G. R. S.
MODEL 2A SIGNAL

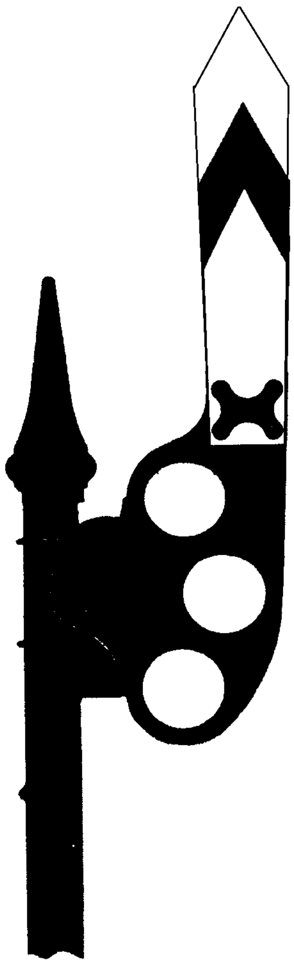
HANDBOOK 2

December 1918

Reprinted
August 1950

GENERAL RAILWAY SIGNAL COMPANY
ROCHESTER 2, NEW YORK, U.S.A.

CONTENTS



G. R. S.
MODEL 2A SIGNAL

BOOKLET 1003A

DECEMBER, 1918

GENERAL RAILWAY SIGNAL COMPANY

ROCHESTER, N. Y.

U. S. A.

New York
Hudson Terminal Building
30 Church Street

Chicago
Peoples Gas Building
122 So. Michigan Avenue

Canadian Agency
General Railway Signal Company
of Canada, Limited
Lachine, Quebec

Australasian Agency
Australian General Railway Signal Co., Ltd.
Dalton Bldg., Sydney,
N. S. W. Australia

MAIN OFFICE AND PLANT, GENERAL RAILWAY SIGNAL COMPANY, ROCHESTER, N. Y., U. S. A.

INTRODUCTION

THE rapid development of railway traffic has created a demand for the power signal in block signaling and interlocking; also the power signal has been developed to meet the increasing requirements and, today, is an important factor in the safe and economical operation of railway trains.

In blocking or spacing trains the power signal, in connection with a track circuit, automatically indicates the presence of a train in the block, a misplaced switch or a broken rail. In connection with electric interlocking the power signal, under control of a leverman, and track circuit also when desired, may be located any distance from the tower so that the limits of the interlocking plant are unrestricted; and as a distant signal, in connection with a mechanical interlocking plant, the power signal may be located at a sufficient distance from the home signal to afford proper braking distance for high speed trains.

Since the invention of the track circuit in 1872, the power signal has passed through successive stages of development: From the clockwork disc to the electro-pneumatic semaphore; from the electro-pneumatic semaphore to the enclosed disc; from the enclosed disc to the electro-gas semaphore; and, finally, to the highly perfected electric motor semaphore.

The principal objections to former types of power signals were: First, the operation of the mechanisms were unreliable; second, the excessive cost of maintenance and operation; third, in the case of electro-pneumatic and electro-gas signals, the inconvenience and additional expense of supplying two kinds of energy—electricity and compressed air or gas.

The superior advantages of a semaphore signal operated by an electric motor were so apparent that for the past twenty years or more signal engineers have confined their efforts to the perfection of this type of power signal.

The General Railway Signal Company was one of the first manufacturers of signal appliances to design electric motor-operated semaphore signals, many of which are still in service.

As the use of the power signal became more extensive, there was urgent need of a mechanism adaptable to the various requirements, a mechanism that could be used as a high or dwarf signal, as an automatic, semi-automatic, or non-automatic signal, a mechanism that would give the desired indications in the upper or lower, right or left hand quadrant, and could be arranged to operate on high or low voltage, alternating or direct current.

The Model 2A top-of-mast signal was designed in 1908 to provide a uniform signal mechanism for all requirements, and embodied many new features in design and construction which were the result of many years' experience in the manufacture of electric signals and from the performance of former types of signals under service conditions.

From the beginning the top-of-mast mechanism was a success and has met with a steady and continuous growth. However, owing to climatic conditions in some parts of the country where extreme temperatures occur, there early developed a demand for a base-of-mast signal which would embody many of the new features of the Model 2A top-of-mast mechanism. It was the opinion of some engineers that the signal mechanism at the base of mast would, under these extreme conditions, would receive more careful inspection and attention than the top-of-mast mechanism.

To meet this demand the Model 2A signal was adapted for use as a base-of-mast mechanism, and as such is giving most excellent service wherever installed. Practically the same parts are used in both the top-of-mast and base-of-mast mechanisms; the arrangement of the parts, however, is somewhat different and is described more fully in the following pages.

The main points of the Model 2A Signal Mechanism, in addition to the adaptability of the top-of-mast type, are:

First—The construction and arrangement of the several parts of the mechanism, providing for quick inspection and adjustments. The circuit controller is placed at the top of the mechanism where all contacts are visible and may be easily arranged or re-arranged so as to control the various circuits.

Second—The elimination of slot and dashpot, which materially increases the efficiency of the power signal and reduces the cost of maintainence as the mechanism requires less attention.

Third—The electrical means of retarding the falling signal arm just before it reaches the caution or stop position.

Fourth—The electrical means of holding the signal arm in the caution or clear position.

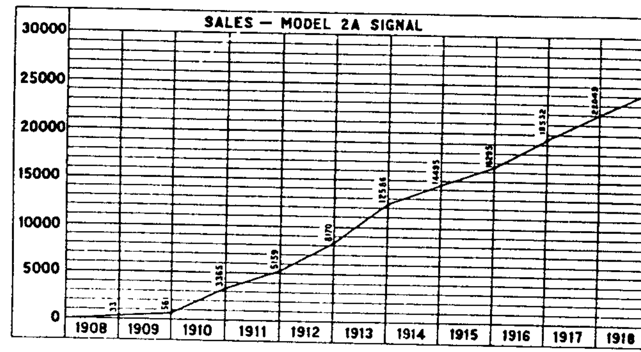
Fifth—The low operating and holding current, resulting in long life of battery.

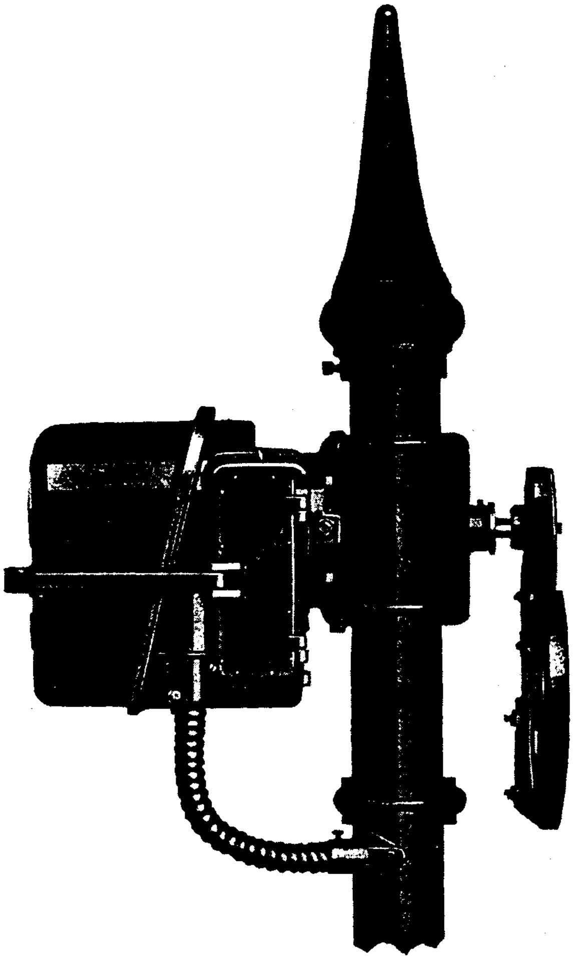
Sixth—The quick clearing time.

Seventh—The facility of applying a Model 2A top-of-mast mechanism to an existing mechanical signal, thereby converting the mechanical signal into a power signal.

SALES

There is no better basis for judging the merits of a power signal than the extent to which it is used. The accompanying diagram shows the total number of Model 2A signals ordered prior to November 1, 1918, by most of the railways in the United States and Canada, also by a number of railways in England, Australia and Japan.





ADAPTABILITY OF THE MODEL 2A TOP-OF-MAST SIGNAL MECHANISM

Application.

Ground............. Bridge.............. Bracket............. Suspended........... Dwarf..............	Signal	Automatic Semi-Automatic— Stick or Non-Stick Non-Automatic

Operation.

8 to 110 volts d-c.
55 to 220 volts a-c., 25 or 60 Cycle.
Low Operating Current—2 amperes for 10-volt, d-c. mechanism.
Low Holding Current—0.016 amperes for 10-volt, d-c. mechanism.
Clearing Time—10 seconds for 10-volt d-c. mechanism.

Indication.

Dynamic.
Battery.

Aspect.

Upper right or left hand quadrant.
Lower right or left hand quadrant.
Two or three position.
Any movement of arm up to 90 degrees.

MODEL 2A BASE-OF-MAST SGNAL MECHANISM

Application.

Ground............ Bridge.............. Bracket............	Signal	Automatic Non-Automatic

Operation, Indication and Aspect.

Same as top of mast mechanism.

There is no slot.

There is no dash-pot.

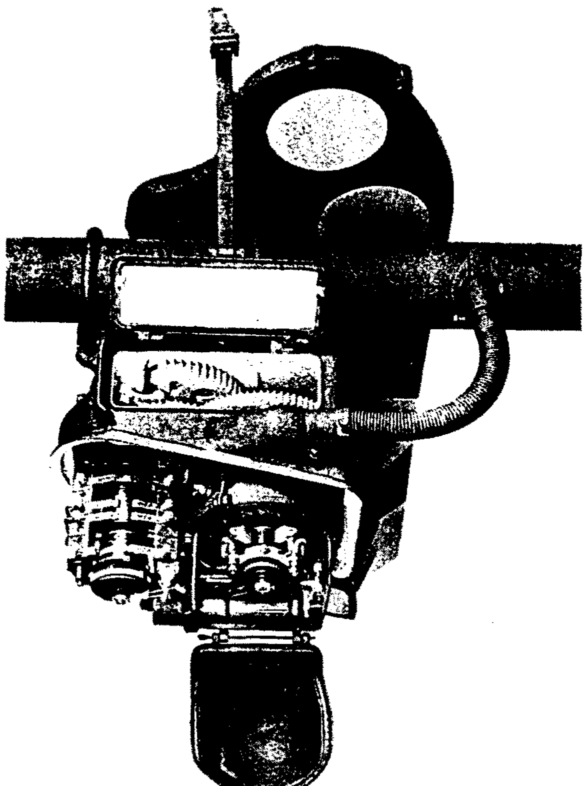


FIG. 1. MODEL 2A, TOP-OF-MAST MECHANISM

MODEL 2A SIGNAL

The operating mechanisms of the Model 2A top-of-mast signal, shown in Fig. 1, and the Model 2A base-of-mast signal, shown in Fig. 2, are essentially the same, the principal difference being in the arrangement of the parts. Both mechanisms comprise the following main parts: High-torque, low-speed motor; train of gears; circuit controller; and a suitable frame or housing. There is no slot or dashpot.

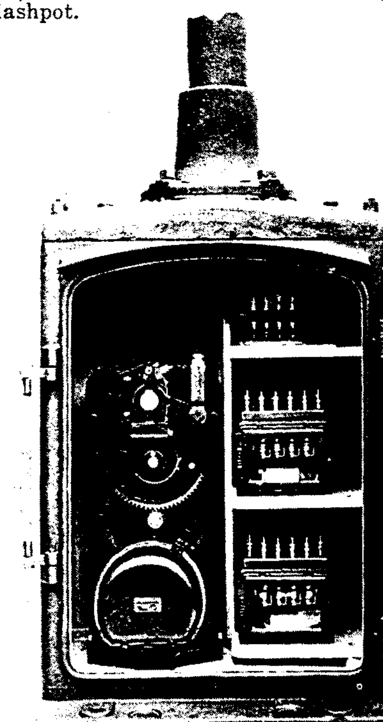


FIG. 2. MODEL 2A, BASE-OF-MAST MECHANISM

The MODEL 2A TOP-OF-MAST MECHANISM is assembled in a cast-iron case which provides the necessary bearings, supports and fastenings for motor, circuit controller and gears. The front part of the case forms a door which exposes the circuit controller and motor, when opened, as shown in Fig. 1. The train of gears is accessible through a door in the side of the mechanism case. The doors are hinged to the case and, when closed, are held firmly in place by a simple, spring-steel, strap-and-toggle arrangement. A staple is provided for a padlock by means of which both doors are locked in place. The case is equipped with a suitable conduit entrance, and the operating and control wires are led into the mechanism through a flexible conduit which is attached to the signal pole by a flanged coupling. The mechanism is practically airtight and free from any action of the elements, dust, cinders and smoke.

The mechanism case is bolted to a clamp bearing which may be clamped to any signal pole by means of two "U" bolts. The main shaft of the mechanism extends back through the mechanism case and is connected to the spectacle shaft in the bearing by means of the coupling shown in Fig. 4, which provides for any variation in the alignment of the two shafts and insures their free movement.

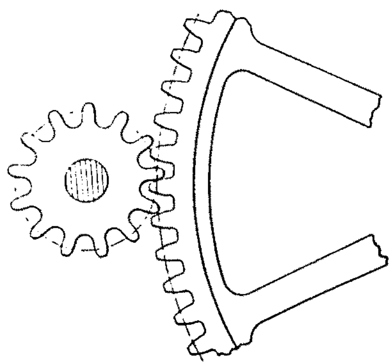


FIG. 3. CLEARANCE OF GEARS

The coupling also affords means for locking the signal so that it cannot be moved from the stop position by manipulating the blade or spectacle. The locking is effected by means of dog B, Fig. 4, and notches on disks C and D. This locking feature is always furnished on dwarf signal mechanisms, but not on high signals unless specified, as in the case of high signals there is little likelihood of any unauthorized person tampering with the mechanism.

The spectacle shaft extends through the clamp bearing, and an adjustable spring stop, shown in Fig. 5, limits the travel of the arm, serves as a buffer, and affords means for adjusting the position of the signal arm so that the full movement is from horizontal to vertical and vice versa.

The principal advantages of the top-of-mast signal are, mechanical efficiency, due to the direct connection of the mechanism to the semaphore shaft, and universality, as this mechanism may be used wherever a power signal is required—as a ground, bridge, bracket, suspended or dwarf signal, or as a block or interlocking signal.

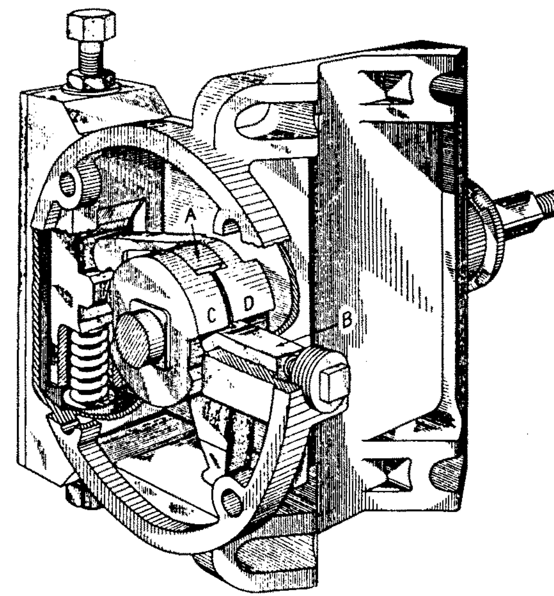


FIG. 4. COUPLING

The MODEL 2A BASE-OF-MAST SIGNAL MECHANISM, as previously stated, operates on the same general principle as the top-of-mast mechanism, in fact the several main parts of the two mechanisms are substantially the same, although somewhat differently arranged.

Base-of-mast signals can be furnished with any of the various mechanisms with the exception of the 110-volt, d-c. semi-automatic mechanism which is furnished only in top-of-mast signals. This is on account of the difficulty of obtaining a suitable arrangement of the springs, shown in Fig. 12, which are an essential part of the semi-automatic mechanisms.

A suitable cast-iron frame is provided for mounting the motor, circuit controller and train of gears. The arrangement of these parts as compared with the top-of-mast mechanism is shown diagramatically in Fig. 6, the parts similarly designated being the same.

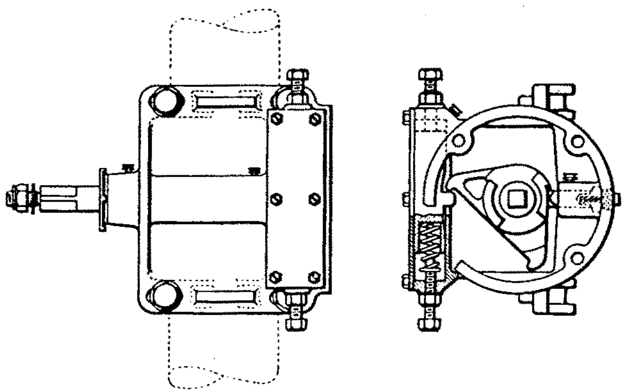


FIG. 5. CLAMP BEARING WITH ADJUSTABLE SPRING STOP

In place of the coupling that connects the main shaft directly with the semaphore shaft in the top-of-mast mechanism, the base-of-mast mechanism is equipped with a crank or sector, the movement of which is transmitted to the semaphore shaft by means of an "up-and-down" rod.

The mechanism case is designed to house either a one-arm or two-arm mechanism. Where there is only a one-arm mechanism, the case may be equipped with shelving for relays, also terminal boards for lightning arresters, terminals, etc.; where there is a two-arm mechanism, a combined mechanism-instrument case affords a convenient arrangement in which the relays and terminal boards are placed in the lower case. The lower part of the combination case is sometimes used as a housing for the signal operating battery.

The mechanism case is substantially constructed with minimum weight. It consists of a cast-iron top, base,

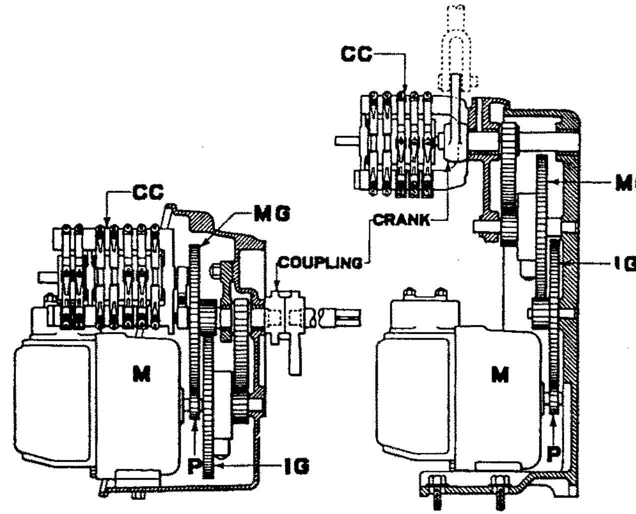


FIG. 6. COMPARISON OF TOP-OF-MAST AND BASE-OF-MAST MECHANISMS

CC Circuit Controller
IG Intermediate Gear
M Motor
MG Main Gear
P Motor Pinion

and door frame with riveted sheet-iron sides, back, and door panel, and is reinforced by steel rods extending between base and top. The case is weather tight, and ample ventilation is provided by means of screened openings which are protected by shields. A receptacle at the top of the mechanism case and directly under the signal pole catches any water that may drip down the pole as a result of condensation, or otherwise, and is discharged outside through suitable openings in the case.

The MOTOR is the same for both top-of-mast and base-of-mast signals. It operates in a dust-proof case in the lower, forward part of the mechanism and has a hinged door with a simple fastening which can be quickly opened for inspection.

There are several types of motors for the various conditions of high or low-voltage, a-c. or d-c., automatic, semi-automatic or non-automatic signals, which are described in detail in connection with various mechanisms.

The method of retarding the signal arm, when it falls by gravity to the caution or stop position, is the same in all d-c. mechanisms and is accomplished electrically in the following manner: The motion of the falling signal arm is transmitted, by means of the train of gears, to the motor, which is operated in the reverse direction, and, just before the signal arm reaches the caution or stop position, the motor is short circuited through a snubbing resistance, by means of proper circuit-controller contacts, which effectively checks the falling signal arm. This arrangement reduces to a minimum the number of operating parts and is far superior to the dash-pot, which in the past has been the source of numerous cases of trouble.

The TRAIN OF GEARS in the top-of-mast mechanism is placed in a compartment in the back part of the case. In the base-of-mast mechanism the gears are arranged in front of the cast-iron frame, as shown in Fig. 10, and are somewhat more open or extended than in the top-of-mast mechanism. The ratio of the gearing is such that thirty revolutions of the armature move the signal arm from the stop to the proceed position. The gear teeth are heavy and there is ample clearance between the teeth, as shown in Fig. 3, to insure free movement of the gears under all conditions.

The CIRCUIT CONTROLLER, shown in Fig. 7, is the brain of the Model 2A Signal Mechanism, as the operation of the motor and signal is controlled through this unit. The design of this circuit controller appeals strongly to signalmen, as all parts are visible and accessible, and there are no parts of the mechanism in the way to interfere with the free use of pliers or wrenches when there are connections or adjustments to be made.

The circuit controller consists of a frame, which carries a hardwood cylindrical drum on which the contact plates are mounted; adjustable contact fingers, with an arrangement for locking them in proper position; an attachment for producing snap contacts, when required; and gear sectors, by means of which the movement of the main shaft is transmitted to the circuit controller. There is space for a maximum of fourteen contacts, each of which can be adjusted to make or break at any position of the signal arm. There is provision for a maximum of four snap contacts which are used to control the operating and indicating circuits of dynamic-indication mechanisms and where a contact performs the function of a pole changer. All other circuits are ordinarily equipped with drag contacts.

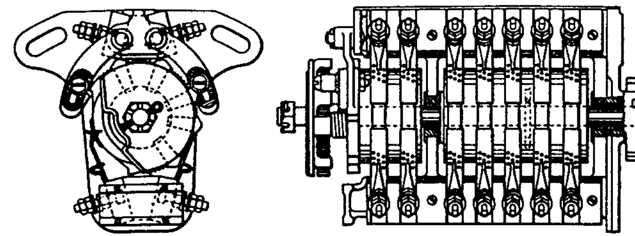


FIG. 7. MODEL 2A CIRCUIT CONTROLLER

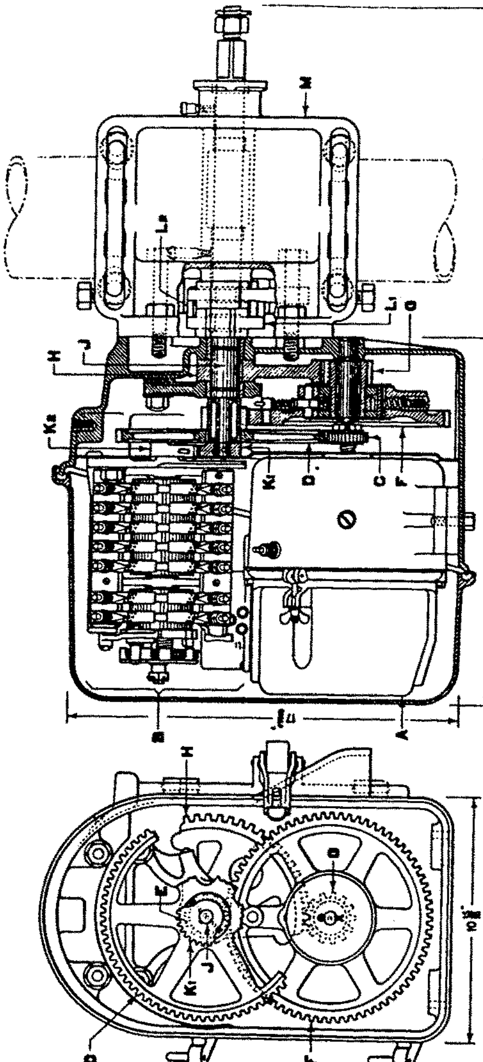


FIG. 8. MODEL 2A, 8-, 10- AND 20-VOLT, D-C. MECHANISM

A Motor
B Circuit Controller
C Driving Pinion
D First Intermediate Gear
E First Intermediate Pinion
F Second Intermediate Gear
G Second Intermediate Pinion
H Operating Sector
J Driving Shaft
K_1-K_2 Segmental Gears
L_1-L_2 Universal Coupling

VARIOUS TYPES MODEL 2A SIGNAL MECHANISMS

8, 10, AND 20-VOLT D-C. MECHANISMS

These mechanisms—especially the 10-volt—are extensively used as automatic block signals, also as power home and distant signals at mechanical interlocking plants, as manually controlled, power-operated block or train-order signals, and as other non-automatic signals where battery indication is desired. See page 36 for operating characteristics of these mechanisms, and pages 66, 67 and 68 for typical circuit diagrams.

The motors with which the above mechanisms are equipped are of the four-pole, series-wound type, and differ only in respect to the windings for the specified voltage.

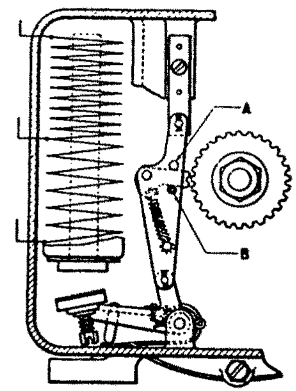


FIG. 9. RETAINING MECHANISM

In the 8, 10, and 20-volt, d-c. mechanisms the signal is held in the caution and clear positions by means of the retaining mechanism, shown in Fig. 9, which operates in conjunction with the motor, of which it forms a part. This retaining mechanism is a simple and efficient hold-clear device which not only insures reliable operation, but also reduces battery consumption to a minimum. As shown in "Operating Data," page 36, only 0.018 of an ampere is required to hold the 10-volt signal in the caution or clear position.

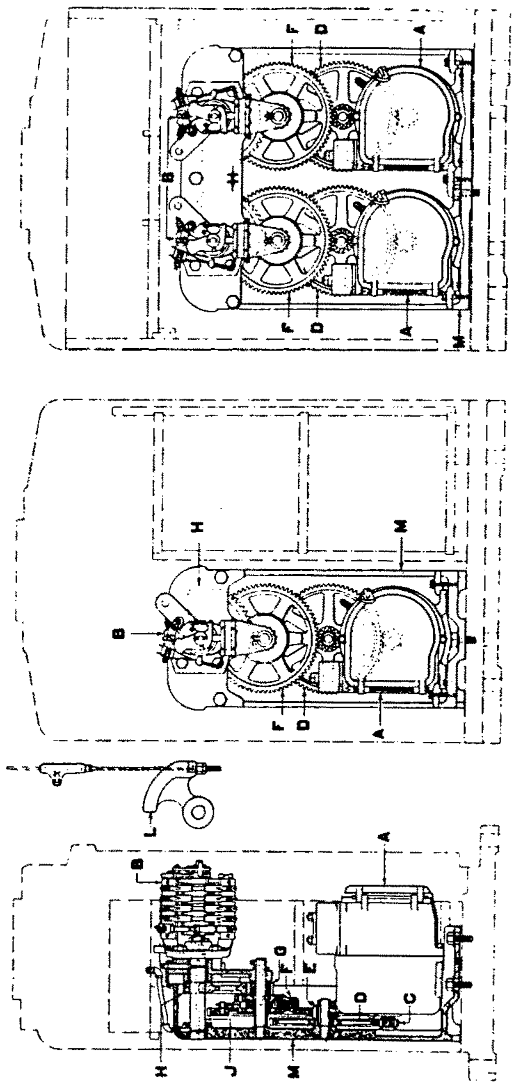


FIG. 10. MODEL 2A, ONE- AND TWO-ARM BASE-OF-MAST MECHANISMS

A Motor
B Circuit Controller
C Driving Pinion
D First Intermediate Gear
E First Intermediate Pinion
F Second Intermediate Gear
G Second Intermediate Pinion
H Operating Sector
J Driving Shaft

As shown in Fig. 9, the hold-clear mechanism comprises an electro-magnet, whose armature is attached to a movable arm carrying a dog or pawl which engages with a toothed disk on the motor shaft when the coils of the electro-magnet are energized. A stop pin "A" is fixed on the movable arm, above the dog or pawl for upper-quadrant signals, and below the pawl, as at "B," for lower-quadrant signals, so that when the hold-clear coils are energized, the motor armature and toothed disk can rotate in a direction to clear the signal, but are prevented by the stop pin from rotating in the opposite direction, thus holding the signal in the position to which it has been operated.

The air-gap between the pole pieces of the hold-clear coils and armature is 0.022 of an inch, which insures a high drop-away.

The hold-clear coils consist of two sets of windings, pick-up coils and holding coils. As ordinarily furnished the pick-up coils have a resistance of 26 ohms, and the holding coils 630 ohms, making a total of 656 ohms in the hold-clear circuit. Hold-clear coils are also furnished in which the resistance of the pick-up coils is 26 ohms, and the holding coils 1010 ohms, or a total of 1036 ohms. Having the total resistance of the hold-clear coils, the resistance of the battery wires, and the voltage of the battery, the hold-clear current may be easily obtained by dividing the battery voltage by the total resistance in the circuit.

The hold-clear coils are made up of two sets of windings, one of low resistance and one of high resistance, in order to reduce battery consumption to a minimum, as it is obvious that more current is required to pick up the hold-clear armature than to hold it up after it has been picked up. In the case of the 10-volt signal with 656 ohm hold-clear coils, approximately 0.25 of an ampere is required to pick up the armature and 0.018 of an ampere to hold it up.

Just before the signal reaches the caution or clear position, a contact on the circuit controller closes circuit through the pick-up coils, and the hold-clear armature picks up; an instant later the first contact opens, but another contact on the circuit controller closes a circuit through the pick-up and holding coils in series, which, on account of the high resistance imposed, results in very low current consumption. When the home relay is de-energized, the battery circuit through the hold-clear coils is opened, the armature drops away and disengages the pawl and toothed disk, and the semaphore arm falls to the stop position.

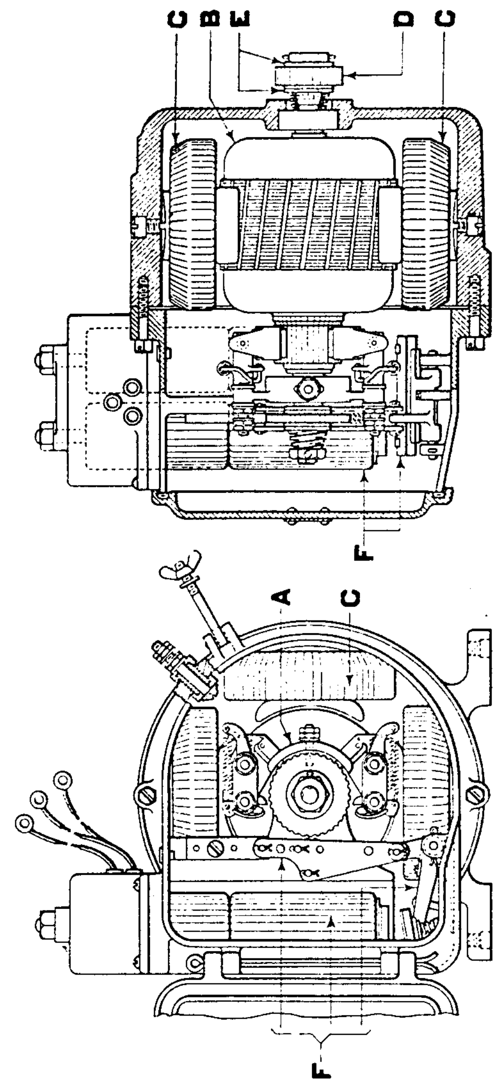
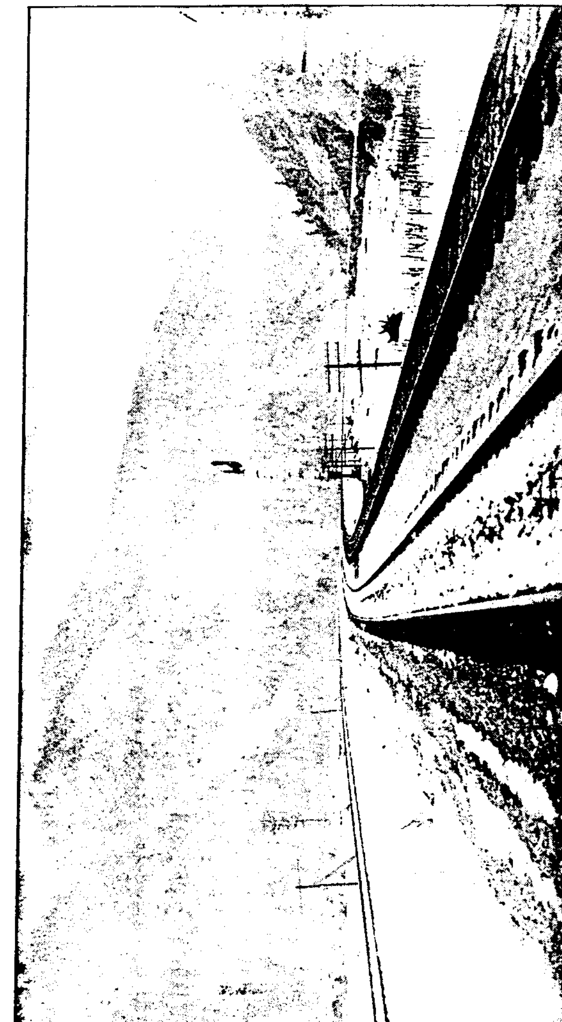


Fig. 11. 8, 10 and 20-Volt, D.C. Motor

A Brush Holder Bracket
B Armature
C Operating Field Windings
D Motor Pinion
E Clutch
F Retaining Mechanism



Model 2A Signal—Northern Pacific Railway Along Hellgate River, Montana.

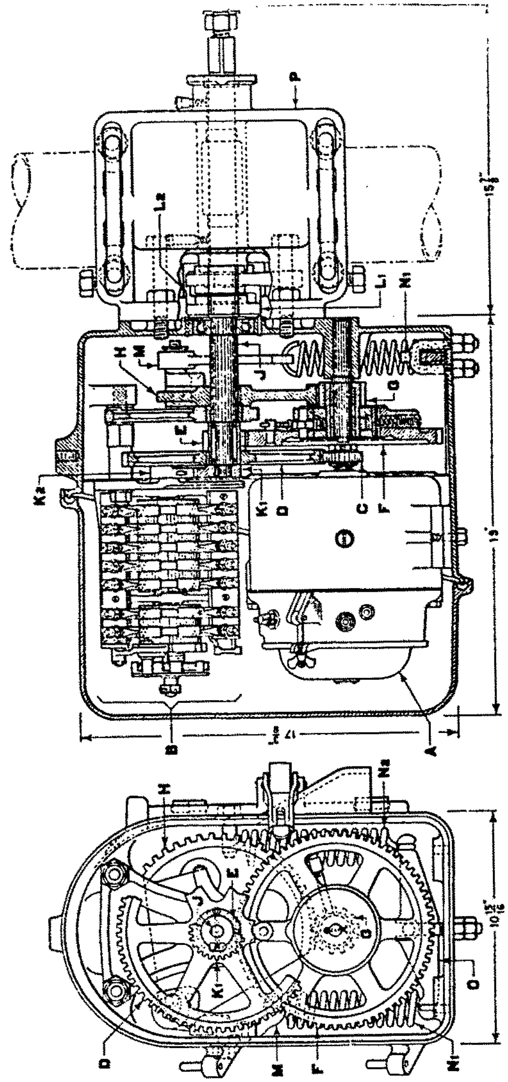


FIG. 12. MODEL 2A, 110-VOLT, D-C. SEMI-AUTOMATIC MECHANISM (DYNAMIC INDICATION)

A Motor
B Circuit Controller
C Driving Pinion
D First Intermediate Gear
E First Intermediate Pinion
F Second Intermediate Gear
G Second Intermediate Pinion
H Operating Sector
J Driving Shaft
K_1-K_2 Segmental Gears
L_1-L_2 Universal Coupling
M Hook
N_1-N_2 Coil Springs
O Equalizer

110-VOLT, D-C. SEMI-AUTOMATIC MECHANISM
DYNAMIC INDICATION

The 110-volt, d-c., semi-automatic mechanism is chiefly used as a power interlocking signal where there is track-circuit control in connection with G. R. S. Electric Interlocking. The signals are operated from a central 110-volt storage battery located at or near the interlocking tower.

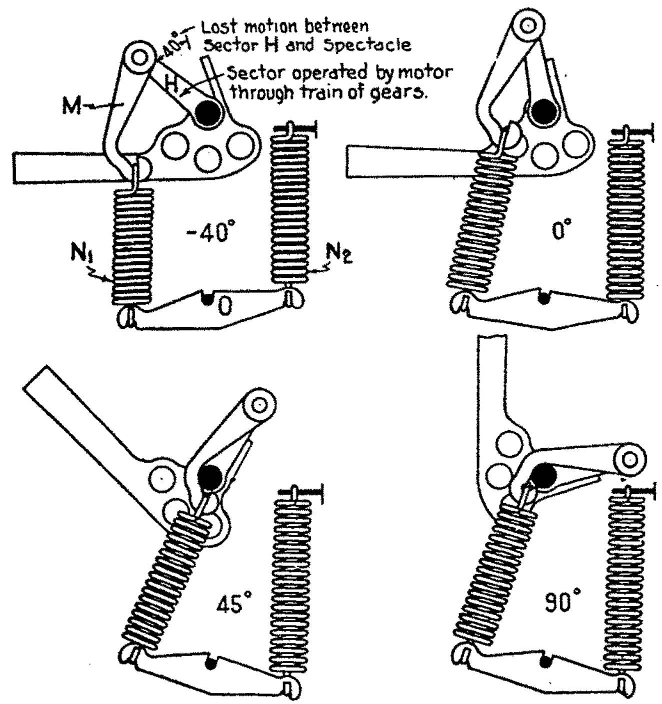


FIG. 13. DIAGRAM SHOWING OPERATION OF SPRING ATTACHMENT

As a large majority of power interlocking signals now have track-circuit control, G. R. S. standard interlocking signals are semi-automatic, but, when required, may easily be connected in the circuit so as to operate as non-automatic signals. See page 36 for operating characteristics, and pages 69, 70, and 71 for typical circuit diagrams.

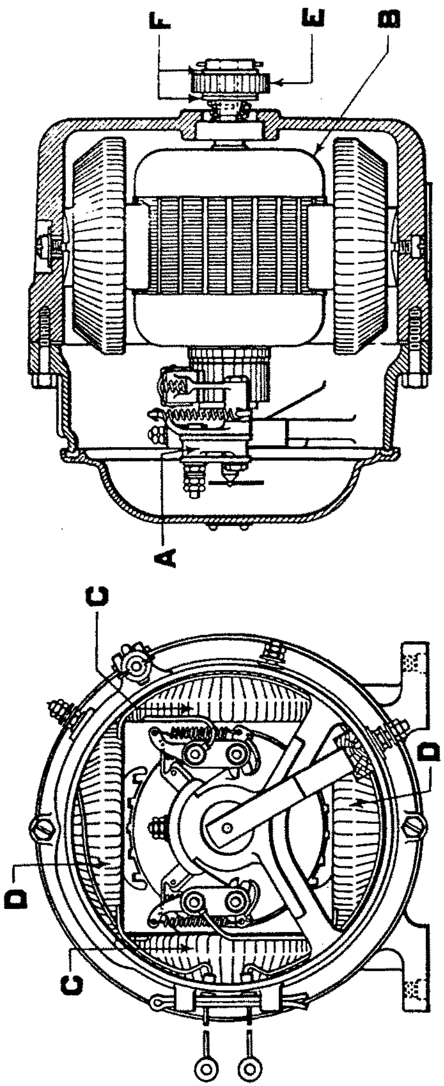


Fig. 14. 110-Volt, D-C, Motor

A Brush Holder Bracket
B Armature
C Operating Field Windings
D Holding Field Windings
E Motor Pinion
F Clutch

This mechanism is equipped with a four-pole, series-wound motor which differs from the 8, 10, and 20-volt mechanisms in that the signal is held in the caution and clear positions 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 and thus holds the signal in the position to which it has been operated.

Although a semi-automatic signal assumes the stop position as soon as a train enters the track circuit, there can be no indication until the signal lever is returned to its normal-indication position, and as the dynamic indication is practically instantaneous, it is evident that some means must be provided to insure the indication at the proper time. This is accomplished in the following manner:

The spring attachment, shown in Fig. 13, operates in connection with the driving shaft, and provides means for rotating the armature shaft to generate the indication current after the signal has returned to the stop position. The coupling is constructed so that there are 40 degrees of lost motion between the driving shaft and spectacle shaft, and, when the motor is energized, the first few rotations of the armature take up this lost motion and put the springs under tension, but do not move the signal arm. After the signal arm has been moved a few degrees above the stop position, the tension in the springs does not exert any torque on the mechanism, which is apparent from the arrangement of the lever arms in the diagrams, Fig. 13. Furthermore, the tension in the springs has no function in connection with the return of the signal arm to the stop position.

When a train enters track section governed by the signal, the track relay is de-energized, which breaks the operating circuit, also the 45- and 90-degree holding circuits in the motor, and the signal arm falls to the stop position, but the springs are not released until the lever is returned to its normal-indication position, which breaks the zero holding circuit, and releases the motor armature. The tension in the springs then rotates the armature to the normal or minus 40-degree position, which generates the indication current.

The operation of the mechanism from the minus 40-degree position to the zero position is controlled by a lever in the interlocking machine, but the movement from zero to the 45-degree position depends upon the track circuit, and to the 90-degree position also upon the signal in advance.

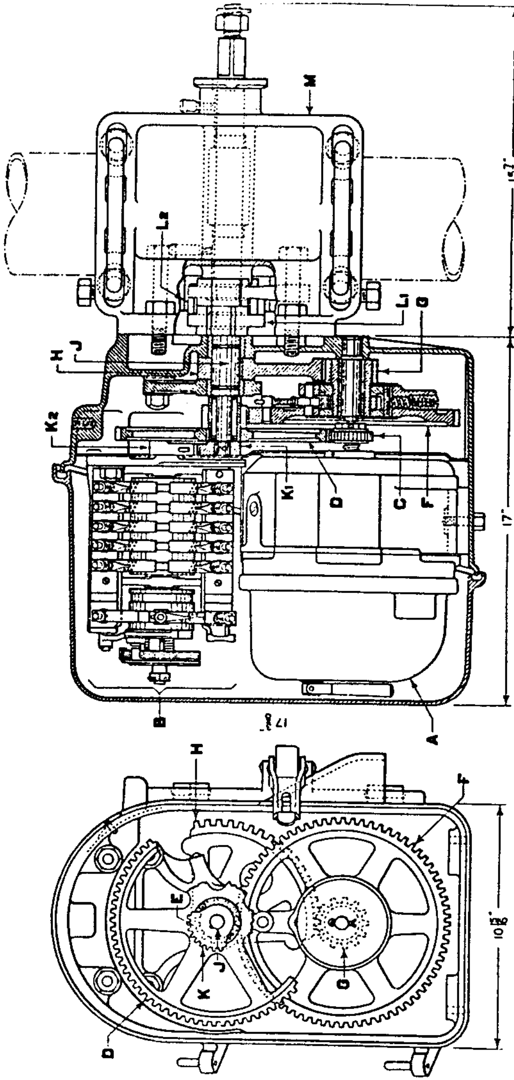


FIG. 15. MODEL 2A, 110-VOLT, A-C. MECHANISM, 25- AND 60-CYCLE

A	Motor	G	Second Intermediate Pinion
B	Circuit Controller	H	Operating Sector
C	Driving Pinion	J	Driving Shaft
D	First Intermediate Gear	K_1-K_2	Segmental Gears
E	First Intermediate Pinion	L_1-L_2	Universal Coupling
F	Second Intermediate Gear		

ALTERNATING-CURRENT MECHANISMS

110-VOLT, 25 OR 60-CYCLE

Alternating-current mechanisms are chiefly used as automatic block signals on steam and electric railways, also in connection with a-c. electric interlocking; with the exception of the motor they are the same, respectively, as non-automatic, top-of-mast and base-of-mast, d-c. signals.

Although it is possible to design an a-c. motor to operate on practically any desired voltage, it is obvious that high voltage is not desirable on account of the danger to construction and maintenance employees, while low voltage requires excessive current. As 110-volt operation is well adapted to all requirements, it has been adopted as standard, and practically all a-c. signals are now designed to operate on 110 volts single-phase; the frequency is the same as the frequency of the transmission line, ordinarily 25 or 60 cycle.

The motor furnished with a-c. signals is of the induction type, which has no commutator or brushes, and gives very efficient service with little attention other than an occasional oiling and inspection. Although the induction motor requires more current than the series-commutating motor formerly used, the advantages which it affords more than offset the increased current consumption.

The motor unit, shown in Fig. 16, includes the hold-clear mechanism, also a reactance coil, the function of which is described in a succeeding paragraph. The internal and external wires are connected to a terminal block mounted on top of the motor frame.

The hold-clear mechanism is a solenoid-ratchet arrangement and operates in practically the same manner as the d-c. low-voltage, hold-clear device described on page 23. The essential difference is the substitution of a solenoid for a tractive magnet, and a slight difference in the arrangement of the several parts.

The induction motor furnished with a-c. mechanisms is what 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.

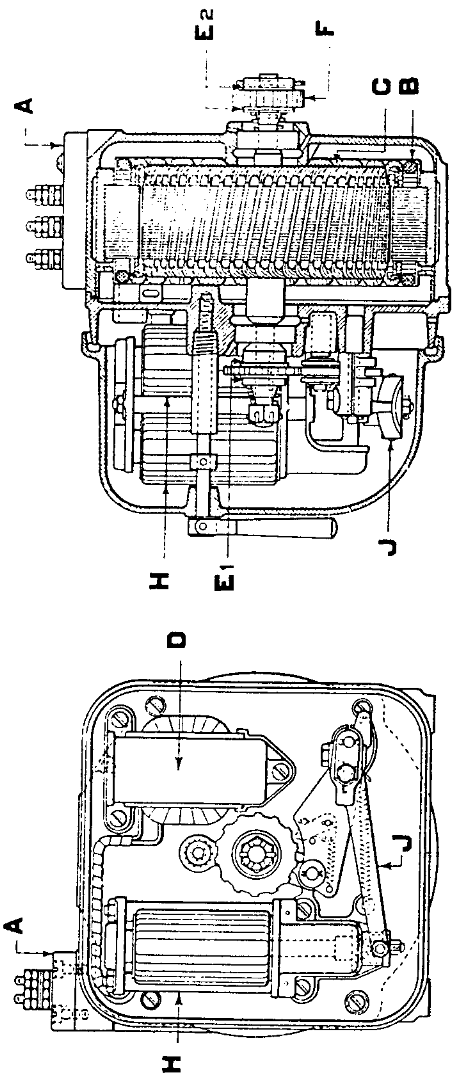


FIG. 16. 110-VOLT, A-C. INDUCTION MOTOR, 25- AND 60-CYCLE

A Terminal Block
B Stator
C Rotor
D Impedance
E_1-E_2 Friction Disks
F Motor Pinion
H Hold-Clear Coils
J Hold-Clear Armature

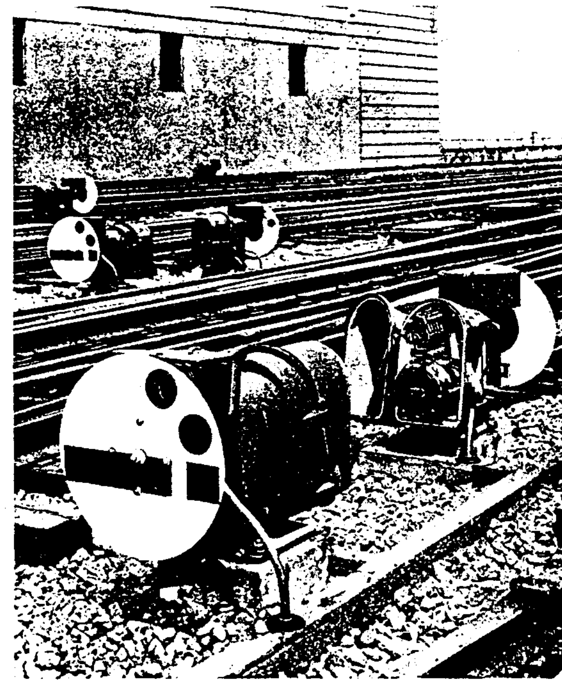


FIG. 17. MODEL 2A, DWARF SIGNALS, CHICAGO TERMINAL, CHICAGO & NORTHWESTERN RY.

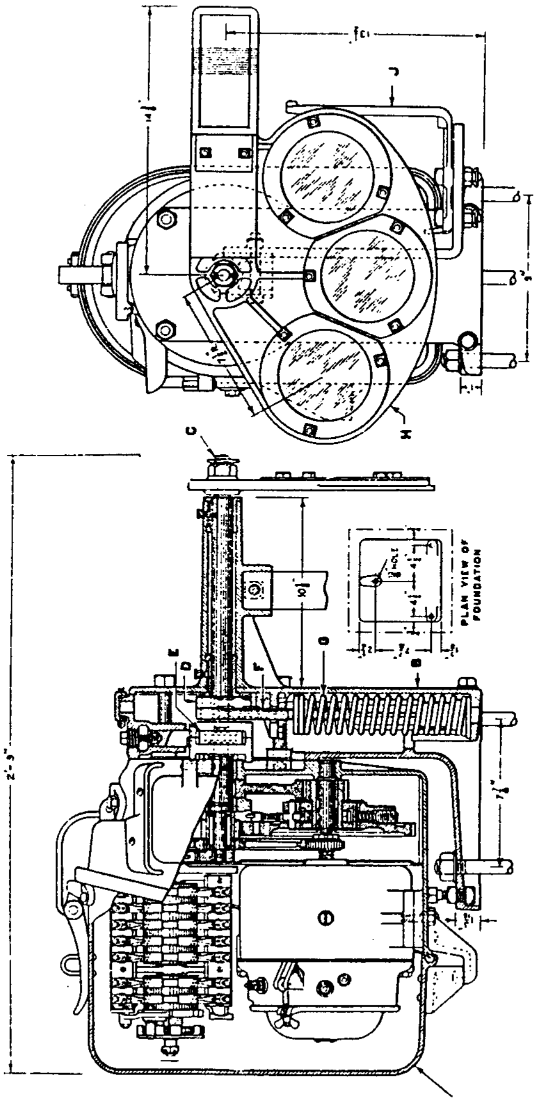


Fig. 18. Model 2A, 110-Volt, D-C. Non-Automatic Dwarf Signal

A Mechanism
B Mast and Bearing
C Spectacle Shaft
D Spring Arm
E Universal Coupling
F Rod for Returning Springs
G Returning Springs
H Spectacle
J Lamp Bracket

MODEL 2A DWARF SIGNALS

Model 2A dwarf signals are chiefly used in connection with d-c. and a-c. electric interlocking, also, occasionally, as automatic signals on low-speed tracks. Dwarf-signal mechanisms are similar, respectively, to the several, automatic, semi-automatic and non-automatic, top-of-mast mechanisms described in the preceding pages. Also, the control, operation, and indication of dwarf-signal mechanisms is the same as similar high-signal mechanisms. On account of the dynamic-indication only one control wire is required for a two-position signal as against two control wires required for most signals.

The dwarf-signal mechanism is mounted on a low stand, as shown in Figs. 18 and 19, which serves as a mast and bearing. In order to have all parts of the mechanism well within the clearance limits, the door of the case is arranged to open downwards instead of to the side, the hasp and staple for padlock being on top of the case.

The return of the signal to the normal position, when operating and holding circuits are broken, is effected by the springs, shown in Figs. 18 and 19, instead of counterweighting the spectacle, which is impracticable owing to the limited clearance ordinarily available.

The Model 2A dwarf signal occupies little space and is well adapted for use at yards and terminals where track centers are close.

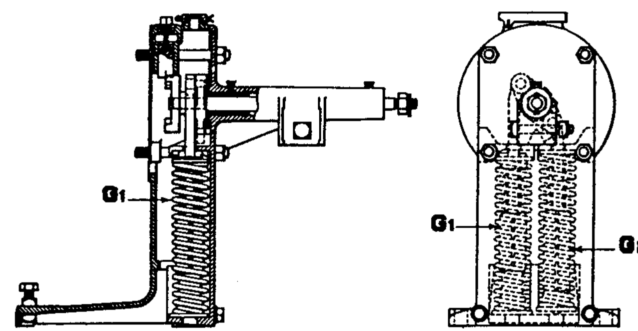


Fig. 19. Model 2A, Dwarf Signal Bearing

OPERATING DATA MODEL 2-A SIGNALS

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	Remarks
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
Volts	Volts	Amp's.	Amp's.	Sec'ds	Volts	Volts	Volts	Ohms	Ohms	
10	10	2.1	2.4	10.0	5.0	5.0	4.2	630	26	
8	8	2.6	2.9	10.0	4.0	5.0	4.2	1000	26	
8-10	8	2.5	2.8	10.0	3.5	4.5	3.6	1000	26	
8-10	10	2.5	2.8	7.5	3.5	4.5	3.6	1000	26	
8-10	10	2.5	2.7	7.5	3.5	1.0	0.75	60	60	Note 1
20	20	1.1	1.2	10.0	8.5	13.0	11.0	5000	138	
110	110	0.85	2.00	6.0	40.0	90.0	40.0	420		Note 2
110	85	0.85	1.40	8.0	40.0	90.0	40.0	450		Note 3
110	110	0.65	2.00	3.0	40.0	80.0	40.0	420		Note 4
110	90	0.65	1.40	4.0	40.0	80.0	40.0	450		Note 5
110-25 ~	110	3.40	Watts 260.	11.0	90.0	90.0	70.0	Volt Amp. 22	Watts 7.5	Note 6
110-60 ~	110	3.75	Watts 260.	10.0	90.0	90.0	65.0	Volt-Amp. 50	Watts 6.5	Note 6

NOTE 1: The hold-clear consists of a single coil wound to operate from two cells of primary battery. The signal controlling circuits are such that for pick-up purposes the motor and hold-clear batteries are in series and for holding purposes but two cells are in circuit.

NOTE 2: The figures cover a semi-automatic mechanism operating a three-position high signal, no line resistance.

NOTE 3: The figures cover a semi-automatic mechanism operating a three-position high signal, 30 ohms line resistance.

NOTE 4: The figures cover a semi-automatic mechanism operating a two-position dwarf signal, no line resistance.

NOTE 5: The figures cover a semi-automatic mechanism ope ating a two-position dwarf signal, 30 ohms line resistance.

NOTE 6: The figures cover the standard 110-volt, 25- and 60-cycle induction motors.

The operating characteristics of a number of the most usual combinations of 2-A signals are given in the accompanying tabulation.

All data with the exception of that for the dwarf signals is based on a top-mast mechanism equipped with R. S. A. standard spectacle No. 1040, Fig. 28, 3' 6" steel blade, and three 8⅜" roundels, the maximum torque of this combination being approximately 43 foot pounds.

The figures cover the performance of a signal in good order and are subject to a variation of five per cent plus or minus.

If adverse conditions exist such as sleet, high resistance at relay contacts, low battery voltage, etc., the figures will vary considerably from those given.

Taking up the various columns in the tabulation in serial order, the following will give the significance and useful purposes of the figures shown therein.

COLUMN 1 gives the normal rated voltage of the motors by which they are known. There is a different winding for every voltage named. The low-voltage motors (8- to 20-volts inclusive) are as shown by Fig. 11, the figures given in the tabulation being based on their use in a standard mechanism as shown by Fig. 8.

The 110-volt motors are as shown by Fig. 14, the figures given in the tabulation being based on their use in a standard semi-automatic mechanism as shown by Fig. 12.

The a-c. motors are as shown by Fig. 16, the figures given in the tabulation being based on their use in a standard mechanism as shown by Fig. 15.

The 10-volt d-c. motors are for use with primary batteries, Edison storage batteries or for 5 cells or more of lead-lead storage batteries. The 8-volt d-c. motor is for use with 4 cells of lead-lead storage batteries. The 8-10-volt motor is universal in that it is satisfactory for operation from any of these batteries, the low minimum shown in Column 6 more than compensating for the higher operating currents shown in Columns 3 and 4.

COLUMN 2 gives the voltage at the motor terminals on which the clearing time, Column 5, is based, it being noted in practice, however, especially with signals fed from primary batteries and where there may be excessive resistance in relay contacts, etc., that this voltage is seldom if ever realized.

COLUMN 3: The figures in this column give the motor current at the point of maximum torque and do not include the current taken by the hold-clear, pick-up winding.

For all direct-current motors this current varies with the torque (although not in direct proportion with the same) and is about the same for any voltage. It is useful in determining whether the signal is in normal condition, so far as its operation is concerned, since if the current were materially greater than that shown in this column, it would indicate excess torque or friction or improper brush setting.

For the 110-volt signals this maximum current is obtained by holding away from contact the spring which bears against the outer end of motor armature as shown in Fig. 14. Holding this spring away prevents the action of the snubbing winding and permits the giving of the true motor operating current, said current increasing or decreasing with variations in torque, brush setting, etc., as in the low-voltage d-c. motors and is the current to be used in figuring line-wire resistance.

For the a-c. motors the current follows a very different law than for the d-c., motors being about the same for any torque but differing with, and in direct proportion to, the voltage. The a-c. motor current therefore cannot be used in determining whether or not a signal is in normal condition as in the case of the direct-current motors. The figures are valuable, however, in determining wire and transformer sizes, etc.

COLUMN 4 gives the maximum .current taken by the motor including the hold-clear, pick-up current and is the total maximum current consumed in the process of clearing a signal. For the 8- to 20-volt motors inclusive it is valuable in determining the drop in voltage due to resistance which may exist between the battery and motor and also in discussing matters connected with primary batteries especially in connection with the drop in voltage at the terminals of a battery caused by the presence of such current.

In connection with the 110-volt signals these currents mean very little since they are on only for an instant while the motor is snubbing preparatory to holding clear. They vary with the applied voltage.

For the a-c. motors this column is used to give the watts consumed at the normal voltages shown in Column 2, said watts remaining practically the same regardless of the torque but differing directly as the square of the applied voltage.

COLUMN 5 gives the approximate clearing time for motors supplied with voltages as in Column 2.

For the direct-current motors the time varies greatly with the voltage, for example, taking from two to four times longer to clear at one-half voltage than at normal voltage.

For the a-c. motors the variation in the time of clearing with variations in voltage is very much less than that for the direct-current motors.

The clearing time is based on 0-90° operation for all except the dwarf signals which are based on 0-45° operation.

COLUMN 6 gives a very important set of figures as it indicates the minimum working voltage at the motors, below which the voltage should not be allowed to go. In engineering a signal layout employing low-voltage motors (8- to 20-volts inclusive) the minimum voltage at the battery should never be less than the voltage given in this column, plus the drop in the lead wires and contacts between battery and motor, using for the purpose of this calculation, the maximum current shown in Column 4. For central-energy plants in which the 20-volt motors would be used, the voltage at the motors for reasonable clearing time should never be less than 15 and the batteries and line wire should therefore be figured accordingly.

COLUMN 7 gives the minimum working voltage of the hold-clear. These figures are useful to anyone intending to operate the hold-clear from a separate battery or from a portion of the motor-operating battery and gives a clue to the minimum voltage beyond which it would be inadvisable to go. The figures in this column will be the voltage which is needed to prevent a hold-clear from "kicking off" when, after the operating current is cut off, the blade settles back on to the hold clear and at which time there is a "kick back" tendency which requires more than the drop-away voltage to hold the signal. This is especially true in the 8- to 20-volt low-voltage motors.

COLUMN 8 gives the average drop-away for which the hold-clears are adjusted at the factory, an allowance of approximately five per cent plus or minus being permitted. Attention is further called to the fact that for the 8- to 20-volt motors the drop-away figures given are based on the holding coil only being effective, the pick-up coil being shunted by the motor through the medium of its controlling contact, this being the standard adjustment for low-voltage signals with the exception that it does not apply to 8-10-volt motors having the 60-ohm hold-clear. With the pick-up winding in circuit the drop-away values would be from 80 to 85 per cent of the values given in Column 8. There is no harm in having the pick-up winding in circuit except that it involves an unduly refined circuit breaker adjustment to avoid "pumping" of the signal at the hold-clear position. Incidentally it might be stated that to avoid this pumping the pick-up contact should remain closed from 3 to 4 degrees after the operating current is cut off.

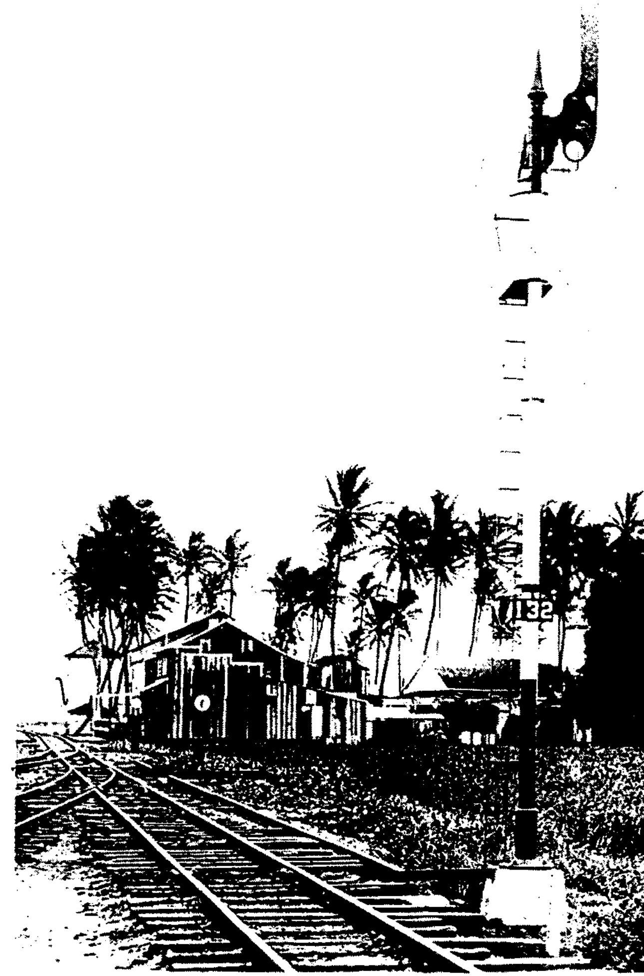
In the regular periodic test of signals, if the drop-away is found to be materially different from the figures given, taking into consideration the possibility that the pick-up coil may or may not be shunted and which can be easily determined by inspection of its controlling contact, this Company is in position to indicate what adjustments or modifications should be made to bring the drop-away to the figures given or to such figures as may be mutually agreed upon.

COLUMN 9 gives the normal resistance of the hold-clear holding circuit with the exception that for the a-c. motors the volt-ampere consumption at normal voltage is given. Knowing this resistance and the voltage actually applied to the hold clear in service, the consumption of energy can be determined, it being remembered, however, that the resistances given are based on a temperature of approximately 70 degrees F and that it will vary approximately 2.3 per cent for every 10 degrees increase or decrease. This is no small item in view of the fact that the temperature of signal apparatus runs up sometimes as high as 130 degrees F and as low as 60 degrees below zero. For example, a hold clear which is 1000 ohms at normal temperature would be approximately 770 ohms at 30 degrees below zero or 1140 ohms at 130 degrees F.

For direct-current hold-clears the resistance is practically constant for any voltage but for the alternating-current hold-clears the resistance, or more properly speaking the impedance, varies with the voltage, automatically increasing as the voltage increases and vice versa thereby maintaining a fairly constant current regardless of reasonable voltage variations. It is for this reason that in the resistance column the volt-amperes are given directly instead of the impedance of the hold-clear.

COLUMN 10 gives for the low-voltage signals the resistance of the hold-clear, pick-up circuit, this resistance being valuable in determining maximum current as in Column 4, it being noted, however, that as the pick-up current is on for a very short time, the magnetic circuit being in the act of closing up prevents this current from reaching its full maximum, especially with normal voltage at the motor terminals.

For the a-c. signals the watts consumption is given in this column.



MODEL 2A SIGNAL—OAHU RAILWAY & LAND COMPANY
Honolulu, Hawaii.

INSTRUCTIONS COVERING THE INSTALLATION AND MANTENANCE OF MODEL 2A SIGNALS

STORING MECHANISMS

All mechanisms should be stored in an upright position and, if possible, in a dry place, and should not be removed from their boxes until they are installed. Avoid disconnecting or removing the motors from the mechanism cases.

INSTALLATION

In assembling mechanisms which are shipped separately from the pole bearings or in reassembling mechanisms which have been disassembled for any purpose, the surface of all exposed mechanical joints must be cleaned and smoothly coated with white lead before assembly, to insure that they are water-tight.

Whenever it becomes necessary to bolt a mechanism to its pole bearing, see that the semaphore shaft and mechanism are approximately in their 'stop" positions. Then rotate the semaphore shaft backward and forward slightly by hand while tightening the bolts, to be sure that no binding takes place during the process.

When working on a mechanism, the motor door should always be kept closed except when necessary to do work inside of the motor.

After a mechanism has been wired, the wire entrance should be sealed to prevent the circulation of air between the inside and outside of the case. Neglect to seal thoroughly may result in trouble due to the probable accumulation of frost or dirt on the circuit breaker parts. If conduit is used between the mechanism case and the pole, the wire entrance or conduit should be likewise sealed.

ADJUSTMENTS

All signals are properly adjusted before shipment, the only adjustments ordinarily required in the field being those due to differences in the semaphore spectacles, as follows: If the blade is not horizontal when in its stop position, it can be brought to such position by means of adjusting screw A, Fig. 20. Spring C, adjusted by screw D, should hold block B firmly against screw A, due allowance being made in the spring adjustment for any increase in weight of the signal arm, due to an accumulation of ice or sleet. Fig. 20 shows relation of adjusting screws, spring, block, etc., when used with upper quadrant signals; this will be reversed when applied to lower quadrant signals.

Having adjusted the blade to the horizontal position, the circuit breaker frame should, if necessary, be rotated

bodily a sufficient amount to cause the blade to assume its exact forty-five or ninety-degree position in operation.

Individual adjustment of the circuit breaker contact springs should not be necessary under ordinary conditions. If required, great care should be exercised to see that all contacts are adjusted to open and close as shown on the circuit plan which accompanies each signal mechanism.

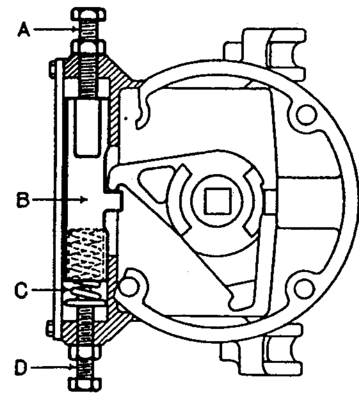


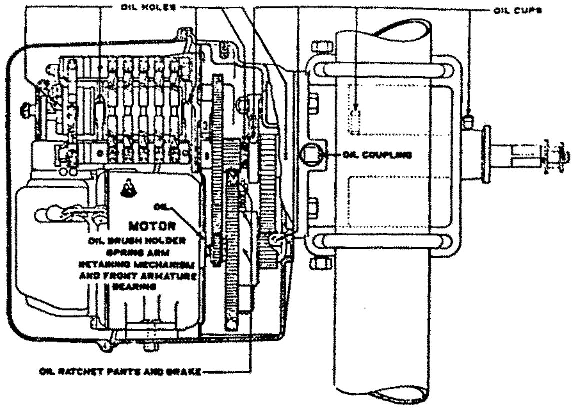
FIG. 20. SECTION OF CLAMP BEARING SHOWING SEMAPHORE SPECTACLE ADJUSTMENT

In replacing a circuit breaker which may have been removed from the mechanism for any cause, great care should be taken to see that the circuit breaker operating segments mesh properly. Otherwise, it will be impossible for the blade to assume its proper position in operation except by extreme adjustment of the contacts and circuit breaker.

LUBRICATION

All moving parts should be thoroughly lubricated with an oil that will not thicken in cold weather or dry up in hot weather. G. R. S. 2A SEMAPHORE OIL, a high-grade, cold-test lubricant, is recommended for this purpose. This oil is specially prepared for the particular requirements and has given excellent service under extreme conditions. For ordering information concerning 2A semaphore oil see Catalog, Plates H-2101 and S-1101.

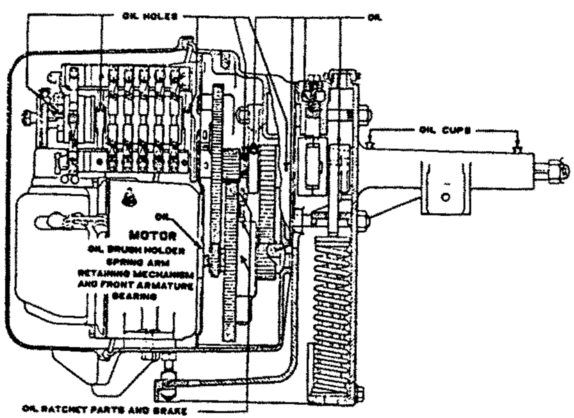
After lubrication the signals should be operated several times in order to work the oil thoroughly into the bearings. Diagrams on pages 44, 45, 46, 48 and 49 indicate clearly the parts of the Model 2A top-of-mast, base-of-mast, and dwarf-signal mechanisms that require lubrication. If the mechanism has become rusty, especial care should be taken to see that all parts are operating freely before attempting to put the signal in service.



Oiling Diagram
Model 2A Signal
Low-Voltage—Top-of-Mast

Form No. 937

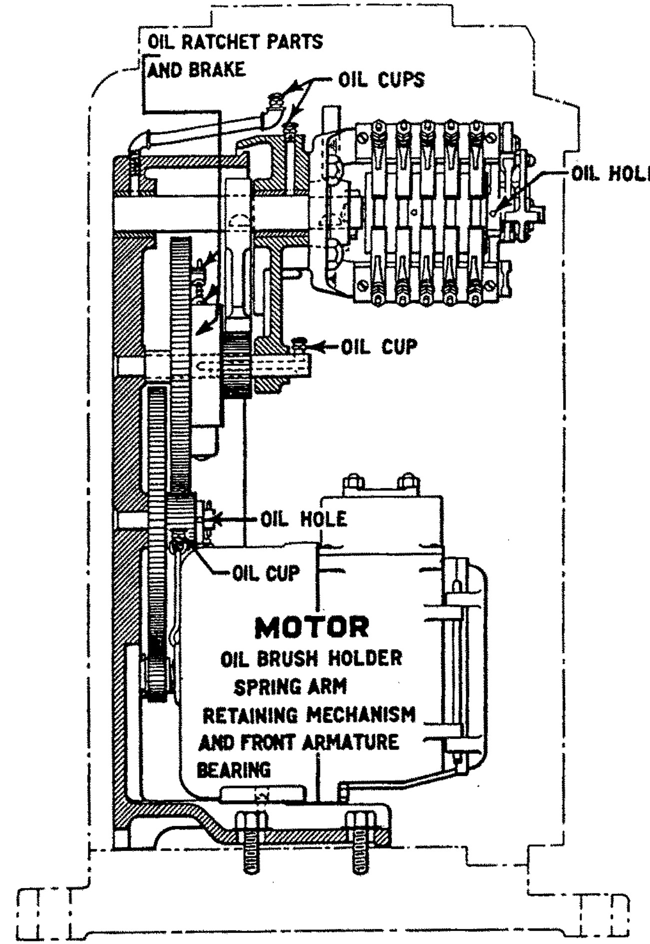
Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
Low-Voltage Dwarf

Form No. 942

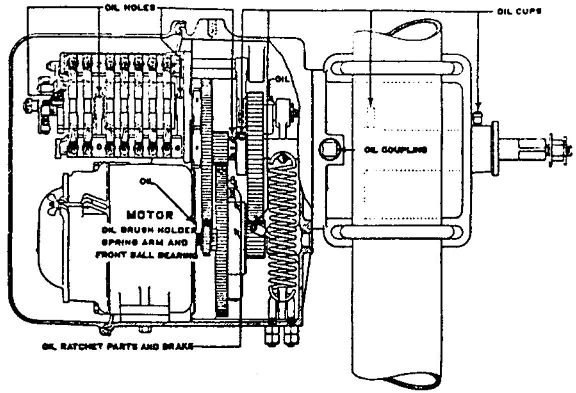
Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
Low-Voltage — Base-of-Mast

Form No. 940

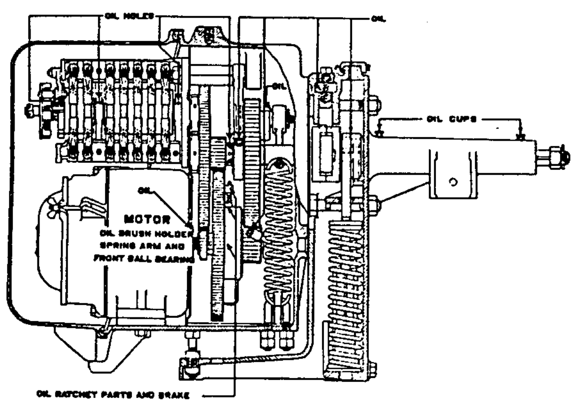
Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
110-Volt D-C. Top-of-Mast

Form No. 938

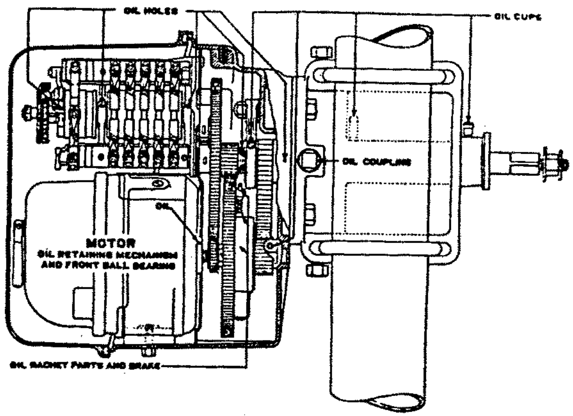
Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
110-Volt D-C. Dwarf

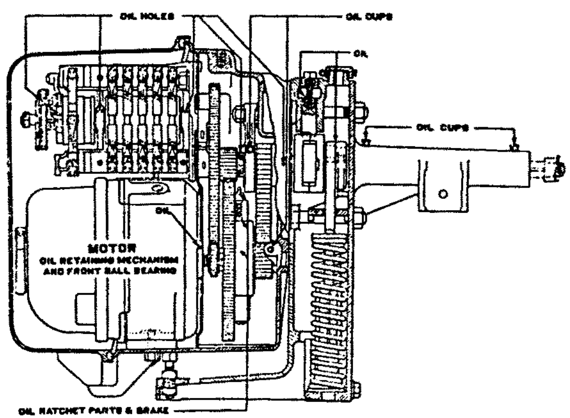
Form No. 943

Use 2A Semaphore Oil



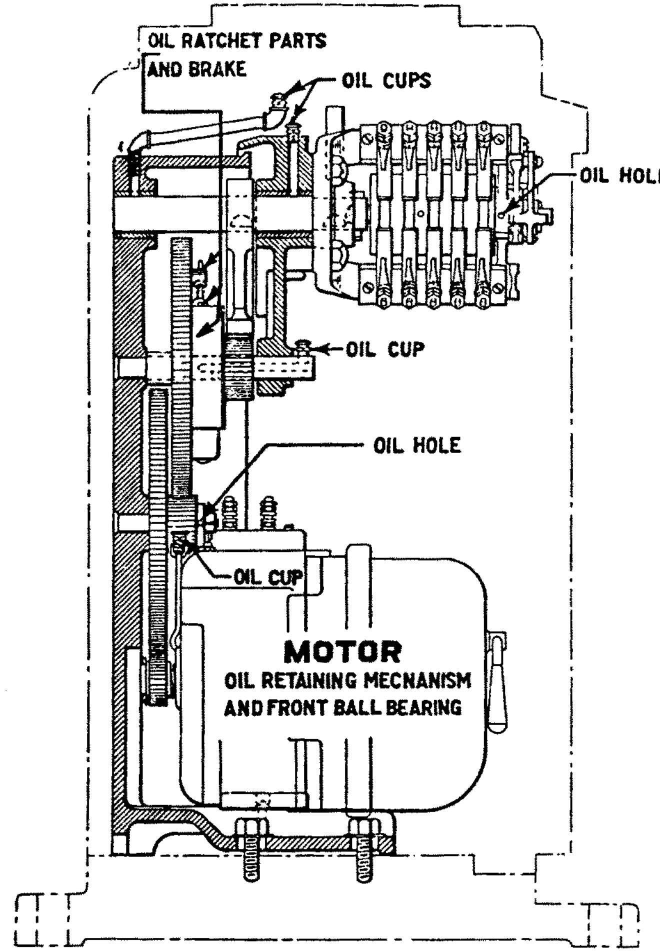
Oiling Diagram
Model 2A Signal
110-Volt A-C. Top-of-Mast

Form No. 939 Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
110-Volt A-C. Dwarf

Form No. 944 Use 2A Semaphore Oil



Oiling Diagram
Model 2A Signal
110-Volt A-C. Base-of-Mast

Form No. 941 Use 2A Semaphore Oil

MAINTENANCE

Ordinarily, in maintaining a signal, the only requirements are that the connections be kept tight, contacts clean, and the mechanism suitably oiled and cleaned.

Tools for the adjustment of circuit breaker frames, binding posts, contacts, etc., for cleaning commutators, and oiling back bearings of motors are shown in catalog Section H, Part 15.

INSTRUCTIONS FOR CARE OF COMMUTATOR AND BRUSHES.

1. If a commutator has a glossy coffee color and especially if signal is operating properly, let it alone with the exception that if carbon dust has accumulated on the brushes or commutator or elsewhere it should be cleaned off. (See precautions, note 1.)

2. Black and dirty commutators may be caused by

(a) Sparking. (See causes for sparking under 3 and 4.)

(b) Too much lubricant. (See note No. 2 for cleaning of commutator.)

3. Sparking at the brushes while signal is clearing may be due to

(a) *Weak brush holder spring.* Brush pressure should not be less than 5 oz. nor more than 8 oz.

(b) *Brush binding in holder* (box type). Clean the brush holder and if still tight, the sides or edges of the brush should be carefully sanded.

(c) *Brush arm binding* (box or radial type). Lubricate the arm and if this does not remedy it, investigate and remove the cause.

(d) *Brushes off neutral* (box or radial type). Shift brush holder and select better position. In the box type of holder the holder sometimes becomes turned. This results in the brushes being more or less than 90 degrees apart. This can be checked by wrapping a piece of paper tightly around the commutator and marking the brush location by scribing a line along the lower side of one brush and the upper side of the other brush. The distance between the two lines should be ¼ of the distance around the commutator.

(e) *High mica or rough commutator.* If not too bad it may be remedied by sanding as outlined in note No. 3. If badly cut or roughened commutator should be turned down in a lathe. (See note No. 4.)

(f) *Poorly fitted brushes.* See note No. 5 for fitting brushes.

4. Sparking when signal snubs may be due to the causes enumerated for sparking while signal is clearing

or it may be caused by the snubbing resistance being too low. (See note No. 6 for proper resistance.)

5. *Cutting of Commutators.* If cutting is not immediately stopped, it will grow worse and ultimately cause trouble. It is generally caused by hard brushes or brushes having "hard spots."

(a) If hard spots are present they should be dug out with the point of a knife.

(b) If cutting is caused by combination metal carbon brush in which the metal predominates (as in the No. 503 brush, drawing No. 37938-1) it can be stopped by the treatment as in note No. 2.

NOTE: It has not been found necessary to lubricate the No. 524 brush (Drawing No. 37938).

(c) If commutator is only slightly roughened or cut and is not causing trouble, it may be treated same as in note No. 2.

(d) If commutator is badly cut it should be remedied as in notes Nos. 2 or 3 as conditions require.

PRECAUTIONS.

Model 2-A signal motors are equipped with ball bearings. Care should therefore be taken that no grit or dirt enters the cases when brushes are being sanded or when commutator is being cleaned. In order properly to protect the front ball bearing a piece of cloth should be placed about the end of the commutator before any sanding or cleaning operation is started. When finished the cloth should be carefully removed and all grit and dirt carefully removed from the motor case. A small paint brush will be found to be very well adapted for removing any accumulated grit or dust from the motor case.

NOTE 1: This coffee color may not be apparent at the time a signal is put in service. It should therefore not be assumed that the commutator needs attention. If none of the troubles enumerated prevail, this glossy color will soon develop.

NOTE 2: A dirty or blackened commutator should be cleaned with a piece of chamois moistened with 2-A semaphore oil and then thoroughly dried with the dry portion of the chamois.

NOTE 3: If a commutator is slightly roughened or if it has high mica it can be put in proper condition by the judicious use of No. 00 sand paper (nothing coarser). The abrasive side of the paper should be oiled as the oil will cause the mica to cut easier. In order to minimize the possibility of flat spots the armature should be revolving while the sand paper is applied. A convenient way to revolve the armature is to remove the motor from mesh with the gears (have signal in the stop position before removing from mesh with gears) by removing one of the screws fastening motor to case and then swing the motor outward to a convenient position. Current can now be applied and the smoothing operation started. When completed commutator and brushes should be carefully cleaned from oil and copper dust.

NOTE 4: In turning a commutator the best method is to support it on its own centers, a tool with what is generally known as a "diamond point" or one with a very sharp edge, slightly rounded, should be used for this purpose. The armature should revolve at approximately 550 R. P. M. After the turning operation the armature should be removed as above and the commutator polished with No. 00 sand paper having the abrasive side oiled.

NOTE 5: Sandpaper should be cut approximately ¾ inch wide and 7 inches long and should be what is commercially known as "flint" sandpaper. No. 0 paper may be used for the roughing and No. 00 for the finishing operation. Long experience has shown that the quickest and easiest way for one man to fit brushes is to place a thumb on each brush thus applying pressure to the brush and with the second finger of each hand extended to press and stretch the sandpaper tightly against the surface of the commutator. The armature is then rocked back and forward (with the second fingers) thus grinding the brushes to the proper form. When finished the contacting surface of the brush and commutator should be cleaned with a dry chamois to insure that all grit is removed from these surfaces.

NOTE 6: It has been found that if the snubbing circuit is closed sooner and kept on longer than formerly, that a much higher snubbing resistance can be used, thereby practically eliminating the sparking at the brushes due to snubbing with a corresponding improvement in the performance of the commutator and brushes. Signals now being shipped are so arranged. It is to be noted that under these conditions while the snubbing is not as abrupt as before, it is still ample to prevent shock to the mechanism.

Signals equipped with the low resistance formerly employed can easily be equipped with the proper resistances by substituting trippers No. 21 or No. 23 catalogue Plate H1407 for those now existing and putting on the correct snubbing resistances as per table below and the railroads are urged to check up the resistances now in use (the tubes being stamped to show the resistance which exists) and if the resistance is not of the proper amount as shown by the table, to substitute the correct ones especially if

the motors spark while snubbing. If the sparking is not considered pronounced and yet the commutators are not acting properly, it is urged that a few of the proper resistances be tried out and if sufficient improvement results that all motors be so equipped.

Table showing proper snubbing resistance to be used with various motors.

Motor	*Resistance*
10 volt	6 ohms
8 "	3 "
8-10 "	4 "
20 "	12 "

In ordering specify resistance units Figs. 26 or 27 catalogue Plate H1407 giving resistance desired. Also specify trippers No. 21 or No. 23 Plate H-1407.

TESTS

If the signal has been properly adjusted and lubricated it will operate freely. If in doubt as to whether a signal is sufficiently free in operation, a drop-away test should be made, as follows: Connect an adjustable resistance in series with the motor. Gradually reduce it until the motor will just move the blade upward. Just before reaching the forty-five-degree position, quickly increase the inserted resistance just to permit the motor to start backward, moved by the weight of the blade grip. The current which will permit it to start backward from a given position should be approximately fifty per cent of the current required to move it up to that position. The same process should be repeated in the ninety-degree position or sixty-degree, as the case may be.

The signal having been oiled and operated a few times, see that the blade snubs properly in descending and also that the ratcheted main gear "F," Figs. 8, 10, 12 and 15, clicks approximately three or four times in so doing. The number of clicks can be regulated by the adjusting screw on the ratcheted main gear.

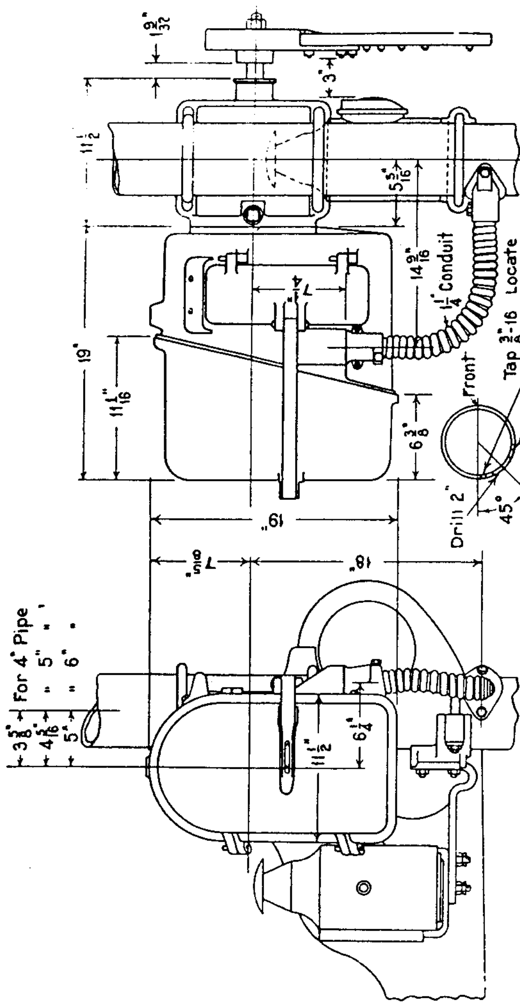


FIG. 21. DIMENSIONS OF MODEL 2A, SEMI-AUTOMATIC SIGNAL
Wires carried from Mast to Signal Mechanism in Flexible Conduit

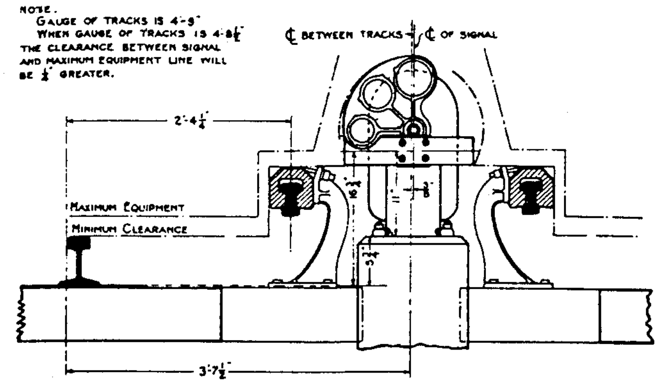


FIG. 22. DIAGRAM SHOWING CLEARANCE BETWEEN MODEL 2A DWARF SIGNAL AND THIRD RAIL. ELECTRIC DIVISION, NEW YORK CENTRAL R. R.
Twelve-foot Track Centers

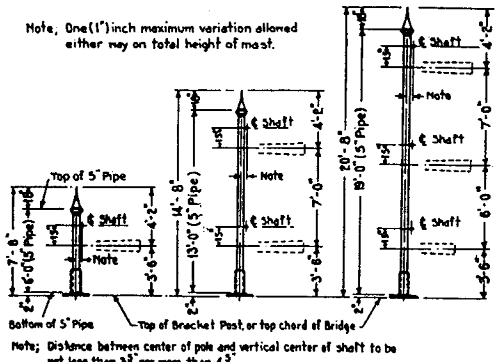


FIG. 23. BRACKET POST AND BRIDGE SIGNAL MASTS
R. S. A. Drawing 1037, Dated 1910

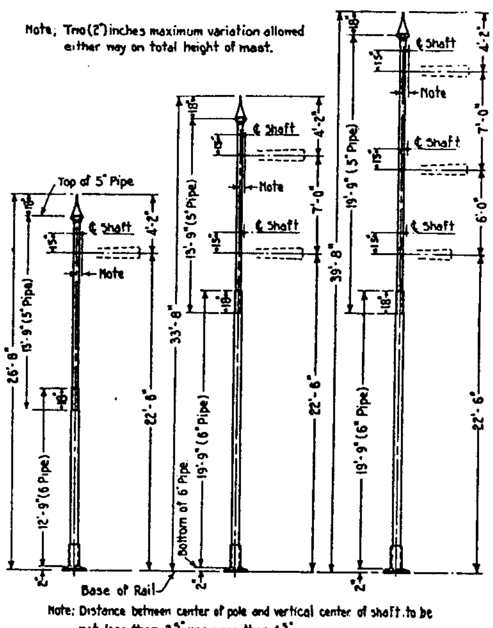


FIG. 24. GROUND SIGNAL MASTS
R. S. A. Drawing 1035, Dated December, 1915

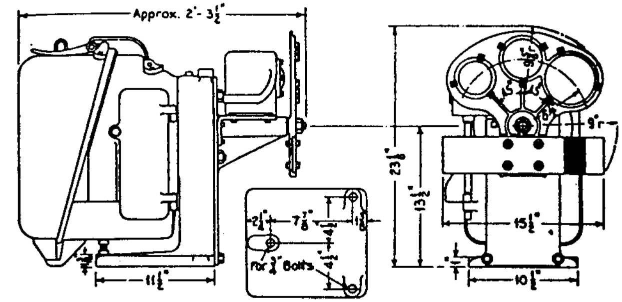


FIG. 25. DIMENSIONS OF MODEL 2A, THREE-POSITION, NON-AUTOMATIC DWARF SIGNAL, EQUIPPED WITH ELECTRIC LAMP

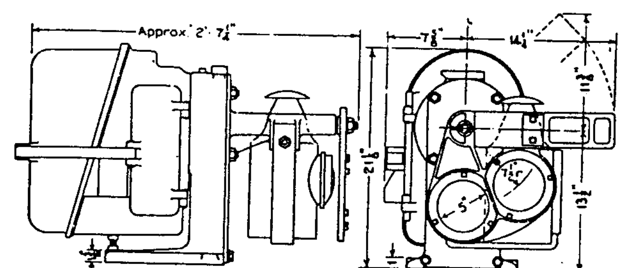


FIG. 26. DIMENSIONS OF MODEL 2A, TWO-POSITION, NON-AUTOMATIC DWARF SIGNAL, EQUIPPED WITH OIL LAMP
Spectacle R. S. A. Drawing 1233, dated September, 1914

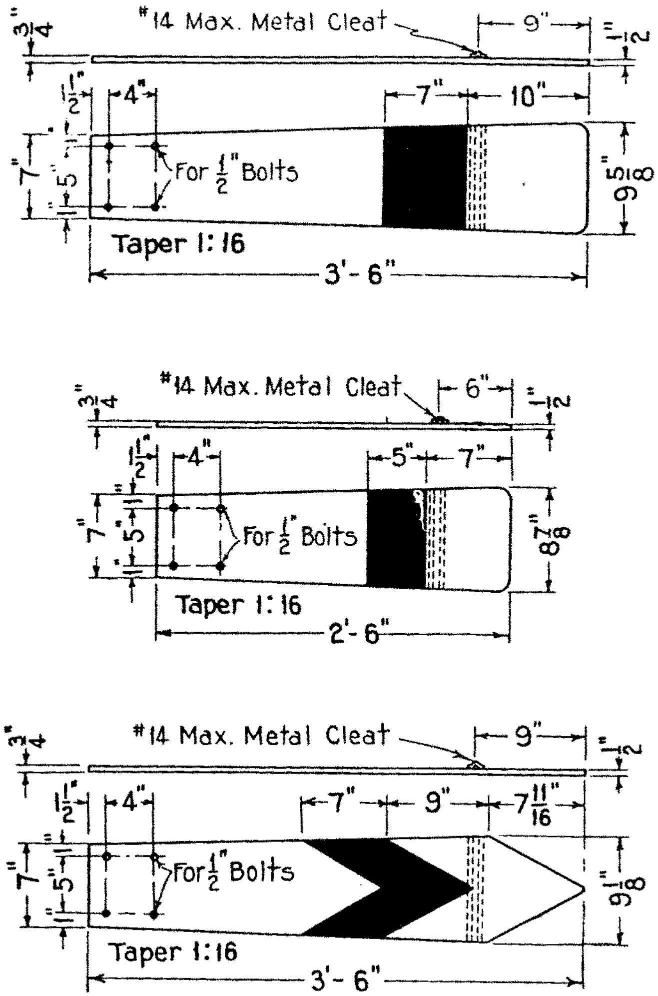


FIG. 27. BLADES FOR UPPER QUADRANT SIGNALS
R. S. A. Drawing 1065, dated September, 1915

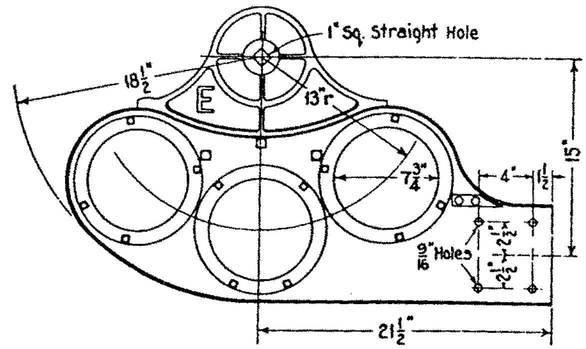


FIG. 28. SEMAPHORE SPECTACLE
R. S. A. Design "A" Drawing 1040, dated May, 1913

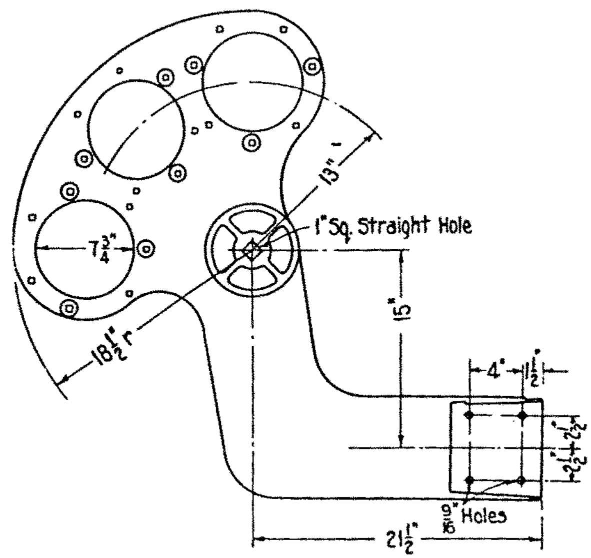


FIG. 29. SEMAPHORE SPECTACLE
R. S. A. Design "B" Drawing 1041, dated May, 1913

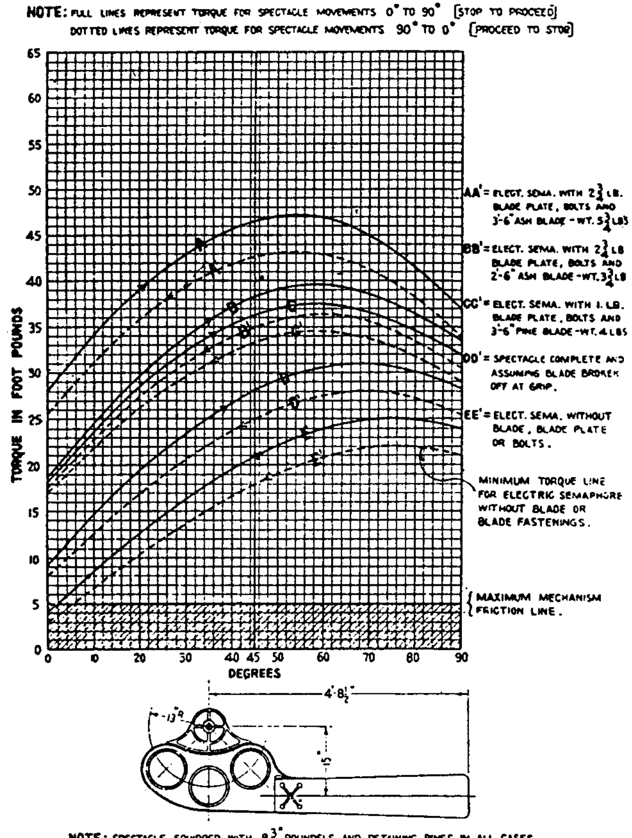


FIG. 30. TORQUE CURVES FOR R. S. A. DESIGN "A" SEMAPHORE SPECTACLE

R. S. A. Plan 1064. Issue December, 1912

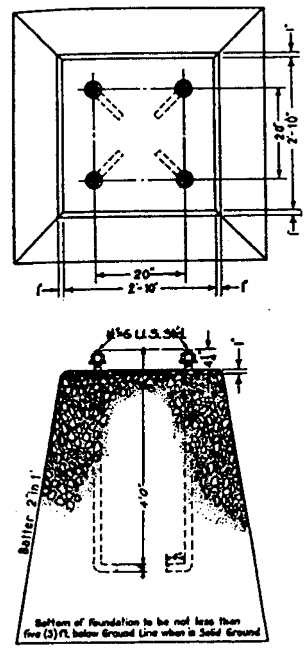


FIG. 31. PIPE BRACKET POST FOUNDATION

R. S. A. Drawing 1108, dated October, 1913

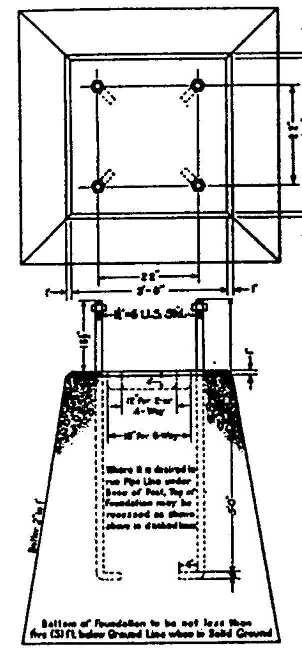


FIG. 32. CHANNEL COLUMN BRACKET POST FOUNDATION

R. S. A. Drawing 1105, dated October, 1913

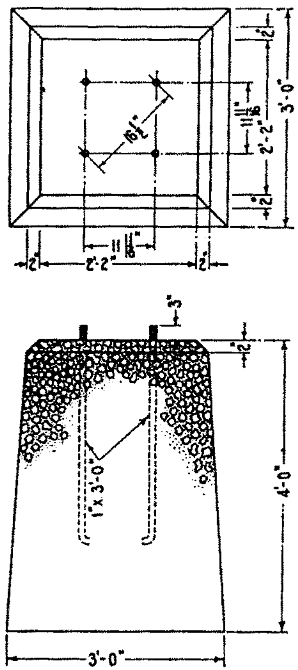


FIG. 33. GROUND SIGNAL MAST FOUNDATION
R. S. A. Drawing 1107, dated May, 1916
(30.25 Cubic Feet of Concrete)

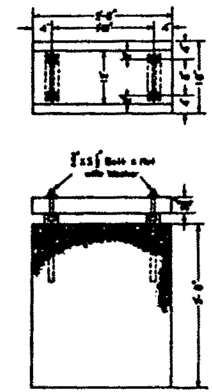


FIG. 34. DWARF SIGNAL FOUNDATION FOR MODEL 2A, MODEL 3 OR ONE-ARM MODEL 2 DWARF SIGNAL
(6.5 Cubic Feet of Concrete)

SHIPPING WEIGHTS MODEL 2A SIGNALS
R. S. A. DIMENSIONS

	Shipping Weights, Pounds
Pipe Bracket Post complete, narrow deck	3400
Pipe Bracket Post complete, wide deck	3800
1 Arm Ground Signal complete, 22′ 6″ base to center of arm	1270
1 Arm Ground Signal complete, 29′ 6″ base to center of arm	1430
2 Arm Ground Signal complete, 22′ 6″ base to center of lower arm	1850
2 Arm Ground Signal complete, 28′ 6″ base to center of lower arm	2000
3 Arm Ground Signal complete, 22′ 6″ base to center of lower arm	2420
1 Arm Bracket or Bridge Signal complete, 3′ 6″ base to center of arm	710
1 Arm Bracket or Bridge Signal complete, 10′ 6″ base to center of arm	900
2 Arm Bracket or Bridge Signal complete, 3′ 6″ base to center of lower arm	1310
2 Arm Bracket or Bridge Signal complete, 9′ 6″ base to center of lower arm	1450
3 Arm Bracket or Bridge Signal complete, 3′ 6″ base to center of lower arm	1860
The above signals complete with mechanism, ladders, spectacles, blades, lamp brackets, foundation bolts, etc.	
Cantilever bracket complete	200
Dummy Mast	300
Fixed Arm complete	130
Model 2A, 110-volt Signal Mechanism complete, with clamp bearing (Fig. 199)	350

DWARF SIGNALS

Model 2A Dwarf Signal complete	380
Model 2, 1 Arm Dwarf Signal complete	150
Model 2, 2 Arm Dwarf Signal complete	300
Model 3, 1 Arm Dwarf Signal complete	140

The above signals complete with spectacle, blade, lamp bracket, foundation bolts, etc.

SIMPLIFIED CIRCUIT DIAGRAMS SHOWING TYPICAL APPLICATIONS FOR MODEL 2A SIGNALS IN AUTOMATIC BLOCK SIGNALING ELECTRIC-INTERLOCKING AND MECHANICAL INTERLOCKING

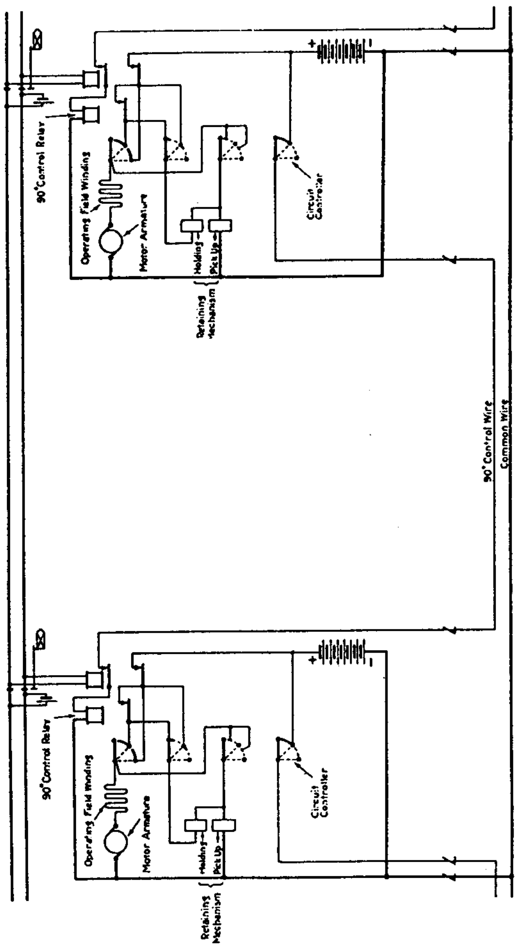


FIG. 35. SIMPLIFIED DIAGRAM, THREE-POSITION, D-C. AUTOMATIC SIGNAL, 8-, 10- OR 20-VOLT MOTOR

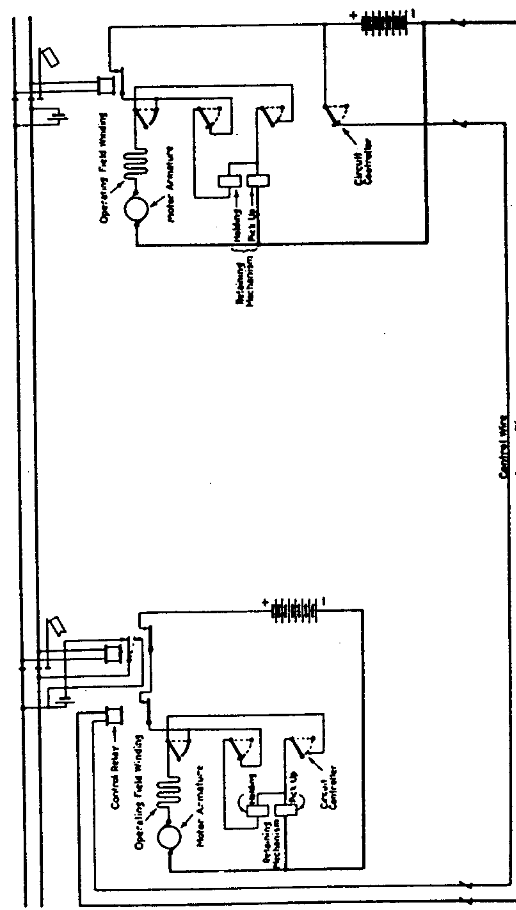


FIG. 36. SIMPLIFIED DIAGRAM, TWO-POSITION, D-C. AUTOMATIC SIGNAL, 8-, 10- OR 20-VOLT MOTOR

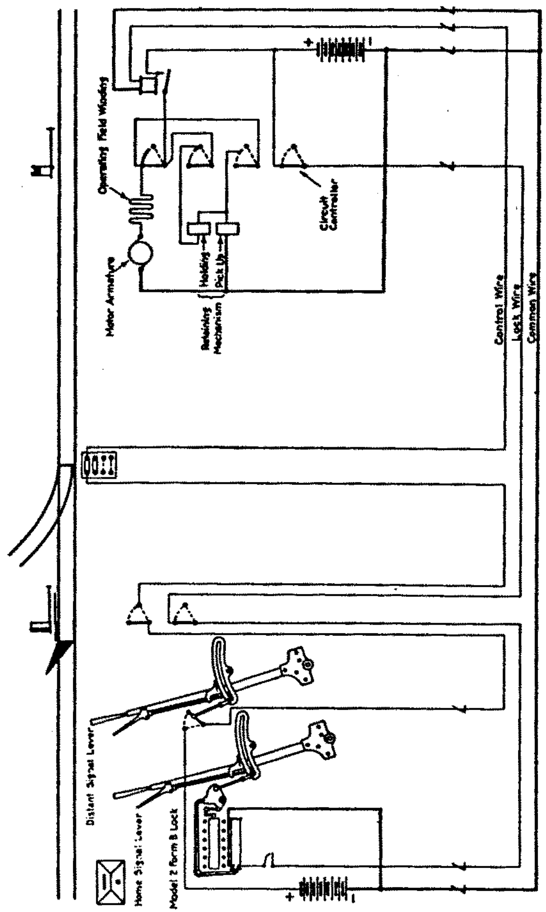


FIG. 37. SIMPLIFIED DIAGRAM, TWO-POSITION, D-C, POWER DISTANT SIGNAL, 8-, 10- OR 20-VOLT MOTOR, BATTERY INDICATION

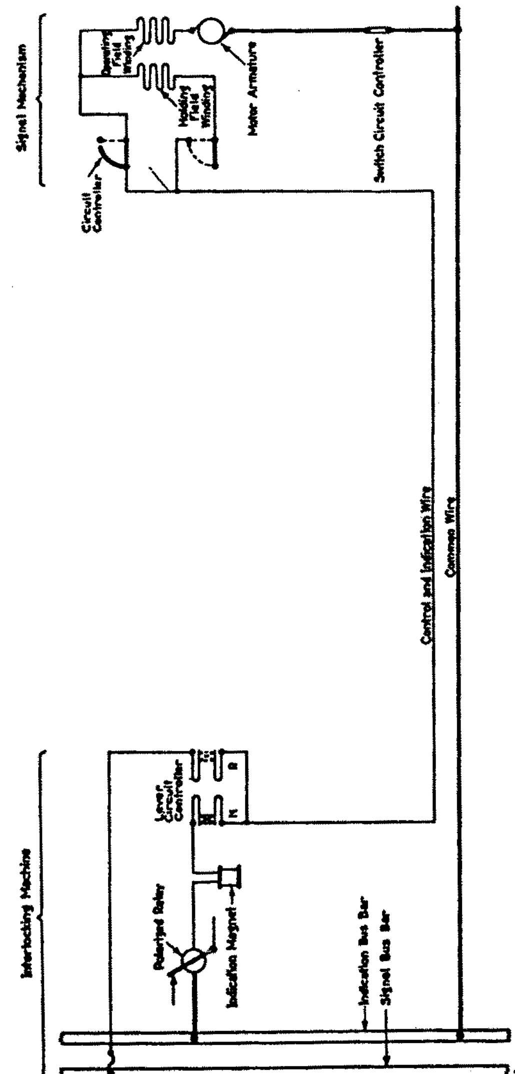


FIG. 38. SIMPLIFIED DIAGRAM, TWO-POSITION, D-C, NON-AUTOMATIC SIGNAL, 110-VOLT MOTOR

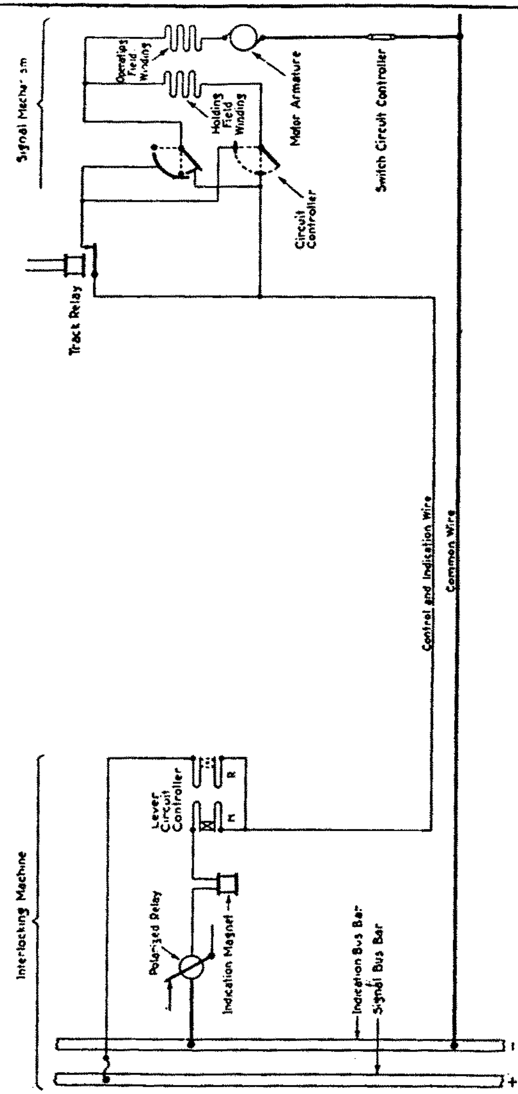


FIG. 39. SIMPLIFIED DIAGRAM, TWO-POSITION, D-C. SEMI-AUTOMATIC SIGNAL, 110-VOLT MOTOR

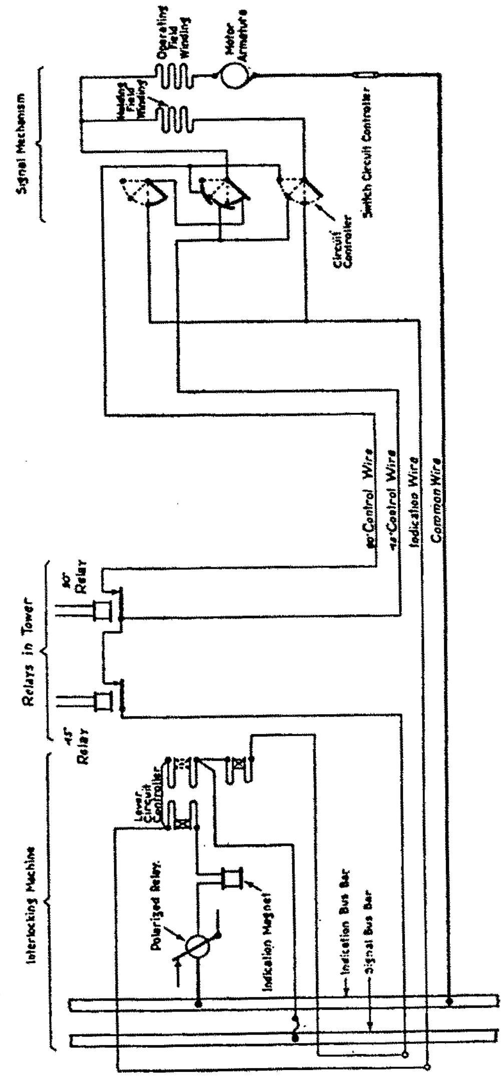


FIG. 40. SIMPLIFIED DIAGRAM, THREE-POSITION, D-C. SEMI-AUTOMATIC SIGNAL, 110-VOLT MOTOR

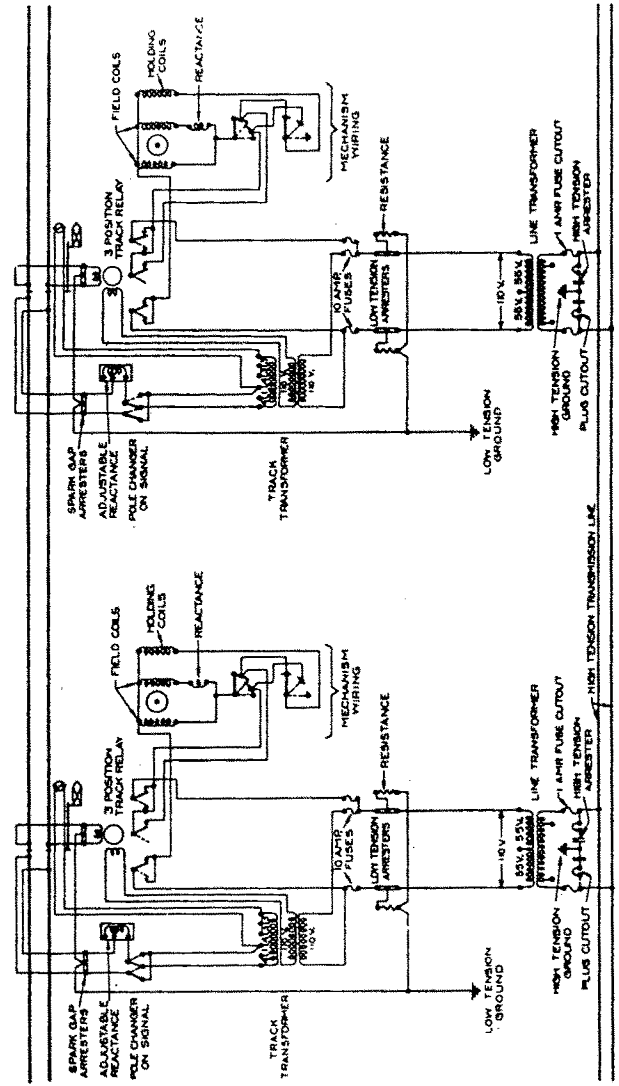


FIG. 41. SIMPLIFIED DIAGRAM, THREE-POSITION, A-C. AUTOMATIC SIGNAL, 110-VOLT MOTOR