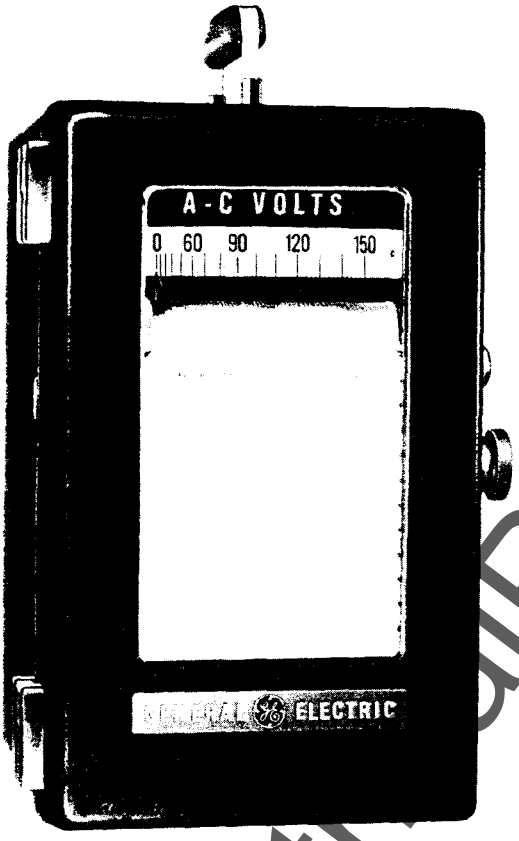
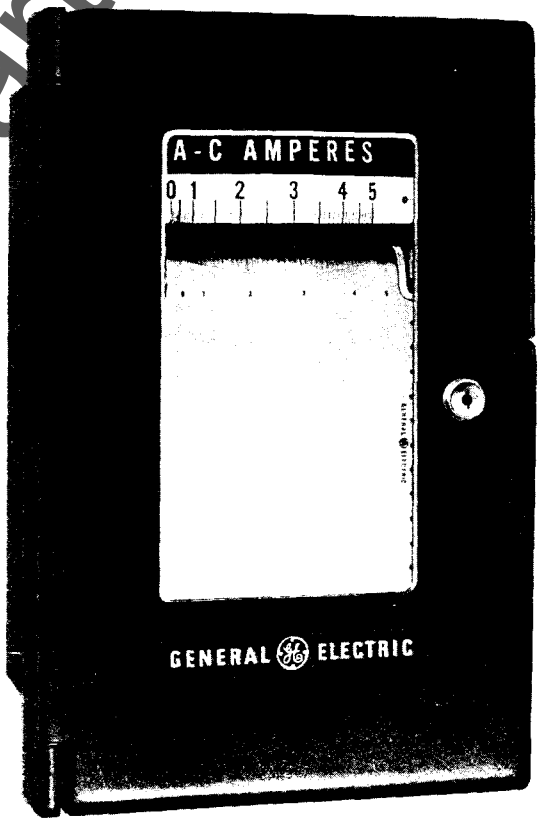
INSTRUCTIONS

GEH-1556C
Supersedes GEH-1556B

TYPE CH
STRIP-CHART RECORDER





GENERAL ELECTRIC

TABLE OF CONTENTS

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

TYPE CH
STRIP-CHART RECORDER

INTRODUCTION

These instructions cover the installation, operation, and maintenance of the General Electric Type CH Recorders.

The recorders, which are available in switchboard or portable types, are strip-chart, ink-type instruments which will measure, indicate, and record the value of an electric quantity, or the value of a mechanical quantity which is converted to an electric signal.

These recorders provide a permanent record of the measured variable, with respect to time, and thus may be used to analyze disturbances and faults in circuits and equipments. In addition, they are useful in general testing work, trouble investigation, and for monitoring purposes.

The instruments are available in chart-speed combinations ranging from 1/4 inch-per-hour to 120 inches-per-minute.

The operation of the recorder is as follows:

The quantity to be measured is "fed" into the recorder's measuring mechanism through appropriate connections. This causes the armature to deflect a pen-and-pointer assembly to a position corresponding to the value of the measured quantity. The pen makes a continuous graphical record of the measured quantity on a moving paper chart.

A feature of these recorders is a new, transparent plastic, throwaway-type, combination inkwell-inkbottle which holds three times as much ink as the old-style inkwells. These containers are filled with ink and then sealed at the factory, thus assuring a factory-fresh supply of clean ink at all times. By utilizing this new type inkwell-inkbottle, the possibility of spilling ink while transferring it from the inkbottle to the inkwell is eliminated. In addition, the possibility of dirt and foreign matter entering into the ink supply and thus causing erratic pen operation is also virtually eliminated.

The design of the chart-carriage assembly makes it possible to interchange all chart-carriages regardless of style. This allows the spring-driven chart carriage to be used in place of an electric-motor-driven chart carriage on either the switchboard or portable models.

RECEIVING, HANDLING, AND STORAGE

RECEIVING

Immediately on receipt of the recorder, examine it for any damage that may have occurred in transit. If injury or rough handling is evident, a damage claim should be filed immediately with the transportation company and the nearest General Electric apparatus sales office should be notified promptly.

The following supplies, which are individually boxed, are shipped with each recorder:

3 record rolls
1 recording pen and a pen cleaner
1 inkwell
1 pen starter and a bottle of chart-carriage lubricating oil
1 instruction book

Recorder components which may be damaged during shipment are either taped or braced in position prior to shipment. The tape and/or braces should be removed as follows:

1. Remove the tape from the scale-support brackets.

2. Remove the scale assembly by pressing inward on both ends of the scale support and then unsnapping the assembly.

3. Grasp the two dowels which are mounted inside of the recorder on top of the chart-carriage mechanism, and carefully pull them down and out. A set of keys which operate the lock on the recorder are taped to one of the dowels. These keys should be untaped prior to throwing the dowels away. Care should be taken to remove the two pieces of felt which are located between the top of the dowels and the recorder case.

4. Remove the tape which is holding the pen-support assembly. This tape is fastened to the ink shield which is located in back of the scale assembly.

5. Replace the scale assembly.

HANDLING

Care should be taken to avoid jarring the recorder when it is being handled. Extreme shock will result in permanent injury to the jewel bearings in which the measuring mechanism is mounted.

STORAGE

If the recorder is to be placed in storage tended period, pack the recorder in the up tion in its original carton and store it in an from corrosive fumes, high humidity, and te extremes.

DESCRIPTION

There are three main sub-assemblies in these recorders. These are: the case, the chart carriage, and the measuring mechanism.

CASE ASSEMBLY

The cases used in these recorders are constructed of cast aluminum which provides a strong, lightweight, and rustproof enclosure for the instrument mechanism.

Two types of finishes are used on the outside of these cases. The switchboard models have a non-glare black finish, and the portable models have a light-grey hammertone finish. All models have a white finish inside of the case. A full-view glass window is provided for ease in viewing the chart and scale. Entrance of dirt and moisture into the case is prevented by a heavy neoprene gasket which forms a tight seal when the door is closed. A cover latch and lock are also provided as standard equipment. The locks on all recorders are identical thereby eliminating the necessity of having an individual key for each recorder.

The switchboard models, which may be of the surface or semi-flush types, contain a fluorescent lamp and a lamp switch.

The portable models are provided with rubber feet and a comfortable leatherette handle for ease in carrying. In addition, the door on this model may be removed by lifting it up and off the hinges.

CHART CARRIAGE

The chart-carriage assembly contained in these recorders is a sturdily-built unit in which simplicity is the keynote. This assembly provides the means for accurately recording the value of the measured quantity, with respect to time, on the moving paper chart.

The chart-carriage assembly is made up of five main sub-assemblies.

These are:

The side-and-back-plate assembly
The timing-drum and writing-table assemblies
The supply- and reroll-spool assemblies
The cover-and-plate assembly
The drive-unit assemblies

SIDE-AND-BACK-PLATE ASSEMBLY

This assembly is the main framework of carriage assembly. It provides the means f ing the chart carriage to the recorder case. parts of the chart-carriage assembly are mc this frame.

TIMING-DRUM AND WRITING-TABLE ASSEM

The timing drum, which receives its pow motor through appropriate gearing, drives t chart by means of sprocket pins contained ends of the drum. The sprockets engage ho chart paper and drive the chart at a pre-de rate of speed.

The writing table provides a smooth su the recording pen to inscribe the value of the ed quantity on the moving chart paper. In it is a convenient writing surface for making a ings that are desired on the chart.

SUPPLY- AND REROLL-SPOOL ASSEMBLIES

The supply spool is located in the lowe of the chart-carriage assembly in back of t spool. The supply spool holds a roll of cha which is 150-feet in length. A paper supply i located on the lower left-hand side of the c riage assembly, shows the amount of paper le supply spool. In addition, it maintains suffici tension on the paper to provide a smooth a paper feed.

The reroll spool winds the chart paper — b of a motor and appropriate gearing — and al tension on the paper so that an accurate r may be made.

COVER-AND-PLATE ASSEMBLY

This assembly provides protection for t units against dust or physical damage, and in it serves as a guide for the chart paper.

DRIVE-UNIT ASSEMBLIES

The drive-unit assemblies consist of a pow and an associated gear train. These assemb vide the means for driving the timing drum roll-spool assemblies.

Two types of drive units are used in these r

These are: a main-drive unit which furnishes power to the timing-drum assembly, and a reroll-drive unit which furnishes power to the reroll-spool assembly.

Main-drive Unit

Five types of main-drive units are available. Four of these are of the electric-drive type, and the fifth is a hand-wound spring-clock type.

The main-drive units, which are designated by Style numbers consist of the following:

Style 1: a high-speed electric-drive unit which provides a single-speed drive in the range from 1/4 to 120 inches-per-minute. A self-contained switch marked HI-OFF-LO is wired to provide ON-OFF-ON control.

Style 2: a low-speed electric-drive unit which provides a single-speed drive in the range from 1/4 to 30 inches-per-hour. A self-contained switch marked HI-OFF-LO is wired to provide ON-OFF-ON control.

Style 3: a double-speed electric-drive unit which provides drives of both inches-per-hour and inches-per-minute in the range from 1/4 inch-per-hour to 120 inches-per-minute. A self-contained switch is wired to provide HI-OFF-LO control.

Style 4: a double-speed electric-drive unit which provides drives of both inches-per-hour and inches-per-minute in the range from 1/4 inch-per-hour to 120 inches-per-minute. This style contains provision for an external switch. (Switch is not supplied.)

Style 5: a double-speed hand-wound spring-clock drive unit which provides drives of both inches-per-hour and inches-per-minute in the range from 1/4 inch-per-hour to 30 inches-per-minute. A self-contained lever provides HI-OFF-LO control. The clock is a self-contained unit which also serves as the power source for the reroll-drive unit.

All main-drive units drive the timing-drum assembly through associated fixed- and change-gear-train assemblies. The change-gears consist of four gears, mounted on the left-hand side of the chart-carriage, mechanism. These gears, which are color coded for ease of identification, may be changed to obtain different gear ratios and thus provide various chart-speed combinations.

Four additional pairs of change gears are supplied with each recorder which contains a double-speed chart carriage (Styles 3, 4, or 5). These gears, when not in use, are stored on the right-hand side of the chart-carriage mechanism.

Long gear life is assured by utilizing precision gears in all recorders.

The toggle switch in Styles 1, 2, and 3 recorders and the lever on Style 5 recorders is located on the left-hand side of the chart-carriage mechanism.

The change-gear combination used, together with Style of chart carriage determines the various chart-speed combinations obtainable. The desired chart speed may be obtained by referring to the nameplate on the chart carriage which contains the information necessary for changing the gear ratios and for positioning the toggle switch or lever. This information is also contained in Tables IV and V.

Reroll-drive Unit

The reroll-drive unit consists of the induction motor and gear-train assembly, or the hand-wound spring clock. The reroll-drive unit provides the power to the reroll spool which winds and keeps tension on the chart paper.

The electric reroll-drive unit is a complete sub-assembly which may be removed from the chart carriage as a unit.

The spring-clock reroll-drive unit obtains its power from the main clock spring through a separate gear train contained within the clock. This gear train is independent of the main-drive unit and therefore is not regulated by the escapement in the clock.

MEASURING MECHANISM

The following table lists the three types of measuring mechanisms used in these recorders.

TABLE I
TYPES OF MECHANISMS

Quantity To Be Measured	Type Of Mechanism
All d-c	Alnico V permanent-magnet moving-coil
All a-c (except current)	Electrodynamic (electrodynamometer)
A-c amperes	Iron-vane

The measuring-mechanism assembly is a self-contained unit which may be easily removed from the recorder for servicing. In addition to the moving system, each assembly contains an ink shield, scale-support brackets, inkwell clamps, pen saddle, and a magnetic shield.

The ink shield is a black rectangular plastic plate which completely covers the moving system. The shield serves as the inkwell support and, in addition, it minimizes the possibility of ink and dirt falling into the moving system.

The inkwell clamps are fastened to the ink shield by means of a hinge assembly. These clamps snap onto the inkwell and hold it tightly in position.

The scale-support brackets hold and position the scale assembly. These brackets allow the scale to be tilted up out of the way in order to facilitate servicing the pen and inkwell.

The pen saddle is rigidly attached to the armature shaft. The saddle holds the pen and positions it on the chart paper in accordance with the angle of rotation of the armature shaft.

Recorders designed to measure a-c quantities are equipped with a magnetic shield. This shield minimizes the possibility of erroneous indications caused by stray magnetic fields.

The moving member, or armature, of each measuring mechanism is mounted on a pivoted shaft. This shaft rotates on bearings contained at each end of a one piece aluminum frame. The upper bearing is of the bronze-sleeve type and the lower bearing is of the sapphire ringstone-endstone type. The ringstone-endstone bearing is protected from shock by means of a helical spring contained in the lower-bearing assembly. This spring virtually eliminates the danger of damaging the pivot and jewel assembly (lower bearing) if the recorder is subjected to excessive jarring or shock.

A resistor-plate assembly is used in recorders which are designed to measure a-c volts, a-c watts, or d-c volts. This assembly is a combination of fixed and adjustable resistors which are mounted on an aluminum support plate contained in the bottom of the recorder case. The resistors, which are temperature compensated, are used to limit the current in the potential circuit of the measuring mechanism.

INSTALLATION

LOCATION

The recorders should be installed in an area free from high humidity, corrosive fumes, and excessive vibrations. In addition, they should be kept a reasonable distance from transformers and conductors carrying high currents.

MOUNTING

SWITCHBOARD RECORDERS

The outline and mounting dimensions of the recorders are shown on page 7. All drilling and hammering on the panel should be completed before mounting the recorder.

Note: If the shipping braces were not removed when the recorder was received, remove them as described in the section entitled RECEIVING.

CONNECTIONS

Connections to the recorder are made through two terminal blocks located on the back of the recorder case. The upper terminal block is used for making connections to the chart-drive motors (on electric-motor-driven recorders) and also to the lamp (switchboard models only) and any accessories which are ordered. The lower terminal block is used on all recorders for making connections to the measuring mechanism.

Connections for the chart-drive motors and lamp are shown in Fig. 1. Refer to the nameplate on the recorder for the proper operating voltage.

For connections to the measuring mechanism refer to the list of connection diagrams on page 20. Care should be taken to insure that the proper diagram is selected.

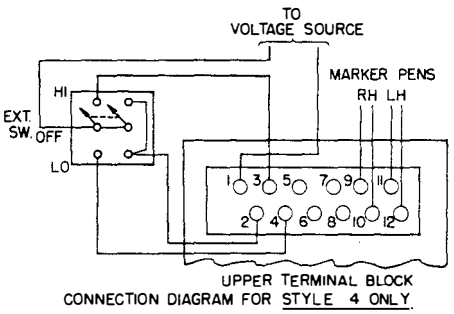


TABLE OF CONNECTIONS	
CHART DRIVE MOTORS	TERMINALS
FOR STYLES 1, 2, & 3	1 & 2 (SINGLE OR LOW VOLTAGE) 1 & 4 (HIGH VOLTAGE)
FOR STYLE 4	SEE CONNECTION DIAGRAM ABOVE
FOR STYLE 5	NO CONNECTION (SPRING CLOCK)
LAMP (SWITCHBOARD MODELS ONLY)	5 & 6
HEATER	7 & 8
RH MARKER PEN	9 & 10
LH MARKER PEN	11 & 12

Fig. 1. Connections for chart-drive motors, lamp, heaters, and marker pens

OUTLINE AND MOUNTING DIMENSIONS

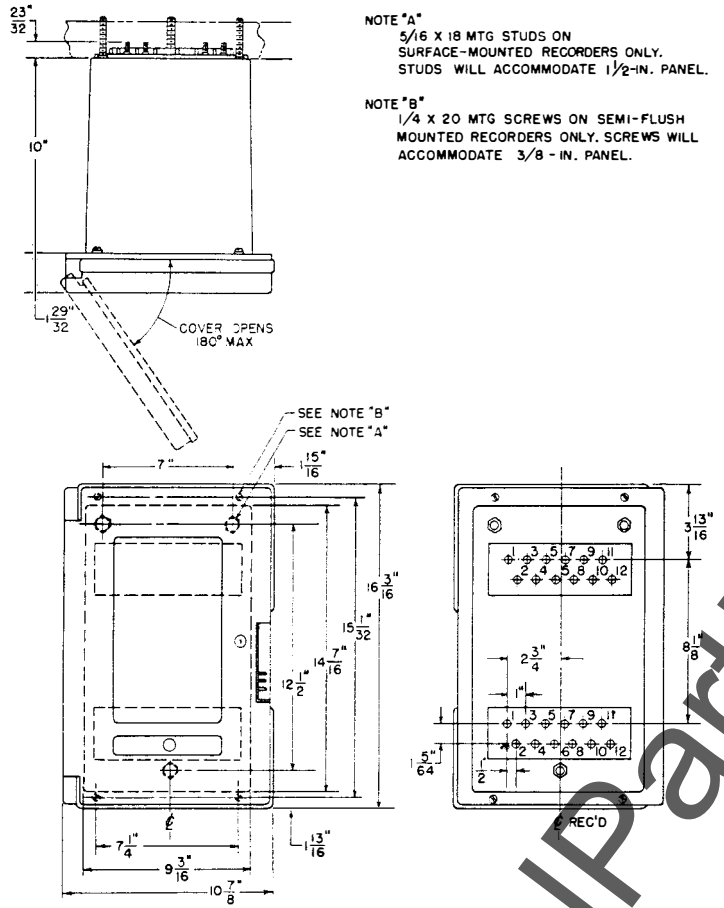


Fig. 2. Outline and mounting dimensions of switchboard models (surface and semi-flush mounting)

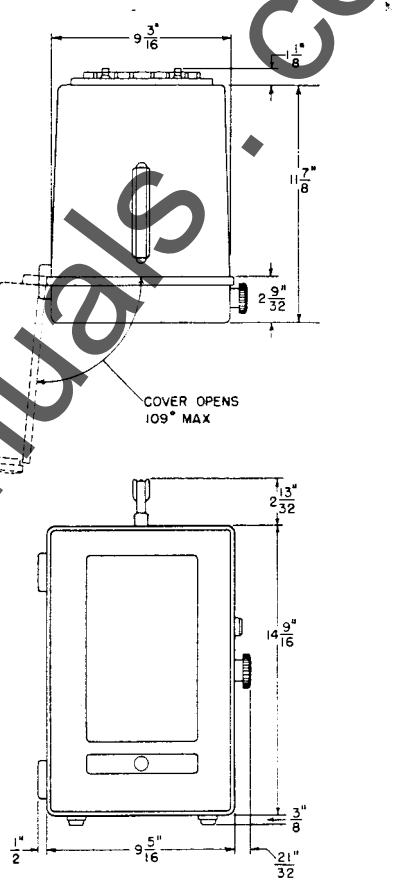


Fig. 3. Outline dimensions of portable models

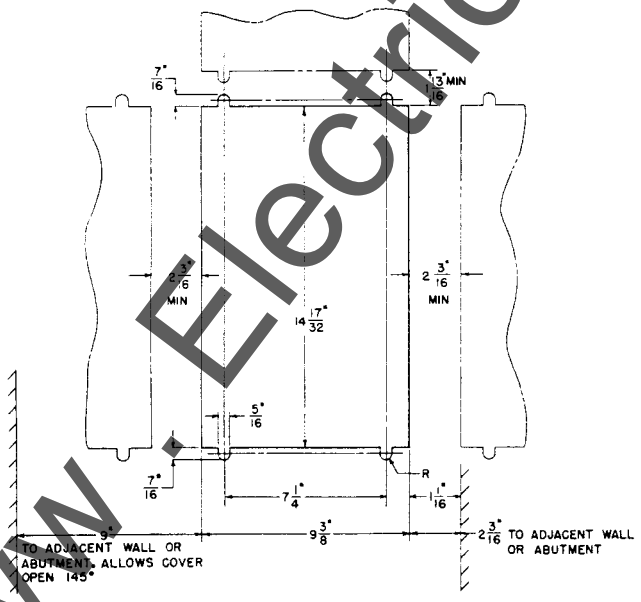


Fig. 4. Panel cutout dimension for semi-flush mounting

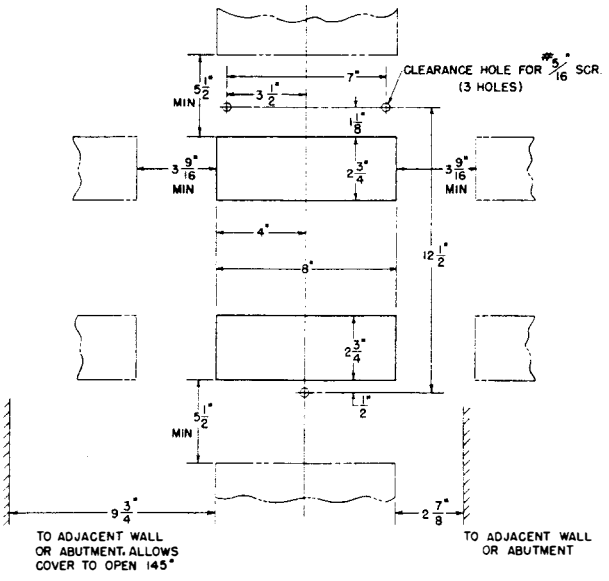


Fig. 5. Panel cutout dimensions for surface mounting

OPERATION

OPERATING LIMITS

Current-measuring recorders may be momentarily overloaded up to the following values without causing any adverse effect on the measuring mechanism:

Alternating-current ammeters—up to 40 times the full-scale value.

Direct-current ammeters—up to 10 times the full-scale value.

The recorders are designed to withstand high-potential tests as follows:

1. 5,000 volts RMS 60 cycles for 1 minute between the measuring circuit and ground.

2. 2,500 volts RMS 60 cycles for 1 minute between circuits.

3. 1,500 volts RMS 60 cycles for 1 minute between accessory circuits and ground.

The temperature range within which the recorder will operate satisfactorily is −5F to +120F. The recorder will not suffer any adverse effects if it is operated for a short length of time at temperatures above or below the recommended limits. However, continuous operation above or below these limits will cause the pen to stop inking and thus, no record of the measured quantity will be obtained. The low temperature range may be extended by adding heaters. See ACCESSORIES section.

Line voltage variations should not exceed ±10% of the recorder's rated voltage. However, the recorder may be operated for a short length of time at voltages below the recommended 10% limit, without having any adverse effect on the drive motors.

If the recorder is operated at the minimum temperature and voltage limits simultaneously, the maximum chart-paper speed under this extreme condition will be limited, as follows:

Styles 1, 3, and 4 recorders, 60 inches-per-minute
Style 2 recorders, 15 inches-per-hour

PRELIMINARY OPERATION

After the proper connections have been completed, it will be necessary to perform the operations described in the SERVICING section under the following sub-headings:

SELECTING AND INSTALLING CHANGE GEARS
INSTALLING THE RECORD ROLLS
INSTALLING THE INKWELL AND PEN
ZERO ADJUSTMENT

OPERATING PROCEDURE

After the steps in the applicable sections under PRELIMINARY OPERATION have been completed, proceed as follows:

1. Check the spring clock to see if it is fully wound (Style 5 recorders only), or energize the chart-drive motors (Styles 1, 2, 3, and 4 recorders). The spring clock must be wound when installing a new record roll, or every 60 days if the recorder is operated at speeds of one inch-per-hour or less.
2. Energize the measuring mechanism.
3. Rotate the timing drum forward, using the knurled portion, until the time markings on the chart paper (if the paper has time markings on it) lines up with the tip of the pen.
4. Turn the lamp in the switchboard models on by pushing the starter switch in and holding it momentarily until the ends of the lamp glow. Then release the switch. To turn the lamp off pull the switch outwards.

The operation of the recorder is now automatic except for periodic replacement of record rolls and ink. Reference should be made to TABLE II which shows the approximate length of time a record roll will last at each chart speed.

TABLE II

RECORDER SPEED vs RECORD ROLL REPLACEMENT

Basic Speed Inches Per Hour	Approximate Time Record Roll Will Last	Basic Speed Inches Per Minute	Approximate Time Record Roll Will Last
1/4	297 days	1/4	5 days
1/3	222 days	1/3	90 hours
1/2	148 days	1/2	60 hours
1	74 days	1	30 hours
2	36 days	2	15 hours
3	24 days	3	10 hours
4	17 days	4	7 hours
7.5	9 days	7.5	4 hours
10	7 days	10	3 hours
15	5 days	15	2 hours
30	60 hours	30	1 hour
60	30 hours	60	29 minutes
90	20 hours	90	19 minutes
120	15 hours	120	14 minutes

MAINTENANCE

SERVICING

INSTALLING THE RECORD ROLL (See Fig. 6)

The following steps, along with the corresponding photographs, describe the proper method for installing a roll of chart paper in the recorder.

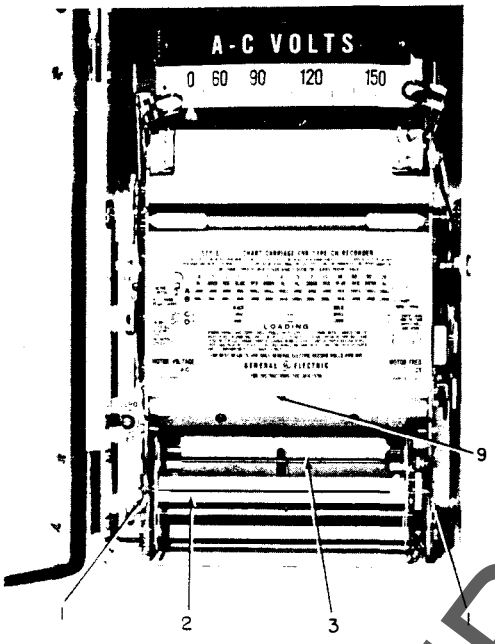


Fig. 6a

1. Press down the latches (1) on each end of the reroll spool (2) and then lift the spool out.

2. Grasp the supply-roll spool (3) and pull it up and out of the recorder.

Note: The indentation (9) is for a roller required on style 5 instruments only.

Fig. 6b

3. Hold a new record roll with the elongated holes to the right and then insert the supply-roll spool into the right-hand side of the record roll. Care should be taken not to "telescope" the record roll when inserting the supply-roll spool.

*Not present on later models

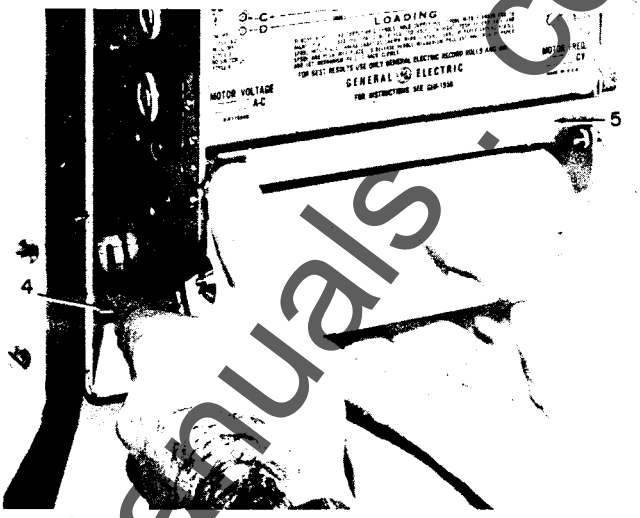


Fig. 6c

4. Snap the new record roll into position while simultaneously holding down the paper-supply indicator (4) and holding up the drag plate (5).

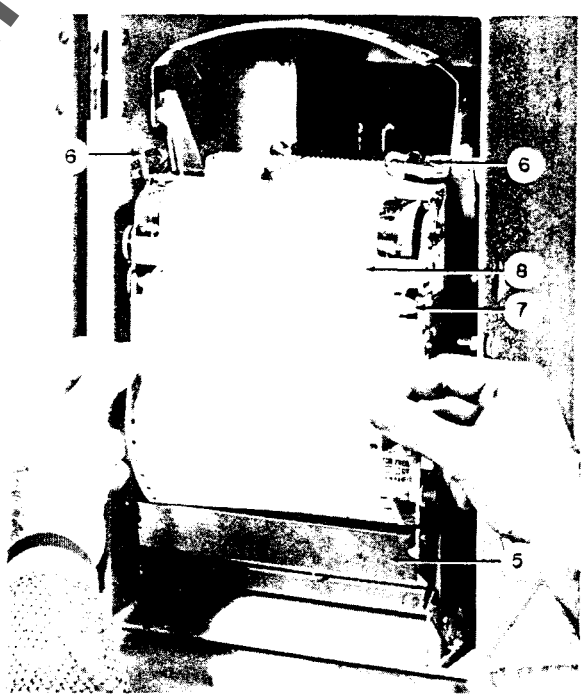


Fig. 6d

5. Lift up the two paper guides* (6) and then pass the end of the chart paper above the drag plate (5) and between the roller (7) and writing table (8).

6. Pull through approximately 16 inches of paper, being careful not to tear the paper on the sprockets in the timing drum.

7. Remove the used record roll (if there is one in the recorder) from the reroll spool, by first pulling out the flange on the end opposite the drive gear and then sliding the roll off the spool. Replace the flange on the spool making sure that it is pushed all the way into the spool.

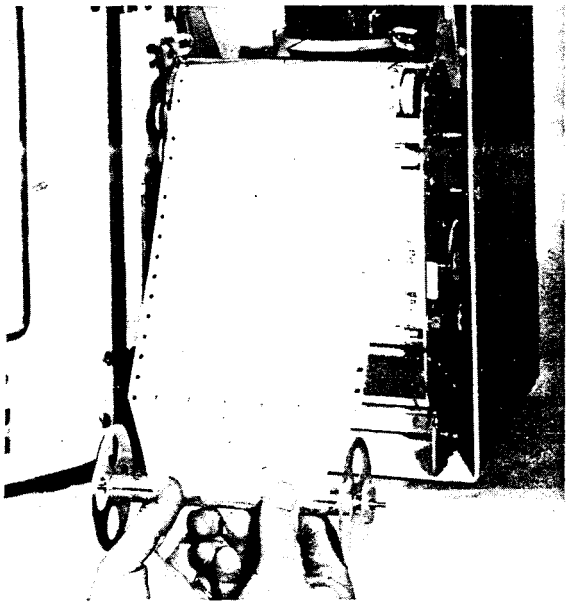


Fig. 6e

8. Tear the end of the chart paper into a V as shown in Fig. 6e.

Fig. 6f

9. Hold the reroll spool so that the gear is on the right-hand side, and then insert the end of the chart paper into the slot in the spool.

10. Wind several turns of the chart paper onto the reroll spool (record side out).

*Not present on later models

11. Hold up the drag plate (5) and then snap the reroll spool into position. Then drop the drag plate so that it rests on the flange and check the reroll-spool drive gear to make sure that the gear is properly engaged.

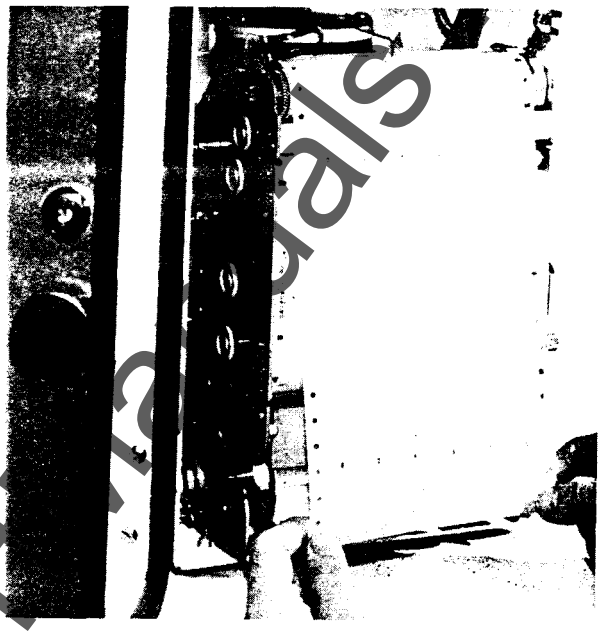


Fig. 6g

12. Pull a few inches of chart paper off the reroll spool (to unlatch the spool) and while allowing the paper to rewind slowly make sure that the sprockets in the timing drum engage the perforations in the paper.

Note: If the reroll spool will not rewind the paper, it may be due to the reroll drive spring being run down. This will make it necessary to either energize the chart-drive motor or wind the spring clock, depending on whether the recorder chart carriage is electric-motor driven or spring-clock driven.

13. Wind the spring clock (Style 5 recorders only).

14. Push down the two paper guides* (6).

INSTALLING THE INKWELL AND PEN

The proper method for installing an inkwell and pen is as follows:

1. Tilt the scale assembly up out of the way.

2. If a pen and inkwell are already in the recorder remove them as follows:

   a. Grasp the pen and carefully unsnap it from the spring clip. Immediately upon removal tip the pen upside down in order to prevent the ink from flowing out.

   b. Unsnap the two clips which are holding the inkwell in place and then carefully lift the inkwell out of the recorder.

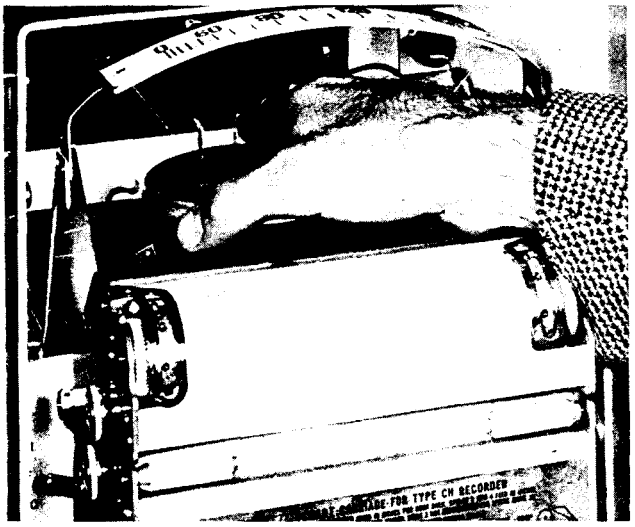


Fig. 7. Installing an inkwell in the recorder

3. Place the new inkwell in the recorder (the side of the inkwell which has the tape or hole should be in the back of the case) and make sure that it is properly seated. (See Fig. 7.)

4. Snap the two holding clips onto the grooves in the inkwell cover.

5. Remove the tape (if present) covering the hole in the inkwell cover.

6. Place the stem of the pen carefully into the inkwell and then very carefully push the pen down into the spring clips on the pen saddle. A click will be "felt" on both sides when the pen has been pushed into the clips.

Note: The tip of the pen will not rest on the chart paper if the pen is not full of ink. This condition will be present in a pen which is being placed into operation for the first time. In addition, this condition will also be present if ink has been spilled from a pen which has already been in operation. To fill the pen and start it inking refer to the section entitled INKING THE PEN.

INKING THE PENS

1. Squeeze the pen starter bulb thus causing it to collapse.

2. Keep the bulb collapsed and then carefully insert the tip of the pen into the hole in the tip of the pen starter.

3. Release the pressure on the bulb slowly while watching the transparent tip.

4. When the ink is visible in the tip, carefully lift the tip of the pen out without further lessening the hand pressure on the pen-starter bulb.

5. Place the tip of the pen on the chart paper.

6. Rinse the pen starter out and allow to dry before replacing it in its container.

INKS

The ink furnished with the recorder is specifically designed to produce a record which provides maximum contrast for ease in reading, and good chart reproduction. Red, black, brown, and green inks are available in three drying speeds to facilitate satisfactory recording over a wide range of temperature and chart speeds.

Table III lists these inks, their drying speeds, and their operating temperatures. Reference should be made to the catalog numbers listed when ordering ink. If color is not specified when ordering, red ink will be supplied as this is the standard color.

TABLE III
INKS

Color	Fast Drying (Fast Chart Speed)	Medium Drying (Medium Chart Speed)	Slow Drying (Slow Chart Speed)
	32F to 95F	20F to 104F	-5F to 120F
Red	8946427G1	8946427G2	8946427G3
Black	8946427G4	8946427G5	8946427G6
Green	8946427G7	8946427G8	8946427G9
Brown	8946427G10	8946427G11	8946427G12

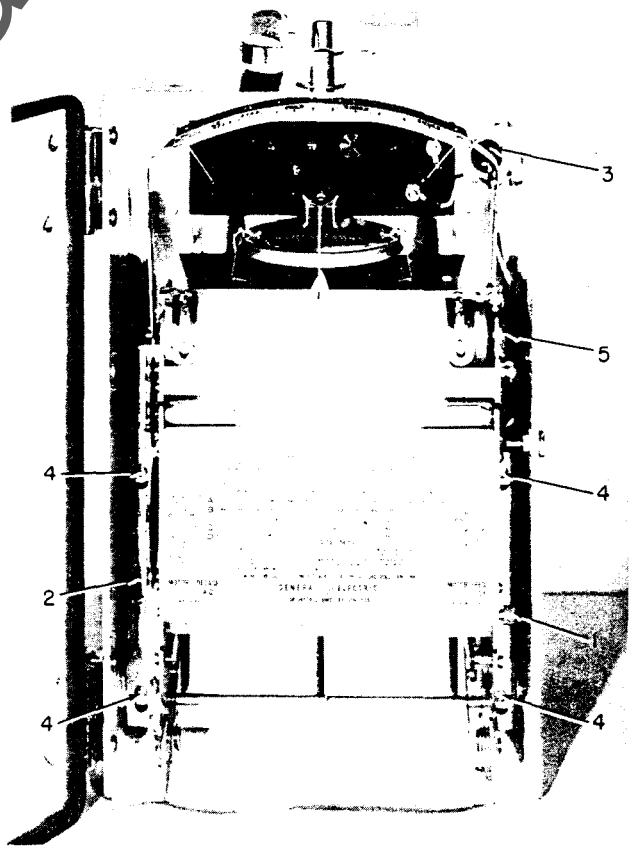


Fig. 8. Front view of recorder, door open; record roll and spools removed

CLEANING THE PENS

1. Unsnap the pen from the pen saddle and lift it out.
2. Fill the pen starter with clean hot water.
3. Insert the back end of the pen tube into the tip of the pen starter and then try to force water through the pen. If a steady stream of clean water cannot be forced through the pen, try to work the small, wire pen cleaner (supplied) through the tip of the pen. Remove the wire and then try to force a steady stream of clean water through the pen.
4. Repeat steps 2 and 3 until a steady stream of clean water can be forced through the pen.
5. Empty the water from the pen starter and then force air through the pen using the starter.

SELECTING AND INSTALLING CHANGE GEARS

This section applies only to recorders which are supplied with extra sets of change gears.

The chart-carriage instruction label in each recorder contains the information necessary for selecting the proper change-gear combination for the paper speed desired. This information is also given in Table IV and Table V below.

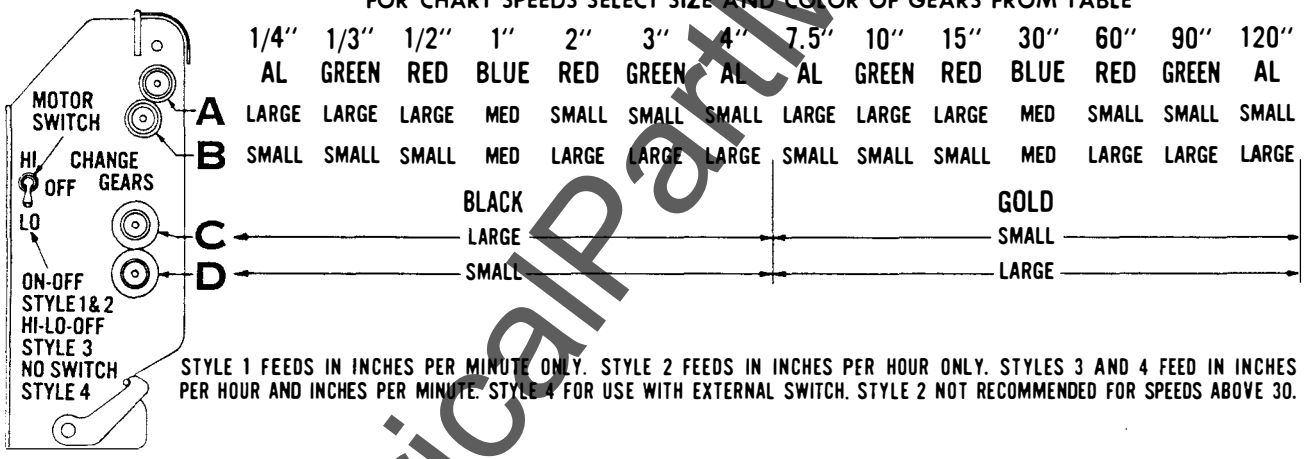
Extra sets of change gears are stored on the right-hand side of the chart-carriage mechanism. After determining the change-gear combination which will provide the desired speed, install the gears (if the gears already in position are not the proper ones) in their proper positions as follows:

TABLE IV

SELECTING AND INSTALLING CHANGE GEARS

ELECTRIC-MOTOR DRIVES — STYLES 1, 2, 3, and 4

FOR CHART SPEEDS SELECT SIZE AND COLOR OF GEARS FROM TABLE



	1/4"	1/3"	1/2"	1"	2"	3"	4"	7.5"	10"	15"	30"	60"	90"	120"
	AL	GREEN	RED	BLUE	RED	GREEN	AL	AL	GREEN	RED	BLUE	RED	GREEN	AL
A	LARGE	LARGE	LARGE	MED	SMALL	SMALL	SMALL	LARGE	LARGE	LARGE	MED	SMALL	SMALL	SMALL
B	SMALL	SMALL	SMALL	MED	LARGE	LARGE	LARGE	SMALL	SMALL	SMALL	MED	LARGE	LARGE	LARGE
C	BLACK LARGE							GOLD SMALL						
D	SMALL							LARGE						

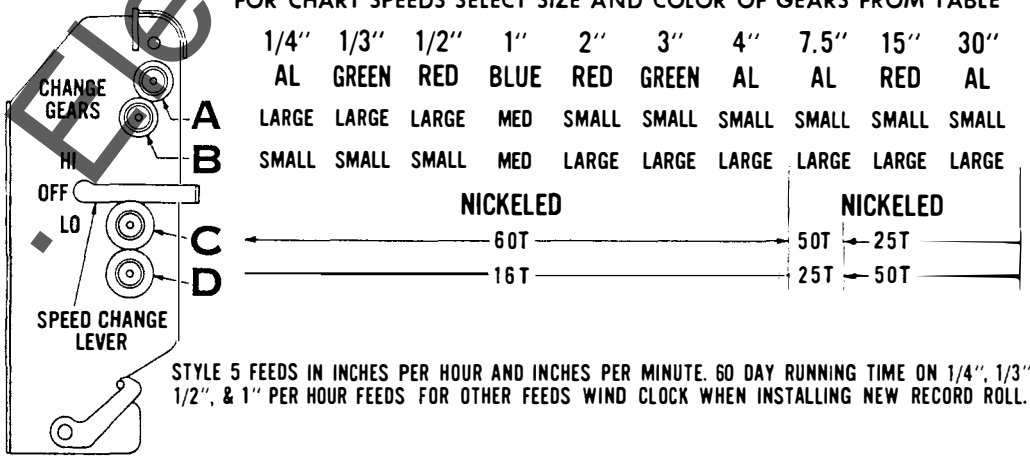
STYLE 1 FEEDS IN INCHES PER MINUTE ONLY. STYLE 2 FEEDS IN INCHES PER HOUR ONLY. STYLES 3 AND 4 FEED IN INCHES PER HOUR AND INCHES PER MINUTE. STYLE 4 FOR USE WITH EXTERNAL SWITCH. STYLE 2 NOT RECOMMENDED FOR SPEEDS ABOVE 30.

TABLE V

SELECTING AND INSTALLING CHANGE GEARS

SPRING-CLOCK DRIVE — STYLE 5

FOR CHART SPEEDS SELECT SIZE AND COLOR OF GEARS FROM TABLE



	1/4"	1/3"	1/2"	1"	2"	3"	4"	7.5"	15"	30"
	AL	GREEN	RED	BLUE	RED	GREEN	AL	AL	RED	AL
A	LARGE	LARGE	LARGE	MED	SMALL	SMALL	SMALL	SMALL	SMALL	SMALL
B	SMALL	SMALL	SMALL	MED	LARGE	LARGE	LARGE	LARGE	LARGE	LARGE
C	NICKELED 60T							NICKELED 50T	25T	
D	16T							25T	50T	

STYLE 5 FEEDS IN INCHES PER HOUR AND INCHES PER MINUTE. 60 DAY RUNNING TIME ON 1/4", 1/3", 1/2", & 1" PER HOUR FEEDS FOR OTHER FEEDS WIND CLOCK WHEN INSTALLING NEW RECORD ROLL.

1. Unscrew the knurled screw (1, Fig. 8) and pull out the change-gear plate.

2. Unscrew the knurled nut and remove the correct gear.

3. Install the gear on the change-gear shaft, making sure that the slot in the gear is facing in towards the recorder. Care should be taken to insure that the keyway on the gear shaft slips into the slot in the gear.

4. Screw the knurled nut on tightly.

5. Store the extra gears on the change-gear plate assembly, and then replace the assembly on the side of the chart-carriage mechanism. Replace the knurled screw.

ZERO ADJUSTMENT

In addition to providing a means for positioning the pen-and-pointer assembly on zero, the zero adjustor can also position the assembly at any desired point on the scale. This feature makes it possible to change, for example, a zero-left recorder (one having a linear scale distribution) to a zero-center recorder by simply rotating the zero-adjusting screw (2, Fig. 8). Since this does not change the full-scale value of the recorder, the electrical value from the "new" zero to each end of the scale will be half of the original full-scale value. For example, a 0-1 ma. full-scale recorder would be changed to a 0.5-0-0.5 ma. recorder.

REMOVING THE CHART CARRIAGE (See Fig. 8)

The chart-carriage assembly may be removed from the recorder case as follows:

1. Disconnect the power from the recorder.
2. Pull out the connecting cord plug (3).
3. Loosen the four mounting screws (4).
4. Lift the chart carriage up and off the four mounting screws and out of the case.

If the chart carriage is to be installed in a different recorder case, the following check, and adjustment if necessary, should be made after the chart carriage, record roll, ink, and pen have been installed:

1. Remove the power from the recorder.
2. Line up a time division on the chart paper with the tip of the pen.
3. Move the pen across the paper noting whether or not the pen point follows the time-line arc on the chart paper. If the pen does not follow the arc, loosen the hex nut (5) and then rotate the hollow adjusting-screw bearing either in or out so that the pen point does follow the arc when the test is repeated.
4. Tighten the hex nut.
5. Reconnect the power to the recorder.

*Reg. Trade-mark of the General Electric Co.

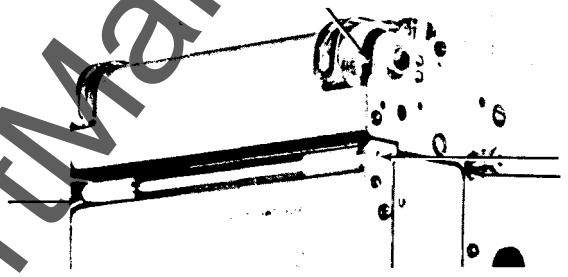
LUBRICATION

The recorders should be cleaned and oiled once a year. It is recommended that all bearings and electric motors in these recorders be lubricated with light machine oil such as G-E Cat. No. 8904152, which is supplied with the recorders. The hand-wound spring clock should be lubricated with a good grade of watch oil.

The following sections should be referred to for the proper lubrication procedure.

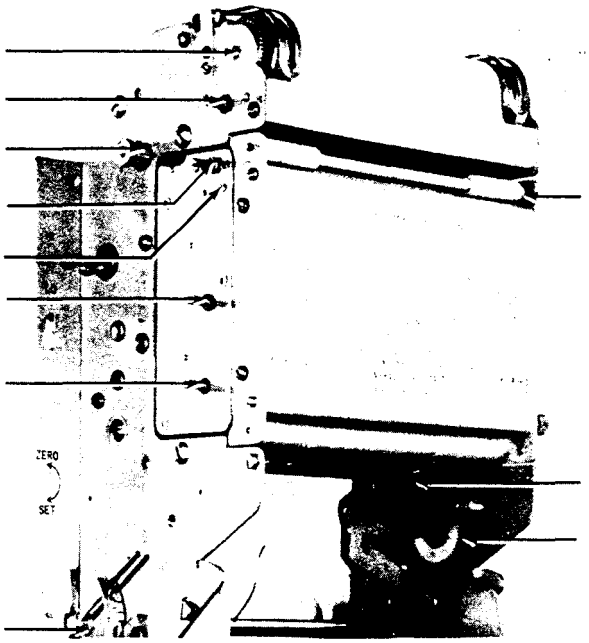
CHART-CARRIAGE ASSEMBLY

All bearings in the chart-carriage assembly (shown in Fig. 9 and 10) should be lubricated with one drop of light machine oil at the points indicated by the arrows.



APPLY ONE DROP OF OIL G-E CAT. NO. 8904152 AT POINTS INDICATED

Fig. 9. Chart-carriage lubrication (also see Fig. 10)



APPLY ONE DROP OF OIL G-E CAT. NO. 8904152 AT POINTS INDICATED

Fig. 10. Chart-carriage lubrication (also see Fig. 9)

ELECTRIC-MOTOR DRIVES

Main-drive Unit

Style 2 chart carriages which are equipped with Telechron* synchronous motors are of the permanently lubricated type. Oil the bearings in the associted gear train with one drop of light machine oil.

Styles 1, 3, and 4 chart carriages are equipped with a reversible motor which is shown in Fig. 11. Oil the

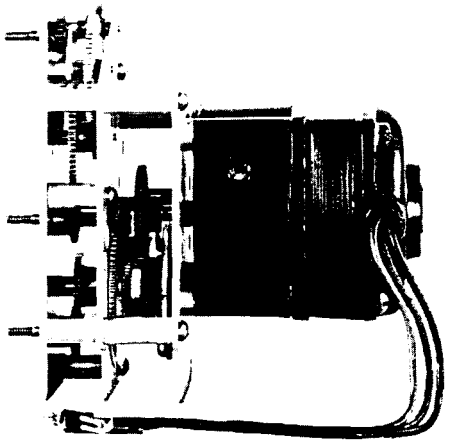


Fig. 11. Main-drive motor

gear box in these motors through the two holes in the gear housing (one hole is covered with a machine screw) with a few drops of light machine oil. Oil the bearings in the associated gear train with one drop of light machine oil. DO NOT OIL THE PAWLS.

Reroll-drive Unit

Oil the two wicks in the reroll-drive motor, shown in Fig. 12, with a few drops of light machine oil. Oil the bearings in the associated gear train with one drop of light machine oil.

Fig. 12. Reroll-drive motor

*Reg. Trade-mark of the General Electric Co.

SPRING-CLOCK DRIVE

Style 5 chart carriages are equipped with a precision hand-wound spring clock as shown in Fig. 13. The clock can be removed as a unit from the chart carriage. The clock has two separate outputs, one for driving and timing the chart, and the other for re-rolling the chart. Each output subassembly can be dis-

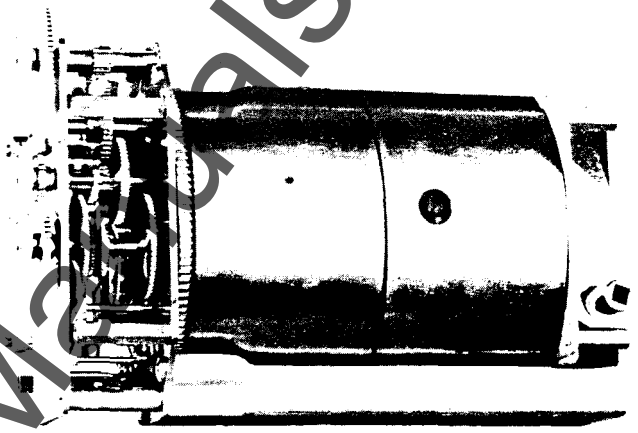


Fig. 13. Hand-wound spring clock

assembled from the main spring barrel as a complete subassembly for cleaning and oiling.

Caution: UNWIND THE CLOCK COMPLETELY BEFORE STARTING DISASSEMBLY.

The jewelled escapement is a subassembly which also can be removed as a unit from its associated gear train.

Under normal operating conditions the clock should be cleaned and oiled every three years. Oil all bearings with a good grade of watch oil, but DO NOT OVEROIL THE ESCAPEMENT.

RENEWAL PARTS

Renewal parts may be ordered from the nearest General Electric apparatus sales office.

When ordering, give a complete parts description or catalog number and also state the model number and serial number of the recorder. These numbers are stamped on the recorder's nameplate which is attached to the inside of the recorder door.

ACCESSORIES

MARKER-PEN ASSEMBLIES

Marker-pen assemblies are mounted on the ink shield on one or both sides to make marks on the margins of the recorder chart. (See Fig. 14.) The marker-pen assemblies are available for either 120-volt a-c or 6-volt d-c operation. They may be adapted for use at higher voltages by inserting resistors, of the proper rating, in series with the coil. The leads of the marker-pen assemblies are connected to the upper terminal block; the left-hand pen to terminals 11 and 12, and the right-hand pen to terminals 9 and 10. The marker-pen assemblies are supplied with their own factory-sealed inkwells.

All components, except the pen arms, are interchangeable for left-hand and right-hand installations.

Before operating the marker pens refer to the Preliminary Operation section below.

Installation of Marker Pens

If the marker pens are to be installed on a recorder in the field, follow the instructions (Dwg. No. K-5465853) furnished with the conversion kit.

Preliminary Operation

1. Remove shipping cap from inkwell and replace it with cap having opening for stem of marker pen.
2. Press inkwell into clamp all the way down until it "bottoms" on the ink shield.
3. Insert stem of marker pen in inkwell and engage tail of pen in "V"-shaped slot.
4. Start the pen inking. (See the procedure in the INKING THE PENS section, page 11.)

The following sections on the main pen also apply to the marker pens:

INKING THE PENS
INKS
CLEANING THE PENS

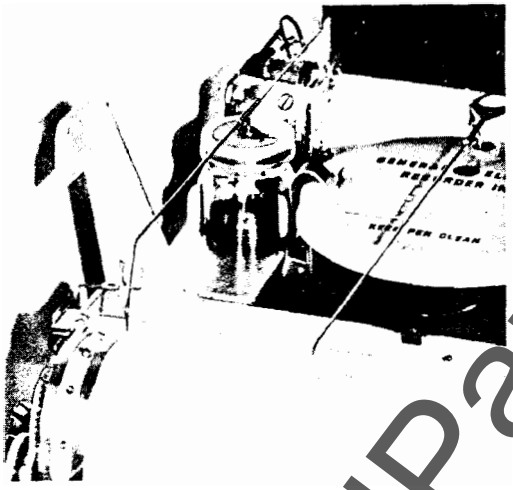


Fig. 14. Left-hand marker-pen assembly mounted in recorder (recorder scale removed)

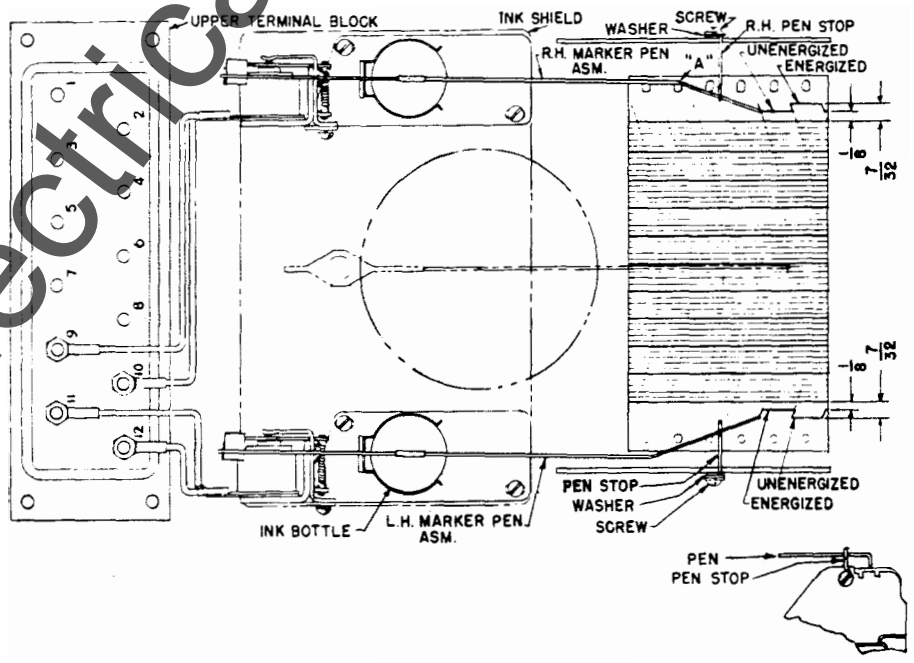


Fig. 15. Diagrammatic view showing left-hand and right-hand marker-pen assemblies

HEATERS

On some recorders the minimum temperature at which they will operate properly may be extended below -5 F by adding heaters and a thermostat (Fig. 16). The thermostat closes at approximately 35 F and opens at approximately 65 F. For further information on heaters for particular applications, contact the General Electric Co., 40 Federal St. W. Lynn, Massachusetts, specifying the model number and rating of the recorder.

Fig. 16. Heater thermostat (actual size)

CHART-CARRIAGE-DRIVE SHAFT EXTENSIONS

The chart carriage of an additional recorder, provided it does not have a chart-carriage motor, may be driven by connecting the two together with a shaft extension. The additional recorder may be placed on either the right or left.

To connect the two chart-carriages together, proceed as follows:

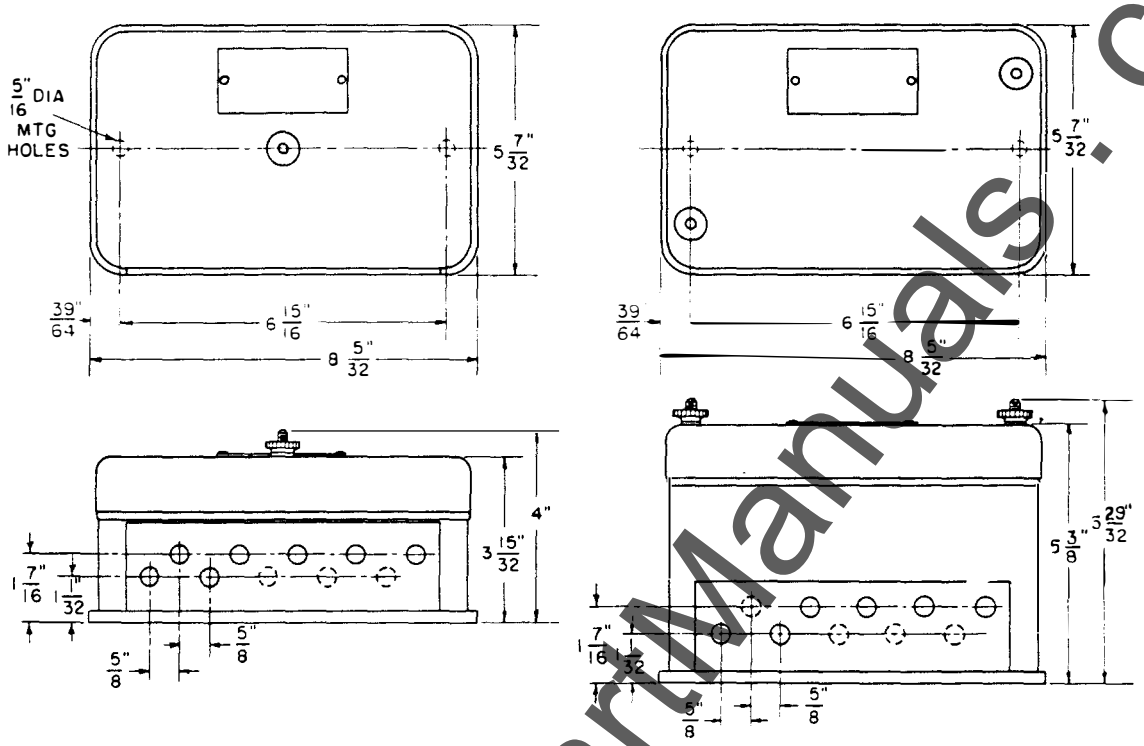
1. Remove the snap buttons from the adjoining sides of the recorders.

2. Slide a shaft-extension coupling through the hole in the side of the case and over the chart-carriage shaft on each recorder.

3. Insert the shaft extension into the couplings and tighten the setscrews in each coupling.

4. Rotate the chart drive until the pen indicates the correct time on the chart.

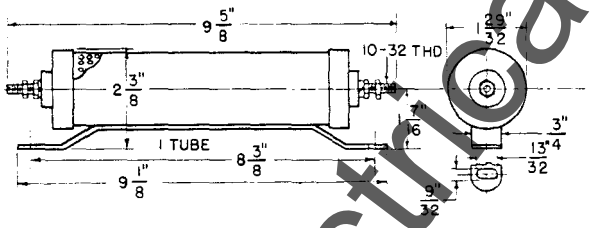
PHASE-SHIFTING TRANSFORMERS



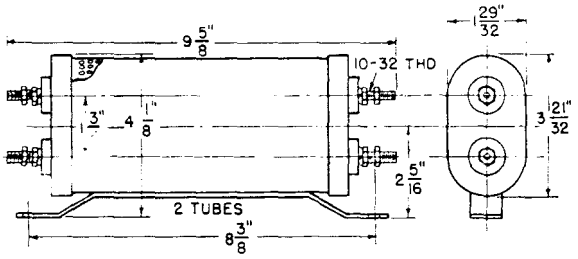
Type MC-22 ratings over 400 volts only

Fig. 17. Phase-shifting transformer used with varmeters

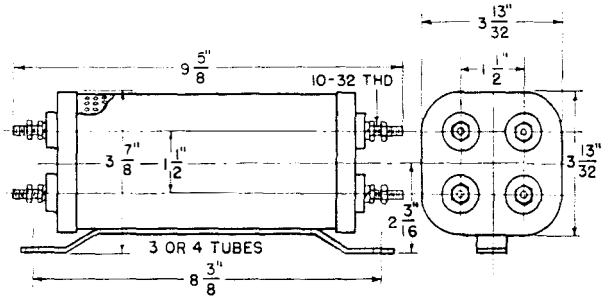
EXTERNAL RESISTORS



Single-tube, Form-3 resistor



Two-tube, Form-3 resistor



Four-tube, Form-3 resistor

Fig. 18. External resistors for switchboard instruments

SHUNTS FOR DIRECT-CURRENT AMMETERS

Form 15 Switchboard Type—50 Millivolt Drop

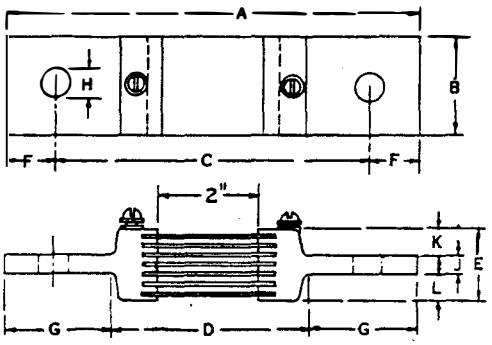


Fig. 19. 75- to 800-amp shunts

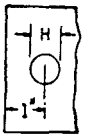


Fig. 20. (Otherwise same as Fig. 21)

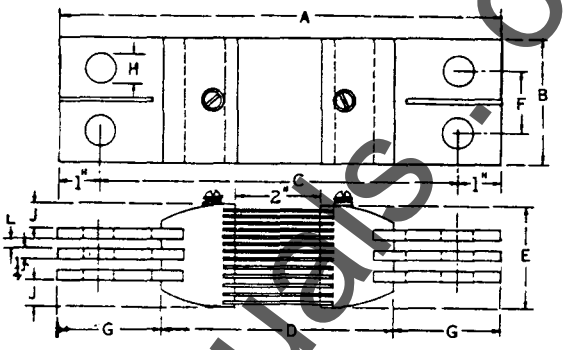


Fig. 21. 1000- to 3000-amp shunts

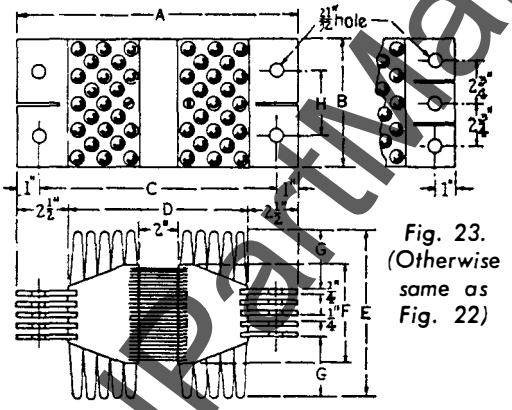


Fig. 23. (Otherwise same as Fig. 22)

Fig. 22. 4000- to 10,000-amp shunts

Amp	Fig. No.	DIMENSIONS IN INCHES											Con. Strips Each End
		A	B	C	D	E	F	G	H	J	K	L	
75	19	6¼	1⅛	5¼	3 11/16	½	½	1 9/32	13/32	¼	⅛	⅛	....
80	19	6¼	1⅛	5¼	3 11/16	½	½	1 9/32	13/32	¼	⅛	⅛	....
100	19	6¼	1⅛	5¼	3 11/16	½	½	1 9/32	13/32	¼	⅛	⅛	....
150	19	6¼	1½	5¼	3 11/16	11/16	¾	1 17/32	17/32	¼	7/32	7/32	....
200	19	6¼	1½	5¼	3 11/16	⅞	¾	1 17/32	17/32	¼	5/16	5/16	....
250	19	6¼	1½	5¼	3 11/16	1 1/16	¾	1 17/32	17/32	¼	13/32	13/32	....
300	19	6¼	1½	5¼	3 11/16	1¼	¾	1 17/32	17/32	¼	½	½	....
400	19	8¼	1½	6¼	3⅞	1 5/8	1	2 3/16	17/32	⅜	⅝	⅝	....
500	19	8¼	1⅞	6¼	3⅞	1 5/8	1	2 3/16	17/32	⅜	⅝	⅝	....
600	19	8¼	2	6¼	3⅞	1 13/16	1	2 3/16	21/32	⅜	23/32	23/32	....
800	19	8¼	2⅜	6¼	3⅞	2	1	2 3/16	21/32	⅜	13/16	13/16	....
1000	21	9¾	3	7¾	4¾	1 11/16		2½	21/32	13/32	....	¼	2
1200	21	10	3	8	5	2 1/16	1¾	2½	17/32	23/32	....	¼	2
1500	21	10	3	8	5	2 5/16	1¾	2½	17/32	17/32	....	¼	3
2000	21	10½	4	8½	5½	2 15/32	2½	2½	21/32	39/64	....	¼	3
2500	21	10½	4	8½	5½	2 15/16	2½	2½	21/32	17/32	....	¼	4
3000	21	11¼	4	9¼	6¼	3 9/16	2½	2½	21/32	29/32	....	¼	4
4000	22	11½	4	9½	6½	7	4 21/32	2⅜	2½	....	....	....	5
5000	22	11¾	5	9¾	6¾	7½	4½	2⅞	2½	....	....	....	5
6000	22	13¾	6	11¾	8¾	8	4 21/32	2⅞	3	....	....	....	5
8000	22	15¾	6	13¾	10¾	9½	6 7/32	3⅛	3	....	....	....	7
10000	22	17¼	8	15¼	12¼	10½	5¾	3⅝	....	....	....	....	7

Form 15 Switchboard Type—100 Millivolt Drop

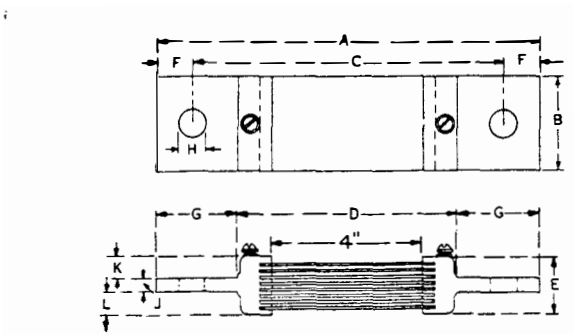


Fig. 24. 75-to 800-amp shunts

Fig. 25. (Otherwise same as Fig. 26)

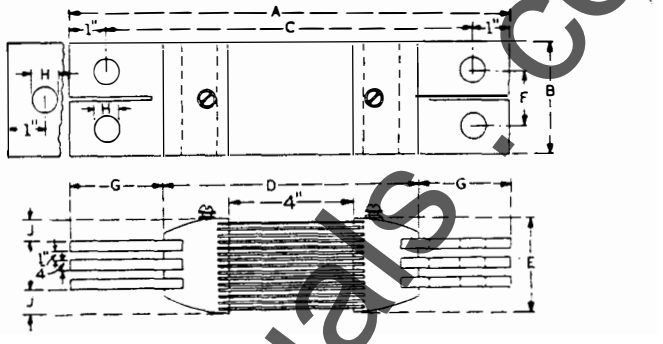


Fig. 26. 1000- to 3000-amp shunts

Amp	Fig. No.	DIMENSIONS IN INCHES										Con. Strips Each End
		A	B	C	D	E	F	G	H	J	K	L	
75	24	8¼	1⅛	7¼	5 11/16	½	½	1 3/32	13/32	¼	1/8	1/8	.
80	24	8¼	1¼	7¼	5 11/16	½	½	1 3/32	13/32	¼	1/8	1/8	.
100	24	8¼	1½	7¼	5 11/16	½	½	1 3/32	13/32	¼	1/8	1/8	.
150	24	8¾	1½	7¼	5 11/16	11/16	¾	1 3/32	17/32	¼	7/32	7/32	.
200	24	8¾	1½	7¼	5 11/16	⅞	¾	1 3/32	17/32	¼	5/16	5/16	.
250	24	8¾	1½	7¼	5 11/16	1 1/16	¾	1 3/32	17/32	¼	13/32	13/32	.
300	24	8¾	1½	7¼	5 11/16	1¼	¾	1 3/32	17/32	¼	½	½	.
400	24	10¼	1½	8¼	5⅞	1 5/8	1	2 3/16	17/32	⅜	5/8	5/8	.
500	24	10¼	1⅞	8¼	5⅞	1 5/8	1	2 3/16	17/32	⅜	5/8	5/8	.
600	24	10¼	2	8¼	5⅞	1 13/16	1	2 3/16	21/32	⅜	25/32	25/32	.
800	24	10¼	2⅜	8¼	5⅞	2	1	2 3/16	21/32	⅜	13/16	13/16	.
1000	26	11¾	3	9¾	6¾	1 1/16	. . .	2½	21/32	13/32	. . .	. . .	2
1200	26	12	3	10	7	2 5/16	1¾	2½	17/32	23/32	. . .	. . .	2
1500	26	12	3	10	7	2 5/16	1¾	2½	17/32	17/32	. . .	. . .	3
2000	26	12½	4	10½	7½	2 13/32	2½	2½	21/32	39/64	. . .	. . .	3
2500	26	12½	4	10½	7½	2 15/16	2½	2½	21/32	19/32	. . .	. . .	4
3000	27	13¼	4	11¼	8¼	3 9/16	2½	2½	21/32	29/32	. . .	. . .	4

Form 18 Shunts—50 and 100 Millivolt Drop

Amp	50- Millivolt			100- Millivolt		
	DIMENSIONS IN INCHES			DIMENSIONS IN INCHES		
	A	B	C	A	B	C
50	6¼	1 13/16	1½	8¼	1 13/16	1½
60	6¼	1 13/16	1½	8¼	1 13/16	1½
75	6¼	1 13/16	1½	8¼	1 13/16	1½
80	6¼	1 13/16	1½	8¼	1 13/16	1½
100	6¼	1 13/16	1¾	8¼	1 13/16	1½
150	6¾	2 5/32	2	8¾	2 5/32	2
200	6¾	2¼	2	8¾	2¼	2
250	6¾	2 11/32	2	8¾	2 11/32	2
300	6¾	2 7/16	2	8¾	2 7/16	2
400	8¼	2 15/16	2½	10¼	2 15/16	2½
500	8¼	2 15/16	2½	10¼	2 15/16	2½
600	8¼	3 1/32	3	10¼	3 1/32	3
800	8¼	3⅛	3	10¼	3⅛	3

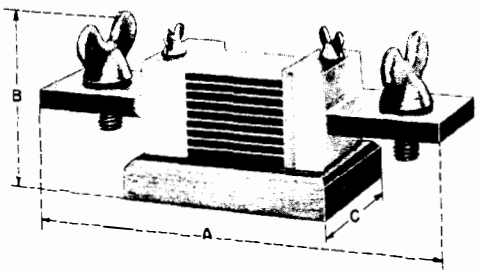


Fig. 27. Form 18 shunt

LIST OF CONNECTION DIAGRAMS

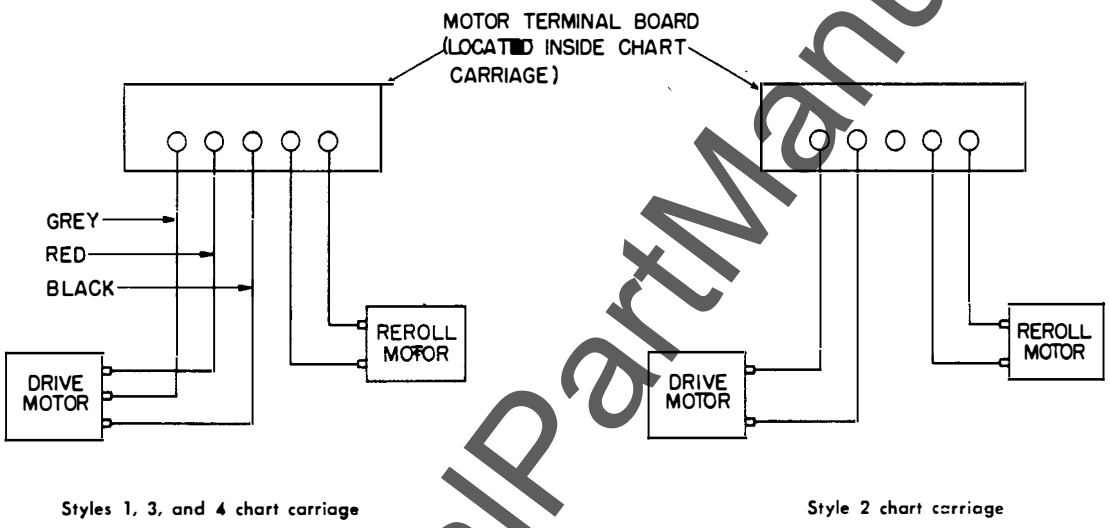
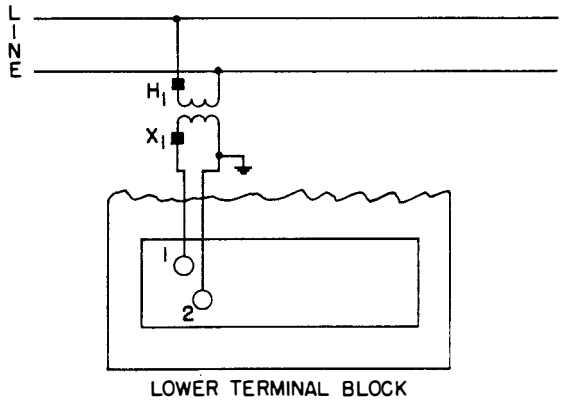


Fig. 28. Internal connections for chart-drive motor and reroll-drive motor



With potential transformer

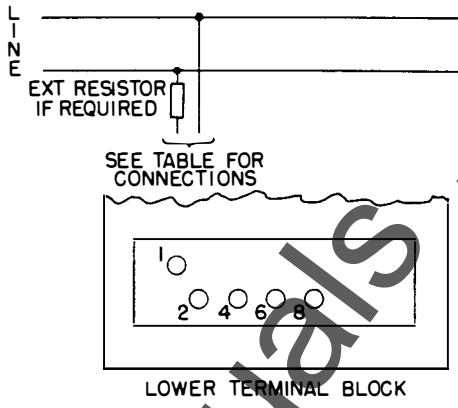


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	1 & 2
2ND	1 & 4
3RD	1 & 6
4TH	1 & 8

Self-contained

Fig. 29. External connections of a-c voltmeter

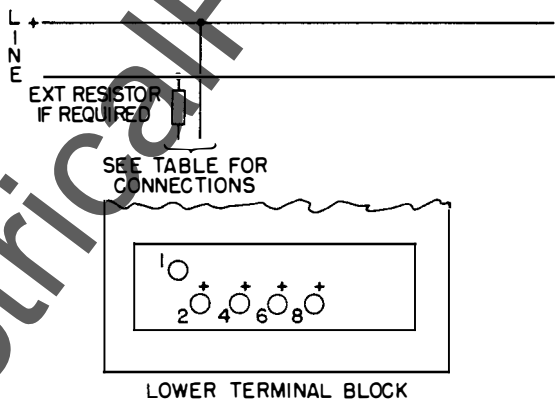
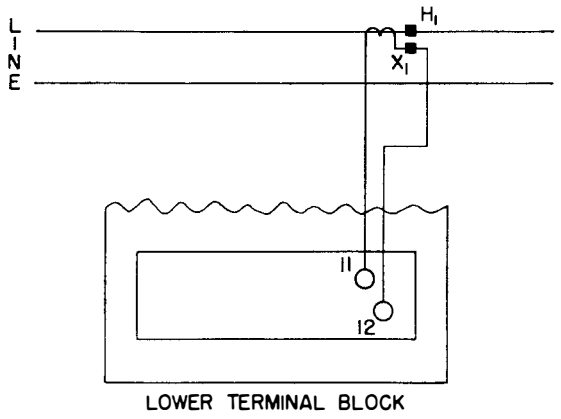


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	1 & 2
2ND	1 & 4
3RD	1 & 6
4TH	1 & 8

Fig. 30. External connections of d-c voltmeter



With current transformer

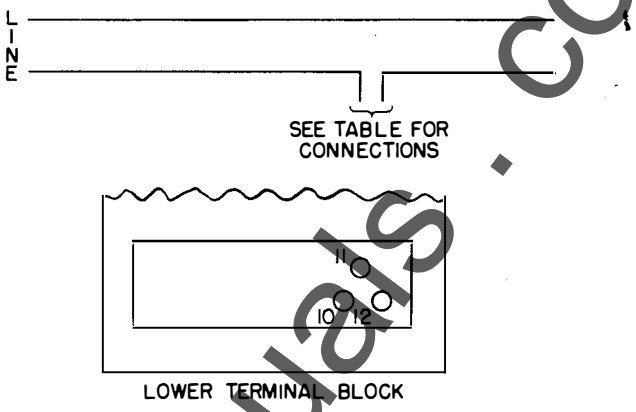


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	11 & 12
2ND	11 & 10

Self-contained

Fig. 31. External connections of a-c ammeter

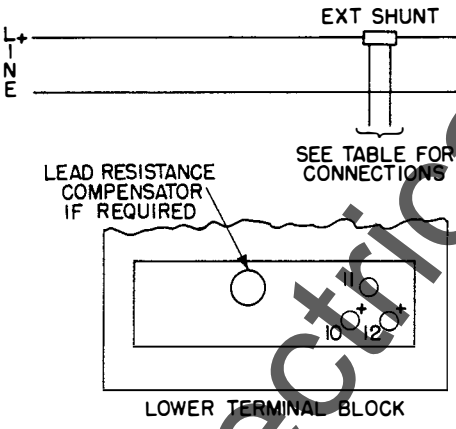


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	12 & 11
2 ND	10 & 11

With external shunt

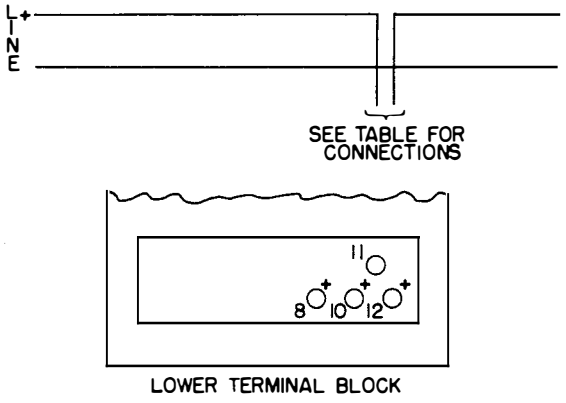
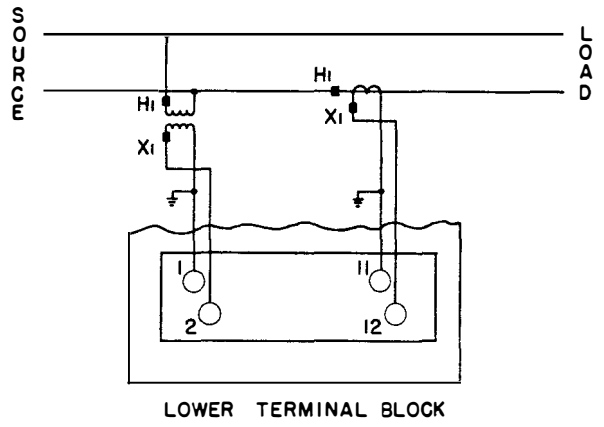


TABLE OF CONNECTIONS	
RATING	TERMINALS
SINGLE OR LOWEST	12 & 11
2 ND	10 & 11
3 RD	8 & 11

Self-contained

Fig. 32. External connections of d-c ammeter



With current and potential transformers

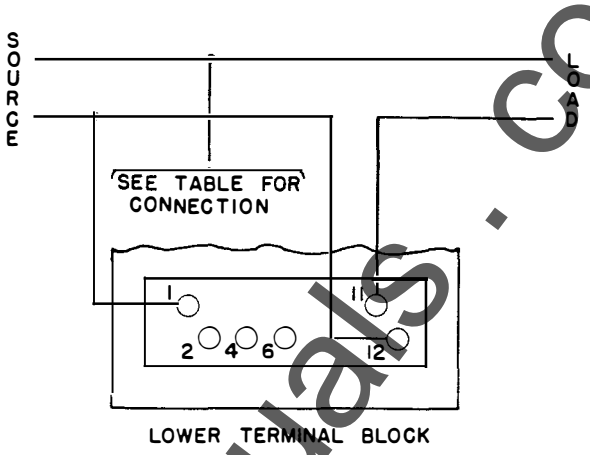
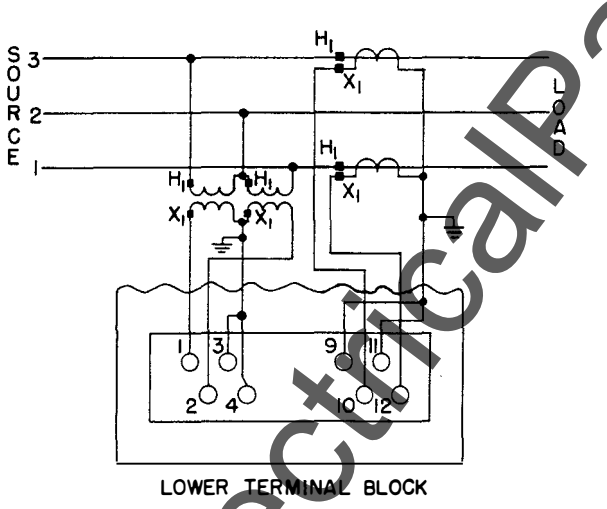


TABLE OF CONNECTIONS	
RATING	TERMINAL
SINGLE OR LOWEST	2
2ND	4
3RD	6

Self-contained

Fig. 33. External connections of single-phase wattmeter



With current and potential transformers

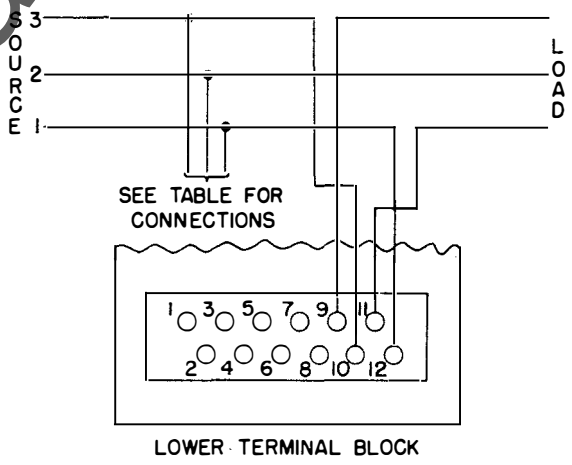


TABLE OF POTENTIAL CONNECTIONS				
RATING	LINE →	1	2	3
SINGLE OR LOWEST	TERMINAL	2	3 & 4	1
2ND	TERMINAL	2	5 & 6	1
3RD	TERMINAL	2	7 & 8	1

Self-contained

Fig. 34. External connections of polyphase wattmeter, 3-wire, 3-phase

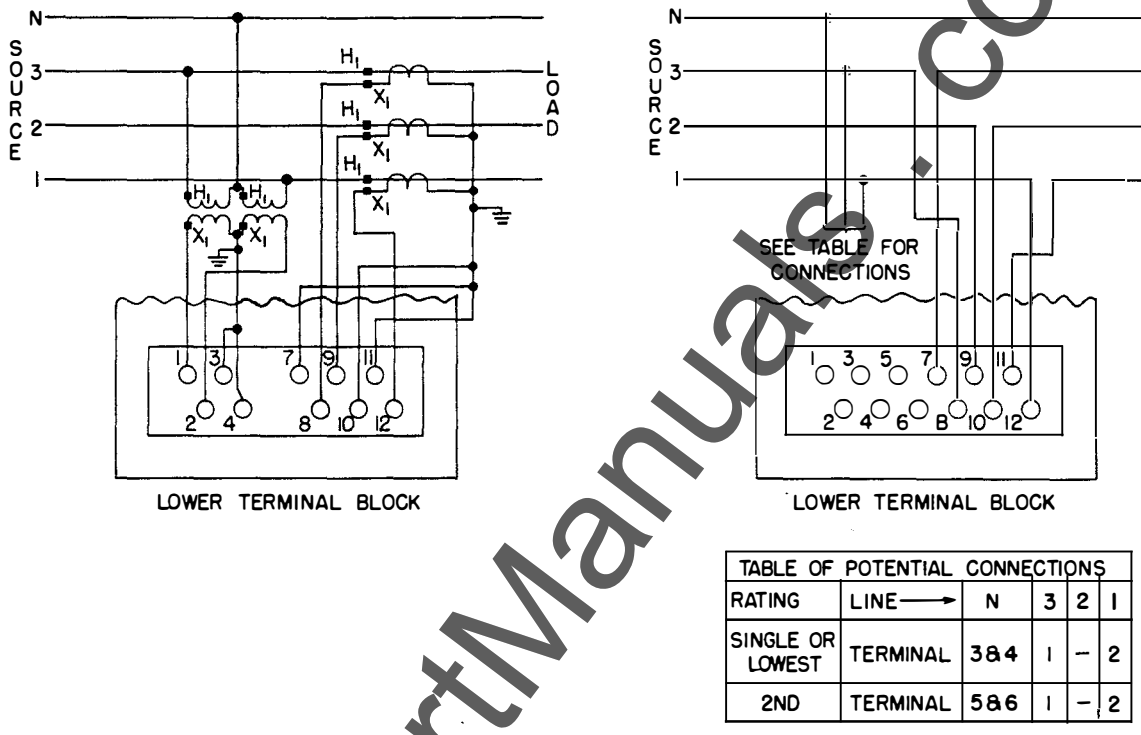


TABLE OF POTENTIAL CONNECTIONS					
RATING	LINE ⟶	N	3	2	1
SINGLE OR LOWEST	TERMINAL	3&4	1	–	2
2ND	TERMINAL	5&6	1	–	2

Fig. 35. External connections of polyphase wattmeter, 4-wire, 3-phase

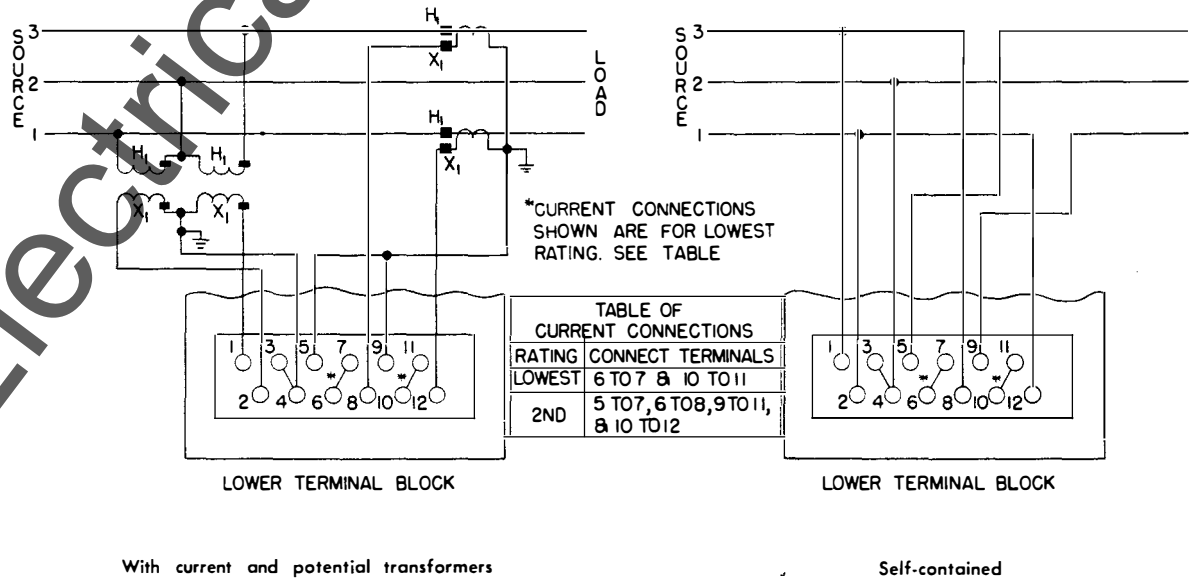


Fig. 36. External connections of universal wattmeter, 3-wire, 3-phase

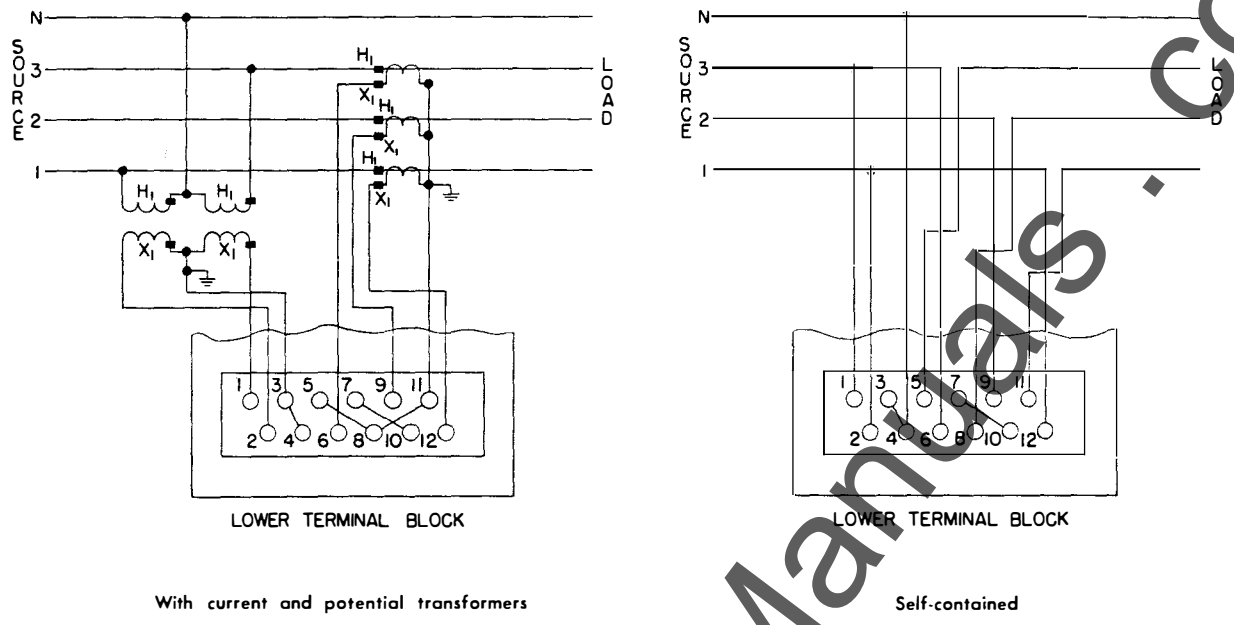


Fig. 37. External connections of universal wattmeter, 4-wire, 3-phase

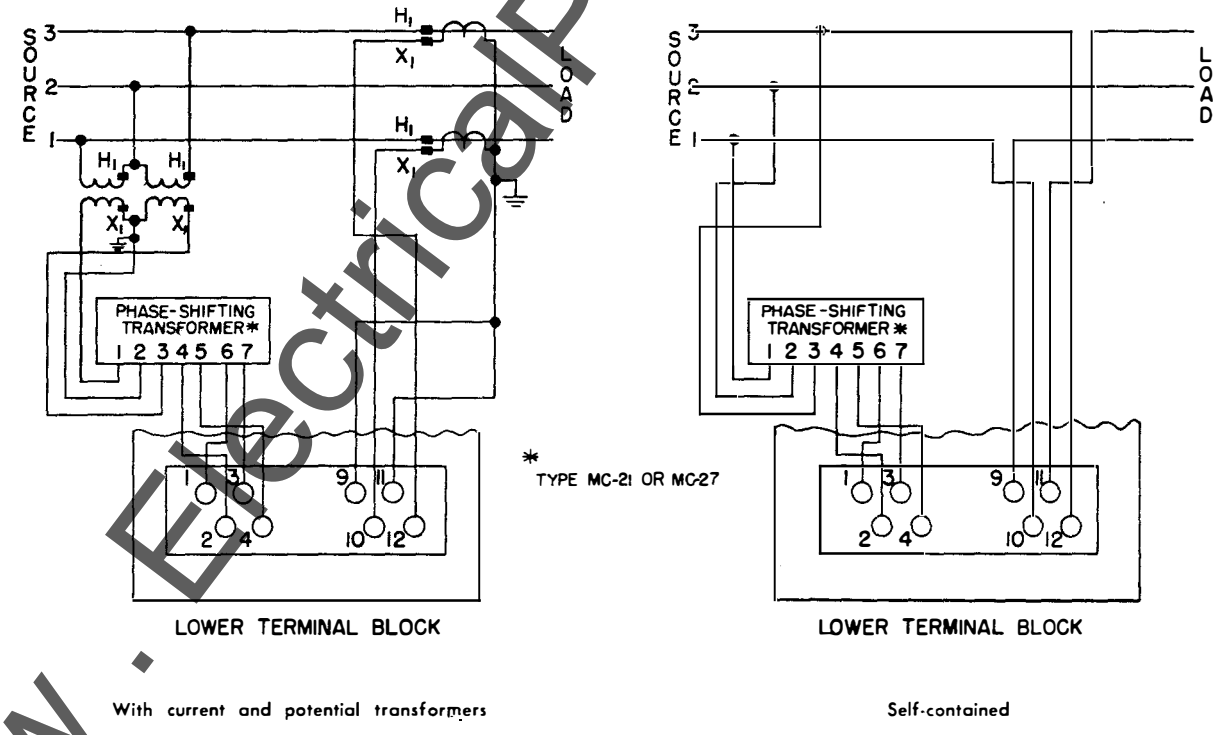


Fig. 38. External connections of polyphase varmeter, 3-wire, 3-phase

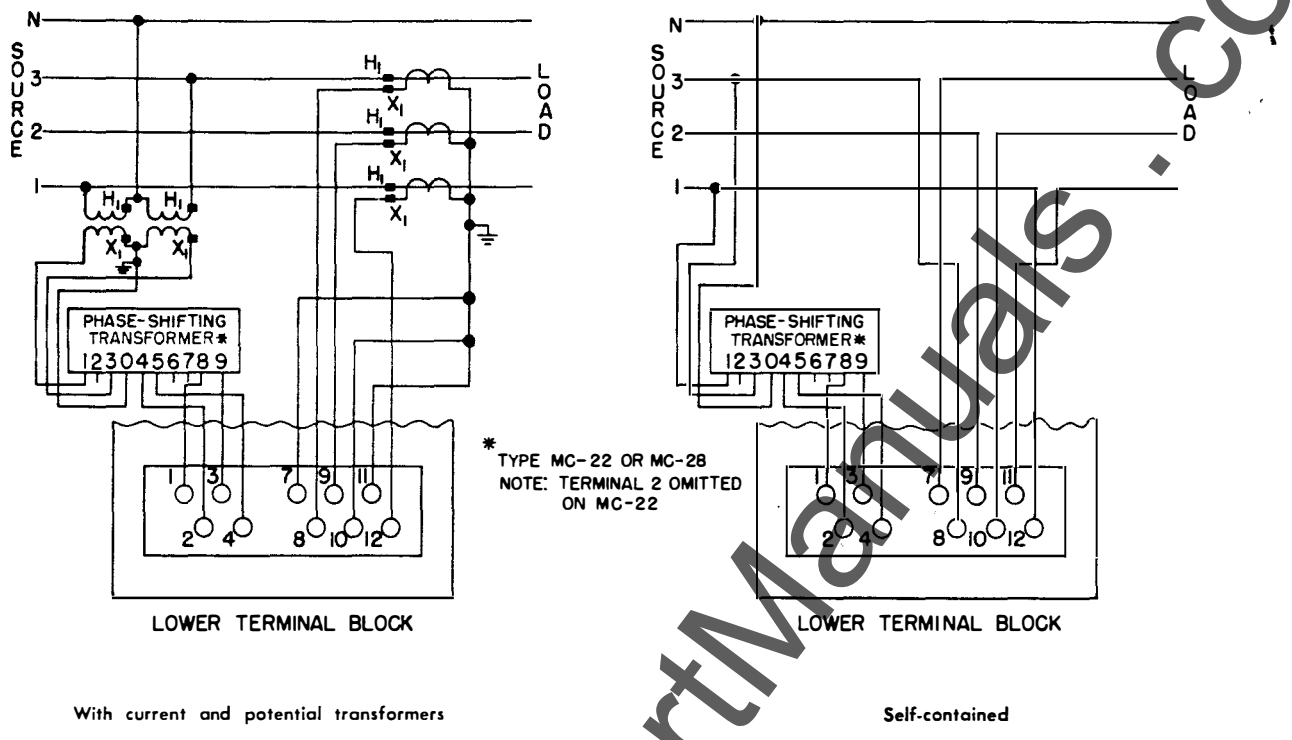


Fig. 39. External connections of polyphase varmeter, 4-wire, 3-phase

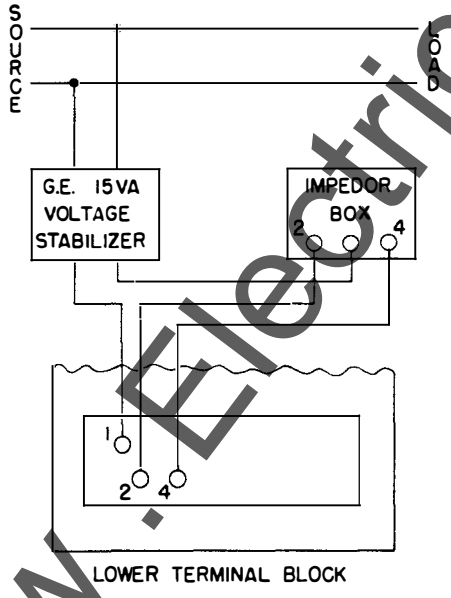


Fig. 40. External connections of 60-cps frequency meter

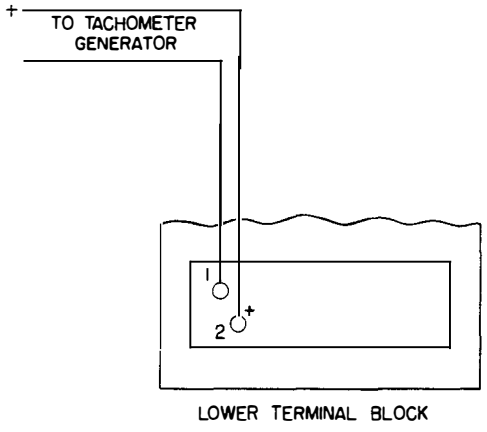


Fig. 41. External connections of d-c tachometer

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