

## KS-5098 CONTACT MAKING AMPERE HOUR METERS DESCRIPTION

### 1. GENERAL:

1.01 The Sangamo contact making ampere hour meters per KS-5098 consist of a simple form of mercury motor made up of a copper disc rotating in a mercury chamber between the pole tips of two permanent magnets, a resistor to change the speed of the meter when the current through it is reversed, a gear train driving a pointer over a dial, a thermocouple and

three sets of contacts, namely, the start, stop and alarm contacts. These are all mounted in a protecting case.

1.02 These ampere hour meters are used in telephone power plants to control automatically the starting and stopping of the charging equipment according to the amount of current which has passed out of or into the battery.



Fig. 1—Contact Making Ampere Hour Meter

## 2. DESCRIPTION OF APPARATUS:

**Motor Element:**

2.01 The design of the motor element is based on Faraday's disc principle, which maintains that, "A metallic disc will rotate, if a current is passed between its axis and its periphery when the path of the current through the disc is subjected to a magnetic field".

2.02 Referring to Fig. 2, the armature element,

mounted near the armature terminals. These permanent magnets serve a double purpose, the first is to produce a magnetic field through which the current in the copper disc flows, thus causing the disc to rotate. The second is to act as a drag on the disc opposing its rotation. This opposition is due to the eddy currents induced in the disc as it passes through the field of the magnets. These eddy currents are in proportion to the speed of the meter, and the various sizes of meters are

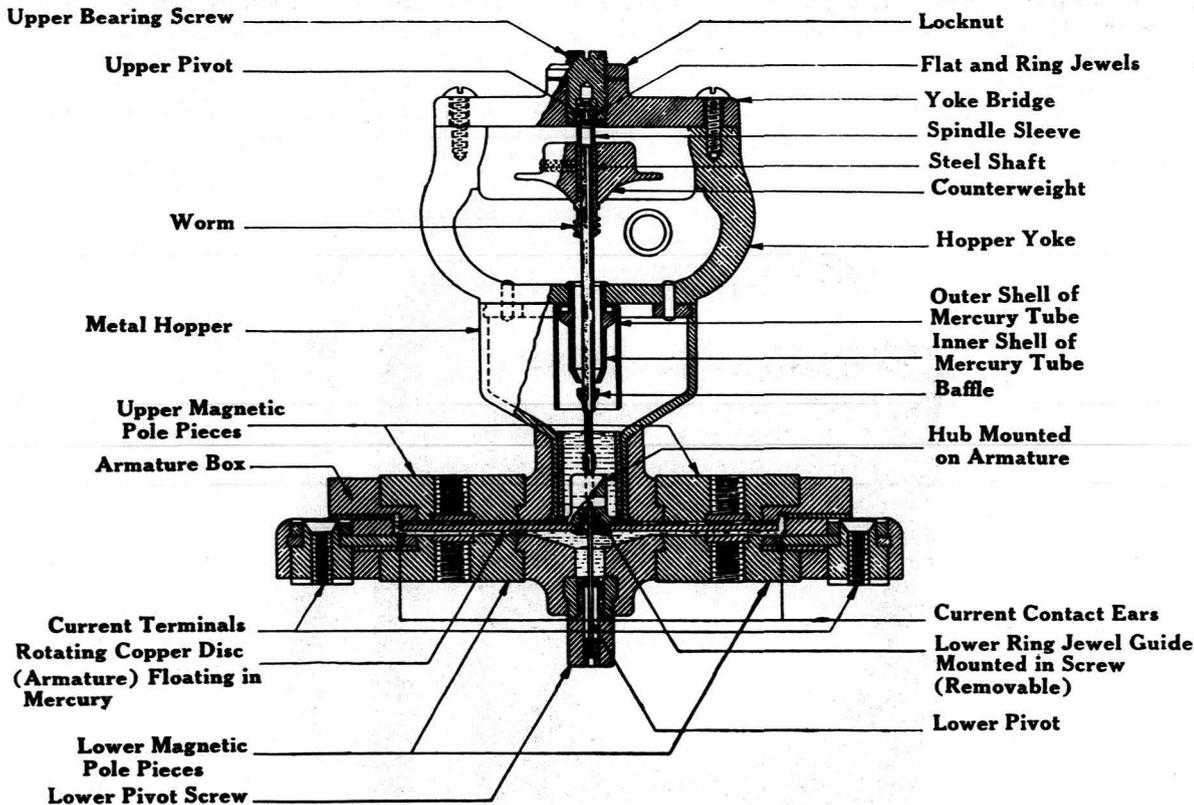


Fig. 2—Mercury Motor Element

or copper disc, of the meter floats in mercury in the armature box. Connections are made at opposite sides of the chamber by means of current terminals and contact ears through which the current flows into the mercury at one side, through the copper disc, (as the copper disc has a much lower resistance than the surrounding mercury) and out through the mercury and terminals at the opposite side. A magnetic field is set up across this disc or armature by two permanent magnets

designed so that the speed of the armature at the same percent load on the meter is the same.

2.03 The armature element consists of a thin copper disc or rotor mounted on a hub. The lower ring jewel, which fits over the lower pivot, is located in the lower end of the hub. A steel shaft fits into the upper section of the hub and holds the upper spindle sleeve, counter-weight, worm drive, and a baffle. The counter-weight is

held in position over a portion of the spindle sleeve and worm drive shell, by means of two set screws. The baffle is a ring fitted around a section of the shaft and designed to deflect the mercury from the shaft when the meter is tilted in handling.

- 2.04 The armature box or mercury chamber consists of two pieces of molded insulating material forming the lower and upper sections of the chamber. The lower section has imbedded in it two current contact ears, terminals and the two lower magnetic pole-pieces to which the lower poles of the permanent magnets are fastened by means of iron screws. A hole is tapped in the center of this lower section of the chamber to hold the lower pivot screw consisting of a steel shaft or pivot mounted on the end of the screw, which provides a guide around which the lower ring jewel rotates. There is no weight on the end of this pivot, as the armature and shaft float in the mercury chamber. The upper section of the chamber also has two tapped pole-pieces imbedded in it, to which are screwed the upper magnet poles. A metal hopper is cast in the center of the upper chamber, and is used as a reservoir for the mercury, (normally in the armature chamber proper) should the meter become inverted. Suspended from the top of the hopper and surrounding the shaft are two cylinders, the outer shell and the inner shell of the mercury tube. The inner shell is beveled in until it forms a seal around the shaft while the baffle on the armature shaft is located just below this inner shell and helps to deflect the mercury from the junction of the shaft and the inner shell. This combination prevents the loss of mercury when the meter is tipped out of its normal position. The hopper cap is in the form of a yoke and is spanned by a metal bridge which carries the upper bearing screw with its ring and flat bearing jewel forming the bearing for the upper pivot on the armature shaft.

#### Resistor:

- 2.05 The resistor unit is also based on Faraday's disc principle and consists of a mercury chamber with an armature floating in it. Refer to Fig. 3. The armature consists of a strip of copper with a pivot located in its center. The rotation of the armature is limited by means of two stops, one of which is movable and may be set in the desired location by means of a lever arm located in the bottom of the resistor. The upper cover of the chamber holds the

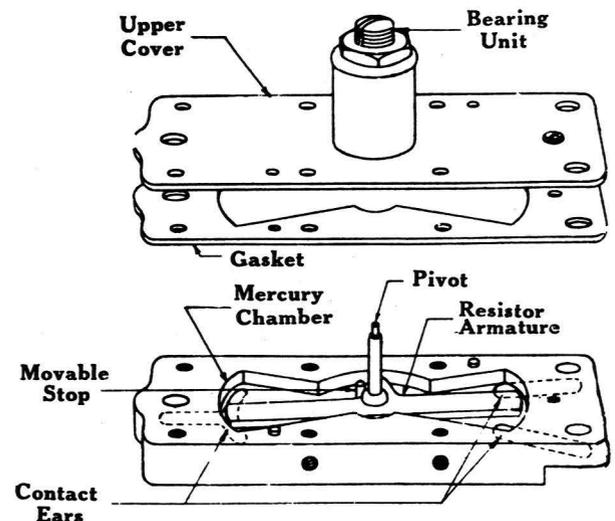


Fig. 3—Resistor

bearing unit for the armature which also is used as a filling well. The lower section or mercury chamber is fastened to the upper one with screws using a gasket to insure a tight joint. This lower section holds the electrical contact ears as well as the adjustable stop. The unit is mounted below and attached to the main armature chamber mechanically, and electrically, forming a variable shunt around the main armature.

- 2.06 The magnetic field for the resistor is furnished by the same poles that produce the field in the motor element. In one position the copper bar acts as a low resistance shunt across the armature terminals, shunting a large portion of the internal meter current from the main armature. This position of the resistor armature also introduces a high resistance path between the negative terminal of the main armature and the negative stud of the meter base, thus further decreasing the current through the main armature. In the other position, the shunting effect is decreased by the high resistance mercury path being introduced in the shunt circuit and the resistance of the path between the negative terminal of the main armature and the negative stud of the meter is reduced, the copper bar forming a low resistance path. In practice, the copper bar or vane is arranged to decrease the current through the motor element while the battery is being charged and to increase the current through the motor element when the battery is discharging. This causes the meter to run slower, while the battery is charging, thus automatically causing the bat-

tery to be given the desired per cent of overcharge. The lever arm on the bottom of the resistor may be shifted manually to the point which will allow a sufficient overcharge to maintain the battery in any particular installation in a satisfactory condition.

**Magnets:**

2.07 There are two permanent magnets held to the cast iron base by means of screws. The armature assembly described above is attached to this unit by means of screws through the pole tips of the magnets and fastened into the pole-pieces imbedded in the armature chamber. The lower armature pole-faces are separated from the associated magnet tips by means of spacers (metal washers). These spacers are important as any change in them will affect the calibration of the meter.

**Gear Train:**

2.08 The gear train is attached to the motor element by means of screws, and consists of a series of gears and worms. One of the gears meshes with the worm on the motor armature shaft and drives the train which moves an indicating hand around a circular dial. This dial is divided into 100 divisions. If the ampere hour ratings of the battery and ampere hour meter are the same, the divisions on the dial indicate the percentages of battery capacity discharged.

2.09 Three fixed contacts are attached to the

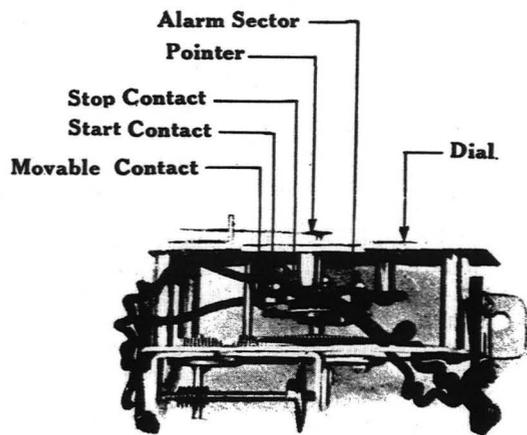


Fig. 4—Contact Mechanism with One Movable Contact

framework of the gear train but insulated from it. The fixed contacts consist of two contact points and a sector. One point designated "Stop" is located at the "Full" or 0 point on the dial. The second point designated "Start" is located at the 10 point on the dial. The sector designated "Alarm" extends from the 35 to the 100 or "Empty" point on the dial. These contacts are wired to the sides of the gear train where they make connection with the control and alarm circuits outside the meter.

2.10 A rotating contact consisting of a spring disc with a cone contact riveted near one edge is fastened to but insulated from the shaft upon which the indicating hand is mounted. This contact makes the connection to the stop, start and alarm contacts.

2.11 On some of the gear train and dial assemblies the contact described in the preceding paragraph makes connection to the alarm sector only, another contact being provided to make the connection to the start and stop contacts.

2.12 The dial hand and movable contacts are fastened to a shaft which fits into the last gear with a friction grip, which permits the resetting of the dial hand manually without disturbing the gear train and allows the battery to be overcharged or discharged beyond the capacity of the dial without damage to the meter.

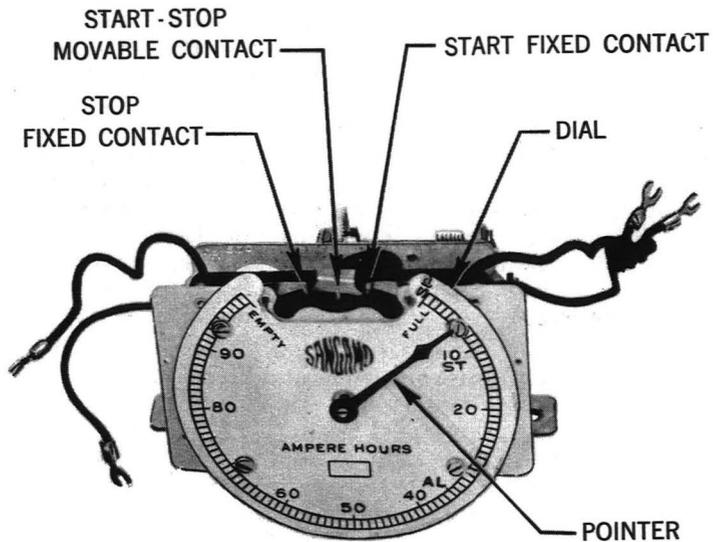


Fig. 5—Contact Mechanism with Two Movable Contacts

**Thermocouple:**

2.13 A thermocouple is placed in the meter to assist in the correct registration of small currents. It is based on the principle that if two dissimilar metals in contact with each other are heated and the ends of the metals are carried to a circuit, a definite current will flow for a given temperature. One end of the resistor winding of the thermocouple is connected to the positive terminal of the meter. The other end is grounded through the contact disc hub. This allows a small current to pass through this winding continuously, heating the thermocouple unit and causing a small local current to flow through the armature of the meter. This current helps

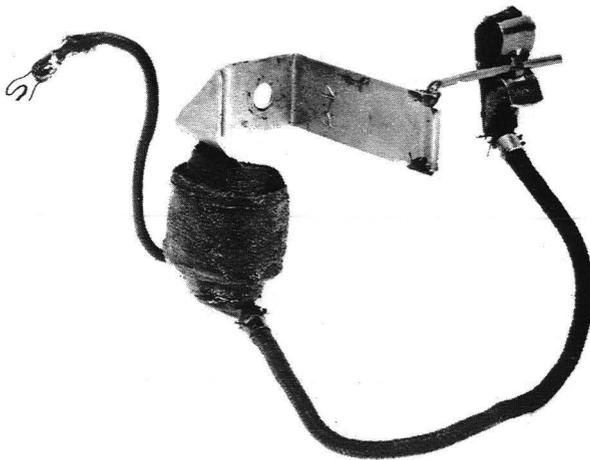


Fig. 6—Thermocouple

to overcome the friction of the moving parts of the meter, thus increasing the accuracy of the meter under light load conditions; however, this current is so small that it does not affect the accuracy of the meter under heavy load conditions. These thermocouples are designed for the particular voltage designated on the nameplate of the meter and the meter should be used only in circuits of this voltage.

**Shunt:**

2.14 A shunt is mounted across the main terminals of the meter in the rear of the power board. This shunt consists of a resistance with a low temperature coefficient which serves to carry the major portion of the current allowing only a small proportion of the total current flowing through the circuit to pass through the meter. Each shunt has plainly stamped

upon it its resistance and current carrying capacity.

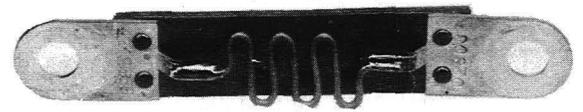


Fig. 7—Shunt

**Control and Alarm Leads:**

2.14 Four colored control and alarm leads make connections at the side of the dial frame and lead to the various control and alarm circuits. The black lead is a ground lead, the green lead makes connection with the "Stop Charge" circuit, the yellow lead makes connection with the "Start Charge" circuit, and the red lead makes connection with the alarm circuit. These leads are cabled and pass through a hole in the meter case and in the power board to the rear of the panel.

**Case (See Fig. 1):**

2.16 The enclosing case of this meter consists of a cast iron base with two current carrying studs, marked for polarity, insulated from the base and extending through the back for rear of board connections. There is also a third stud for supporting the meter. The front cover is made of pressed steel partially lined with insulation on the inside, and having rubber washers for the screw holes and around the edge of the cover making it water and dust proof. The cover is provided with a round glass window, and is held to the base by means of flister headed screws which are arranged for sealing.

**Theory of Operation:**

2.17 Referring to Fig. 8 the operation of the ampere hour meter under service conditions is as follows. When the battery is discharging the current flows from the positive terminal of the battery, through the load to the meter. The current here divides, a part flowing through the shunt connected across the terminals of the meter and back to the negative end of the battery.

2.18 The second portion flows into the meter where it divides into three parts, the most important portion flowing through the motor element, through the resistor armature, to the negative terminal of the meter and back to the battery. This is the cur-

rent which causes the motor element to rotate and the meter to function. This current as it flows through the resistor, will cause the resistor armature to move into a position where it provides a low resistance path for the current through the mercury motor element. The second portion of the internal current will be shunted from the motor element through the high resistance mercury, in the resistor. The third part of the internal current passes through a second internal fixed resistance which is shunted across the motor element for light load adjustment.

- 2.19 The rotation of the motor element causes the dial hand and the movable contact to move around the arc of the circle in proportion to the percentage of the battery capacity used. When the dial hand reaches the 10% discharge point, the movable contact makes connection with the fixed "Start" contact, closing auxiliary circuits

tion of the motor element. The reversal of current through the resistor will cause the copper bar (or resistor armature) to shift its position, so that the resistance of the variable shunt across the motor element is low and the high mercury resistance is in series with the motor armature. These changes result in a smaller proportion of the internal current of the meter flowing through the motor element thus cutting down its speed. The actual amount of speed variation is adjusted manually by means of a lever arm which shifts the location of the pin which determines the amount of resistance which is introduced in the mercury resistor.

- 2.21 When the dial hand reaches the 0 or full charge point on the dial, the movable contact makes connection with the "Stop" contact, closing the auxiliary circuit which shuts down the charging equipment and disconnects it from the battery.

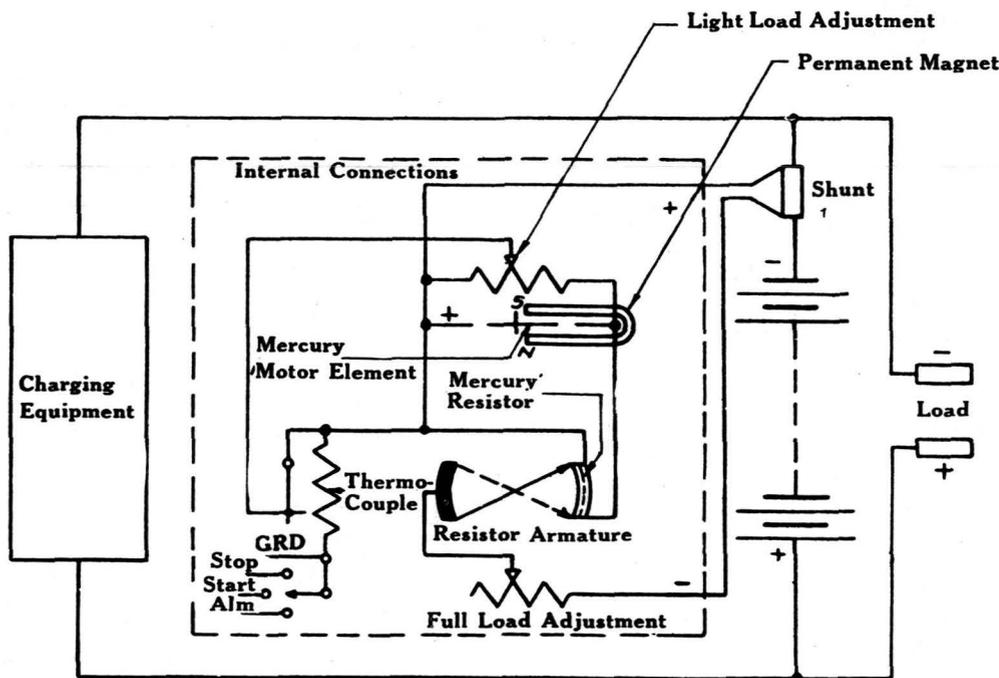


Fig. 8—Schematic Circuit of Connections

which start the charging equipment and connect it across the battery.

- 2.20 As the battery starts to charge, the current flows through the meter in the opposite direction, reversing the direction of rota-

- 2.22 In case the charging equipment for any reason, has not functioned to overcome the discharge from the battery, a movable contact will complete an alarm circuit when the dial hand reaches the 35 point on the dial. This alarm circuit connection is

maintained between the 35 and the full discharge (100) points on the dial.

- 2.23 If it becomes necessary to overcharge the battery in excess of that normally permitted by the meter, the necessary overcharge may be obtained by removing the

cover of the meter and moving the pointer in a clockwise direction (toward discharge) as many points as required to delay the stopping of the charging equipment until the desired overcharge has been obtained.