American Railway Signaling Principles and Practices

CHAPTER XII

Semaphore Signals

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General

Historical.

About the year 1841, the semaphore type of signal was first designed and erected at New Cross, England, by Mr. C. H. Gregory, and proved to be a very important step in the development of railway signaling.

The first semaphore type signals were mechanically operated; first by levers or handles on the mast; later by wires; and by rods or pipes connected so the signal could be controlled from a remote point. Counterweights were added to the arm or spectacle to cause the signal to assume the Stop position by gravity.

The earlier types of semaphore signal were of the lower-quadrant type; the arms being displayed to the left of the mast in England and on the Continent where left-hand running is the practice; and to the right of the mast in America where right-hand running is used.

About the year 1903 the upper-quadrant semaphore type signal was introduced and is the type most generally used by American railroads.

This chapter will deal with the various types of semaphore signals, their construction, operation and maintenance.

Indications.

The day indications of semaphore signals are displayed by the position of the semaphore arm and the night indications by colored lights. The aspects and indications are explained in Chapter II.

Blades.

The blades are of wood or enameled steel and are usually red or yellow in color, the ends of the blades being either square, pointed, fishtail or round, depending on the purpose for which the signal is used. Details of standard signal blades are shown on R.S.A. 1065 and A.R.A. Sig. Sec. 1548.

Spectacles and roundels.

The spectacles used in upper-quadrant semaphore signals are shown on R.S.A. 1040, R.S.A. 1233 and A.R.A. Sig. Sec. 1041B. The blades are bolted to these spectacles, and colored glasses or roundels are placed in the openings provided for this purpose. The roundels are shown on Drawing 1414.

A minimum clearance of ¾ inch shall be maintained between the semaphore bearing and spectacle. See R.S.A. 1093.

Lamp and bracket.

The lamp for the night aspects is mounted on a bracket in such a position that the lens is immediately behind and in the center of a roundel in the spectacle. The bracket is shown on A.R.A. Sig. Sec. 1049A.

The lamps may be either oil or electric. Oil lamps are usually fitted with a long time burner and an oil fount with a capacity of 31 ounces. This amount of oil is sufficient for six days burning when a long time burner is used. A special grade of kerosene oil is used, known as "long time burning oil."

A lamp with long time burner and chimney is illustrated in Fig. 1.

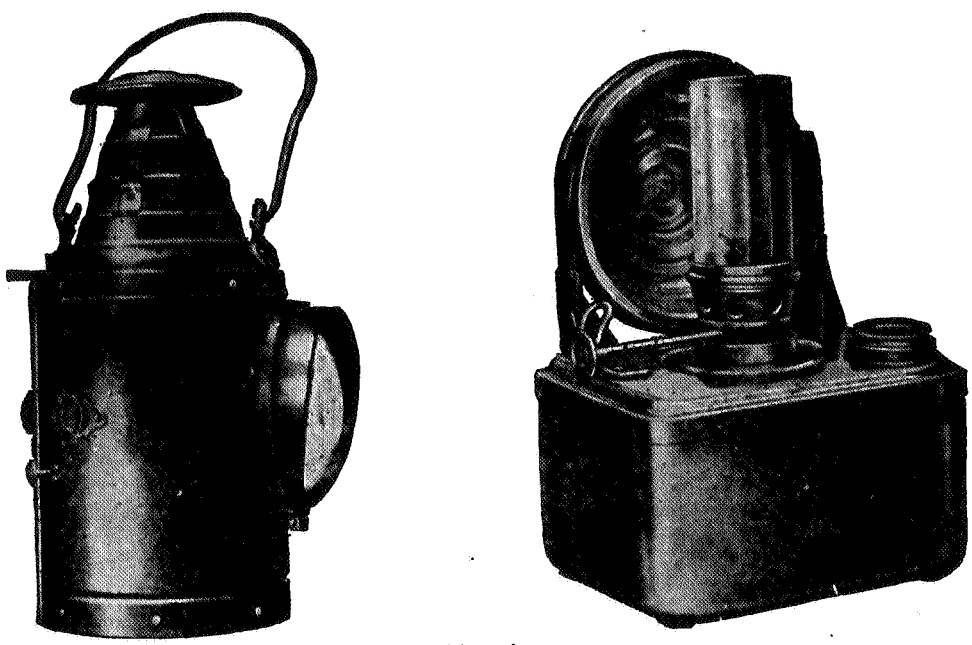


Fig. 1.
Oil Burning Semaphore Lamp and Parts.

Oil burning lamps are sometimes converted to electric lamps by removing the fount and burner and using in their place a socket and electric lamp, or by inserting a specially constructed reflector unit in place of the lens. A converted oil lamp is illustrated in Fig. 2.

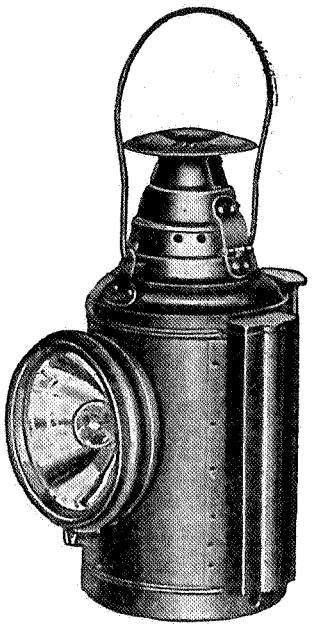


Fig. 2.
Oil Lamp Equipped for Electric Light.

A lamp case designed for electric light only is shown on A.R.A. Sig. Sec. 1563B.

The electric lamps generally used for lighting semaphore signals are shown on A.R.A. Sig. Sec. 1544B.

In some cases the special reflector unit previously mentioned is used in the lamp instead of the socket shown on the drawing.

The electric lamp used in semaphore signals is further described under "Lamps" in Chapter XIII—Light Signals.

A minimum clearance of one inch shall be maintained between the semaphore spectacle and the lamp. See R.S.A. 1093.

Mechanical Signals

Mechanically-operated semaphore signals consist of one arm, or more, supported by a bearing attached to a signal mast and operated, generally, by a rod connection consisting of sections of one-inch pipe extending from a crank attached to the base of the mast to a pin or stud on the semaphore casting or spectacle.

Details of one, two and three-arm upper-quadrant mechanical ground signals are shown on A.R.A. Sig. Sec. 1043B, A.R.A. Sig. Sec. 1044B and A.R.A. Sig. Sec. 1045B.

Dwarf Signals

Dwarf signals are used for movements against current of traffic, movements from sidings, at terminals and at locations where conditions make it impracticable to use high signals. They may be mechanically or power operated similar to high signals of the types described in this chapter.

Due to the low torque of dwarf signal spectacles, a spring attachment is provided in all types except pipe-connected, to return the spectacle to its most restrictive position.

Mechanical dwarf signals are shown on R.S.A. 1097 and A.R.A. Sig. Sec. 1545B.

Train Order Signals

Train order signals are used at stations or telegraph offices to indicate orders to trains when orders are held at that office for them.

Two spectacles and blades are mounted on one mast as shown on A.R.A. Sig. Sec. 1236B and a lamp with two lenses opposite to each other used for the night indication.

These signals are usually operated mechanically, being connected by pipe to two levers on or near the operator's desk, although some are operated electrically when the signal is located a remote distance from the control point.

A two-lever wall machine for operating train order signals is shown on R.S.A. 1197.

Electro-Mechanical Slotted Signals

Mechanically-operated signals are sometimes controlled by track circuits by introducing an electro-mechanical slot between the semaphore spectacle and the crank at the base of the mast. One type of slot consists of an electromagnet which, when energized, causes a latch to engage with the portion of the rod connected with the semaphore spectacle and thus forms a mechanical connection between the spectacle and the crank. The circuit for the slot magnet is controlled through contacts on the track relay, or relays, in the block through which the signal governs train movements, and when the circuit is open, due to a train entering the block, the semaphore arm assumes

the Stop position by gravity. A cushioning device is generally introduced to check the force with which semaphore arms assume the Stop position. An electro-mechanical slot is illustrated in Fig. 3.

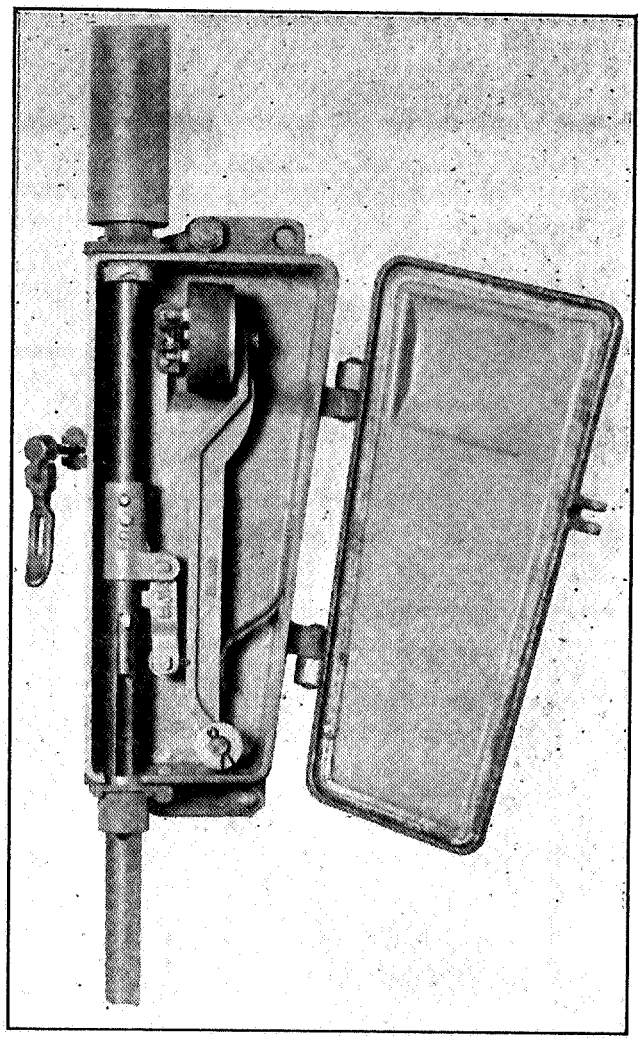


Fig. 3.
Electro-Mechanical Slot.

Power-Operated Signals

Electro-pneumatic.

Electro-pneumatic signals are operated by compressed air controlled by electrically-operated valves and are used mostly in connection with electro-pneumatic interlockings, although they are sometimes used for other than interlocking purposes.

Compressed air is admitted to the operating cylinder by means of a pin valve operated by an electromagnet. Motion is transmitted

from the piston to the semaphore arm, and a circuit controller attached to the mechanism is used to open or close circuits as desired.

Figure 4 illustrates in cross-section the general arrangement of admitting compressed air to the cylinder. When the electromagnet is energized the armature is attracted to the magnet closing exhaust valve and opening pin valve, permitting air to flow from air supply

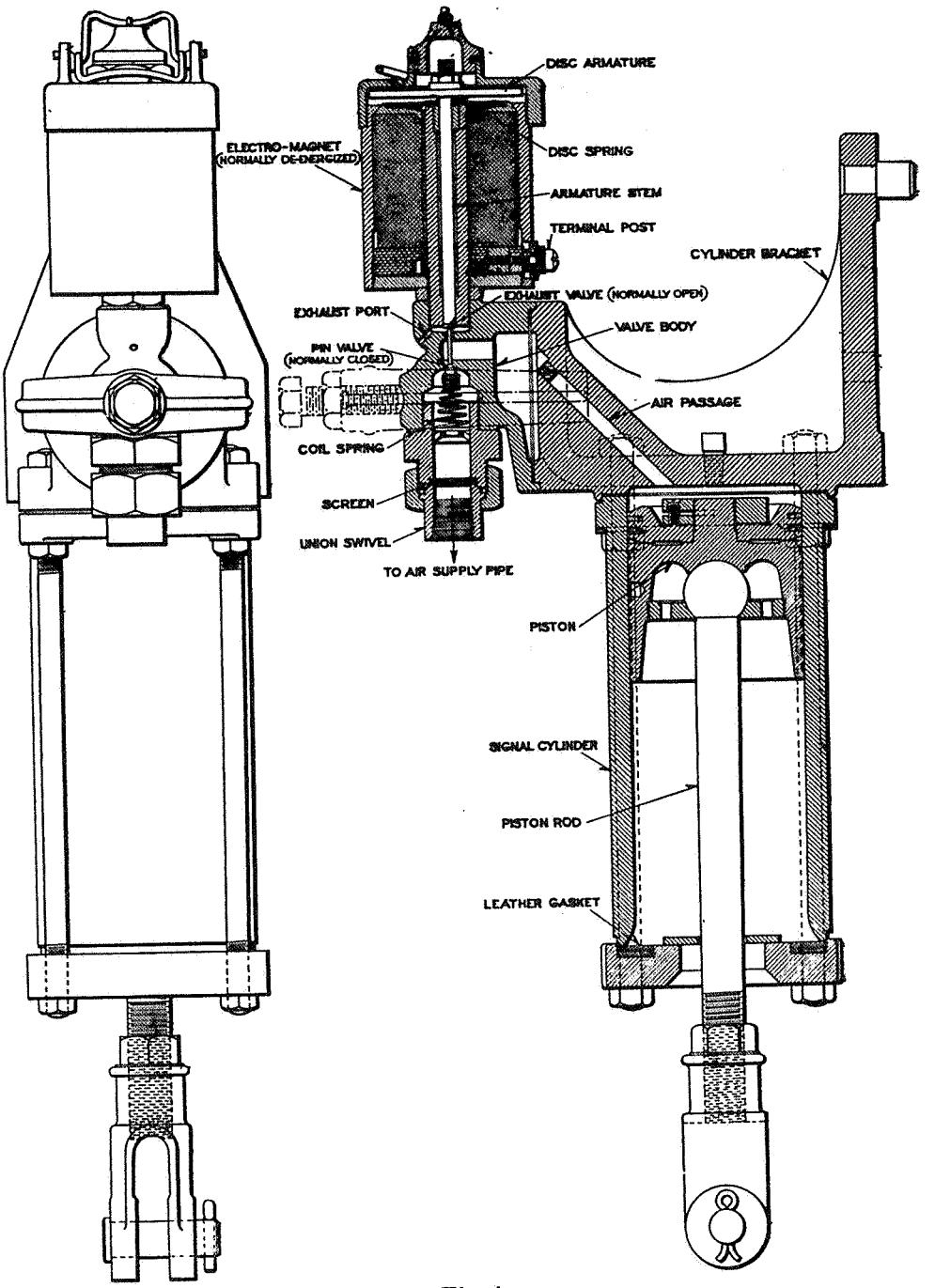


Fig. 4.
Electro-Pneumatic Signal Magnet and Cylinder.

pipe, through pin valve, to air passage to top of piston in cylinder, forcing piston down and causing the signal to clear by moving the necessary cranks and connections.

When the control circuit is opened, the armature assumes its de-energized position, closing pin valve which shuts off the air supply and at the same time opens the exhaust valve, permitting the air in the cylinder to exhaust to atmosphere through the exhaust port. As the pressure is released from the piston the signal arm returns to Stop position by gravity, forcing the piston back in the cylinder to the position shown in Fig. 4.

Various types of mechanisms are in use, being divided into two general classes: base of mast and top of mast.

A base-of-mast mechanism is shown in Fig. 5, which illustrates what is known as a rack and pinion type. Connection from the air line is made to the right-hand magnet and when this magnet is energized it forces the piston in right-hand cylinder down. This moves the right-hand rack down causing the pinion or cogged wheel in the center to turn which pulls the up-and-down rod connected thereto down, causing signal arm to move to the 45 degree position. When the left-hand magnet is energized, air is admitted to the left-hand cylinder forcing its piston down, which also moves the rack connected thereto, causing the signal arm to go to the 90 degree position.

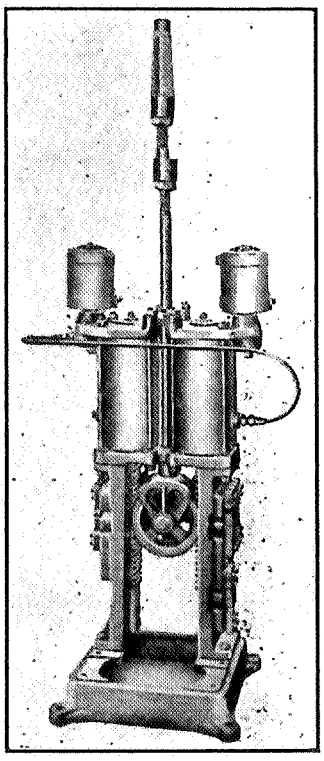


Fig. 5.
Electro-Pneumatic Base-of-Mast Mechanism.

Attention is called to the air tap connected to the left-hand cylinder. It will be seen that this cylinder cannot obtain an air supply unless the right-hand magnet is energized, which means that the signal must return to Stop position should the 45 degree magnet become de-energized regardless of whether or not the 90 degree magnet remained energized. This feature can be taken care of by controlling the circuit to the 90 degree position through the circuit controller operated by the 45 degree cylinder, but is by far more desirable to control the air for the 90 degree through the 45 degree magnet.

Circuit controllers can be seen on the right and left of the mechanism in Fig. 5, connected to the two racks. Circuits are controlled through these in the positions desired, being operated as the racks move from one position to the other.

Figure 6 illustrates a top-of-mast mechanism which, while more compact, operates along the same lines as previously mentioned. The two magnets are shown to the left with the cylinders on the right, the pistons of which are connected directly to the semaphore shaft through a small crank. The circuit controller may be seen, being connected directly to the semaphore shaft.

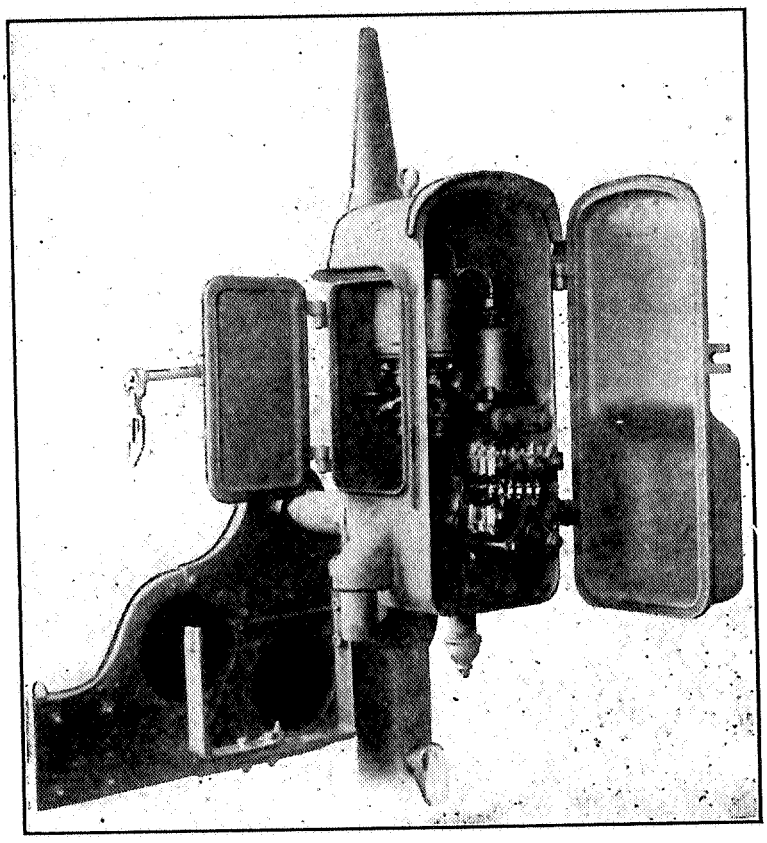


Fig. 6.
Electro-Pneumatic Top-of-Mast Mechanism.

Any of these mechanisms can be used as a two or three-position signal, the two-position being zero to 45 degrees or zero to 90 degrees. When used as two-position zero to 45 degrees, only one magnet is used: *i.e.*, right hand in Fig. 5 or one nearest front of case in Fig. 6. When used as two-position zero to 90 degrees, both magnets are connected in multiple. The three-position signal is arranged as already described.

Electro-gas.

The electro-gas signal is operated by means of carbonic acid gas stored under pressure and was used to quite some extent before the electric semaphore signal was developed.

Gas was admitted to a cylinder which operated the signal arm by means of a valve controlled by an electromagnet similar to that used in the electro-pneumatic signal. Gas was provided in tanks at a pressure of 600 to 1200 pounds per square inch and reduced for use to between 40 and 60 pounds by a pressure reducing valve.

Electric motor.

The early types of motor-driven semaphore signals consisted of a motor, usually operated on 10 volts, which drove the semaphore arm through a train of gears; the connection between the gears and the

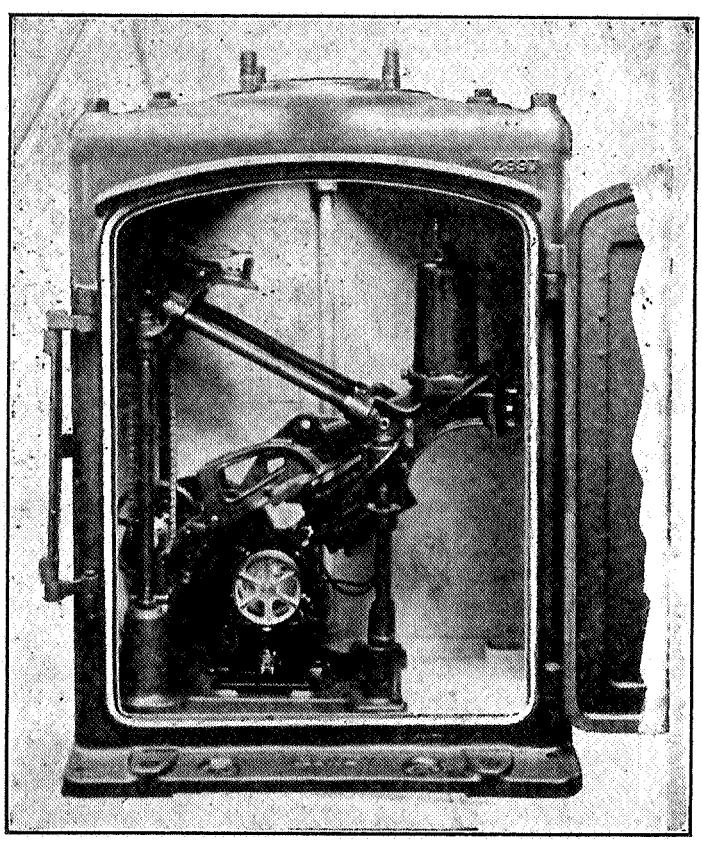


Fig. 7.
Electric Motor Signal, Base-of-Mast Mechanism.

semaphore being by means of an electromagnet which, when energized, engaged a latch. These types of mechanisms are mounted in a case at the base of the mast, and the motion transmitted to the semaphore arm by means of a rod passing upward through the mast. This type is known as a base-of-mast mechanism, one of which is illustrated in Fig. 7.

One, two or three arms may be operated by one motor by the application of an electromagnet or slot-arm for each arm to be operated.

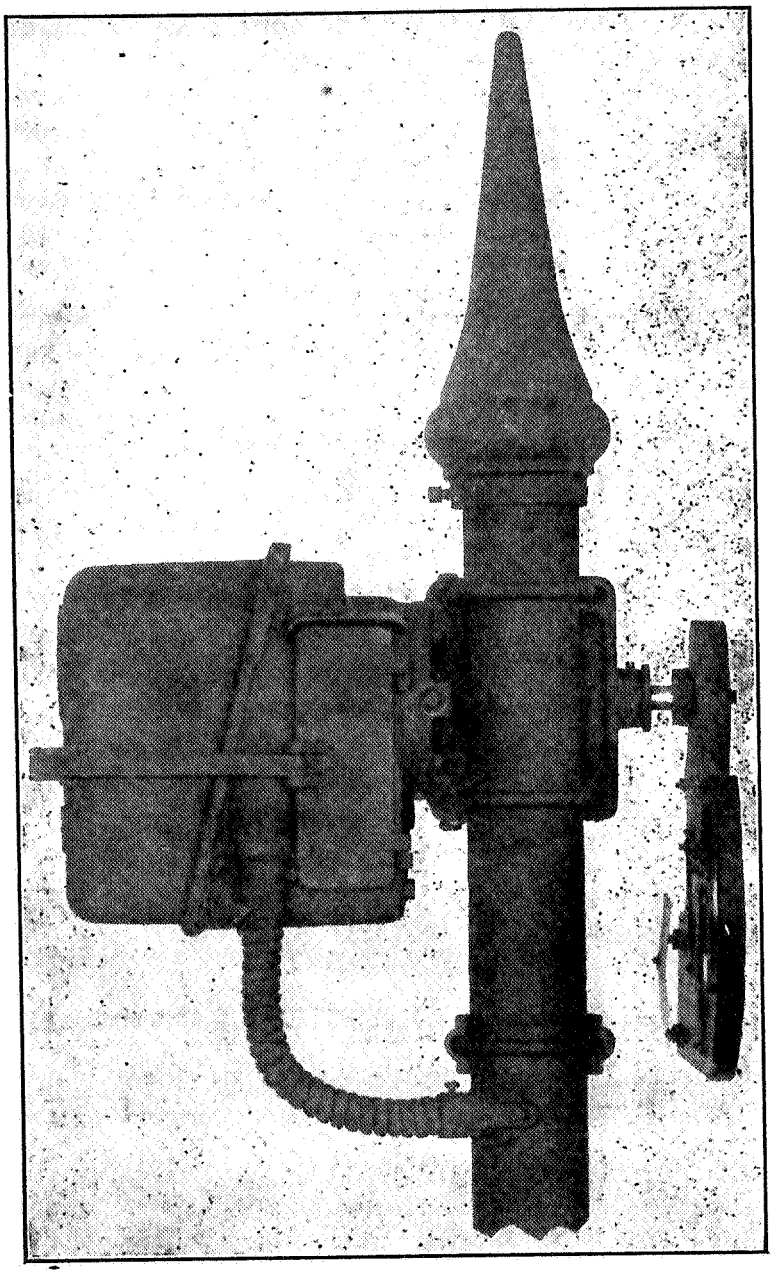


Fig. 8.
Electric Motor Signal, Top-of-Mast Mechanism.

As the use of electric motor semaphore signals became more extensive there was developed a type of mechanism which was self-contained in a case containing the semaphore shaft and operating mechanism, and which could be clamped to the side of a signal mast. This type is known as a top-of-mast mechanism, one of which is illustrated in Fig. 8.

This mechanism has the advantage of being readily clamped to an existing signal mast, and has a direct connection between the mechanism and the spectacle.

Mechanisms of the base-of-mast and top-of-mast types are made to operate on either direct or alternating current with slight altera-

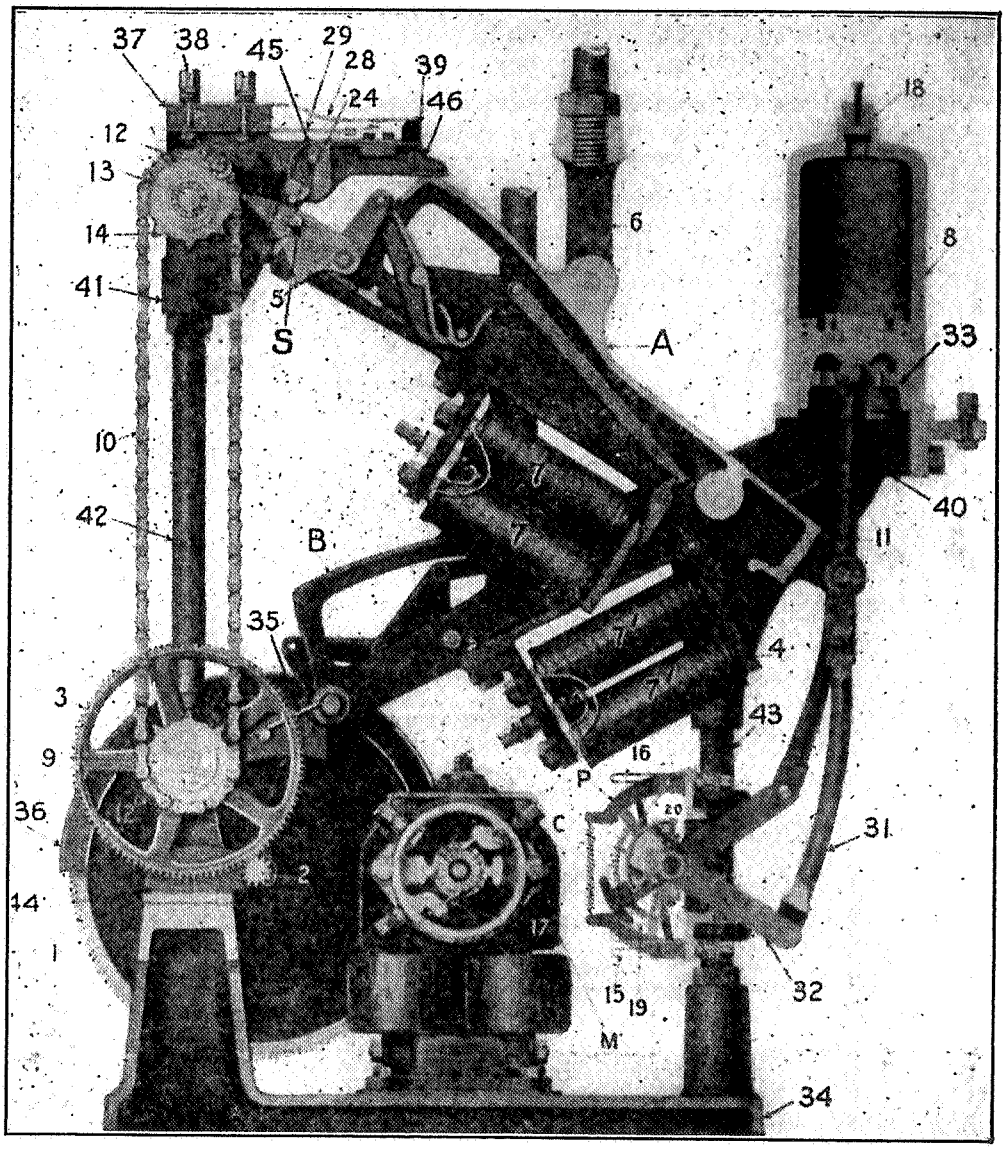


Fig. 9.
Section View of Two-Arm Two-Position Style B Base-of-Mast Mechanism.

tions, the principal difference being in the motor and slot-arm or holding magnets.

The motors used on signals for direct current operation are usually series-connected; that is, their field coils and armatures are connected in series on account of the load which the motor carries being constant. For alternating current operation, an induction type motor which has no commutator or brushes is used.

Types of Mechanisms

Style B.

The Style B mechanism is illustrated in Fig. 9.

The operation of a two-arm two-position Style B mechanism is as follows: with the signal in the Stop position and current applied to the home signal, slot coil 7 and motor M (see Fig. 9) in multiple, the motor revolves the gear 3 by means of the large gear 1 and pinion 2.

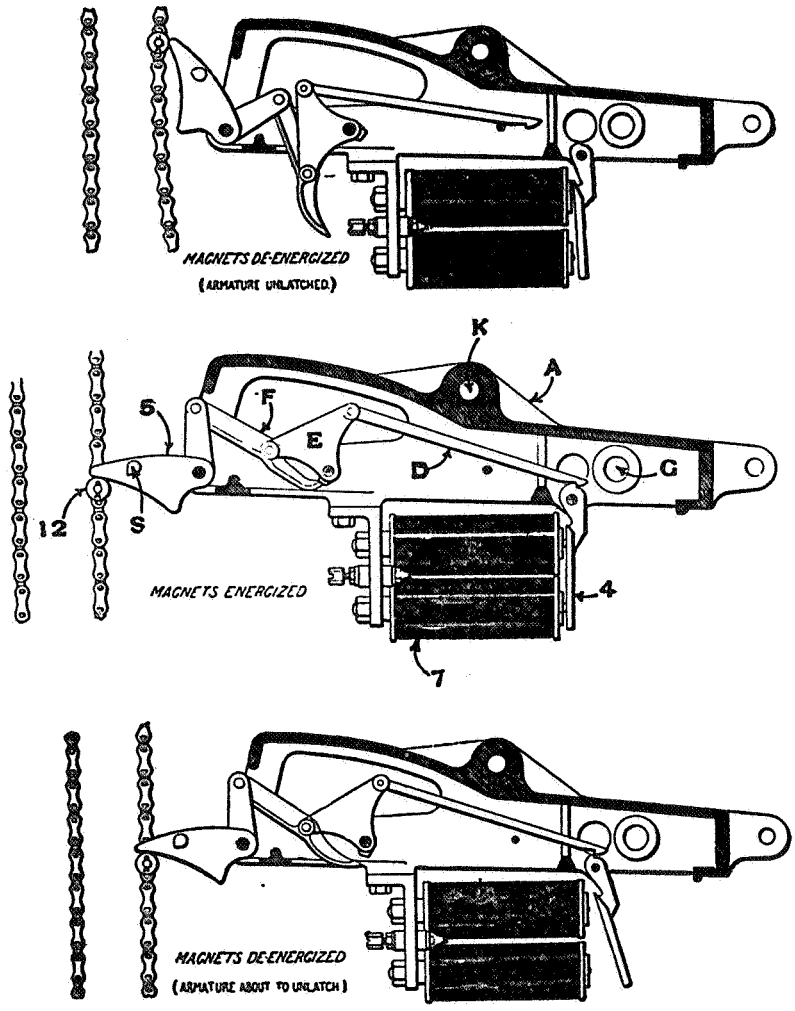


Fig. 10.
Section through Slot-Arm of Style B Mechanism, Showing Successive Positions.

This causes the trunnion 12 on chain 10 to engage the prongs of the fork head 5, and move the slot-arm about G (see Fig. 10) as a center. This clears the signal which is operated by an up-and-down rod attached at K by jaw 6. When the slot-arm has reached the position shown at A (Fig. 9) the lugs S on the fork head 5 engage hooks on the pawl 24 (shown dotted in Fig. 9). This supports the arm in the Clear position. In assuming this position, the top of slot-arm strikes against the lever 46. This causes the insulated block 39 to raise contact spring 28 off contact spring 29, thereby opening the motor circuit and stopping the motor. It also closes the contact spring through which the distant signal is controlled. In order that pawl 24 shall be certain to engage lugs S, a spring 45 is fastened to lever 46. Its lower end bears on pawl 24 so that the raising of lever 46 by the slot-arm puts tension on the spring and forces pawl 24 into engagement with the lugs S. When the slot magnet is de-energized the armature 4 falls away by gravity. This releases latch D, permitting link F and fork head 5 to assume the de-energized positions shown in Fig. 10. This allows the signal to go to the Stop position. A dashpot 8 provides an air cushion to absorb the shock incident to the return of the signal to its normal position. Fork head spring 35 restores the fork head to its normal position after the slot-arm has passed the trunnion of pawl when returning to the Stop position. One feature of this signal is the arrangement of the parts whereby the slot armature 4 moves both to and away from the pole pieces by gravity. The distant slot 7^1 clears the distant signal in exactly the same way as the home signal was cleared, except that it has two windings, one high and one low. The low-resistance winding is generally of 0.1 ohm resistance and is connected in series with the motor so as to provide sufficient holding power while driving the signal to the Clear position. Being in series with the motor, it is cut out when the signal reaches the Clear position. The high resistance winding is generally of 1000 ohms resistance and is used for holding the signal in the Clear position. Connecting link 31 is used to actuate a pole changer P or circuit controller C for the control of outside circuits. Mechanisms of this type for operating one arm only are furnished with one slot-arm, sprocket, chain and dashpot.

When polarized control circuits are used it is necessary to make the home slot magnet slow-acting due to the slot battery being interrupted on the home slot-arm at the time of polarity reversal of the control relay. The slow release on the home slot magnet is accomplished by means of a copper sleeve over the core of the magnet inside the coil. This acts as a short-circuited winding of large current capacity, which induces sufficient magnetism in the core to keep it energized a short time after the current has been cut from the coils on account of the current induced in it when the holding circuit is broken.

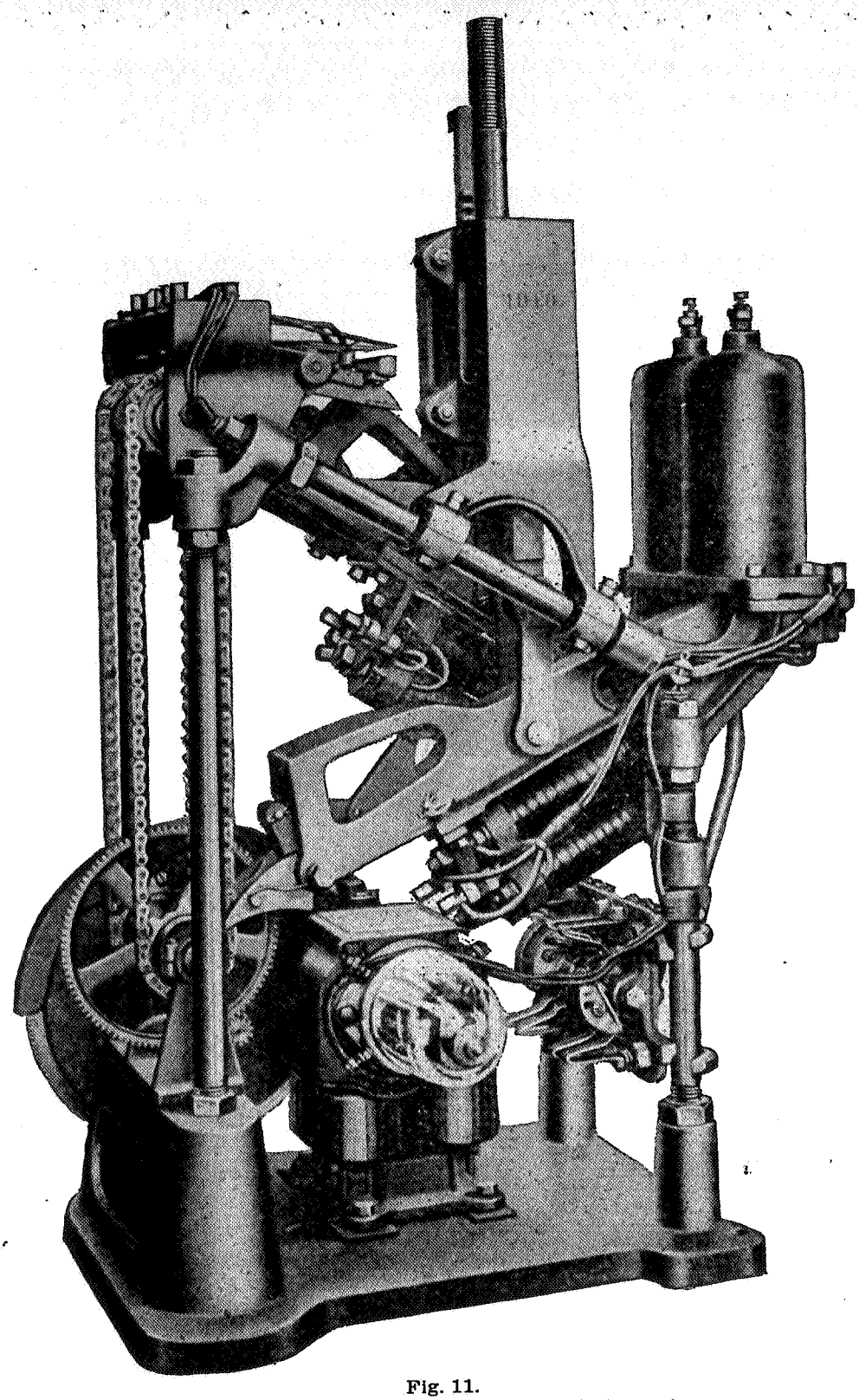


Fig. 11.
One-Arm Three-Position Style B Signal Mechanism.

Figure 11 illustrates mechanism equipped to operate a single-arm three-position signal. The up-and-down rod terminates in a jaw carrying a pinion. This pinion engages on each side with a rack operated by each slot-arm. The pinion and two racks are enclosed in a case clamped to the frame of the mechanism. Thus, when one slot-arm is raised its rack revolves the pinion which travels upward on the other rack. This raises the semaphore arm to the intermediate position. Raising of the second slot-arm causes the pinion to travel up the first rack and completes the stroke of the semaphore arm. The buffer functions in the same manner as the air buffer described under Style S mechanism.

The motor of the Style B signal is illustrated in Fig. 12. Its brake is controlled by the field magnet and prevents the motor running free after current is cut off. The commutator is enclosed in a glass case to keep it free from dust and prevent formation of frost.

The Style B mechanism is made to operate on alternating or direct current.

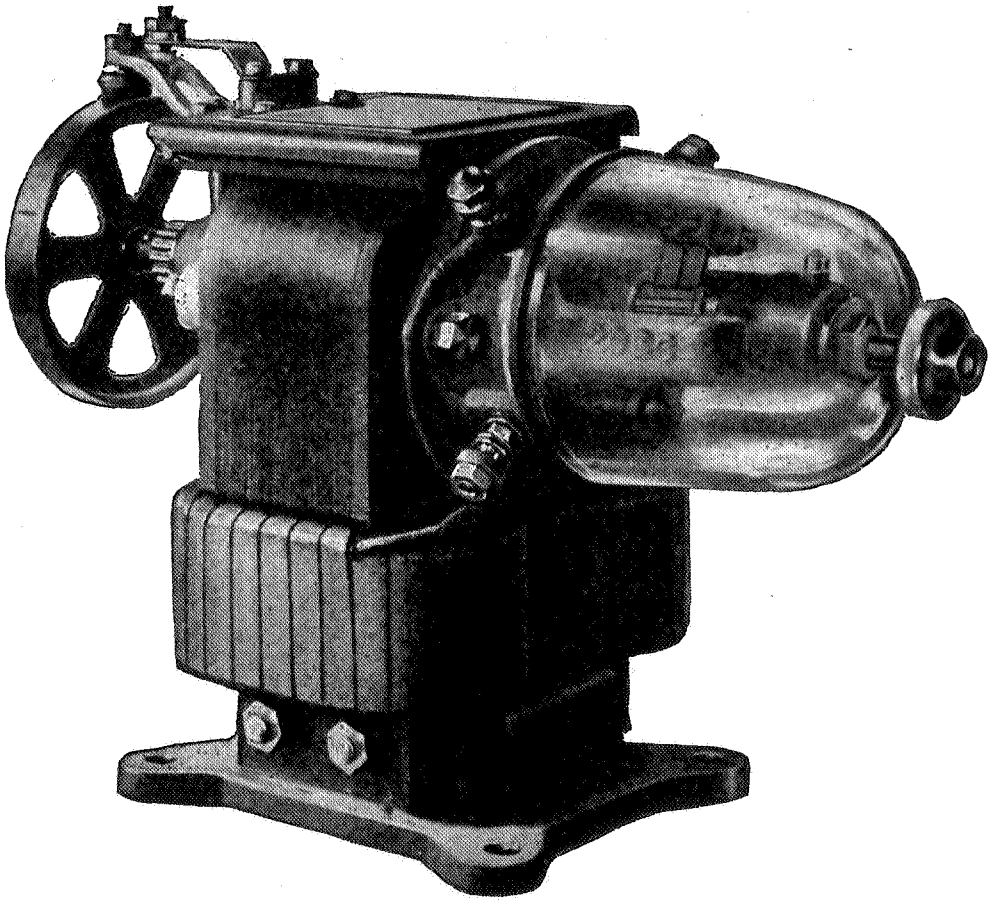


Fig. 12.
Direct Current Motor for Style B Mechanism.

Style S.

The Style S mechanism is a development of the Style B mechanism to meet the requirements of the three-position signal, and is made to operate on direct or alternating current, shaded pole slot magnets and induction motor being used on the alternating current mechanism.

In the Style S three-position signal but one slot-arm with its transmission parts is employed for the operation of each semaphore arm. An air buffer is pivoted to the frame immediately below the point on the slot-arm to which the vertical signal rod is attached.

The upper end of the buffer piston rod and the lower end of the signal rod are fitted with jaws and connect to the slot-arm with one common pin in the same manner as the well-known wide and narrow jaws are connected to a crank in mechanical interlocking practice. This method transmits the shock of the signal arm when returning to Stop position directly to the buffer.

The early mechanisms of this type were equipped with an oil buffer as illustrated in Fig. 13.

A vent V shown in Fig. 13 allows oil to pass upward through the piston rod past the head on the downward or buffing stroke, while on the up stroke the plate P falls away from the lower surface of the piston head and allows the oil to pass through the by-pass shown. On the down stroke the pressure of the oil forces P against the piston ahead and stops the flow of oil through the by-pass. The vent V

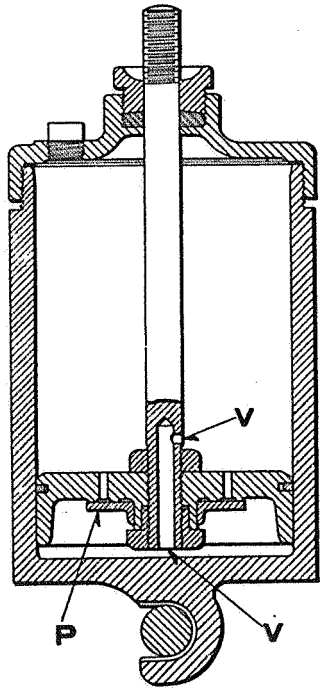


Fig. 13.
Oil Buffer, Style S Mechanism.

is made large to minimize the possibility of blocking it with dirt or foreign matter in the oil.

A special non-freezing oil is used in the buffer.

Later types of this mechanism are equipped with air buffers as illustrated in Fig. 14.

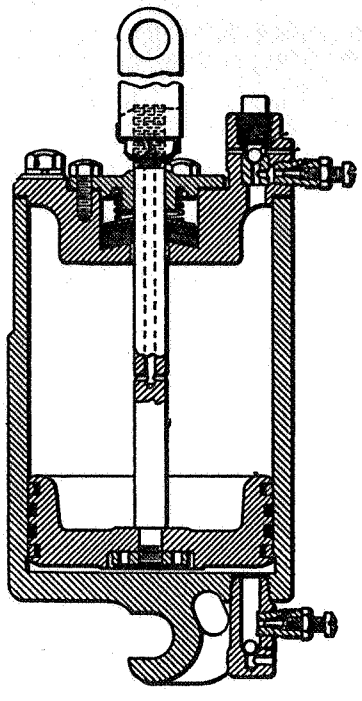


Fig. 14.
Air Buffer, Style S Mechanism.

This buffer cushions the signal by vacuum as well as compression. The return of the signal from the 90 to the 45 degree position is accomplished almost entirely by the vacuum created in the top position of the cylinder during the first half of the downward stroke of the piston.

The movement from the 45 to the zero degree position is cushioned by the compression created in the bottom portion of the cylinder during the second half of the downward stroke of the piston.

The main circuit controller to which a pole changer can be applied when required, is located to the right and above the slot-arm, thus providing space for two relays in each mechanism case and keeping the controller contacts out of the way of oil and dirt.

The base of the controller is made of porcelain dipped in black insulating varnish. By this means all hidden insulations liable to be charred by lightning, such as bushings and washers, are dispensed with. The controller is equipped with non-turning binding posts and otherwise is designed to comply with Signal Section, A.R.A., requirements.

The circuits for the intermediate or 45 degree position of the arm pass through this controller, which also serves as a main terminal board for the mechanism. Additional circuit controllers are carried on the left-hand upper corner of the mechanism and operated directly by the slot-arm.

The slot-arm is identical in design and principle with that used on the Style B except that the fork head or lifting crank has three prongs.

Two chains are employed, the center lines of which are tangential to the arc described by the slot-arm. The lower chain lifts the slot-arm from the zero to the 45 degree position, and the upper chain from the 45 to the 90 degree position. The chains are staggered with relation to each other, the lower engaging the front and middle prongs of the fork head, and the upper the middle and rear prongs.

The slot-arm rests on hooks in both the 45 and 90 degree positions, thus retaining two of the important features of the Style B signal: viz., (1) the 90 and 45 degree positions are definite and do not depend on the adjustment of circuit controllers; and (2) in both these positions the signal is entirely free from its running gear.

The motor straddles a pin passing through both frames, to which it is secured by set screws. A connection between the motor and a cam on the frame permits of adjustment between the motor pinion and the gears. Figure 15 illustrates a Style S mechanism.

Model 2-A.

The Model 2-A signal mechanism is made in both base-of-mast and top-of-mast types, and for any aspect; two or three positions of the semaphore blade, upper or lower quadrant, and right or left hand of mast, and for alternating current of any voltage or frequency up to 220 volts, and for direct current up to 110 volts.

The mechanism (Fig. 16) is practically the same for the base-of-mast and top-of-mast signals.

The motor (Fig. 17) is directly connected to the semaphore shaft through a train of gears so that the armature revolves with it in either direction. By the use of a high torque, low-speed motor, low reduction gearing is used, 30 revolutions of the motor being required to clear the signal to the 90 degree position.

The direct current signal is held in the desired 45 or 90 degree position by means of a retaining device (Fig. 18) with which the motor is equipped. It consists of an electromagnet, the armature of which is connected, through a crank and link movement, to a dog designed to engage a toothed disc mounted on the armature shaft of the motor; the design embodies an escapement movement so that when the electromagnet is energized, the motor armature will be held only when it begins its rotation toward the Stop position.

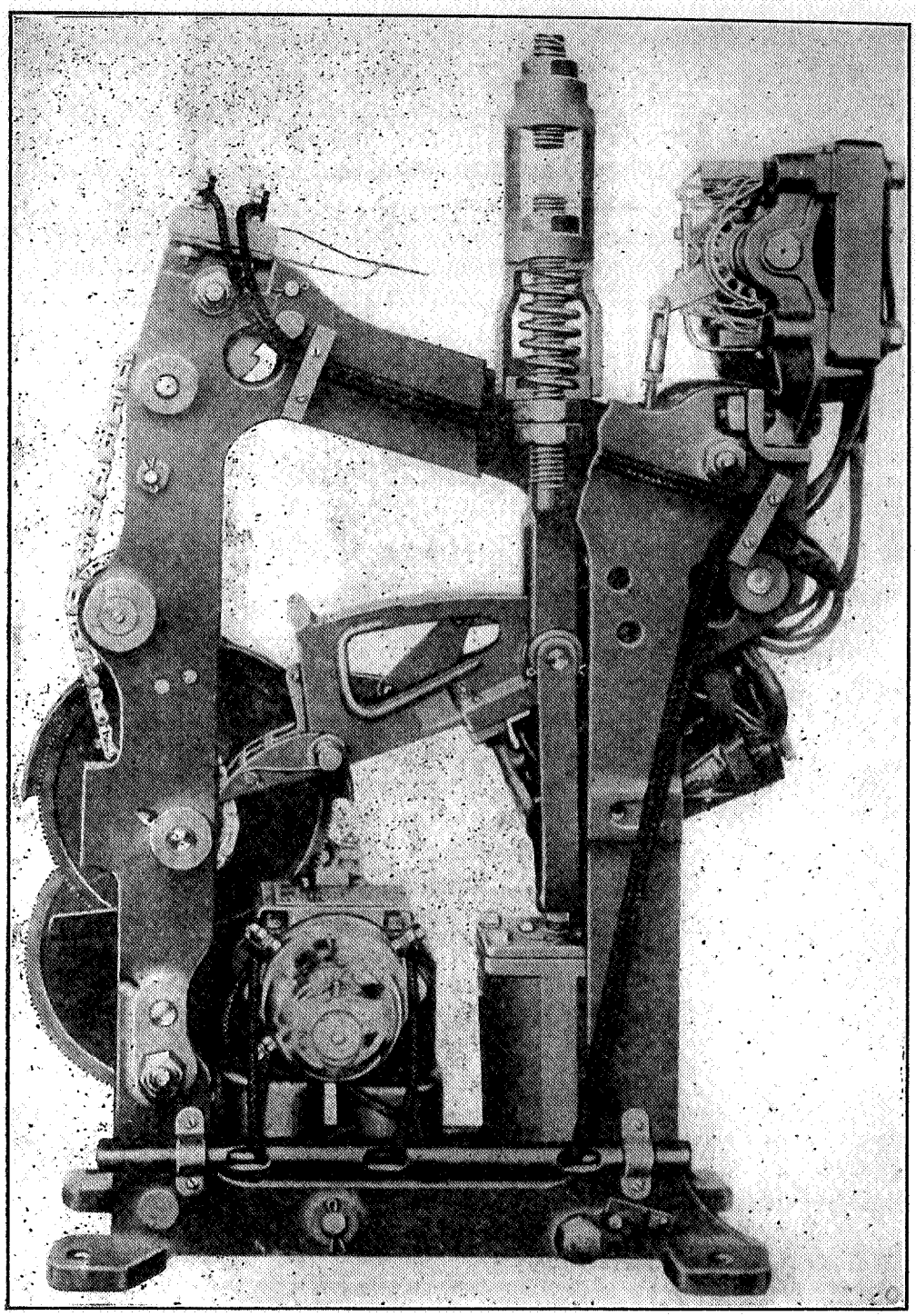


Fig. 15.
Style S Base-of-Mast Mechanism.

An exceedingly high drop-away is procured through having an air gap of 0.020 inch.

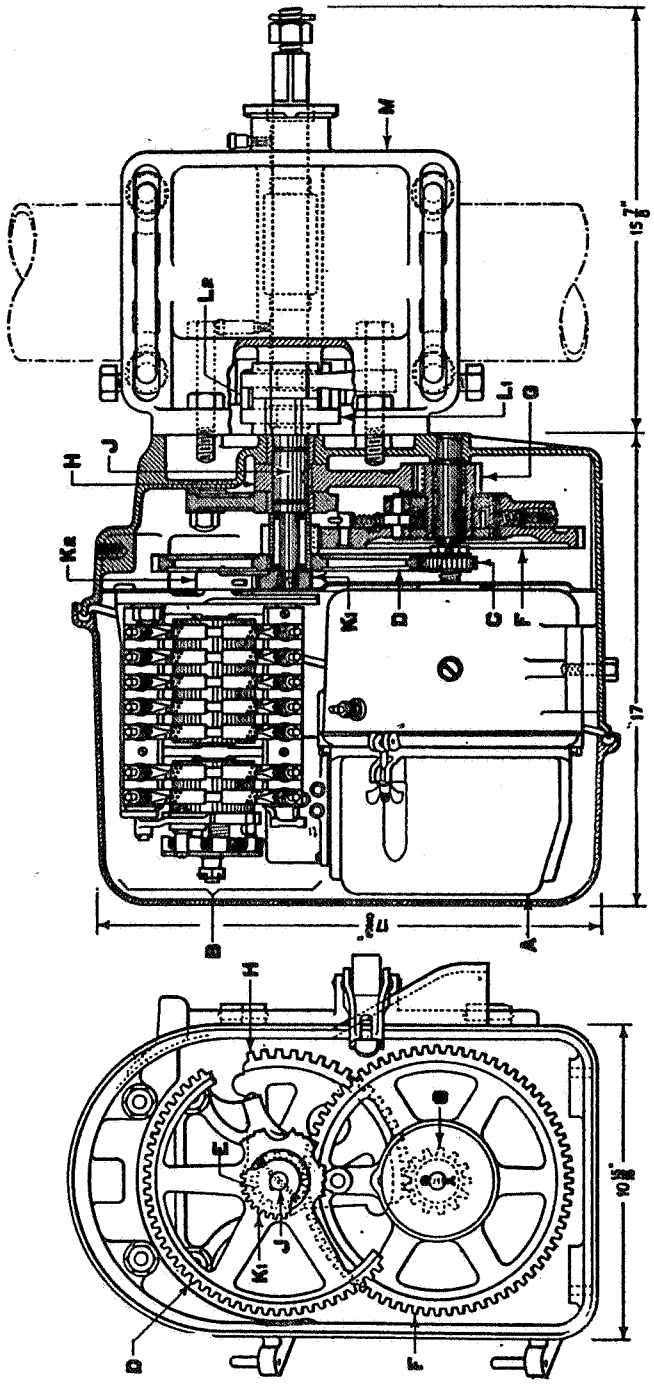


Fig. 16.
Model 2-A Direct Current Signal Mechanism.

Due to the motor being driven backward when the semaphore is returning towards the Stop position, electrical means may be used for snubbing the movement of the signal blade without the use of a dash-pot or other additional mechanical contrivance. This is accom-

plished in the last few degrees movement of the mechanism by shunting the motor, which causes it to generate sufficient current to effectively check the speed of the mechanism so that the signal parts and semaphore arm are brought to rest without shock.

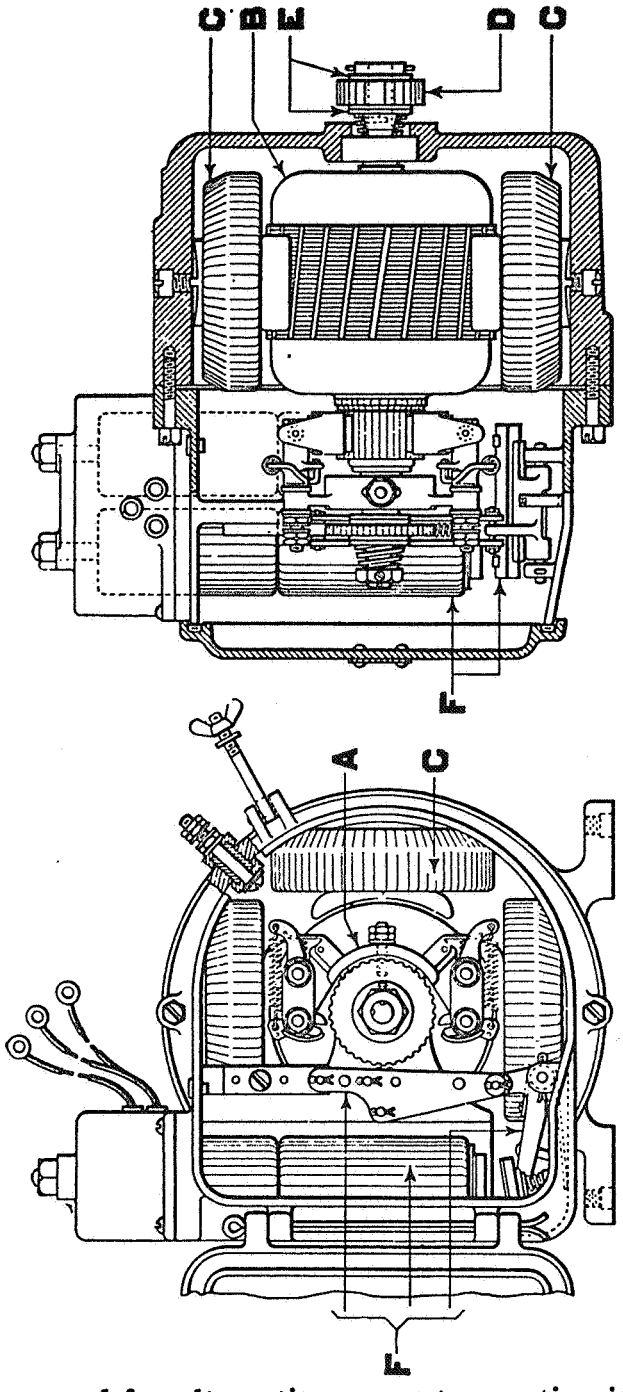


Fig. 17.
Motor for Model 2-A Direct Current Signal Mechanism.

The motor used for alternating current operation is of the induction type, having such efficiency that it may operate directly over the line without the intervention of line relays.

The motor unit, illustrated in Fig. 19, includes the hold clear mechanism, also a reactance coil. The hold clear mechanism is a solenoid magnet arrangement and operates in practically the same manner as the direct current low-voltage hold clear device previously described. The essential difference is the substitution of a solenoid for a tractive magnet and a slight difference in the arrangement of the several parts.

This motor is known as a split-phase motor; in other words, it is a two-phase motor arranged to operate on single phase by means of the reactance unit which is connected in series with one of the stator windings in order to obtain the necessary phase displacement. Both stator windings are in service while the motor is operating, which eliminates the necessity of contacting devices such as are ordinarily used with single-phase motors to interrupt the current through a starting winding after the motor has developed normal speed.

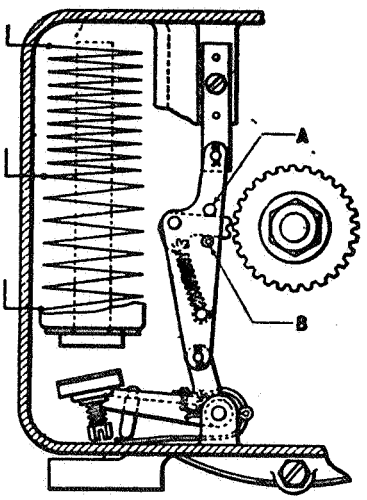


Fig. 18.
Retaining Mechanism for Model 2-A Low-Voltage
Direct Current Mechanism.

In the base-of-mast signal the same motor, gearing and circuit breaker parts are used as in the direct-connected type, and the signal arm is operated by means of a mechanical connection. The case is designed to house one or two mechanisms, to operate one or two arms respectively.

The 110-volt direct current Model 2-A signal mechanism is chiefly used as a power interlocking signal in connection with electric interlocking, and is generally operated from a central storage battery located at or near the interlocking tower. This mechanism can be made non-automatic or semi-automatic. It is equipped with a four-pole, series-wound motor and differs from the 8, 10 and 20-volt mechanisms in that the signal is held in the 45 or 90 degree position by means of the motor armature. The surface of two of the pole

pieces is serrated, and when the holding field windings are energized, the magnetic attraction between these pole pieces and the armature prevents rotation of the armature in either direction thus holding the signal in the position to which it has been operated.

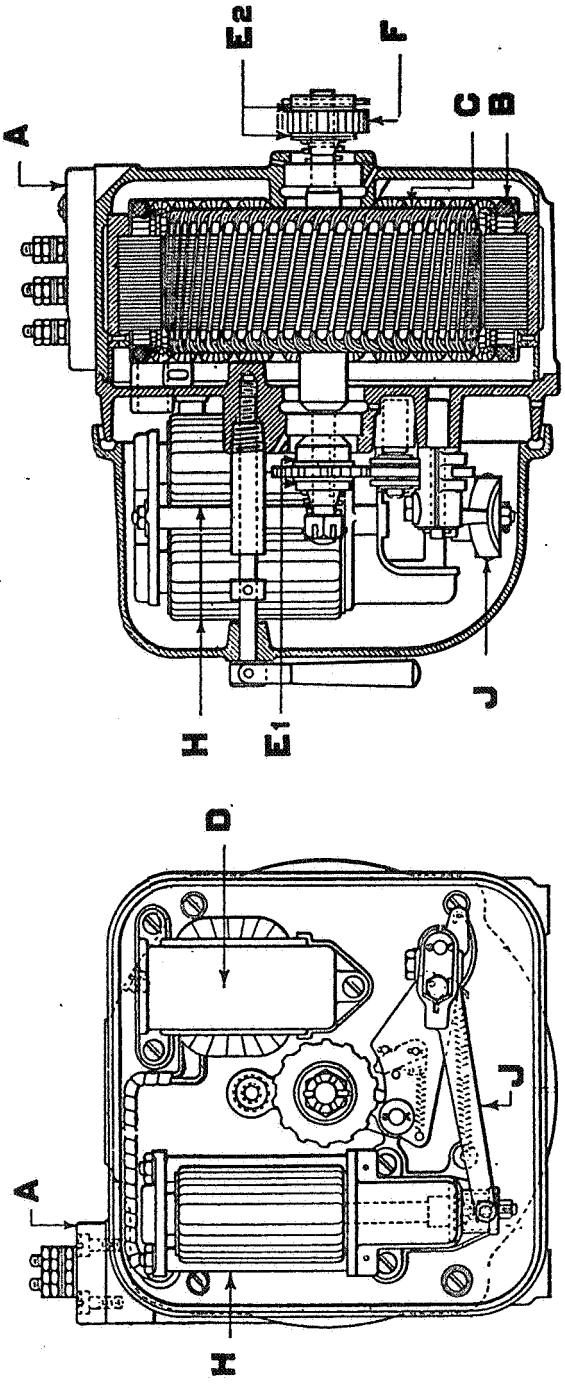


Fig. 19.
110-Volt Alternating Current Induction Motor, 25 and 60-Cycle, for Model 2-A Signal Mechanism.

When the Model 2-A signal mechanism is used as a semi-automatic signal and controlled by means of a lever employing the "dynamic" principle of indication, the signal is equipped with a spring attachment located in the gear housing which is used to produce rotation of the motor armature for indication purposes after the signal has reached the Stop position.

The "dynamic" principle of indication is explained in detail in Chapter XIX—Electric Interlocking.

Style T-2.

The Style T-2 signal mechanism (Fig. 20) is made only in the top-of-mast type, and consists of an electric motor driving a train of gears, a circuit controller and a means for holding the semaphore arm in the 45 or 90 degree position. The holding slot controls the 45

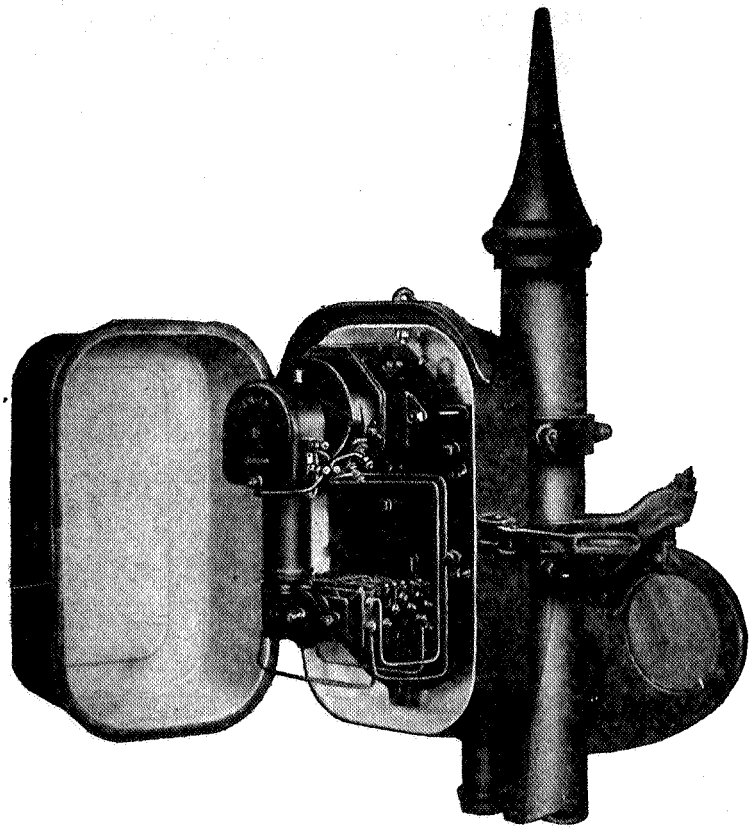


Fig. 20.
Style T-2 Direct Current Signal Mechanism.

degree motor circuit in addition to holding the semaphore arm in the 45 or 90 degree position, and can be inserted direct in a line circuit thereby eliminating the use of a relay at the signal solely for controlling the 45 degree motor circuit.

The semaphore arm, when returning toward the Stop position, drives the motor backward so that it acts as a generator discharging current through a resistance and the frictionless dynamic brake effect thus produced is utilized to check the speed of the mechanism so that the signal parts and semaphore arm are brought to rest without shock, practically in the same manner as previously described in the Model 2-A signal mechanism.

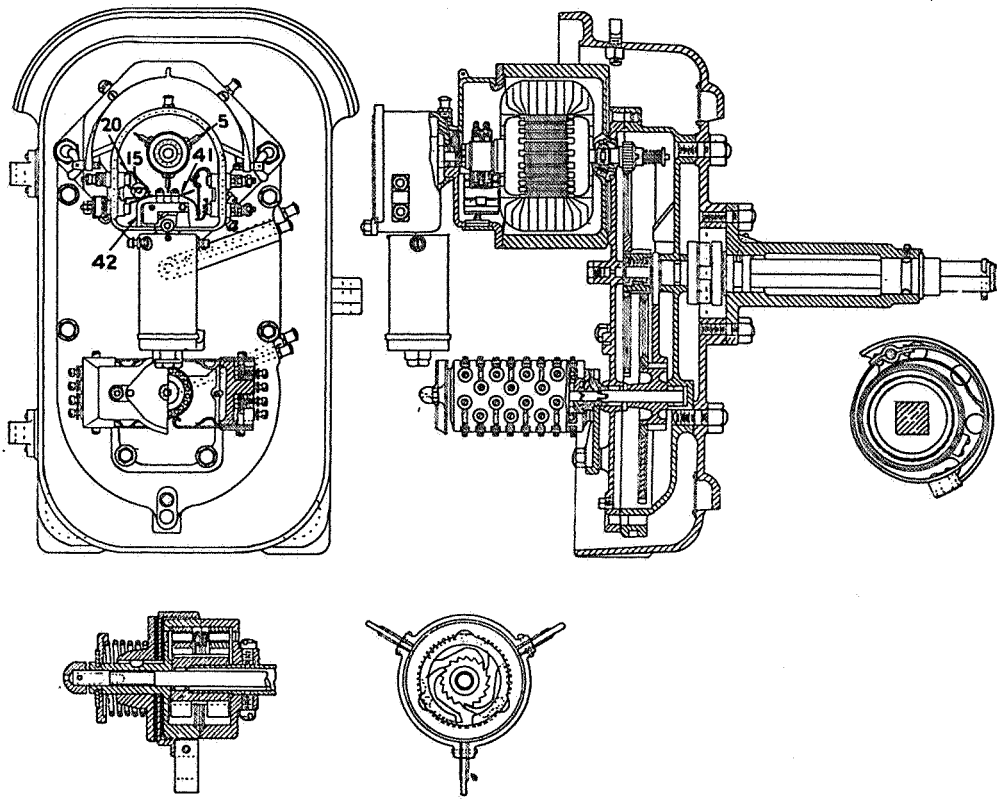


Fig. 21.
Diagram of Style T-2 Direct Current
Signal Mechanism and Parts.

The armature rachet and the holding mechanism are placed in an aluminum case at the outer end of the motor shaft, thus leaving no movable parts of the mechanism exposed except the drum of the circuit controller. The slot magnet is of the iron-clad type and when energized raises the arm 42 (Fig. 21) which carries the steel roller 15 and the contact finger 41 closing the motor circuit at 20. This movement brings the roller into the path of the blades 5 of the stop drum, which is attached to the end of the motor shaft, stopping the rotation but allowing the motor to revolve by means of its rachet. When the motor circuit is opened by the contacts of the circuit

controller, due to the semaphore arm having reached the desired position, current is cut from the motor, and the torque of the semaphore arm then tends to rotate the motor backward, and the signal is held in the position to which it has been driven by means of the rachet on the armature shaft coming into play and the roller 15 being engaged with the blade 5 of the stop drum prevents the backward movement of the motor and holds the signal in position. When the slot magnet is de-energized the arm 42 is released and falls back by gravity.

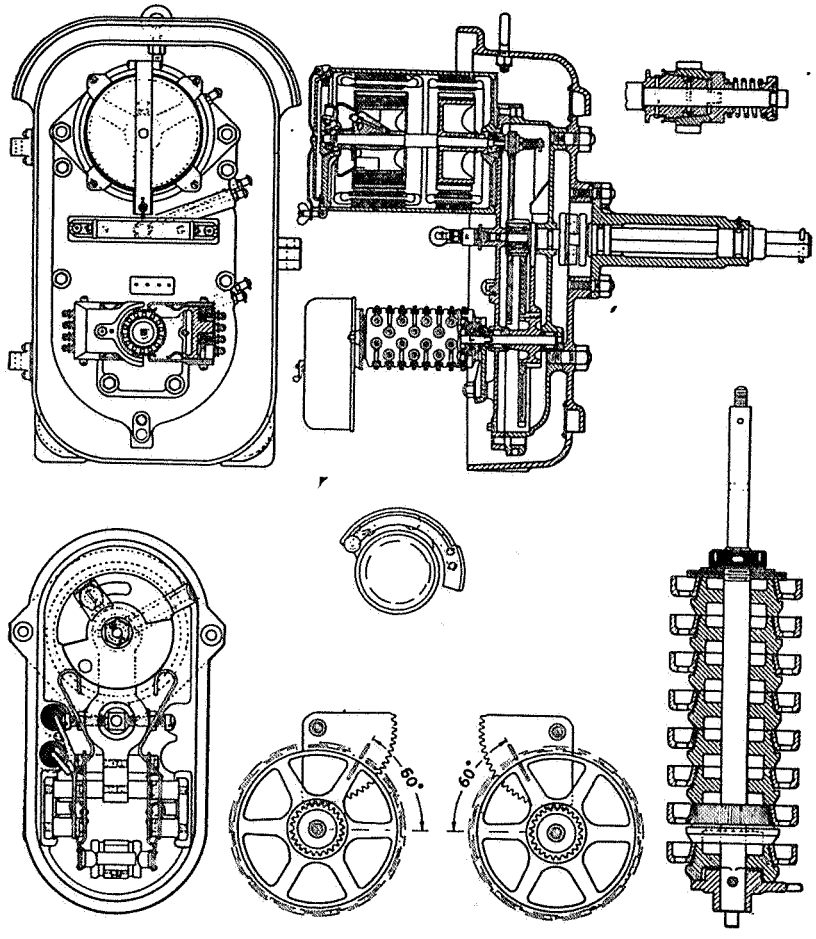


Fig. 22.
Diagram of Style T-2 Alternating Current
Signal Mechanism and Parts.

For alternating current operation the Style T-2 signal is fitted with an alternating current motor into which is built a holding slot which differs from the direct current holding slot in that it is in the form of a rotor and stator, so that all latches or other mechanical holding devices are eliminated. This arrangement is illustrated in Fig. 22.

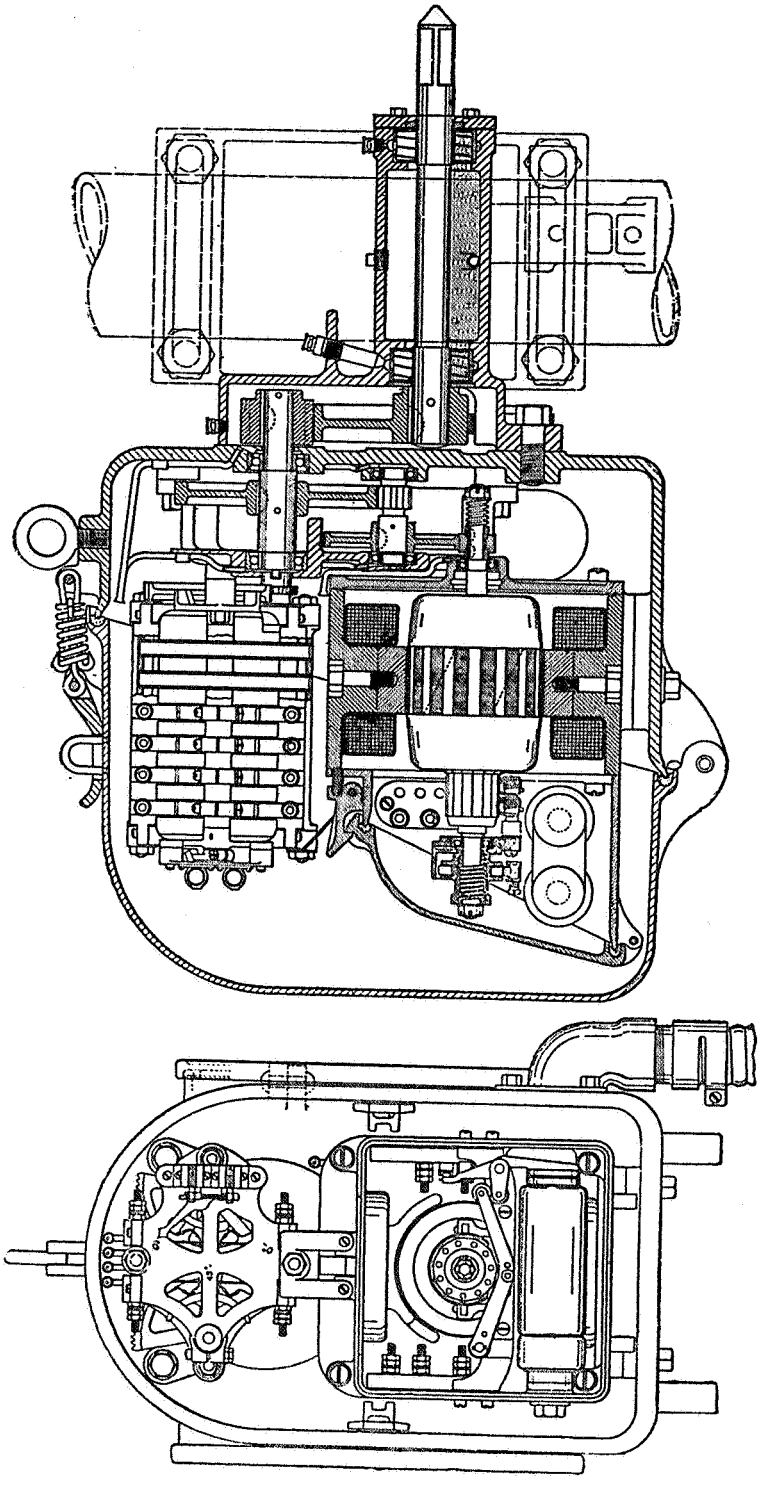


Fig. 23.
Style L Signal Mechanism.

Style L.

The Style L signal mechanism is made in either the top-of-mast or base-of-mast type and to operate on either alternating or direct current.

The top-of-mast type of this signal is similar to the Model 2-A and Style T-2 in that the motor is direct connected to the semaphore shaft through a train of gears and is driven in the reverse direction when the semaphore arm is returning toward the Stop position; this feature being used to check the speed of the mechanism so that the signal parts and semaphore arm are brought to rest without shock. This signal employs a roller bearing for the semaphore shaft shown in Fig. 23.

The retaining device for holding the signal in the 45 and 90 degree positions is located in the motor housing immediately under the motor commutator and is illustrated in Fig. 24.

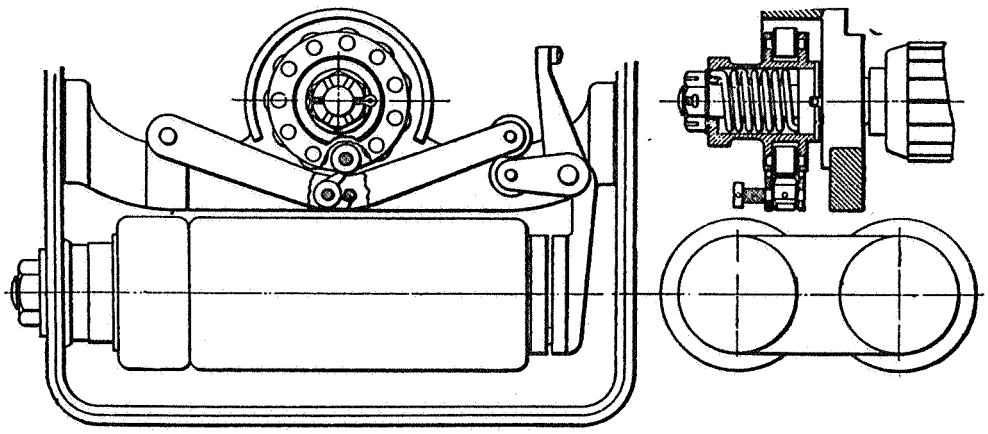


Fig. 24.
Retaining Device for Style L Direct Current Mechanism.

The retaining mechanism consists of a latch lever in which is located a spring-actuated latch dog. One end of this lever is pivoted on the motor case and the lever itself is free to swing downward. When this lever is in the operating position, due to the energization of the magnet coils, the latch dog engages with one roller of a series of rollers which are carried in a cage flexibly connected to the outer end of the armature shaft. The armature of the hold clear magnet is pivoted so that a roller carried on a projecting arm engages a roller on the free end of the latch lever. Thus, when the armature is pulled against its magnet, the latch lever is raised forcing its dog into the path of the rollers carried on the end of the armature shaft. The motor is thus prevented from rotating backward by the engagement of the latch dog with one of the rollers.

The flexible connection of the roller cage to the armature shaft prevents the hold clear from kicking off when the load settles on the dog after the motor circuit has opened.

A circuit controller is provided similar to those on other top-of-mast mechanisms, details of which are illustrated in Fig. 25.

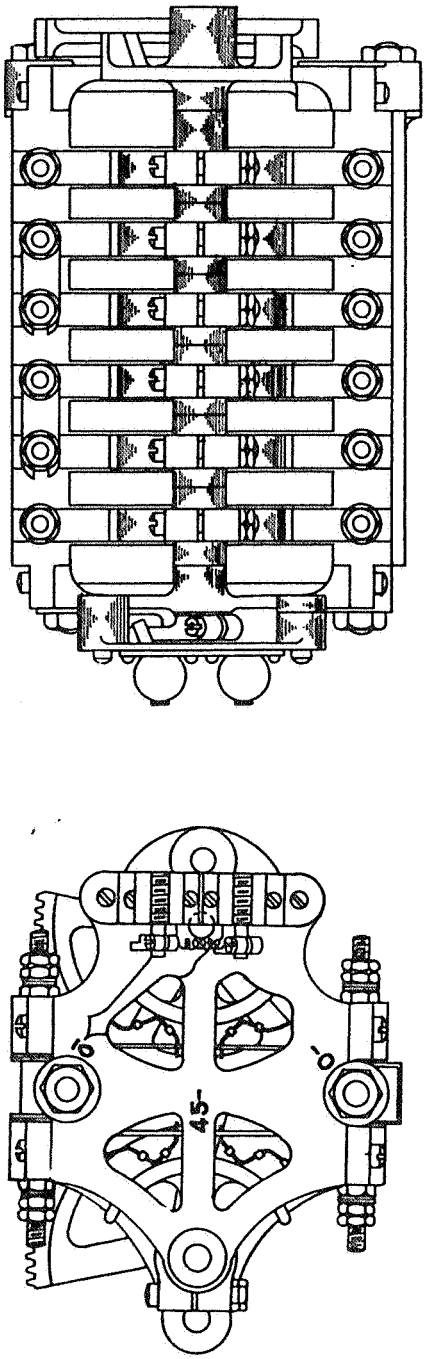


Fig. 25.
Circuit Controller, Style L Signal Mechanism.

Both the top-of-mast and base-of-mast types of the Style L mechanism are made to operate up to 110 volts direct current or on alternating current of standard voltages and frequencies. In either the alternating or direct current signal, the motor and hold clear mechanism constitutes a unit so that to change from direct to alternating current operation it is necessary to change only motors with their hold clear mechanisms, which may be done by removing two cap screws.

The base-of-mast mechanism is similar to that used in the top-of-mast type and in operation is the same as the Model 2-A base-of-mast signal.

Typical mechanism wiring.

Figures 26, 27, 28, 29 and 30 show typical mechanism wiring as installed by the manufacturers.

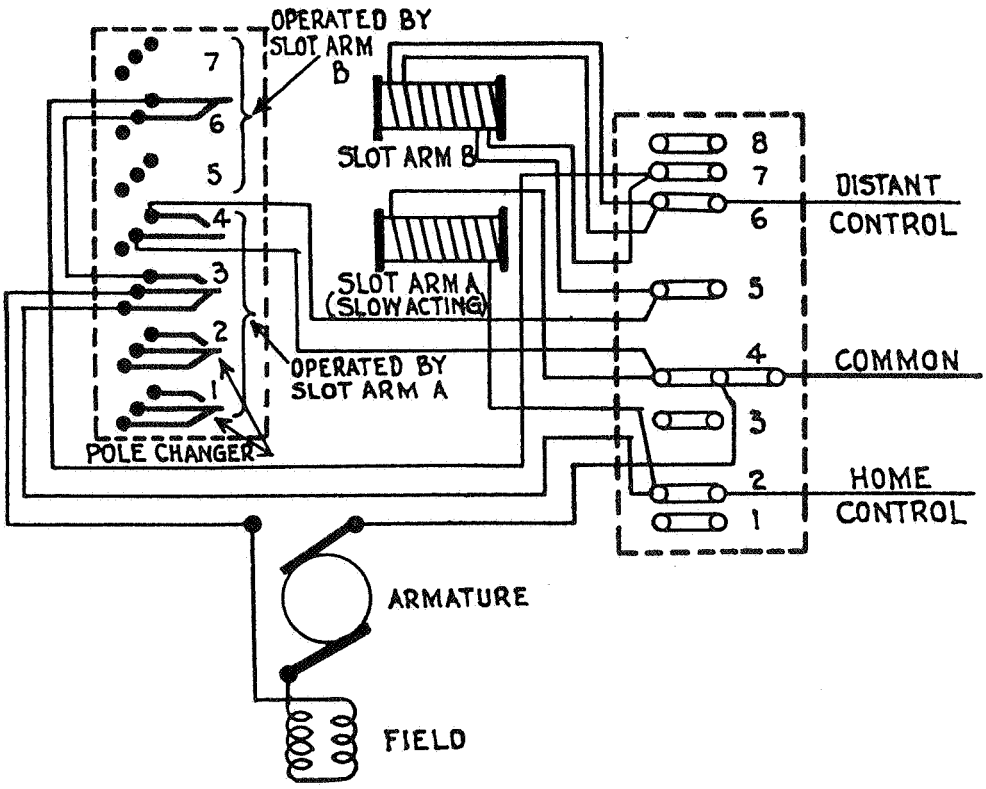


Fig. 26.
Mechanism Wiring, Style B Signal.

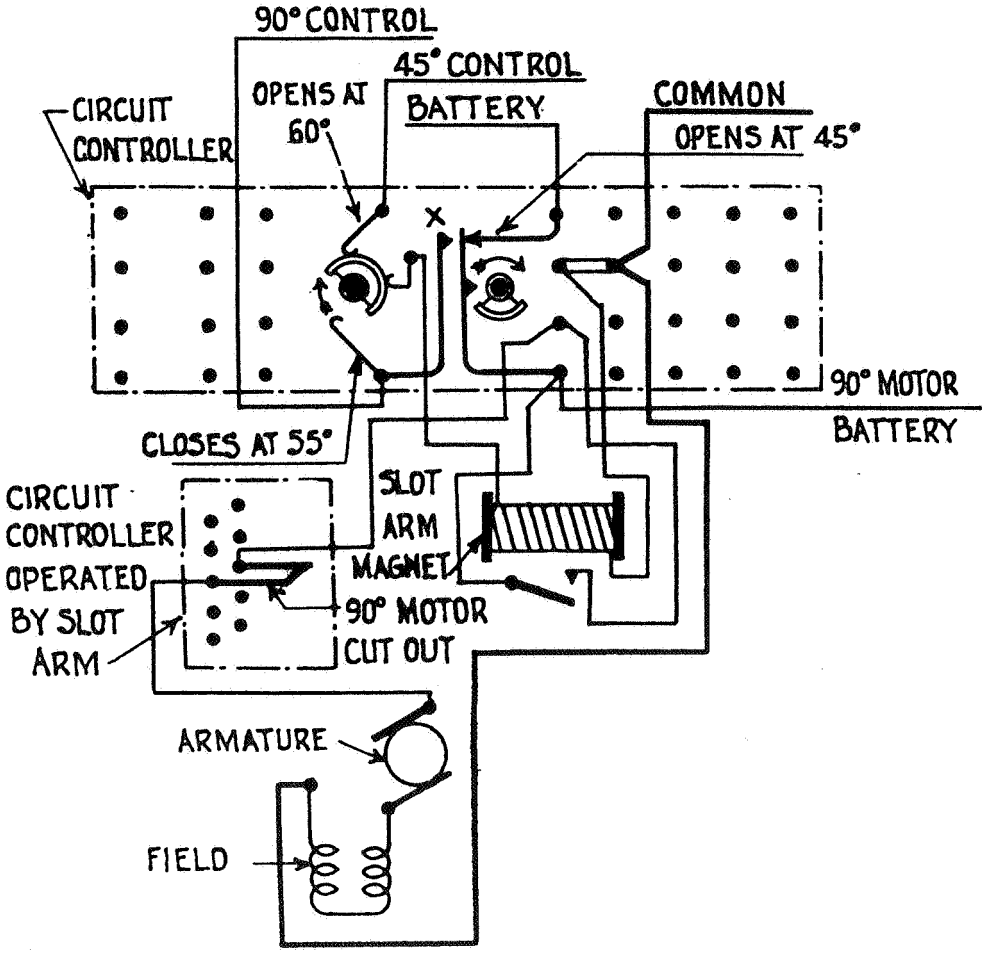
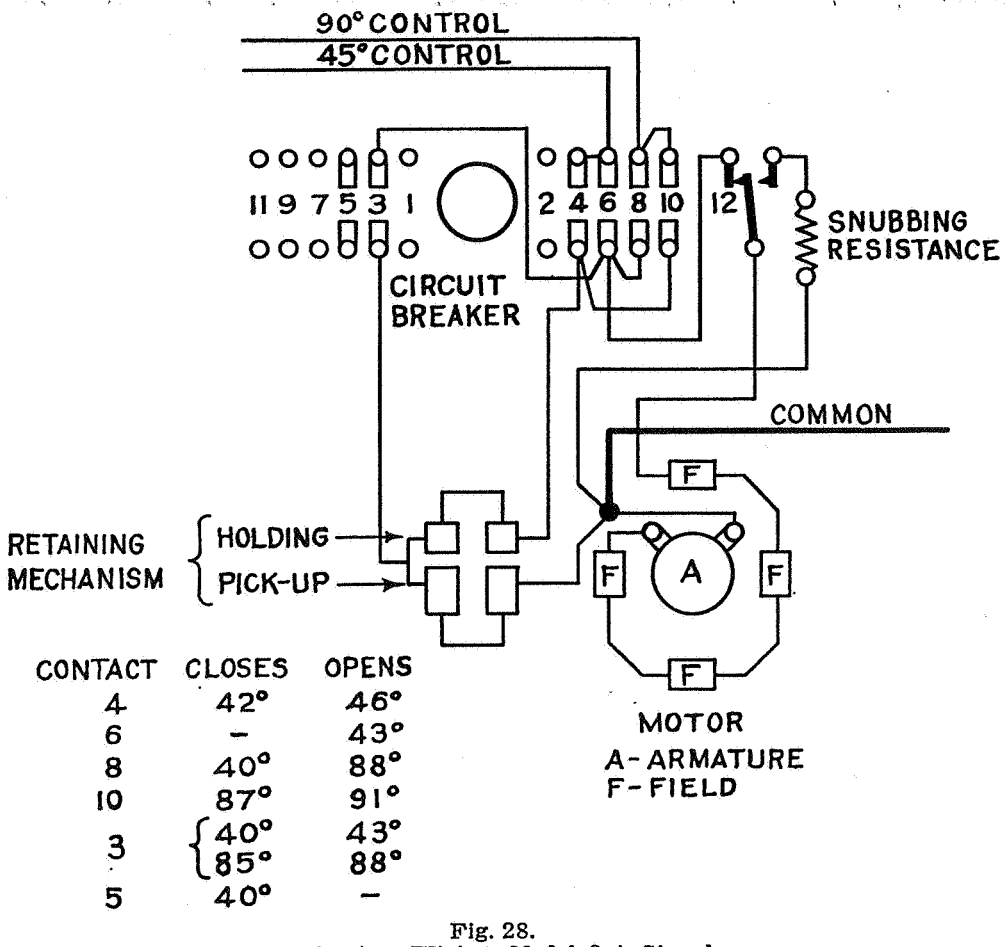


Fig. 27.
Mechanism Wiring, Style S Signal.



CONTACT	CLOSES	OPENS
4	42°	46°
6	–	43°
8	40°	88°
10	87°	91°
3	40°	43°
	85°	88°
5	40°	–

Fig. 28.
Mechanism Wiring, Model 2-A Signal.

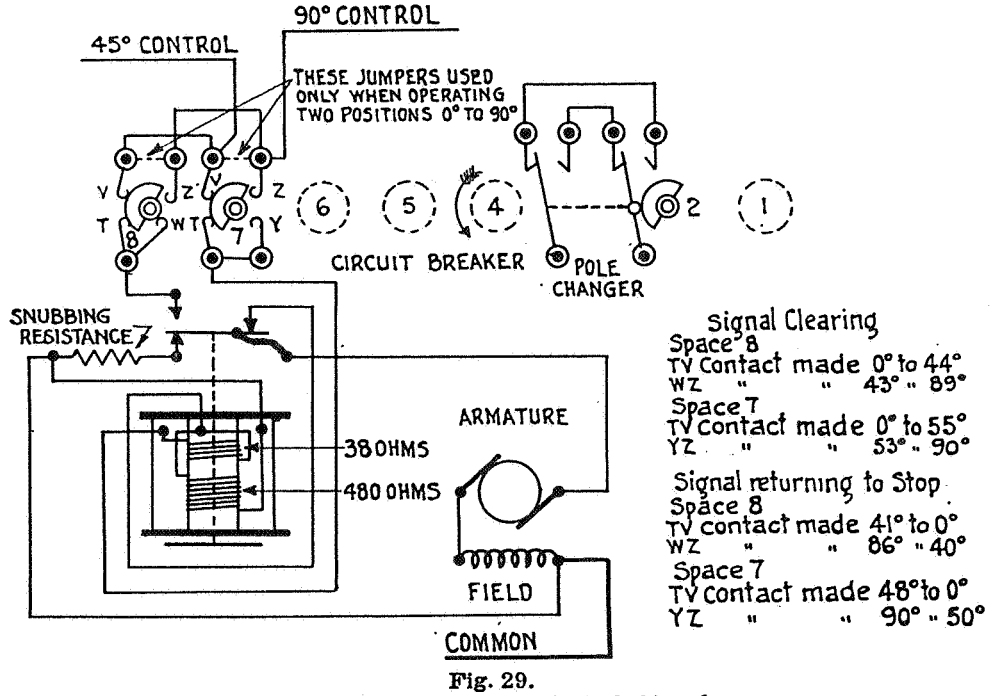


Fig. 29.
Mechanism Wiring, Style T-2 Signal.

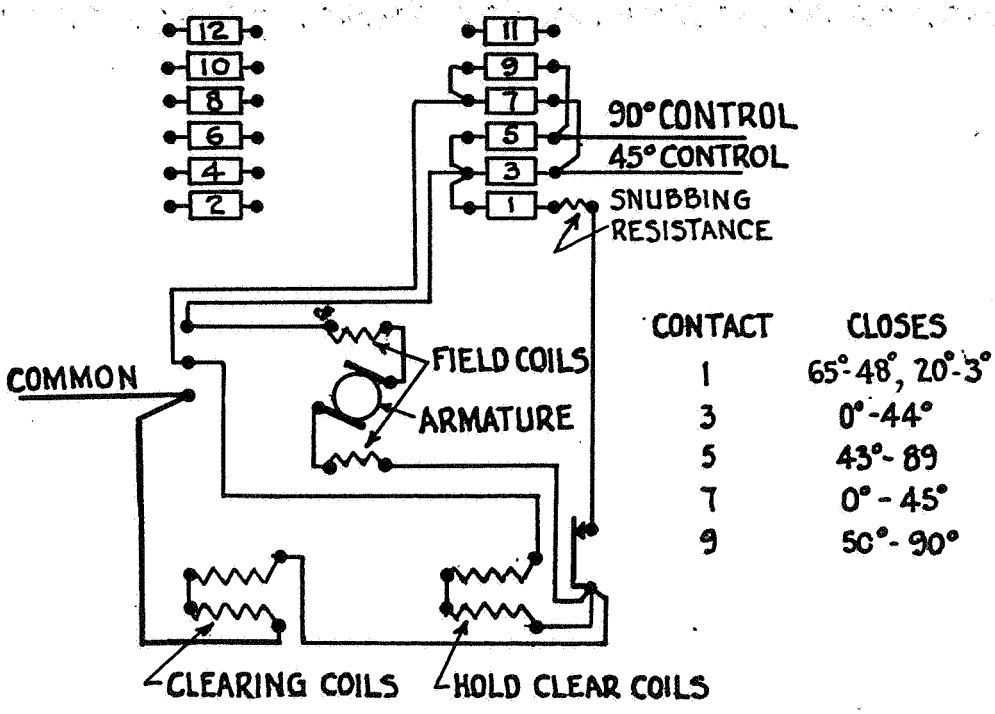


Fig. 30.
Mechanism Wiring, Style L Signal.

Instructions.

Semaphore signals should be maintained and tested in accordance with the following instructions:

General.

1. Mast must be vertical and signal aligned to give the best possible indication for approaching trains.

2. Signal blades, lenses and roundels must be kept clean.

3. Lamp bracket must be securely fastened and adjusted to insure proper alignment of lamp with respect to spectacle and track. All parts of lamp must clear spectacle not less than 1 inch.

4. Ladders, hand railings and platforms must be kept in good condition and securely fastened.

5. Base of ladder must be secured to a suitable support.

6. Movable parts of the signal must move freely under all weather conditions.

7. Semaphore spectacle casting must rest against the stop provided for that purpose, allowing slot-arms and vertical connections to be free from all downward pressure when in the most restrictive position.

8. Signals must not be placed in service until semaphore bearings have been cleaned, and all oil, dirt and grease removed from the armature and poles of slot magnets and gears, all parts lubricated, and electrical torque tests made when practicable.

9. Bearings must be kept free from grit and dirt, and lubricated.

10. Semaphore shaft bearings must be lubricated in accordance with detailed instructions.

11. Cone clutch between motor shaft and pinion gear on signals so equipped must be kept free from oil and lubricated in accordance with detailed instructions.

12. Bearings and movable parts except those covered in Instructions 10 and 11 must be oiled monthly with A.R.A. Signal Division Specification 10220 or 10320 oil.

13. Mechanism must be kept in proper adjustment and without excessive lost motion. Excessively worn or defective parts must be replaced.

14. Slot or equivalent device must release on voltage not less than that specified by manufacturer.

15. Air gap between movable and fixed member of slot or retaining device must be not less than that specified by manufacturer. Movable and fixed member of slot or retaining device must be kept free from grease, oil and dirt.

16. Electrical contacts must be kept clean and in proper adjustment. Cloth free from lint (chamois preferable) must be used to clean contacts.

17. Buffing of signal must be effective and at the proper time to eliminate undue strain on mechanism.

18. Armature of signal motor must not have excessive lost motion in bearing and the clearance between armature and field piece on direct current motors and between rotor and stator on alternating current motors specified by manufacturer must be maintained.

19. Commutator must be smooth, clean and have a glossy appearance and oiled, if necessary, by using a cloth free from lint (chamois preferable) moistened with A.R.A. Signal Division Specification 10220 or 10320 oil. Segment wires must be securely fastened to segments. Where composition brushes are used, commutator must be kept free from oil.

20. Number 00 or finer sandpaper must be used on parts of mechanism and motor. Emery paper or emery cloth must not be used.

21. Brushes must be kept clean, fitted to commutator, free in brush holder, or brush holder free on stud (depending upon type of brush holder) and in the neutral plane either 90 or 180 degrees apart, as required. They must be free from hard spots on the contact surface. Springs must be in place and maintained so that brushes will have proper bearing.

22. Counters must be adjusted to correctly register operation of mechanism. Counters must not be oiled.

23. Wires must be so arranged that they will be neat and not interfere with operating parts of mechanism.

24. Buffers must be cleaned and lubricated in the Fall of each year. Air buffers using oil for lubricant must be oiled monthly with A.R.A. Signal Division Specification 10220 or 10320 oil.

25. Door of mechanism case and motor housing must be kept in good working order, gasket in place and in good condition so as to keep out moisture and dirt. Door must not be opened in severe or stormy weather, except when conditions require.

26. Mechanism case must be kept clean and no material, tools or supplies kept therein. Ventilators must be protected by wire mesh and kept unobstructed.

27. Bolts, nuts, pins and cotters must be of proper size, kept in place, nuts tight, and cotters properly spread.

28. Broken or cracked roundels must be replaced.

29. Work that may interfere with the safe movement of trains must not be started until train movements have been fully protected.

30. Circuit controller contacts must be kept clean and properly adjusted.

31. Circuits must be kept free from grounds.

32. Signal apparatus must be tested in accordance with Instructions .....

33. Manufacturer's instructions must be followed unless they conflict with general or detailed instructions in which case proper authority must be consulted for correct procedure.

Styles S and B Motor Signals

General.

34. Brushes must be set one slightly in advance of the other so they will bridge the space between adjacent segments of the commutator and in a staggered position with a slight overlap to prevent wearing a groove in the commutator.

35. Contact tips on circuit controller springs must be kept tight.

36. Contact tips on circuit controller springs must make full surface and sliding contact on contact post, or spring, to prevent arcing.

37. Semaphore shaft journals must be packed with lubricant specified by manufacturer (or its equivalent), and replenished at least once every six months. The lubricant must be kept in a semi-fluid state by adding a small amount of A.R.A. Signal Division Specification 10220 or 10320 oil when necessary.

38. Chains and sprockets must be cleaned when necessary with gasoline and coated lightly with a grease similar to that used for semaphore bearings.

39. To avoid improper operation of the signal, the slot toggle adjustment must not be changed from its original setting. Links are stamped 1, 3 or 5, meaning 1/4, 3/8 or 5/32 inch toggle, respectively. If adjustment of toggle changes from that stamped on link, due to wear, slot-arm must be replaced.

40. Lifting chains must be maintained so that with a spring balance over the chain at a point midway between the upper and lower shafts and with a horizontal pull of 5 pounds, the distance between center lines will not be less than 2 1/8 inches nor more than 2 5/16 inches for Style S signals, nor less than 1 7/8 inches nor more than 2 1/16 inches for Style B signals.

41. Motor brake must be set so that the overtravel of rollers after leaving the end of lifting fork will be not more than 1/2 inch beyond the top of sprocket when motor is operated at rated voltage. With motor operating, brake shoe must clear brake wheel 0.020 inch.

Alternating current—Styles S and B.

42. Slot magnet armature must have sufficient end play to allow armature to seat firmly against pole face under all conditions, to insure against armature chattering, which, in time, would hammer down the core pins, thus reducing the air gap between armature and pole faces.

43. Core pins of slot magnet must not strike shading bands. The four pins must bear on pole faces of magnet when energized.

44. Slot armature must not ride on projecting part of shading bands.

45. Shading bands of slot-arm magnets must project 0.015 inch beyond pole faces except on 25-cycle Style S slot magnets on which the shading bands should project 0.010 inch.

Alternating current—Style S.

46. Motor pinion must mesh with gear of driving mechanism so that a slight backlash is present in all positions of the gears. An adjusting lever is provided on the mechanism frame at the left of the motor to control this backlash.

Direct current—Style B.

47. Slot armature side play, measured at lower end of armature, must not exceed 1/8 inch. The upper pins should be 0.003 inch shorter than the lower pins, and the air gap maintained parallel and equal across both pole faces.

Direct current—Styles S and B.

48. Motor pinion must mesh with gear of driving mechanism so that a slight backlash is present in all positions of the gears. An adjusting lever is provided on the mechanism frame, at the left of the motor, to control this backlash.

Table of Operating Characteristics of Styles S and B Signals

SHOP REQUIREMENTS											FIELD REQUIREMENTS						
RATING OF MOTOR	VOLTS AT MOTOR	MAX. TO JUST CLEAR AND LATCH SIG.	MAXIMUM CLEARING	MAXIMUM TIME CLEARING	MIN. RELEASE AT 45° OR CLEAR	CHARGE	MIN. HOLD CLEAR ARM. AIR GAP FORGED CORE HEX. POLE	MIN. HOLD CLEAR ARM. AIR GAP OLD TYPE ROUND POLE	MIN. HOLD CLEAR ARMATURE AIR GAP	MAX. TO JUST CLEAR & LATCH SIGNAL	MAXIMUM CLEARING	MAXIMUM TIME CLEARING	MIN. RELEASE AT 45° OR CLEAR	MIN. HOLD CLEAR ARMATURE AIR GAP FORGED CORE HEX. POLE	MIN. HOLD CLEAR ARM. AIR GAP OLD TYPE ROUND POLE	MINIMUM HOLD CLEAR ARMATURE AIR GAP
VOLTS	VOLTS	VOLTS	AMPS.	SECS.	VOLTS	VOLTS	INCHES	INCHES	INCHES	VOLTS	AMPS.	SECS.	VOLTS	INCHES	INCHES	INCHES
		S - SLOW ACTING 500 OHM SLOT COILS $\frac{5}{32}$" TOGGLE														
10	10	7	3	13	1.5	12			.015	7.7	3.3	15	1			.011
		S - ORDINARY ACTING 1000 OHM SLOT COILS $\frac{5}{32}$" TOGGLE														
10	10	7	3	13	3.75	12	.020	.017		7.7	3.3	15	2.5	.015	.013	
		S - ORDINARY ACTING 3500 OHM SLOT COILS $\frac{5}{32}$" TOGGLE														
110	110	75	.75	6	35	120			.030	87	.82	7	28			.024
		B - SLOW ACTING 500 OHM SLOT COILS $\frac{1}{4}$" TOGGLE														
10	10	7	3	10	1.6	12			.020	7.7	3.3	11	1			.015
		B - ORDINARY ACTING 1000 OHM SLOT COILS $\frac{3}{8}$" TOGGLE														
10	10	7	3	10	3.2	12			.015	7.7	3.3	11	2			.011
		B - ORDINARY ACTING 3500 OHM SLOT COILS $\frac{1}{4}$" TOGGLE														
110	110	75	.70	5	30	120			.036	87	.77	6	24			.028
		S - 60 CYCLE $\frac{5}{32}$" TOGGLE														
110	110	87	.90	8	35				.020	96	1	9	28			.015
		S - 25 CYCLE $\frac{5}{32}$" TOGGLE														
110	110	80	.35	8	45				.015	88	.39	9	36			.011
		B - 60 CYCLE $\frac{1}{4}$" TOGGLE														
110	110	75	.45	8	50				.020	83	.50	9	40			.015
		B - 25 CYCLE $\frac{1}{4}$" TOGGLE														
110	110	75	.26	8	50				.020	83	.29	9	40			.015
55	55	40	.44	8	25				.020	.45	.49	9	20			.015

49. Slow-acting slots of round pole face type must hold without tripping when circuit is opened 0.6 second and slots having magnets with hexagon pole face must hold 0.9 second, with slot-arm in the 45 degree position and at 8 volts.

50. Tests must be made and record kept on A.R.A. Signal Section Form 11 (shown in Chapter VI—Direct Current Relays) at least once each year and values maintained in accordance with the Table of Operating Characteristics of Styles S and B Signals.

Buffers, air—Style S.

51. Buffers must be disassembled, thoroughly cleaned and repacked in the Fall of each year, and more often if necessary, to maintain proper buffing, as follows:

(a) Lubricant, as specified by manufacturer (or its equivalent), must be used for packing and lubricating inside of cylinders and leather packing washers.

(b) Piston rings and grooves must be carefully packed with lubricant and surplus grease removed from bottom face of piston before placing it in cylinder and from top face after piston is in place.

(c) One or two lead gaskets should be applied as the occasion demands to bring top and bottom valves in a vertical line, the joint having been made air-tight before screwing head into cylinder.

(d) In assembling packing box, leather packing washers, as furnished, treated with lubricant, must be used.

(e) A thin coating of grease must be applied to both sides of individual washers and from seven to ten washers inserted, as required, to obtain just less than full compression of the spring with stuffing box nut firmly screwed down, except that in no case must the total thickness of washers exceed 5/16 inch.

(f) After buffer is replaced in signal, check must be made to see that stem or yoke cannot touch slot magnet and signal must be operated from all positions to all positions to determine that buffer functions as intended.

52. A few weeks after cleaning and packing it usually is necessary to close the top needle valve, and any further regulation on either the 45 or 90 degree operation must be taken care of by adjustment of the bottom needle valve. Cushioning for the 45 to zero degree operation is regulated by adjusting the bottom needle valve, and the 90 to 45 degree operation principally by the top needle valve.

53. If undue leakage at the stuffing box develops, treat the leather packing washers with lubricant and examine the packing nut, and if worn, replace it with a new one. If the trouble is not overcome the entire stuffing box must be cleaned and repacked.

54. Piston stem must be lubricated once each month with a thin film of approved oil applied with a cloth.

55. A special wrench which may be obtained from the manufacturer must be used for removing or replacing stuffing box nut on old style air buffers.

56. Piston stem must be turned by means of pliers protected by leather band.

57. Buffers must be kept in proper adjustment. When the signal is at Proceed, the piston must be set to obtain a clearance of 1/8 to 3/16 inch between the top of the piston and the cylinder head. This clearance can be obtained by raising the slot-arm 1/8 to 3/16 inch above the proceed latching point and screwing up the piston until it strikes the cylinder head, then restoring the slot-arm to the proceed latched position. When signal is at Stop, piston should clear bottom of cylinder.

58. With buffers properly maintained and adjusted, signal arm will move from the 90 to the zero degree position in not more than 6 seconds.

Buffers, oil—Style S.

59. Buffers must be disassembled, cleaned and refilled in the Fall of each year, and more often if necessary to maintain proper buffing, as follows:

(a) Piston must be removed and all parts of piston and cylinder cleaned with gasoline. Rings must be carefully removed and scraped with knife blade when gasoline will not remove the dirt. Grooves in piston must be thoroughly cleaned. Special attention must be given to vent in piston, oil passages, piston rings and grooves.

(b) Worn or damaged parts must be replaced.

(c) Piston ring must work freely in groove and assembly nut at the bottom of piston rod must be secured.

(d) Piston and inside of cylinder must be free from lint, dirt or other foreign matter.

(e) Cylinders must be refilled with new oil as provided for that purpose. Oil must be kept in sealed containers until used.

(f) After buffer is replaced in signal, check must be made to see that stem or yoke cannot touch slot magnet and signal must be operated from all positions to all positions to determine that buffer functions as intended.

60. Buffers must be maintained so they do not flutter while signal is clearing.

61. Buffers must be kept in proper adjustment. When the signal is clear, the piston must be set to obtain a clearance of 1/8 to 3/16 inch between the top of the piston and the cylinder head. This clearance can be obtained by raising the slot-arm 1/8 to 3/16 inch above the

proceed latching point and screwing up the piston until it strikes the cylinder head, then restoring the slot-arm to the proceed latched position. When signal is at Stop, piston should clear bottom of cylinder.

62. With buffers properly maintained and adjusted, signal arm will move from the 90 to the zero degree position in not more than 6 seconds.

Buffers, air—Style B.

63. Buffers must be disassembled, thoroughly cleaned and lubricated in the Fall of each year, and more often if necessary to maintain proper buffing, as follows:

(a) Vent screw and ball valve must be removed, cleaned and oiled with a few drops of approved oil.

(b) After buffer is replaced in signal, check must be made to see that stem or yoke cannot touch slot magnet, and signal must be operated from all positions to all positions to determine that buffer functions as intended.

64. Buffer cylinders must be lubricated once each month by removing the plug containing the vent and dropping a small amount of approved oil into the cylinder. The outside of the cylinder must be wiped clean before the plug is removed and special care taken that no dirt or grit enters the cylinder.

65. With buffers properly maintained and adjusted, signal arm will move from the 90 to the zero degree position in not more than 6 seconds.

Model 2-A Signals

66. Semaphore shaft bearings must be lubricated with A.R.A. Signal Division Specification 10220 or 10320 oil.

67. On signals with dynamic indication only sufficient tension must be maintained on storing spring to insure that proper indication is received.

68. Where locking dog in main bearing is used, it must be given an application of an approved lubricant at least once each year.

69. When assembling mechanisms to pole bearings, exposed mechanical joints must be cleaned and evenly coated with white lead to insure water-tight joints.

70. Semaphore shaft and mechanism must be in approximately the Stop position when bolting mechanism to its pole bearing. Semaphore shaft should be rotated backward and forward when tightening bolts to insure that no binding takes place between moving parts.

71. Fibre washers in the clutch, and the pawl and ratchet pinion must be lubricated at least semi-annually with A.R.A. Signal Division Specification 10220 or 10320 oil.

72. Motor shaft must have at least $\frac{1}{64}$ inch and not more than $\frac{3}{64}$ inch end play.

Table of Operating Characteristics of Model 2-A Signals

SHOP REQUIREMENTS										FIELD REQUIREMENTS									
VOLTAGE RATING OF MOTOR	VOLTAGE AT MOTOR	MAXIMUM MOTOR CURRENT	MAXIMUM MOTOR CURRENT INCLUDING HOLD CLEAR PICK-UP CURRENT	CLEARING TIME WITH MOTOR VOLTAGES AS IN COL. 2	MINIMUM WORKING VOLTAGE OF MOTOR	MINIMUM WORKING VOLTAGE OF HOLD-CLEAR	HOLD-CLEAR DROP-AWAY ADJUSTED FOR	RESISTANCE OF HOLD-CLEAR HOLDING CIRCUIT	RESISTANCE OF HOLD-CLEAR PICK-UP CIRCUIT	VOLTAGE RATING OF MOTOR	VOLTAGE AT MOTOR	MAXIMUM MOTOR CURRENT	MAXIMUM MOTOR CURRENT INCLUDING HOLD-CLEAR PICK-UP CURRENT	CLEARING TIME WITH MOTOR VOLTAGES AS IN COL. 2	MINIMUM WORKING VOLTAGE OF MOTOR	MINIMUM WORKING VOLTAGE OF HOLD-CLEAR	HOLD-CLEAR DROP AWAY ADJUSTED FOR	RESISTANCE OF HOLD-CLEAR HOLDING CIRCUIT	RESISTANCE OF HOLD-CLEAR PICK-UP CIRCUIT
VOLTS	VOLTS	AMPS.	AMPS.	SEC.	VOLTS	VOLTS	VOLTS	OHMS	OHMS	VOLTS	VOLTS	AMPS.	AMPS.	SEC.	VOLTS	VOLTS	VOLTS	OHMS	OHMS
10	10	2.1	2.4	10.0	5.0	5.0	4.2	630	26	10	10	2.3	2.64	11	5.5	5.5	3	630	26
8	8	2.6	2.9	10.0	4.0	5.0	4.2	1000	26	8	8	2.86	3.2	11	4.4	5.5	3	1000	26
8-10	8	2.5	2.8	10.0	3.5	4.5	3.6	1000	26	8-10	8	2.75	3.06	11	3.86	4.95	2.54	1000	26
8-10	10	2.5	2.8	7.5	3.5	4.5	3.6	1000	26	8-10	10	2.75	3.06	8.25	3.86	4.95	2.54	1000	26
8-10	10	2.5	2.7	7.5	3.5	1.0	0.75	60	60	8-10	10	2.75	3.0	8.25	3.86	1.1	.53	60	60
20	20	1.1	1.2	10.0	8.5	13.0	11.0	5000	138	20	20	1.21	1.32	11	9.35	14.3	7.75	5000	138
110	110	0.85	2.00	6.0	40.0	90.0	40.0	420		110	110	.94	2.2	6.6	44	95	28	420	
110	85	0.85	1.40	8.0	40.0	90.0	40.0	450		110	85	.94	1.54	8.8	44	95	28	450	
110	110	0.65	2.00	3.0	40.0	80.0	40.0	420		110	110	.72	2.2	3.3	44	95	28	420	
110	90	0.65	1.40	4.0	40.0	80.0	40.0	450		110	90	.72	1.54	4.4	44	95	28	450	
CYCLES			WATTS					VOLT-AMP.	WATTS	CYCLES			WATTS					VOLT-AMP.	WATTS
110-25	110	3.40	260	11.0	90.0	90.0	70.0	22	7.5	110-25	110	3.4	260	12	90	90	50	22	7.5
CYCLES			WATTS					VOLT-AMP.	WATTS	CYCLES			WATTS					VOLT-AMP.	WATTS
110-60	110	3.75	260	10.0	90.0	90.0	65.0	50	6.5	110-60	110	3.75	260	11	90	90	46	50	6.5

73. Clearance between motor armature and pole pieces must be not less than 0.025 inch measured with a metal gauge as furnished by the manufacturers, 0.015 inch thick and 1½ inches wide, circular in form.

74. Air gap between the pole pieces of the hold clear coil and armature must be not less than 0.022 inch.

75. An air gap of at least 1/16 inch must be maintained between armature and armature support, with slot coil energized and the signal at rest in the 45 or 90 degree position.

76. Occasional tests must be made to insure that snub is effective. Signal should travel from the 90 to the zero degree position in approximately 8 seconds when controlling circuit is opened. The ratcheted main gear should click three or four times when signal is moving from the 90 to the zero degree position.

77. Motor friction clutch must be adjusted to slip, when blade is held and current applied, with normal voltage at motor terminals.

78. Tooth disc on motor armature or pawl on retaining mechanism which has become worn or burred must be replaced.

79. Tests must be made and record kept on A.R.A. Signal Section Form 11 or 16 (shown in Chapter VI—Direct Current Relays and Chapter X—Alternating Current Relays) at least once each year, and values maintained in accordance with the Table of Operating Characteristics of Model 2-A Signals.

Style T-2 Signals

80. Semaphore shaft journals must be packed with lubricant specified by the manufacturer (or its equivalent), and replenished at least once every 6 months. The lubricant must be kept in a semi-fluid state by adding a small amount of A.R.A. Signal Division Specification 10220 or 10320 oil when necessary.

81. Pockets in the cone clutch must be filled once each year with dry graphite (or its equivalent), as specified by the manufacturer.

82. Cone surface must be kept free from oil. If the clutch slips and is free from oil, spring should be stretched slightly (by turning spring on a cylindrical surface). If the clutch is too tight a small amount of dry graphite should be rubbed over the cone surfaces.

83. Stop drum clutch must have a drop of oil rubbed over the surface of washers once a year to keep them soft so as to maintain the friction between the stop drum and ratchet.

84. Motor shaft must have not less than 1/64 inch nor more than 3/64 inch end play.

85. Contact springs must not bear on their respective segments with more than one pound pressure. Steel stop springs must be maintained so as to prevent the contact springs being bent down far enough to be buckled by the segments.

86. To increase the pressure of a contact spring, it must be removed from its slot, and given a set 1¼ inches from the slotted end.

Table of Operating Characteristics of Style T-2 Signals

SHOP REQUIREMENTS												FIELD REQUIREMENTS						
MOTOR					SLOT							MOTOR			SLOT			
RATING OF MOTOR	VOLTS AT MOTOR	MAX. TO JUST CLEAR AND LATCH SIGNAL	MAX. CLEARING 0°-90°	MAX. TIME CLEARING 0°-90°	PICK-UP WINDING	HOLDING WINDING	CHARGE	MAX. PICK-UP	MIN. RELEASE AT 45° OR 90° WITH SPRINGS	MIN RELEASE AT 45° OR 90° WITHOUT SPRINGS	MIN. ARM. AIR GAP	MAX. TO JUST CLEAR AND LATCH SIGNAL	MAX CLEARING 0°-90°	MAX. TIME CLEARING 0°-90°	MAX. PICK-UP	MIN. RELEASE AT 45° OR 90° WITH SPRINGS	MIN. RELEASE AT 45° OR 90° WITHOUT SPRINGS	MIN. ARM. AIR GAP
VOLTS	VOLTS	VOLTS	AMPS.	SECS.	OHMS	OHMS	VOLTS	VOLTS	VOLTS	VOLTS	INCHES	VOLTS	AMPS.	SECS.	VOLTS	VOLTS	VOLTS	INCHES
D.C. EQUIPPED WITH SLOT MAGNETS AND CONTACTS FOR PICK-UP AND HOLDING WINDINGS IN SERIES																		
10	10	7	2.5	10	38	480	12	6.5	3	2	.015	7.7	2.75	11	7.15	2.4	1.6	.012
8	8	6.5	2.9	9	38	480	12	6.5	3	2	.015	7.15	3.2	10	7.15	2.4	1.6	.012
110	110	75	.50	5	1500+3000		** NOTE		35	30	.040	82	.55	5.5		28	24	.030
D.C. EQUIPPED WITH INDEPENDENT PICK-UP AND HOLDING WINDINGS - PICK-UP WINDING IN SERIES WITH MOTOR																		
10	10	7	2.5	10	.25	27				.75	.018	7.7	2.75	11			.6	.015
8	8	5	2.9	9	.25	27	* NOTE			.75	.018	5.5	3.2	10			.6	.015
10	10	7	2.5	10	.25	460				3.7	.020	7.5	2.75	11			3	.017
8	8	5	2.9	9	.25	460				3.7	.020	5.5	3.2	10			3	.017
10	10	7	2.5	10	.25	670				4.6	.020	7.7	2.75	11			3.7	.017
8	8	5	2.9	9	.25	670				4.6	.020	5.5	3.2	10			3.7	.017
10	10	7	2.5	10	.25	1000				3.85	.015	7.7	2.75	11			3	.012
8	8	5	2.9	9	.25	1000				3.85	.015	5.5	3.2	10			3	.012
NORMAL - 60 CYCLE																		
					VOLTS	AMPS												
110	110	94	3.4	9.5	110	.7			35	30	.025	100	3.75	11		28	24	.020

* FOR A 27 OHM SLOT WHERE AN INDEPENDENT BATTERY IS USED FOR ENERGIZATION, THE SLOT SHOULD PICK UP WITH ONE VOLT ACROSS THE HOLDING WINDING AND THE MINIMUM OPERATING VOLTAGE ACROSS THE MOTOR - OTHER SLOTS ARE USED WITH A COMMON BATTERY FOR SLOT AND MOTOR OPERATION AND THE SLOT PICKS UP ON VOLTAGE EQUAL TO OR BELOW MAXIMUM OPERATING VOLTAGE TO JUST CLEAR SIGNAL.

** HIGH VOLTAGE SIGNAL HOLDS CLEAR WITH THE TWO WINDINGS IN SERIES MAKING A TOTAL OF 4500 OHMS. - SOME HIGH VOLTAGE T-2 SIGNALS ARE EQUIPPED WITH 1000 OHM SLOT WINDING WITH AN EXTERNAL RESISTANCE OF 3500 OHMS TO WHICH THE ABOVE VALUES ALSO APPLY.

87. Occasional tests must be made to insure that snub is effective. Signal should travel from the 90 to the zero degree position in approximately 8 seconds when the control circuit is opened.

88. Motor friction clutch must be adjusted to slip, when blade is held and current applied, with normal voltage at motor terminals.

89. Air gap between motor rotor and stator must be uniform and not less than 0.025 inch measured by passing a wire 0.025 inch in diameter between the rotor and stator.

90. Tests must be made and record kept on A.R.A. Signal Section Form 11 or 16 (shown in Chapter VI—Direct Current Relays and Chapter X—Alternating Current Relays) at least once each year, and values maintained in accordance with the Table of Operating Characteristics of Style T-2 Signals.

Style L Direct Current Signals

91. Clearance between motor armature and field coil pole pieces must be sufficient to permit the free movement of a gauge 3/8 inch wide and 0.015 inch thick.

92. Periodical tests must be made to insure that snub is effective. The hold clear armature must be adjusted so it will not vibrate while signal snubs.

93. Motor friction clutch must be adjusted to slip when blade is held and current applied, with 8 volts at motor terminals.

94. Semaphore shaft oil-well must be emptied, bearings and oil-well cleaned with gasoline and oil-well refilled each year with A.R.A. Signal Division Specification 10220 or 10320 oil, preferably between September 1st and November 1st. Bearings must be cleaned by squirting gasoline through oiler over each bearing. Weather plate and felt gasket must be removed, outer semaphore shaft bearing inspected and taken out and cleaned when necessary.

95. Oil-well must be filled so that oil will touch bottom of semaphore shaft only.

96. Oil must be removed, as necessary, from semaphore shaft gear housing to prevent overflowing.

97. Bearings must be periodically lubricated through oil holes.

98. Felt weather plate gasket on semaphore shaft must be turned once each year, so that the top sector becomes the bottom sector, to insure that all parts of the felt will be saturated with oil.

99. Tests must be made and record kept on A.R.A. Signal Section Form 11 (shown in Chapter VI—Direct Current Relays) at least once each year, and values maintained in accordance with the Table of Operating Characteristics of Style L Signals.

Table of Operating Characteristics of Style L Signals

SHOP REQUIREMENTS									FIELD REQUIREMENTS						
RATING OF MOTOR	VOLTS AT MOTOR	MAX. TO JUST CLEAR AND LATCH SIGNAL	MAX. CLEARING 0° - 90°	MAX. TIME CLEARING 0° - 90°	MIN. RELEASE AT 45° OR 90°	MIN. HOLD CLEAR ARM. AIR GAP 500 OHM SLOT COILS	MIN. HOLD CLEAR ARM. AIR GAP 1000 OHM SLOT COILS	MIN. HOLD CLEAR ARM. AIR GAP 3400 OHM SLOT COILS	MAX. TO JUST CLEAR AND LATCH SIGNAL	MAX. CLEARING 0° - 90°	MAX. TIME CLEARING 0° - 90°	MIN. RELEASE AT 45° OR 90°	MIN. HOLD CLEAR ARM. AIR GAP 500 OHM SLOT COILS	MIN. HOLD CLEAR ARM. AIR GAP 1000 OHM SLOT COILS	MIN. HOLD CLEAR ARM. AIR GAP 3400 OHM SLOT COILS
VOLTS	VOLTS	VOLTS	AMPS.	SECS.	VOLTS	INCHES	INCHES	INCHES	VOLTS	AMPS.	SECS.	VOLTS	INCHES	INCHES	INCHES
8-10	10	5	3	9	3.8	.040	.030		6	3.3	10	3	.030	.023	
110	110	55	.4	8	50			.040	61	.44	9	40			.030

Method of Making Service Test of Motor Semaphore Signals

100. Connections for instruments are illustrated in Fig. 31.

101. In starting tests the signal must be in its most restrictive position and motor circuit open. Connections must be made and motor circuit closed, allowing motor to operate and hold clear device to become effective.

102. Motor must be tested while signal is clearing by reducing voltage until armature rotates slowly. If motor does not run smoothly at slow speed, it is evidence of a faulty condition which must be corrected.

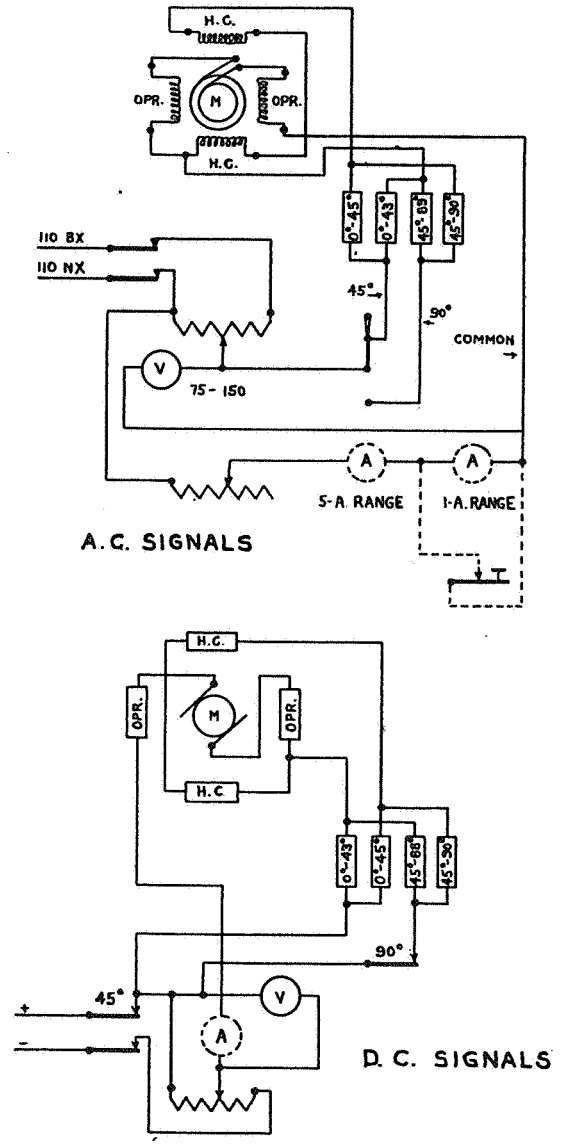


Fig. 31.
Connections for Making Service Tests of Motor Semaphore Signals.

103. Test for minimum clearing values must be made by reducing voltage until signal just clears and holds.

104. Test for release values of hold clear device must be made by increasing voltage until normal operating value is obtained, then reduce voltage gradually until hold clear device releases.

105. In making tests on 45 degree position of three-position signals, the 90 degree operating circuit must be opened to prevent the signal clearing beyond the 45 degree position.

106. In making tests on 90 degree position of three-position signals, the 45 degree operating circuit must be closed and the instruments connected in the 90 degree circuit.

107. Ground tests using voltmeter must be made as follows:

(a) Connect positive lead of voltmeter to positive side of circuit and negative lead of voltmeter to ground. A deflection of the needle to the right will indicate a negative ground.

(b) Connect negative lead of voltmeter to negative side of circuit and positive lead of voltmeter to ground. A deflection of the needle to the right will indicate a positive ground.

(c) When making ground tests of individual parts or wires they must be disconnected from both sides of the circuit and tests made with prescribed instruments.

Method of Making Shop and Field Electrical Torque Tests of Motor Semaphore Signals

Direct current motor signals Styles T-2 and L, and Model 2-A (except 110-volt Model 2-A with dynamic indication motors).

108. Connect an adjustable resistance and ammeter in series with the motor, gradually reduce the risistance until the motor will just move the arm upward. Just before the arm reaches the 45 degree position, quickly insert sufficient resistance to permit the motor, with snubbing circuit open and moved by the arm, to start backward. With Styles T-2 and L signals, hold clear armature must be fixed in the de-energized position.

(a) The current which will permit it to start backward from a given position should be not less than 50 per cent of the current required to move it to that position. If this current is less than 50 per cent, inspection must be made to determine that brush pressure is not excessive, that proper clearance exists between motor armature and pole faces, that shaft and gears are lubricated and working freely and that there is no binding in circuit controller.

(b) The same test must be made starting just before arm reaches the 90 degree position.

(c) Variations in readings may be caused by wind pressure on blade.

Alternating current motor signals Style T-2 and Model 2-A.

109. Supply sufficient voltage to the motor, for any given semaphore position, to just cause the motor rotor to revolve one or two times, then reduce the voltage until the rotor turns back one or two times. The percentage of the latter voltage to that of the first should not be less than 80 per cent for Style T-2 signals and 65 per cent for Model 2-A signals. Care must be taken to see that these readings are taken at approximately the same semaphore position.

(a) Readings at several angular positions of the semaphore must be made in order to determine actual friction of the mechanism.

(b) Variations in readings may be caused by wind pressure.

Method of Making Shop Torque Tests at the Semaphore Shaft of Motor Semaphore Signals

Mechanism friction torque test.

110. Tests must be made by the use of torque wheel and windlass, as shown on Drawing 1456, and weights or circular spring balance with a range of zero to 50 pounds, as required.

111. Without weight of semaphore spectacle:

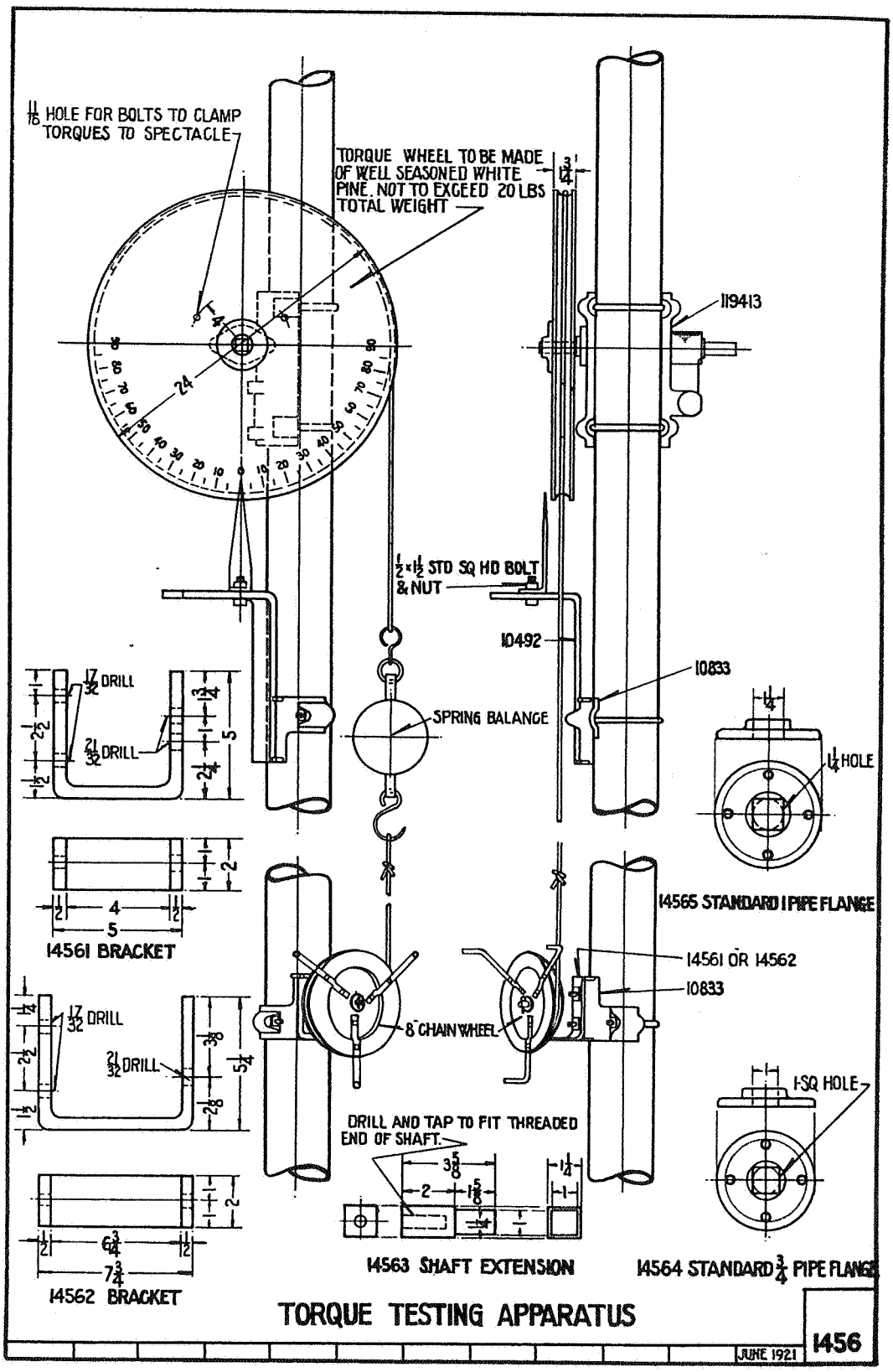
(a) Remove spectacle and apply torque wheel to semaphore shaft, then attach one end of cord to torque wheel and pass it part way around periphery of torque wheel in the direction that a weight suspended by the cord will tend to move mechanism toward the Stop position.

(b) With a weight sufficient to exert a torque equal to the allowable maximum mechanism friction torque, attached as provided in Instruction 111-a, the mechanism must be moved by hand to the position in which test is to be made, the motor held stationary until any backlash between motor and shaft is taken up and the motor then released, particular care being used to avoid giving motor or mechanism an impulse tending to rotate it.

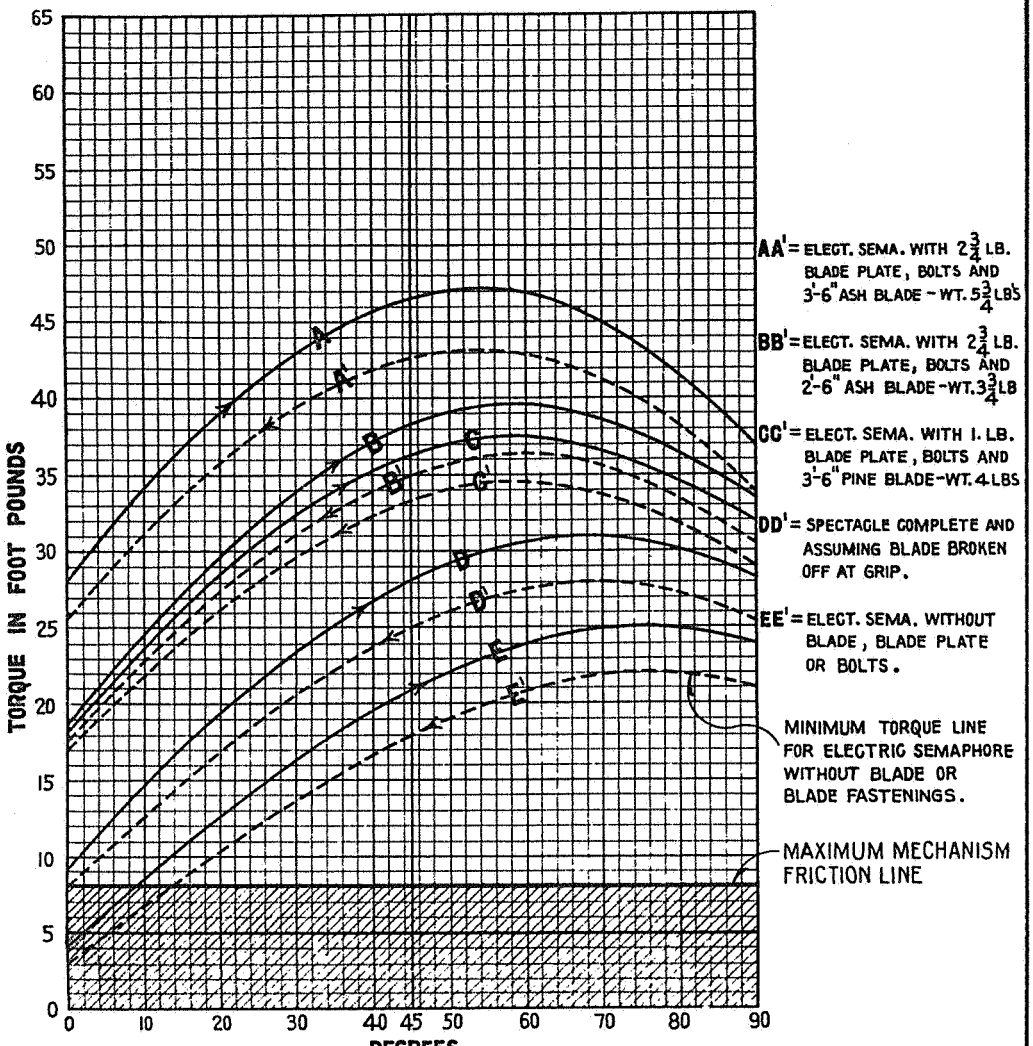
(c) This test must be made at a sufficient number of points in the travel of the mechanism to insure that the mechanism will meet the mechanism friction torque requirements at any point in its arc of travel.

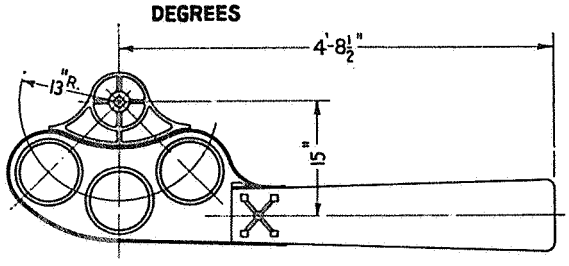
112. With weight of semaphore spectacle:

(a) Add balanced weight to semaphore shaft equal to total weight of complete semaphore. Repeat tests in Instructions 111-a, b and c to determine the increased friction due to the weight of semaphore.


11/16 HOLE FOR BOLTS TO CLAMP TORQUES TO SPECTACLE
TORQUE WHEEL TO BE MADE OF WELL SEASONED WHITE PINE. NOT TO EXCEED 20 LBS TOTAL WEIGHT
3/4
119413
1/2 x 1 1/2 STD SQ HD BOLT & NUT
10492
10833
SPRING BALANCE
17/32 DRILL
21/32 DRILL
14561 BRACKET
14565 STANDARD 1 PIPE FLANGE
1 1/4 HOLE
14561 OR 14562
10833
8 CHAIN WHEEL
1-SQ HOLE
DRILL AND TAP TO FIT THREADED END OF SHAFT.
14562 BRACKET
14563 SHAFT EXTENSION
14564 STANDARD 3/4 PIPE FLANGE
TORQUE TESTING APPARATUS
JUNE 1921
1456

NOTE: FULL LINES REPRESENT TORQUE FOR SPECTACLE MOVEMENTS 0° TO 90° [STOP TO PROCEED]
DOTTED LINES REPRESENT TORQUE FOR SPECTACLE MOVEMENTS 90° TO 0° [PROCEED TO STOP]





NOTE: SPECTACLE EQUIPPED WITH 8 3/8" ROUNDELS AND RETAINING RINGS IN ALL CASES.

TORQUE CURVES FOR ELECTRIC SEMAPHORE SPECTACLES

RSA 1064

MAN'L 1924 | MAR. 1923 | DEC. 1912 | OCT. 1912

Semaphore spectacle torque test.

113. Test for semaphore spectacle torque—zero to 90 degree position: R.S.A. 1064, Curves A-B-C-D-E:

(a) Apply spectacle and torque wheel on opposite ends of shaft which is to work freely and without unnecessary friction in its bearings, then attach one end of cord to torque wheel, pass it part way around periphery of torque wheel, and attach to windlass in the direction that rotating the windlass will tend to move the spectacle toward the 90 degree position, first inserting spring balance between torque wheel and windlass. With spectacle in the zero degree position it must be moved slowly toward the 90 degree position by turning the windlass, and the readings of the spring balance recorded as described in Instructions 116, 117, 118 and 119.

114. Test for semaphore spectacle torque—90 to zero degree position: R.S.A. 1064, Curves A′-B′-C′-D′-E′:

(a) Apply spectacle and torque wheel to shaft as provided in Instruction 113. With spectacle in the 90 degree position it must be moved slowly toward the zero degree position by turning the windlass, and the readings of the spring balance recorded as described in Instructions 116, 117, 118 and 119.

115. The average curve as obtained in Instructions 113 and 114 should represent the true torque curves.

Readings.

116. Accurate readings of spring balance may be obtained without calculations by adjusting the pointer back of the readings on the dial to compensate for the weight of the spring balance.

117. Readings must be taken when the predetermined degree indicated on the torque wheel passes the pointer and without relaxation of tension on the windlass at any point where readings are taken. The windlass must be moved slowly and uniformly in the proper direction.

118. Readings must be observed and recorded by one person while another is operating the windlass.

119. Readings must be taken and recorded at each 10 degrees in the arc of travel of the spectacle.

Semaphore spectacle counter torque test.

120. With spectacle and blade in place, apply torque wheel to ends of shaft and attach one end of cord to torque wheel, passing it part way around periphery of torque wheel in the direction that a weight suspended by the cord will tend to move the spectacle toward the 90 degree position.

121. With a weight sufficient to exert a torque equal to the required minimum counter torque, attached as provided in Instruction 120, the spectacle must be moved by hand to the position in which test is to be made, motor held stationary until any backlash between motor and shaft is taken up and the motor then released, particular care being used to avoid giving motor an impulse tending to rotate it.

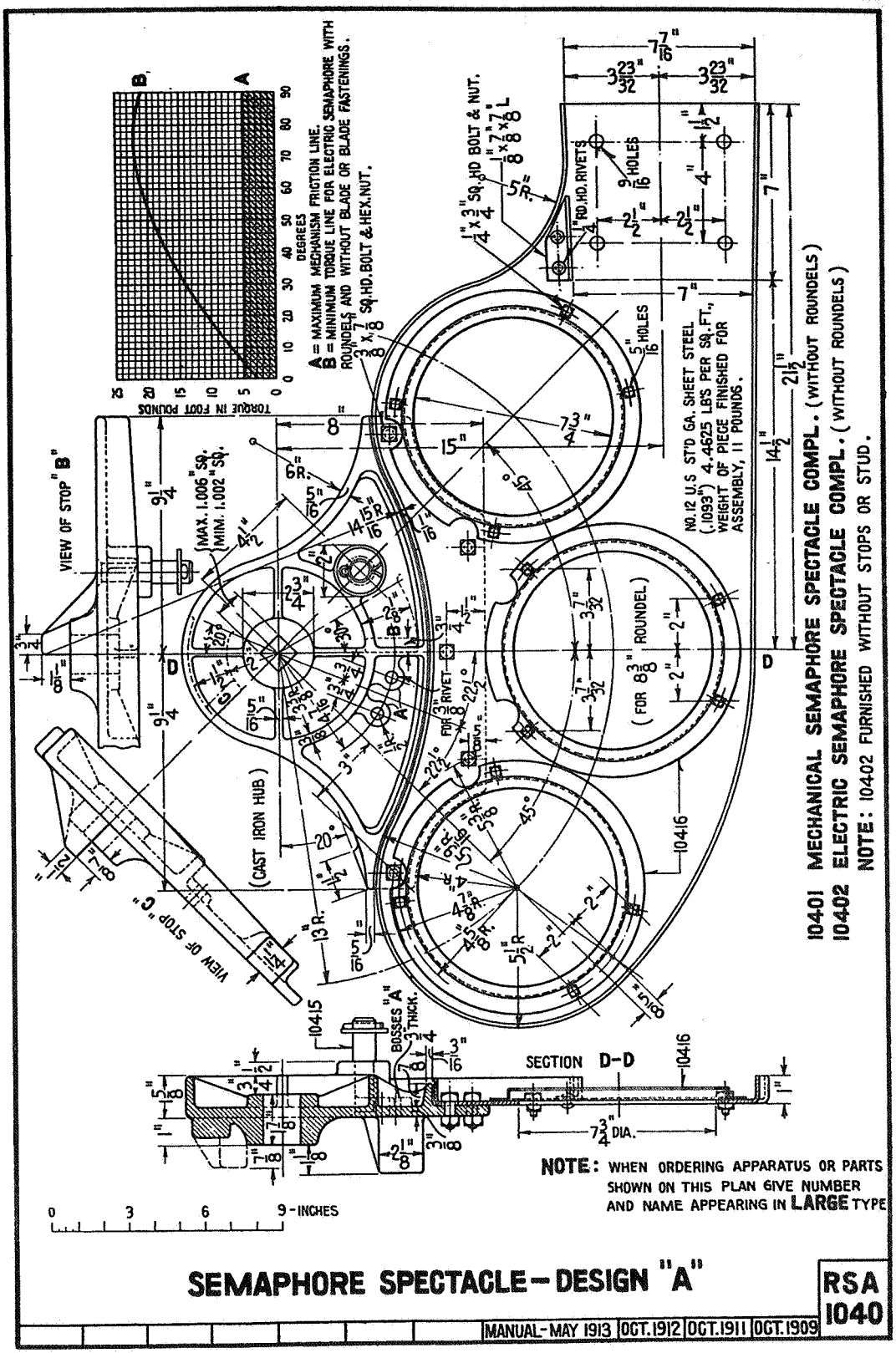
122. Test must be made at a sufficient number of points in the arc of travel of the spectacle to insure that it will start toward the zero degree position with the required counter torque.

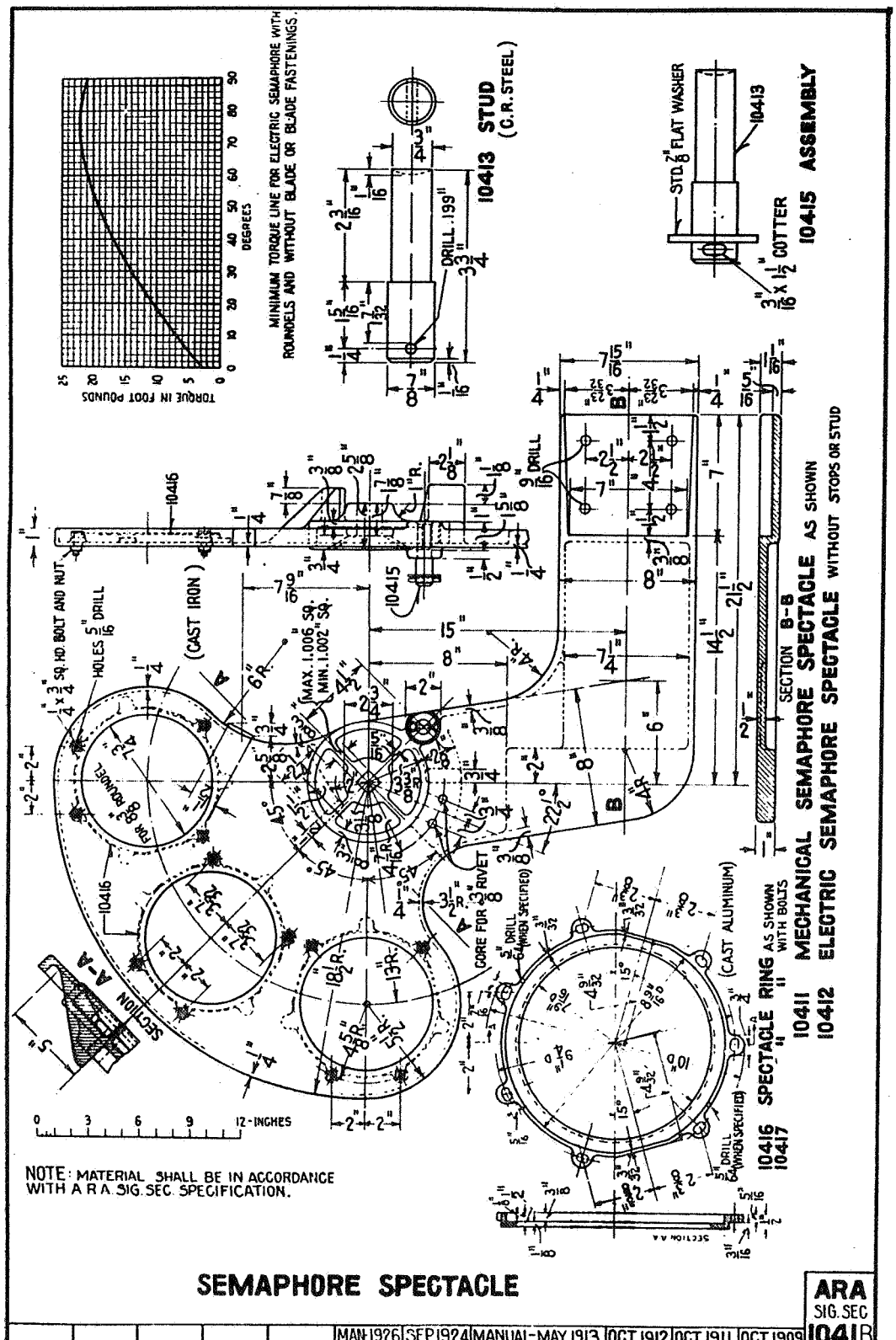
Motor starting torque test.

123. Remove spectacle and apply torque wheel to semaphore shaft. Attach one end of cord to torque wheel and pass it part way around periphery of torque wheel in the direction that a weight suspended by the cord will tend to move mechanism toward the zero degree positon.

124. With a weight sufficient to exert a torque equal to the required motor starting torque, attached as provided in Instruction 123, the mechanism must be moved by hand to the position in which test is to be made and apply the prescribed voltage at the motor terminal which should drive the motor.

125. Test must be made at a sufficient number of points in the arc of travel of the spectacle to insure that the motor will start the mechanism with the required foot-pounds torque when the prescribed voltage is applied at the motor terminals.


10401 MECHANICAL SEMAPHORE SPECTACLE COMPL. (WITHOUT ROUNDELS)
10402 ELECTRIC SEMAPHORE SPECTACLE COMPL. (WITHOUT ROUNDELS)
NOTE: 10402 FURNISHED WITHOUT STOPS OR STUD.
A = MAXIMUM MECHANISM FRICTION LINE.
B = MINIMUM TORQUE LINE FOR ELECTRIC SEMAPHORE WITH ROUNDELS AND WITHOUT BLADE OR BLADE FASTENINGS.
TORQUE IN FOOT POUNDS
DEGREES
NO. 12 U.S. ST'D GA. SHEET STEEL (.1093") 4.4625 LBS PER SQ.FT., WEIGHT OF PIECE FINISHED FOR ASSEMBLY, 11 POUNDS.
VIEW OF STOP "B"
VIEW OF STOP "C"
(CAST IRON HUB)
(FOR 8 3/8" ROUNDEL)
SECTION D-D
BOSSES "A" 3/16 THICK.
7 3/4" DIA.
10415
10416
0 3 6 9 - INCHES
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE
SEMAPHORE SPECTACLE - DESIGN "A"
RSA 1040
MANUAL - MAY 1913 | OCT. 1912 | OCT. 1911 | OCT. 1909

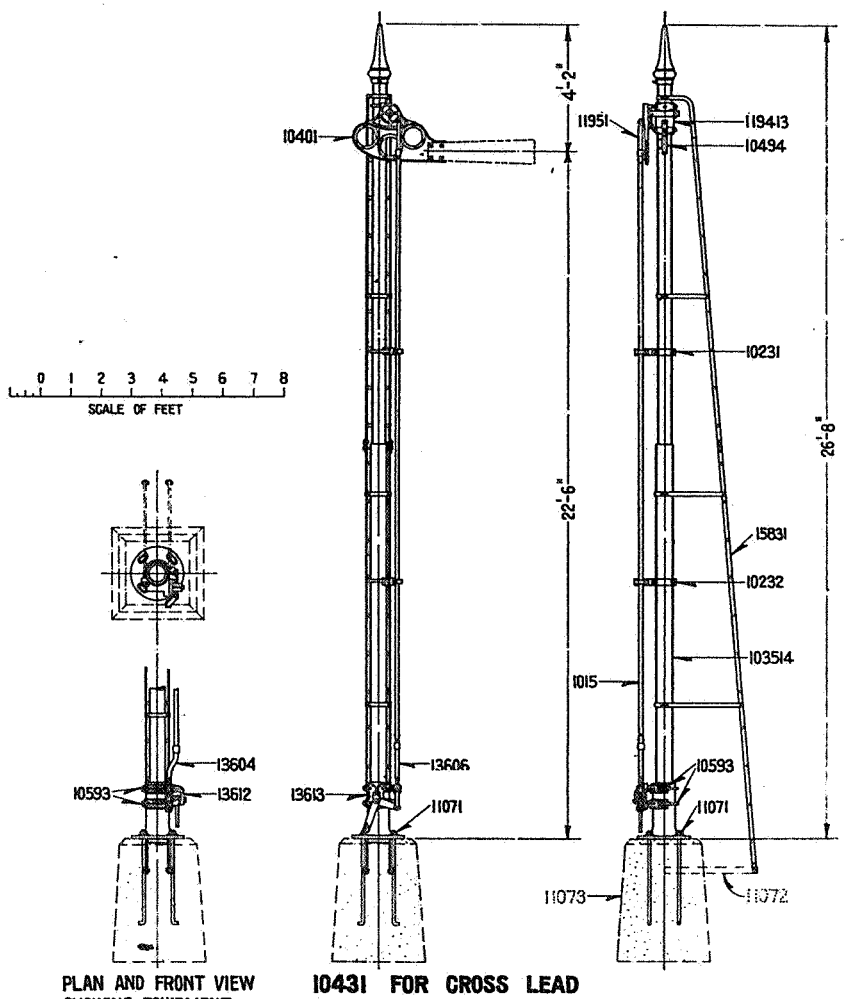


NOTE: MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A. SIG. SEC. SPECIFICATION.

SEMAPHORE SPECTACLE

ARA SIG. SEC 1041 B

						MAR 1926	SEP 1924	MANUAL-MAY 1913	OCT. 1912	OCT. 1911	OCT. 1909



PLAN AND FRONT VIEW SHOWING EQUIPMENT FOR PARALLEL LEAD.

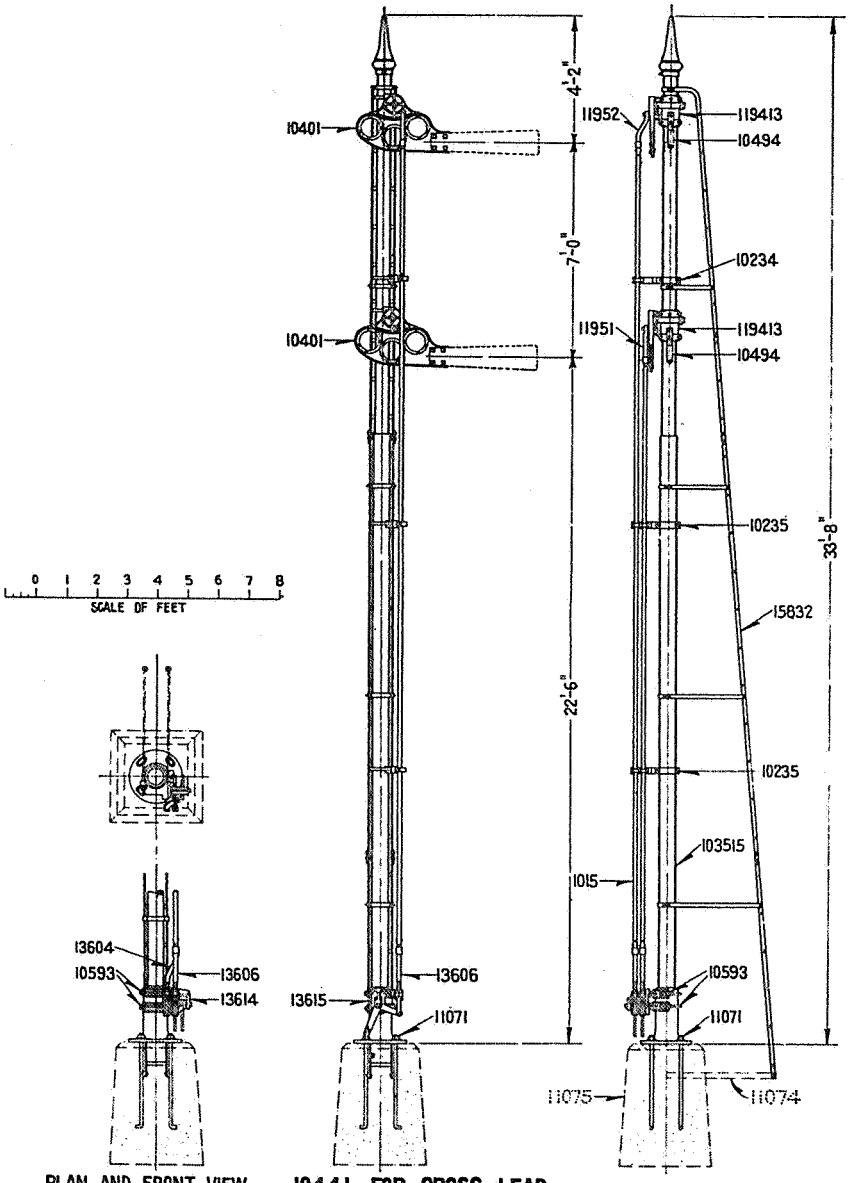
10431 FOR CROSS LEAD
10432 FOR PARALLEL LEAD

NOTE: MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A. SIG. SEC. SPECIFICATION

ONE-ARM MECHANICAL GROUND SIGNAL.

ARA SIG. SEC. 1043B

M-1926 | SEP. 1925 | SEP. 1915 | DEC. 1910



PLAN AND FRONT VIEW SHOWING EQUIPMENT FOR PARALLEL LEAD.

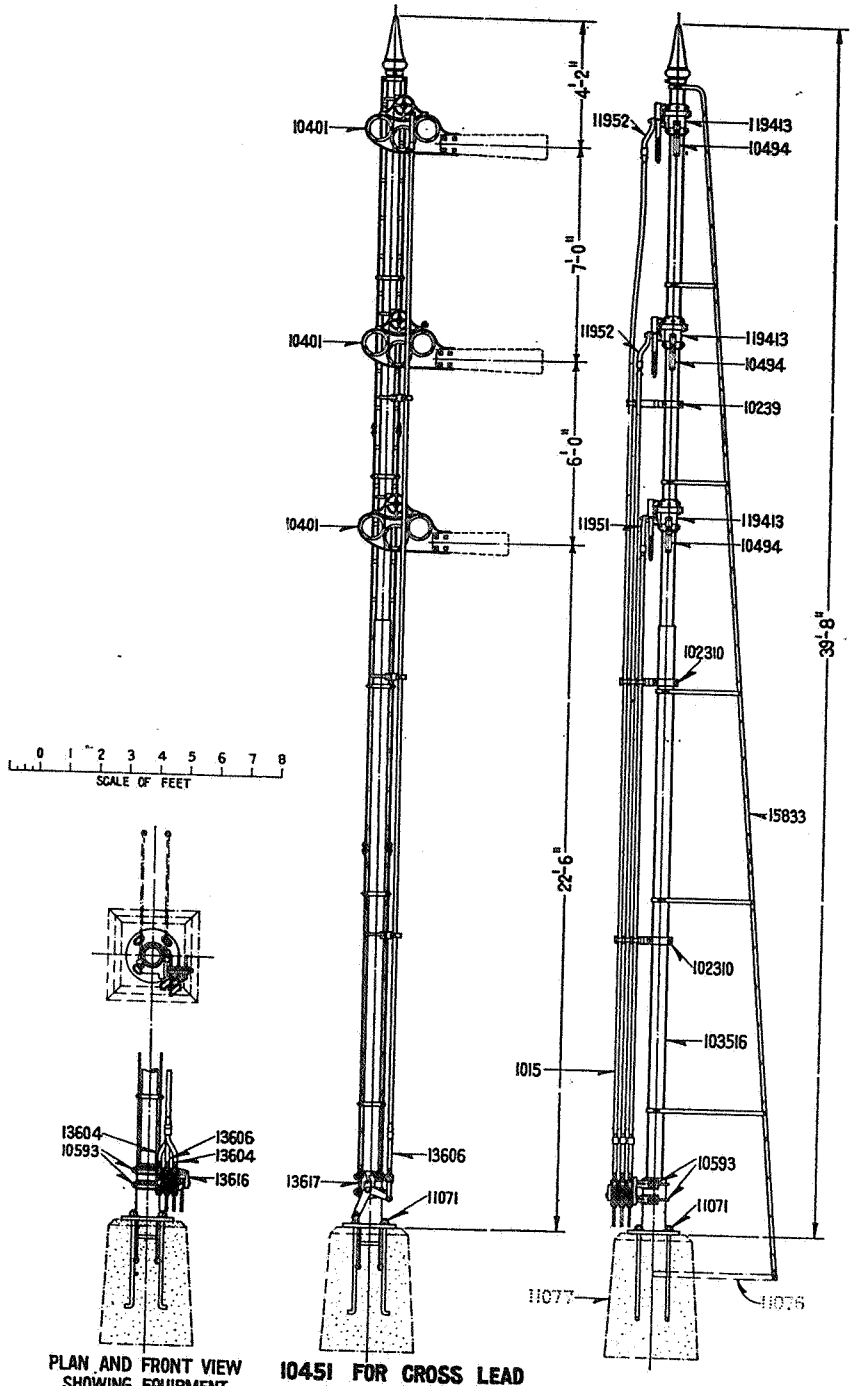
10441 FOR CROSS LEAD
10442 FOR PARALLEL LEAD

NOTE: MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A. SIG. SEC. SPECIFICATION

TWO-ARM MECHANICAL GROUND SIGNAL

ARA SIG. SEC. 1044B

M-1926 | SEP. 1925 | SEP. 1915 | DEC. 1910



PLAN AND FRONT VIEW SHOWING EQUIPMENT FOR PARALLEL LEAD.

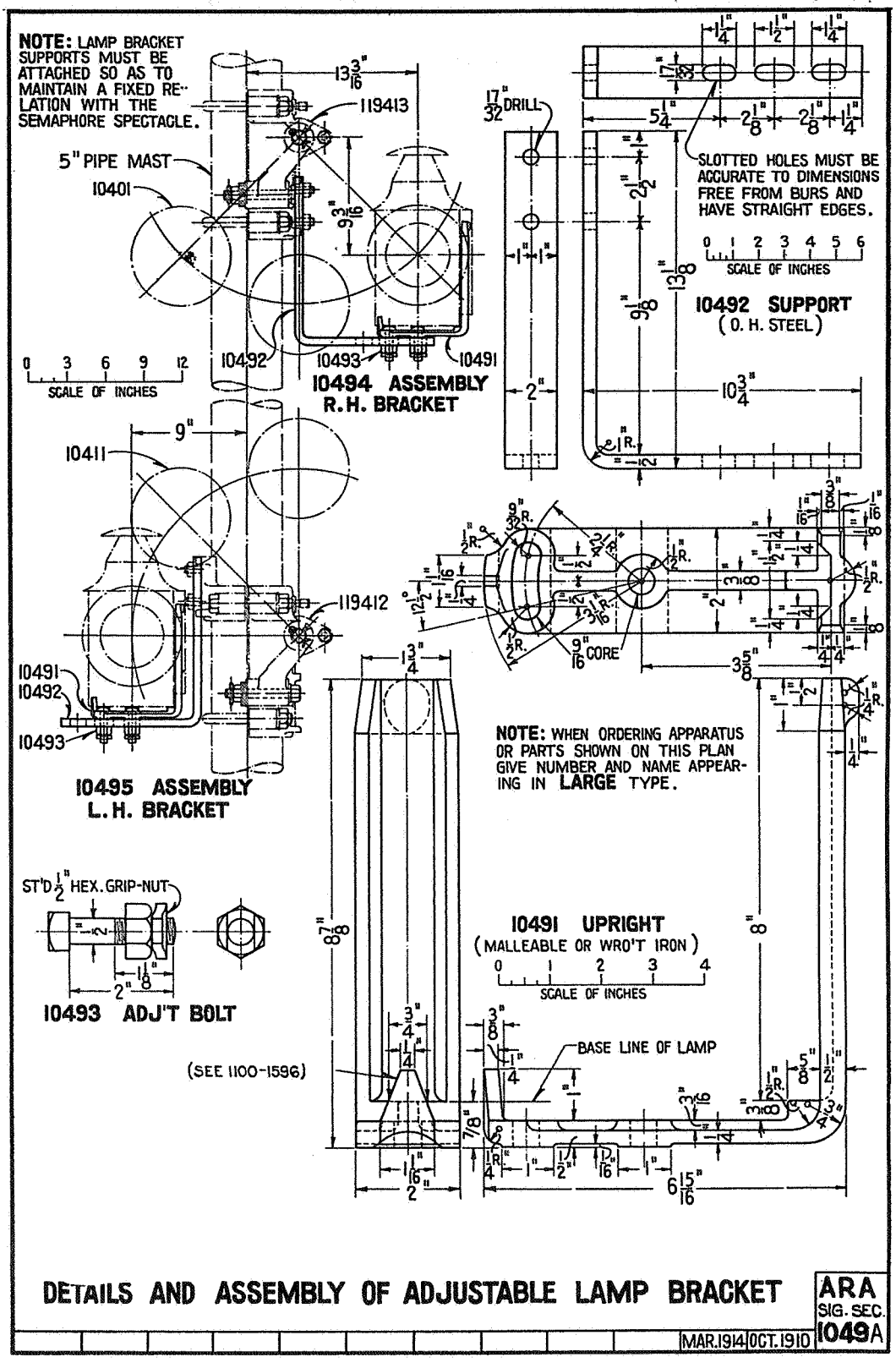
10451 FOR CROSS LEAD
10452 FOR PARALLEL LEAD

NOTE MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A. S.S. SEC SPECIFICATION.

THREE-ARM MECHANICAL GROUND SIGNAL

M-1926 | SEP. 1925 | SEP. 1915 | DEC. 1910

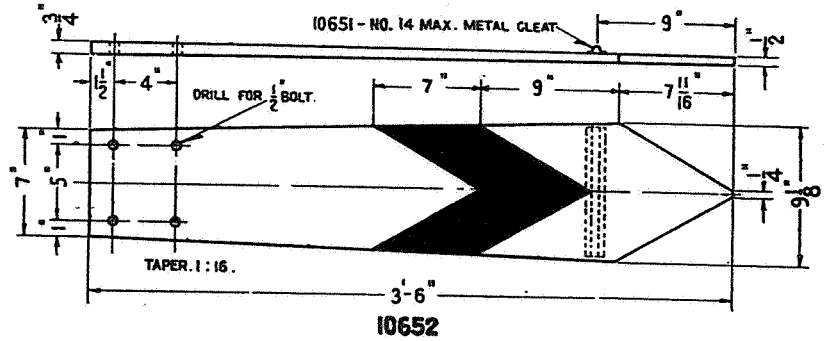
ARA SIG. SEC. 1045B



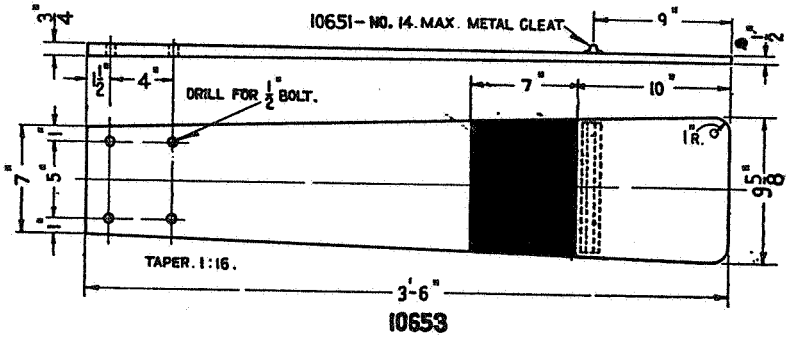
DETAILS AND ASSEMBLY OF ADJUSTABLE LAMP BRACKET

ARA SIG. SEC. 1049A

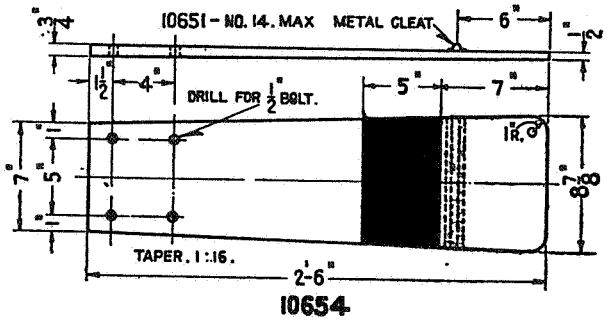
MAR. 1914 OCT. 1910



10652



10653



10654

COLOR FRONT { **RED** WITH **WHITE** STRIPE
YELLOW WITH **BLACK** STRIPE

COLOR BACK AND EDGES SAME AS STRIPE.

0 3 6 9 12
SCALE OF INCHES

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

WOOD SIGNAL BLADES

RSA 1065

MAN'L 1924 | MAR. 1923 | MAR. 1918 | SEP. 1915 | MAY 1915 | M-8-1914 | OCT. 1911

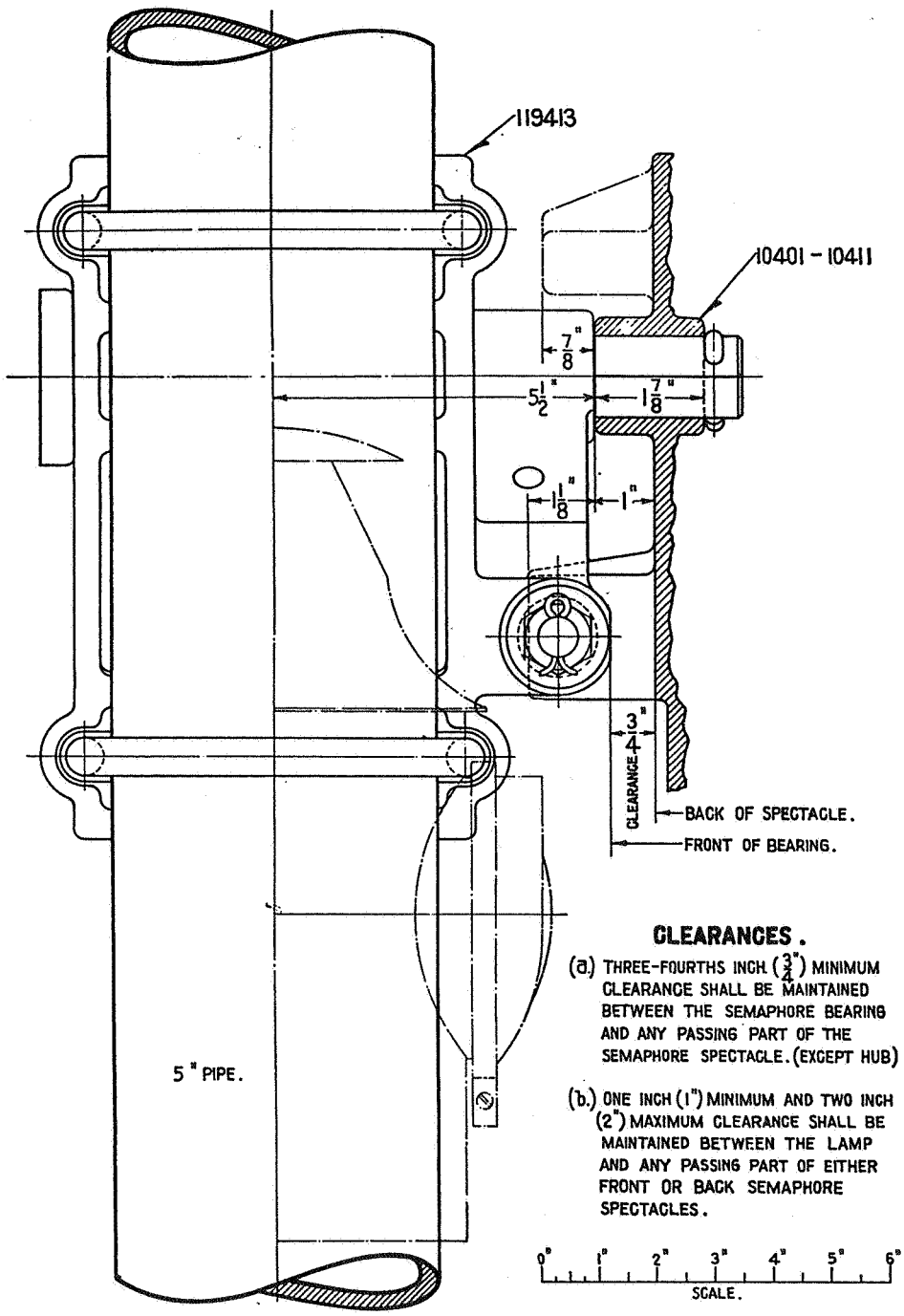
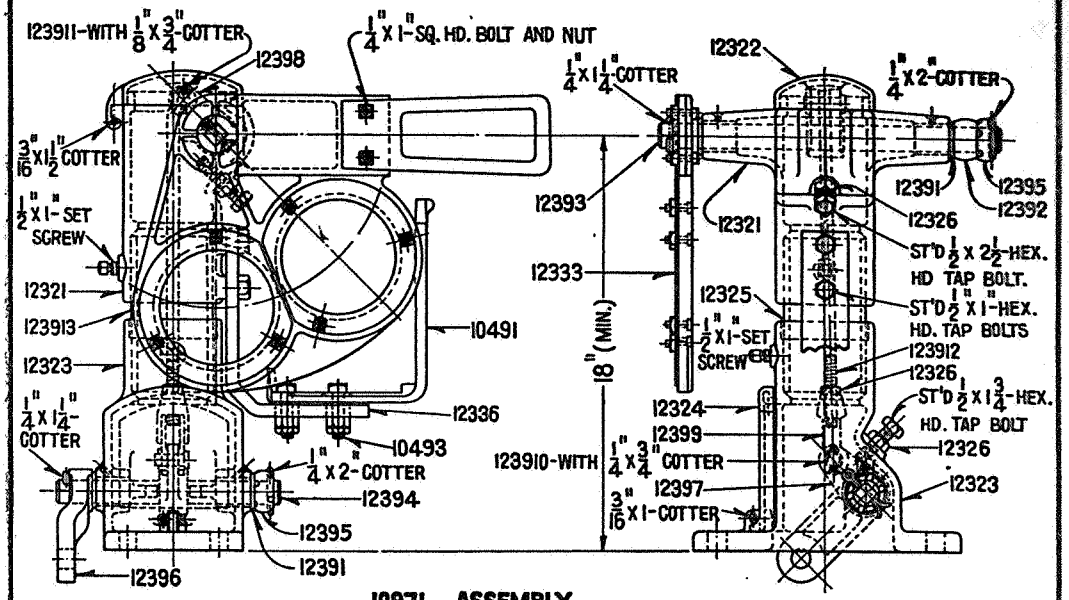


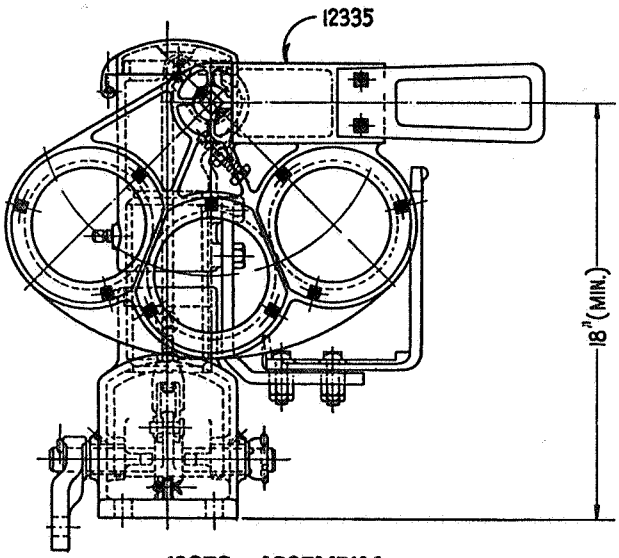
DIAGRAM OF SPECTACLE CLEARANCE

RSA 1093

MANUAL-DEC. 1913 OCT. 1911



10971 ASSEMBLY
WITH 2-POSITION SPECTACLE
AND WITHOUT ROUNDELS



10972 ASSEMBLY
WITH 3-POSITION SPECTACLE
AND WITHOUT ROUNDELS

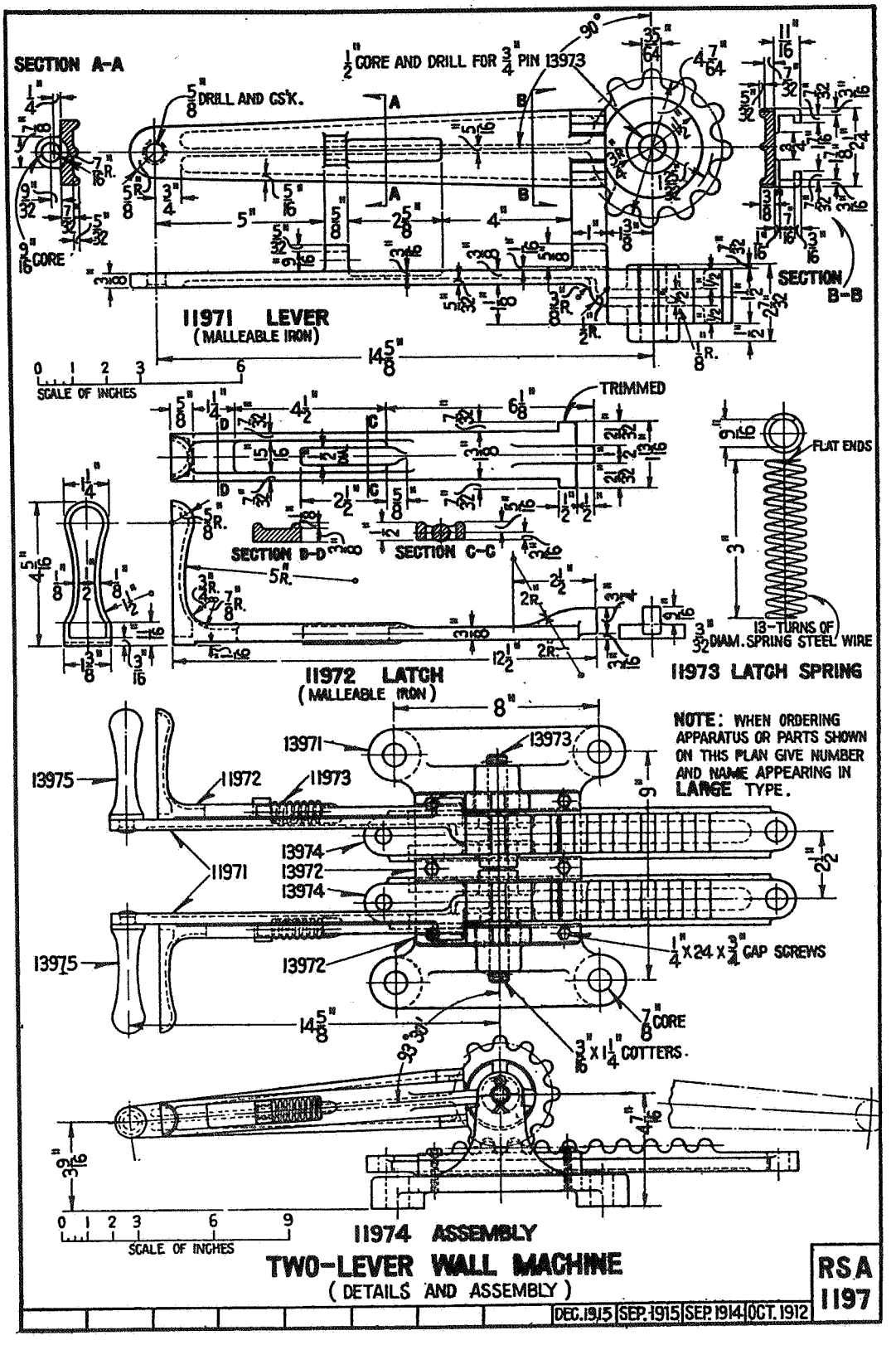
0 3 6 9 12
SCALE OF INCHES

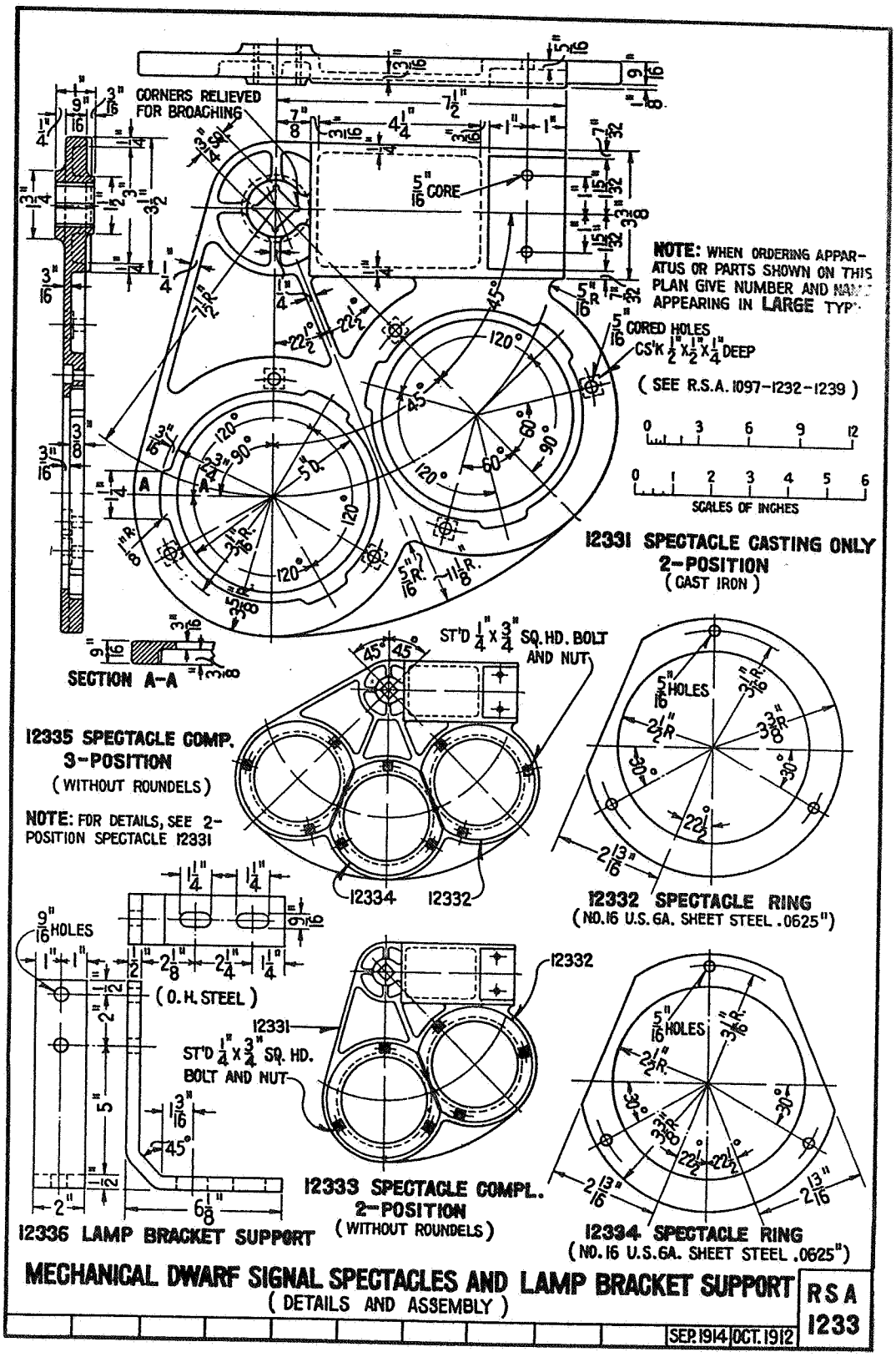
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE (SEE R.S.A. 1232-1233-1239)

MECHANICAL DWARF SIGNALS
(ASSEMBLY)

RSA 1097

SEP. 1914 | OCT. 1912 | OCT. 1911


SECTION A-A
½" CORE AND DRILL FOR ¾" PIN 13973
⅝" DRILL AND CS'K.
SECTION B-B
11971 LEVER
(MALLEABLE IRON)
SCALE OF INCHES
TRIMMED
SECTION B-D
SECTION C-C
FLAT ENDS
13-TURNS OF
DIAM. SPRING STEEL WIRE
11972 LATCH
(MALLEABLE IRON)
11973 LATCH SPRING
NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN LARGE TYPE.
13971
13973
13975
11972
11973
13974
11971
13972
¼" X 24 X ¾" CAP SCREWS
⅞" CORE
3/16" X 1¼" COTTERS.
11974 ASSEMBLY
TWO-LEVER WALL MACHINE
(DETAILS AND ASSEMBLY)
RSA 1197
DEC. 1915 SEP. 1915 SEP. 1914 OCT. 1912

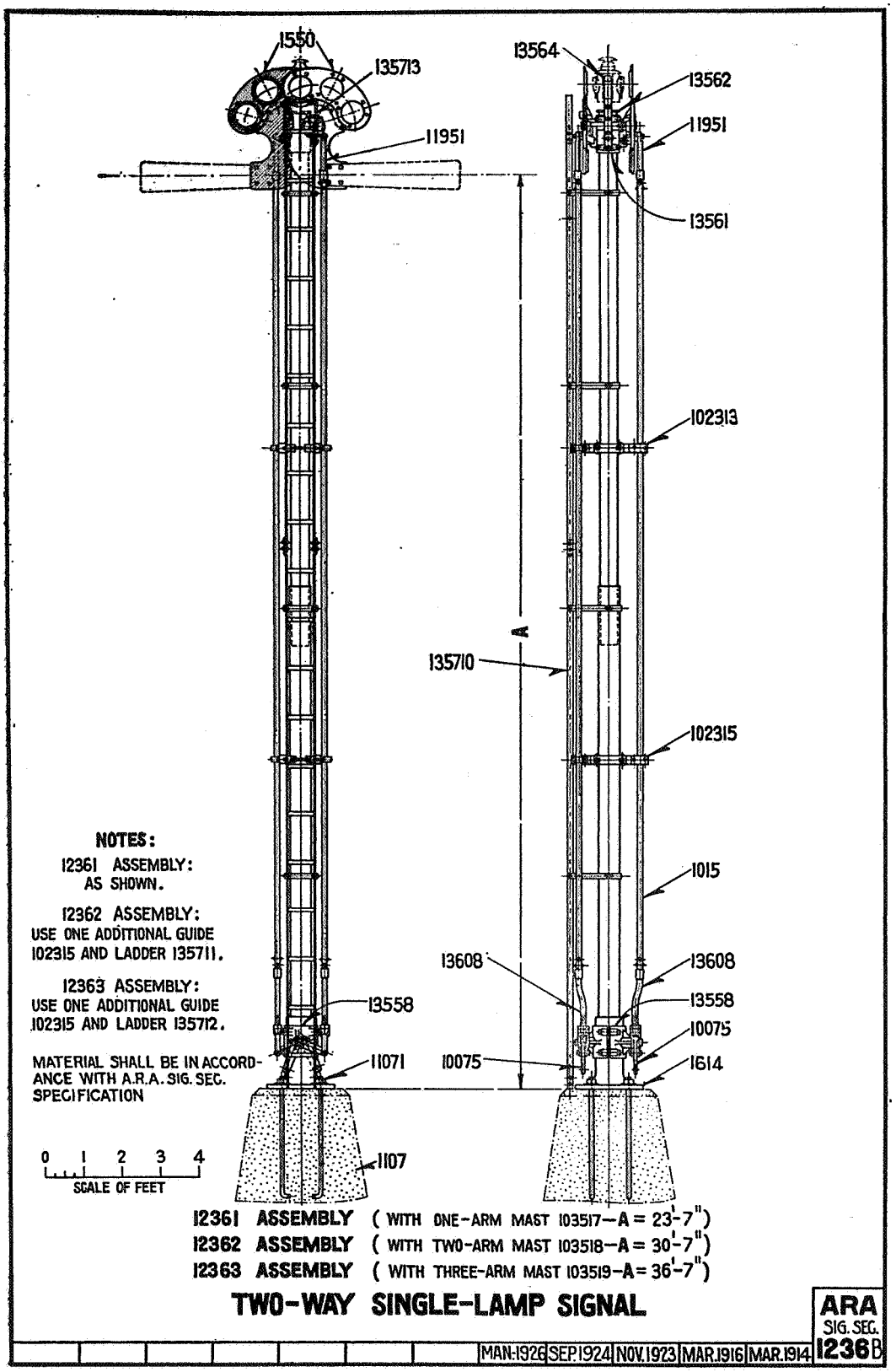


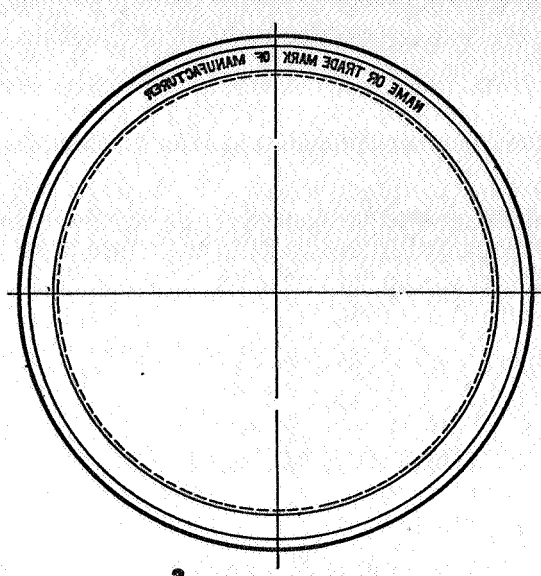
MECHANICAL DWARF SIGNAL SPECTACLES AND LAMP BRACKET SUPPORT

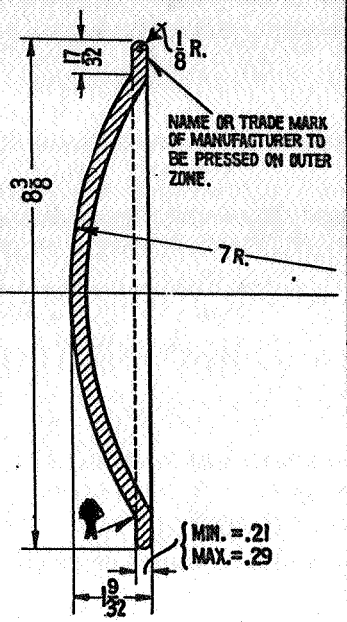
(DETAILS AND ASSEMBLY)

RSA 1233

SEP. 1914 OCT. 1912


1550
135713
11951
13564
13562
11951
13561
102313
A
135710
102315
1015
13608
13608
13558
13558
10075
1614
10075
11071
1107
NOTES:
12361 ASSEMBLY:
AS SHOWN.
12362 ASSEMBLY:
USE ONE ADDITIONAL GUIDE
102315 AND LADDER 135711.
12363 ASSEMBLY:
USE ONE ADDITIONAL GUIDE
102315 AND LADDER 135712.
MATERIAL SHALL BE IN ACCORD-
ANCE WITH A.R.A. SIG. SEC.
SPECIFICATION
0 1 2 3 4
SCALE OF FEET
12361 ASSEMBLY (WITH ONE-ARM MAST 103517—A = 23'-7")
12362 ASSEMBLY (WITH TWO-ARM MAST 103518—A = 30'-7")
12363 ASSEMBLY (WITH THREE-ARM MAST 103519—A = 36'-7")
TWO-WAY SINGLE-LAMP SIGNAL
ARA
SIG. SEC.
1236B
MAR.1914
MAR.1916
NOV.1923
SEP.1924
MAR.1926





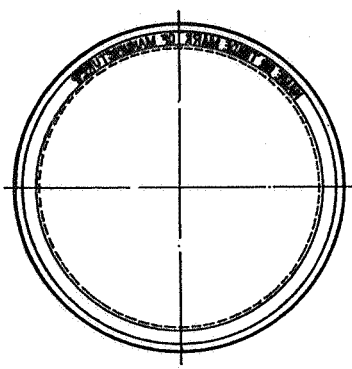
8 3/8 CONVEX ROUNDEL
HIGH TRANSMISSION GLASS

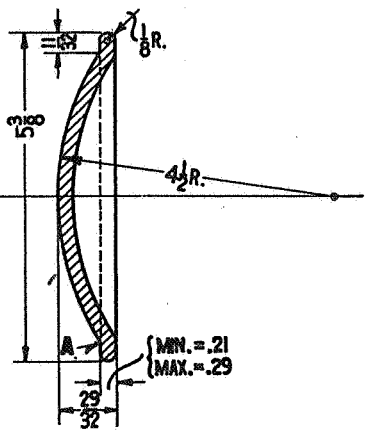
0 1 2 3 4 5
SCALE

NOTES:
SCALE AND ALL DIMENSIONS ARE GIVEN IN INCHES.

REINFORCING BEAD MAY BE USED AT 'A'.

WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE.

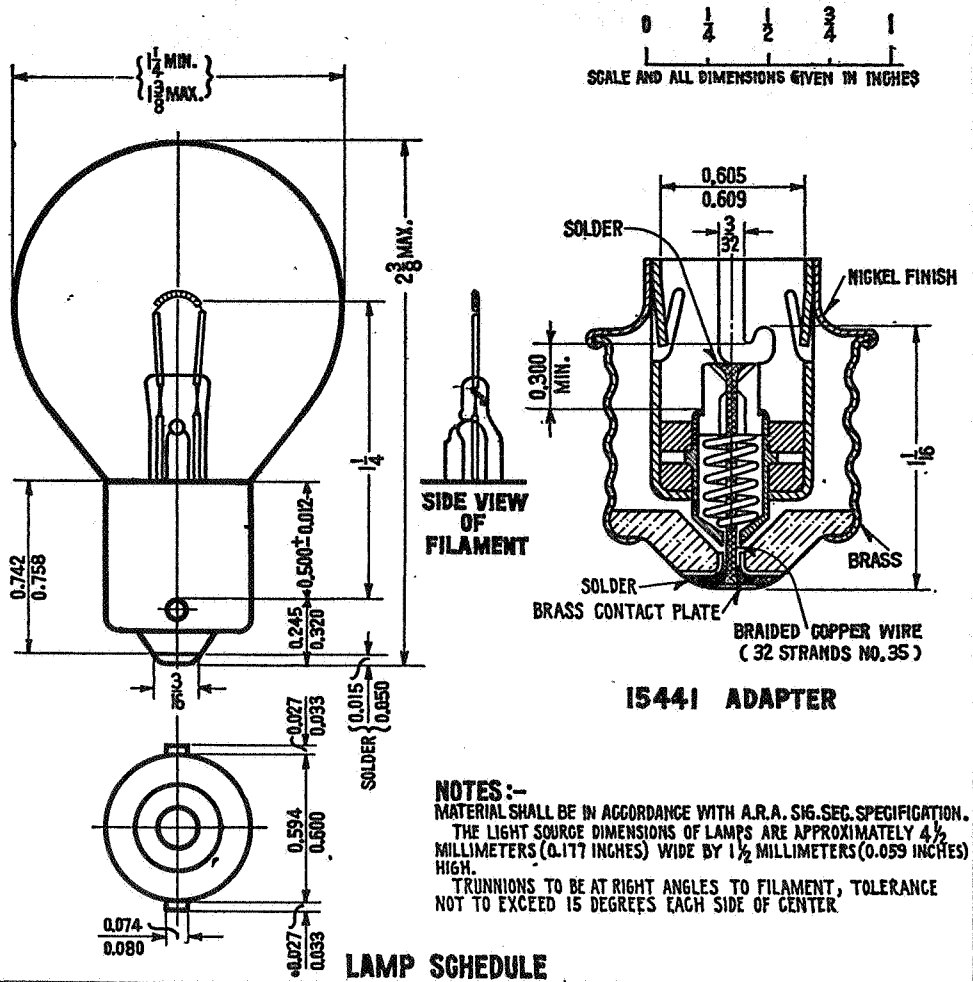




5 3/8 CONVEX ROUNDEL
HIGH TRANSMISSION GLASS

DIAMETER	REF. NOS. FOR SIZE AND COLORS					
	RED	YELLOW	GREEN	LUNAR WHITE	PURPLE	BLUE
5 3/8	14141	14142	14143	14144	14145	14146
8 3/8	14147	14148	14149	14140	14141	14142

ROUNDELS FOR SIGNALS



15441 ADAPTER

NOTES:-
MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A. SIG.SEC. SPECIFICATION.
THE LIGHT SOURCE DIMENSIONS OF LAMPS ARE APPROXIMATELY 4½ MILLIMETERS (0.177 INCHES) WIDE BY 1½ MILLIMETERS (0.059 INCHES) HIGH.
TRUNNIONS TO BE AT RIGHT ANGLES TO FILAMENT, TOLERANCE NOT TO EXCEED 15 DEGREES EACH SIDE OF CENTER.

LAMP SCHEDULE

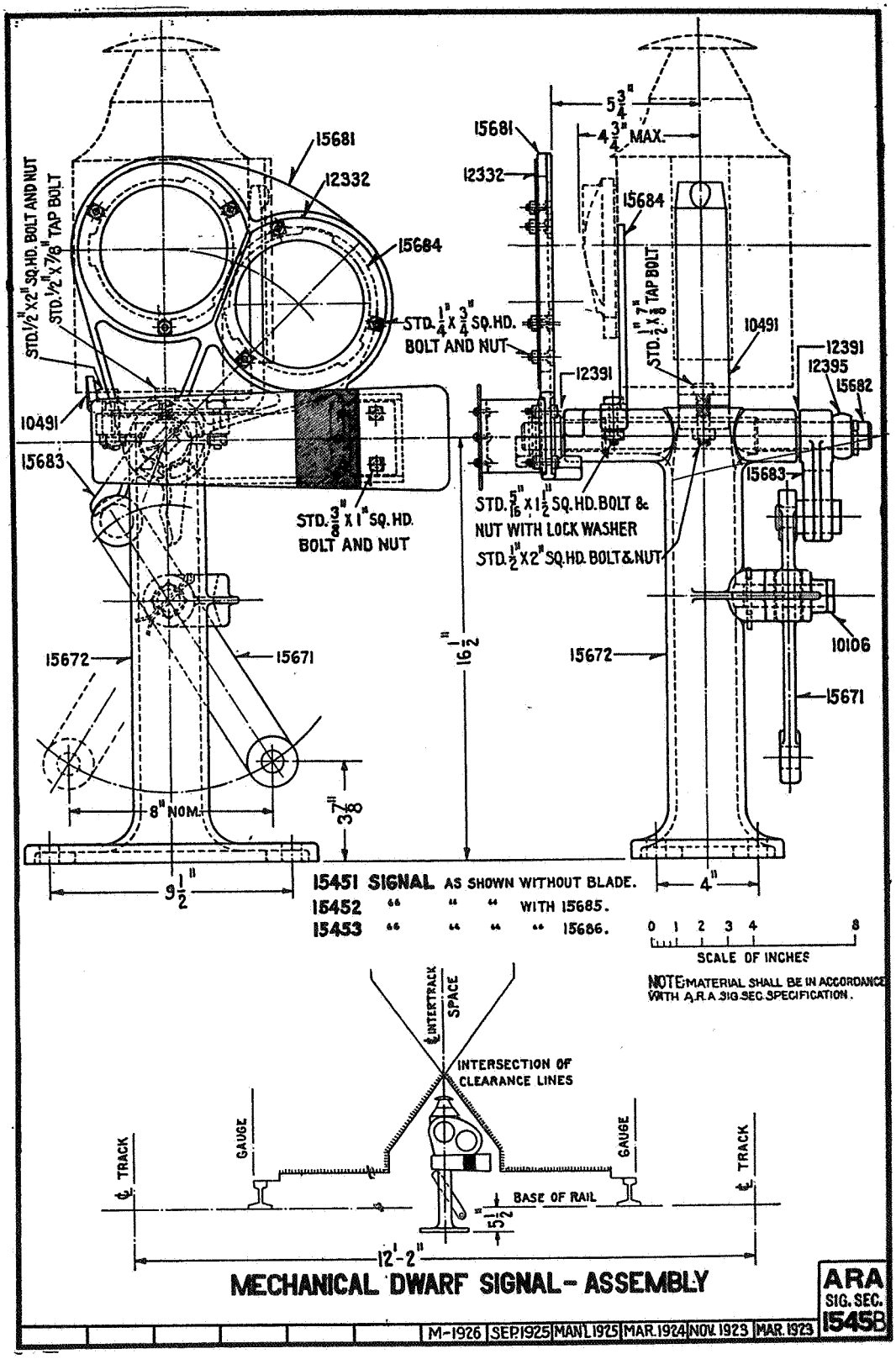
GENERAL APPLICATION	ORDER NO.	VOLTS	AMPS.	WATTS	BULB	BASE	FILAMENT	RATED AVERAGE LIFE (HOURS)	MAXIMUM VARIATION IN LIGHT CENTER LENGTH AND AXIAL ALIGNMENT (INCHES PLUS OR MINUS)		
									COMMERCIAL	COMMERCIAL PRECISION	SPECIAL
* NIGHT INDICATION, INCLUDING SWITCH LAMPS, SEMAPHORES, WIG-WAG HIGHWAY CROSSING AND CROSSING GATES.	15443	3.5	.3		S-11	S.C.	C-2	1000	4/64	2/64	
	15444	10.	.25		S-11	S.C.	C-2	1000	4/64	2/64	
	15445	13.5	.25		S-11	S.C.	C-2	1000	4/64	2/64	
	15446	10.		5	S-11	S.C.	C-2	1000	4/64	2/64	
DAY AND NIGHT INDICATION, INCLUDING LIGHT SIGNALS AND HIGHWAY CROSSING FLASHING SIGNALS.	15446	10.		5	S-11	S.C.	C-2	1000	4/64	2/64	1/64
	15447	10		10	S-11	S.C.	C-2	1000	4/64	2/64	1/64
	15448	10.		18	S-11	S.C.	C-2	1000	4/64	2/64	1/64

* **15442** — 3.5 VOLT, .12 AMPERE, IS AVAILABLE BUT ITS USE FOR SWITCH LIGHTING HAS NOT BEEN EXTENSIVE ENOUGH TO DATE TO GIVE IT A PLACE IN THE ABOVE SCHEDULE.

INCANDESCENT ELECTRIC LAMPS AND ADAPTER

A R A SIG. SEC. 1544 B

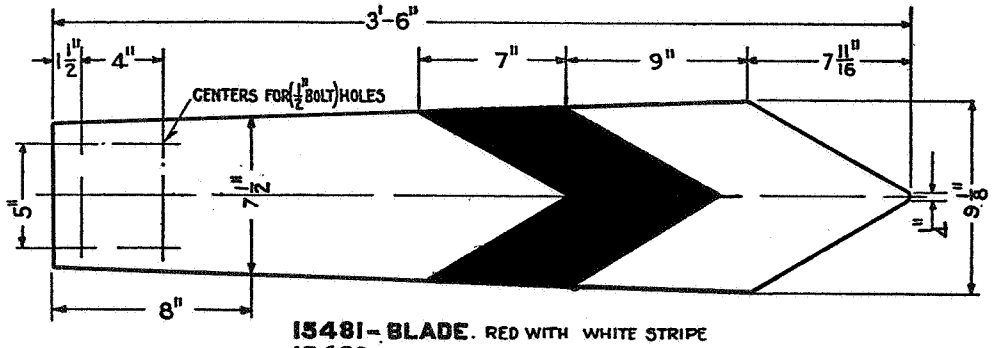
M-1929 | MAR. 1929 | SEP. 1928 | MAR. 1925 | MAR. 1924 | NOV. 1923 | MAR 1923



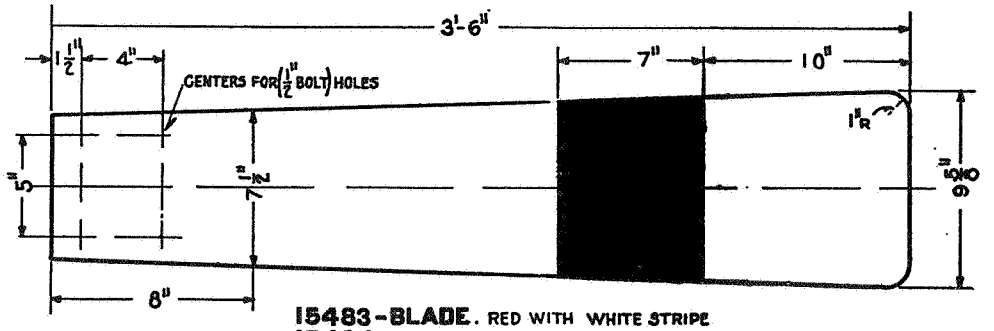
MECHANICAL DWARF SIGNAL - ASSEMBLY

ARA SIG. SEC. 15458

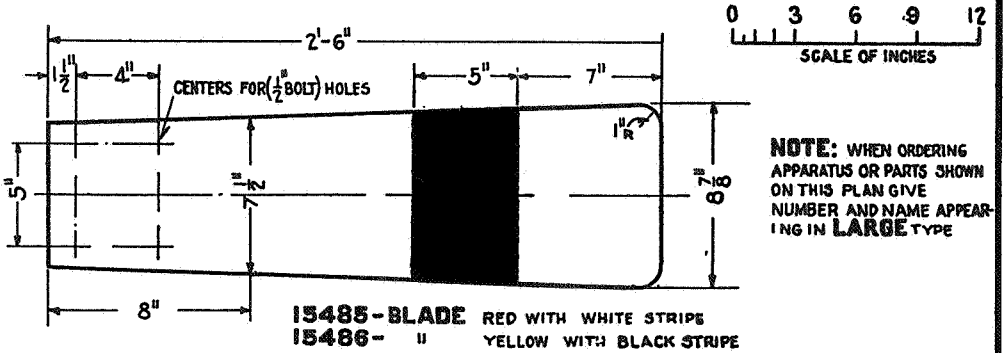
M-1926 | SEP.1925 | MAN'L 1925 | MAR.1924 | NOV. 1923 | MAR. 1923



15481-BLADE. RED WITH WHITE STRIPE
15482- " YELLOW WITH BLACK STRIPE

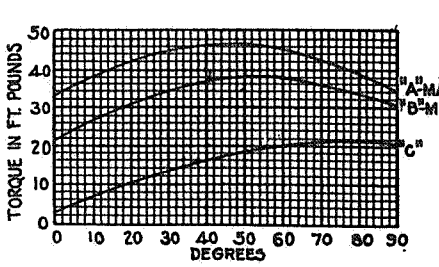


15483-BLADE. RED WITH WHITE STRIPE
15484- " YELLOW WITH BLACK STRIPE.



15485-BLADE RED WITH WHITE STRIPE
15486- " YELLOW WITH BLACK STRIPE

NOTE: WHEN ORDERING APPARATUS OR PARTS SHOWN ON THIS PLAN GIVE NUMBER AND NAME APPEARING IN **LARGE** TYPE



CURVES "A" AND "B" FOR BLADE, SPECTACLE AND ROUNDELS, 0°-90°
CURVE "C" FOR SPECTACLE AND ROUNDELS (WITHOUT BLADE AND FASTENINGS) 0°-90°

1. BLADES SHALL BE MADE OF OPEN HEARTH ENAMELING STEEL AND ENAMELED WITH NOT LESS THAN THREE (3) COATS OF VITREOUS ENAMEL
2. COLOR BACK OF ALL BLADES BLACK.
3. UNLESS OTHERWISE SPECIFIED, BLADES SHALL BE FURNISHED WITH FASTENINGS TO FIT A.R.A STANDARD SEMAPHORE SPECTACLE

WIND PRESSURE TEST

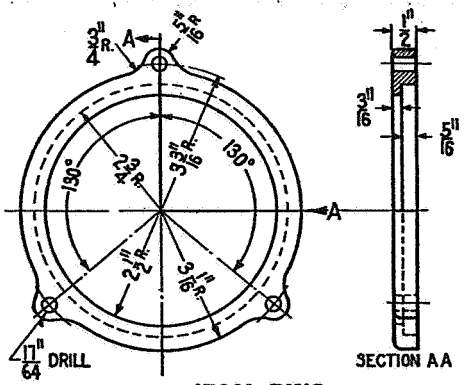
ATTACH THE BLADE TO A.R.A. STANDARD SEMAPHORE SPECTACLE; WITH SURFACES OF BLADE, FIRST THE FRONT AND THEN THE BACK, PARALLEL TO AND TOWARDS THE FLOOR. APPLY A LOAD OF 60 LBS AT THE GEOMETRIC CENTER OF THAT PORTION OF THE BLADE EXTENDING BEYOND THE FASTENINGS

DURING EITHER OF THE ABOVE TESTS, THE BLADE SHALL NOT TAKE A PERMANENT SET.

ENAMELED STEEL SIGNAL BLADES

ARA SIG. SEC. 1548

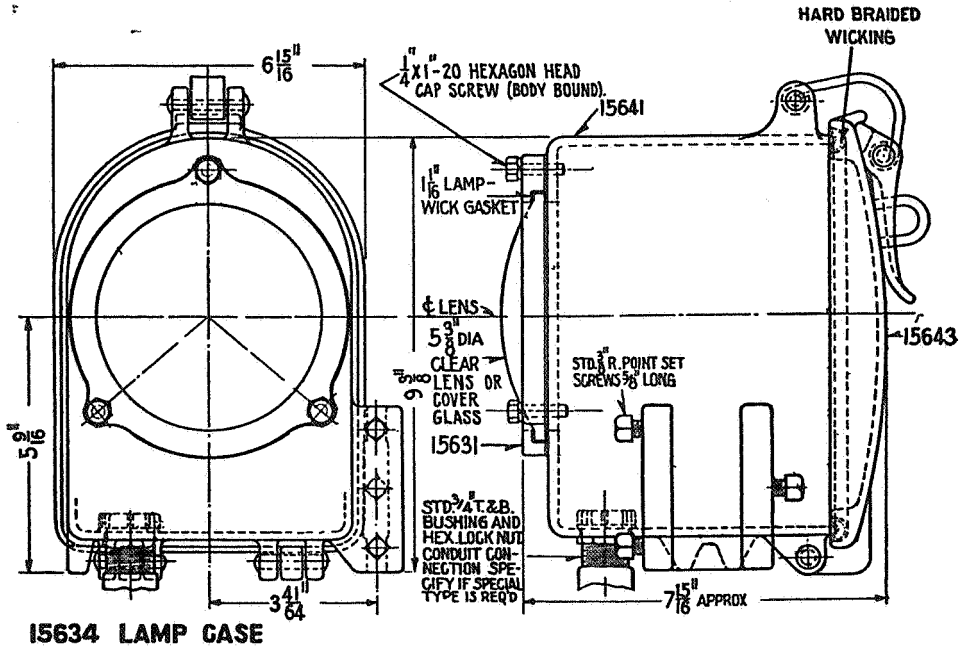
MAR. 1925 MAR. 1924 NOV. 1923



15631 RING
CAST IRON

SCALE OF INCHES

NOTE:-MATERIAL SHALL BE IN ACCORDANCE WITH A.R.A SIG.SEC. SPECIFICATION



15634 LAMP CASE

ELECTRIC LAMP CASE

ARA SIG. SEC. 1563B

M-1929 SEPT. 1928 MAN-1926 MAR. 1925 SEP. 1924

American Railway Signaling Principles and Practices

QUESTIONS ON

CHAPTER XII

Semaphore Signals

QUESTIONS ON CHAPTER XII

SEMAPHORE SIGNALS

General

Historical.

1. When and by whom was the first semaphore type of signal designed and erected?
2. How were the first semaphore type signals operated, and why?
3. Why were counterweights added to the arm or spectacle?
4. Were the earlier types of semaphore signals of the upper or lower quadrant type?
5. Were the arms displayed to the right or left of the masts in England and on the Continent?
6. How did practice differ in America, and why?
7. When was the upper-quadrant semaphore type signal introduced and how extensive is its use?

Indications.

8. How are the day indications of the semaphore signal displayed?
9. How are the night indications displayed?

Blades.

10. Of what materials are blades constructed and what are their usual colors?
11. What shapes are the ends of blades and on what do they depend?

Spectacles and roundels.

12. How are blades and roundels applied to the spectacles?
13. What minimum clearance must be maintained between a semaphore bearing and spectacle?

Lamp and bracket.

14. How is the lamp which provides the night aspect mounted?
15. What kinds of lamps may be used?
16. How are oil lamps usually fitted?
17. When a long time burner lamp is properly fitted and filled, how long will the oil supply permit it to burn?
18. What grade of oil is required in long time burning lamps?
19. How are oil burning lamps sometimes converted into electric lamps?
20. What is substituted for the lamp socket in some cases?
21. What minimum clearance must be maintained between the lamp and the semaphore spectacle?

Mechanical Signals

22. Of what do mechanically-operated semaphore signals consist?

Dwarf Signals

23. For what are dwarf signals used?
24. How are they operated?
25. Why is a spring attachment used on all types, except pipe-connected signals, to return the spectacle to its most restrictive position?

Train Order Signals

26. Where and for what purpose are train order signals used?
27. Of what does a train order signal consist?
28. How are train order signals operated?

Electro-Mechanical Slotted Signals

29. How is track circuit control of mechanically-operated signals sometimes accomplished?
30. Describe one type of slot.
31. How is the slot circuit controlled?
32. What is introduced to check the force with which the arms assume the Stop position?

Power-Operated Signals

Electro-pneumatic.

33. How are electro-pneumatic signals operated?
34. Where are they used mostly?
35. Describe their operation.
36. Into what two general classes are they divided?
37. Describe the operation of what is known as the rack and pinion type.
38. Why is air to the 90 degree cylinder controlled by the 45 degree magnet?
39. How are the circuits controlled in this type of signal?
40. How does the top-of-mast signal operate?
41. How can any of these mechanisms be arranged to operate a two or three-position signal?

Electro-gas.

42. What is used to operate this signal?
43. When was the signal used?
44. Describe its operation.

Electric motor.

45. Of what did the early types of motor-driven signals consist?
46. Where were the mechanisms mounted?
47. How may as many as three arms be operated by a single motor?
48. What type of mechanism was developed as the use of electric motor semaphore signals became more extensive?
49. What is this type known as?
50. What are the advantages of this mechanism?

51. On what kinds of current are base-of-mast and top-of-mast types made to operate?
52. What must be changed if the current is changed?
53. Explain how motors used for direct current operation are connected.
54. What kind of motor is used for alternating current operation?

Types of Mechanisms

Style B.

55. Describe the operation of a two-arm two-position Style B mechanism.
56. What is the purpose of the dash-pot?
57. In what way does the distant slot differ from home slot coil?
58. What is generally the resistance of the low-resistance winding on the distant slot and how is it connected?
59. What is generally the resistance of the high-resistance winding and for what is it used?
60. How are mechanisms of this type furnished for operating one arm only?
61. When polarized control circuits are used, what must be done to the home slot magnets?
62. How are the home slot magnets made slow-acting?
63. What is the action of a copper sleeve over the core of a magnet inside the coil?
64. Describe the operation of a one-arm three-position Style B signal mechanism.
65. How is the brake of a Style B motor controlled and what is its purpose?
66. In what is the commutator of a Style B motor enclosed, and why?
67. On what kinds of current can Style B mechanisms be made to operate?

Style S.

68. From what did the Style S mechanism develop?
69. On what kinds of current can it be made to operate?
70. What type of magnets and motors are used for alternating current operation?
71. In this signal how many slot-arms are used for each signal arm?
72. How is the air buffer connected and what is the result?
73. Were oil buffers ever used with this mechanism?
74. Describe the operation of the oil buffer?
75. What kind of oil is used in the oil buffer?
76. How does the air buffer cushion movement of the signal from the 90 to the 45 degree position?
77. How does it cushion the movement from the 45 degree to the zero degree position?

78. Where is the main circuit controller located?
79. Describe the main circuit controller.
80. Where are other circuit controllers located?
81. How does the slot-arm compare with that of the Style B signal?
82. How many chains are used and what is their purpose?
83. How is the slot-arm supported in the 45 or 90 degree position?
84. How is the motor applied?

Model 2-A.

85. In what types and for what aspects can 2-A signals be made?
86. On what kinds of current will it operate?
87. Is the mechanism practically the same for base-of-mast or top-of-mast signals?
88. How is the motor connected to the semaphore shaft?
89. How many revolutions of the motor are required to clear the signal to the 90 degree position?
90. How is the direct current signal held in the 45 or 90 degree position?
91. Of what does the retaining device consist?
92. What does the design of this device embody?
93. How is a high drop-away procured?
94. What means may be used for snubbing the movement of the signal blade?
95. How is this snubbing accomplished?
96. For alternating current operation, what type of motor is used?
97. What is the hold clear mechanism and how does it operate?
98. Describe the motor.
99. Are the same parts used in the base-of-mast signal as in the direct-connected type?
100. Where is the 110-volt direct current Model 2-A signal chiefly used, and why?
101. When is the signal equipped with a spring to produce rotation of the motor armature and what is its purpose?

Style T-2.

102. In what type is the Style T-2 signal made and of what does it consist?
103. What special feature makes it possible to control this signal to the 45 degree position without a relay?
104. When returning to the Stop position, what causes the motion of the semaphore arm to be retarded?
105. Describe the operation of the holding mechanism.
106. Describe the combination motor and holding slot used on alternating current.

Style L.

107. In what types is the Style L signal made and on what kinds of current will it operate?

108. How is the motor connected to the semaphore shaft?

109. Where is the retaining device for holding the signal in the 45 or 90 degree position located?

110. Of what does this device consist?

111. How does it operate?

112. Is a circuit controller provided?

113. What parts must be changed if a change in current for operation is to be made?

Typical mechanism wiring.

114. Draw a diagram showing the mechanism wiring of a Style B signal.

115. Draw a diagram showing the mechanism wiring of a Style S signal.

116. Draw a diagram showing the mechanism wiring of a Model 2-A signal.

117. Draw a diagram showing the mechanism wiring of a Style T-2 signal.

118. Draw a diagram showing the mechanism wiring of a Style L signal.

Maintaining and Testing Motor Semaphore Signals

General.

119. How must the mast be set and signal aligned?

120. How must blades, lenses and roundels be kept?

121. How must the lamp bracket be fastened and adjusted?

122. What clearance must be maintained between all parts of lamp and spectacle?

123. How must ladders, hand railings and platforms be kept?

124. How must the base of ladder be secured?

125. How must movable parts of the signal move?

126. How must the spectacle casting rest when in the most restrictive position?

127. What must be done before signals may be placed in service?

128. How must bearings be kept?

129. How must semaphore shaft bearings be lubricated?

130. When cone clutches are used in signals, how must they be kept?

131. How must bearings and movable parts be oiled?

132. How must mechanism be kept?

133. On what voltage must slot or equivalent device release?

134. What minimum air gap between moving and fixed members of slot or retaining device must be maintained, and how must these members be kept?

135. How must electrical contacts be cared for?

136. What must be used to clean contacts?

137. Why must buffing be effective and at the proper time?

138. What clearance must be maintained between the armature and field pieces on direct current motors and between rotor and stator on alternating current motors?

139. In what condition must commutator be kept and what attention does is require?

140. If an abrasive cloth or paper is necessary on mechanism or motor, what must be used?

141. What attention must be given motor brushes?

142. What attention do counters require and should they be oiled?

143. How must wires be arranged?

144. At what time each year must buffers be cleaned and when must they be lubricated?

145. What attention must be given doors of mechanism cases?

146. In what condition must mechanism cases be kept?

147. What attention must be given to bolts, nuts and cotters?

148. What must be done with broken or cracked roundels?

149. What must be done before work that may interfere with the safe movement of trains may be started?

150. How must circuit controller contacts be kept?

151. Must circuits be kept free from grounds?

152. How must signal apparatus be tested?

153. To what extent must manufacturers' instructions be followed?

Styles S and B Motor Signals

General.

154. How must brushes be set?

155. How must contact tips on circuit controllers be kept?

156. What kind of contact must tips on circuit controller springs make on contact posts?

157. What attention must be given to the lubrication of semaphore shafts?

158. What attention must be given to chains and sprockets?

159. Why must the slot toggle adjustment not be changed?

160. How must lifting chains be maintained?

161. How must motor brake be set?

Alternating current—Styles S and B.

162. Why must armature of slot magnet have sufficient end play to allow it to seat firmly against the pole face?

163. Must core pins of slot magnet clear the shading bands?

164. Must all four pins of slot magnet bear on pole face when magnet is energized.

165. May slot armature ride on projecting part of shading bands?

166. How far must shading bands of slot-arm magnets project beyond the pole faces?

Alternating current—Style S.

167. How must motor pinion mesh with driving mechanism?

Direct current—Style B.

168. What is the maximum allowable side play in a slot armature when measured at the lower end and how should air gap be maintained?

Direct current—Styles S and B.

169. How must motor pinion mesh with gear of driving mechanism?

170. How long must slow-acting slots hold without tripping when the circuit is opened with the arm in the 45 degree position with 8 volts at the magnet?

171. How often must tests be made, how recorded, and what values must be maintained?

Buffers, air—Style S.

172. What attention do buffers require?

(a) What lubricant must be used?

(b) How must it be applied?

(c) What must be done to bring top and bottom valves in vertical line?

(d) What must be used in assembling packing box?

(e) How must washers be applied?

(f) What test must be made after buffer is replaced in signal?

173. When is it usually necessary to adjust the valves of the buffers and how is proper buffing thus secured?

174. How can leakage at the stuffing box be overcome?

175. How must piston stem be lubricated?

176. What must be used for removing or replacing stuffing box nut on old style air buffers?

177. How must piston stem be turned?

178. How is proper clearance for the piston secured?

179. If buffer is properly adjusted, what is the maximum period of time it will take signal to move from the 90 to the zero degree position?

Buffers, oil—Style S.

180. What attention do buffers require?

(a) How is buffer cleaned?

(b) What must be done with worn or damaged parts?

(c) How must piston rings work?

(d) How must piston and inside of cylinder be kept?

(e) May old oil be used to refill cylinder? How must oil be kept until used?

(f) What test must be made after buffer is replaced in signal?

181. How must buffers be maintained?

182. What is proper clearance for the piston, and how is it secured?

183. If buffer is properly adjusted, what is the maximum period of time it will take signal to move from the 90 to the zero degree position?

Buffers, air—Style B.

184. What attention do buffers require?

(a) What attention must be given vent screws and ball valves?

(b) What test must be made after buffer is replaced in signal?

185. How often must buffers be lubricated and how is this accomplished?

186. If buffer is properly adjusted, what is the maximum period of time it will take signal to move from the 90 to the zero degree position?

Model 2-A Signals

187. With what oil must semaphore shaft bearings be lubricated?

188. On signals with dynamic indication what tension must be maintained on the storing spring?

189. Where locking dog in main bearing is used, how often must it be lubricated?

190. When assembling mechanisms to pole bearings, what must be done to insure water-tight joints?

191. In what position must semaphore shaft and mechanism be when bolting mechanism to its pole bearing and what must be done to insure that no binding takes place between moving parts?

192. With what oil and when must fibre washers and pawl and ratchet pinion be lubricated?

193. What end play must motor shaft have?

194. What clearance must there be between armature and pole pieces and how is it measured?

195. What is the minimum allowable air gap between pole pieces of the hold clear coil and armature?

196. What air gap must be maintained between the armature and its support when the slot is energized and signal at rest in the 45 or 90 degree position?

197. What must be done to insure that the snub is effective?

198. How must motor friction clutch be adjusted?

199. If tooth disc on motor armature or pawl on retaining device becomes worn, what must be done?

200. How often must tests be made, how recorded, and what values must be maintained?

Style T-2 Signal

201. How must semaphore shaft journals be lubricated?

202. How must the cone clutch be lubricated?

203. What must be done to maintain proper slippage of the cone clutch?

204. How must the stop drum clutch be lubricated, and why?

205. What end play must motor shaft have?

206. What is the maximum allowable pressure of contact springs?

207. How must pressure of a contact spring be increased?

208. What must be done to insure that the snub is effective?

209. How long should it take signal to travel from the 90 to the zero degree position?

210. How must motor friction clutch be adjusted?

211. What air gap must be maintained between rotor and stator and how is it measured?

212. How often must tests be made, how recorded, and what values must be maintained?

Style L Direct Current Signals

213. What clearance must be maintained between motor armature and pole pieces and how it is measured?

214. How must it be determined that the snub is effective?

215. How must motor friction clutch be adjusted?

216. How should the signal be cleaned and oiled and how often must this be done?

217. How must oil-well be filled?

218. Must oil be removed from semaphore shaft gear housing, and why?

219. How must bearings be lubricated?

220. How often must felt weather plate gasket be turned, and why?

221. How often must tests be made, how recorded, and what values must be maintained?

Method of Making Service Test of Motor Semaphore Signals

222. How are instruments to be connected?

223. What conditions must be set up to start the test?

224. How must motor be tested?

225. How must test for minimum clearing values be made?

226. How must test for release values of hold clear device be made?

227. In making tests on 45 degree position of three-position signals, why must the 90 degree operating circuit be opened?

228. In making tests on 90 degree position of three-position signals, must the 45 degree operating circuit be closed?

229. (a) How must test be made with voltmeter to determine if negative ground exists?

(b) How must test be made with voltmeter to determine if positive ground exists?

(c) Must wires be disconnected from both sides of the circuit when testing individual parts or wires?

Method of Making Shop and Field Electrical Torque Test of Motor Semaphore Signals

Direct current motor signals Styles T-2 and L, and Model 2-A (except 110-volt Model 2-A with dynamic indication motors).

230. What instruments are used, and how are they connected?

231. How is the test made?

232. What is the minimum permissible current value which will permit the signal to start backward from a given position?

233. If it is less than the permissible minimum, what must be done?

234. At what positions of the signal must the test be made?

235. What may cause variations in readings?

Alternating current motor signals Style T-2 and Model 2-A.

236. How is the test made?

237. What relation should exist between the voltage which will cause the signal to move upward and the voltage which will just permit it to move downward for Style T-2 signals and for Model 2-A signals?

238. At how many positions of the signal must the test be made and what care must be taken?

239. What may cause variations in readings?

Method of Making Shop Torque Tests at the Semaphore Shaft of Motor Semaphore Signals

Mechanism friction torque test.

240. What instruments are required for the test?

241. For testing without weight of semaphore spectacle:

(a) How is the apparatus connected?

(b) How is the test made?

(c) At how many points in the travel of mechanism must the test be made?

242. For testing with weight of semaphore spectacle:

(a) How is the apparatus connected?

(b) How is the test made?

(c) At how many points in the travel of mechanism must the test be made?

Semaphore spectacle torque test.

243. How should one proceed to test for semaphore spectacle torque—zero to 90 degree position?

244. How should one proceed to test for semaphore spectacle torque—90 to zero degree position?

245. What are true torque curves?

Readings.

246. How may accurate readings of spring balance be obtained without calculation?

247. When and how must readings be taken during the test?

248. How many persons are required to make a torque test and what part must each perform?

249. At what space intervals in the arc of travel of the spectacle must readings be taken and recorded?

Semaphore spectacle counter torque test.

250. How is the apparatus attached to the signal?

251. How is the test made?

252. At how many points in the arc of travel of the spectacle must test be made?

Motor starting torque test.

253. How is the apparatus attached to the signal?

254. How is the test made?

255. At how many points in the arc of travel of the spectacle must test be made?