DC WATT-HOUR METERS
KS-15530 AND OTHER MERCURY TYPES
REQUIREMENTS AND ADJUSTING PPROCEDURES

1. GENERAL

1.01 This section covers the KS-15530 and earlier type d-c watt-hour meters manufactured by the Sangamo Electric Company.

1.02 It is reissued to include the KS-15530 meter and to bring the section generally up to date. The list of tools, materials, and test apparatus has been changed to meet present day ordering codes and Fig. 5 has been added. Significant changes are marked by arrows.

1.03 Reference shall be made to Section 020-010-711 covering General Requirements and Definitions for additional information necessary for the proper application of the requirements listed herein.

1.04 Requirements and associated procedures marked with a number sign (#) need not be checked by the installer unless it is thought that the requirement is not being met or performance indicates that such a check is advisable.

1.05 Requirements and associated procedures marked with an asterisk (*) need not be checked during maintenance unless the apparatus or part is made accessible for other reasons or performance indicates that such a check is advisable.

1.06 No adjustments shall be made on these meters without authorization from the supervisor.

2. REQUIREMENTS

*2.01 Direction of Rotation: The meter shall be so connected that the damping disc rotates in a clockwise direction as viewed from above, or from right to left as viewed from the front when current is flowing through the series coil of the meter.

2.02 Lubrication: The upper bearing jewel shall be lubricated with a trace of oil once every two years.

*#2.03 Accuracy and Adjustment: With the voltage specified on the nameplate of the meter, and the load varying from light load (10 per cent) to full load (100 per cent) of the nameplate ampere rating, the older type meters shall not register more than 2 per cent slow or 2 per cent fast. Under the same conditions of voltage and current, the KS-15530 meter shall not register more than 1-1/2 per cent slow or 1-1/2 per cent fast.

*#2.04 General Condition: The interior parts of the meter shall be free of all dust and dirt and the mercury shall be clean.

3. ADJUSTING PROCEDURES

3.001 List of Tools, Gauges, Materials, and Test Apparatus (Equivalents may be substituted)

Tools

Brush - KS-14164
Pliers - P- Long Nose, 6-1/2"
Screwdriver, Regular, 4"
Screwdriver, Cabinet, 3"
Screwdriver, Watchmaker's No. 3

Gauges

Ammeter, d-c Weston Model 280, ranges 30 amperes or 100 amperes as required
Voltmeter, d-c, Weston Model 280, range 150-60-3
Watch, stop, KS-3008

Materials

Cloth, Cleaning, Twill Jean, D-98063
Container - Porcelain or Glass
Mercury, Redistilled
Oil, Nye's Watch
Paper, Wrapping
Chamois

Test Apparatus

Battery, storage, one cell of an ordinary automobile battery (obtained locally), or spare central office battery
Clips, battery, obtained locally as required
Rheostat, Allen Bradley, Bul 410, Form WM; No. 438198, size 1/2, 0.25 to 22.5 amperes, 75 watt; or No. 438197, size 5, 1.5 to 75 amperes, 375 watt
Wire, as required
Resistances, #18 type, as required

3.002 Procedures described herein refer to the standard two-wire element but apply equally to each element of the horizontal duplex meter having two standard two-wire elements mounted side by side in a single case.

*3.01 Direction of Rotation: Check by eye. If rotation is incorrect, disconnect service by operating a switch or removing fuses and check polarity of input leads.

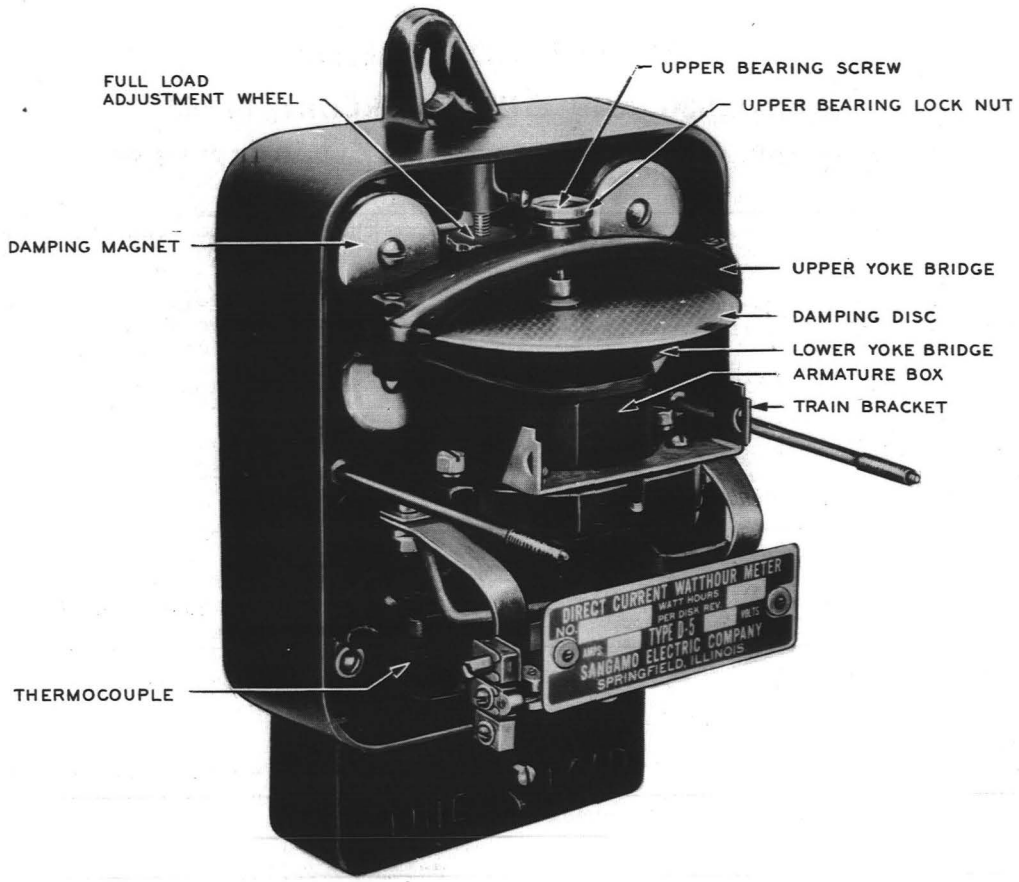

Fig. 1 - Direct Current Watt-hour Meter Assembly - Dial and Gear Train Removed

3.02 Lubrication (Rq. 2.02) See Figs. 1 and 2.

(1) Loosen the upper bearing lock nut and screw out the upper bearing screw. Clean the cavity in which the upper bearing jewel is located with a sharp pointed piece of soft wood. With the point of a fine needle, feel the surface of the jewel carefully. If cracked or rough, procure a new upper bearing screw. Place a trace of thin watch oil in the bearing cavity.

(2) In replacing the upper bearing screw, start the screw in the upper half of the arch or yoke bridge and turn down slowly until all of the end play has been removed from the moving system. Do not screw down far enough to injure the bearing jewel in the bottom of the armature float. When the point is reached where all of the end play is removed, turn the bearing screw back 1/2 to 3/4 of a full turn and lock in position with the bearing lock nut. There should be approximately 1/64 inch of end play for the moving element. If the moving element has too much end play the armature might rise high enough to rub on the top of the armature box and cause friction.

*#3.03 Accuracy and Adjustment (Rq. 2.03)

General

(1) When testing 5- or 10-ampere meters use the No. 438198 rheostat. For 25-, 50-, or 75-ampere meters use the No. 438197 rheostat. In testing a 5-ampere meter for ten per cent load it may be necessary, in some instances, to insert additional resistance in series with the meter and rheostat to secure the small current desired. #18-type resistances of suitable size are satisfactory.

(2) All meters of 100-ampere capacity or greater are operated off external shunts. Since the meter circuit of externally shunted meters is always calibrated for a 10-ampere full load, all

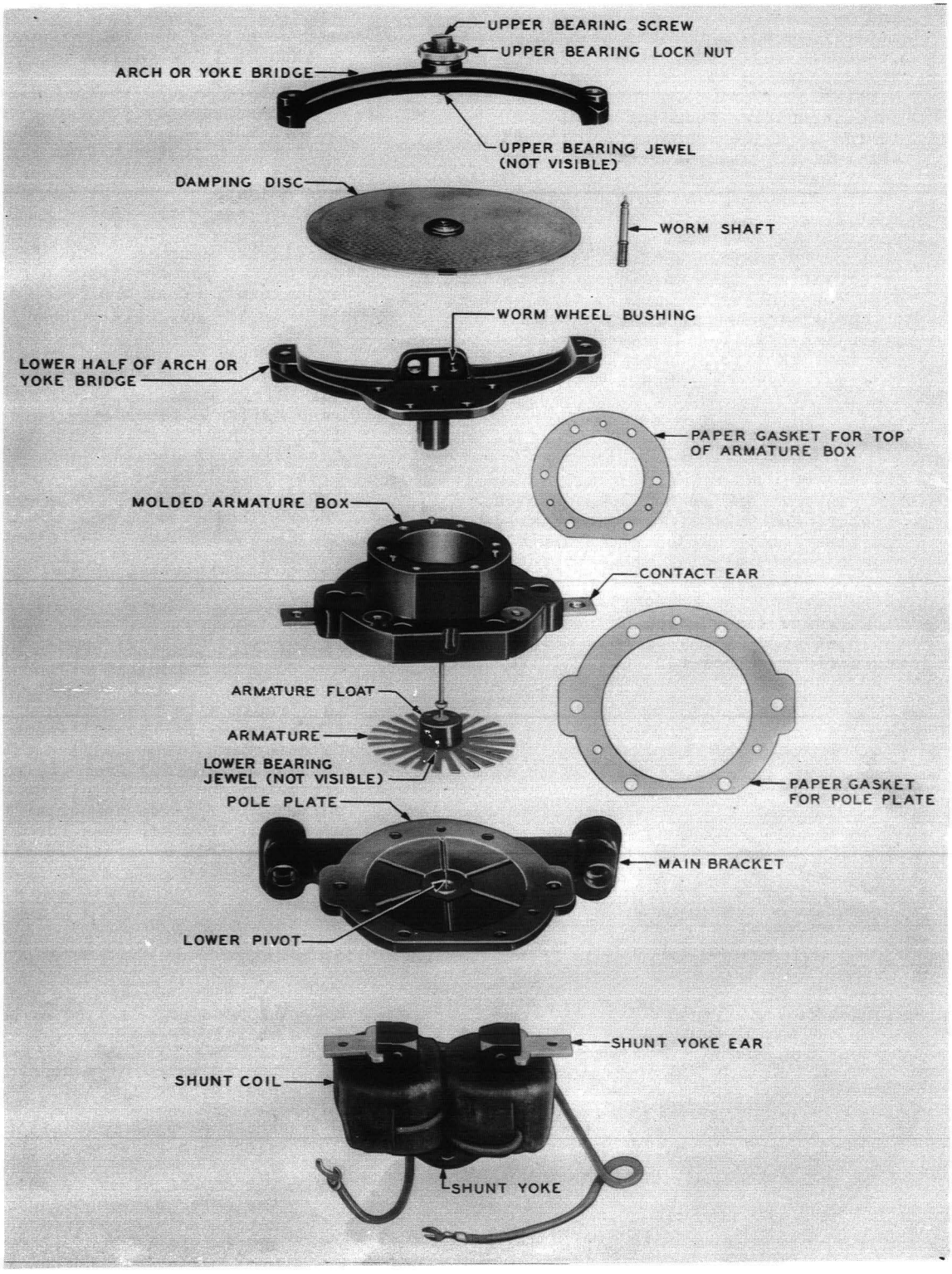

Fig. 2 - Meter Details

externally shunted meters are identical and may be tested by disconnecting the meter from the shunt and using a 10-ampere test load, without in any way disturbing the main circuit. When a meter of 100-ampere capacity or greater is disconnected from its shunt and tested as a 10-ampere meter, the disc constant (K) stamped on the disc or meter nameplate cannot be used directly in the formula given in 3.03 (5) but must be reduced to the adjusted disc constant (K') as follows: Divide 10 amperes by the current rating of the meter and multiply this quotient by the disc constant of the meter. For example, if the disc constant of a 2000-ampere, 24-volt d-c watt-hour meter is 40, the constant (K') to be used when testing this meter as a 10-ampere meter would be:

$$K' = \frac{10}{2000} \times 40 = 1/5$$

(3) Two methods of testing may be employed. One method uses a watch, ammeter, and voltmeter. (See Fig. 4.) The alternative method is to use a direct current rotating standard watt-hour meter. (See Fig. 5.) The first method is recommended as preferable in installations where the current and voltage of the test circuit may be held uniform at the desired values for test. In installations where the load and potential vary considerably over short periods of time and cannot be controlled, the second method is to be preferred.

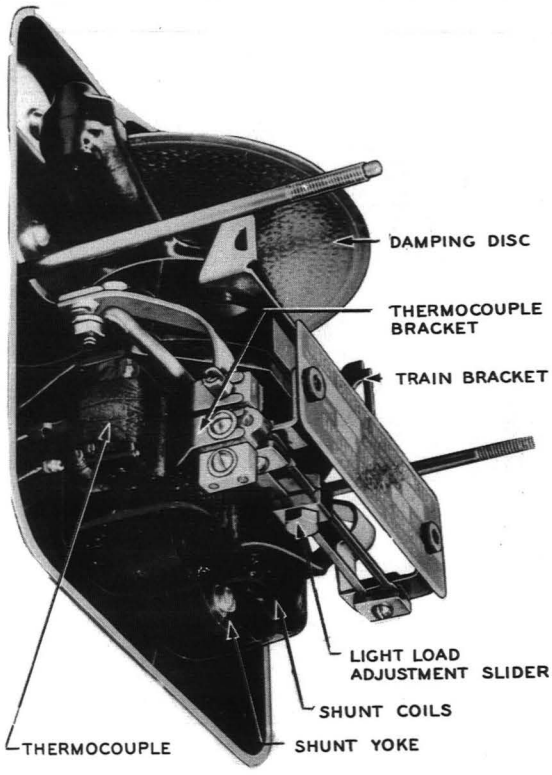

Fig. 3 - Detail Showing Thermocouple and Light Load Adjustment

(4) Meters should be tested first at approximately full load and adjusted within the required limits by means of the full load adjustment (see Fig. 1) and then tested at approximately one-tenth load and adjustment made by means of the light load adjustment. (See Fig. 3.) A 1 per cent change in the light load adjustment should not cause a change of over one-tenth of 1 per cent in the full load adjustment. When the meter is to be tested, the potential should be connected to the test circuit at least 15 minutes before test is made in order that the thermocouple and shunt coils may have time to warm up and, become stable. In readjusting a meter, the meter should be left so that it will read fast rather than slow but should still be within the prescribed limits.

Method No. 1 - Testing with Watch, Voltmeter, and Ammeter (See Fig. 4.)

(5) Each revolution of the disc of the meter represents a certain amount of electrical energy measured in watt-hours. This amount of energy is known as the disc constant and is stamped on the disc or nameplate of the meter. When an ammeter and voltmeter are connected in circuit with the watt-hour meter, the accuracy of the watt-hour meter may be determined from reading the watts load as determined from the ammeter and voltmeter and ascertaining the time required for a given number of revolutions of the meter disc. The formula for determining this accuracy is given by:

$$\text{Per Cent Registration} = \frac{(K \text{ or } K') \times R \times 3600 \times 100}{W \times S}$$

in which

K = the disc constant in watt-hours as stamped on the disc or meter nameplate. See 3.03(2).

K' = the adjusted disc constant in watt-hours. See 3.03(2).

R = the number of revolutions of the disc in 5 seconds.

W = the number of watts passing through the meter as computed from the ammeter and voltmeter readings. W equals the product of the ammeter and voltmeter readings if the two readings have been constant throughout the elapsed time S.

S = the time in seconds required for the given number of revolutions of the disc.

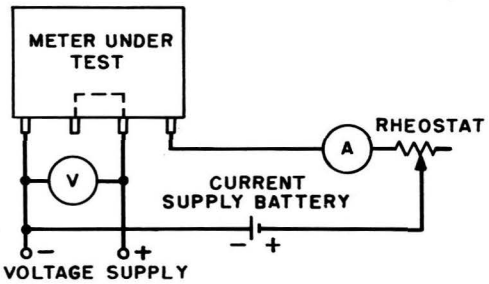

FIG. 4A - SERVICE TYPE METER, UP TO AND INCLUDING 75 AMPERE CAPACITY

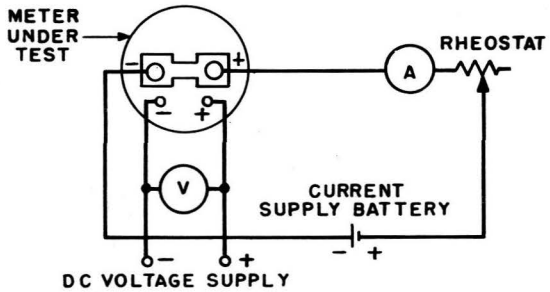

FIG. 4C - SWITCHBOARD TYPE METER, UP TO AND INCLUDING 75 AMPERE CAPACITY

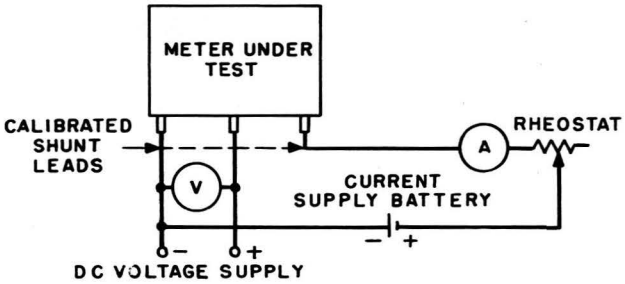

FIG. 4B - SERVICE TYPE METER, 100 AMPERE CAPACITY OR GREATER

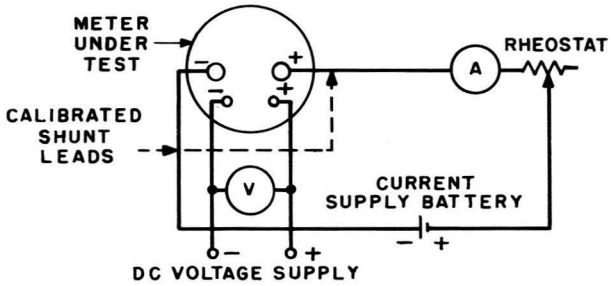

FIG. 4D - SWITCHBOARD TYPE METER, 100 AMPERE CAPACITY OR GREATER

FIG. 4 - SCHEMATIC CONNECTIONS - TESTING WATTHOUR METERS WITH INDICATING INSTRUMENTS

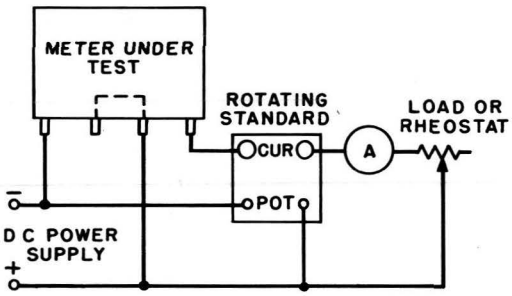

FIG. 5A - SERVICE TYPE METER, UP TO AND INCLUDING 75 AMPERE CAPACITY

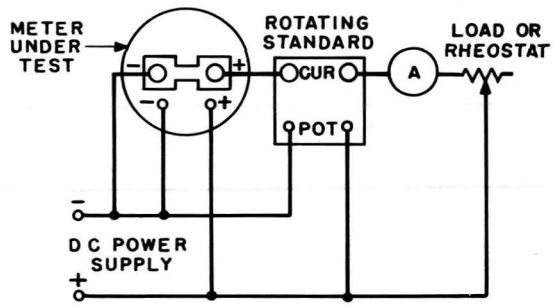

FIG. 5C - SWITCHBOARD TYPE METER, UP TO AND INCLUDING 75 AMPERE CAPACITY

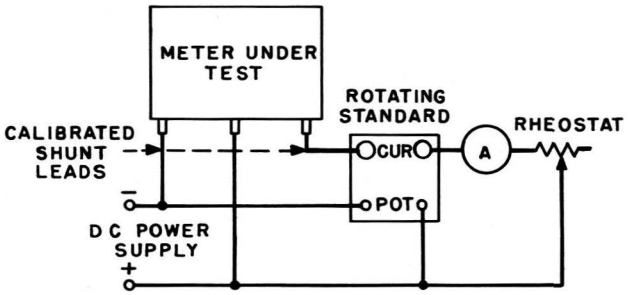

FIG. 5B - SERVICE TYPE METER, 100 AMPERE CAPACITY OR GREATER

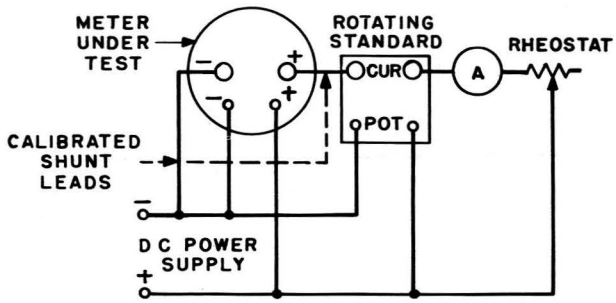

FIG. 5D - SWITCHBOARD TYPE METER, 100 AMPERE CAPACITY OR GREATER

FIG. 5 - SCHEMATIC CONNECTIONS - TESTING WATTHOUR METERS WITH ROTATING STANDARD

(6) Place a jumper around the meter to be tested so as to maintain service (not necessary when leads can be removed from an external shunt) and remove the leads connected to the load side of the meter. Connect the indicating instruments in the circuit as indicated in Fig. 4 and connect the positive and negative current terminals of the meter to the current supply battery through the portable ammeter and rheostat. The potential coil should remain connected to the d-c voltage supply to obtain the proper voltage. Never attempt to clean calibrated shunt terminals or calibrated shunt lead terminals with sandpaper. Use dry cloth.

(7) Pass maximum value of test current through the meter (see note below) noting the ammeter and voltmeter reading, count the revolutions of the watt-hour meter disc and note the time for a given number of revolutions. Assume that a 10-ampere, 24-volt meter with a disc constant of 1/5 revolves 20 times in 61 seconds. Then:

$$\text{Per Cent Registration} = \frac{1/5 \times 20 \times 3600 \times 100}{240 \times 61} = 98.4 \text{ per cent}$$

Adjust the meter as necessary by means of the full load adjustment shown in Fig. 1. Then repeat the test with light load.

Note: When testing a meter of 100-ampere capacity or greater, the test current shall never exceed 10 amperes. When testing a meter which has a capacity up to and including 75 amperes, the test current shall not exceed the value stamped on the nameplate of the meter under test.

(8) If the meter shows a tendency to be slow on very light load, clean in accordance with 3.04.

(9) After all adjustments and cleaning operations have been finished, retest the meter on light load and move the light load adjustment to the right or left as required. (See Fig. 3.) After making the light load adjustment, check the full load requirement and see that its limits have not been exceeded by the light load adjustments.

(10) If the meter is found to be running fast and adjustment cannot be made with the heavy load adjustment, it will be necessary to replace the permanent magnets with new ones having the same marked strength as the original ones.

Method No. 2 - Testing with Rotating Standard (See Fig. 5.)

(11) In testing with a rotating standard, connect the current elements of the meter under test and the rotating standard in series, and the potential elements in parallel, as indicated in Fig. 5. (Jumper the meter as described in 3.03(6) if necessary to maintain continual service while making test connections.) In connecting the potential coils, make sure that the potential element of the standard is connected to the line ahead of the meter under test so that the potential loss in the standard meter is not recorded in the meter under test. Never attempt to clean calibrated shunt terminals or calibrated shunt lead terminals with sandpaper. Use dry cloth.

(12) When testing with a rotating standard, either connected load or artificial load (see note below) may be used as both meters automatically integrate any changes in load which is not the case with indicating meters where the average reading is required.

Note: When testing a meter of 100-ampere capacity or greater, the test current shall never exceed 10 amperes. When testing a meter which has a capacity up to and including 75 amperes, the test current shall not exceed the value stamped on the nameplate of the meter under test or the current rating of the rotating standard.

(13) When connected, allow both meters to warm up on potential for about 15 minutes before starting tests. Count the number of revolutions of the standard meter for a given number of revolutions of the meter under test. The number of revolutions of each meter times its respective disc constant (see 3.03(2)) will give the number of watt-hours measured by each meter which should agree within the limits permitted. Readings should be taken on both light and heavy loads and adjustments made in the same manner as outlined under testing the ammeter, voltmeter, and stopwatch. The formula for determining the accuracy of the meter under test is shown below.

$$\text{Per Cent Registration} = \frac{R_T \times (K_T \text{ or } K'_T)}{R_S \times K_S} \times 100$$

in which

R_S = the number of revolutions of the standard meter.

R_T = the number of revolutions of the meter under test.

K_S = the disc constant of the standard meter in watt-hours.

K_T = the disc constant of the meter under test in watt-hours as stamped on the disc or meter nameplate. See 3.03(2).

K'_T = the adjusted disc constant of the meter under test in watt-hours. See 3.03(2).

Note: R_S and R_T must be counted simultaneously for about a minute.

(14) An example of the use of the equation shown in 3.03(13) above is shown below. Assume that after the revolutions of the standard meter and the meter under test are counted simultaneously, the values listed below are recorded.

R_S = 12.2) counted simultaneously
R_T = 20)
K_S = 1/3
K'_T = 1/5

Then:

$$\text{Per Cent Registration} = \frac{R_T \times K'_T}{R_S \times K_S} \times 100$$

$$= \frac{20 \times 1/5 \times 100}{12.2 \times 1/3}$$

$$= 98.4\%$$

*#3.04 General Condition (Rq. 2.04)

(1) If the meter shows a tendency to be slow on very light load, be sure that there is no collection of iron dust or filings on the damping magnets forming (whiskers) which will retard the disc. It is also advisable to clean out and oil the upper bearing jewel as described in 3.02. In the event that oiling the upper bearing jewel does not correct the tendency to be slow on light load, it will be necessary to replace or clean the mercury in the armature chamber. Remove all power from the meter either by removing fuses or bridging the load and disconnecting the line and load wires. Remove the motor element by first disconnecting the leads inside the meter from the binding posts and then removing the main bracket screws, one on each side. Then remove the gear train by raising the two locking levers or latches until they are vertical. Remove the shunt coils and yoke by removing the screws from beneath the armature chamber. Take off the upper bearing arch which allows the disc and the upper spindle to be removed. Then remove the lower sectio nof the arch (the hopper cap) and pour the mercury into a porcelain, enamel, or glass container. Dismantle the armature box by unscrewing the main bracket from the box, exercising care in removing the pole plate and armature. The armature box and pole plate should be thoroughly cleaned with a soft brush or rag. The lower bearing should be cleaned with a sharp-pointed piece of soft wood. With the point of a fine needle, feel the surface of the jewel carefully. If cracked or rough, the lower bearing jewel shell or screw should be replaced. The lower bearing jewel should be lubricated with a trace of thin watch oil.

(2) One way to clean the mercury is to make a cornucopia of wrapping paper with an opening at the bottom about the size of a pin point and pour the mercury into the cornucopia and catch it in a clean porcelain or glass cup as it comes through the bottom. Repeat this operation several times until the mercury is clean, using a new cone each time. Another way to clean the mercury is to place it carefully in the center of a chamois square. Lift the four corners and twist until the mercury is forced through the chamois. Repeat if necessary with a clean piece of chamois. If, after two or three times, the mercury appears greasy or muddy, it should be replaced.

(3) After all the parts have been thoroughly cleaned and any defective parts replaced, set the armature on the pole plate making sure that the lower pivot is in the lower bearing, then replace the pole plate and the main bracket, lining up with the dowel pins on the lower face of the armature box, being sure that any paper washers are in place and undamaged. After tightening the screws, pour the mercury into the armature box and replace the hopper cap, disc, the spindle, and the upper bearing arch. The shunt coils can then be replaced and the element put back into the meter. In replacing the train, start the end of the worm in the worm wheel bushing and slide the end of the train brackets into the slot provided in the back plate of the train and lock in position by pulling down the two latches until they are horizontal, care being taken not to injure the worm.