allow the cam to trip the clutch to both positions and check for end play of lever arm. It is also important at this point to observe the relation of the arm with respect to the cam to make sure that the trip lever does not stop on the trip slopes of the cam. This insures that the register cannot be tripped in the dwell position. If when checking, the trip lever does stop on the slopes of the cam, Step 7 will have to be repeated paying particular attention to step 7(a).

When the clutch is properly adjusted tighten the locking screw in the hub to lock the shaft in position.

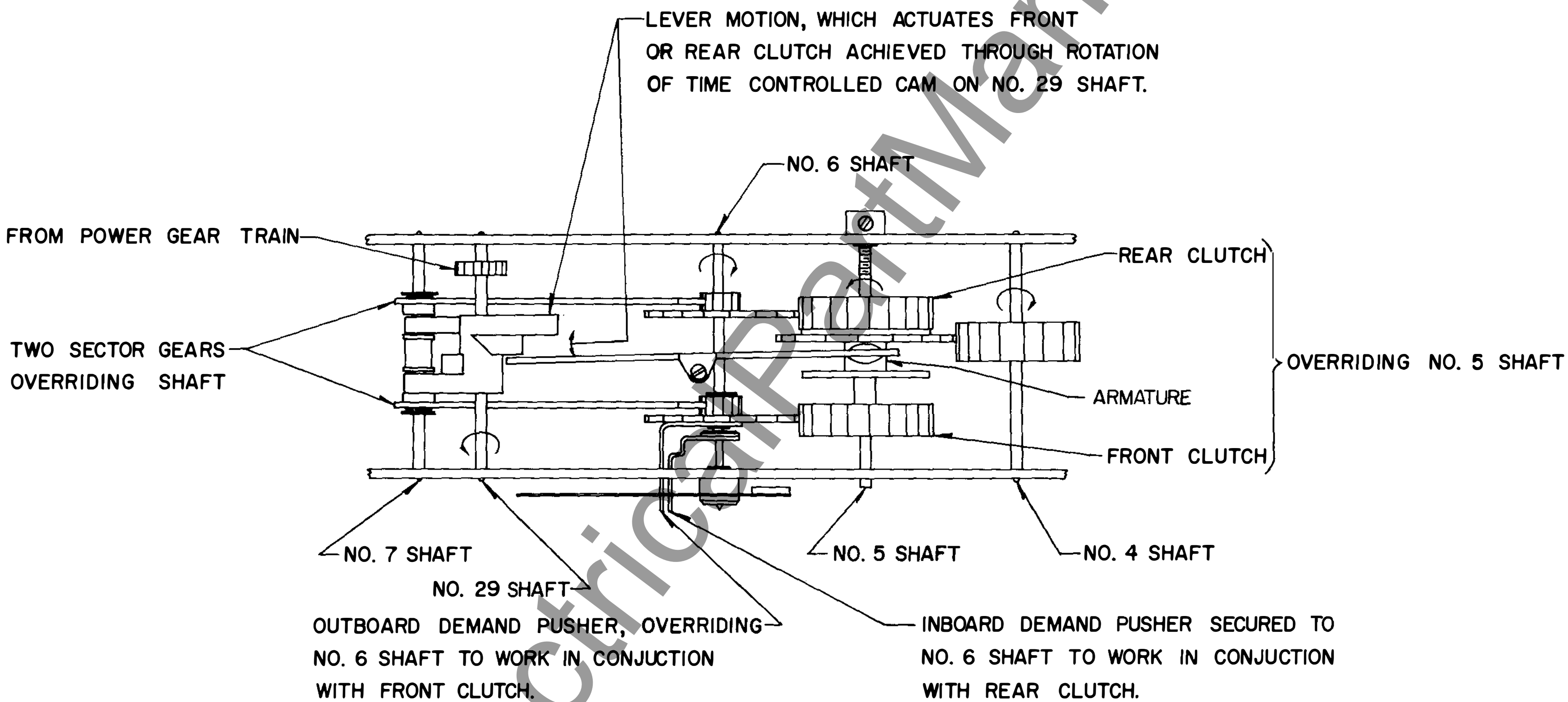

LEVER MOTION, WHICH ACTUATES FRONT OR REAR CLUTCH ACHIEVED THROUGH ROTATION OF TIME CONTROLLED CAM ON NO. 29 SHAFT.
NO. 6 SHAFT
FROM POWER GEAR TRAIN
REAR CLUTCH
TWO SECTOR GEARS OVERRIDING SHAFT
OVERRIDING NO. 5 SHAFT
ARMATURE
FRONT CLUTCH
NO. 7 SHAFT
NO. 5 SHAFT
NO. 4 SHAFT
NO. 29 SHAFT
OUTBOARD DEMAND PUSHER, OVERRIDING NO. 6 SHAFT TO WORK IN CONJUCTION WITH FRONT CLUTCH.
INBOARD DEMAND PUSHER SECURED TO NO. 6 SHAFT TO WORK IN CONJUCTION WITH REAR CLUTCH.

Fig. 6

9. #10 Shaft

Put register face down in assembly block and put #10 shaft in its front plate bearing hole. The other end of this shaft will have the gear on the outside of the middle plate and the shaft will go thru the cut out section of the plate.

10. #4 Shaft

Put this into its bearing holes in front plate so that large gear is closest to the front plate.

11. #3 Shaft (Dual Range Shaft) (See Figure 3)

Put the long end of the shaft thru the hole in the middle plate and into the bearing hole in front plate.

12. #11 Shaft

Put this shaft into its front plate bearing hole with the large gear closest to the front plate.

13. Ratio Plate

Put plate in its relative position and put each shaft in its bearing hole. Put 2 screws in right hand side and the flat spring goes under the 3rd screw on the left hand side. Center the spring over pivot of dual range shaft and tighten screw.

14. #2 Shaft

Put the end of the shaft which has two gears on it in the bearing hole of the middle plate and meshing with gear on dual range shaft. For some ratios it may be necessary to pull back on #3 shaft to allow the pivot of the #2 shaft to go in its bearing hole.

15. #25 Shaft (Crown Gear)

Put this shaft in its bearing hole in the sub plate.

16. Motor Assembly

Lay the motor in its proper position resting on the middle plate with the output pinion in relative position to mate with crown gear on #25 shaft.

17. Back Plate Assembly

If #1 shaft was removed, put it back in bearings and turn the round edge of the retaining screw towards the back plate.

Place back plate in proper relation to its posts and with worm mating with gear on #2 shaft, and seat the crown gear shaft in its bearing hole in the back plate.

Put the 5 screws and spacer in and tighten down.

18. Scale Assembly

Put register in a meter, meter frame or assembly block as shown in Figure 4 with dial up. Put scale in place and put screws in.

19. Multiplier Tag

Replace multiplier tag if used by putting keyhole slot over screw and sliding the tag down. Tighten the screw.

20. Kilowatt Hour and Interval Pointers

Put large pointers on kilowatt hour shafts and the small pointer on interval indicator shaft.

21. Demand Pointer Assembly

With register in same position as described in Step 9 assemble as follows:

a. Put fibre washer on demand pointer hub.

b. Put demand pointer on.

c. Put spinner on.

d. Put protective bracket and spring on and tighten two screws down that hold bracket on.

e. Put spring tension screw in and tighten enough to hold spinner on.

22. Zero Adjustment (See Figure 7)

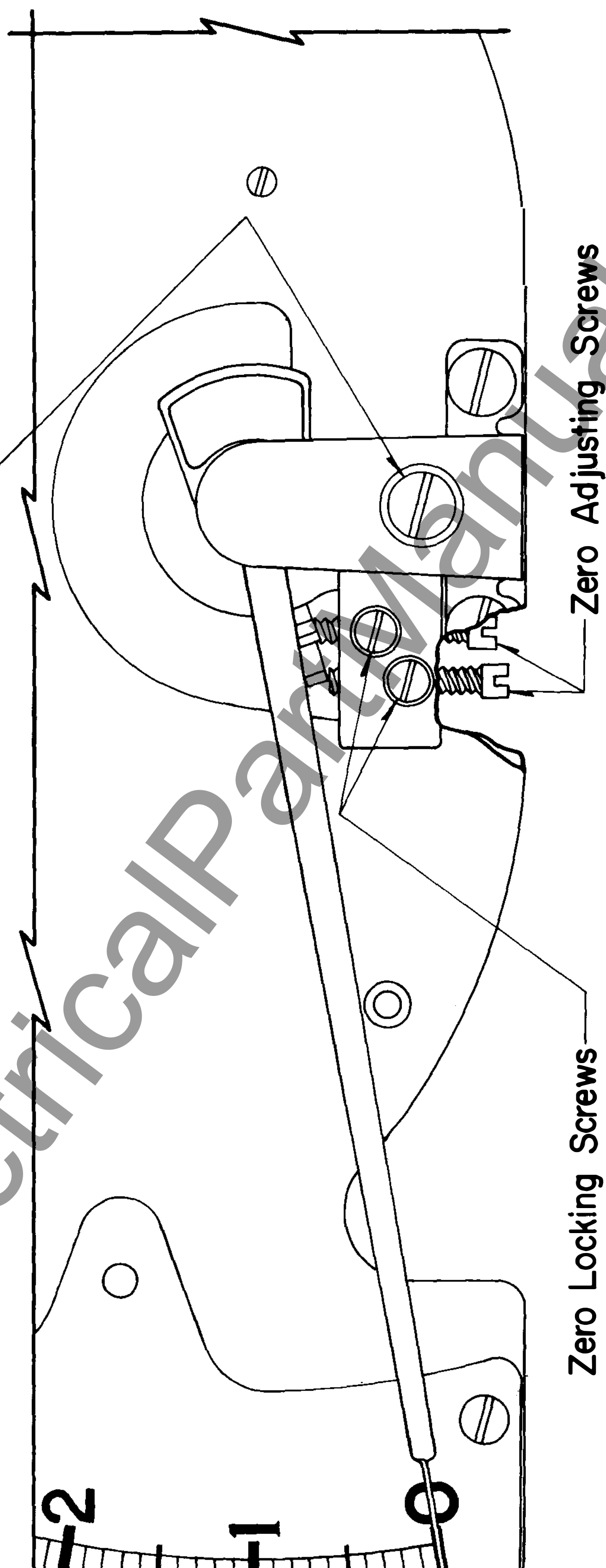
a. Check the two zero adjusting lock screws to be sure they are loose.

b. Put demand pointer against pushers at the zero end of the scale. Pointer should be below the zero marking on the scale.

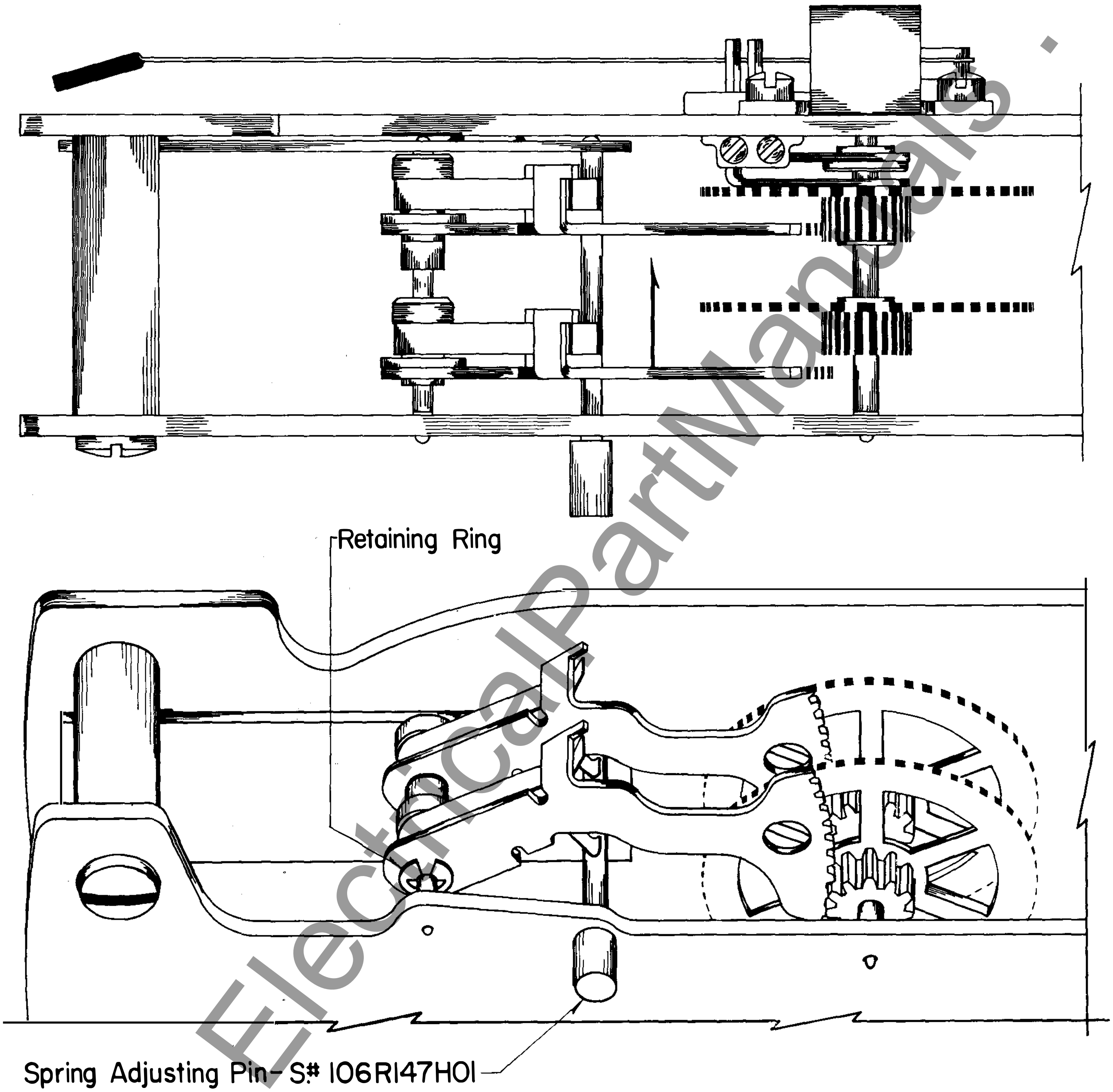
c. Holding demand pointer against pushers adjust the inboard pusher first by turning the inboard Zero Adjusting screw (just under the dial plate) until pointer rests on zero.

d. Tighten inboard locking screw to maintain this adjustment.

e. Holding demand pointer against pushers adjust outboard pusher by turning the outboard zero adjusting screw until pointer rests on zero.



Zero Adjustment
Fig. 7



Sector Adjustment
Fig. 8

f. Tighten out board locking screw to maintain this adjustment.

23. Sector Gear Mesh and Adjustments. (See Figure 8)

Put register in bottom up position and insert sector spring adjusting pin S# 106R147H01 thru the hole provided in the middle plate until it rests in hole provided in front bearing plate.

a. Remove snap ring from sector Shaft #7 so that sector gears can be moved on the shaft to be engaged with their mating pinion on #6 shaft.

b. Rotate both pushers to the zero position on the scale and hold on zero against the pusher.

c. Allow springs on sector gears to rest on spring adjusting pin S# 106R147H01 and slide sectors on the shaft so that they can be meshed with their respective pinions on the #6 shaft.

d. Put snap ring back on sector shaft. Applicators are available for applying snap rings to shafts.

e. Remove spring adjusting pin from middle plate.

24. Interval Indicator Adjustment (See Figure 2)

The interval indicator can always be set at 12 o'clock position by adjusting the gear on the #27 shaft which has a hub and set screw adjustment for this purpose. Loosen screw and turn pointer and shaft to 12 o'clock position. Tighten screw.

25. Checks to be Made After Assembly

a. Check all shafts for end play.

b. Turn the power gear train thru manually by using slip clutch on #25 shaft.

c. Turn the #1 shaft and get a demand and kilowatt hour reading on both clutches similating two complete intervals.

d. Adjust spring tension screws on demand pointer to give from 2 3/4 to 3 1/2 cmg. of torque on demand pointer.

26. Testing Watthour Demand Meters

The same method of test employed for corresponding watthour meters are used when testing demand meters. However, when calibrating demand meters the timing motor should be running and the register meshed. The demand pointer should be set at a position such that it will not be advanced by the pointer pushers at any time during the test.

27. Testing Demand Registers

Calibration - The first step in the calibration should be to check the synchronism of the motor. Observe the rotor in the light of a neon glow lamp or equivalent operated from the same circuit as the motor. When in synchronism the rotor will appear to stand still.

The best way to check the register calibration is by means of some constant speed device such as S# 110C174G01. On this device the register can be driven at several constant speeds to simulate different meter loads.

A portable register checker S# 111C217G01 is also available for a quick check on the kilowatt hour gear train, demand gear train and interval timing gear train. See I.L. 42-315.1E for more information on portable test devices for demand registers.

WESTINGHOUSE ELECTRIC CORPORATION

METER DIVISION • RALEIGH, N. C.

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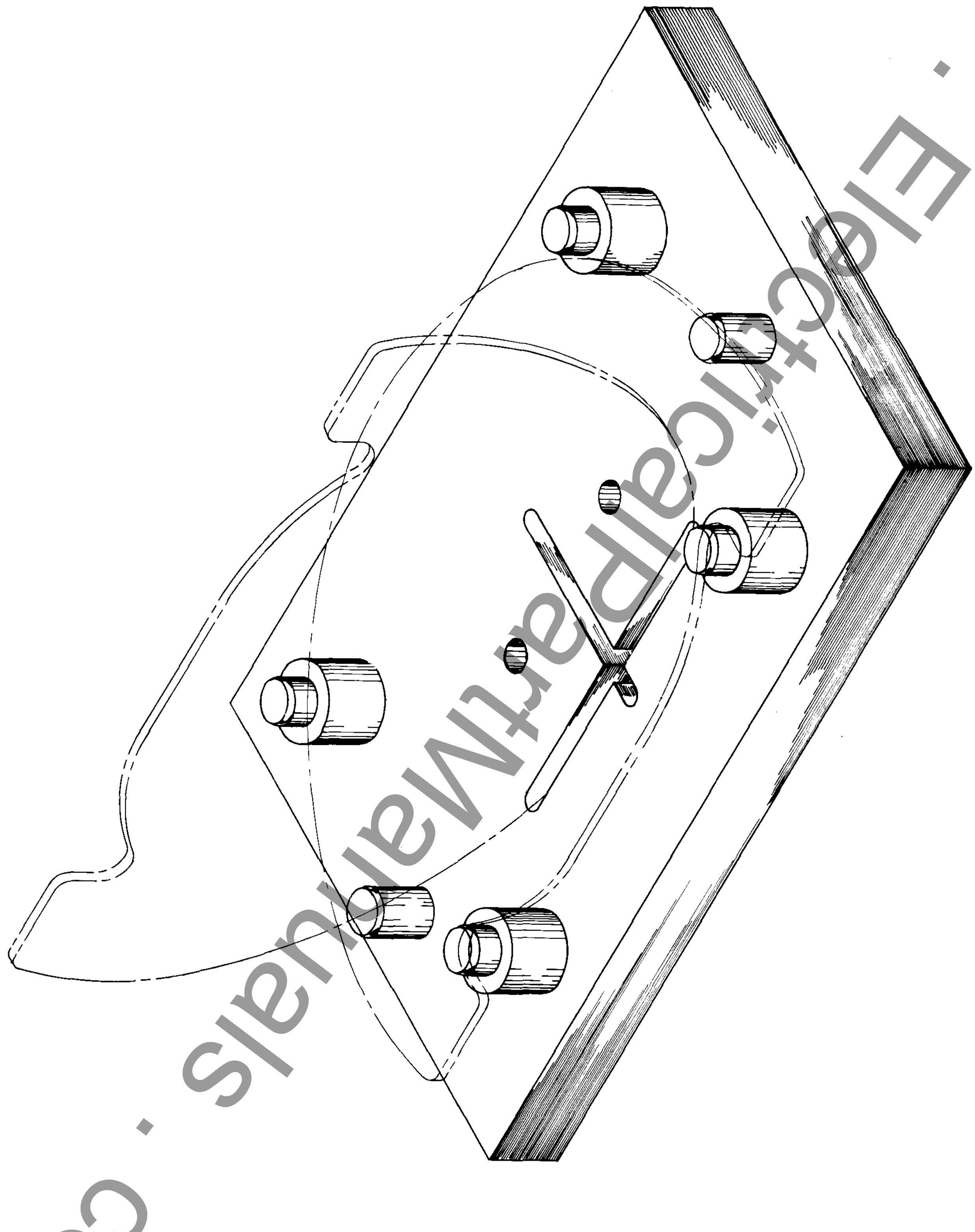


Assembly Block
Fig. 4 S#110C152G01

3. Put the castings together and tighten all screws. Seal screw heads and the joint between cover and case with lacquer P.D. #7241 using artist brush.
4. After allowing the shellac to dry from 12 to 15 15 hours add 1 1/3 cc of oil S#1723639 through the refill hole. A Combination oil gage and filter S#1340457 is recommended for adding oil to the gear case.
5. Apply anti-creep fluid P.D. 9289-1 around the top of the #24 shaft and bearing, to the inside of the breather hole, and on the casting adjacent to the hole.
6. Re-date motor whenever it is re-oiled.

Disassembly of Register

The following procedure is recommended for the disassembly of the Mark I register. An assembly block such as shown in Figure 4 facilitates the disassembly of the register.

By placing the register mounting bayonets in a meter, meter frame, or in a block the following parts can be removed: (See Fig. 1 for Plates)

1. Demand Pointer. Remove the spring tension screw and then the two screws holding the pointer protective bracket and spring. Remove spinner, demand pointer, and fibre washer.
2. Scale. Remove the screws holding scale to dial plate.
3. Pointers - Kilowatt Hour and Interval Indicating. Remove pointers from ends of shaft being careful not to scratch the dial.
4. Multiplier Tag. Remove screw and take off or loosen screw and push tag up and lift off.
5. Motor - Terminal Block - Back Plate. Put register face down in assembly block. Remove 5 screws and take back plate, motor and terminal block off. Remove #25 shaft assembly.

   CAUTION: Place back plate down on bayonet side to prevent damage to the worm wheel.
6. Worm Wheel (#1 Shaft). Turn screw until flat on screw head allows shaft to be removed.
7. Nameplate. Remove two screws.
8. Ratio Plate - Dual Range Spring. Remove #2 shaft. Remove 3 screws holding ratio plate and dual range spring and lift plate off. The following shafts can now be removed: #3, #4, #10, and #11 shafts.
9. Middle Plate. Loosen lock screw on hub in middle plate holding the clutch shaft (#5).

   CAUTION: Be sure armature is engaged with front clutch (one nearest front plate).

   Turn register bottom up and using small screw driver in slotted end of #5 shaft turn counter clockwise to disengage threaded portion of shaft from hub threads.

   Turn register back on its face and remove 4 screws holding middle plate and lift off. The following shaft assemblies can now be removed: #27, #28, #29, #30, #26, #7, and clutch shaft #5.

   The clutch shaft (#5) can be completely disassembled by removing a snap ring on each end of the shaft.
10. Sub Plate. Remove 2 screws and lift plate off and at the same time remove the pusher shaft (#6). The lever arm will come off with the sub plate since it is attached to it. The following kilowatt hour shafts can now be removed: #12, #13, #14, and #15.

Reassembly of Register

The Mark I can be reassembled as follows: Again an assembly block as shown in Figure 4 facilitates this assembly. Applicators are also available for applying snap rings to shafts. (See Fig. 1 for Plates)

1. Front Plate (Dial)

   Place plate face down in assembly block. Put the following shaft assemblies in their bearing holes in the front plate with the long tapered pivot end thru the plate: #15, #14, #13, and #12.
2. Sub Plate.

   Put #6 shaft in its relative position to the sub plate so that trip lever and sub plate are in between the 2 gears on the #6 shaft assembly. Put sub plate on posts and guide shafts into bearing holes. Put two screws in and tighten.
3. Clutch Shaft #5

   If clutch shaft was disassembled use the following procedure for reassembly:

   a. Put one gear and magnet assembly on the screw driver slotted end of the shaft.
   b. Put snap ring in the groove provided in the shaft to hold this gear on.
   c. Put armature on shaft so that the gear on the armature is closest to the threaded end of the shaft.

6. Connect the leads to the motor.
7. Apply rated voltage and see that motor functions correctly.
8. Recheck complete meter on full load and light load adjustment. A slight light load adjustment might be necessary to compensate for the additional friction load of the mechanism. While this adjustment is being made the demand pointer should be up scale so that it is not being driven when calibrating the meter. This corresponds to actual operating conditions as it is very unlikely that maximum demand will occur when the meter is operating at very low loads.
9. Apply demand type cover. For Mark I check to see that reset wire is the proper length.
10. Install complete meter in service as usual for watthour meters.

ADJUSTMENT AND MAINTENANCE

General

Mark I demand registers should be given a periodic cleaning and lubrication. The frequency of the servicing varies according to the conditions to which the device is subjected.

It is not possible to specify in a general instruction leaflet any rigid rules to govern time intervals between servicing or inspection. The conditions and applications are so variable that dependence must be placed upon the experience and judgment of the local operators. Some companies consider that the registers should be serviced every five years, or more frequently if installed where subject to high temperatures or unusual environments.

Cleaning the Register

The Mark I register can be ultrasonically cleaned. The following procedure is recommended for this cleaning.

1. Remove the motor from the register by removing the two screws in the back plate holding the motor in. The motor is then pushed upward and brought out through the top of the register by rotating slightly around the crown gear shaft #25.
2. The register can now be ultrasonically cleaned.

Where the ultrasonic method of cleaning is not used, the following cleaning procedure is recommended.

1. Disassemble the register completely as described on Page 9.
2. Each component should be cleaned with a good grade of clock cleaning fluid and rinses such as L & R solutions.
3. Dry all parts thoroughly after cleaning.
4. Reassemble the register as described on Page 9.

Cleaning the Motor

Since the motor gear reduction is completely enclosed and running in a good grade of oil it should not require cleaning as often as the register. Instead it is recommended that the motor be tilted so that all of the oil will drain down under the oil filler screw. Take the syringe S# 1340457 used to put oil in the motor and insert it in the oil filler hole. Try to draw out the oil. If oil can be drawn up in the syringe or if it can definitely be established that there is oil in the motor then put this oil back in the motor and add another 1/2 cc of oil. This should be all the service necessary for the motor. If oil cannot be detected in the motor then the motor should be disassembled as described below and cleaned and re-oiled.

1. Remove cover from motor assembly by using a sharp gas flame or a soldering iron to soften the yellow lacquer on screw heads. Remove screws while hot.
2. Remove motor gear train.
3. Scrape shellac from castings and clean inside of castings being careful not to get cleaning fluid in rotor shaft and bearing.
4. Motor gear train can be cleaned ultrasonically or disassembled and individual shaft assemblies and plates cleaned with a good grade of clock cleaning fluid and rinses such as L & R solutions.

Reassembly of Motor Gear Train

After parts have been cleaned the following procedure should be followed:

1. If gear train was disassembled, re-assemble and mount it back in position on top casting.
2. Apply thin coat of shellac P.D. # 1154-5 around the matching surfaces of both top and bottom casting. Be sure to apply the shellac on all surfaces around the holes. Allow shellac to dry a few minutes before assembly.

A dial multiplier with the words "Multiply all Readings By" is available for meters on which required. A second position is also available on the left hand side of the register for special applications where additional multipliers or information is desired.

In special cases where a customer has standardized on a given demand scale (Example: 0-2.0KW the scale plate is not reversed to change the scale class. Instead a special multiplier tag is reversed which accomplishes the gear shift required and shows the new demand multiplier.

The base speed of D-line meters on which these registers are used is 1000 rev./hr. and the disc shaft has a single lead worm that meshes with a 100 tooth worm wheel. Listed in the table below are some standard register ratios (R_R), watthour constants (K_h), and their corresponding demand scales.

					Full Scale Reading Kilowatts*			
Volts	Amperes	Wire	R_R	K_h	Class2*	Class6	Class3	Class5
120+	2.5	2	333 1/3	.3	1	2	.75	1.5
120	15	2	55 5/9	1.8	6	12	4.5	9
240+	2.5	3	166 2/3	.6	2	4	1.5	3
240	15	3	27 7/9	3.6	12	24	9	18
240	30	3	13 8/9	7.2	24	48	18	36

+ secondary rated transformer type meter only.

* The Mark I register has 2 classes built into one register depending on the scale used.

Universal Register

It is sometimes desirable to use one universal register for all meters, this can be accomplished by varying the register dial multiplier. For example a register that has a register ratio of 166 2/3 and demand class 2/6 could be used on all D-line meters with an appropriate dial multiplier. This register would have a 2 KW or 4 KW full scale depending on the class setting. The dial multiplier is determined as follows:

$$\text{Dial Multiplier} = \frac{\text{Meter Constant}}{C}$$

$C = K_h$ of meter for which this register is direct reading. For a register with 166 2/3 R_R $C = .6$

The meter nameplate gives the meter constant (K_h). On transformer rated meters the primary (K_h) is determined as follows:

$$K_h \text{ primary} = K_h \text{ X CT ratio X PT ratio}$$

The dial multiplier is:

$$\text{Dial Multiplier} = \frac{\text{Meter Constant}}{C} = \frac{K_h \text{ X CT X PT}}{C}$$

Example:

For a DSP-2M 3-wire, 3-phase meter with a meter constant of 0.6, a CT of 200/5 and a PT of 2400/120 the dial multiplier would be $\frac{0.6 \text{ x } 20 \text{ X } 40}{0.6} = 800$

INSTALLATION

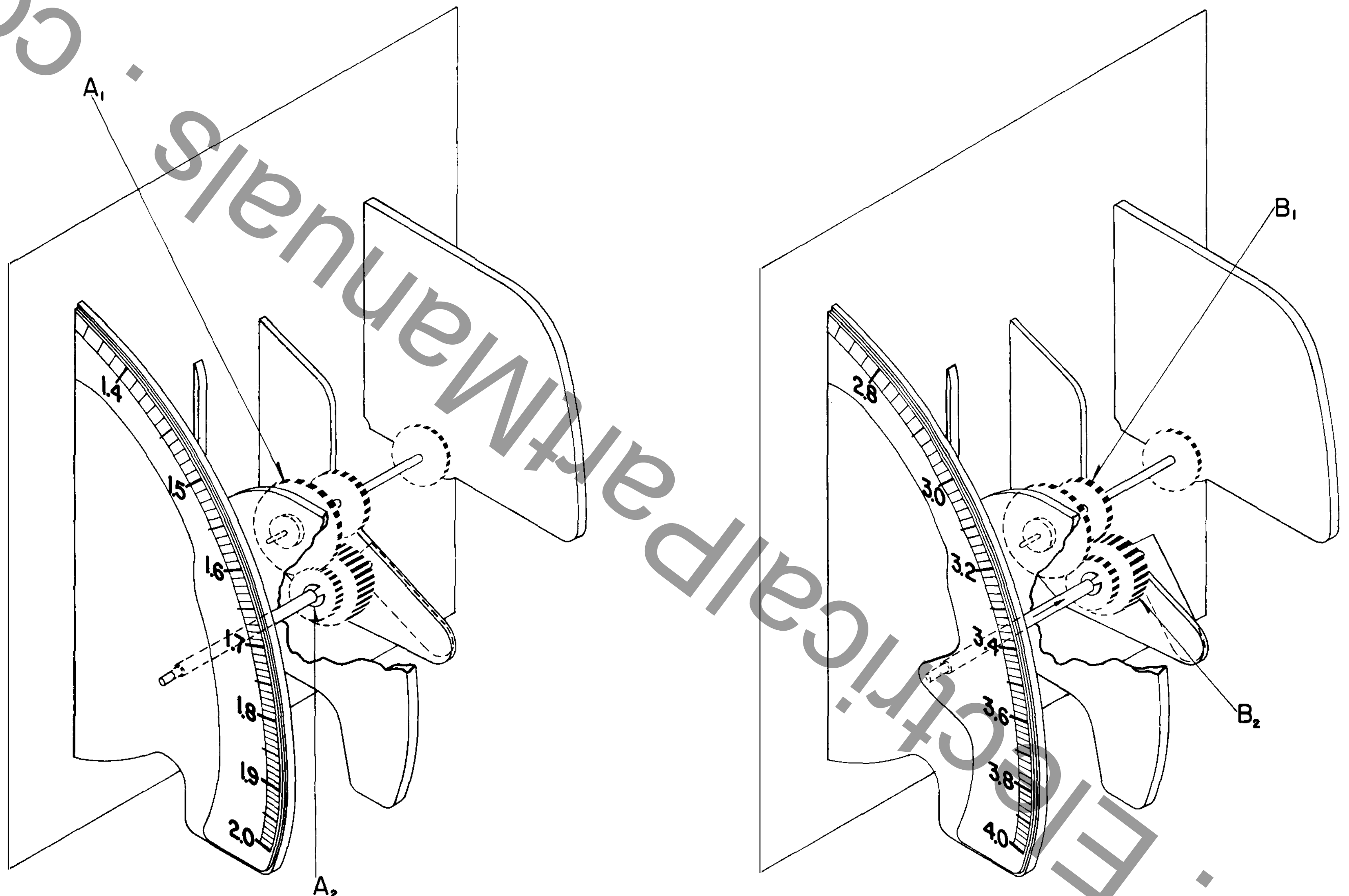
These registers are designed for use only on Westinghouse meters. They are designed to be interchangeable with the standard kilowatt hour register in order to convert from a standard kilowatt hour meter to a demand meter.

The registers are adjusted and checked for accuracy of registration at the factory and are ready for immediate installation. However, to insure that the register has not been damaged in shipment and that the necessary parts have been received for field conversion the following procedure should be followed:

1. Unpack the register with care.
2. Inspect the register as follows:
   a. Check the nameplate mounted on top of register back plate to insure that the register is correct for the meter with which it is to be used. Check scale vs class.
   b. Check all shaft assemblies for end play and gear mesh.
   c. If it is desired to check the calibration, proceed as outlined in the Maintenance and Adjustments Section.
3. Remove Kilowatt hour register and attach leads to meter potential terminals. The leads are furnished with the proper connectors so that any disassembly of the meter proper or soldering is eliminated. This is true for all meters except the 3 wire single phase meter which if converted in the field will require one lead to be soldered to the disconnect link.
4. On 120 volt meters the Mark I is furnished with a 120 volt motor and on 240 volt meters the Mark I is furnished with a 240 volt motor. On 480 volt meters a 240 volt motor and 240 volt reactor coil are used.

Wiring drawings for the installation of leads and reactors are shown in I.L. 42-300.

5. In place of the kilowatt hour register install the new Mark I register. No changes are necessary in the meter proper.



Dual Range
Fig. 3

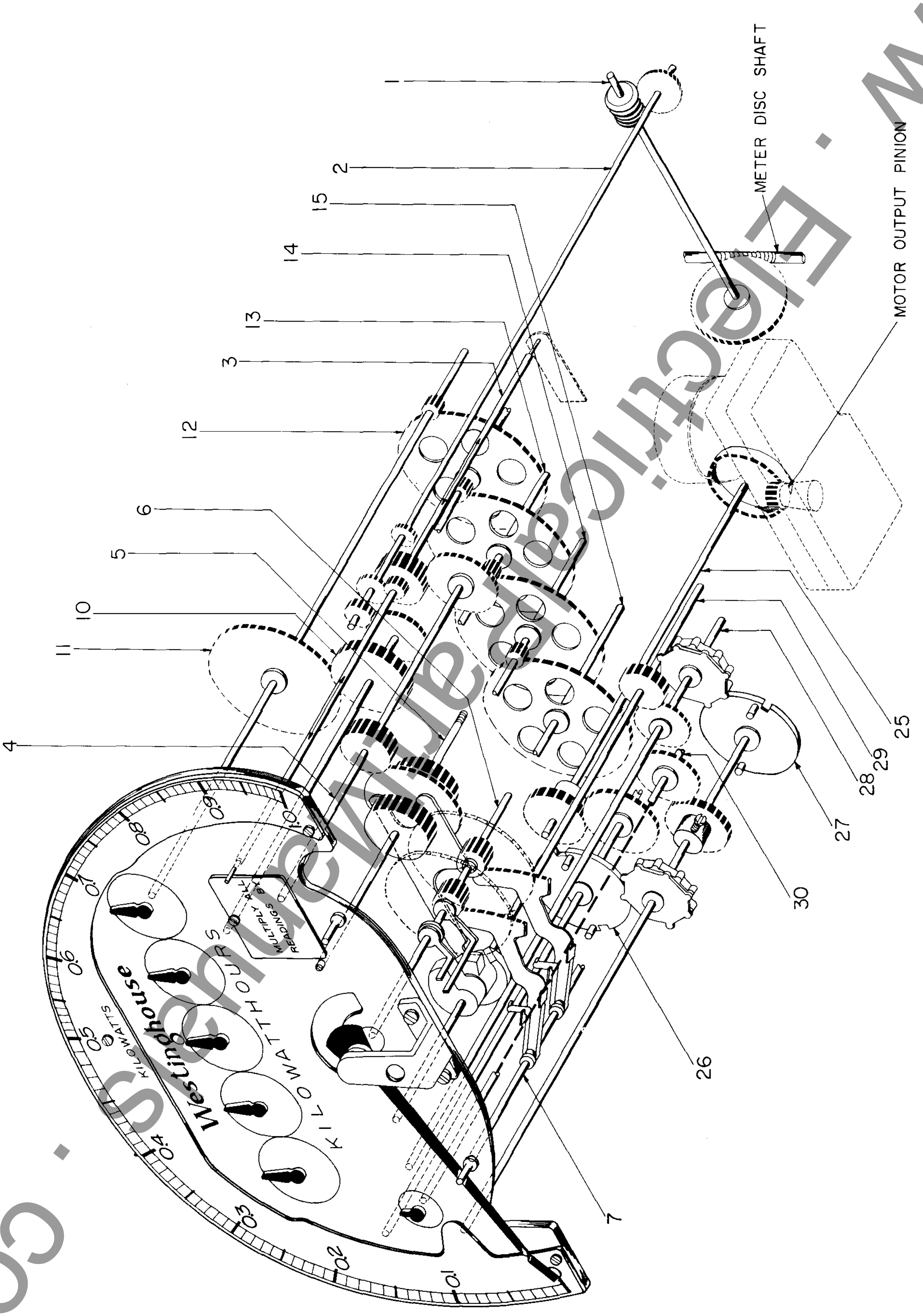


FIG. 2
PERSPECTIVE VIEW

INTRODUCTION

The Mark I registers convert watthour meters to block interval demand meters. The "watthour demand meters" are identical to watthour meters except for the addition of the demand register and its necessary components; two lead connections for the motor, and a glass cover with a mechanical reset. The mechanical demand register gives a combination of the kilowatt hour consumption, just like the standard kilowatt hour register, and in addition gives the maximum kilowatt demand over a definite time interval by means of a pointer moved over a graduated demand scale.

GENERAL DESCRIPTION

The Mark I demand register has a standard kilowatt hour gear train plus a demand gear train. Both gear trains are driven by the disc shaft.

The interval is accomplished by a synchronous motor and a gear train which turns a cam. The cam pivots an arm which engages a magnetic clutch. The clutch when engaged turns a gear on a shaft which also holds a pusher. The pusher contacts a demand pointer. The pointer has enough friction to hold it on any point of the scale to which it is pushed.

During the time interval, the pointer pusher is driven up scale at a rate proportional to the load on the watthour meter. If the demand of the interval exceeds that of the previous interval with the highest demand, the pusher moves the pointer up scale to the point representing the new maximum demand. The pusher is returned to zero at the end of each interval by the action of the cam on a sector gear. The cam is so designed that it performs two functions: (1) it engages thru a lever arm one magnetic clutch for one interval and then thru the same lever arm engages a second magnetic clutch on the same shaft for the 2nd interval. (2) The Mark I has two pushers, one to engage with each clutch mentioned above. The top outer surface of the cam returns to zero the pusher which is not engaged during the interval, this gives a minimum open time since one pusher takes over the instant the other is released by the clutch. For each pusher there is also a corresponding sector gear which returns the pusher to zero.

PRINCIPLE OF OPERATION

The following is a description of the operating principle of the Mark I demand register, see Figure 2.

The meter disc shaft drives the worm wheel on shaft (1). Shaft (1) turns shaft (2) which turns shaft (10) the kilowatt hour gear train and the pointer shafts (11) (12) (13) (14) and (15). Shaft (2) also turns shaft (3).

Shaft (3) turns shaft (4) which turns the demand clutches on shaft (5) alternately depending on which clutch is engaged. Each clutch on shaft (5) turns its mating gear on shaft (6) when its clutch is engaged. Shaft (6) also has two pushers which work with the two corresponding clutches and push the demand pointer up scale to indicate the demand.

Both shafts (2) and (3) have 2 gears and pinions which change mesh when the scale plate is reversed to change class. This gives the dual range feature. As an example to change from Class 2 to Class 6 the scale is reversed and a tab on the scale when placed on the Class 6 side depresses shaft (3) which is then put under spring tension. This action disengages a gear and mating pinion on shafts (2) and (3) and automatically engages a different gear and pinion on these two shafts. This change in ratios corresponds with the scale in use automatically due to the contour of the scale. (See Figures 2 and 3).

The time interval is established by the operation of a synchronous motor as it drives thru a gear train to a cam which trips the clutches and returns the pushers to zero by its action on two sector gears. The operations are accomplished as follows: crown gear shaft (25) is turned by the output shaft of the synchronous motor. Shaft (25) turns shaft (26) and the driving disc on this shaft turns shaft (27) which turns the time elapsed indicator shaft (30) and also has a driving disc which turns shaft (28). Shaft (28) drives the cam shaft (29). The cam on shaft (29) performs a dual function:

(1) It pivots a lever arm, which rides in the center of the cam, and engages a clutch for the interval. On the next interval the cam pivots the lever arm in the opposite direction and engages the opposite clutch. (See Figure 6).

(2) The top outer surface of the cam depresses a spring on the corresponding sector gear on shaft (7) and drives the pushers on shaft (6) back to zero.

The cam action always returns the disengaged pusher to zero before the end of the interval and keeps the clutch open time to less than 1 second.

SCALES

The Mark I is a dual range register and is available as Class 2 and 6 or Class 3 and 5. The class change is accomplished by reversing the scale which mechanically changes the gear ratios to correspond with the scale in use. (See Figure 3).

MARK I DUAL RANGE DEMAND REGISTERS

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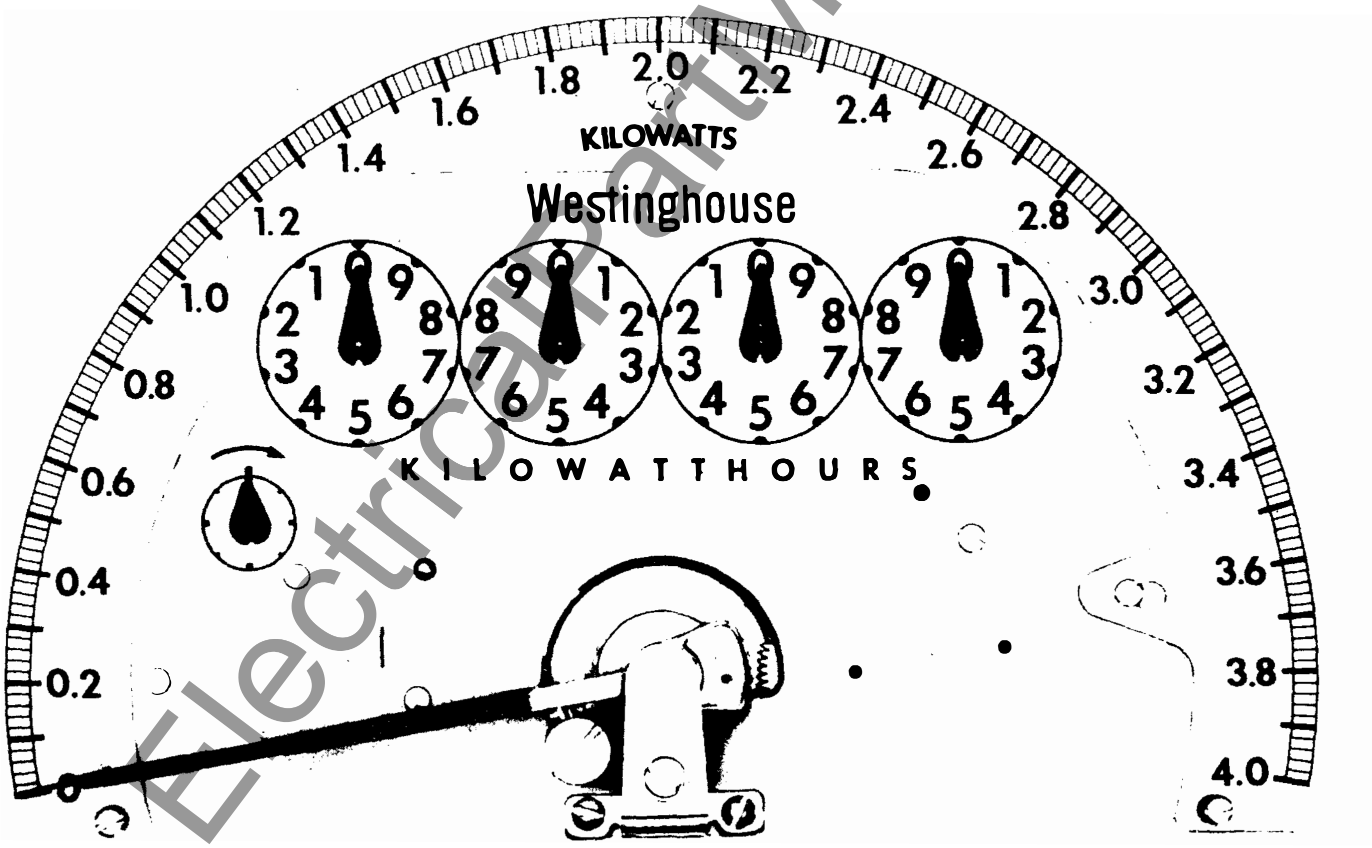
INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

MARK 1a DUAL RANGE DEMAND REGISTERS FOR USE ON D-LINE WATTHOUR METERS



All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding his particular installation, operation or maintenance of his equipment, the local Westinghouse Electric Corporation representative should be contacted.

Supersedes I.L. 42-302.11A
dtd December 1970

JANUARY 1973

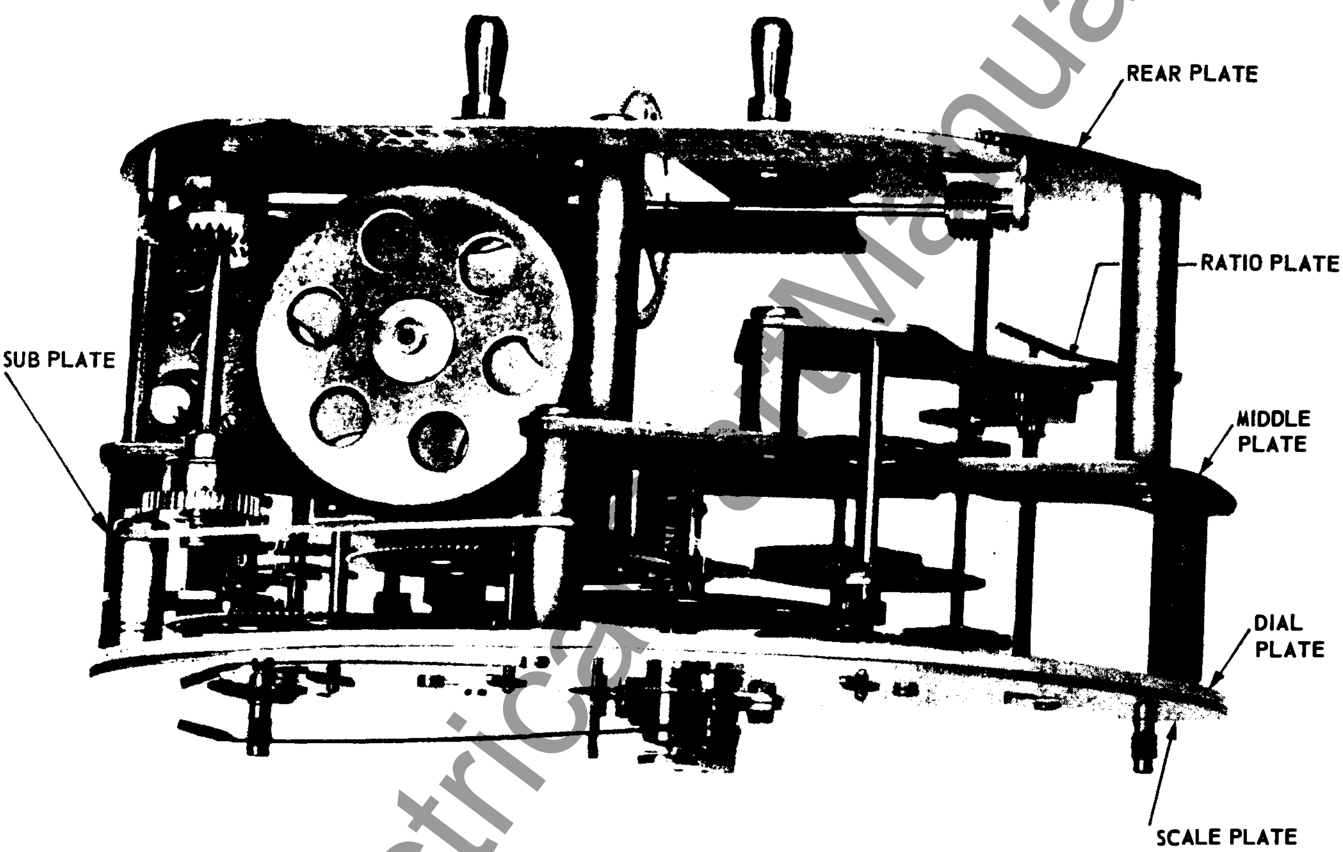

REAR PLATE
RATIO PLATE
SUB PLATE
MIDDLE PLATE
DIAL PLATE
SCALE PLATE

FIG. 1

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INTRODUCTION

The Mark Ia register eliminates the two-pusher design used in the Mark I thereby reducing test time and improving reliability.

The Mark Ia registers convert watthour meters to block interval demand meters. The "watthour demand meters" are identical to watthour meters except for the addition of the demand register and its necessary components: two lead connections for the motor and a glass cover with a mechanical reset. The mechanical demand register gives a combination of the kilowatt hour consumption, just like the standard kilowatt-hour register, and in addition gives the maximum kilowatt demand over a definite time interval by means of a pointer moved over a graduated demand scale.

GENERAL DESCRIPTION

The Mark Ia demand register has a standard kilowatt-hour gear train plus a demand gear train. Both gear trains are driven by the disk shaft.

The interval is accomplished by a synchronous motor and a gear train which turns a cam. The cam pivots an arm which engages a clutch. The clutch when engaged turns a pusher. The pusher contacts a demand pointer. The pointer has enough friction to hold it on any point of the scale to which it is pushed.

During the time interval, the pointer pusher is driven up scale at a rate proportional to the load on the watthour meter. If the demand of the interval exceeds that of the previous interval with the highest demand, the pusher moves the pointer up scale to the point representing the new maximum demand. The pusher is returned to zero at the end of each interval by the action of the cam on a sector gear.

PRINCIPLE OF OPERATION

The following is a description of the operating principle of the Mark Ia demand register (Fig. 2).

The meter disk shaft drives the wormwheel on shaft (1). Shaft (1) turns shaft (2) which turns shaft (10), the kilowatt-hour gear train and the pointer shafts (11) (12) (13) (14) and (15). Shaft (2) also turns shaft (3). Shaft (3) turns the pusher (41) on clutch shaft (6) through shafts (4) and (5).

Both shafts (2) and (3) have two gears and pinions which change mesh when the scale plate is reversed to change class. This gives the dual range feature. As an example to change from Class 2 to Class 6, the scale is reversed and a tab on the scale when placed on the Class 6 side depresses shaft (3) which is then put under spring tension. This action disengages a gear and mating pinion on shafts (2) and (3) and automatically engages a different gear and pinion on these two shafts. This change in ratios corresponds with the scale in use automatically due to the contour of the scale. (Figures 2 and 3).

The time interval is established by the operation of a synchronous motor as it drives thru a gear train to a cam which trips the clutch and returns the pusher to zero by its action on the sector gear (7) and the lever arm (43). The operations are accomplished as follows: crown gear shaft (25) is turned by the output shaft of the synchronous motor. Shaft (25) turns shaft (26), and the driving disk on this shaft turns shaft (27) which turns the time elapsed indicator shaft (30) and also has a driving disk which turns shaft (28). Shaft (28) drives the cam shaft (29). The cam on shaft (29) performs a dual function:

(1) It pivots lever arm (43) which disengages the clutch for the interval reset.

(2) The top outer surface of the cam depresses the spring on the sector gear (7) and drives the pusher (41) on shaft (6) back to zero.

SCALES

The Mark Ia is a dual range register and is available as Class 1 and 2, Class 2 and 6, Class 3 and 5, or Class 4 and 8. The class change is accomplished by reversing the scale which mechanically changes the gear ratios to correspond with the scale in use. (Fig. 3).

A dial multiplier with the words "Multiply all Readings By" is available for meters on which required. A second position is also available on the left hand side of the register for special applications where additional multipliers or information is desired.

In special cases where a customer has standardized on a given demand scale (Example: 0-2.0 KW), the scale plate is not reversed to change the scale class. Instead, a special multiplier tag is reversed which accomplishes the gear shift required and shows the new demand multiplier.

The base speed of the following D-line meters on which these registers are used is either 1000 r.p.h. or 500 r.p.h., and the disk shaft has a single lead worm that meshes with a 100-tooth wormwheel. Listed in the tables (Pg. 7) are some typical register ratios (Rr), watthour constants (Kh), and their corresponding demand scales.

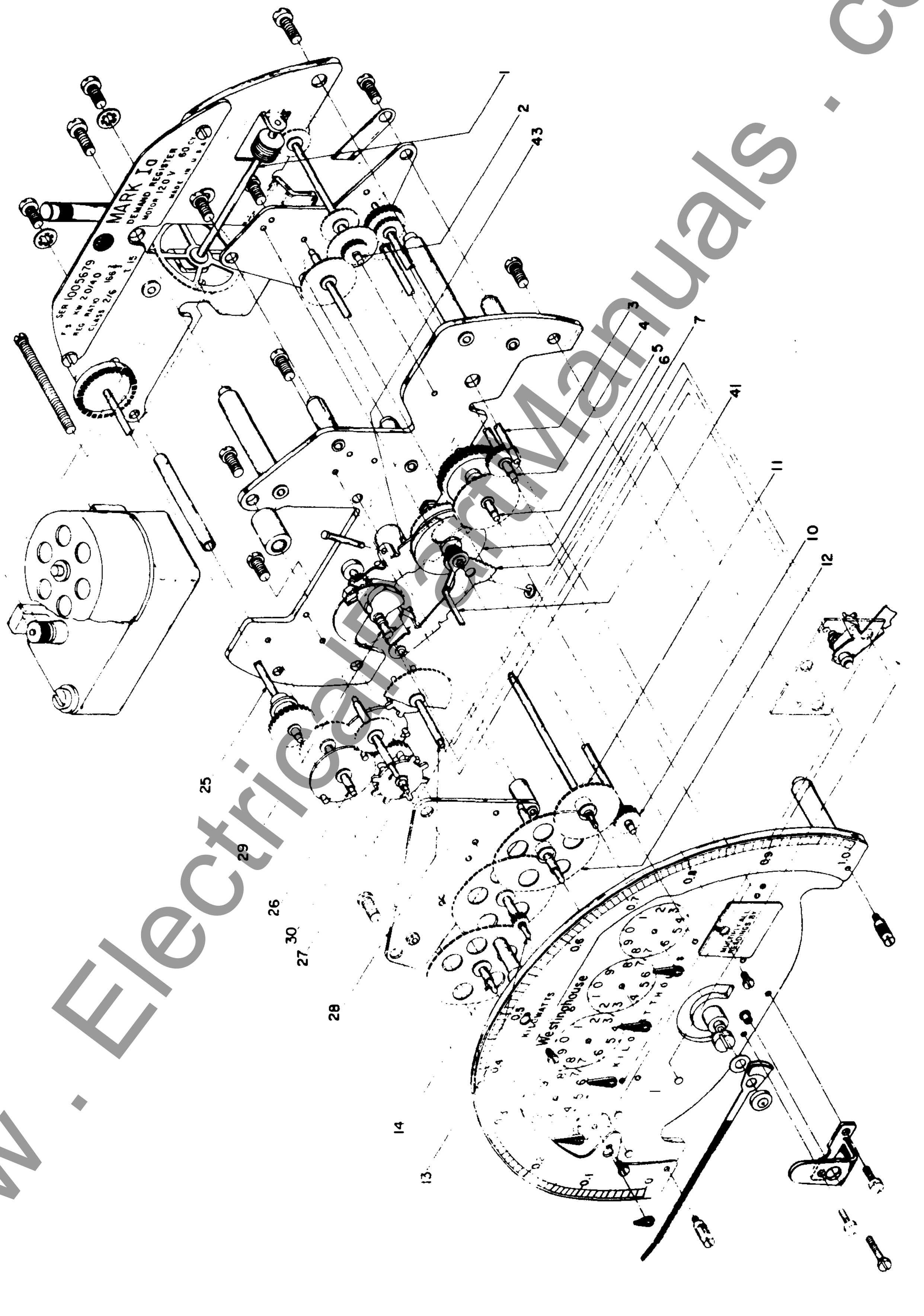


Fig. 2

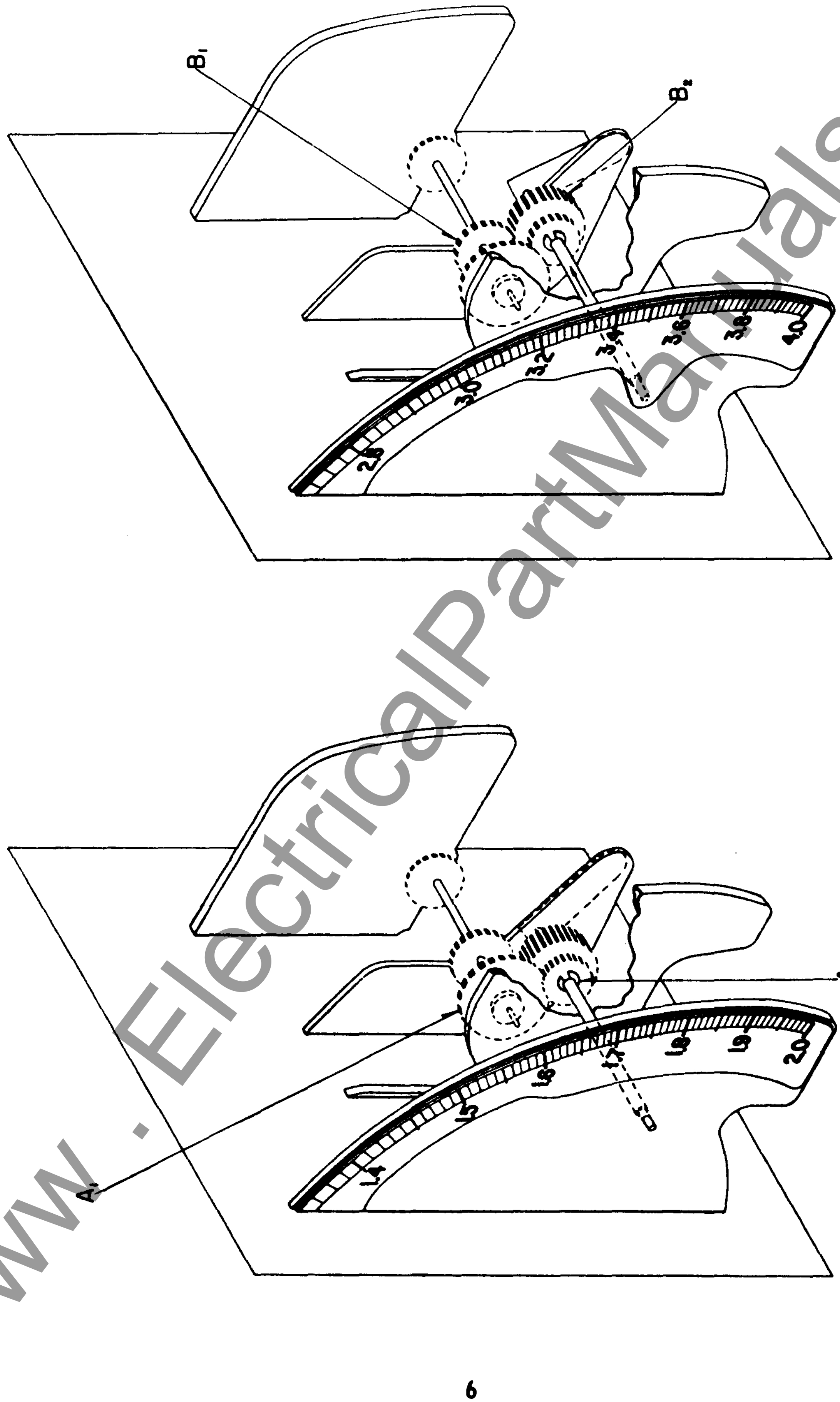


Fig. 3 Dual Range

For Meters with Base Speed 1000 r.p.h.

Volts	Amperes	Stators	Kh	Rr	Full Scale Reading Kilowatts *			
					Class 2	Class 6	Class 3	Class 5
120	2.5	1	.3	333 1/3	1	2	.75	1.5
120	15	1	1.8	55 5/9	6	12	4.5	9
120	2.5	2	.6	166 2/3	2	4	1.5	3
120	15	2	3.6	27 7/9	12	24	9	18

For Meters with Base Speed 500 r.p.h.

Volts	Amperes	Stators	Kh	Rr	Full Scale Reading Kilowatts *			
					Class 2	Class 6	Class 4	Class 8
120	2.5	2	1.2	83 1/3	2	4	2.4	4.8
120	15	2	7.2	13 8/9	12	24	14.4	28.8
120	2.5	3	1.8	55 5/9	3	6	3.6	7.2
120	15	3	10.8	9 7/27	18	36	21.6	43.2

*The Mark Ia register has 2 classes built into one register depending on the scale used.

UNIVERSAL REGISTER FOR METERS WITH BASE SPEED 16 2/3 RPM TYPES DS-DA-D2S-D3S D2A-DSP-2-5-7-8 DAP-2-5-7-8 D2S-2-5-7-8 D2A-2-5-7-8 D4SM SINGLE-PHASE

In order to provide flexibility in application of registers to meters of any KW capacity, the "Universal" demand register is recommended. For self-contained class 100 and 200 meters this is the R-166 2/3 ratio (direct reading on meters with Kh .6) with a class 2/6 demand scale. This register would have a 2 KW or 4 KW scale depending on the class setting.

The 166 2/3 register ratio is chosen because it provides register dial multipliers that are whole numbers (not fractions) on practically every type and rating of self-contained meter. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant (Kh)}}{0.6}$$

In the case of transformer rated class 10 meters, the proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant(Kh)} \times \text{CT ratio} \times \text{PT ratio}}{.6}$$

Since Kh pri = Kh sec X CT ratio X PT ratio, this formula can be used:

$$\text{Multiplier} = \frac{\text{Kh pri}}{.6}$$

UNIVERSAL REGISTERS FOR D4 POLYPHASE METERS WITH BASE SPEED 8 1/3 RPM

With the advent of the D-4 polyphase meters which have a base speed of 500 R.P.H. and a first reduction of 100, a universal register with less gear reduction (twice as fast) should be considered. For self-contained class 200 meters, this is the R_r = 83 1/3 ratio (direct reading on meters with Kh = 1.2) with a full scale of 2 KW or 4 KW depending on the class setting.

The 83 1/3 register ratio is chosen because for the 500 R.P.H. meter it provides register dial multipliers that are whole numbers (not fractions) on practically every type and rating of self-contained meter. The R_r 83 1/3 is direct reading on a meter with a Kh = 1.2. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant (Kh)}}{1.2}$$

In the case of the transformer rated class 20 meter, the R_r - 83 1/3 ratio (direct reading on meter with K_h = 1.2) register with a class 4/8 full scale is recommended. This register would have a full scale of 2.4 KW or 4.8 KW depending on the class setting. The proper register multiplier is found as follows:

$$\text{Multiplier} = \frac{\text{Meter Constant(Kh)} \times \text{CT ratio} \times \text{PT ratio}}{1.2}$$

Since Kh pri = Kh sec X CT ratio X PT ratio this formula can be used.

$$\text{Multiplier} = \frac{\text{Kh pri}}{1.2}$$

In all cases the multiplier will apply to both KWH and KW demand readings.

INSTALLATION

These registers are designed for use only on Westinghouse meters. They are designed to be interchangeable with the standard kilowatt-hour register in order to convert from a standard kilowatt-hour meter to a demand meter.

The registers are adjusted and checked for accuracy of registration at the factory and are ready for immediate installation. However, to insure that the register has not been damaged in shipment and that the necessary parts have been received for field conversion, the following procedure should be followed:

1. Unpack the register with care.

2. Inspect the register as follows:
   a. Check the nameplate mounted on top of register back plate to insure that the register is correct for the meter with which it is to be used. Check the meter class vs Register Full Scale to verify that register KW full scale corresponds with the thermal capacity of the meter. For instance, a Class 200-240 volt, 2 stator polyphase meter would have a thermal capacity of 200 x 240 x 2 = 96 KW. The correct matching register for this meter should have a full scale of 96 KW.

   b. Check all shaft assemblies for end play and gear mesh.

   c. If it is desired to check the calibration, proceed as outlined under Testing Watthour Demand Meters and Testing Demand Registers.

3. Remove Kilowatt-hour register and attach leads to meter potential terminals. The leads are furnished with the proper connectors so that any disassembly of the meter proper or soldering is eliminated. This is true for all meters except the 3-wire, single-phase meter which is not recommended for field conversion.

4. On 120-volt meters, the Mark Ia is furnished with a 120-volt motor and on 240-volt meters the Mark Ia is furnished with a 240-volt motor. The 240-volt motor will operate between 200 and 300 volts and is adequate for 277-volt application. On 480-volt meters, a 240-volt motor and 240-volt reactor coil are used.

   Wiring drawings for the installation of leads and reactors are shown in Figures 10 through 25. All A-base polyphase meters above Serial No. 53,980,000 are shipped equipped with Demand Motor Leads.

5. In the place of the kilowatt-hour register, install the new Mark Ia register. No changes are necessary in the meter proper.

6. Connect the leads to the motor.

7. Apply rated voltage and see that motor functions correctly.

8. Recheck complete meter on full load and light load adjustment. A slight light load adjustment might be necessary to compensate for the additional friction load of the mechanism. While this adjustment is being made, the demand pointer should be up scale so that it is not being driven when calibrating the meter. This corresponds to actual operating conditions as it is very unlikely that maximum demand will occur when the meter is operating at very low loads.

9. Apply demand type cover. For Mark Ia, check to see that reset wire is the proper length.

10. Install complete meter in service as usual for watthour meters.

ADJUSTMENTS AND MAINTENANCE

GENERAL

Mark Ia demand registers are constructed of compatible materials and designed to give maximum trouble-free service. The design is such that preventative maintenance is easily performed and should failure occur, the register can be repaired with minimum difficulty.

CLEANING THE REGISTER

The Mark Ia register can be ultrasonically cleaned. The following procedure is recommended for this cleaning.

1. Remove the motor from the register by removing the two screws in the backplate holding the motor in. The motor is then pushed upward and brought out through the top of the register by rotating slightly around the crown gear shaft No. 25.

2. The register can now be ultrasonically cleaned.

   CAUTION: In order to avoid trapping cleaning solutions in the over-rides and with some cleaning solutions causing corrosive action, the clutch should be propped open and rinsed properly. A toothpick or paper clip can be used to prop the clutch open.

Ultrasonic cleaning is an art and science in itself, and its' success or failure in many cases is related to the understanding of the subject and equipment by those who are responsible for its use. For instance, a knowledge of the following variables is essential: effects of frequency, power density, tank size, holding fixtures or basket design, solution contamination, attitude of parts to be cleaned, type of soil to be removed, cleaning agent concentration and its effects on the particular metals, plastic or fibers in the apparatus, time element to achieve satisfactory cleaning without damaging the components of the apparatus, the number of parts to be cleaned vs. the power level.

It is also important to realize that after the registers have been ultrasonically cleaned the parts are chemically clean and subject to galling; therefore, either a final dip, rinse, or application of a lubricant is recommended. One such lubricant solution for dipping or rinsing which is very satisfactory consists of .373 grms. lithium stearate per liter of denatured alcohol (.031 ounces per gallon). An alternate method of applying a lubricant would be to use powdered lithium stearate and apply to the bearing surfaces with a small artist brush. These materials are available from any chemical supply house.

A typical example of an ultrasonic cleaning process found to be satisfactory for Mark registers by Westinghouse using an ultrasonic cleaner with the following capacity is as follows: Average power output 1000 watts - peak output of 2000 watts - nominal frequency of 20 KC (variable from 18 to 20 KC) and a cleaning tank of 2-gallon capacity.

1. Suspend register in a solution of Bendix 25-1** (2 ounces per gallon water) heated to 140 to 150 degrees Fahrenheit and ultrasonically agitate for one minute.

2. Rinse in hot, running tap water for 30 seconds.

3. Ultrasonically rinse in hot, clean tap water 30 seconds.

4. Blow with clean compressed air until all signs of water are removed.

5. Dry in 100 degrees Centigrade (212 degrees Fahrenheit) oven for 5 minutes.

6. Allow to cool to room temperature.

7. Dip in an alcohol-lithium stearate solution 0.373 grams lithium stearate/liter denatured alcohol (0.031 ounces per gallon).

8. Drain over the lithium stearate solution until dripping ceases.

9. Hang to dry at room temperature for 10 to 15 minutes.

**Cleaner Concentrate, Pioneer Central Division, Bendix Aviation, Inc., Davenport, Iowa.

Where the ultrasonic method of cleaning is not used, the following cleaning procedure is recommended.

1. Disassemble the register completely as described under Disassembly of Register.

2. Each component should be cleaned with a good grade of clock cleaning fluid and rinses such as L & R solutions.

3. Dry all parts thoroughly after cleaning.

4. Reassemble the register as described under Reassembly of Register.

5. Apply lubricant as described under Ultrasonic Cleaning.

CHECKING THE MOTOR

Since the motor gear reduction is completely enclosed and running in a good grade of oil, it should not require cleaning. Instead, it is recommended that the motor be tilted so that the oil will drain down under the oil filler screw. Use a syringe to put oil in the motor. Insert it in the oil filler hole. Try to draw out the oil. When the motor contains the recommended 1-1/2 cc of oil, it is only possible to draw 6/10 to 8/10 cc with the syringe. The remainder is trapped in the bearings and lubricating clearances. If oil can be drawn up in the syringe or if it can definitely be established that there is oil in the motor and it is clean, then put this oil back in the motor and replace the oil filler screw. This should be all the service necessary for the motor. If oil is dirty, indicating wear, motor should be replaced.

DISASSEMBLY OF REGISTER

The following procedure is recommended for the disassembly of the Mark Ia register. An assembly block such as shown in Figure 4 facilitates the disassembly of the register.

By placing the register mounting bayonets in a meter, meter frame, or in a block the following parts can be removed (See Fig. 1 for Plates):

1. **Demand Pointer.** Remove the spring tension screw and then the two screws holding the pointer protective bracket and spring. Remove spinner, demand pointer, and fibre washer.

2. **Scale.** Remove the screws holding scale to dial plate.

3. **Pointers.** Using a pointer puller, Style No. 285A555H01, or large screw-driver with paper protecting the dial, remove pointers from ends of shafts being careful not to scratch the dial.

4. **Multiplier Tag.** Remove screw and take off or loosen screw and push tag up and lift off.

5. **Motor — Terminal Block — Back Plate.** Put register face down in assembly block. Remove 5 screws and take back plate, motor and terminal block assembly off. Remove No. 25 shaft assembly.

CAUTION: Place back plate down on bayonet side to prevent damage to the worm wheel.

6. **Worm Wheel (No. 1 Shaft).** Turn screw until flat on screw head allows shaft to be removed.

7. **Nameplate.** Remove two screws.

8. **Ratio Plate – Dual Range Spring.** Remove No. 2 shaft. Remove 3 screws holding ratio plate and dual range spring and lift plate off. The following shafts can now be removed: No. 3, No. 4, No. 10, and No. 11 shafts.

9. **Middle Plate.** Remove 4 screws holding middle plate and lift off. The following shaft assemblies can now be removed: (27), (28), (29), (30), (26), (5), and clutch shaft (6).

   The clutch shaft can be completely disassembled by removing the retaining rings on the front, middle, and rear of the shaft.

10. **Sub Plate.** Remove spacer, one screw, and lift plate off. The following kilowatt-hour shafts can now be removed: (11), (12), (13), (14), and (15).

11. **Sector Gear.** Remove the retaining ring and lift off.

REASSEMBLY OF REGISTER

The Mark Ia can be reassembled as follows: Again an assembly block as shown in Figure 4 facilitates this assembly. Applicators, Style No. 1960343, are available for applying retaining rings to shafts (See Fig. 1 for plates).

1. **Front Plate (Dial)**
   Place plate face down in assembly block. Put the sector gear (7) on its front plate pin. It is not necessary to apply retaining ring at this time. Put the following shaft assemblies in their bearing holes in the front plate with the long tapered pivot end thru the plate: (11), (12), (13), (14), and (15).

2. **Sub Plate.**
   Put sub plate on posts and guide shafts into bearing holes. Put screw in and tighten. Put spacer over post.

3. **Clutch Shaft (6)**
   If the clutch shaft was disassembled use the following procedure for reassembly:
   a. Put rear retaining ring into one of the inboard four grooves. Guide the spring centering spacer over the shaft with small diameter to the front.

   b. Place spring over shaft and guide on shoulder of spring centering spacer.

   c. Place rear assembly on shaft, compress spring and apply center retaining ring.

   d. Place front assembly on shaft and apply front retaining ring.

4. **Cam Shaft No. 29**

   Put this shaft in the front plate with the gear toward the rear of the register. Make sure small spring is on front end of shaft.

5. **Interval Gear Train**

   Assemble in the following order (Fig. 2):
   a. No. 26 shaft, put in with the driving disk and pins closest to the front plate.

   b. No. 30 shaft. (Interval Indicator) put in with the long tapered pivot end through the front plate.

   c. No. 27 shaft, put in with the driving disk and pins toward the rear of the register.

   d. No. 28 shaft, put in with the gear toward the rear of the register.

6. Orient disk and pins in neutral position and position cam shaft as shown in Figure 5 (b). This position will facilitate the assembly of the middle plate and trip lever.

7. **Middle Plate.**

   Guide the middle plate assembly into position making sure the prongs of the lever are located between the disk and the gear on the (6) clutch shaft. Put four screws in and tighten down. The cam should be in the second neutral position as shown in Figure 5 (b). The second neutral position facilitates the assembly of the middle plate.

8. **No. 10 Shaft**

   Keep register face down in assembly block and put No. 10 shaft in its front plate bearing hole. The other end of this shaft will have the gear on the outside of the middle plate and the shaft will go thru the cut out section of the plate.

9. **No. 5 Shaft**

   Put this into its bearing hole in the front plate thin gear closest to the front plate.

10. **No. 4 Shaft**

    Put this into its bearing holes in front plate so that large gear is closest to the front plate.

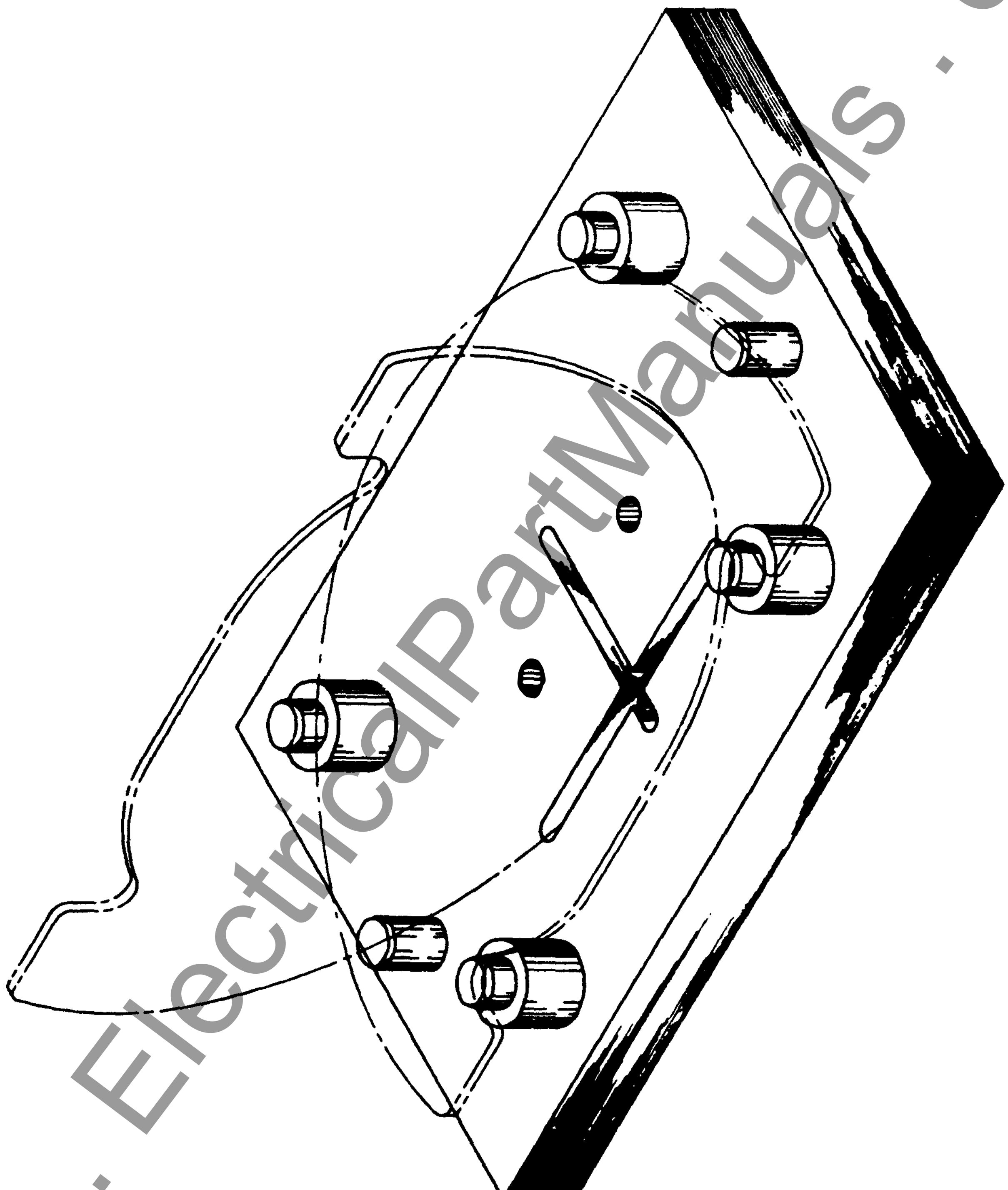
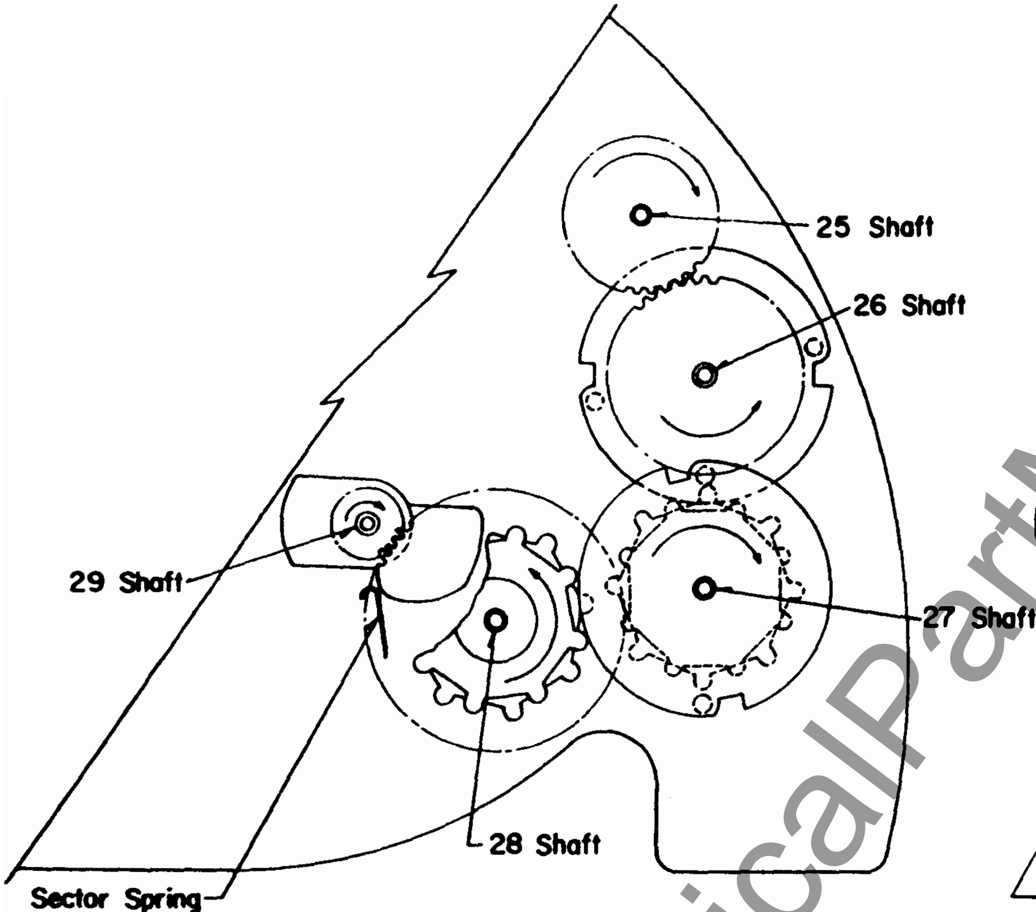
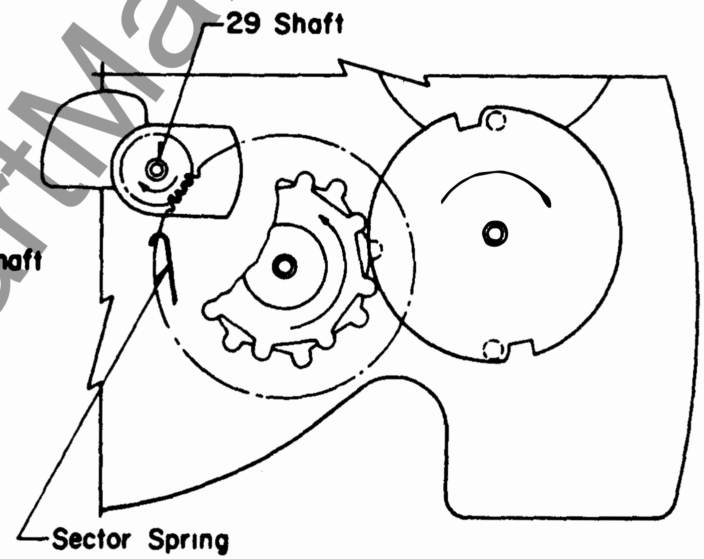


Fig. 4 Assembly Block S# 110C152G01



Cam, Interval Gear Train & Sector Spring Locations (1st Neutral Position)
Fig. 5A



Cam & Interval Gear Train Locations For Reassembly (2nd Neutral Position)
Fig. 5B

Fig. 5a & 5b Cam & Interval Gear Train Locations for Reassembly.

11. No. 3 Shaft (Dual Range Shaft) (Fig. 3)

Put the long end of the shaft thru the hole in the middle plate and into the bearing hole in front plate.

12. No. 11 Shaft

Put this shaft into its front plate bearing hole with the long tapered pivot end through the front plate.

13. Ratio Plate

Put plate in its relative position and put each shaft in its bearing hole. Put 2 screws in right hand side and the flat spring goes under the 3rd screw on the left hand side. Center the spring over pivot of dual range shaft and tighten screw.

14. No. 2 Shaft

Put the end of the shaft which has three gears on it in the bearing hole of the middle plate and meshing with gear on dual range shaft. For some ratios it may be necessary to pull back on No. 3 shaft to allow the pivot of the No. 2 shaft to go in its bearing hole.

15. No. 25 Shaft (Crown Gear)

Put this shaft in its bearing hole in the sub plate.

16. Motor Assembly

Lay the motor in its proper position resting on the middle plate with the output pinion in relative position to mate with crown gear on No. 25 shaft.

17. Back Plate Assembly

If No. 1 shaft was removed, put it back in bearings and turn the round edge of the retaining screw toward the back plate.

Place back plate in proper relation to its posts and with worm mating with gear on No. 2 shaft, and seat the crown gear shaft in its bearing hole in the back plate.

Put the 5 screws, spacer, and motor-mounting lockwashers in and tighten down.

18. Scale Assembly

Put register on a meter, meter frame or assembly block as shown in Figure 4 with dial up. Put scale in place and put screws in.

19. Multiplier Tag

Replace multiplier tag if used by putting keyhole slot over screw and sliding the tag down. Tighten the screw.

20. Kilowatt-Hour and Interval Pointers

Put large pointers on kilowatt-hour shafts and the small pointer on interval indicator shaft.

21. Demand Pointer Assembly

With register in same position as described in Step 18, assemble as follows:

a. Put fibre washer on demand pointer hub.

b. Put demand pointer on.

c. Put spinner on.

d. Put protective bracket and spring on and tighten two screws down that hold bracket on.

e. Put spring tension screw in and tighten enough to hold spinner on.

22. Zero Adjustment

Turn the register dial face up and gently hold demand pointer against the pusher at the zero end of the scale. Rotate the zero adjusting post (Fig. 6) and position the demand pointer in the center of the zero line.

23. Sector Gear Mesh Adjustment (Fig. 7)

Put the register in the bottoms up position and insert sector spring adjusting pin Style No. 106R600H01 thru the hole in the middle plate until it rests in the hole provided in the front bearing plate.

a. Gently hold demand pointer against the zero end of the scale as described under Step 22 above.

b. Allow spring on sector gear to rest on adjusting pin and guide teeth of sector into groove in pinion of (6) clutch shaft. Slide sector forward on the shaft so that it can be meshed with pinion on the (6) shaft.

c. Put retaining ring on sector pivot post.

d. Remove spring adjusting pin from middle plate.

24. Interval Indicator Adjustment

The interval indicator can be set at 12 o'clock trip position by slipping small pointer on the shaft pivot.

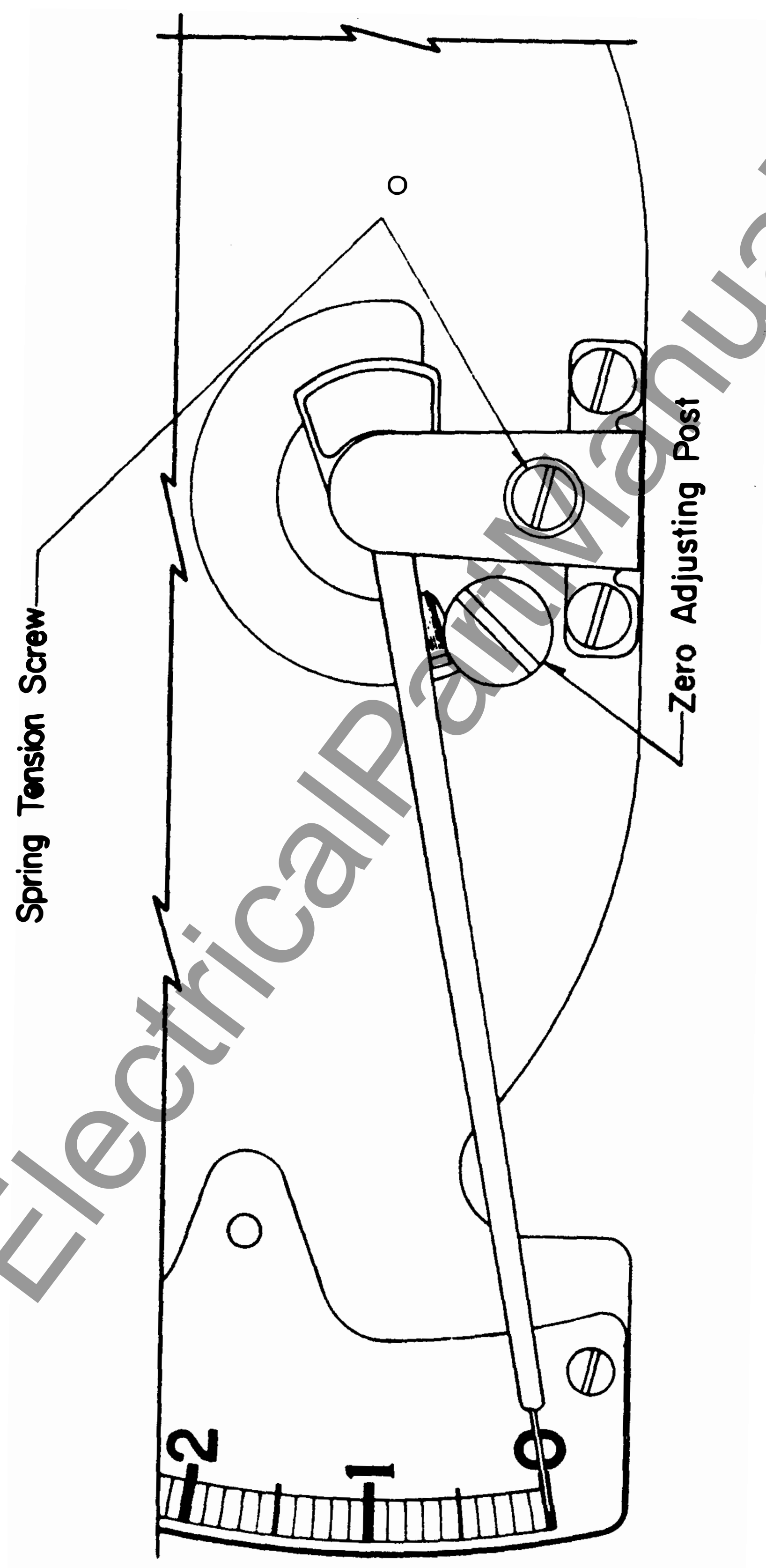


Fig. 6 Zero Adjustment

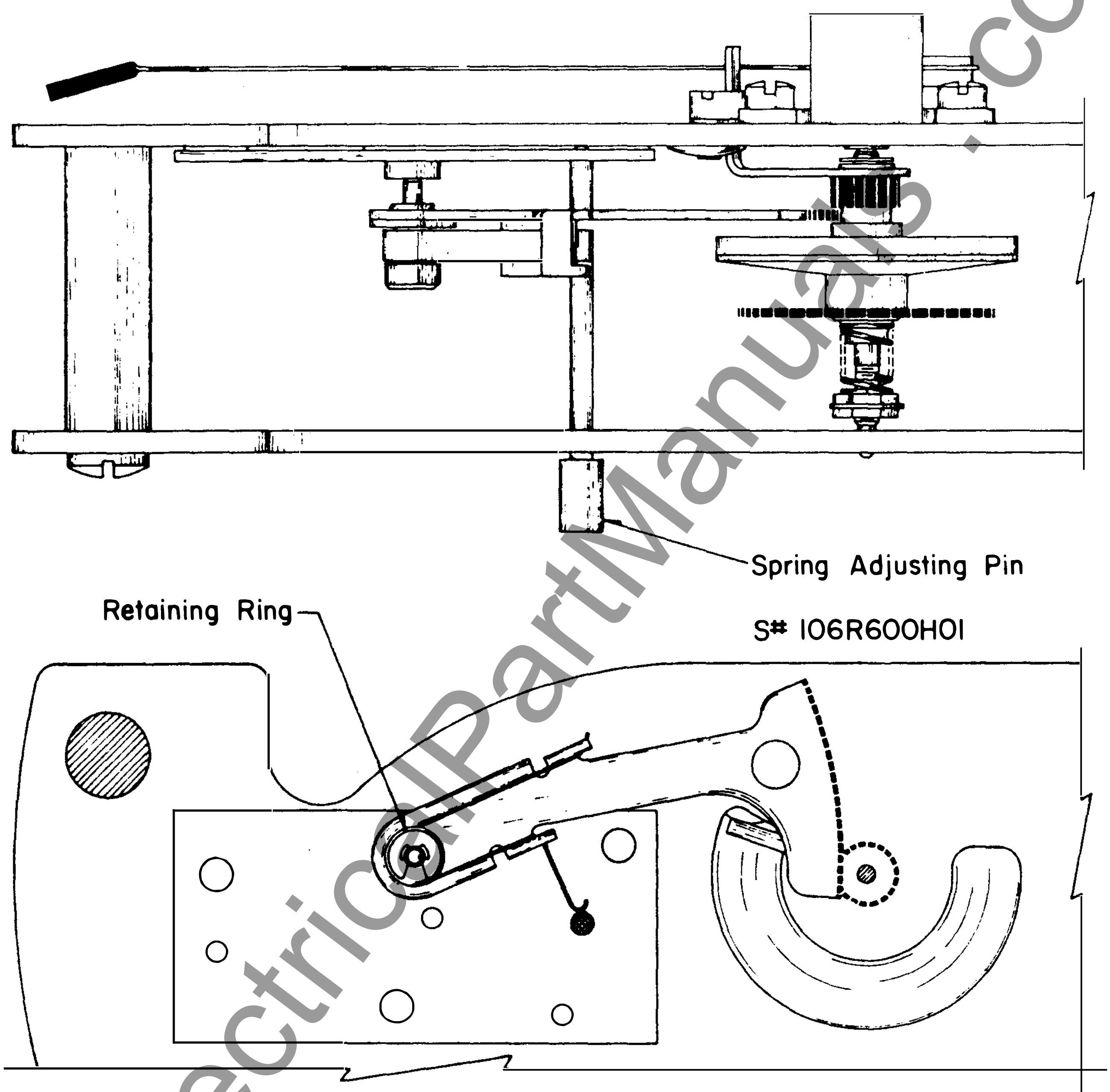


Fig. 7 Sector Adjustment

25. **Checks to be Made After Assembly**

    a. Check all shafts for end play.

    b. Turn the power gear train thru manually by using the slip clutch on the (25) shaft.

    c. Turn the (1) shaft and deflect the demand pointer to full scale making sure the sector spring clears the cam for both neutral positions (Fig. 5).

26. **Final Cam Setting**

Before the middle plate was assembled the interval gear train was positioned so that the cam neutral positions were as shown in Figures 5a and 5b. To insure the best location for smooth tripping action and proper open-time, the following check should be made.

a. Rotate the (1) shaft until the demand pointer is deflected to the off-scale (pegged) position.

b. Rotate the (25) shaft until the cam is in the first neutral position as shown in Figure 5a. Check to see that the sector spring is almost in contact but not putting pressure on the forward edge of the cam.

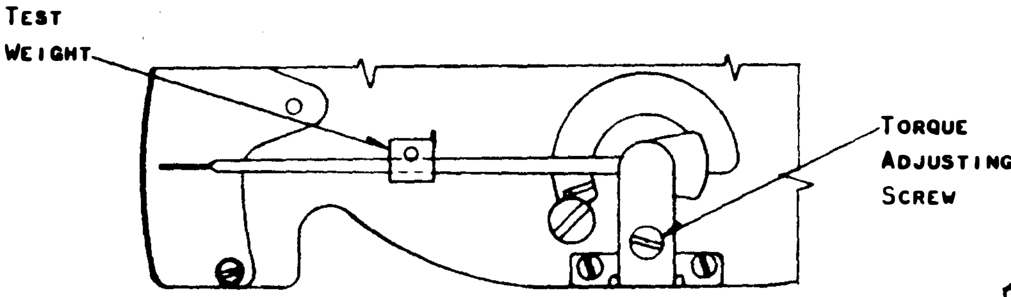
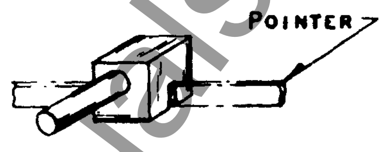


FIGURE 8A



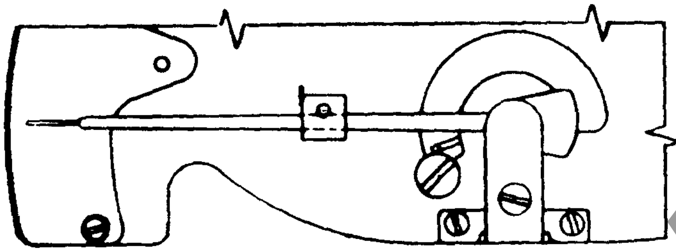


FIGURE 8B

c. In the event it is necessary to make an adjustment in the neutral position of the cam the following procedure should be followed:

1) Push the cam shaft forward compressing the coil spring until the pinion is demeshed from its mating gear on the (28) shaft.

CAUTION. When pushing the cam forward in order to demesh make sure the lobe on the cam is not in a position to hit the large gear on the left hand kilowatt hour shaft.

2) With the gearing demeshed, the cam can be rotated in the desired direction.

3) Once the gear teeth are disengaged and rotation has commenced the pressure on the cam shaft can be released. The coil spring will snap the pinion back in mesh on the next tooth thereby insuring only one tooth rotation.

4) After rotating one tooth recheck the clearance between the lobe of the cam shaft and the sector spring per steps a and b, Pg. 15. Check the smoothness of operation by advancing the (25) shaft clutch manually and trip the (6) clutch.

27. **Clutch Open-Time Check**

If the cam has been set as outlined in Step 26 the open-time should be between 2 and 5 seconds. If the open-time is outside the 2 to 5 second range, the cam and sector probably needs to be shifted as outlined in Step 26. The open-time is checked with a stop watch as follows:

a. Turn the first (1) shaft and deflect the pusher (41) up scale.

b. With the motor energized, advance the demand gear train until the clutch is just before tripping as indicated by the interval indicator.

c. The open-time is measured between the time the pusher (41) drops back to zero and the clutch disk on the (6) shaft moves forward.

28. **Demand Pointer Spring Tension Adjustment**

The spring tension on the demand pointer is adjusted by using test weight Style No. 284A400G01 in the following manner. See Figure 8A and 8B.

1. Hold register in its normal operating position and make sure pusher is at zero.

2. Mount test weight to demand pointer and locate the right hand edge of weight with the vertical line as shown in Figure 8A. The pointer should slip down scale to a lower reading. (If pointer does not fall then turn counterclockwise on the torque adjusting screw until pointer does fall). This insures that the slip torque is below the maximum allowable.

3. Push demand pointer back to the horizontal position and slide test weight so that the left edge is in line with the vertical line as shown in Figure 8B. This insures that the slip torque is above the minimum requirement. (If pointer slips, it will be necessary to turn clockwise on screw until pointer does not slip and then recheck Step 2.)

29. Clutch Shaft Safety Check

The clutch on the (6) shaft can be given a two to one safety check by positioning the test weight as shown in Figure 8a. If by turning the first (1) shaft in the register the pusher will rotate the demand pointer and advance the test weight through the horizontal, then the clutch has at least a two to one safety factor.

30. **Testing Watthour Demand Meters**

The same method of test employed for corresponding watthour meters are used when testing demand meters. However, when calibrating demand meters, the timing motor should be running and the register meshed. The demand pointer should be set at a position such that it will not be advanced by the pointer pusher at any time during the test.

TESTING DEMAND REGISTERS

1. **Mechanical Over-all Test Device Serial No. 110C174G01**

The best way to check the register calibration is by means of a constant speed device such as 110C174G01.

The test device simulates a meter operating under constant load. The register can be driven at a speed corresponding to meter speeds of 16-2/3, 33-1/3, and 66-2/3 rpm. This device has a shaft driven by a synchronous motor and three different worms to give the speeds indicated above.

The device is connected to a 120-volt source and the toggle switch is put in either the 120V or 240V position depending upon the voltage of the register motor. The register is mounted in the desired position and the motor leads coming from the binding posts on the left of the device are connected to the motor terminal block of the register. Varying frequency has no effect since both the test device drive motor and the timing motor in the register will change equally. The three speeds are used to check the full load point and multiples thereof. Therefore, this device will check all classes and three points of the scale.

The actual indication of a Mark II register may be computed by using the following formula.

$$\text{KW Reading} = \frac{6 \times \text{Test Device Setting } (16\text{-}2/3,\ 33\text{-}1/3,\ 66\text{-}2/3)}{\text{Register Ratio}}$$

2. **Portable Gear Checker 111C217G01**

This device shown in Figure 9 is designed for a quick check on the kilowatt demand gear train with respect to the interval timing gear train (exclusive of motor gearing). It is designed to check the full load point of all Mark Ia registers regardless of interval or register ratio.

Operation

Disconnect the motor leads and remove register from meter. Mount register checker bayonets in meter and tighten screws. Mount the register in the checker. This automatically engages the worm wheel of the register with the gear on the checker. Now pull the top of the checker (which is mounted on pivots) down on the register so that gear "A" on checker meshes with the overriding gear on the No. 25 shaft of the register. Push the latch on the front of the register checker under the post on the register to hold the checker in mesh. Turn the handle on the checker clockwise until the interval indicator on the register shows that the clutch is about to trip. Energize the motor and allow the motor to trip the clutch. Reset the demand pointer by hand below the point on the scale which is to be tested. Turn the handle advancing the gear train manually until the interval indicator shows that the clutch is again about to trip. Allow the motor to trip the clutch. Take the existing reading on the KW demand scale. The checker has a high (H) and low (L) deflection and is set by shifting a ratio plate that engages the desired gear train. Two register checkers are available depending on the desired deflection.

111C217G01 Low Range Deflection (Test KW) $= \frac{100}{Rr}$

High Range Deflection (200% Test KW) $= \frac{200}{Rr}$

111C217G04 Low Range Deflection (200% Test KW) $= \frac{200}{Rr}$

High Range Deflection (400% Test KW) $= \frac{400}{Rr}$

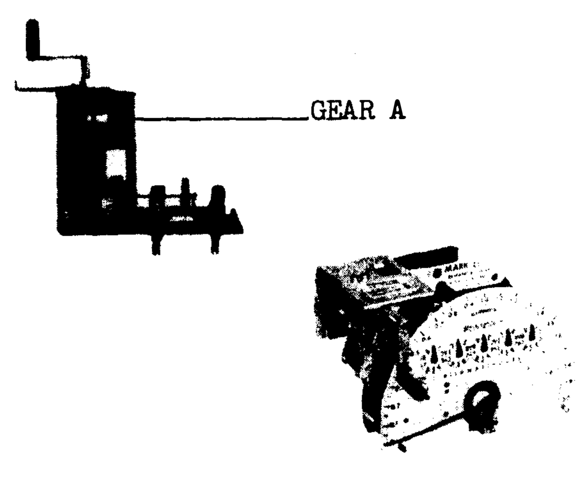


Fig. 9 Gear Checker for Mark Ia Register Style No. 111C217G01

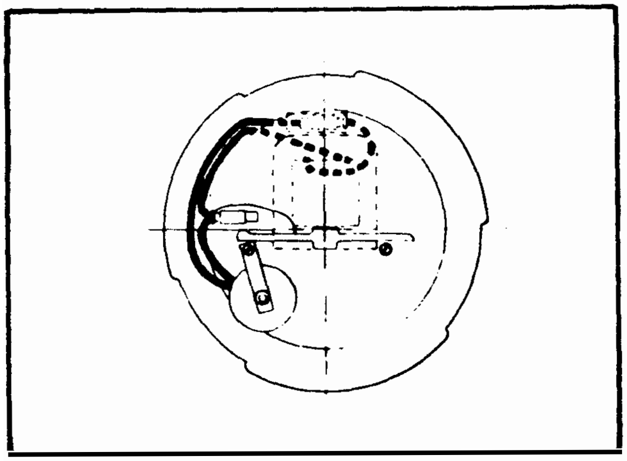


Fig. 10 D4SM-3 Wire Self Contained, 240V. (120V Reg. Motor).

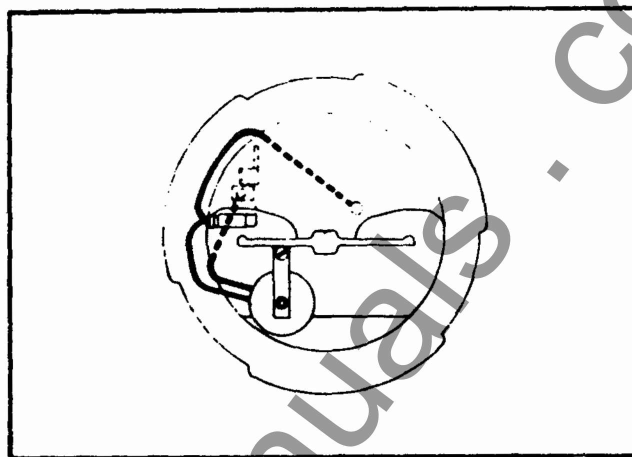


Fig. 11 DSM-D2SM & D3SM-3 Wire Self Contained, 240V. (120V Reg. Motor). DSM-D2SM & D3SM-3 Wire Self Contained, 480V. (240V Reg. Motor).

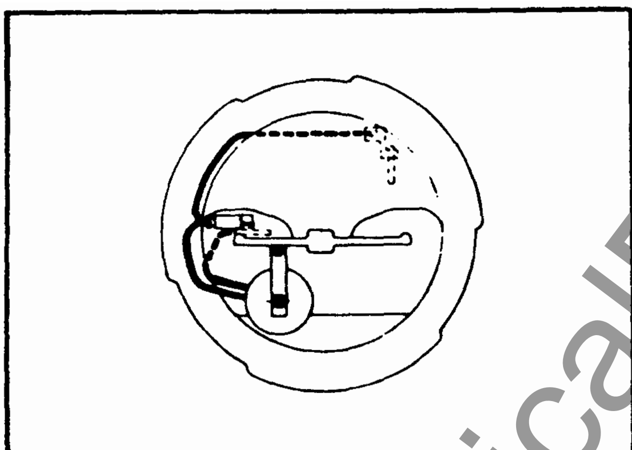


Fig. 12 DSM & D2SM 2 Wire Trans. Type, 240V. (120V Reg. Motor). DSM & D2SM 2 Wire Trans. Type, 480V. (240V Reg. Motor).

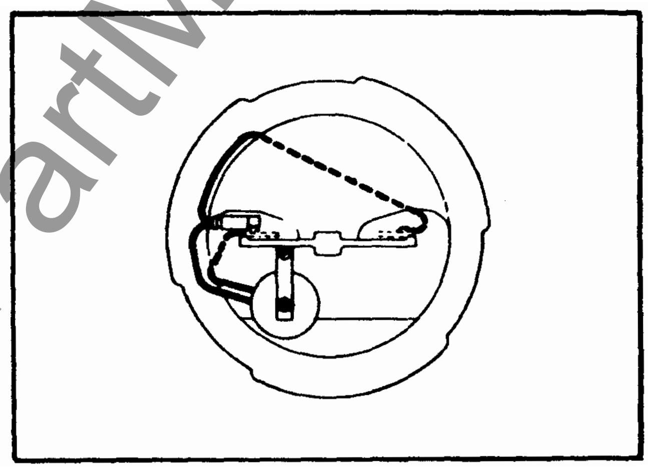


Fig. 13 DSM & D2SM 3 Wire Trans. Type, 240V. (120V Reg. Motor). DSM & D2SM 3 Wire Trans. Type 480V. (240V Reg. Motor).

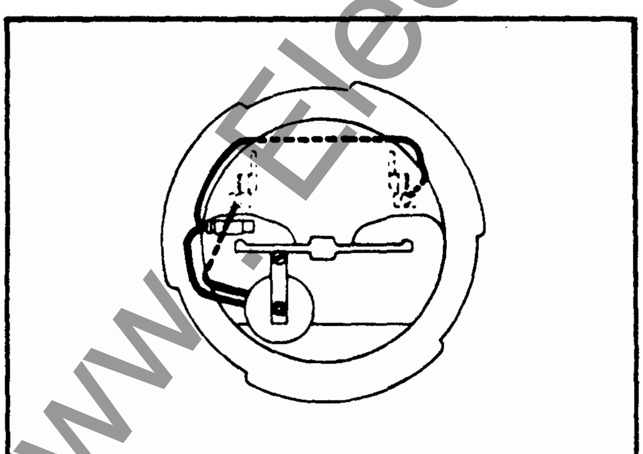


Fig. 14 DSM-D2SM & D3SM 2 Wire Self Contained, 240V. (120V Reg. Motor). DSM-D2SM & D3SM 2 Wire Self Contained, 480V. (240V Reg. Motor).

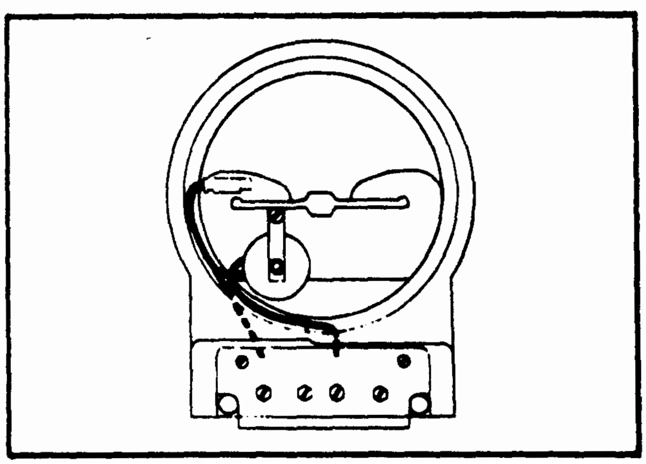


Fig. 15 DAM & D2AM 2 Wire Self Contained, 240V. (120V Reg. Motor). DAM & D2AM 2 Wire Self Contained, 480V. (240V Reg. Motor).

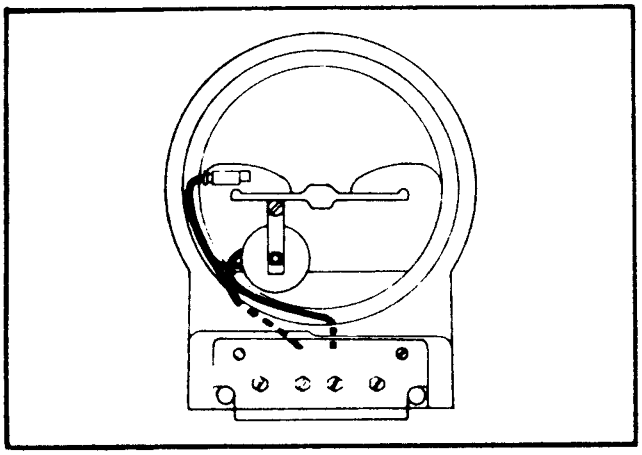


Fig. 16 DAM & D2AM 2 Wire Trans. Type, 240V. (120V Reg. Motor). DAM & D2AM 2 Wire Trans. Type, 480V. (240V Reg. Motor).

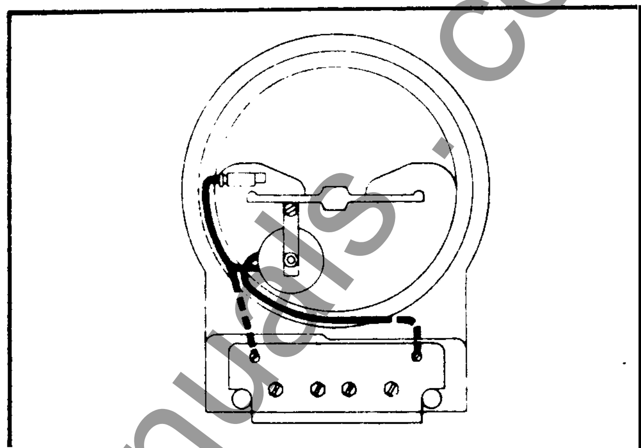


Fig. 17 DAM & D2AM 3 Wire Trans. Type, 240V., DAM & D2AM 3 Wire-4 Terminal Self Contained 240V. (120V Reg. Motor).

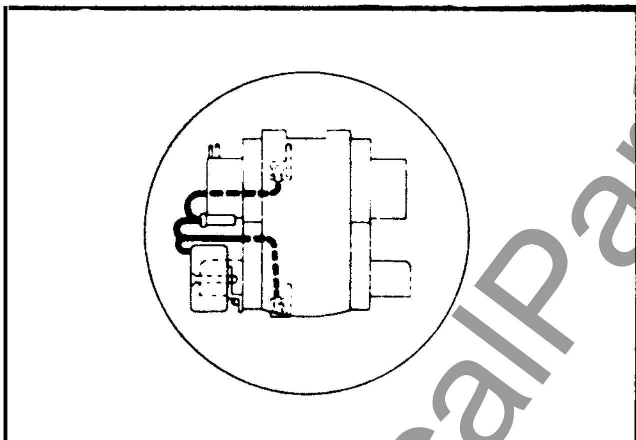


Fig. 18 DSP-2M & D2S-2M Self Cont. & Trans. Type, 240V. (120V. Reg. Motor). DSP-2M & D2S-2M Self Cont. & Trans. Type, 480V. (240V. Reg. Motor).

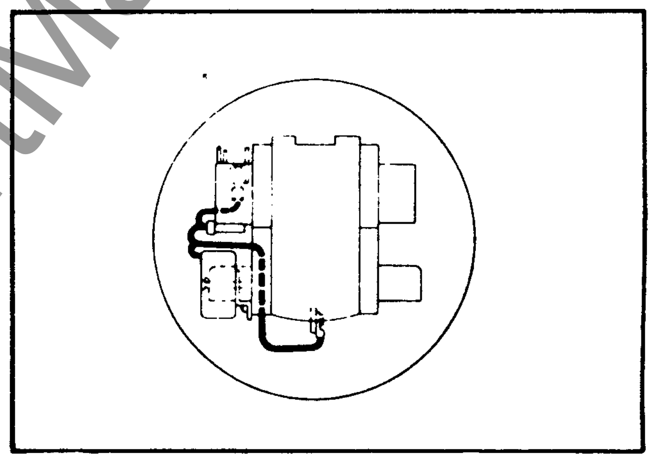


Fig. 19 DS-5M & D2S-5M 240V. (120V Reg. Motor). DS-5M & D2S-5M 480V. (240V Reg. Motor).

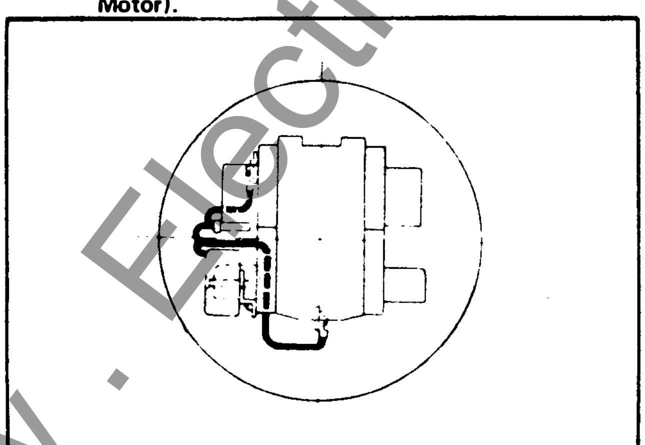


Fig. 20 DS-5M & D2S-5M-30 Amp-480V. (240V Reg. Motor).

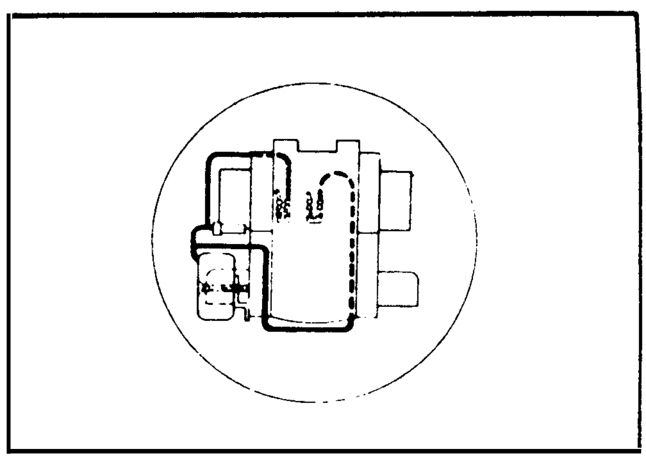


Fig. 21 DSP-7M & D2S-7M Self Contained, 240V. (120V Reg. Motor). DSP-7M & D2S-7M Self Contained, 480V (240V Reg Motor).

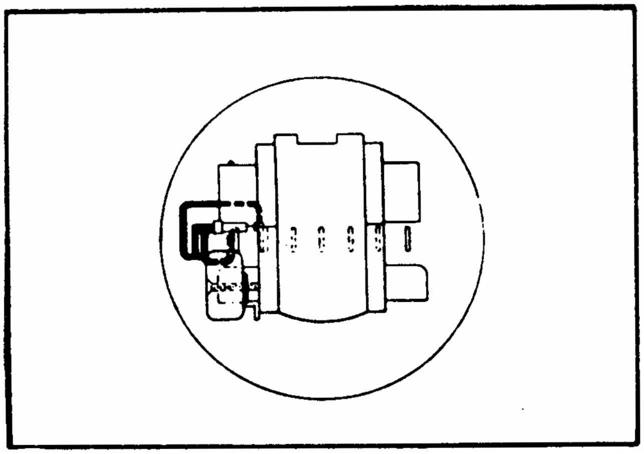


Fig. 22 DSP-7M & D2S-7M Trans. Type, 240V. (120V. Reg. Motor). DSP-7M & D2S-7M Trans. Type, 480V. (240V Reg. Motor).

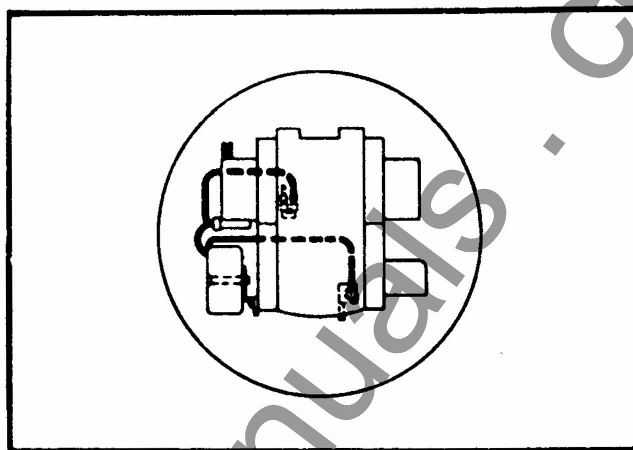


Fig. 23 DSP-8M & D2S-8M Self Contained, 240V. (120V Reg. Motor). DSP-8M & D2S-8M Self Contained, 480V. (240V Reg. Motor).

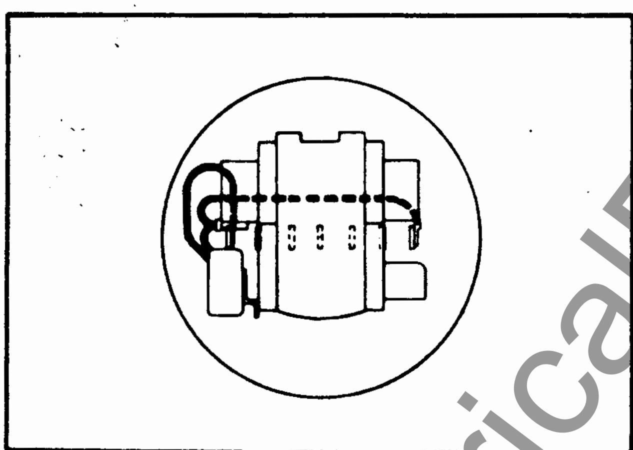


Fig. 24 DSP-8M & D2S-8M Trans. Type, 240V. (120V Reg. Motor). DSP-8M & D2S-8M Trans. Type, 480V. (240V Reg. Motor).

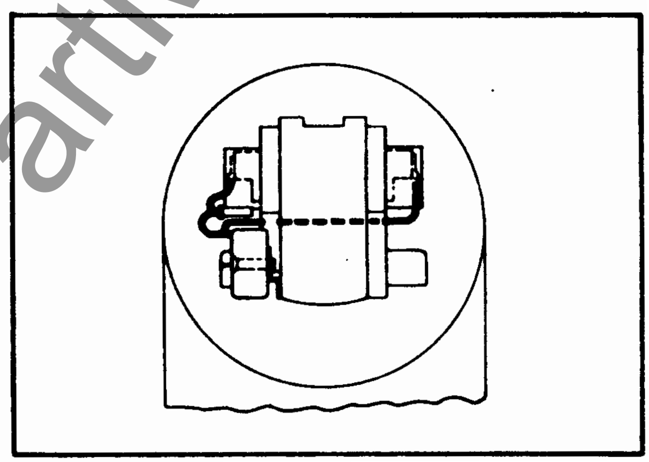


Fig. 25 DAP-2-7-8M & DA-5M & D2A-2-5-7-8M-240V (120V Reg. Motor). DAP-2-7-8M & DA-5M & D2A-2-5-7-8M, 480V. (240V Reg. Motor).