American Railway Signaling Principles and Practices

CHAPTER XVII

Mechanical and Electro-Mechanical Interlocking

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MECHANICAL AND ELECTRO-MECHANICAL INTERLOCKING

General.

The first interlocking plant in America was of the mechanical type. Saxby and Farmer, of London, England, furnished the material for the original installation as well as the mechanics to do the work. Spring catch type locking, the forerunner of the preliminary latch locking now in general use, was employed. The switches were operated and locked by the same lever by means of a switch-and-lock movement connected to the lever by pipes and the signals were connected by wire to their respective levers. An arrangement of dogs and notched bars constituted the locking which necessitated moving the levers in a predetermined order. Except in the development of mechanical interlocking, the present Saxby and Farmer machine conforms closely to the principles of design used in the original machine.

As the mechanical interlocking came into general use, various improvements were made to provide the security demanded by the increasing speed and traffic. Among the many improvements made were independent levers for operating and locking switches; wire-connected signals changed to pipe-connected; introduction of track circuits; electro-mechanical slots for signals; power signals; semi-automatic signals; detector bars replaced by electric switch locking, also time and approach locking.

Experience of the railroads of the country in operating the mechanical interlocking developed the limitations of its use and demonstrated that it was not adequate to economically meet many operating problems whereby both time and money could be saved by the use of power-operated switches and signals. In response to this new demand, the power interlocking was devised. The first development was the hydraulic, followed by the hydro-pneumatic, then the pneumatic which in turn was followed by the electro-pneumatic. The hydro-pneumatic interlocking, while not satisfactory, was the inspiration for the present electro-pneumatic system. Later developments were the electric, electro-mechanical, and automatic interlockings.

This chapter is confined to mechanical and electro-mechanical interlocking, the principal units of which may be classified as follows:

Interlocking station
Machine
Mechanical locking
Machine appurtenances
Leadout
Foundation
Pipe and wire lines
Switch mechanism
Signal.

Interlocking Station

The Standard Code of the American Railway Association defines Interlocking Station as: A place from which an interlocking plant is operated.

The design of an interlocking station varies to meet local conditions and is constructed of any of the standard building materials. Figures 1, 2 and 3 are typical of stations in general use. Within the interlocking station is housed the machine and equipment necessary for the efficient operation of the interlocking plant, such as track model or diagram, indicators, annunciators, bells, releases, relays, batteries, etc. The circuits for this equipment are explained in detail in Chapter XX—Interlocking Circuits.

The general practice is to locate the building centrally with reference to the functions to be operated which also permits the signalman to have the best view possible of the interlocking layout.

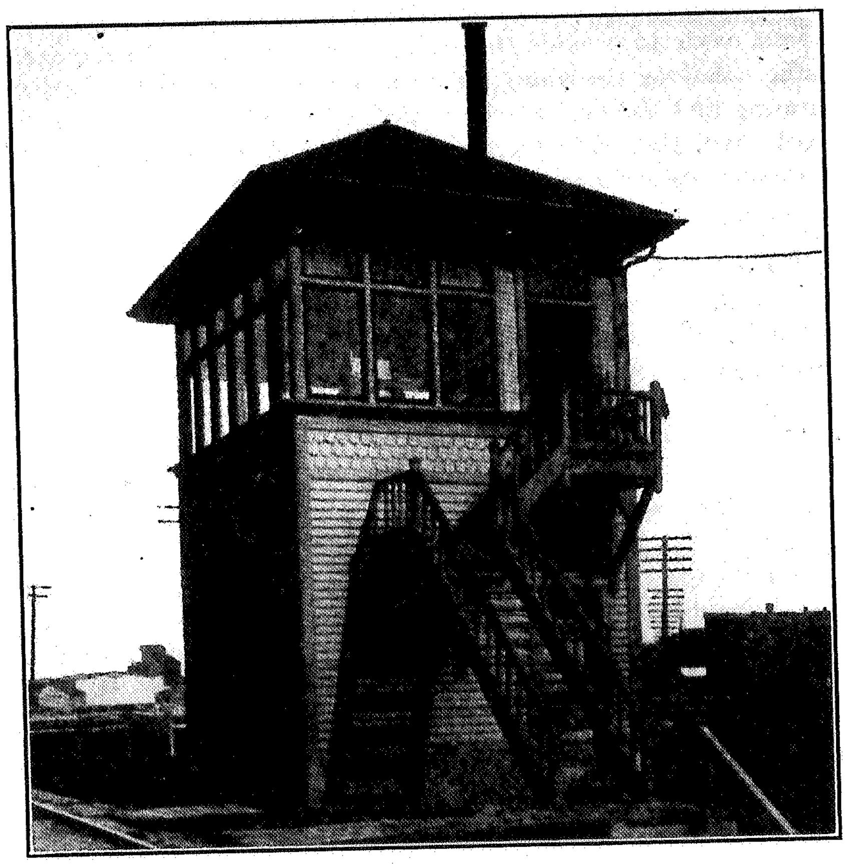


Fig. 1.
Frame Interlocking Station.

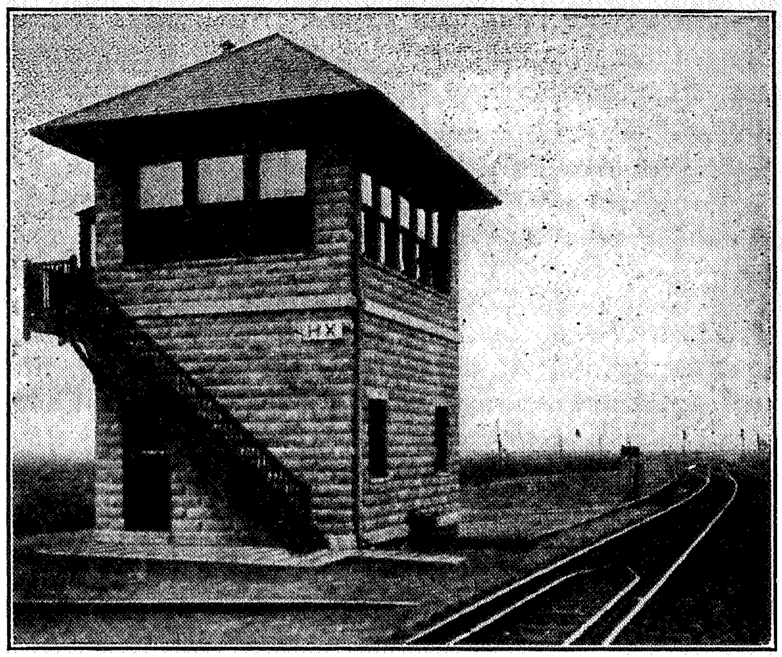


Fig. 2.
Cement Block Interlocking Station.

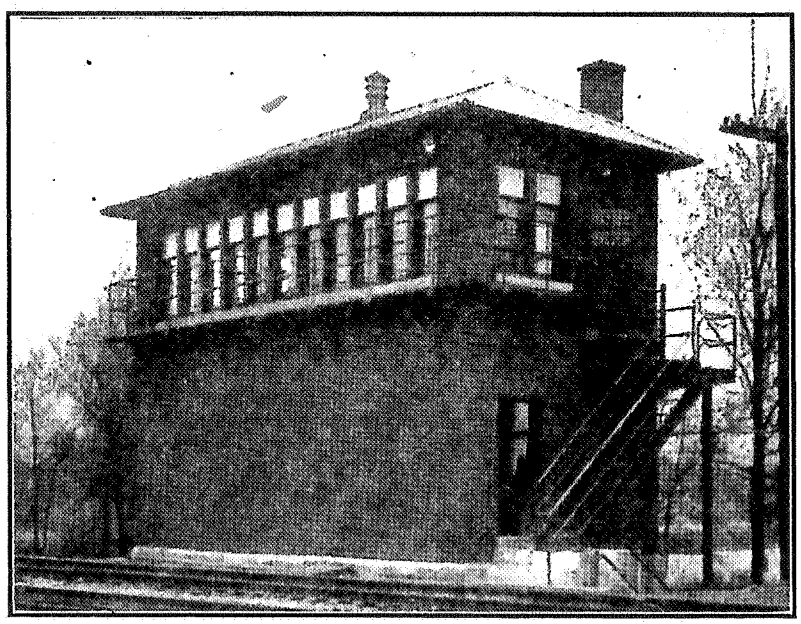


Fig. 3.
Brick Interlocking Station.

Machine

Signal Section, American Railway Association, specifications for mechanical and electro-mechanical interlockings cover the following types of machines:

Mechanical interlocking machine, S. & F. locking.

Mechanical interlocking machine, Style "A" locking.

Electro-mechanical interlocking machine, S. & F. miniature locking.

Electro-mechanical interlocking machine, vertical locking.

Electro-mechanical interlocking machine, unit electric levers, S. & F. locking.

Mechanical machine.

The Signal Section, A.R.A., defines Mechanical Interlocking Machine as: An interlocking machine designed to operate the units mechanically although some of the units may be controlled and operated electrically.

There are two types of mechanical machines in general use known as the improved Saxby and Farmer machine illustrated in Fig. 4, and the Style "A" machine illustrated in Fig. 5. It will be seen from a study of these figures that many parts of the machines are similar and that the principal difference is in the arrangement of the mechanical locking. The Saxby and Farmer machine has a horizontal locking bed while the Style "A" machine has a vertical locking bed.

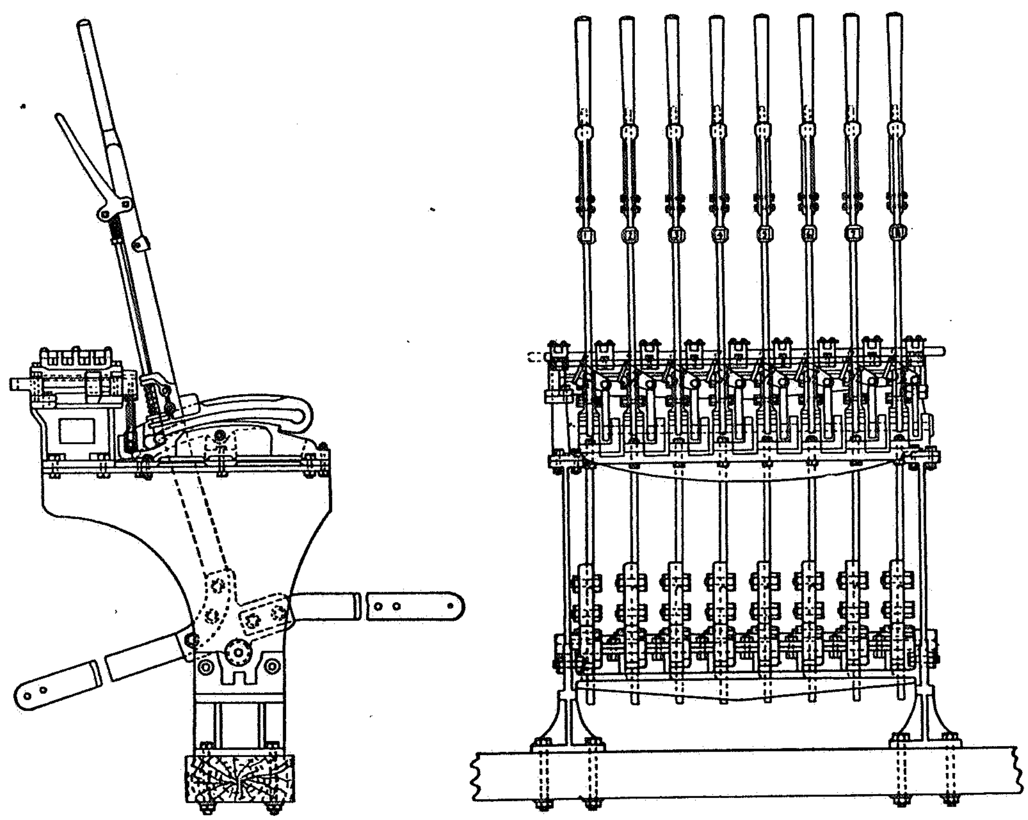


Fig. 4.
Improved Saxby & Farmer Mechanical Machine.

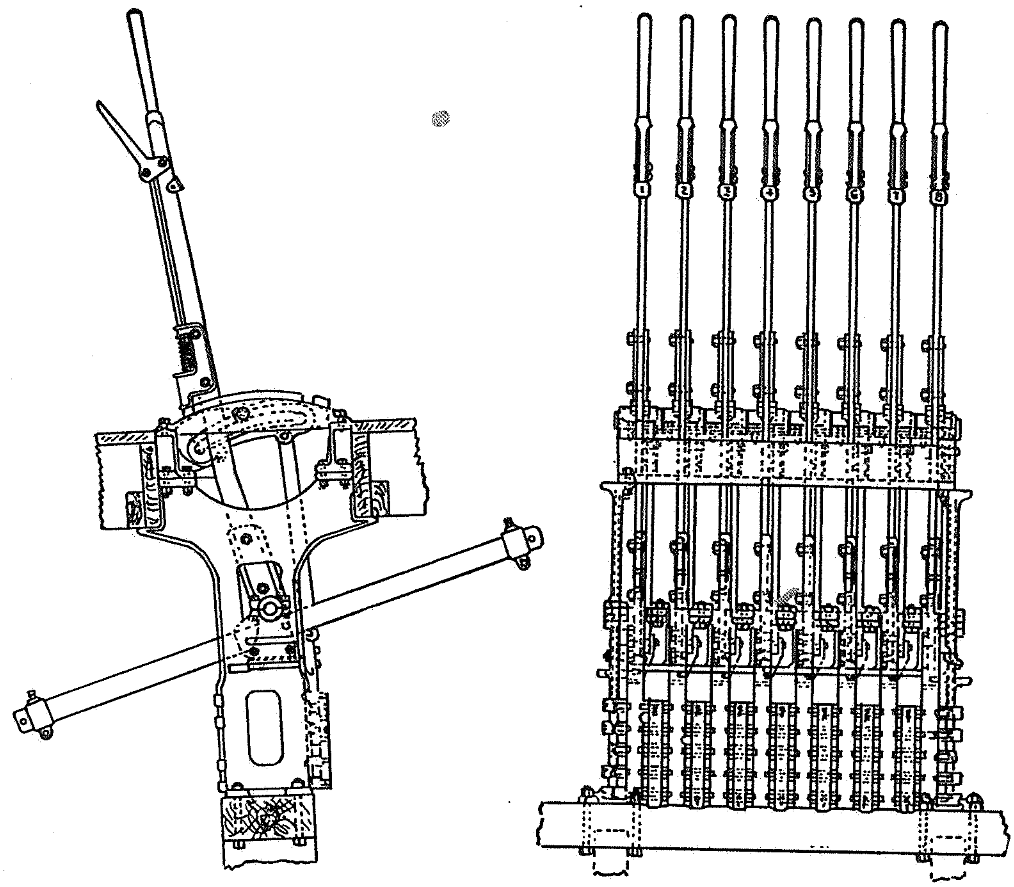


Fig. 5.
Style "A" Mechanical Machine.

Improved Saxby and Farmer machine.

The operation of the improved Saxby and Farmer (hereinafter referred to as "S. & F.") machine is covered in detail in Chapter XVI—Interlocking The machine is furnished in four and eight-lever sections or multiples thereof. The levers are 5 feet 10⅛ inches long from center of fulcrum to end of handle, extending about 4 feet above the floor. They are spaced 5 inch centers Each lever is equipped with a number plate, the numbering being from left to right. In Fig. 4 the levers are in the normal position and are said to be reversed when in the opposite position.

Style "A" machine.

The operation of the Style "A" machine is covered in detail in Chapter XVI—Interlocking. The machine is furnished in four and eight-lever sections or multiples thereof. The levers are of the same length and spacing as is used in the S. & F. machine. Each lever is equipped with a number plate, the numbering being from left to right.

Electro-mechanical machine.

The Signal Section, A.R.A., defines Electro-Mechanical Interlocking Machine as: An interlocking machine which is a combination of mechanical and electrical levers.

The addition to a mechanical machine of an electric lock, a circuit controller operated by a mechanical lever, or an entirely detached circuit controller effecting the operation of correlated units within the plant do not, in the strictest sense, constitute an electro-mechanical machine. What is now termed electro-mechanical machine had its origin in about 1909 when electrical and mechanical levers were combined in such a manner that a common locking bed would assure safety and facility of operation.

At that time there was a tendency to use power-operated signals at plants having mechanically-operated switches, and to provide for the thorough equipment of these plants with electric locking. There was also a desire to eliminate separate facing point locks, bolt locks and detector bars, resulting in the design of the electro-mechanical machine. In this development, two general types of electric machines were used in combination with mechanical machines as illustrated in Figs. 6 and 7. The mechanical part of each is the same as shown in Figs. 4 and 5 and is explained in Chapter XVI—Interlocking.

Electro-mechanical machine, S. & F. miniature locking.

Figure 8 is a typical illustration of the mechanical and electrical control features of an early type of electro-mechanical machine. Although 23 years of development have occasioned considerable refinement in structural details, and provisions have been made for the addition of lever lights, stick push button control for "call-on" signals, extra lock magnets, automatic time releases, etc., the original principles are retained in the present day designs.

The characteristic feature which makes this type of machine particularly applicable to the requirements is the mechanical locking device between each mechanical switch lever and the electric type lever located directly above. The latter, as shown in Fig. 9, locks the switch lever in both normal and reverse positions. The lock consists of a horizontal rod connected to the rocker link on the mechanical lever, with notches cut in it in such a manner that it is securely locked by a vertical rod connected to the electric lever. The electric lever is equipped for electric locking and thus cannot be manipulated unless the track circuits included in control of the sectional or route locking of the switch are unoccupied. When it is operated to the middle position, the mechanical lever is unlocked and can be reversed. Before the stroke of the electric lever can be completed, an electrical indication must be received, through contacts on the mechanical switch-and-lock movements, insuring that the switch points have completed their movement and are locked. Completion of the stroke of the electric lever then locks the mechanical switch lever in its new position and the interlocking provided between the electric levers thus establishes the necessary safeguard against improper lever manipulation.

The machine, as shown in Fig. 6, consists of a standard S. & F. machine, excepting the rocker links and locking bed, these being replaced by special

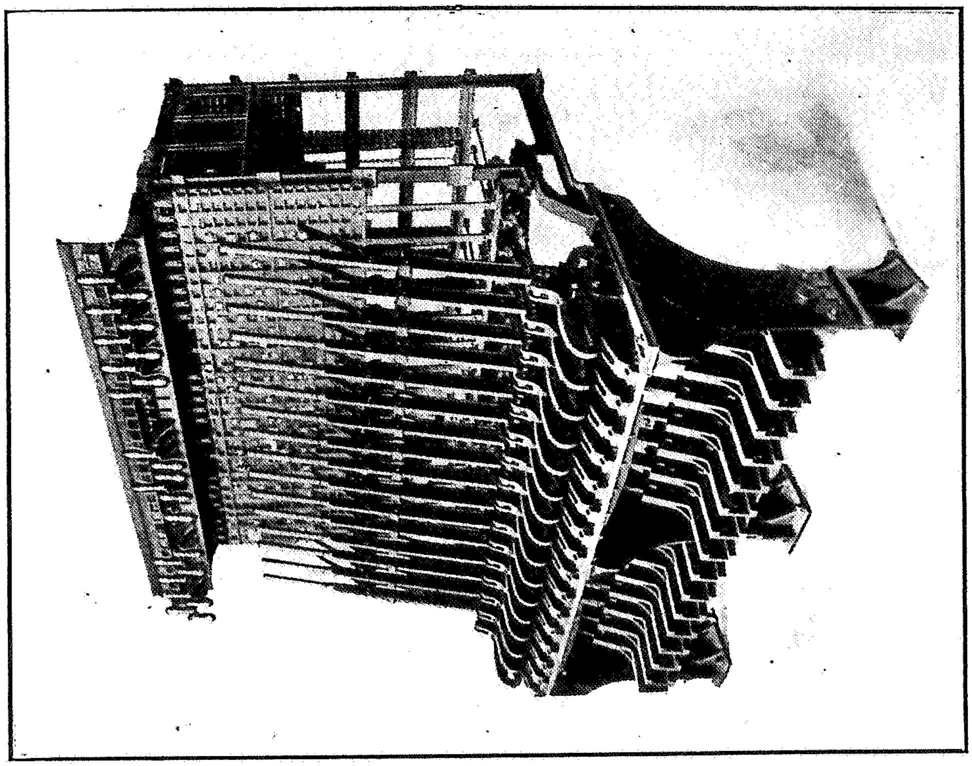


Fig. 7.
Model 2B Electro-Mechanical Machine.

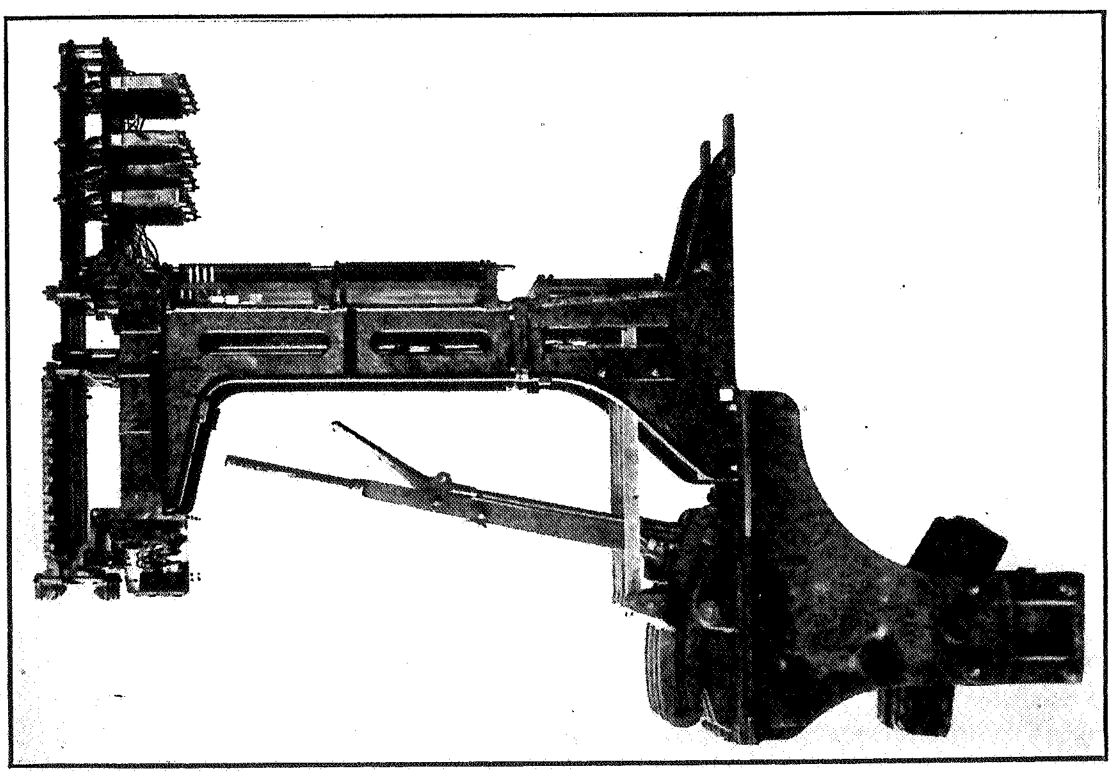


Fig. 6.
Electro-Mechanical Machine, Style P-5.

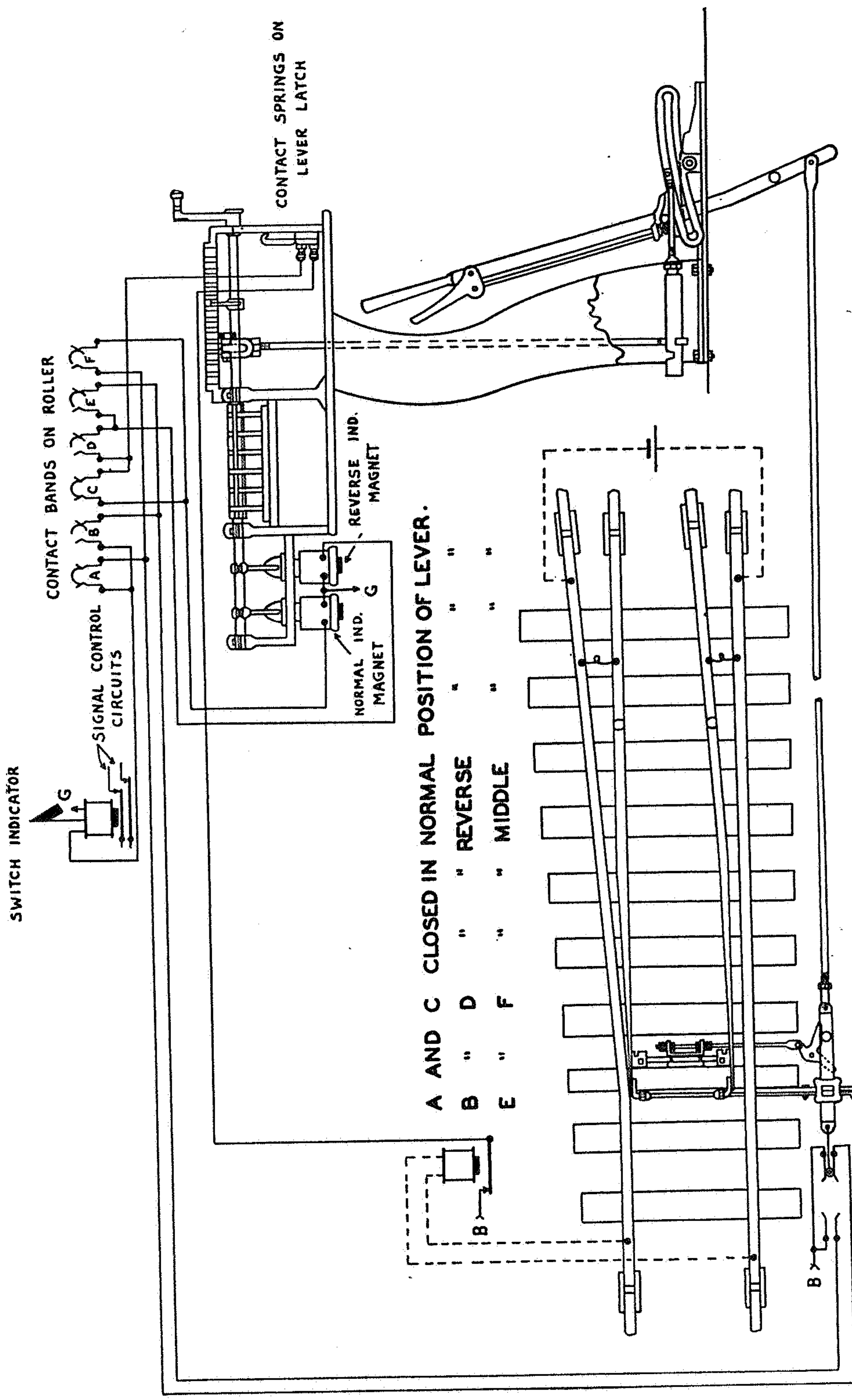


Fig. 8.
Control Features of an Early Type Electro-Mechanical Machine.

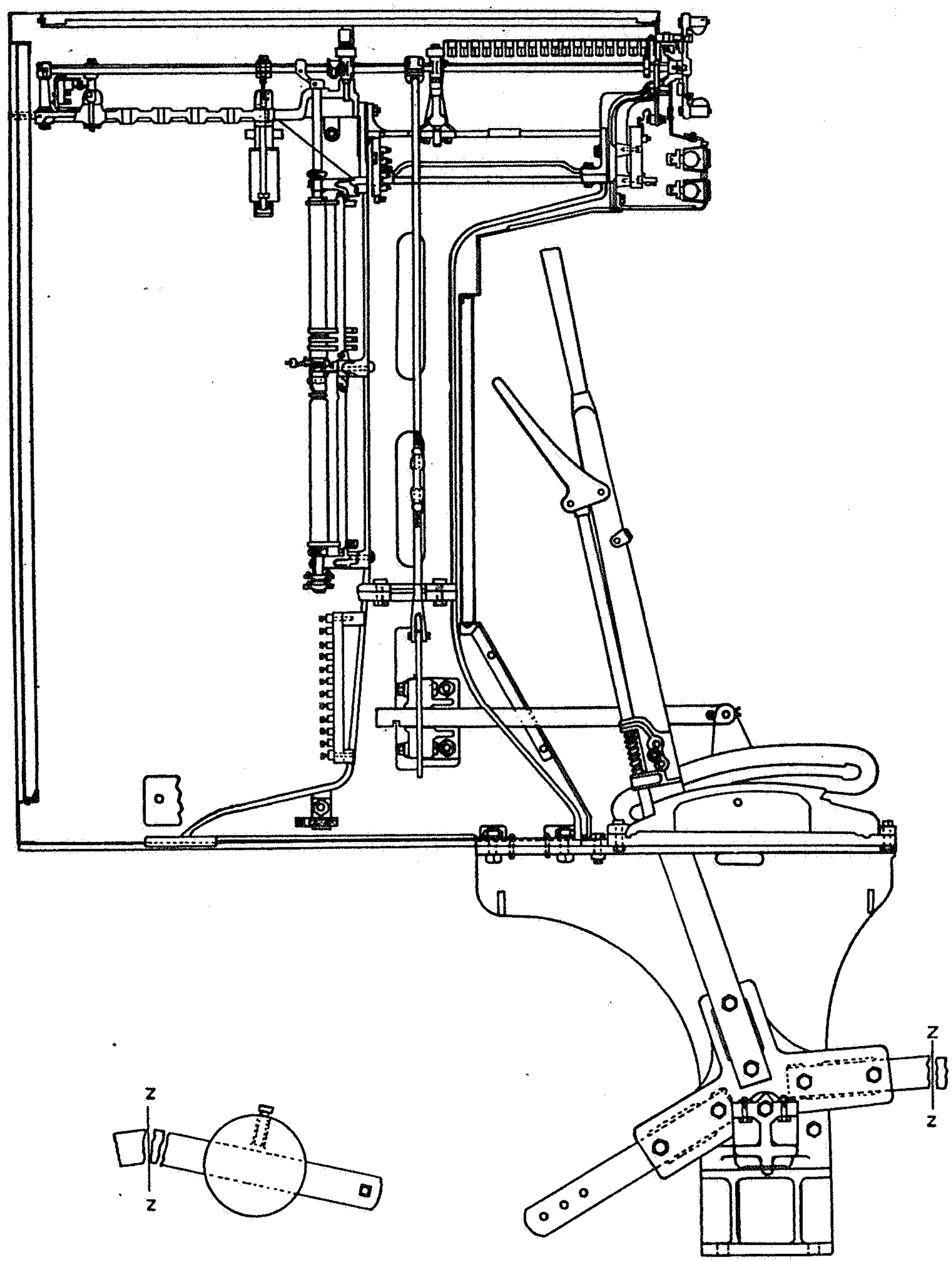


Fig. 9.
P-5 Electro-Mechanical Machine.

rocker links and a supporting frame for the electric units. The frame includes a locking bed for miniature locking between electric levers only. A locking bed of 18 way brackets (36 bars) is furnished on all sizes of machines.

The electric levers are spaced 2½ inch centers, and the mechanical levers 5 inch centers. The electric lever which mechanically locks a mechanical lever is located directly above it, and usually is numbered the same as the mechanical lever. The intermediate electric levers are used for the control of power signals, etc. The distance from the floor line to the center of the electric lever shafts is 5 feet 3 inches. The combination board, on which are mounted the contact springs and terminal posts, is of moulded insulation and is made up in units of convenient size. Thirty-six grooves provide a capacity for the same number of contacts for each roller. However, this is not the maximum for each lever as the rollers are so arranged that they can be divided in the middle and the lower halves operated independently. Thus, if one roller does not provide a sufficient number of contacts, the lower half of the roller of an adjacent lever or any number of other levers, can be utilized by providing link connections to cranks at the bottom of the various rollers, therefore it is possible to operate a large number of contacts by a single lever.

The electric switch levers are equipped with a handle or knob which actuates a locking device on a quadrant through a strong spring. The quadrant is notched so that the jar or strain of moving the lever from normal to reverse or vice versa will be absorbed on the more rugged quadrant instead of the projection on the segment. To insure further the quadrant taking the strain, a latch depressor is used which necessitates releasing the lever latch in moving the lever to either the normal or reverse position. In some instances the lever is equipped with a latch circuit controller by which the life of the battery is extended.

Electro-mechanical machine, vertical locking.

Figures 10 and 11 illustrate the application of an electric machine with vertical locking to an S. & F. machine, as shown in Fig. 7.

The details of machines shown in Figs. 10 and 11 are practically the same except for the width, which is 1 foot 3¾ inches less in Fig. 11 than Fig. 10. This additional width affords a longitudinal passageway through the machine from which the various terminal connections are accessible.

The mechanical machine is of the same type and construction as used in machines already explained. The electric machine consists of cabinet, frame, levers, indication magnets, lever locks, lever lights, tappets, locking, terminal board and rotary circuit controllers.

The electric levers are of two general types: signal levers and switch indicating and locking levers. They are spaced 2½ inch centers so that alternate levers are in the same vertical plane with mechanical levers which are spaced 5 inch centers. The electric machine is 2½ inches longer than the mechanical machine, the additional length extending on the right-hand end of the mechanical machine. The number of electric lever spaces is double that of the mechanical lever spaces.

The rotary circuit controllers are made in tiers, each tier having 6 contacts, with a total capacity of 5 tiers or 30 contacts for each circuit controller. The individual contacts may be arranged to open or close a circuit at any position in the stroke of the lever. By means of a crank operated by its lever, each tier of circuit controller contacts actuated by a mechanical lever is revolved through 60 degrees, and each tier of circuit controller contacts actuated by an electric lever is revolved 90 degrees. When electric and mechanical levers are in the same vertical plane, either lever may be arranged to operate all contacts, or the former may be arranged to operate the upper tier of contacts, and the latter the lower tier, independently of each other. The tiers of contacts in one space may also be arranged to operate with one or more tiers of contacts in adjacent spaces, thus making available a large number of contacts.

The mechanical locking is vertical as in the electric machine and the tappets are actuated by means of a cam slot in the respective electric and me-

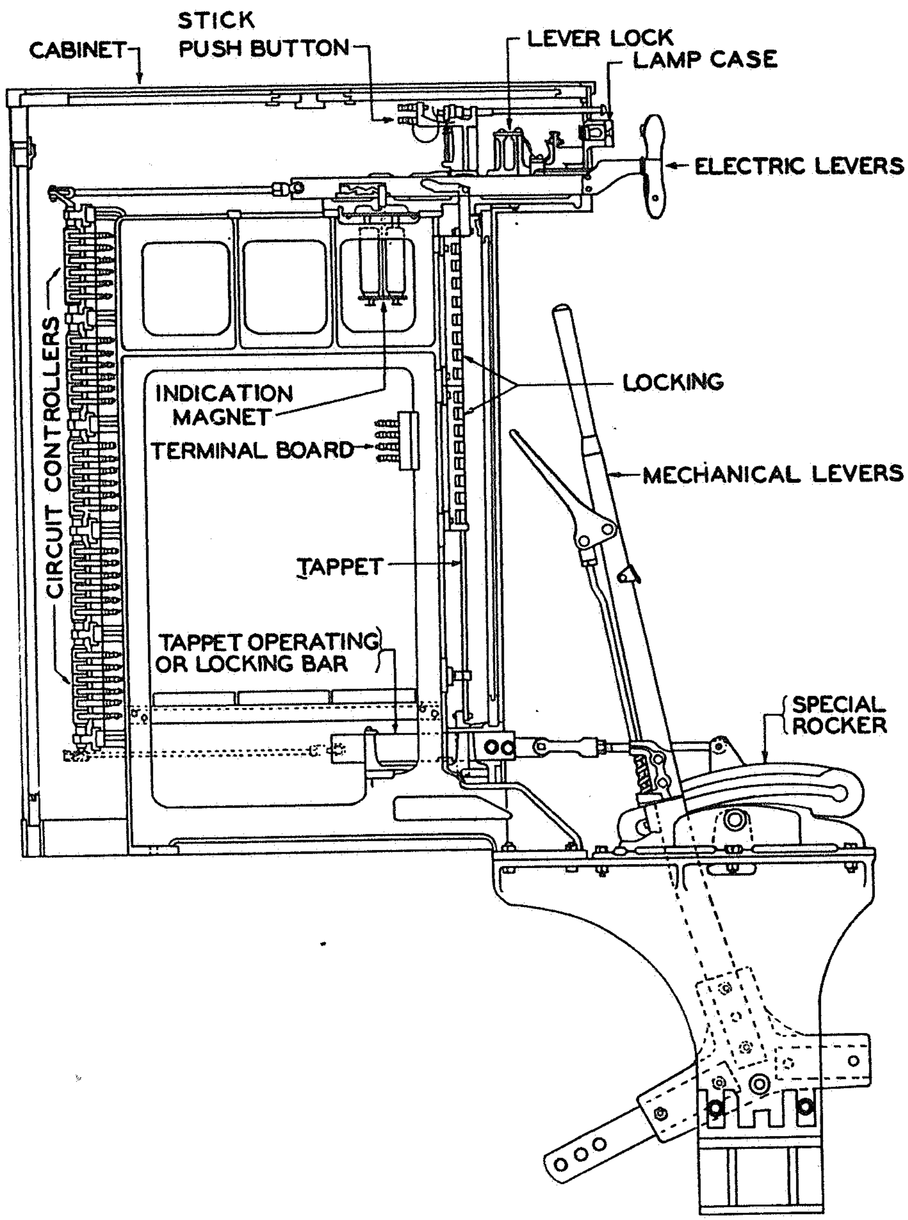


Fig. 10.
Model 2B Electro-Mechanical Machine.

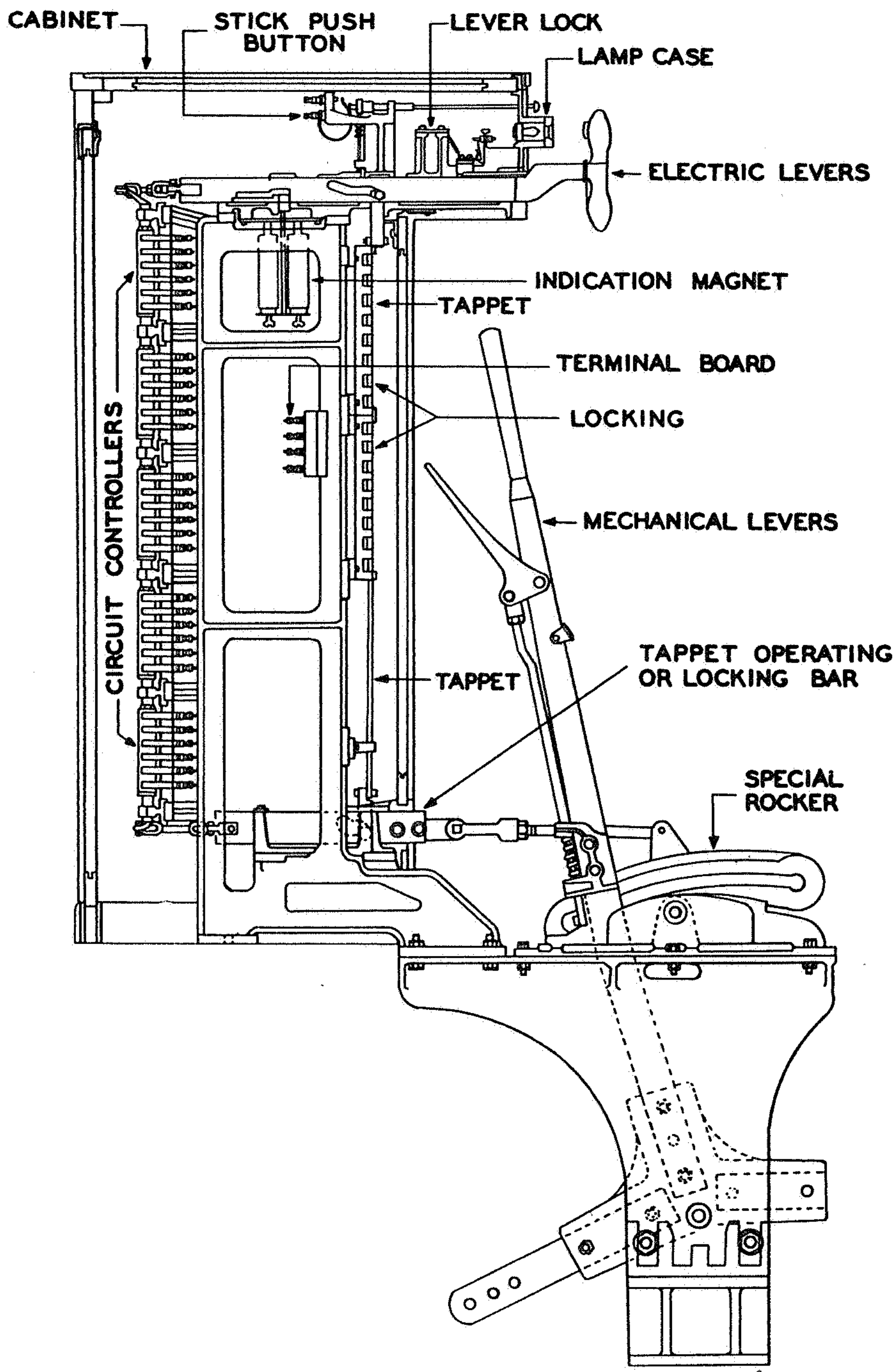


Fig. 11.
Model 2C Electro-Mechanical Machine.

chanical lever locking bars. Provision is made for either the electric or mechanical levers to operate the locking. This is explained in detail in Chapter XVI—Interlocking.

Referring to Fig. 10, it will be seen that the mechanical lever does not actuate the mechanical locking, but is bolt-locked by the electric lever. The mechanical lever shown in Fig. 11 has the locking bar equipped with a cam slot and tappet and actuates the locking. Thus, by the proper application of cam slots with accompanying tappets to electric and mechanical levers it is possible to obtain the same flexibility of locking as shown in electro-mechanical machines previously described in this chapter.

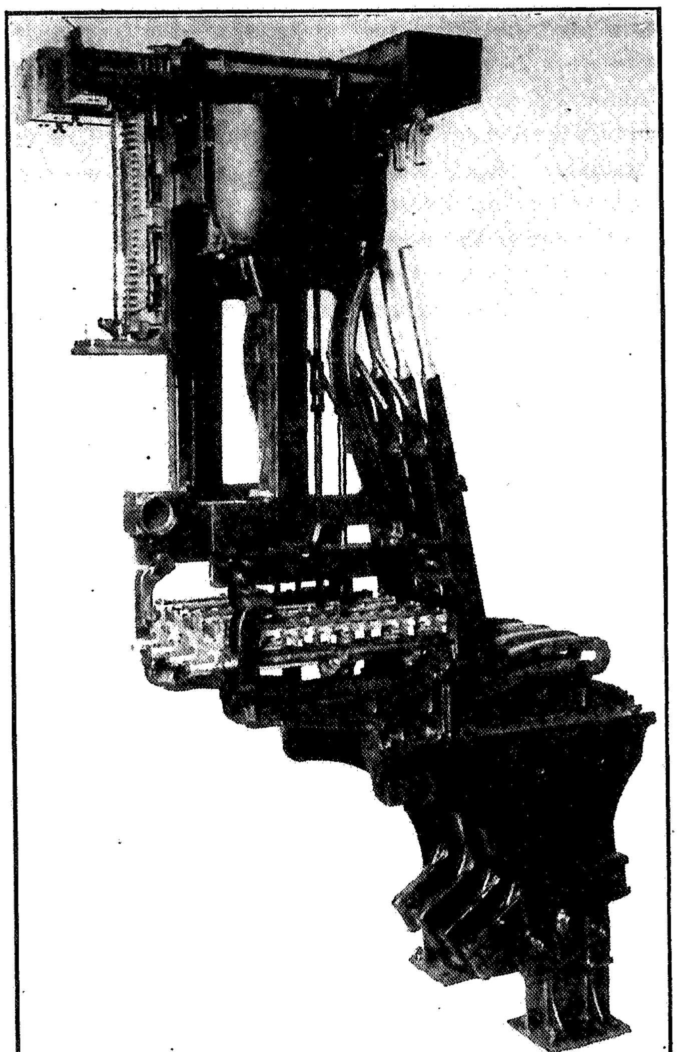


Fig. 12.
Unit Electric Levers.

Unit electric lever.

Immediately after the development of electro-mechanical interlocking machines, it was recognized that a number of advantages would be gained by combining miniature electric levers with the existing mechanical interlocking frames so that the locking between mechanical and electric levers could be accomplished in the standard mechanical locking bed. This resulted in the introduction of various types of machines, of which the one shown in Fig. 12 has been most generally used. It is, therefore, possible to add electric levers to existing mechanical interlocking frames and, under many circumstances, more than double the possible number of operative units, without adding to the floor space in the interlocking station.

The combination consists of an S. & F. machine, above the locking bed of which electric levers are supported and arranged as shown in Fig. 12. The electric levers are made in individual units, spaced 5 inch centers, thus providing for the same number of units as there are mechanical levers and spaces. The units are mounted on supporting frames of four and eight-lever sections or multiples thereof and may be located on any part of or extend the full length of the machine. Each electric unit consists of two main parts: the master unit and the circuit controller. The master unit is that part which is mounted directly upon the supporting frame and includes a lever, lever shaft, and one, two or three magnets, also a latch circuit controller, stick push button or, if desired, a time release. These are shown in Fig. 13. The circuit controllers are furnished with either 12 contacts in the horizontal position or 24 in the vertical position, with a 16 contact extension to the latter when necessary. When but one magnet is required the 12 horizontal contacts may be mounted inside the master units as shown in Fig. 14. When two or three magnets are used, the 12 horizontal contacts are bolted to the end of the master unit as shown in Fig. 15, the 24 vertical contacts being mounted in a similar manner as shown in Fig. 16, each of which is provided with a coupling. The controllers shown in Figs. 14 and 15 are interchangeable. The master unit, the horizontal controller and the vertical controller are each provided with an individual cover. A cylinder lock on the master lever unit cover secures all covers in place.

Electric levers are connected to the locking bed by means of crank arms on the lever shafts and adjustable connecting rods, the latter extending down through the locking brackets as shown between bars 10 and 11 or 22 and 23, to crank arms on the mechanical locking shafts, or to loose sleeve drivers rotating on split journals supported by the mechanical locking shafts. The last mentioned arrangement permits a locking bar to be operated without affecting the function of the shaft supporting the driver. The loose sleeve drivers are made in various lengths so that a selection of locking bars may be obtained. In a 40-bar bed, 20 bars may be operated by the rack type driver and 38 bars by the jaw type driver.

Each electric lever is capable of controlling any unit which can be controlled from an electric or electro-pneumatic interlocking machine, or it may be used as an indication lever for a mechanically-operated switch, or for

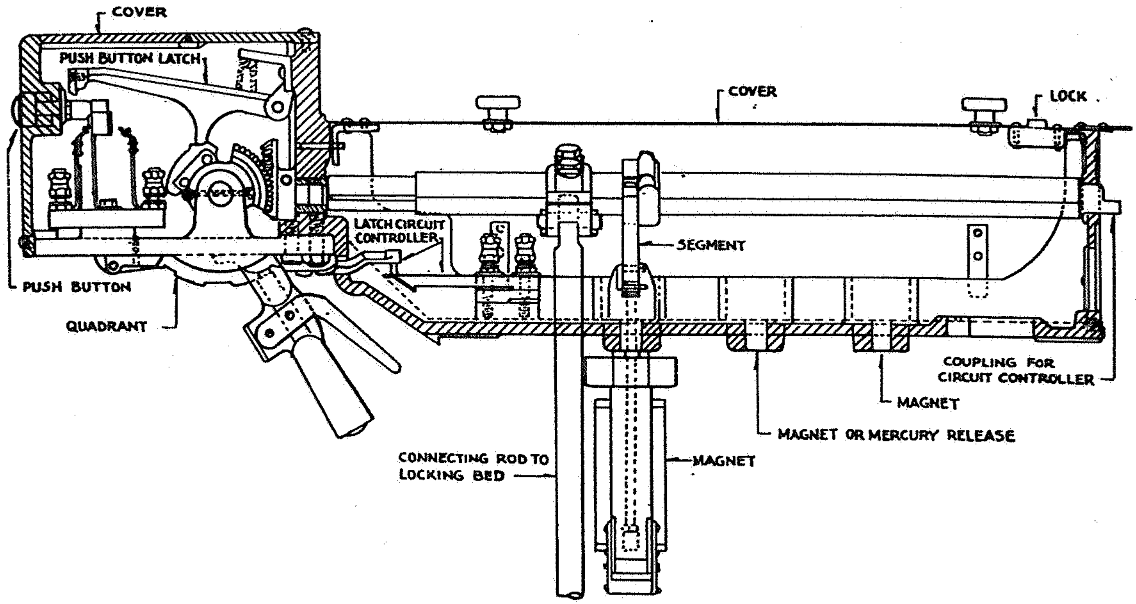


Fig. 13.
Master Unit.

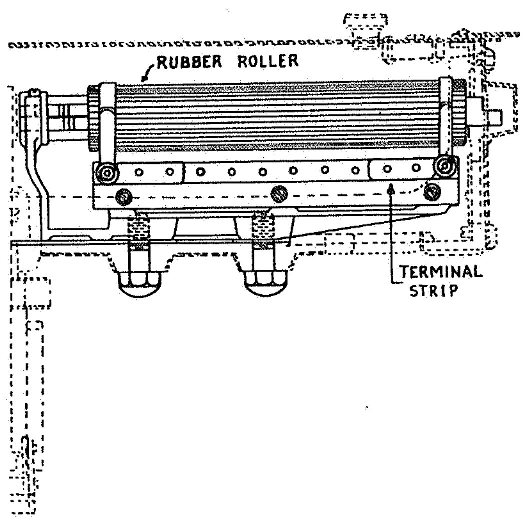


Fig. 14.
Horizontal Circuit Controller Mounted Inside the Master Unit.

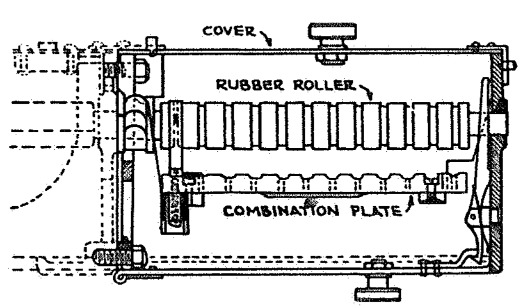


Fig. 15.
Horizontal Circuit Controller Bolted to the End of Master Unit.

electric switch locking when it is desired to retain the use of a mechanical facing point lock, but eliminate the detector bar. When used for either of the purposes last mentioned, the locking between the electric lever and the mechanical lever is obtained by a cam device on the end of the locking shaft. The shaft is operated by a connecting rod from the electric lever, and the cam engages a lock bar connection on the rocker link of the mechanical lever as shown in Fig. 17. With this arrangement the mechanical lever is locked normal when the electric lever is in the normal position. Moving the electric lever to the center position, releases the mechanical lever so that the latter may be reversed. Reversing the mechanical lever, releases the electric lever which can then be fully reversed. Completing the stroke of the electric lever, locks the mechanical lever in the reverse position. Similar manipulation is necessary when returning both levers to the normal position.

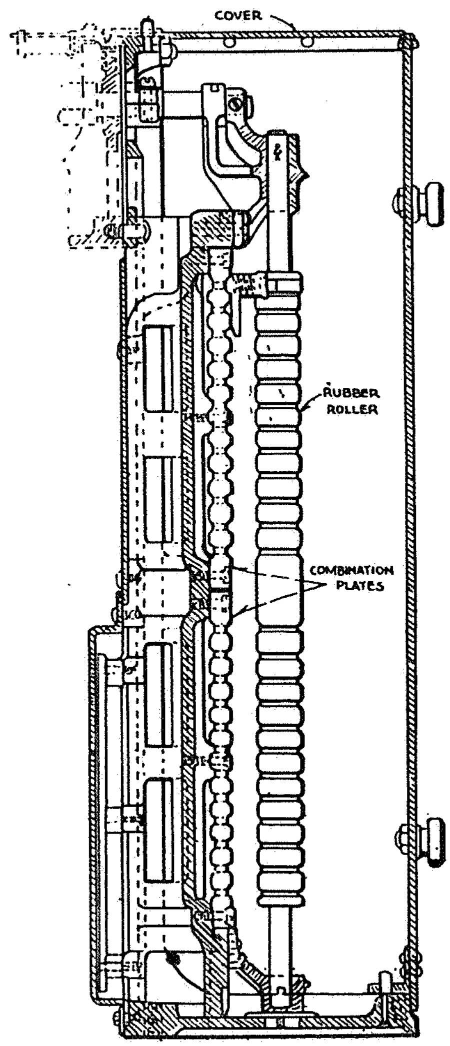


Fig. 16.
Vertical Circuit Controller Mounted on the End of Master Unit.

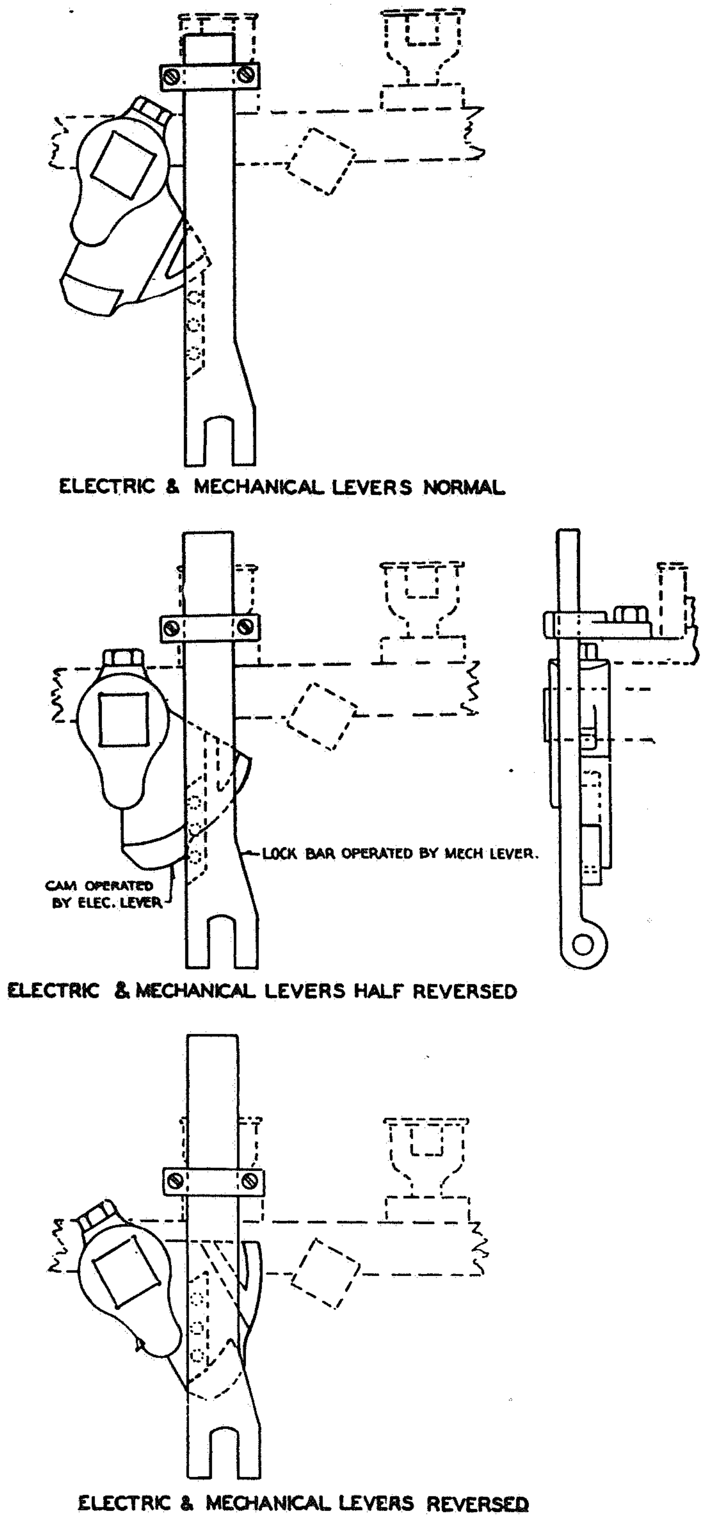
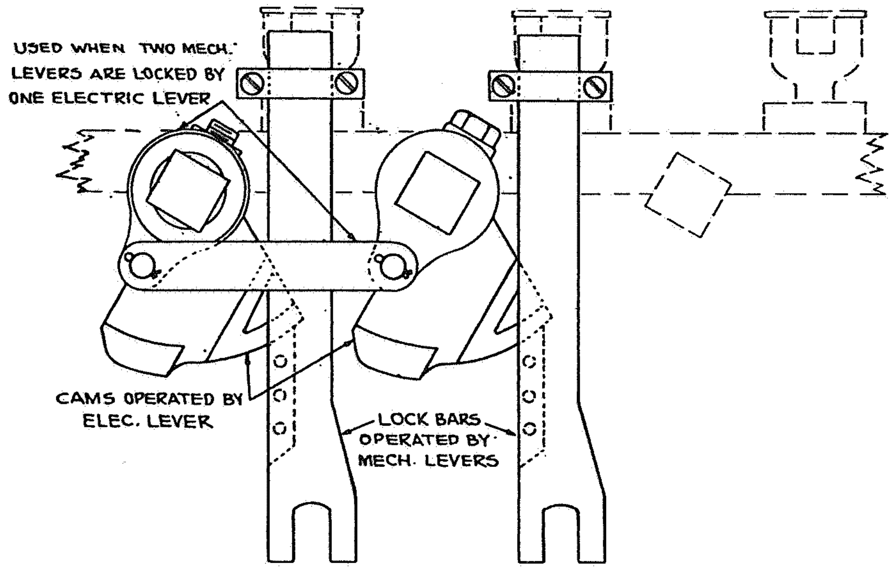


Fig. 17.
Cam Locking between Electric and Mechanical Lever.

Two or more mechanical levers may be locked by one electric lever by equipping the locking shaft of each additional lever with a locking cam supported by but operated independently of the locking shaft, the cams being joined together by the connecting link shown in Fig. 18.



ELECTRIC & MECHANICAL LEVERS – NORMAL

Fig. 18.

Double Cam Application for Locking Two or More Mechanical Levers by One Electric Lever.

The electro-mechanical machine, therefore, not only retains all the functions of a mechanical machine, but also includes the additional functions of a power machine, combining the two in such a way that the interlocking of all levers is accomplished in a common locking bed, which bed, without change, is a standard part of all S. & F. machines. An existing mechanical machine can be readily converted into an electro-mechanical machine. The replacing of mechanical signals with electric, the elimination of detector bars, the addition of one or more power-operated switches within the limits of the interlocking plant, the operation of an outlying switch by power, route locking, traffic control, or any other special feature may be taken care of by the addition of unit electric levers.

Unit electric lever, Style "A" mechanical machine.

Figure 19 illustrates the application of unit electric levers to a Style "A" mechanical interlocking machine.

The same general results are obtained in the application to the Style "A" machine as were obtained with the S. & F. type, the principal variation being in the method of locking between mechanical and electric levers. The mechanical locking bed of the Style "A" machine being vertical and located below the floor level at the front of the machine necessitates the use of crank arms to transmit the proper motion from the electric levers to the locking bars,

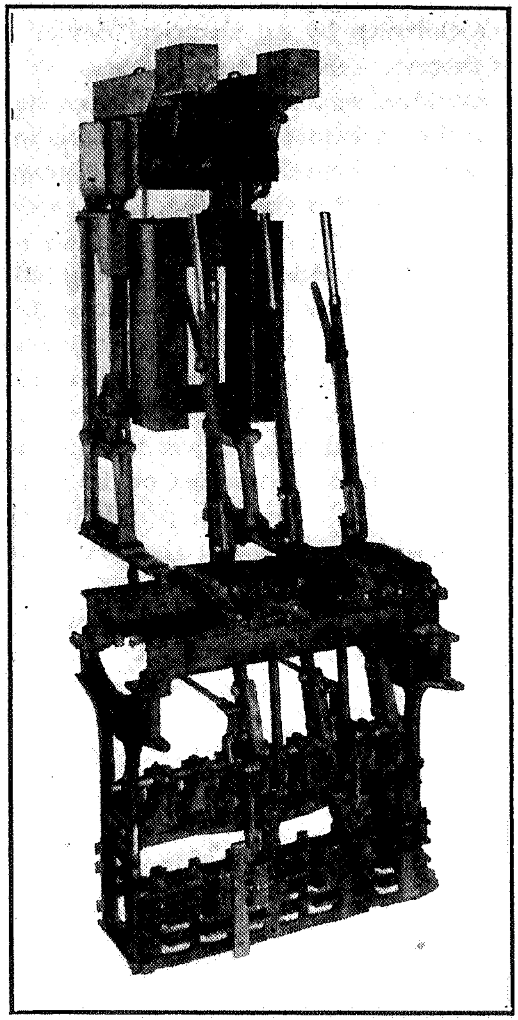


Fig. 19.
Unit Electric Levers on Style "A" Mechanical Machine.

whereas in the S. & F. machine, the electric levers are mounted directly above the locking bed and the connecting rods are direct connected between electric levers and crank arms on locking shafts of mechanical levers.

Mechanical Locking

The mechanical locking for the mechanical and electro-mechanical interlocking machines is explained in detail in Chapter XVI—Interlocking.

Machine Appurtenances

Electric lock.

The Signal Section, A.R.A., defines Electric Lock as: A device to prevent or restrict the movement of a lever, a switch or a drawbridge, unless the locking member is withdrawn by an electrical device, such as an electro-magnet, solenoid, or motor.

Electric locks are employed as a safeguard and may be applied to meet the requirements of the various schemes of electric locking in general use. They may be applied to mechanical machines in various ways; Fig. 20 shows an electric lock connected to a rocker shaft; Fig. 21 shows an electric lock connected to a rocker link.

The operation of the electric lock as shown in Fig. 20 is as follows: The rocker shaft is connected by a link to the crank arm which operates the segment and contact rollers. A notch is cut into the segment to admit the locking dog when the lever is in the position in which its latch is to be locked. The locking dog is secured to one end of a locking lever, to the other end of which is secured the armature suspended over the pole faces of the magnet. When the magnet is energized the movement of the armature withdraws the locking dog from the notch in the segment permitting the lever latch to be operated. Contact bands on roller permit the electric lock to be used as a circuit controller.

The same results are obtained with the electric lock shown in Fig. 21 by driving the segment from the rocker link. This arrangement provides a more direct connection to the device operated by the lever latch.

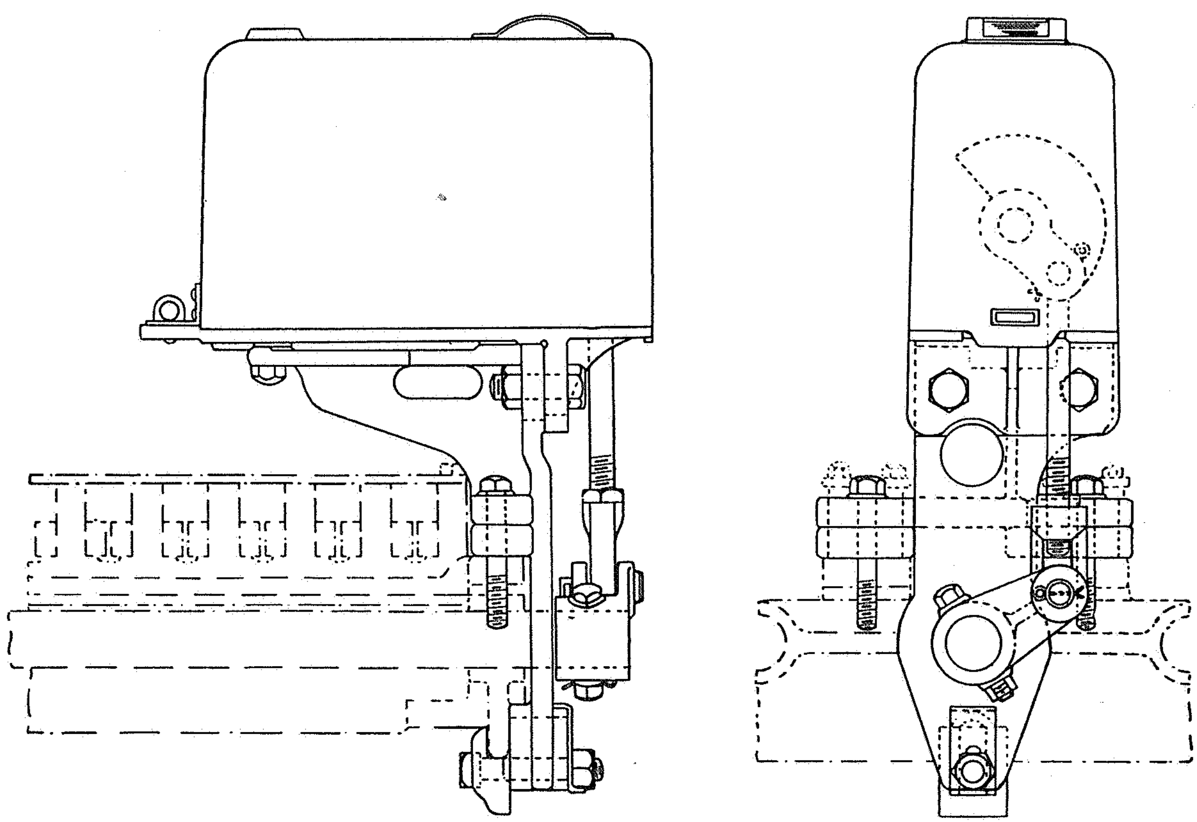


Fig. 20.
Electric Lock on Rocker Shaft, S. & F. Machine.

Forced drop electric lock.

The forced drop feature, as applied to the electric lock, insures that the lever is locked when the magnets are de-energized. The mechanism consists of a locking piece operated by a solenoid magnet as illustrated in Fig. 22, a locking slide bar and crank, and a rack and pinion movement to operate a rotary circuit controller. The movement of the slide bar mechanically forces down the locking member. This type of lock is designed for mounting below the floor and may be applied to an S. & F. machine as shown in Fig. 23, and to a Style "A" machine as shown in Fig. 24. Provision is made for locking the latch in the various positions of the latch and lever by changing the locking stops and guide bars. This type of forced drop electric lock may be equipped with adjustable rotary circuit controllers in tiers of six contacts each. The number of tiers that may be used is limited only by the space available below the floor.

Another type of forced drop electric lock is illustrated in Fig. 25. This type of lock is arranged so that it may be mounted above the locking bed or

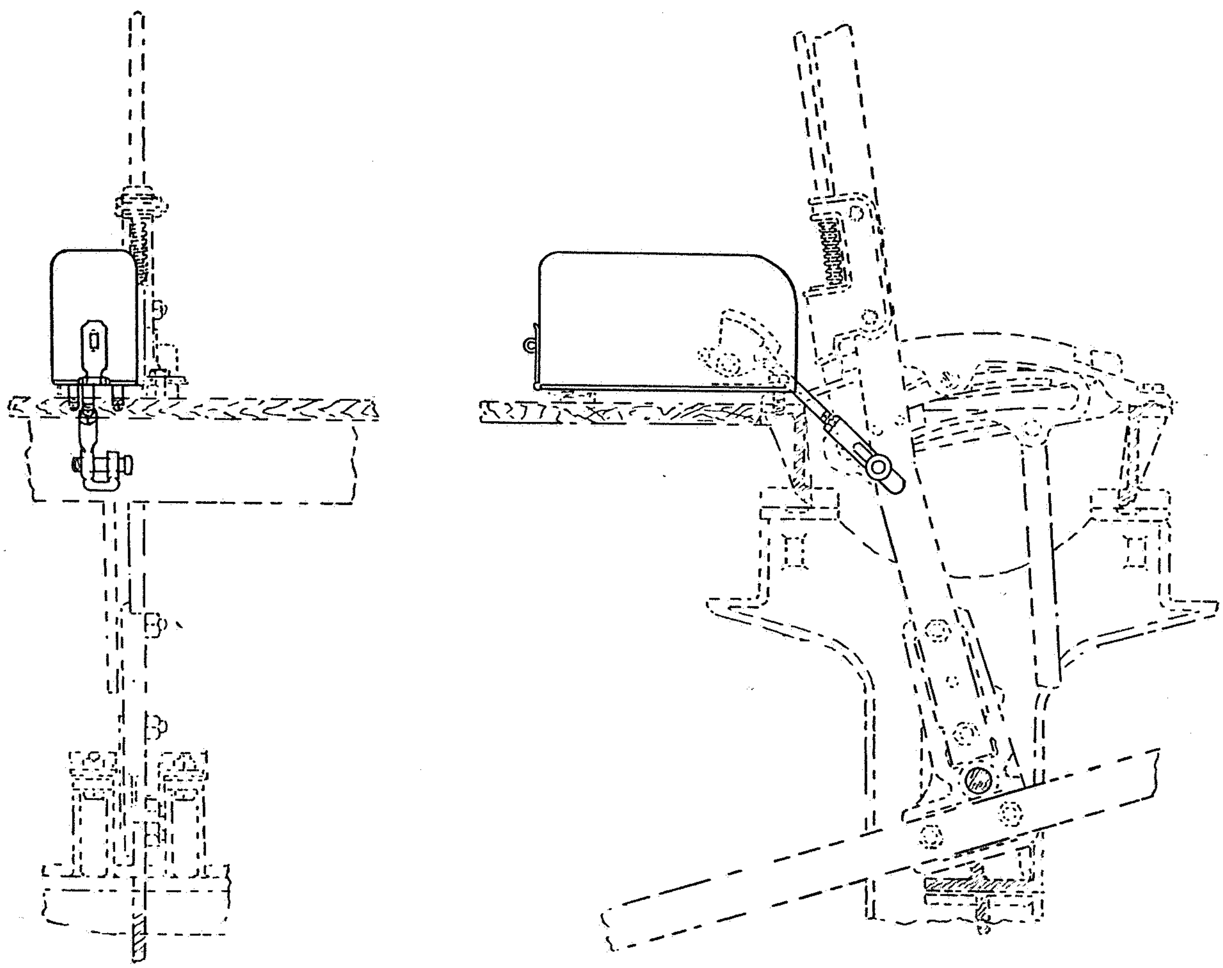


Fig. 21.
Electric Lock on Rocker Link, Style "A" Lever.

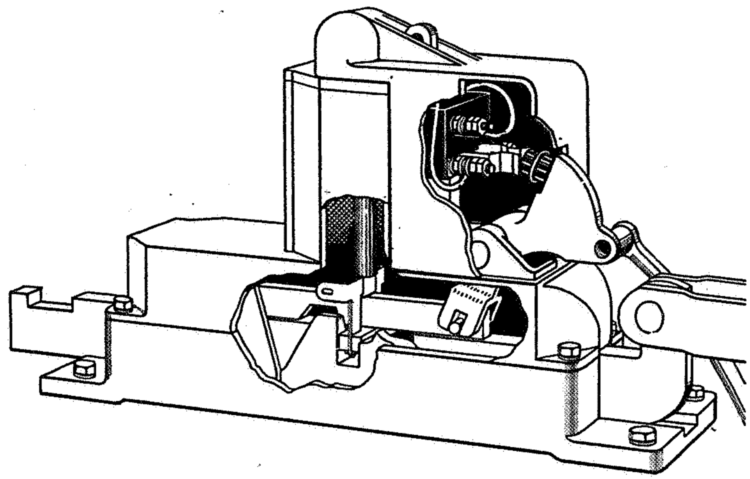


Fig. 22.
Forced Drop Electric Lock.

below the floor similar to Fig. 26. Additional sections may be added to the circuit controller when mounted below the floor. Figure 27 illustrates the application of the forced drop electric lock mounted above the locking bed of an S. & F. machine.

The slide bar is operated by a crank of adjustable length and the circuit controller is operated by an arm keyed to the circuit controller shaft and studded to the base of the slide bar. The locking dog is pinned to the magnet armature and engages the lock bar secured to the slide bar.

Provision is made for variation of the locking operation by substituting the desired lock bar.

Another method of electrically locking a mechanical lever is by means of the latch lever lock. This lock is mounted on the lever of the interlocking machine and is operated by the latch rod. The locking is secured by use of a segment and a locking dog. The segment is studded to a lug on the latch rod and is so cut as to force the locking dog down when the lever is latched and the magnet de-energized, thus providing the forced drop feature. The segment and locking piece are illustrated in Fig. 28. To secure latch locking with the latch in either the raised or down position different segments are provided. A three-way circuit controller is operated from the same stud on the lug as the segment.

Circuit controller.

In addition to the circuit controllers contained in the electric locks, other circuit controllers may be attached to the machine when required. They may be connected to the locking shaft, tappet, rocker link or latch rod for checking position of latch lever and to the tail lever for checking position of lever. An application to the locking shaft and tail lever is shown in Fig. 29. The circuit controller consists of a hard rubber roller equipped with metallic bands which make contact with springs at predetermined positions of the lever or lever latch.

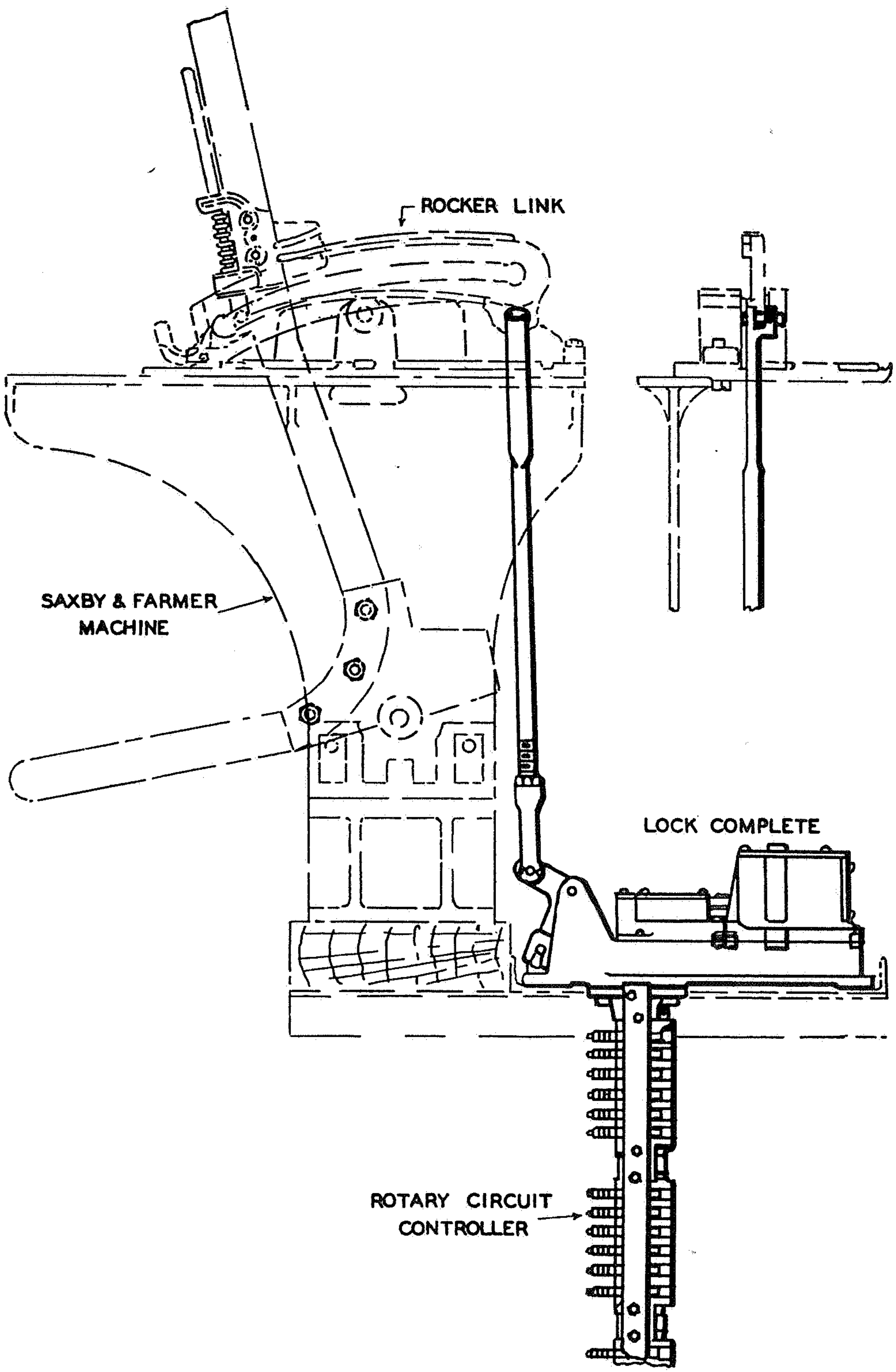


Fig. 23.
Forced Drop Electric Lock on S. & F. Machine.

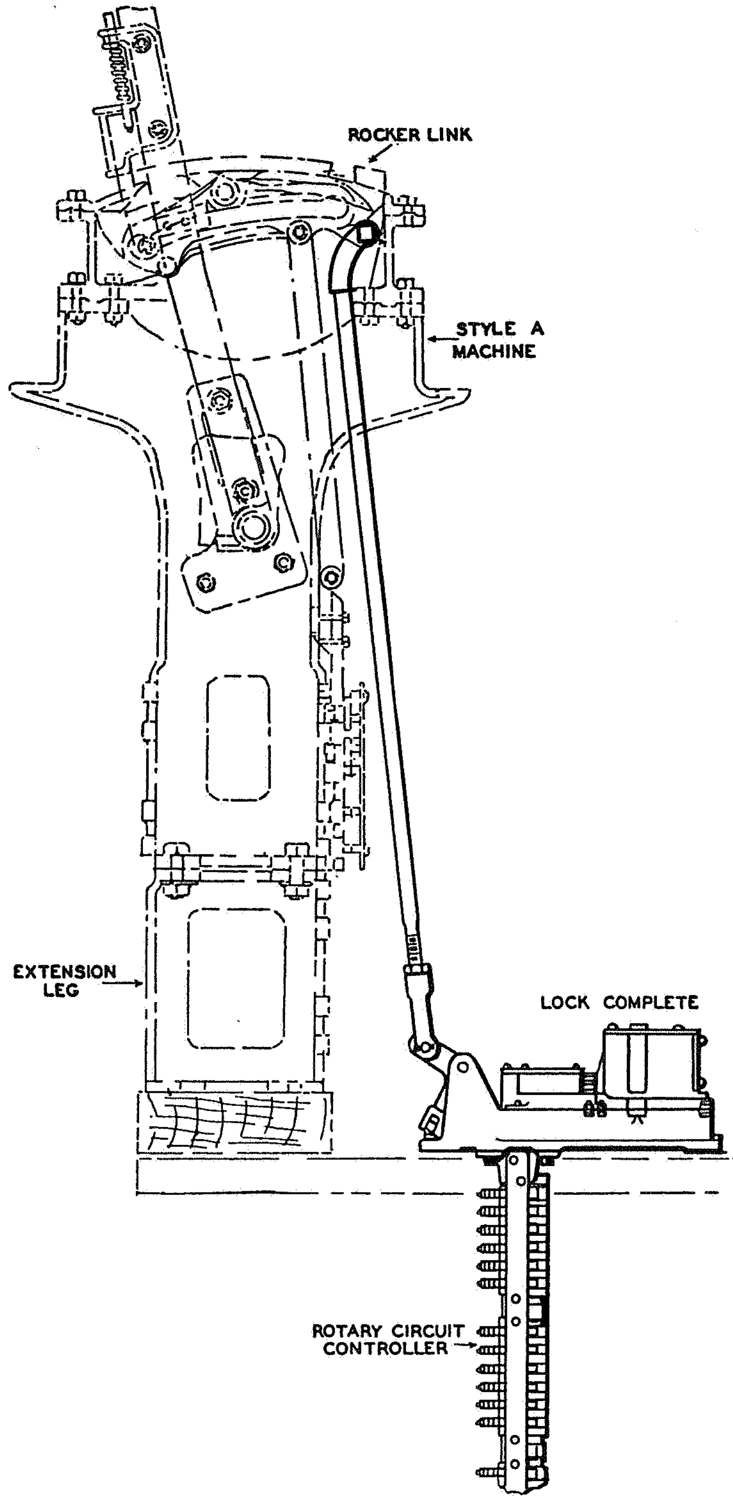


Fig. 24.
Forced Drop Electric Lock on Style "A" Machine.

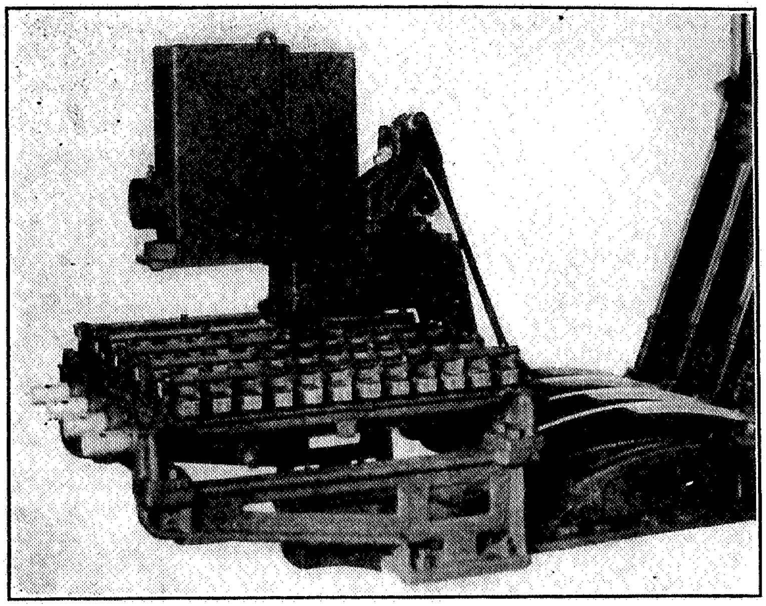


Fig. 25.
Forced Drop Electric Lock. Style ML-10.

Another type of circuit controller is the slide type. The controller is connected to the rocker link as shown in Fig. 30. The operation of this circuit controller consists of a contact rod equipped with metallic buttons insulated from each other, sliding between contact springs secured to an insulated base as shown in Fig. 31. It is made in four, eight and ten-way sizes and can be connected in tandem to provide additional contacts on the same lever.

Indicator.

The Signal Section, A.R.A., defines Indicator as: A device used to convey information.

Indicators are employed to follow more closely the movements of trains. The indicators are relays equipped with a small disc or semaphore arm operated by the armature of the magnet. Figure 32 illustrates a commonly used type.

Time Release

The Signal Section, A.R.A., defines Time Release as: A device used to prevent the operation of an operative unit until after the lapse of a specified time.

The application of the time release to circuits is explained in Chapter XX—Interlocking Circuits.

Hand-operated clockwork time release.

Clockwork time releases are provided with or without latch. A clockwork time release with latch is normally wound by the operation of its knob. To

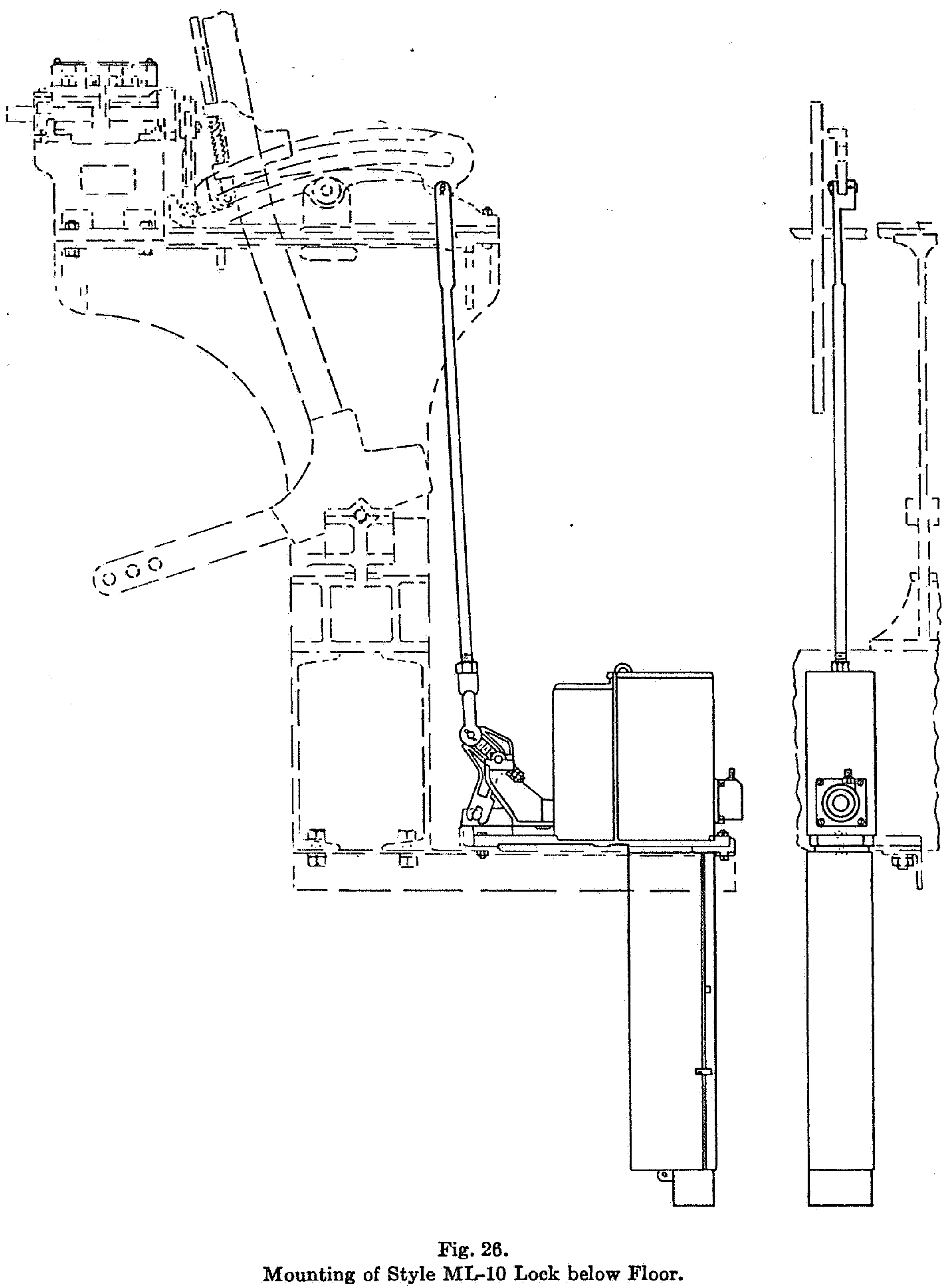


Fig. 26.
Mounting of Style ML-10 Lock below Floor.

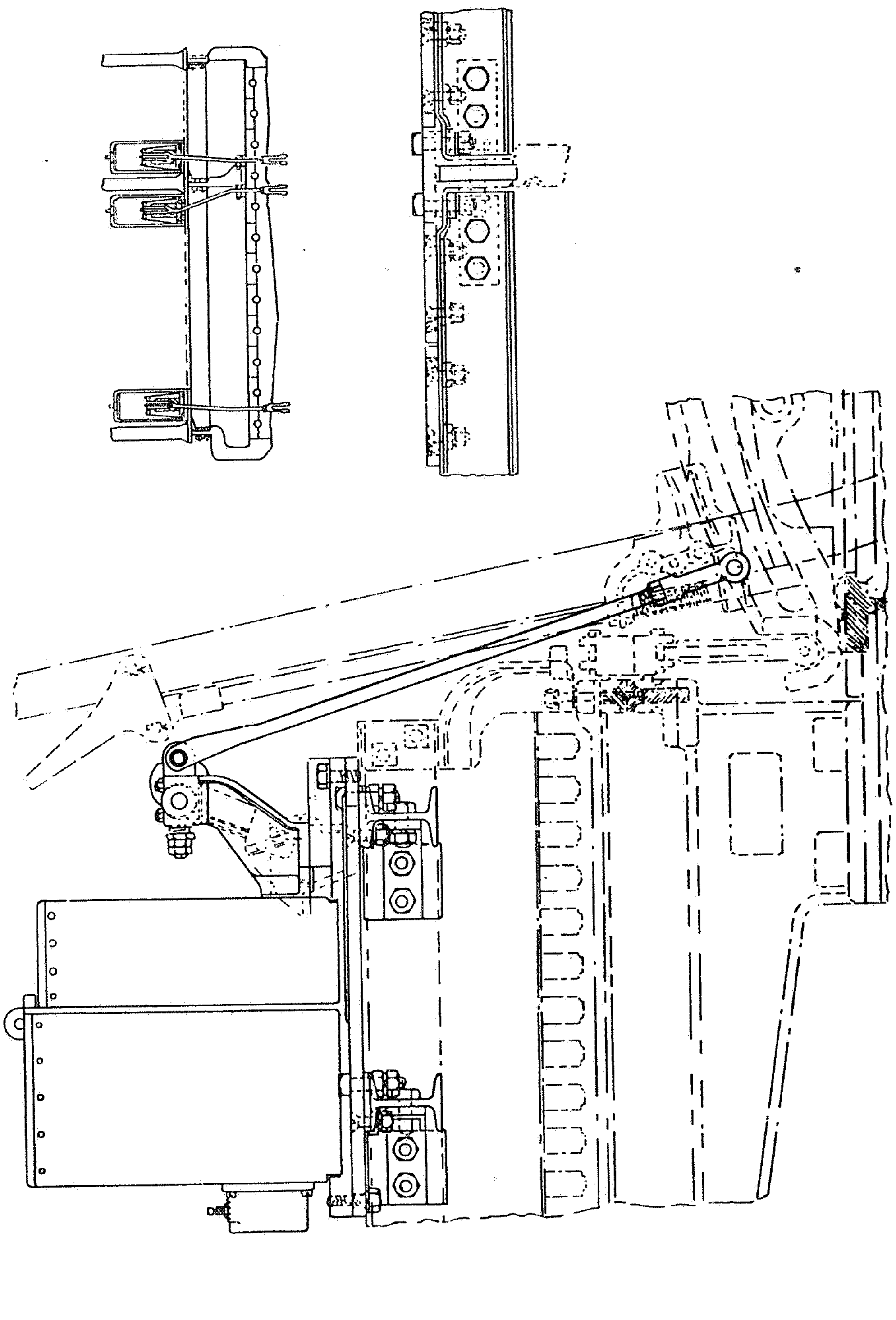


Fig. 27.
Mounting of Style ML-10 Lock above the Locking Bed.

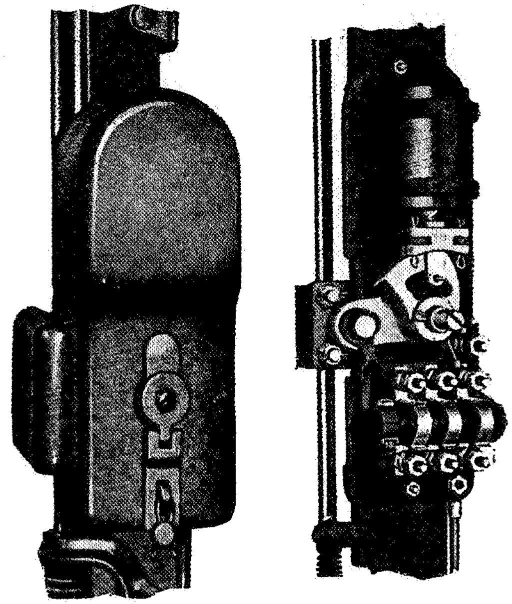


Fig. 28.
Latch Lever Lock.

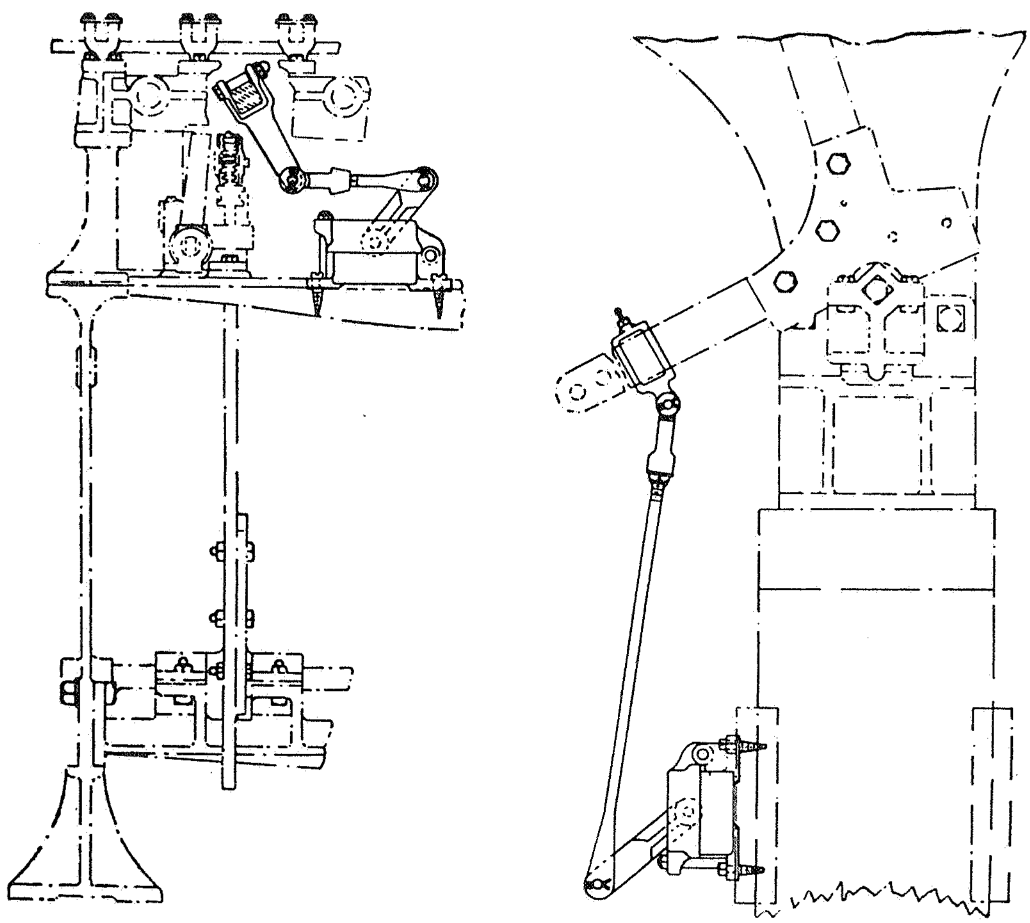


Fig. 29.
Circuit Controllers.

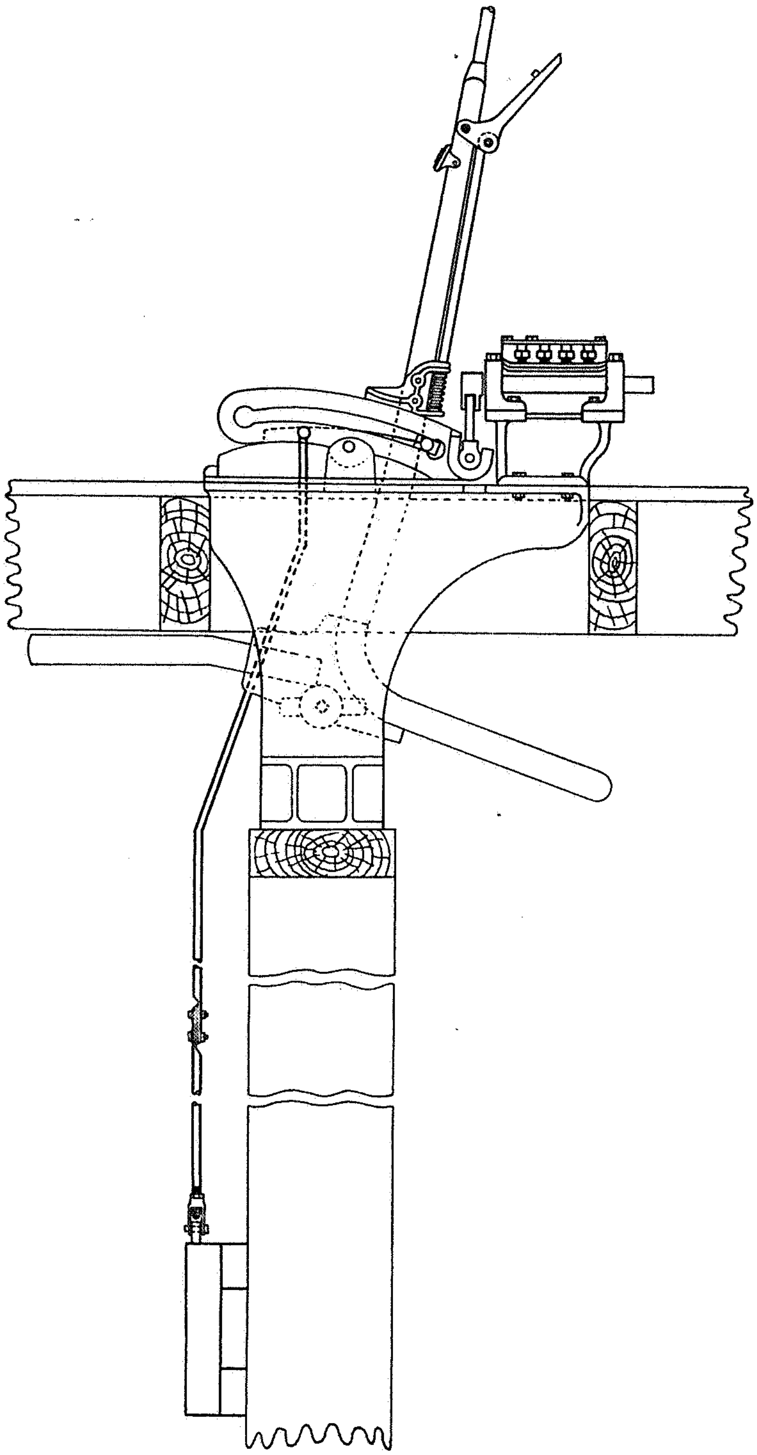


Fig. 30.
Slide Type Circuit Controller Mounting.

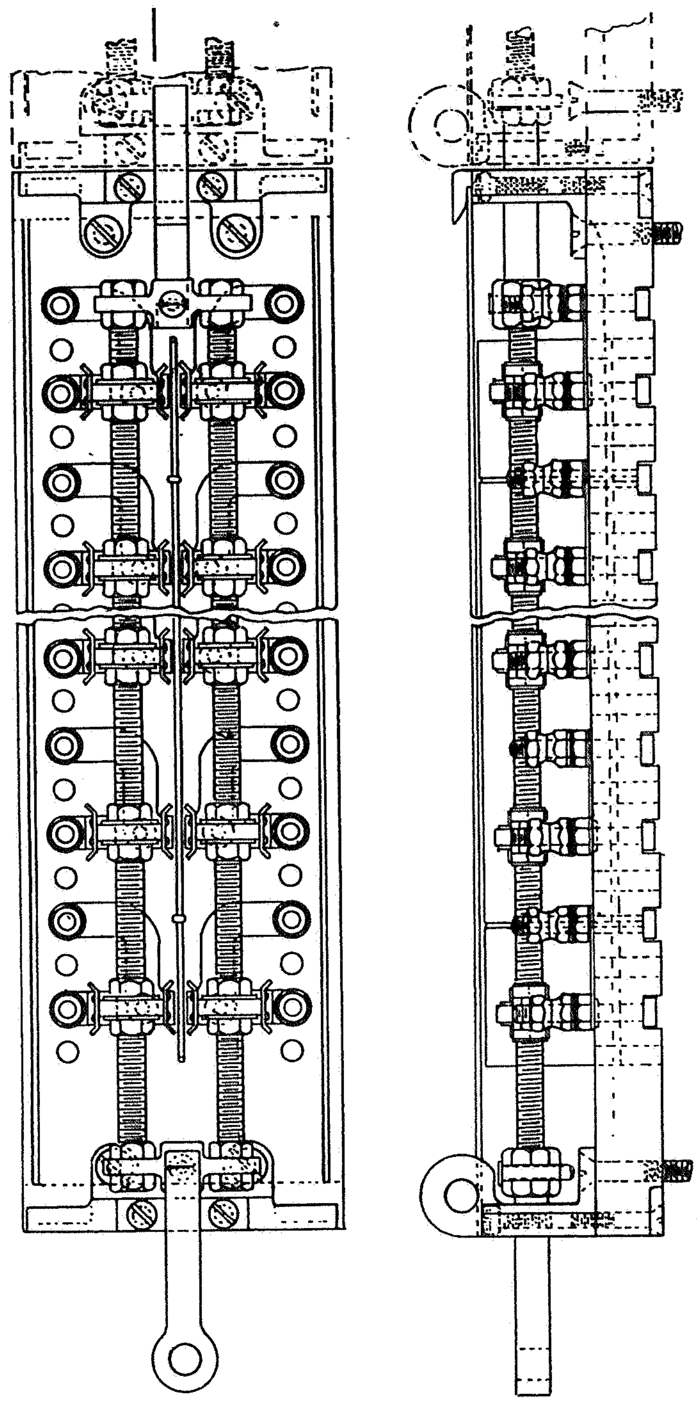


Fig. 31.
Slide Type Circuit Controller.

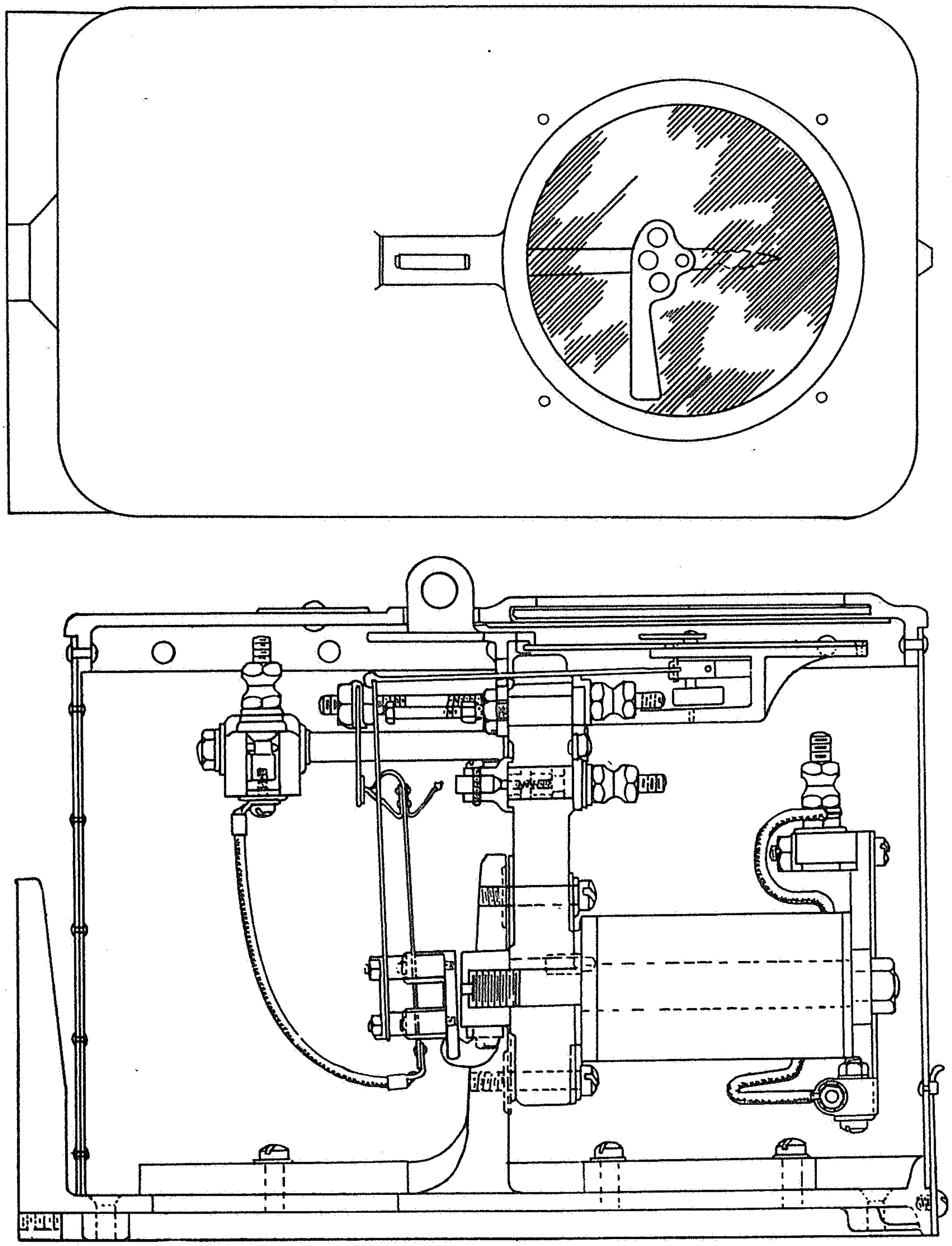


Fig. 32.
Indicator.

operate it, the latch is tripped by turning the knob, the release then slowly unwinds to the reverse position. After the release of the operative unit has been obtained, the knob is turned until the mechanism is latched in the normally wound position.

A release without latch is normally unwound. To operate it and secure the release of the operated unit, the knob is turned as far as it will go. This movement winds the mechanism which, when released, slowly unwinds. The time interval may be adjusted to a maximum of 8 minutes. A clockwork time release is illustrated in Fig. 33.

Hand-operated time release.

To release the operative unit, the operating handle is revolved a required number of turns to the right. After the release of the operative unit has been obtained the operating handle is revolved the required number of turns to restore it to the normal position. The release may be set to require a time interval of 4 minutes for a complete operation. A hand-operated time release is illustrated in Fig. 34.

Mechanical time lock.

Figure 35 illustrates a mechanical time lock applied to a lever used to provide time locking instead of electrical track circuit approach locking. This application prevents the leverman from changing the route after it has once been set up, until after the lapse of a specified time.

When the signal lever is reversed a vertical locking bar or rack is raised, driving a piece of locking, previously seated in a notch in the rear edge of the rack, against the face of a dog on the longitudinal bar for that lever, which prevents the immediate dropping of the latch when the lever is moved to the normal position. An escapement pawl and ratchet wheel freely permit the raising of the rack but allow descent only as the oscillations of the pendulum release. A notch is provided in the quadrant near the end of the lever movement to receive the rocker die, thereby preventing the lever latch spring from forcing the piece of locking against the rack preventing it from dropping.

On the Style "A" machine a cross-lock is connected to the end of the rocker link, the effect of which is practically the same as on the S. & F. machine. It may be adjusted to require from 1 minute to 1 minute and 20 seconds for operation.

Leadout

The Signal Section, A.R.A., defines Leadout as: The term applied to the mechanical connections of an interlocking plant between the machine and outside pipe and wire lines.

It consists of two or more supports, usually "I" beams, channel irons, or old rails resting on concrete foundations, and supports the leadout equipment. There are two general types of leadouts: horizontal and vertical.

With a horizontal leadout the connection between lever of machine and leadout crank extends horizontally; with a vertical leadout this connection

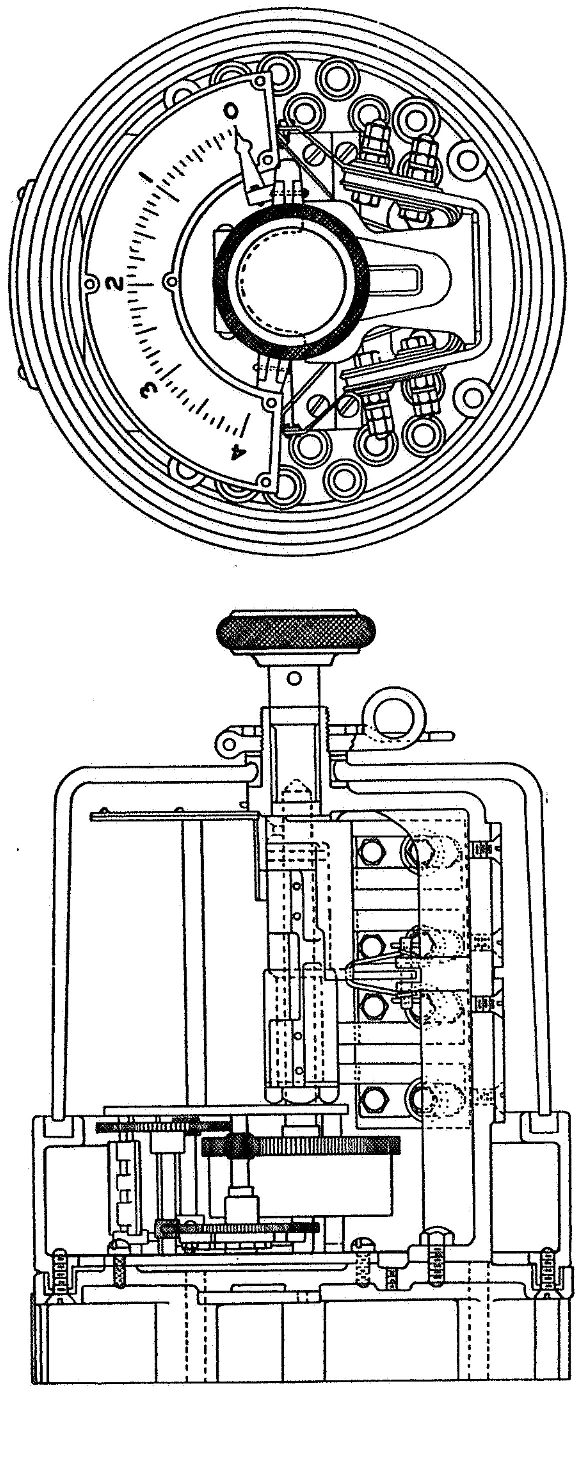


Fig. 33.
Clockwork Time Release.

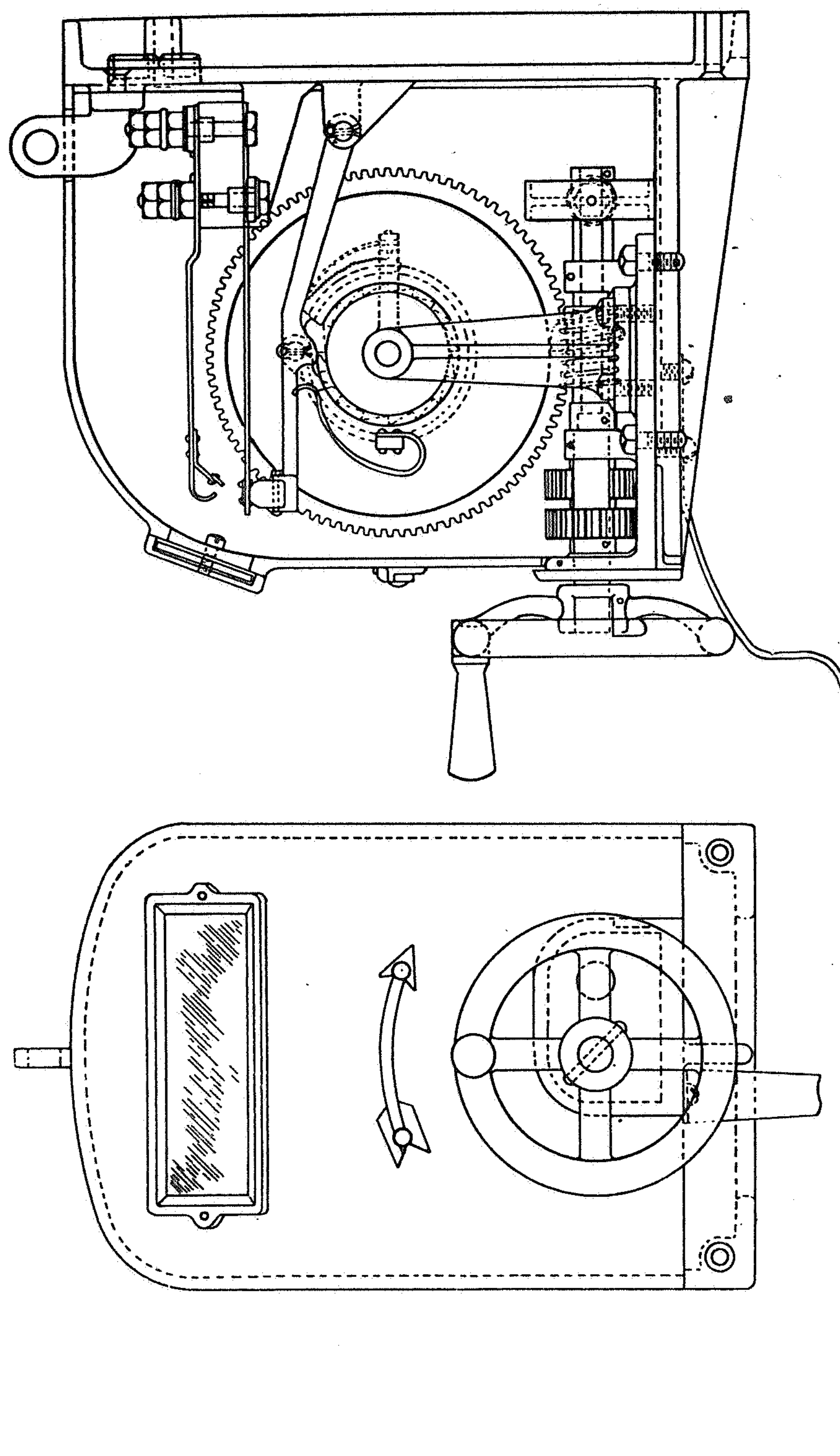


Fig. 34.
Hand-Operated Time Release.

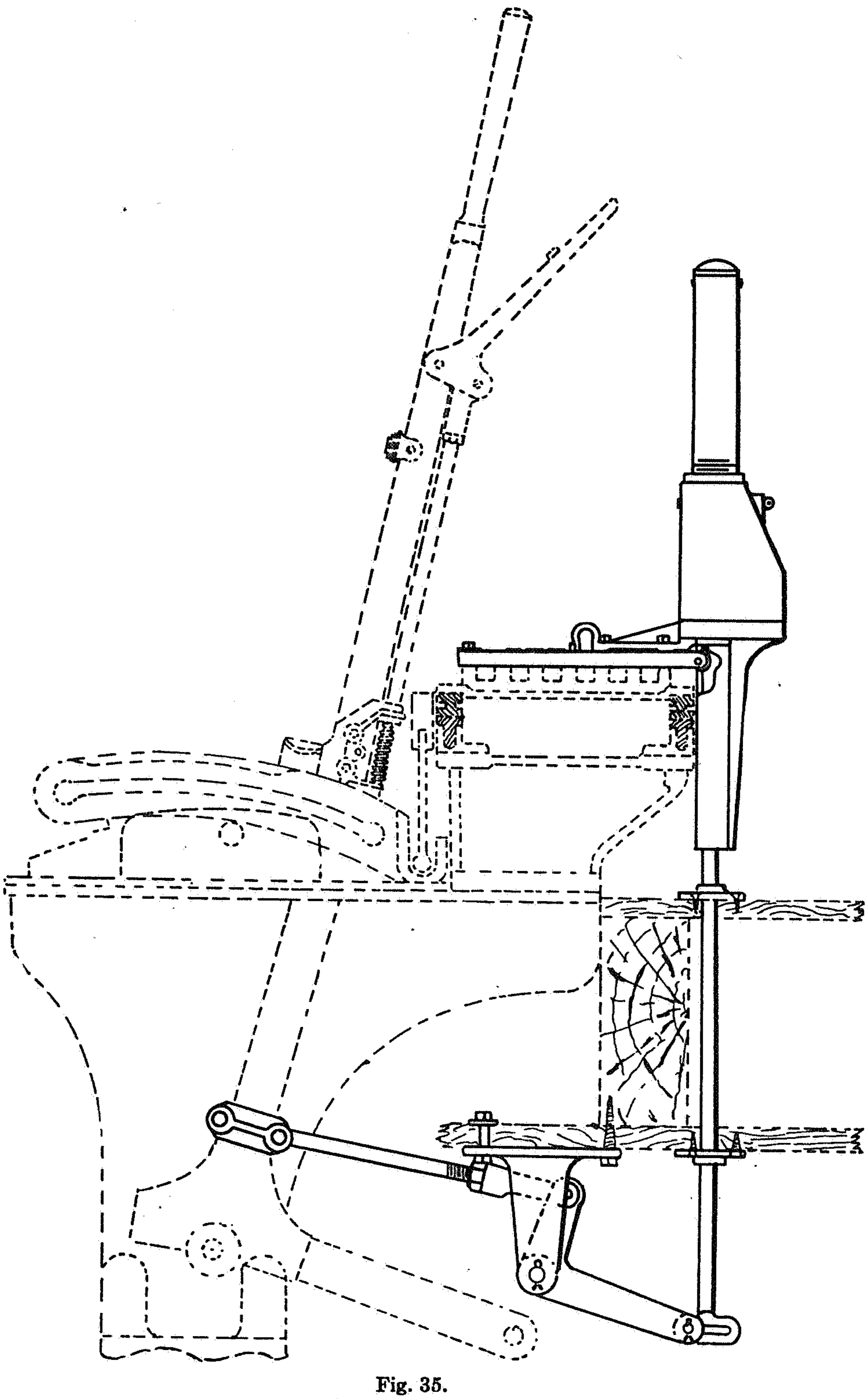


Fig. 35.
Mechanical Time Lock, Pendulum Type.

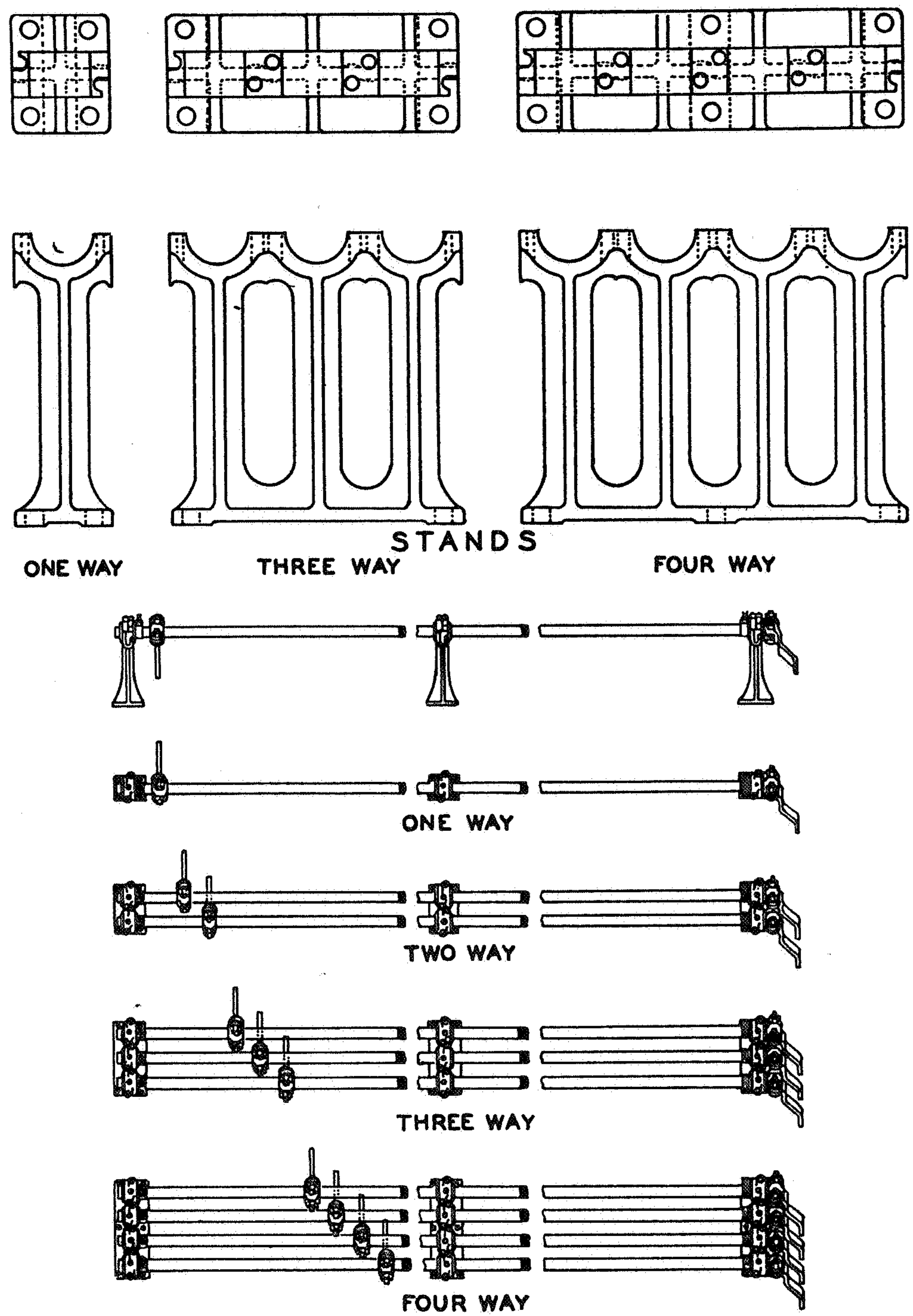


Fig. 36.
Rocker Shaft Assembly and Bearings.

extends vertically. If the vertical leadout is used, vertical cranks, rocker shafts or deflecting bars are used within the interlocking station to change the motion from vertical to horizontal. In either type, outside of station, horizontal cranks, rocker shafts or deflecting bars are employed, the cranks frequently being arranged in a frame and called a box crank. A combination of these is sometimes used in the same leadout.

If the machine is located at track level, a horizontal leadout is used. If the machine is elevated, a vertical leadout is necessary.

Rocker shaft leadout.

A rocker shaft is a 2 inch by 2 inch square steel bar of the required length, supported by bearings spaced horizontally not more than 6 feet apart secured to the leadout support by ¾-inch bolts. The bearing within the interlocking station is so located on the rocker shaft as to permit an offset arm, to which the down rod is connected, to be placed on the end of the rocker shaft. Figure 36 illustrates the rocker shaft assembly and bearings.

The pipe-line connection to the leadout is by means of a solid jaw and a straight rocker shaft arm which is placed on the rocker shaft outside the interlocking station. In complicated leadouts it is often impossible to use straight arms and provide sufficient clearance with those adjacent. In such cases it is necessary to use offset arms as well as offset solid jaws in the pipe-line connection.

Deflecting bar leadout.

The Signal Section, A.R.A., defines Deflecting Bar as: A device used for making a turn in pipe line in lieu of a crank.

A deflecting bar consists of a curved bar which slides between two sets of rollers supported in a frame. Figure 37 illustrates a deflecting bar and vertical stand.

In a deflecting bar type of leadout the down rods are connected to vertical deflecting bars as illustrated in Fig. 38. Both ends of the leadout are connected to the deflecting bars by means of solid jaws, as are the pipe-line connections to the horizontal deflecting bars outside of the interlocking station. This type of leadout requires more space than the rocker shaft leadout for the same number of pipe lines although its parts are more accessible.

Crank leadout.

In the crank type of leadout the down rods and the connections leading out of the interlocking station are similar to those employed in the deflecting bar type. The down rods connect to the vertical cranks which in turn are connected to the horizontal cranks outside of the interlocking station to which the pipe line is connected by a solid jaw. The horizontal cranks are usually arranged in a frame and called box cranks, providing a compact and readily accessible arrangement. Figure 39 illustrates the layout of the crank type of leadout employing the box crank.

Figure 40 illustrates an arrangement of cranks and deflecting bars employing vertical cranks within and horizontal deflecting bars outside of the interlocking station.

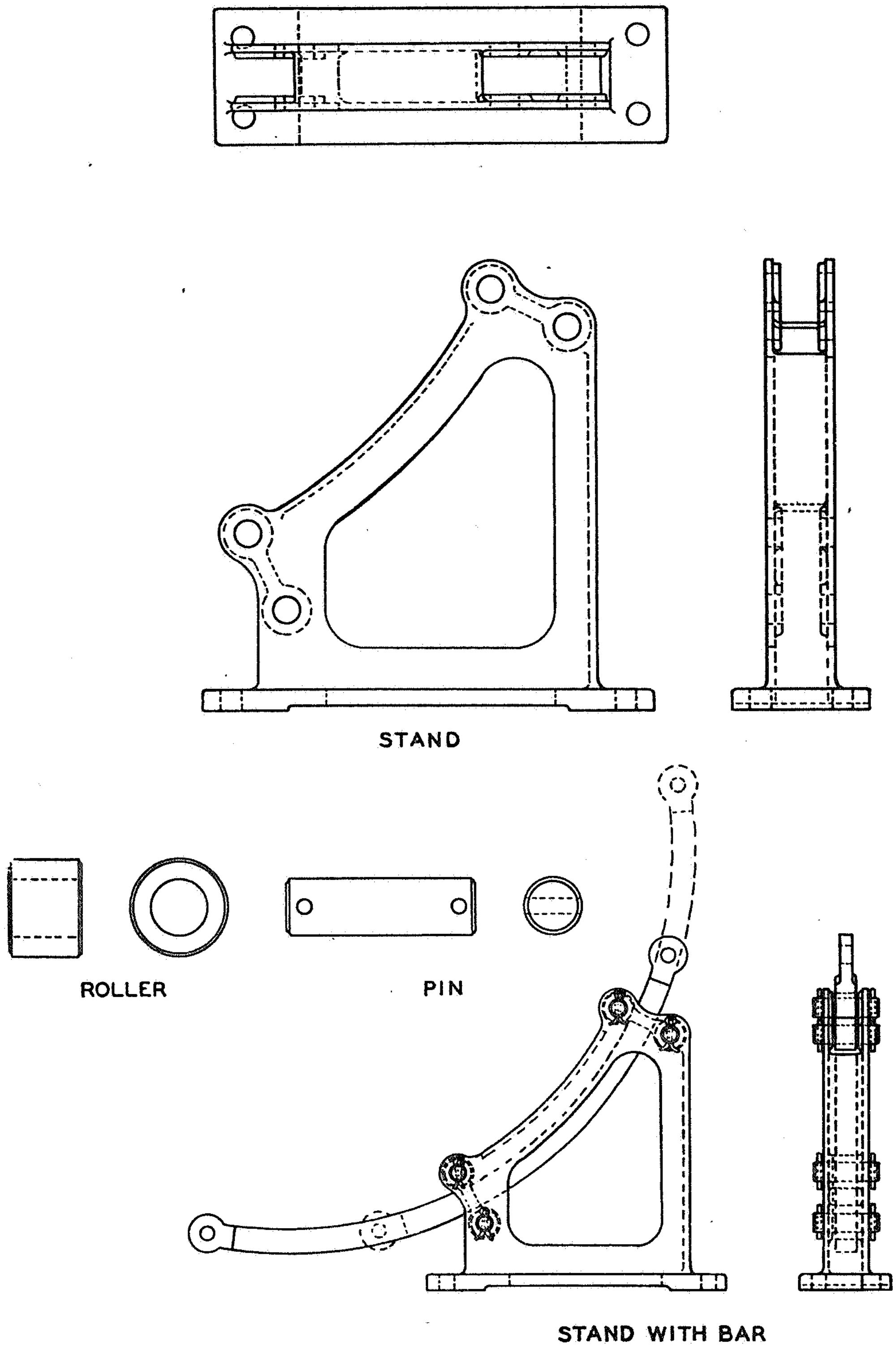


Fig. 37.
Deflecting Bar and Vertical Stand.

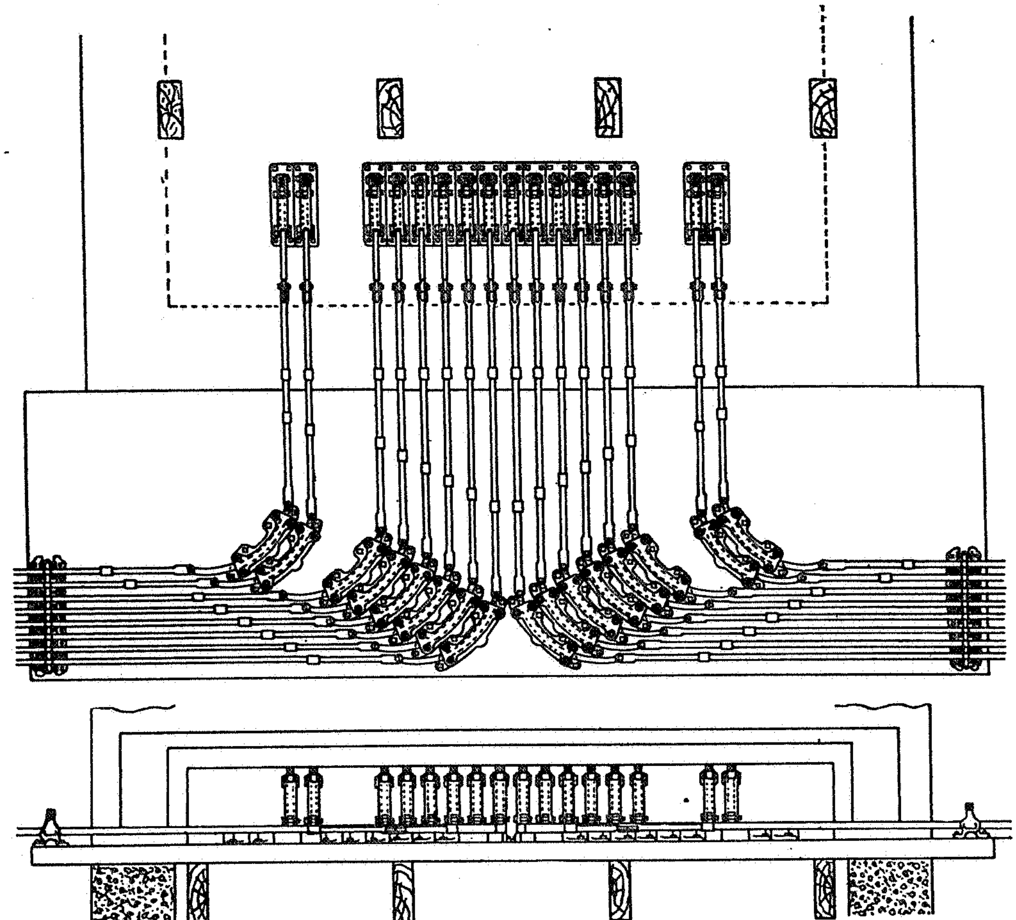


Fig. 38.
Deflecting Bar Leadout.

Figure 41 illustrates a leadout arrangement using deflecting bars and rocker shafts.

Foundation

Interlocking station and leadout.

The Signal Section, A.R.A., defines Foundation as: A fixed support, usually set in the ground, for signal devices.

Foundations for interlocking stations are usually of reinforced concrete, the size depending upon the size of the station and the nature of the ground on which the building is to be placed. Leadout foundations are usually constructed as a part of the foundation for the interlocking station. The leadout appliances are bolted to beams resting on the foundation. The details of a method for supporting the beams are shown in Fig. 42. The "I" beams are set in concrete and are parallel to the leadout. They extend from the leadout foundation through the front to the rear wall of the station.

Parallel to the front of the station, channel irons or wood planks which hold the leadout appliances are bolted to the "I" beams. The channel irons are more generally used for the construction of horizontal leadouts, spaced so as to provide supports for rocker shaft bearings not more than 6 feet apart.

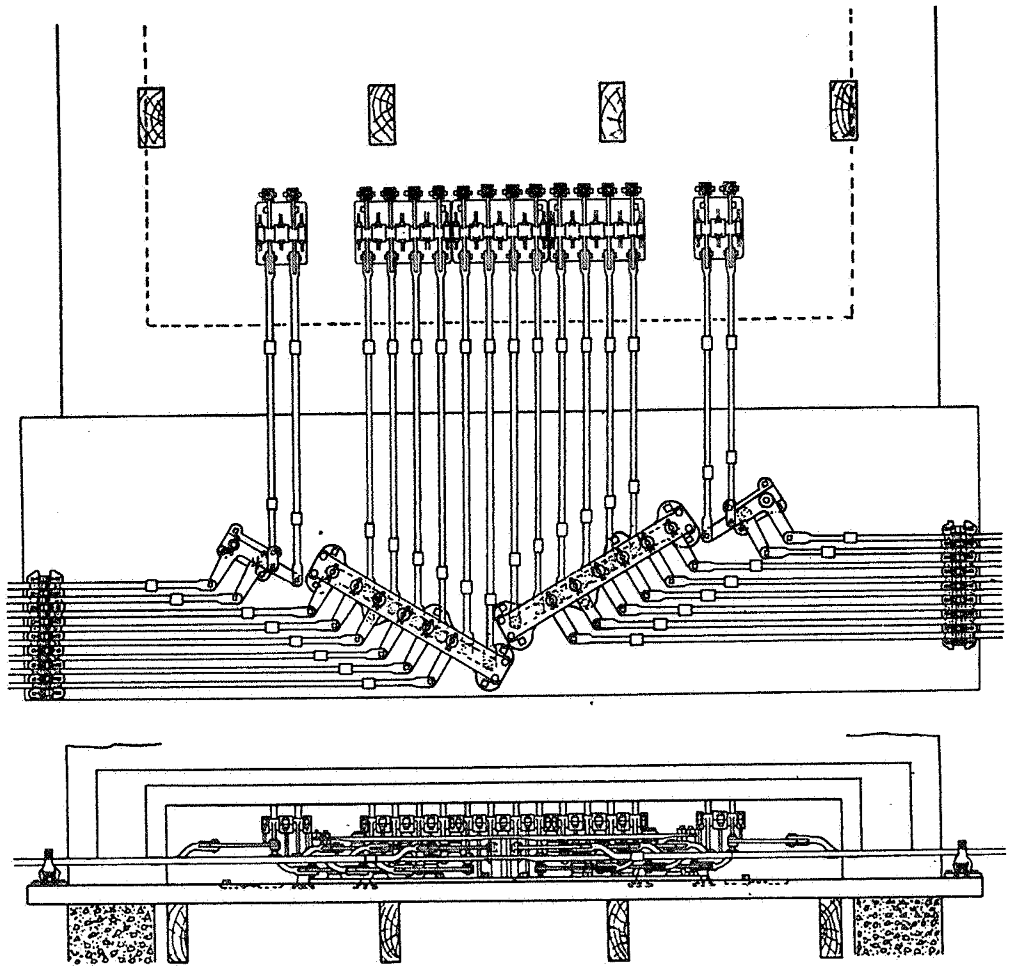


Fig. 39.
Crank Leadout.

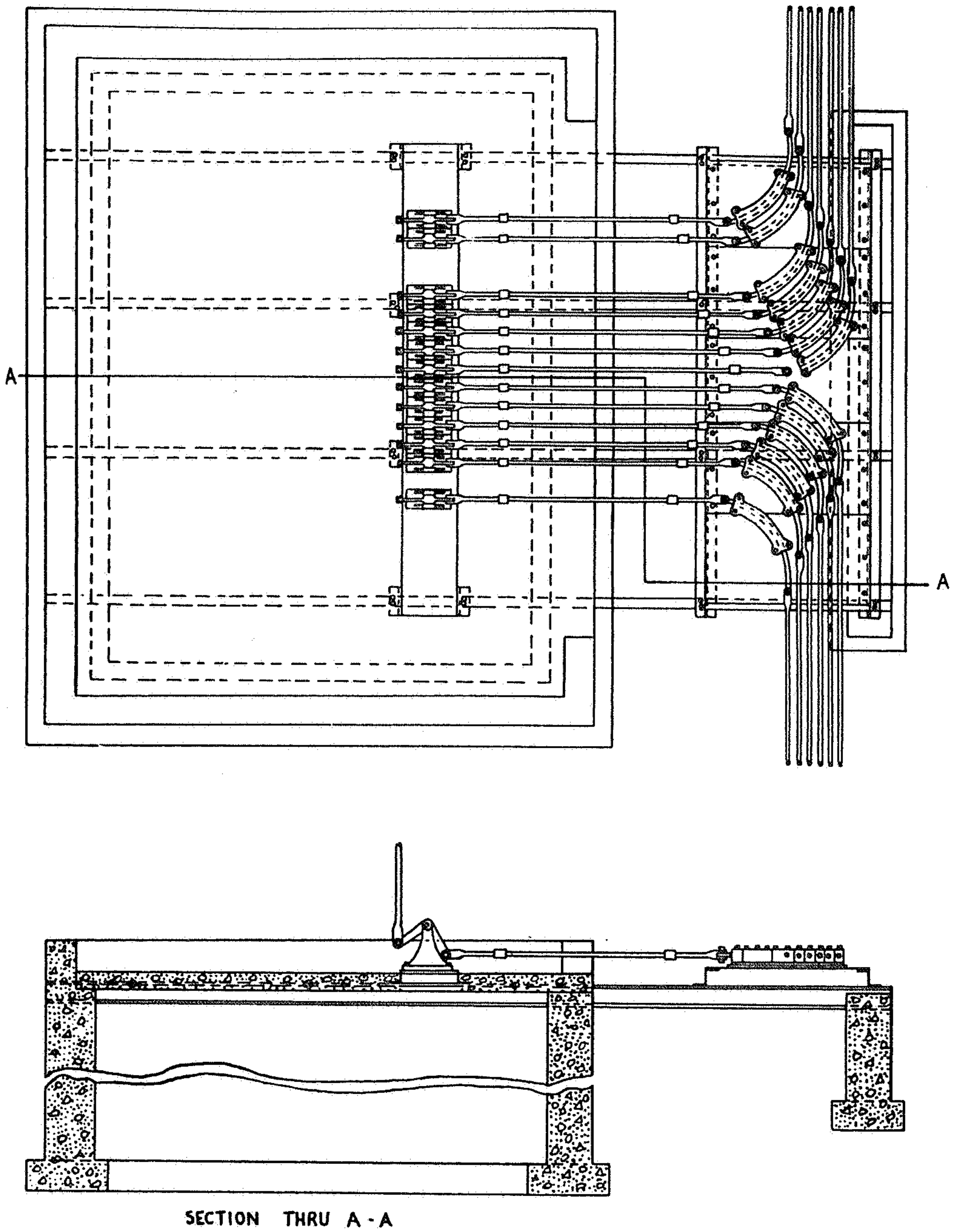


Fig. 40.
Vertical Cranks and Horizontal Deflecting Bars.

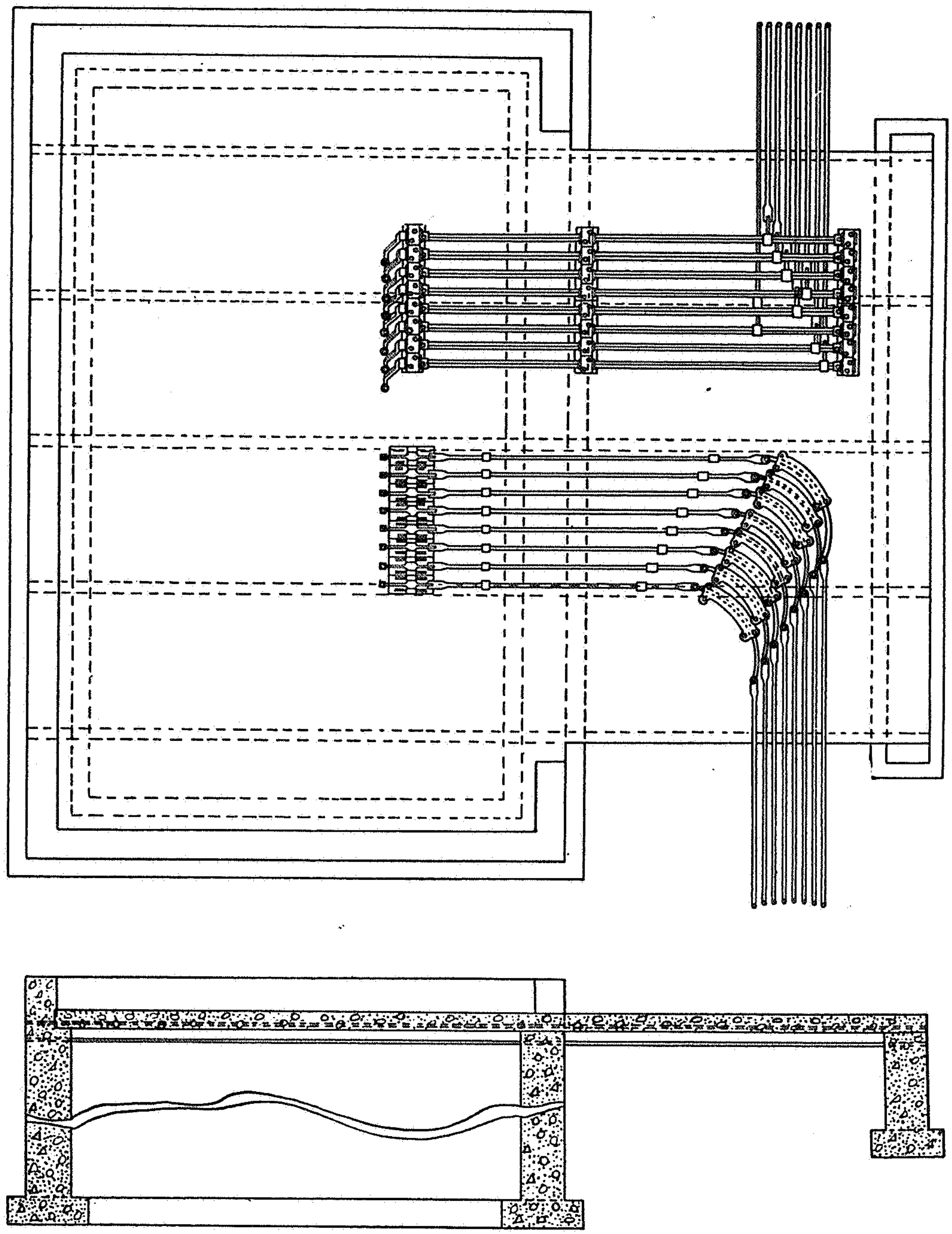
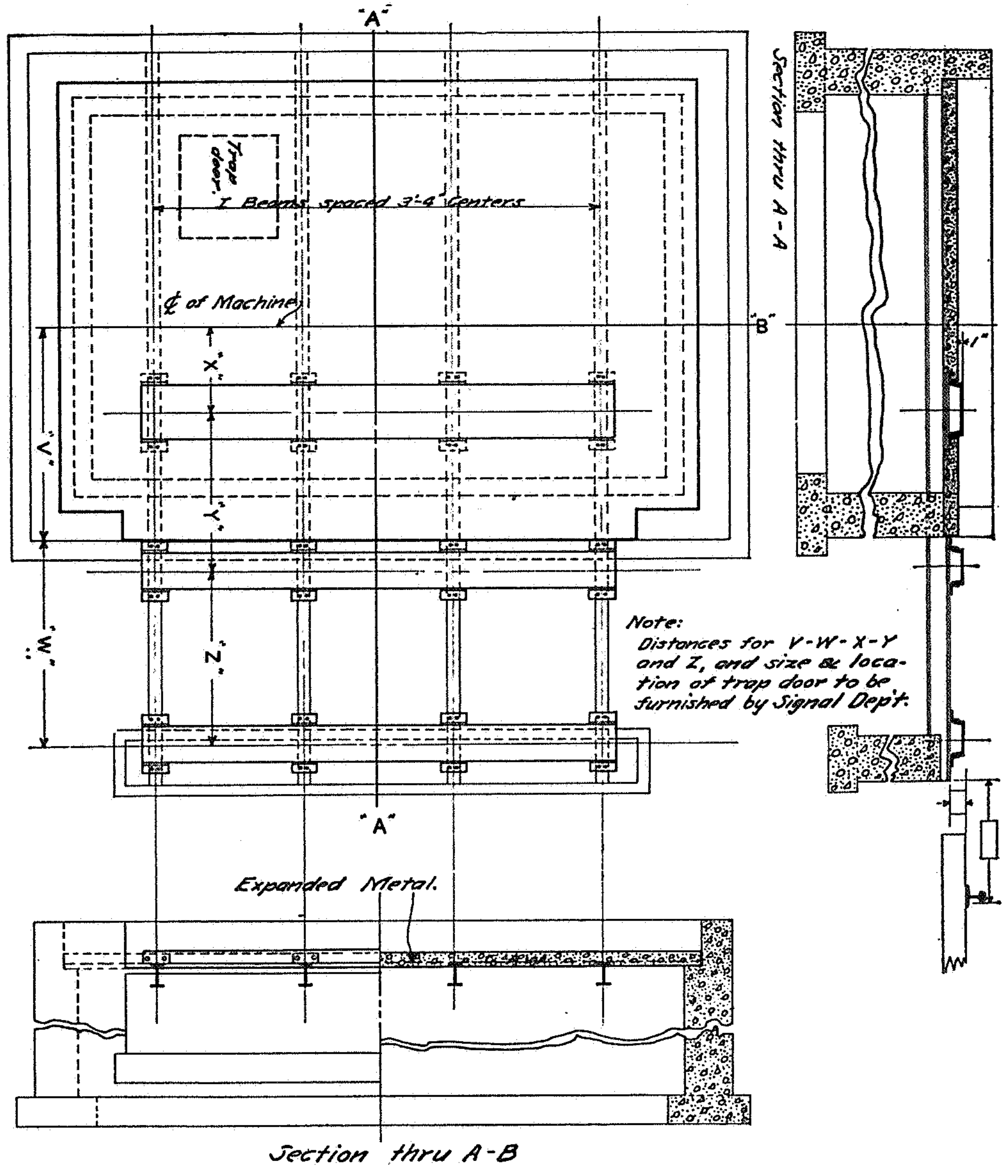


Fig. 41.
Deflecting Bars and Rocker Shafts.



SIZE OF TOWER	I BEAMS REQ'D.
16 Levers	4
24 "	5
32 "	6
40 "	7
48 "	8
56 "	9
64 "	10

Details of fastening channels to I beams.

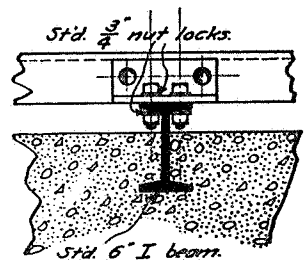


Fig. 42.
Leadout Foundations for Rocker Shafts.

Pipe and Wire Lines

Pipe line.

The Signal Section, A.R.A., defines Mechanical Pipe Line as: A connection made with pipe with its supporting apparatus from the operating lever to the operated unit.

The pipe line is constructed of 1-inch pipe of convenient length, joined together by a coupling and a steel plug through which two ¼-inch soft iron rivets are passed at each end and riveted after the pipes have been drawn to abut within the coupling, as illustrated in Fig. 43.

Pipe carrier and support.

The Signal Section, A.R.A., defines Pipe Carrier as: A device used to support, guide and facilitate the longitudinal movement of a pipe line.

The pipe carrier consists of a grooved wheel and a roller between which the pipe moves, supported in a frame providing support, a definite direction of motion and a reduction in the amount of friction encountered by the pipe line in motion. The carriers are arranged in multiple to carry the required number of pipes and are termed one-way, two-way, etc., depending upon the number of pipes in the line. The center to center dimension of multiple carriers is 2¾ inches.

The specifications of the Signal Section, A.R.A., require that carrier supports be spaced not more than 7 feet center to center on tangents and not over 6 feet on curves exceeding 2 degrees.

The proper arrangement of the pipes is such that they will lead off on the track side in regular order to prevent any unnecessary crossing over or under other pipes. The pipe couplings are so located that with the levers in the center position they will be not less than 12 inches from the pipe carrier. Figure 44 illustrates various methods of supporting pipe carriers.

When it is necessary to run pipe lines across the tracks, transverse pipe carriers, as illustrated in Fig. 45, are used. These are spaced not more than 7 feet apart and are fastened to the ties by ¾ inch by 4 inch lag screws. Transverse carriers are so placed as to permit proper tie spacing and not interfere with track tamping operations. Not more than two pipe lines are usually placed in the same tie space.

Crank.

The Signal Section, A.R.A., defines Crank as: A lever, the arms of which form an angle, with the fulcrum at the vertex of the angle, which is used to transmit motion from one part of a line to another part. The alignment of the pipe line generally follows that of the track.

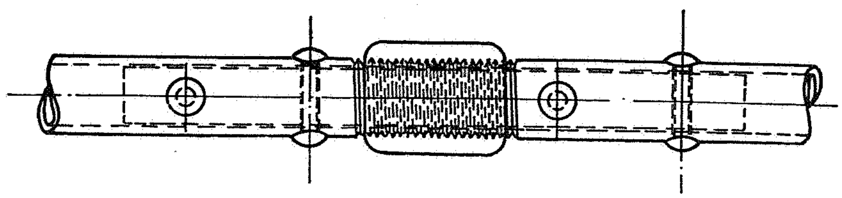


Fig. 43.
One-Inch Signal Pipe and Coupling.

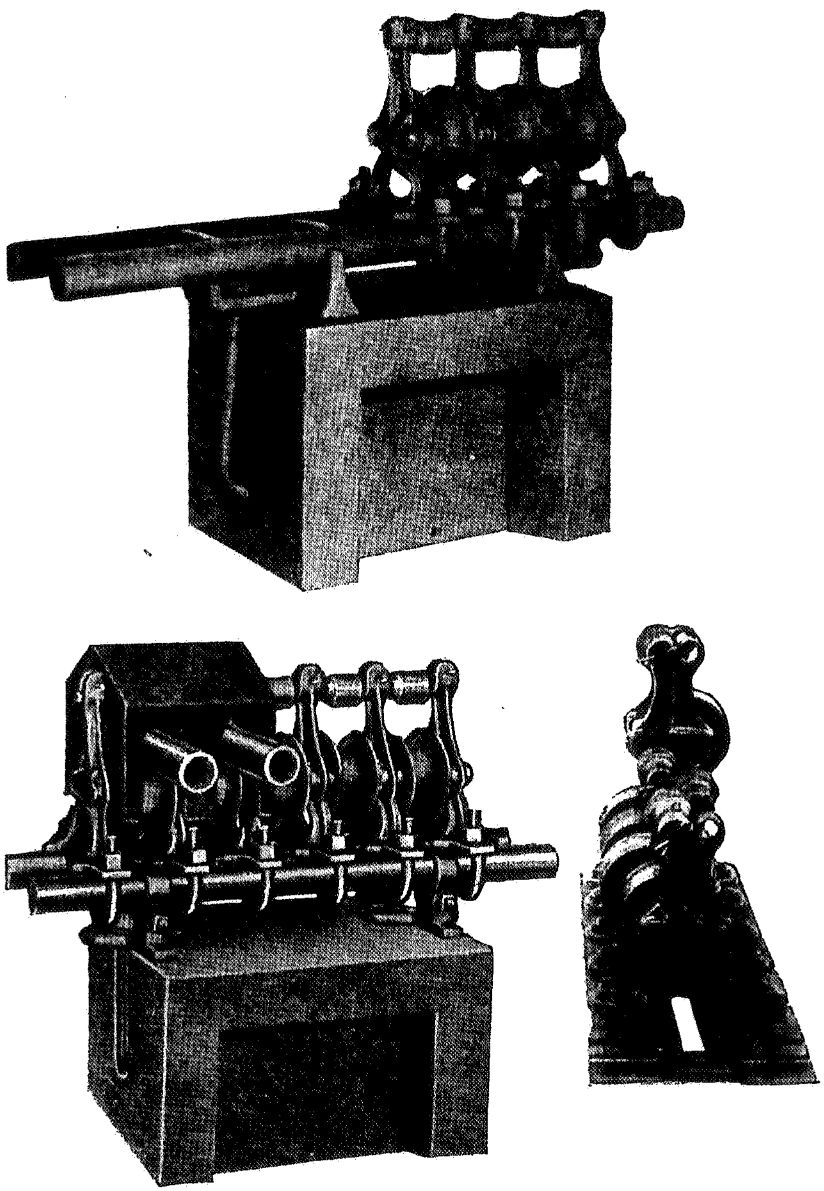


Fig. 44.
Pipe Carrier Supports.

The Signal Section, A.R.A., recommends that turns in a pipe line be made in accordance with the following table:

Degree turn	Device to be used
0—30	Radial arm
30—75	60-degree acute-angle crank
75—105	90-degree right-angle crank
105—140	120-degree obtuse-angle crank
140—180	180-degree equalizing arm

The radial arm is a pivoted arm supported in a stand, the end of which provides for the connection of two pipe lines and is illustrated in Fig. 46. Its use is limited to pipe-line turns on a small degree of curvature. The radial arm is obtained in one, two or three-way assembly. The one-way arm is 9, 11¾, or 14½ inches long; the two-way arm is provided with one arm 9 inches long and the other arm 11¾ inches long; the three-way is provided with three arms, one 9 inches, one 11¾ inches and one 14½ inches long.

Cranks are more generally used for changing the direction of motion of the pipe lines. The 90-degree right-angle crank is illustrated in Fig. 47. The acute-angle crank is one in which the angle between the two arms is less than 90 degrees, and the obtuse-angle crank is one in which the angle between the two arms is greater than 90 degrees. When two or more cranks are assembled in a box-shaped frame, each crank having a separate bearing, the assembly is called a box crank.

Deflecting bars are also used to some extent for changing the direction of a pipe line. The specifications of the Signal Section, A. R. A., limit the use of deflecting bars to pipe lines where the total movement of the line due to stroke and expansion is less than 11 inches.

Jaw and lug.

The Signal Section, A.R.A., defines Jaw as: A forked attachment used for making a pivotal connection.

There are two types of jaws in general use: the solid jaw as illustrated in Fig. 48 and the screw jaw in Fig. 49. The solid jaw is always used except at points where it may be necessary to adjust the length of a pipe line in which case the screw jaw is provided. When necessary to place offsets in a pipe line for the purpose of correcting alignment or elevation, it is made in the body of the solid jaw.

Figure 50 illustrates a lug generally inserted in a pipe line operating two separate units. It provides a convenient means of connecting the second unit to the pipe line.

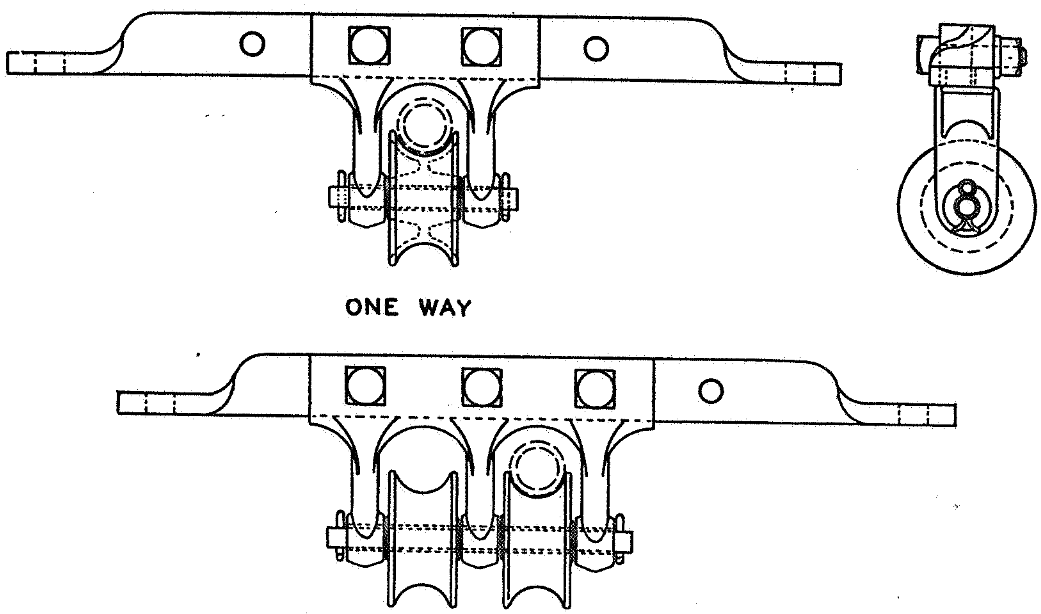


Fig. 45.
Transverse Pipe Carriers.

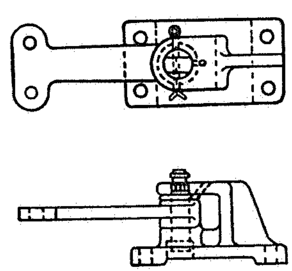


Fig. 46.
Radial Arm and Stand.

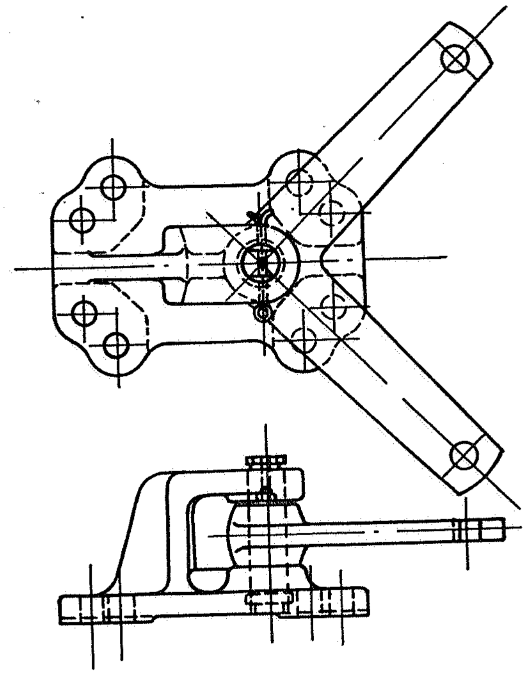


Fig. 47.
Right-Angle Crank.

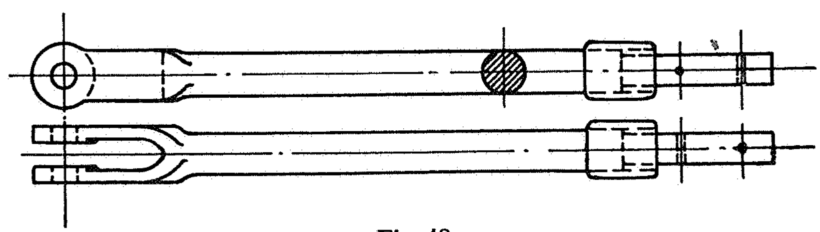


Fig. 48.
Solid Jaw.

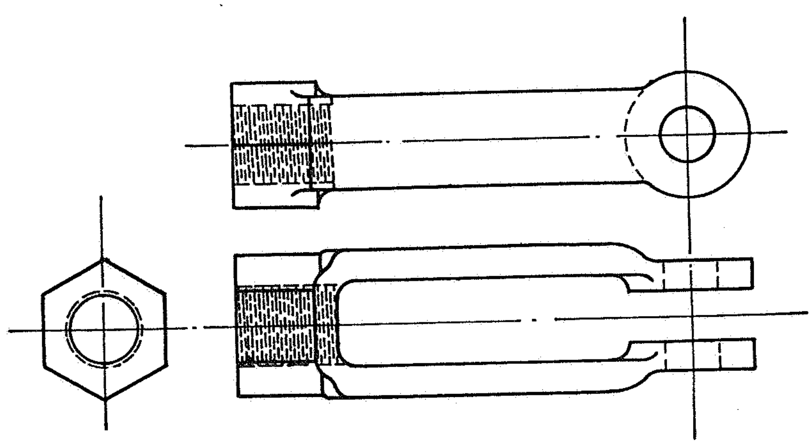


Fig. 49.
Screw Jaw.

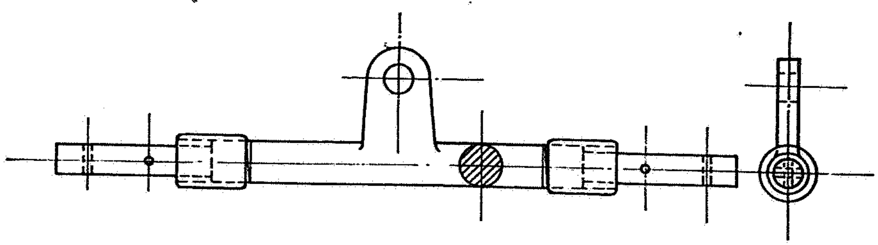


Fig. 50.
Lug.

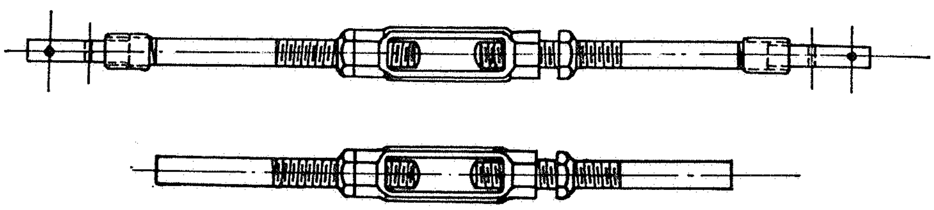


Fig. 51.
Adjusting Screw.

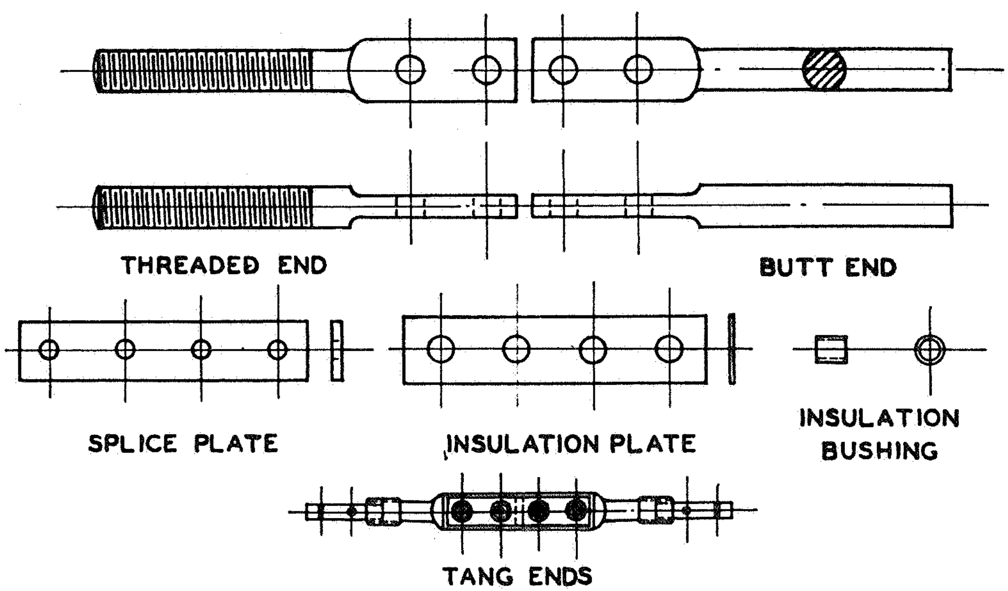


Fig. 52.
Pipe-Line Insulation.

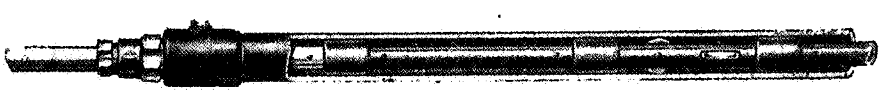


Fig. 53.
Stuffing Box with 2-inch Pipe Equipped with Inside Pipe Carrier.

Adjusting screw.

As a means of providing adjustment in the pipe line, use has been made of an adjusting screw as illustrated in Fig. 51.

Pipe-line insulation.

It is sometimes necessary to insulate a pipe line, which is accomplished in a manner similar to the method employed in the insulated rail joint. Fibre plates, bushings, etc., are used, the details and assembly of which are illustrated in Fig. 52.

Stuffing box.

When necessary to construct pipe lines under tracks or other obstructions, it is customary to use stuffing boxes as illustrated in Fig. 53. The arrangement provides for a stuffing box to be attached to each end of a 2-inch galvanized pipe which is filled with a non-freezing solution and through which the 1-inch signal pipe passes. The 2-inch pipe is sometimes equipped with inside pipe carriers as shown in Fig. 53.

Pipe-line foundation.

Pipe carrier foundations were originally constructed of wood, iron, or a combination of both, but present day construction is very generally concrete and of the type illustrated in Fig. 54.

The foundations are generally pre-cast and then set in place. The work is done at a fixed location where mixer and materials are available, and then transported to the place where they are to be installed. The depth of the foundation is either 2 or 3 feet, depending upon the nature of the ground in which the foundation is set. Pipe carrier supports are secured to the foundation in various ways. The top of the foundation is usually set level with the base of the rail. The foundations are set so that the nearest pipe line to the track is not less than 4 feet 6 inches from the gage line of the nearest rail.

The foundations for cranks, compensators, deflecting bars, locks, etc., are generally poured in place and are large enough to eliminate any possibility of shifting due to the movement of the pipe line. Cranks and compensators are usually placed so that the field side of the pipe line is free for additional lines or for trunking.

The location of crank, compensator and lock foundations, etc., is accurately determined before the pipe carrier foundations are set in order to allow for the proper spacing of the pipe carriers. Every precaution within practicable limits is taken to secure a rigid level foundation in perfect alignment with the pipe line in which the apparatus it supports is to be inserted.

Wire line.

Mechanical interlocking signals are operated either by pipe or wire lines. Each arm requires one pipe line if pipe-connected, and two wire lines if wire-connected. The wire in tension when the signal is being cleared is called the "pull" wire. The wire in tension when the signal is being returned to its most restrictive position is called the "back" wire. Distant signals are usually located stopping distance from the home signal and may be either mechanically or power operated. Experience has shown that it is difficult to operate wire-connected signals at a distance greater than 1500 feet. With high-speed operation this distance does not provide proper stopping distance and consequently mechanical distance signals are being replaced by power signals.

Compensation.

A pipe line is a solid connection between the leadout and the operated unit. It is subject to expansion and contraction due to temperature changes. The amount of expansion due to a rise in temperature of a given length of pipe line is equal to the amount of contraction for a corresponding drop in temperature. The amount of expansion or contraction is dependent upon the length of the pipe line, the coefficient of expansion of the material of which the pipe is constructed, and the temperature change. Thus, long lines have an appreciable change in length between the highest summer and lowest winter temperatures and, if not compensated, would result in serious difficulties in maintaining proper adjustment of the units controlled by such pipe lines. It is, therefore, necessary when constructing pipe lines to compensate for such temperature changes as are common to the locality where the installation is made, and in such a manner that the compensation will take place automatically.

The Signal Section, A.R.A., defines Compensator as: A device for counteracting the expansion and contraction caused by changes of temperature in a pipe or wire line, thereby maintaining a constant length of line between units.

Figure 55 illustrates a compensator which is generally used in a pipe line; it is known as a lazy jack compensator. The compensator consists of one 60-degree and one 120-degree angle crank mounted on a common metal base, each crank being held in position by a steel center pin located with 22 inch centers. These two cranks are connected by a link. Any movement or thrust applied to one crank will result in an equal movement or thrust in the other crank but in the opposite direction. Figures 56 and 57 illustrate charts approved by the Signal Section, A. R. A., for finding compensator centers and the setting of cranks toward or away from the fixed point. Right-angle cranks are at times used to compensate pipe lines at turns by setting the crank so that the movement of the pipe line is changed from a thrust to a pull or vice versa. Figure 58 illustrates typical examples of compensation. These charts are self-explanatory.

Another type of compensator is known as a straight-arm compensator or equalizer. It is used primarily where it is necessary to make considerable offset in the pipe lines, such as at drawbridges; its use is not general on account of the required offset. With the lazy jack compensator the pipe line is run in a continuous line. A straight-arm compensator is illustrated in Fig. 59.

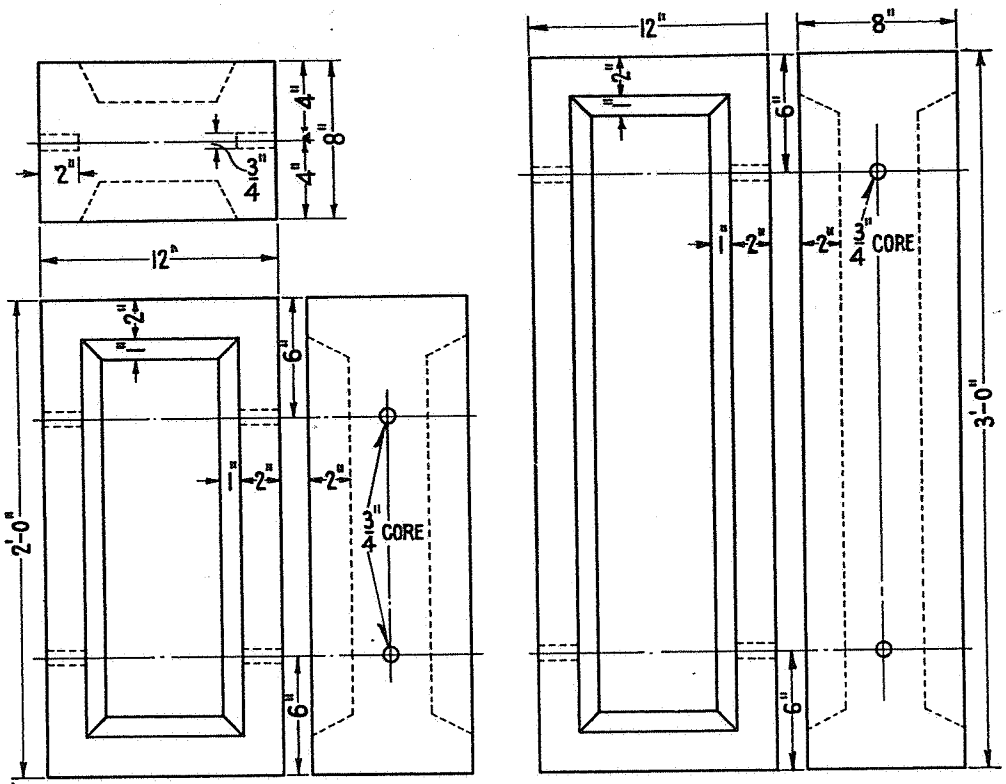


Fig. 54.
Pipe Carrier Foundations.

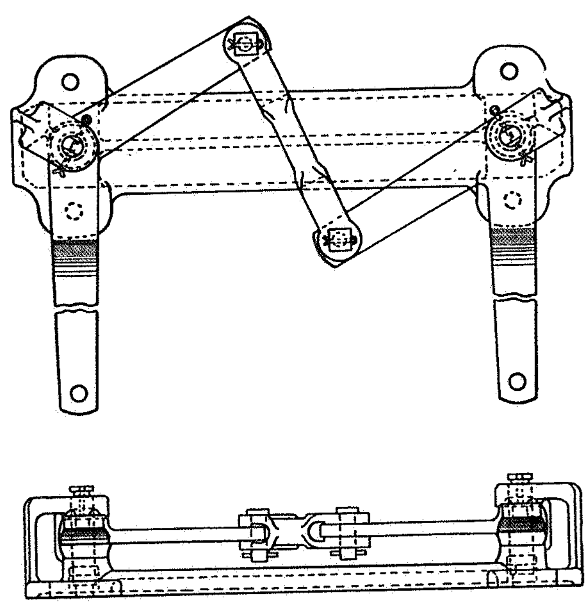


Fig. 55.
One-Way Horizontal Pipe Compensator.

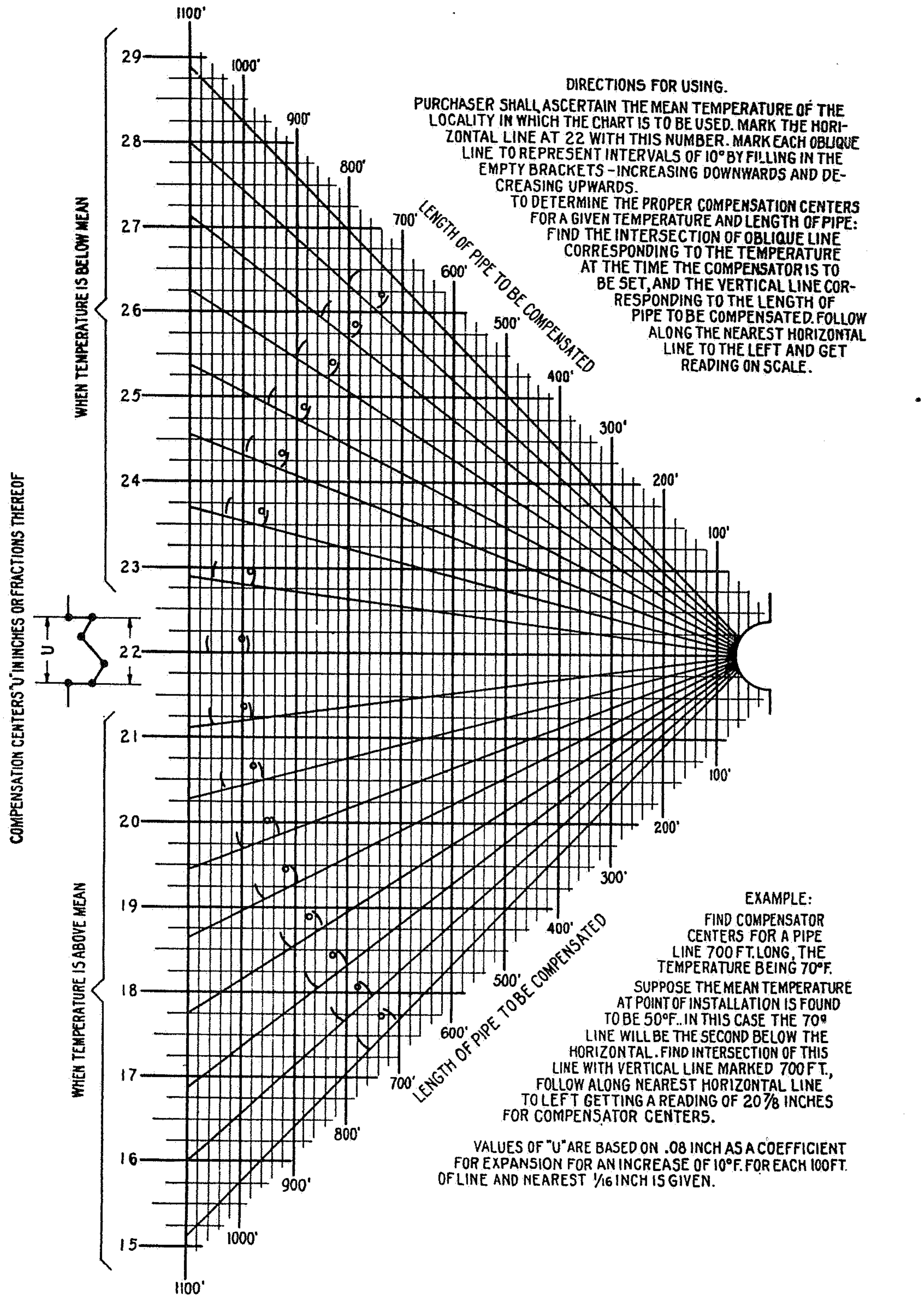
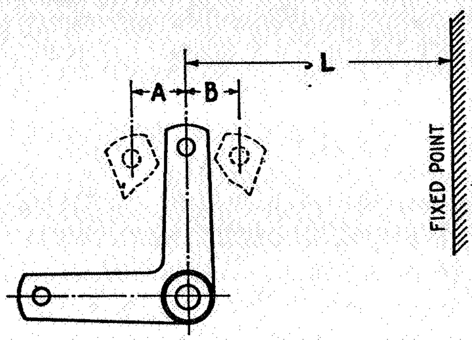


Fig. 56.
Compensation Chart.

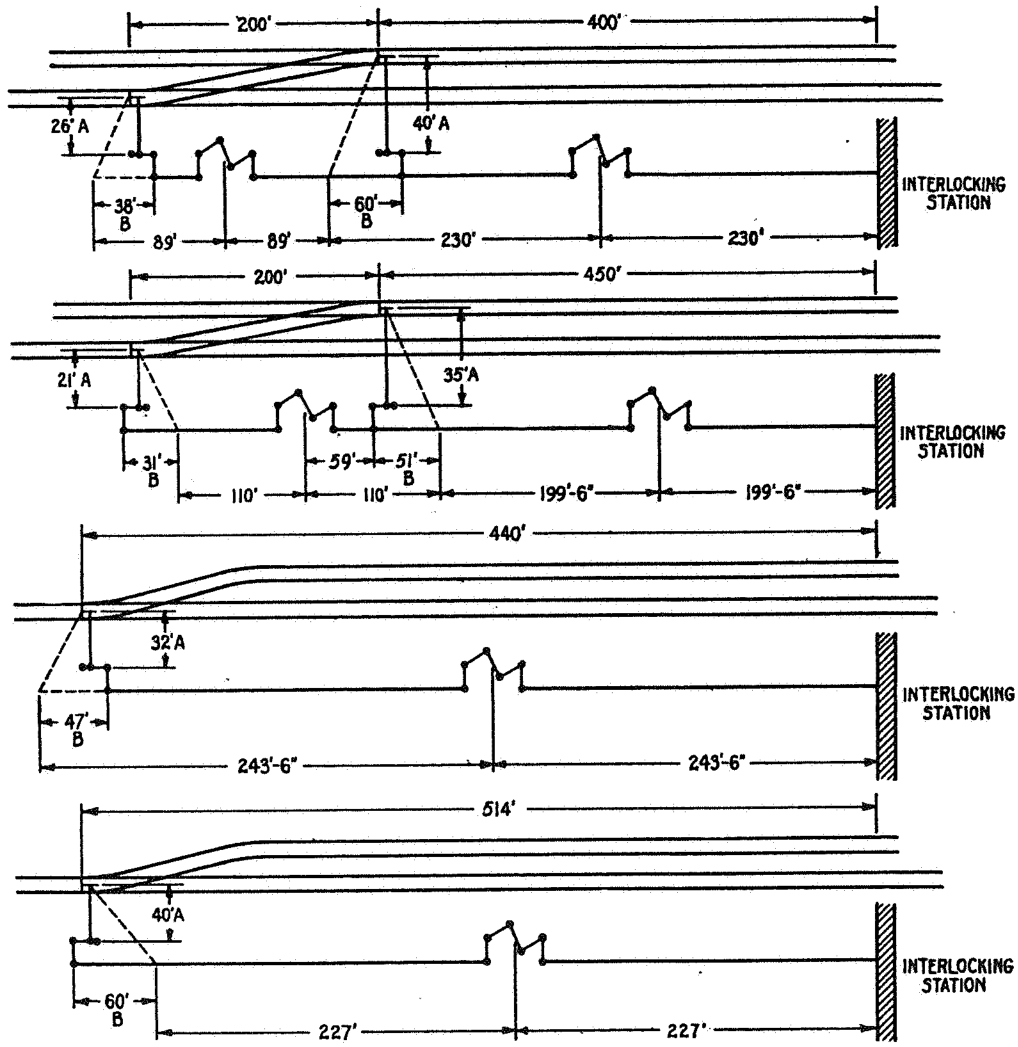


DIRECTIONS FOR USING

WRITE THE MEAN TEMPERATURE (IN F. DEGREES) FOR LOCALITY IN WHICH THE CHART IS TO BE USED, IN DEGREE COLUMN OPPOSITE "MEAN TEMPERATURE", GRADUATING 10° FOR EACH SPACE, INCREASING UPWARD AND DECREASING DOWNWARD. THE FIGURE IN SQUARE OPPOSITE TEMPERATURE AT TIME OF INSTALLATION AND UNDER THE NUMBER OF FEET (L), BETWEEN CRANK AND FIXED POINT, IS THE DISTANCE (A OR B), IN INCHES, THE CRANK SHOULD BE SET TOWARDS OR AWAY FROM THE FIXED POINT.

F°	20'	40'	60'	80'	100'	120'	140'	160'	180'	200'	220'	240'	260'	280'	300'	L
°	1/8	5/16	1/2	5/8	13/16	15/16	1 1/8	1 1/4	1 7/16	1 5/8	1 3/4	1 15/16	2 1/16	2 1/4	2 3/8	A-AWAY FROM FIXED POINT
°	1/8	1/4	7/16	9/16	3/4	7/8	1	1 1/8	1 1/4	1 7/16	1 9/16	1 3/4	1 7/8	2	2 3/16	
°	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	
°	1/8	1/4	5/16	7/16	9/16	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 7/16	1 9/16	1 11/16	
°	1/8	3/16	5/16	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1 1/16	1 1/8	1 1/4	1 3/8	1 7/16	
°	1/16	3/16	1/4	5/16	3/8	1/2	9/16	5/8	3/4	13/16	7/8	15/16	1 1/16	1 1/8	1 3/16	
°	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	
°	1/16	1/8	1/8	3/16	1/4	5/16	5/16	3/8	7/16	1/2	1/2	9/16	5/8	11/16	3/4	
°	1/16	1/16	1/8	1/8	3/16	3/16	1/4	1/4	5/16	5/16	3/8	3/8	7/16	7/16	1/2	
°	1/16	1/16	1/16	1/16	1/16	1/8	1/8	1/8	1/8	3/16	3/16	3/16	3/16	1/4	1/4	
°	← MEAN TEMPERATURE →															
°	1/16	1/16	1/16	1/16	1/16	1/8	1/8	1/8	1/8	3/16	3/16	3/16	3/16	1/4	1/4	B-TOWARDS FIXED POINT
°	1/16	1/16	1/8	1/8	3/16	3/16	1/4	1/4	5/16	5/16	3/8	3/8	7/16	7/16	1/2	
°	1/16	1/8	1/8	3/16	1/4	5/16	5/16	3/8	7/16	1/2	1/2	9/16	5/8	11/16	3/4	
°	1/16	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16	5/8	11/16	3/4	13/16	7/8	15/16	
°	1/16	3/16	1/4	5/16	3/8	1/2	9/16	5/8	3/4	13/16	7/8	15/16	1 1/16	1 1/8	1 3/16	
°	1/8	3/16	5/16	3/8	1/2	9/16	11/16	3/4	7/8	15/16	1 1/16	1 1/8	1 1/4	1 3/8	1 7/16	
°	1/8	1/4	5/16	7/16	9/16	11/16	13/16	7/8	1	1 1/8	1 1/4	1 3/8	1 7/16	1 9/16	1 11/16	
°	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1	1 1/8	1 1/4	1 7/16	1 9/16	1 11/16	1 13/16	1 15/16	
°	1/8	1/4	7/16	9/16	3/4	7/8	1	1 1/8	1 1/4	1 7/16	1 9/16	1 3/4	1 7/8	2	2 3/16	
°	1/8	5/16	1/2	5/8	13/16	15/16	1 1/8	1 1/4	1 7/16	1 5/8	1 3/4	1 15/16	2 1/16	2 1/4	2 3/8	

Fig. 57.
Crank Chart.



DRILLING OF CRANKS
LEVER SIDE 11.75"
SWITCH SIDE 8"

NOTE 1

DRILLING OF CRANK ARMS FOR SWITCH

TO FIND DRILLING FOR LENGTH OF CRANK ARM ON SWITCH SIDE WHICH WILL GIVE THE REQUIRED STROKE: MULTIPLY THE REQUIRED STROKE AT SWITCH BY LENGTH OF CRANK ARM ON LEVER SIDE AND DIVIDE BY THE STROKE OF THE LEVER.

EXAMPLE.

THROW OF SWITCH POINTS	4.5"
LOST MOTION IN SWITCH ADJUSTMENT	1.5"
REQUIRED STROKE AT SWITCH	6"
LENGTH OF CRANK ARM ON LEVER SIDE	11.75"
STROKE OF LEVER	8.75"

$$\frac{6 \times 11.75}{8.75} = 8\text{" APPROX.}$$

NOTE 2

SETTING OF COMPENSATORS

WHEN DRILLING OF CRANK ARMS AT SWITCH ARE OF UNEQUAL LENGTHS, THE LENGTH OF PIPE "B" TO BE COMPENSATED WILL NOT BE EQUAL TO LENGTH OF PIPE "A". TO FIND LENGTH "B" USE THE FOLLOWING FORMULA:

$$\frac{\text{LENGTH "A"} \times \text{LENGTH OF CRANK ARM ON LEVER SIDE}}{\text{LENGTH OF CRANK ON SWITCH SIDE}} = \text{LENGTH "B"}$$

OR

GIVEN:

LENGTH "A"	32'
CRANK ON LEVER SIDE	11.75"
CRANK ON SWITCH SIDE	8"

THEN:

$$\frac{32 \times 11.75}{8} = 47\text{ FT.}$$

WITH NORMAL CRANK LENGTH "B" MUST BE ADDED TO LENGTH OF PIPE LINE; WITH REVERSED CRANK IT MUST BE SUBTRACTED.

Fig. 58.
Instructions for Applying Compensation.

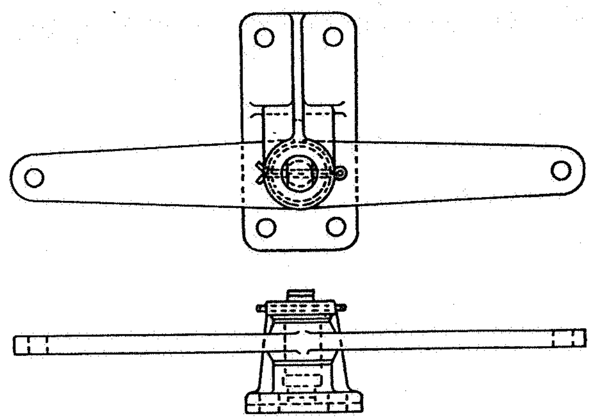


Fig. 59.
Straight-Arm Compensator.

Facing point lock.

The Signal Section, A.R.A., defines Facing Point Lock as: A mechanical lock for a switch, derail or a movable point frog, comprising a plunger which engages a lock rod attached to the switch points to lock the switch or other operated unit in its normal and/or reverse position.

The facing point lock is generally used in mechanical interlocking to insure that the switch points are properly secured against the stock rails. The use of the facing point lock in mechanical interlocking requires two levers for each switch, derail or movable point frog. One lever is employed to throw the switch and the other to operate the facing point lock. The locking of the switch is accomplished, in either the normal or reverse position of the switch, by a plunger engaging in a groove or hole cut in the lock rod which is actuated by the switch points. To operate the switch to the reverse position the plunger of the lock is withdrawn from the normal groove in the lock rod by operation of the facing point lock lever in the interlocking machine. The switch may then be operated by moving the switch lever to the reverse position and the plunger of the lock brought into engagement with the reverse groove in the lock rod by again manipulating the facing point lock lever to the reverse position.

There are two types of plungers in general use, a 1-inch circular and a 2-inch by ¾ inch rectangular. When the circular plunger is used, horizontal holes in the lock rod are provided through which the plunger passes to effect the locking. When the rectangular plunger is used, corresponding grooves are cut in the top edge of the lock rods through which the plunger passes.

The main lock rod carries the groove or hole for locking the switch in the normal position and the adjustable locking piece is slotted so that the plunger may pass through it and engage the groove. In the same manner the adjustable locking piece carries the groove or hole for locking the switch in the reverse position and the main lock rod is slotted in this position to permit the plunger to pass through. The adjustable locking piece affords a means of adjusting for any variation in the throw of a switch.

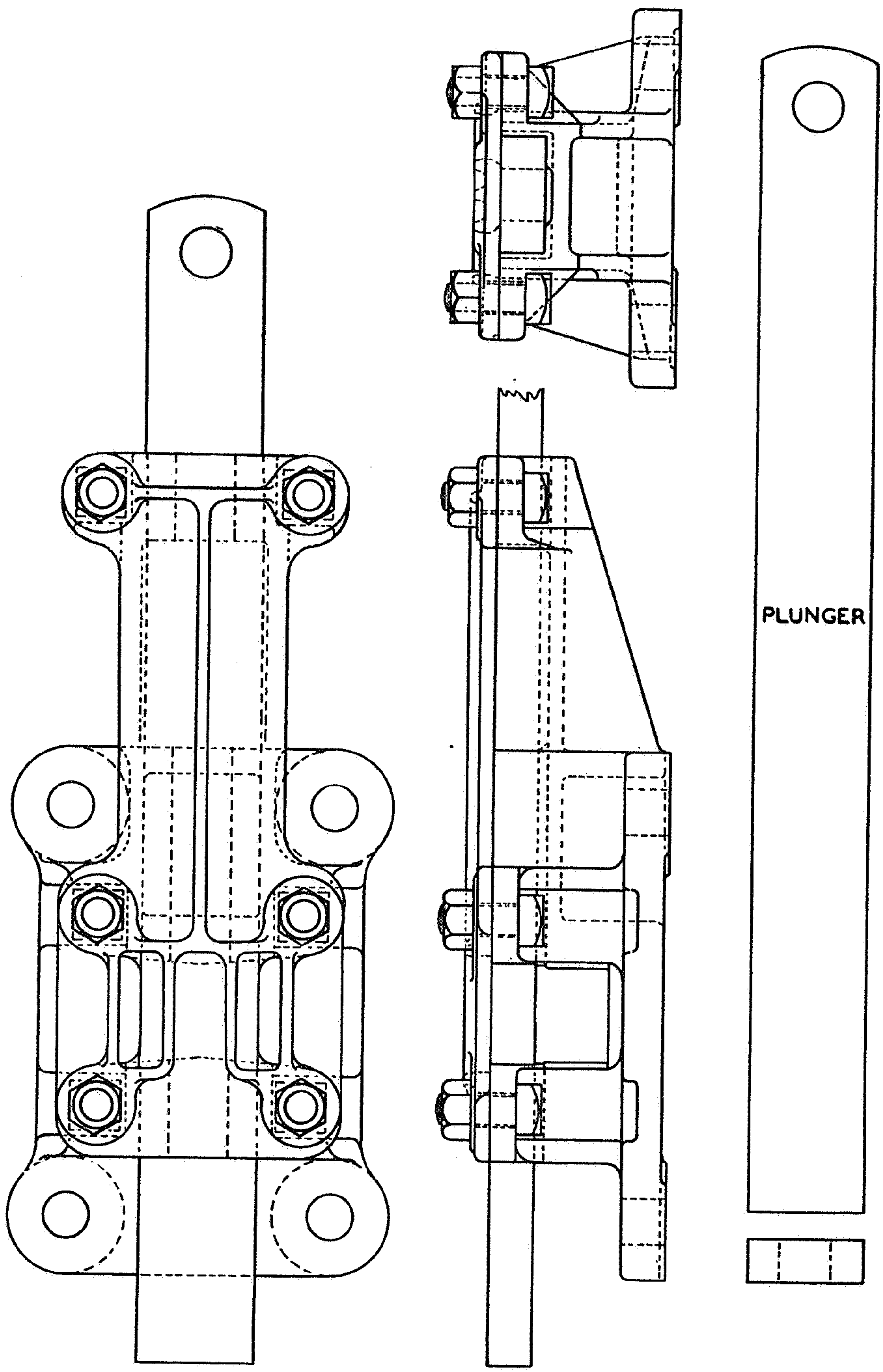


Fig. 60.
Plunger Lock.

Figure 60 illustrates the plunger lock casting and the rectangular plunger. The casting is designed to permit the lock rod and the plunger to enter the lock at right angles to each other. It is mounted on a rectangular base plate which is secured to the cross-ties.

The connection between the plunger and the pipe line is made with a screw jaw to permit adjusting for any variation in the travel of the plunger.

Bolt lock.

The Signal Section, A.R.A., defines Bolt Lock as: A mechanical lock so arranged that if a switch, derail or movable point frog is not in the proper position for a train movement, the signal governing that movement cannot be cleared, and that will prevent a movement of the switch, derail or movable point frog unless the signal is in its most restrictive position.

Figure 61 illustrates the details and assembly of a multiple-unit bolt lock. It may be employed in a one, two or three-way assembly depending on the number of signals governing movements over the switch to be locked.

The bolt lock casting is so located that the signal locking bar may be connected in series with the pipe or wire line controlling the signal. A lock rod working through the casting at right angles to the signal locking bar is connected to the switch point. The locking is accomplished by a predetermined order of dogs riveted to the signal locking bar and grooves cut in the upper side of the lock rod connected to the switch. The principle of operation of the bolt lock is similar to that of the facing point lock.

Switch Mechanism

The fittings for equipping a switch to be operated from an electro-mechanical machine conform closely with those of the mechanical interlocking covered in the preceding description. The electro-mechanical interlocking systems, however, usually employ switch-and-lock movements operated by one lever rather than a directly connected switch and facing point lock separately operated by two levers. In either case there is a circuit controller at the switch to provide means for an electric indication.

Switch-and-lock movement.

The Signal Section, A.R.A., defines Switch-and-Lock Movement as: A device, the complete movement of which performs the three operations of unlocking, operating and locking a switch, movable point frog or derail. Figure 62 illustrates a commonly used switch-and-lock movement.

This movement was designed especially for use with the electro-mechanical interlocking machine and to operate and lock a switch by a direct thrust from a single pipe line. The thrust from the pipe line is parallel with the movement of the switch operating rod. The operating slide bar is made of two parallel pieces of metal riveted together with a space between for the entrance of the locking bar. Cam slots are cut in the motion plate and guides are cast in the top and bottom stationary parts of the frame in such a way that the first portion of the movement of the motion plate actuates a slide

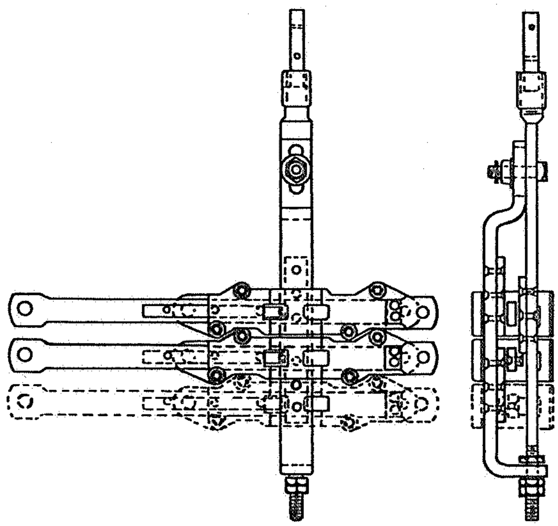


Fig. 61.
Multiple Unit Bolt Lock.

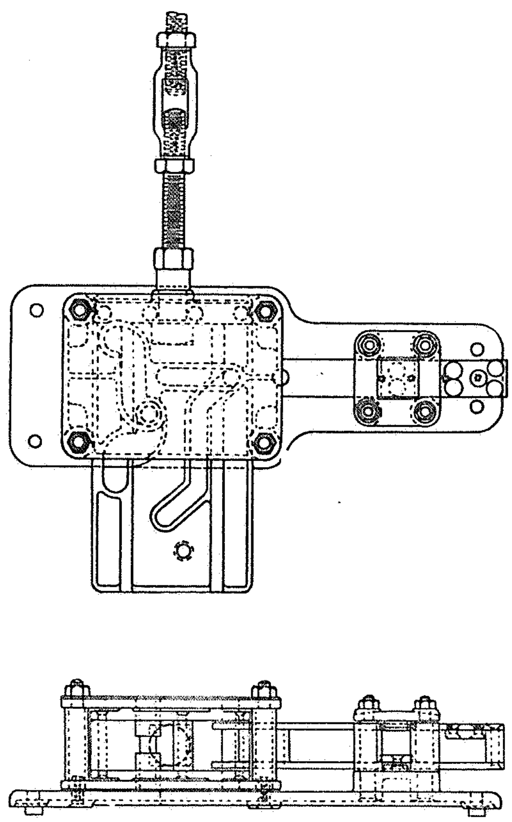


Fig. 62.
Type "G" Switch-and-Lock Movement.

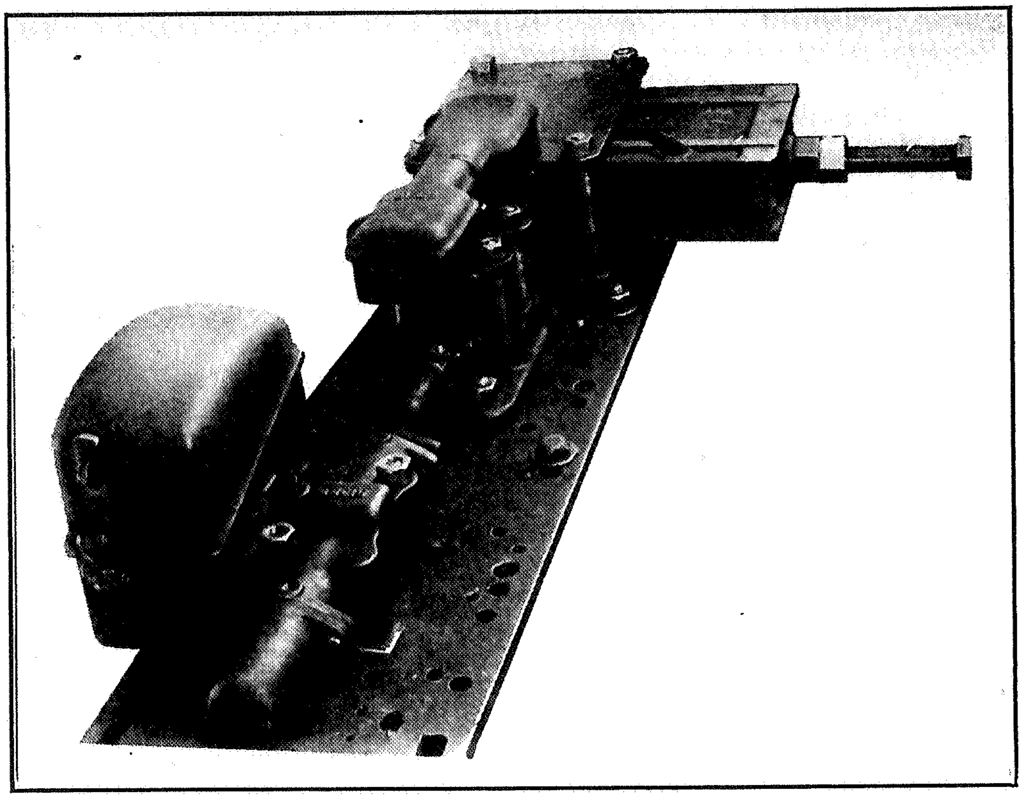


Fig. 63.
Electric Lock Applied to Type "G" Switch-and-Lock Movement.

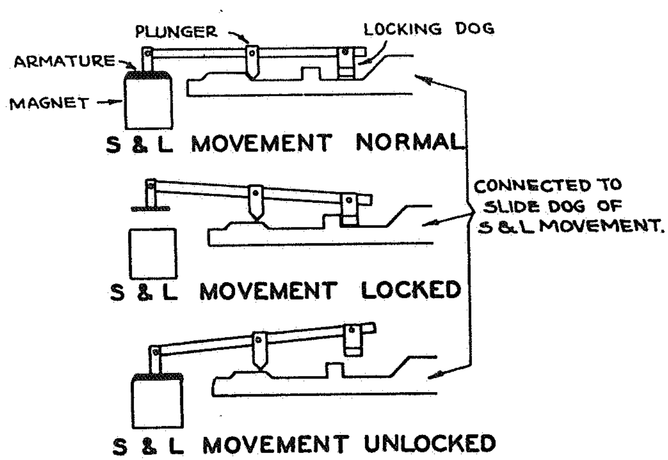


Fig. 64.
Diagram Showing the Operation of Electric Lock Applied to Type "G" Switch-and-Lock Movement.

bar at right angles to the throw rod to unlock the switch, and at the same time move the pin holding the end of the throw rod to one side, thus placing it in the operating position. The middle portion of the stroke operates the switch, but does not effect the slide bar, while the last portion of the stroke moves the pin holding the end of the throw rod out of the operating position and locks the switch in the usual manner. Thus the sequence of operation is the same as in other types of switch-and-lock movements. The movement is equipped with an indication box of the same type as used with certain power interlockings.

In some cases an electric lock, as shown in Fig. 63, is applied to switch-and-lock movements which operate facing point switches, especially when the mechanical pipe connections pass under adjacent tracks and there is a possibility of dragging equipment catching the lateral pipe connections and pulling the switch open. Figure 64 illustrates the operation of this lock. The magnet is de-energized when the indicating lock lever is normal or reverse and should the pipe line be pulled by dragging equipment, the first movement of the slide rod would lift the armature and the locking dog would engage the projection on the slide rod, thereby locking the switch against further movement. If the indicating lock lever is on center, as is the case when the switch is to be operated, the magnet is energized and the first movement of the slide rod would lift the locking dog, allowing the switch to be operated in the usual way. The lock is sufficiently rugged so that should the pipe line become disconnected it will hold the switch points in place.

Switch adjustment.

In order to adjust for the wear of a mechanically-operated switch it is customary to provide more motion of the operating equipment than is required to move the switch from one position to the other. This excess of motion is taken care of in the switch adjustment attached to the head rod of the switch through which the operating rod passes and is attached as illustrated in Fig. 65. Space is provided between one side of the switch adjustment on the head rod and the nuts on the operating rod. This space is consumed during the first portion of the motion of the operating rod through the switch adjustment before the nut comes against it to move the switch. As lost motion gradually develops in the mechanical operating connections, this excess motion decreases.

The pressure required to hold the nuts on operating rod against the head rod will vary with the length and weight of the switch points but must be sufficient to keep the points firmly against the stock rails. This pressure is usually determined by prying the point away from the stock rail with a small bar.

After adjusting the normal switch point firmly against the stock rail by use of the adjustment on the operating rod, which brings the groove on the lock rod nearly in line with the plunger of the lock, the lock rod is shifted so that the plunger will engage with the groove in the lock rod, thus permitting

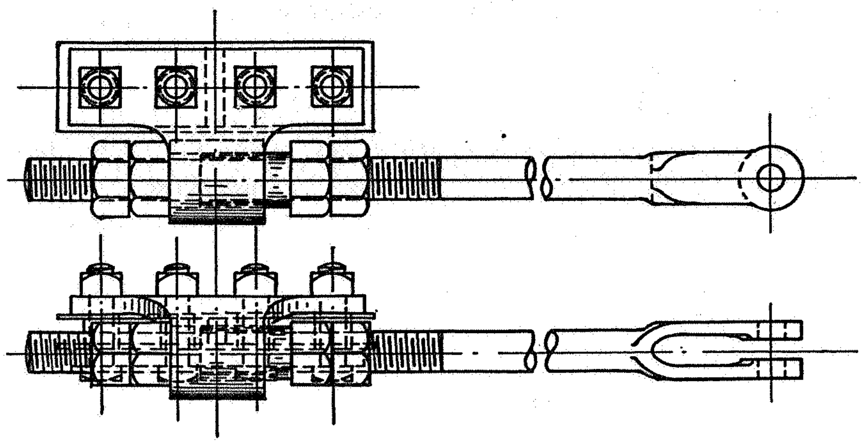


Fig. 65.
Switch Adjustment.

locking the switch in the normal position; the lock rod is then tightened. The same operation is repeated with the switch in the reverse position, with the exception that the adjustable portion of the lock rod is moved until the plunger of the lock engages with the groove of the lock rod, thus permitting locking the switch in the reverse position. After tightening all nuts the adjustment is complete.

Signal

The mechanical signals of an interlocking plant are of the semaphore type, operated by pipe or wire lines. Those operated by pipe lines are known as pipe-connected signals and are illustrated in Fig. 66.

A crank is located at the bottom of the signal mast connected to the pipe line which is operated by the signal lever in the interlocking machine. Pipe-connected signals usually require one pipe line for each working arm and wire-connected signals usually require two wire lines for each working arm. In some instances a selector is used which permits operating more than one arm from each pipe or wire line. Figure 67 illustrates a pipe selector.

All appliances are secured to the mast by clamps. The up-and-down connections on the mast are of 1-inch pipe connected to the spectacle casting of the signal with a solid jaw and pin and connected to the crank at the bottom of the mast by a screw jaw. Signals are generally equipped with counterweights to return them to the normal position in case the pipe or wire lines should fail. For a signal mast equipped with more than one arm a multiple arrangement of cranks and up-and-down rods is employed.

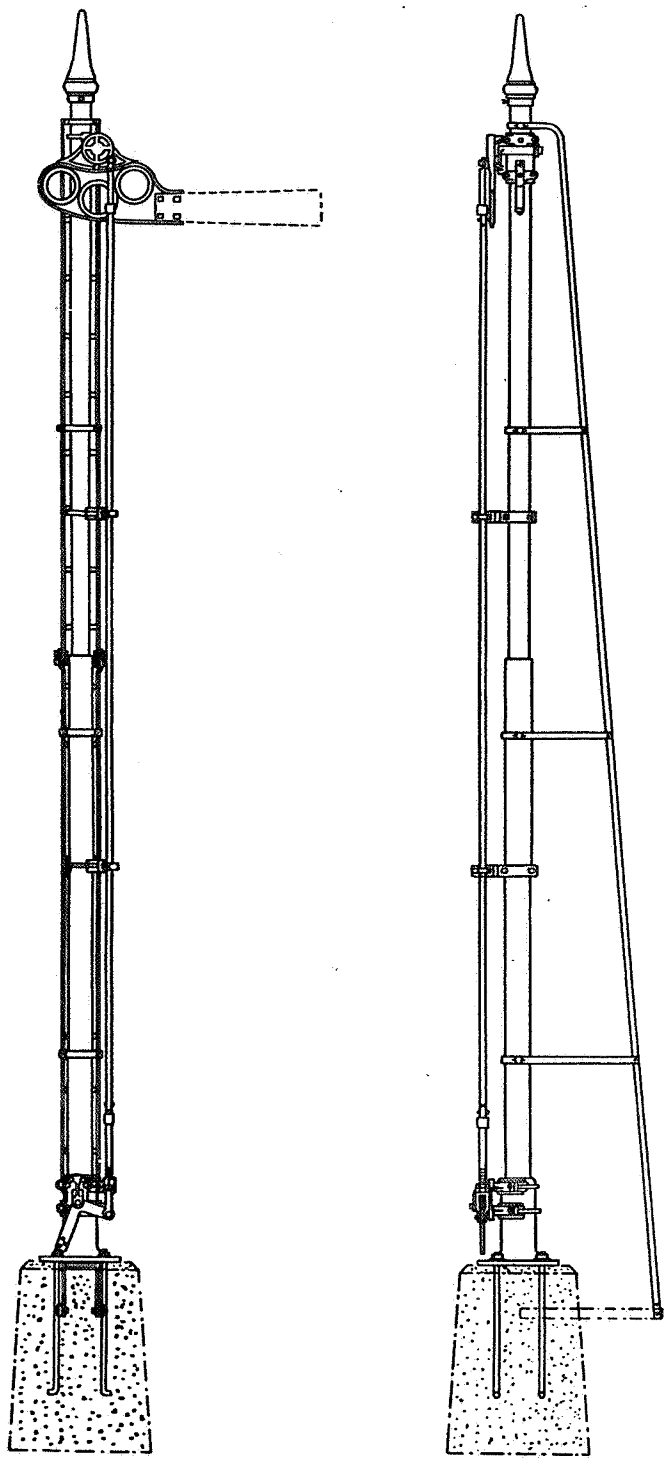


Fig. 66.
Mechanical Signal.

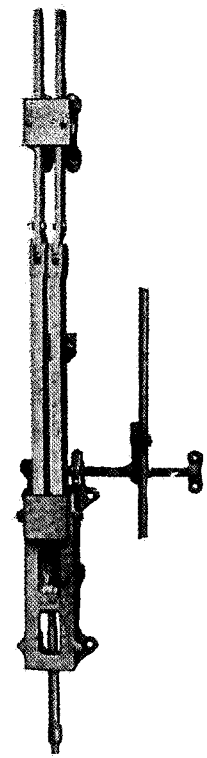


Fig. 67.
Pipe Selector.

Instructions

Mechanical and electro-mechanical interlocking should be maintained and tested in accordance with the following instructions:

1. Interlocking machine must be kept in good condition, free from dust, grease, dirt and excessive lost motion. Levers and locking must be kept clean. All bearing parts must be kept lubricated but excessive lubrication is to be avoided. Bolts, dowel pins, etc., must be kept tight, cotters properly spread and sufficient tension in latch springs. Contacts must be kept clean and properly adjusted.

2. The following instructions and advice must be given to levermen when necessary:

(a) How to disconnect and secure switches, derails, and other units in emergency.

(b) How to operate time releases and other special apparatus.

(c) How to read the various indicators or lights, etc.

(d) How to handle levers with special reference to the undesirability of forcing the lever or latch when the switch points may be obstructed or other undesirable conditions exist.

(e) Any other information which is necessary for the efficient operation of the plant.

3. During snow and sleet storms interlocking plants must be carefully watched to see that switches, pipe lines, etc., are kept clean and in operation. Sufficient force should be available to keep switches, etc., free from obstruction. Snow and ice must be removed from signal blades, roundels, lenses and other apparatus to maintain proper operation and indication. Where snow melting oil or open flame devices are used, care must be exercised to prevent damage to wires, wire conduits, insulations, etc.

4. Levers or other operating appliances must not be operated by other than leverman except for inspection or test and then only after a thorough understanding with the leverman.

5. Periodic inspection and tests must be made to insure that all appliances, including machine locking, are in proper condition and that levers can be operated only in the predetermined order.

6. Locking of an interlocking machine must not be changed nor removed from the machine without proper authority. If it becomes disarranged or broken, signals affected must be set to display their most restrictive indication; switches, etc., in the route affected must be securely spiked until repairs are made. In all such cases .... must be notified by wire.

7. Seals and padlocks, where provided, must be maintained and handled in accordance with instructions from ....

8. Opening or short circuiting circuits, or taking any other action which may cause failure of signals or other apparatus with resultant train delays must be avoided.

9. Relays must not be turned over. Contacts of relays or other controlling devices must not be bridged nor any other action taken which will endanger the safety of trains. All train movements must be properly safeguarded.

10. Standard clearances must be maintained.

11. Foundations must be rigid, level and in alignment.

12. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. The entire surface of pipe and other exposed parts must be covered, except paint must not be applied to threads of screw jaws, adjustable screws, cotters or gaskets.

13. Threads and bearings of all movable parts must be kept clean, and, except pipe carriers, must be lubricated. Sufficient oil must be used, but not wasted. Parts must be cleaned before being lubricated. Special oil must be used where required.

14. Cotter pins of the proper size must be in place in every hole provided for that purpose, must be in good condition and properly spread.

15. Gaskets for relay boxes and other housings must be in place and in good condition.

16. When movable parts are worn to such an extent as to create excessive lost motion, they must be replaced.

17. Signals should be maintained and tested in accordance with the instructions covered in Chapter XII—Semaphore Signals and/or Chapter XIII—Light Signals.

18. Relays should be inspected and tested in accordance with the instructions covered in Chapter VI—Direct Current Relays and/or Chapter X—Alternating Current Relays.

19. Electric locking should be tested in accordance with the instructions covered in Chapter XVIII—Electro-Pneumatic Interlocking.

20. Rectifiers should be maintained and operated in accordance with the instructions covered in Chapter IX—Rectifiers.

21. Batteries should be maintained in accordance with the instructions covered in Chapter V—Batteries.

22. Switch points must be so adjusted that they cannot be locked when ¼ inch rod is placed between stock rail and switch point 6 inches back from point of switch. Locking edges must be kept square.

23. Switch circuit controllers must be so adjusted that when the switch point is open more than ¼ inch circuit will be shunted or opened, or both. They must be securely fastened to the tie and contacts must be clean and of minimum resistance.

24. Fouling circuits must be so maintained that there are no breaks, leaks, or undue resistance.

25. Wires must be so supported that there will be no interference with proper operation of apparatus.

26. Wires must be kept tight on binding posts to insure good conductivity.

27. Insulated wire must be protected from mechanical injury. Insulation must not be punctured for test purposes.

28. Wire joints must be made in accordance with A.R.A. Signal Division Specification 11020; they must not be made in insulated wires underground or where they cross tracks.

29. Lightning arresters must be properly connected and grounds maintained with resistance to ground of not more than 25 ohms.

30. Bootlegs and conduits must be maintained in good condition.

31. Fibre insulations must be renewed in ample time to prevent interruptions. Section foreman must be notified promptly when an insulated joint or insulated switch rod requires attention. Supervising officer must be notified promptly if defective conditions are not corrected.

32. Before removing rails, switch points or frogs, protecting signals must be secured so as to display the most restrictive indication. Signals must not be restored to regular operation until it is known that the track is safe.

33. Maintainers should know that section foremen understand that where rails are bonded for electric circuit, new rails must not be put in or electric connections broken without facilities to promptly restore the signals to working order. In emergency cases repairs may be made by track forces and maintainer notified promptly.

34. When a signal, switch, movable point frog, derail, lock, detector bar or locking circuit is disconnected, the maintainer must give to the leverman an "out of service" notice in duplicate, showing the part or parts affected; this must be signed by each leverman on duty and one copy handed to the maintainer. All points affected must be safely secured.

35. Line wire must be supported by insulators properly tied in and excessive slack taken up. Broken insulators must be replaced.

36. Pole lines carrying signal wires must be frequently inspected, and maintainers must see that they are properly maintained. Signal wires or cables crossing the track must clear the top of rail not less than .... feet.

37. Top of rail must be kept free from sand, rust and other foreign matter that would affect proper shunting of track circuit.

38. Cranks, compensators, etc., must work freely, but must not have excessive lost motion in moving parts. They must be kept clean, properly centered, lubricated and in correct alignment with pipe line.

39. Pipe lines must be kept free from weeds and dirt. Tops of all pipe carrier foundations must be level and not less than 2 inches above the ground. Pipe lines must be in good condition and in true alignment. All rollers must be free and all bases firmly attached to foundations.

40. Holes or notches in lock rods must have square edges and must not be more than 1/16 inch larger than the plunger.

41. Plunger of facing point lock must have at least 8-inch stroke and when its lever is in the normal position the end of the plunger must clear the lock rod 1 inch. The end of the plunger must have square edges.

42. Bolt locks must be adjusted so that signals governing movements over switch cannot be cleared when switch point is open more than 1/4 inch. Signal bar must be up against the stop when signal lever is normal. Notches must have square edges. When two or three-way bolt locks are used signal bars must be provided with proper locking section.

43. Driving bar of switch-and-lock movement must have its full stroke so that it travels, both normal and reverse, to the Stop position.

44. When circuit controller is mounted on switch-and-lock movement it must be adjusted so that the contacts will not close until driving bar has traveled to within ½ inch of the stop.

45. Top of detector bar must be within ¼ inch of top of rail when lever is in the full normal or reverse position. Rail clips and motion plates must be tight, all rollers working freely, all parts free from dirt and lubricated. Bar must be adjusted so that when lever is on center the motion plates are on center. Bar must be straight without kinks, and must lie evenly along the rail. Gage of track must not be more than ¼ inch in excess of standard gage along the full length of the bar. Battered rail must be trimmed to prevent interference with operation of bar.

46. When necessary to disconnect a switch, derail or any other unit, it should be done at the crank nearest the unit.

47. Switch movements must be kept in good condition, free from dust, grease, dirt and excessive lost motion. All bearing parts must be kept lubricated but excessive lubrication is to be avoided. Lubricants used should be suitable to the weather conditions encountered and should be in accordance with the recommendation of the manufacturer. Bolts must be kept tight and cotters properly spread. Contacts must be kept clean and properly adjusted.

American Railway Signaling Principles and Practices

QUESTIONS ON

CHAPTER XVII

Mechanical and Electro-Mechanical Interlocking

QUESTIONS ON CHAPTER XVII

MECHANICAL AND ELECTRO-MECHANICAL INTERLOCKING

General.

1. Of what type was the first interlocking plant in America?
2. By whom and from where were the material and mechanics furnished for the original installation?
3. What type locking was employed?
4. How were the switches operated and locked?
5. How were the signals connected to the interlocking machine?
6. What constituted the locking, and what effect did it have on the movement of the levers?
7. How does the present Saxby and Farmer machine conform to the original machine?
8. As the mechanical interlocking came into general use, why were various improvements made?
9. What were some of the improvements made as the machine came into general use?
10. What method of operation of switches and signals followed the mechanical interlocking, and what brought it about?
11. What type interlockings were developed, and in what order did they follow the original machine?
12. What interlocking was the inspiration for the present electro-pneumatic system?
13. What were the later developments?

Interlocking Station

14. How is interlocking station defined by the Standard Code of the American Railway Association?
15. What is housed within an interlocking station?
16. What is the general practice in regard to location of the interlocking station?

Machine

17. Signal Section, American Railway Association specifications for mechanical and electro-mechanical interlockings cover what types of machines?

Mechanical machine.

18. How is mechanical interlocking machine defined by the Signal Section, A. R. A.?
19. How many types of mechanical machines are there in general use?
20. How do these types differ?

Electro-mechanical machine.

21. How is electro-mechanical interlocking machine defined by the Signal Section, A. R. A.?

22. In what year did the electro-mechanical machine have its origin?

23. What factor brought about the development of this type of machine?

Electro-mechanical machine, S. & F. miniature locking.

24. What characteristic feature makes this type of machine particularly applicable to the requirements?

25. Of what does the lock consist?

26. Of what does the machine consist?

27. How are the levers spaced?

28. Where are the electric levers located, and how are they numbered?

29. Describe the combination board.

30. How is the locking device on a switch lever operated?

Electro-mechanical machine, vertical locking.

31. Of what two general types are the electric levers?

32. How does the spacing of levers compare with that of the mechanical levers?

33. How does the length of the electric machine compare with the mechanical machine?

34. How does the number of electric lever spaces compare with that of the mechanical lever spaces?

35. How are the rotary circuit controllers made with respect to tiers and contacts?

36. At what position in the stroke of the lever may contacts be arranged to open or close a circuit?

37. How is each tier of circuit controller contacts actuated?

38. When electric and mechanical levers are in the same vertical plane, how may they be arranged to operate contacts?

39. How may a large number of contacts be made available?

40. In what position is the mechanical locking, and how are tappets actuated?

41. By what levers is provision made to operate the locking?

42. How may the same flexibility of locking be obtained as shown in electro-mechanical machines described in this chapter?

Unit electric lever.

43. How is the locking between the miniature electric levers and existing mechanical interlocking frames accomplished?

44. What is the advantage of adding electric levers to existing mechanical interlocking frames?

45. In what number are electric lever units made up and how are they spaced?

46. How are the units mounted, and how may they be located on the mechanical machine?

47. Of what two main parts does each electric unit consist?
48. Where is the master unit mounted, and what does it include?
49. How are contacts arranged on circuit controllers?
50. When but one magnet is required, how may contacts be mounted?
51. When two or three magnets are used, how are contacts arranged?
52. What units are provided with individual covers?
53. What secures all covers in place?
54. How are electric levers connected to the locking bed?
55. How do the adjustable connecting rods extend, and how does this arrangement affect the locking bar?
56. Why are the loose sleeve drivers made in various lengths?
57. In a 40-bar bed, how many bars may be operated by the rack type driver and how many by the jaw type driver?
58. What is each electric lever capable of controlling?
59. When used as an indication lever for a mechanically-operated switch, or for electric switch locking, how is the locking between the electric lever and the mechanical lever obtained?
60. How is the shaft operated?
61. With the shaft operated as mentioned, how is the mechanical lever locked?
62. What effect does moving the electric lever to the center position have on the mechanical lever?
63. What effect does reversing the mechanical lever have on the electric lever?
64. What effect does completing the stroke of the electric lever have on the mechanical lever?
65. What procedure is necessary in returning both levers to the normal position?
66. How may two or more mechanical levers be locked by one electric lever?
67. What is the advantage of the electro-mechanical machine with respect to handling units and simplifying the locking?
68. Are there any difficulties in converting an existing mechanical machine into an electro-mechanical machine?
69. What special features may be taken care of by the addition of unit electric levers?

Unit electric lever, Style "A" mechanical machine.

70. How does the application of unit electric levers to the Style "A" machine compare with the application to the S. & F. type?
71. What necessitates the use of crank arms to transmit the proper motion from the electric levers to the locking bars with the Style "A" machine?

Mechanical Locking

72. Where may a detailed explanation of the mechanical locking for the mechanical and electro-mechanical interlocking machines be found?

Machine Appurtenances

Electric lock.

73. How is electric lock defined by the Signal Section, A. R. A.?

74. Why are electric locks employed, and how may they be applied to mechanical machines?

75. Explain the operation of the electric lock as shown in Fig. 20.

76. To what is the locking dog secured?

77. To what is the armature secured?

78. How is the locking dog affected by the energization of the magnet?

79. What feature permits the electric lock to be used as a circuit controller?

80. How are the same results obtained with the lock shown in Fig. 21 as that shown in Fig. 20?

81. How does the connection to the device operated by the lever latch in Fig. 21 compare with that shown in Fig. 20?

Forced drop electric lock.

82. What is the advantage of the forced drop feature of the electric lock?

83. Of what does the forced drop mechanism consist?

84. What forces down the locking member?

85. Where is this type of lock designed for mounting, and to what machines may it be applied?

86. How is provision made for locking the latch in the various positions of the latch and lever?

87. With what circuit controllers may this type lock be equipped?

88. To what is the number of tiers that may be used limited?

89. Where is the type of lock shown in Fig. 25 arranged for mounting?

90. When may additional sections be added to the circuit controller?

91. How is the slide bar operated?

92. How is the circuit controller operated?

93. Where is the locking dog attached, and with what does it engage?

94. How is provision made for variation of the locking operation?

95. What other method is used for electrically locking a mechanical lever?

96. How is this lock mounted and operated?

97. How is the locking secured?

98. How is the segment attached, and how does it provide the forced drop feature?

99. How is latch locking secured with the latch in either the raised or down position?

100. How is a three-way circuit controller operated?

Circuit controller.

101. How may circuit controllers other than those contained in the electric locks be connected to the machine?

102. Describe the circuit controller contained in the electric lock.

103. What other type of controller is used, and how is it connected?

104. Describe the operation and design of the slide type controller.

Indicator.

105. How is indicator defined by the Signal Section, A. R. A.?
106. Why are indicators employed?
107. Describe the indicators.

Time Release

108. How is time release defined by the Signal Section, A. R. A.?

Hand-operated clockwork time release.

109. What is the normal position of a clockwork time release with latch, and how does it operate?
110. What is the normal position of a clockwork time release without latch, and how does it operate?
111. To what extent may the time interval of time releases be adjusted?

Hand-operated time release.

112. Explain the operation of the hand-operated time release.
113. For what time interval may the time release be set?

Mechanical time lock.

114. Where is the mechanical time lock applied, and what does it provide?
115. What does the lock prevent?
116. Describe the operation of the mechanical time lock, pendulum type.
117. What additional connection is made when the lock is applied to a Style "A" machine?
118. To what time interval may the lock be adjusted?

Leadout

119. How is leadout defined by the Signal Section, A. R. A.?
120. Of what does the leadout consist?
121. What are the two general types of leadout?
122. How does the connection between the lever of machine and leadout extend with a horizontal leadout, and how does it extend with a vertical leadout?
123. What additional material is required when the vertical leadout is used, and why?
124. What is required outside of station to turn pipe lines, when either type of leadout is used?
125. How are cranks frequently arranged, and what is the arrangement called?
126. What combination is sometimes used in the same leadout?
127. When is the horizontal leadout used, and when the vertical?

Rocker shaft leadout.

128. What is the dimension of a rocker shaft, and how is it supported and secured to the leadout support?

129. How is the bearing inside the interlocking station located on the rocker shaft, and why?

130. How is the pipe line connection from the rocker shaft to the leadout made?

131. What is it often necessary to do with arms and jaws with complicated leadouts?

Deflecting bar leadout.

132. How is deflecting bar defined by the Signal Section, A. R. A.?

133. Of what does a deflecting bar consist?

134. How are connections made with a deflecting bar type of leadout?

135. How does the space consumed by the deflecting bar type of leadout compare with the rocker shaft, and what are the advantages?

Crank leadout.

136. How are connections made with a crank type of leadout?

137. How are the horizontal cranks usually arranged, and what is the arrangement called?

Foundation

Interlocking station and leadout.

138. How is foundation defined by the Signal Section, A. R. A.?

139. Of what are foundations for interlocking stations usually made, and upon what does their size depend?

140. How are leadout foundations usually constructed?

141. How are the leadout appliances fastened?

142. How are "I" beams fastened, how do they line up with leadout, and from where and to where do they extend?

143. Where and how are channel irons or wood planks, which hold leadout appliances, placed?

144. With what type leadout are channel irons more generally used, and how are they spaced?

Pipe and Wire Lines

Pipe line.

145. How is mechanical pipe line defined by the Signal Section, A. R. A.?

146. How is the pipe line constructed and joined together?

Pipe carrier and support.

147. How is pipe carrier defined by the Signal Section, A. R. A.?

148. Of what does a pipe carrier consist, and what is its function?

149. How are pipe carriers arranged, and how is the make-up termed?

150. What is the center to center dimension of multiple carriers?

151. What does the specification of the Signal Section, A. R. A., require that pipe carrier supports be spaced?

152. What is the proper arrangement of pipes with respect to lines leading off, and why is it desirable?

153. How are pipe couplings located with respect to pipe carriers?

154. When it is necessary to run pipe lines across the tracks, what type carriers are used?

155. How far apart are transverse carriers spaced, and how are they fastened?

156. How are transverse carriers placed with respect to tie spacing and tamping?

157. What is the maximum number of pipe lines usually placed in the same tie space?

Crank.

158. How is crank defined by the Signal Section, A. R. A.?

159. What device does the Signal Section, A. R. A., recommend be used for the following degree turn:

(a) 0 to 30 degrees?
(b) 30 to 75 degrees?
(c) 75 to 105 degrees?
(d) 105 to 140 degrees?
(e) 140 to 180 degrees?

160. Describe the radial arm.

161. To what degree of pipe line turns is the radial arm limited?

162. In what assembly is the radial arm obtained?

163. What are the usual lengths of radial arms:

(a) One-way arm?
(b) Two-way arm?
(c) Three-way arm?

164. What device is more generally used for changing the direction of motion of pipe lines?

165. What term is used for cranks in which the angle between the two arms is:

(a) Less than 90 degrees?
(b) Greater than 90 degrees?

166. When two or more cranks are assembled in a box-shaped frame, each crank having a separate bearing, what is the assembly called?

167. To what extent does the specification of the Signal Section, A. R. A., limit deflecting bars for changing the direction of a pipe line?

Jaw and lug.

168. How is jaw defined by the Signal Section, A. R. A.?

169. How many types of jaws are there in general use?

170. Where are solid jaws always used, and when are screw jaws used?

171. When necessary to place offsets in a pipe line for the purpose of correcting alignment or elevation, where is the offset made?

Adjusting screw.

172. What are the purposes of adjusting screws?

Pipe-line insulation.

173. Why are pipe-line insulations used, and how is it accomplished?

Stuffing box.

174. When are stuffing boxes used, and what is the arrangement?

175. With what is the two-inch pipe sometimes equipped to lessen the friction of the one-inch pipe?

Pipe-line foundation.

176. How were pipe carrier foundations originally constructed, and of what are they generally constructed at present?

177. Where and how are pipe carrier foundations generally made?

178. What is the depth of the foundation?

179. How are pipe carrier supports secured to foundation?

180. How is the top of the foundation usually set compared with the rail?

181. How are foundations set with respect to distance from rail?

182. How are the foundations for cranks, compensators, deflecting bars, locks, etc., generally cast?

183. How are cranks and compensators usually placed with respect to pipe lines, and why?

184. Why is the location of crank, compensator and lock foundations, etc., accurately determined before pipe carrier foundations are set?

185. What precaution is taken in setting foundations?

Wire line.

186. How are mechanical interlocking signals operated?

187. How many pipe lines, if pipe-connected, or how many wires, if wire-connected, are required to operate each arm?

188. What is the wire in tension when the signal is being cleared called?

189. What is the wire in tension when the signal is being returned to its most restrictive position called?

190. Where are distant signals usually located, and how may they be operated?

191. Beyond what distance is it difficult to operate wire-connected signals?

192. Why are mechanical distant signals being replaced by power signals?

Compensation.

193. What is a pipe line, and why is it subject to contraction and expansion?

194. How does the amount of expansion, due to a rise in temperature, of a given length of pipe line compare with the contraction of the line for a corresponding drop in temperature?

195. Upon what is the amount of expansion or contraction dependent?

196. What would be the effect on long pipe lines between the highest summer and lowest winter temperatures, and how would it affect the adjustment of units controlled by the pipe lines?

197. What must be done to compensate for temperature changes?

198. How is compensator defined by the Signal Section, A. R. A.?

199. What is a compensator generally used in a pipe line known as?

200. Of what does the compensator consist?

201. How will any movement or thrust on one crank affect the other crank?

202. What other type of compensator is sometimes used?

203. Why is the straight-arm compensator not very generally used?

Facing point lock.

204. How is facing point lock defined by the Signal Section, A. R. A.?

205. Where and why is the facing point lock generally used?

206. How many levers does the use of the facing point lock in mechanical interlockings for each switch, derail or movable point frog require?

207. How are the levers employed?

208. How is the locking of the switch accomplished?

209. What is the procedure to operate the switch to the reverse position?

210. How is the plunger of the lock rod brought into engagement with the reverse groove in the lock rod?

211. How many type plungers are in general use, and how are they designed?

212. When the circular plunger is used, how are holes in the lock rod provided, and how is the locking effected?

213. When the rectangular plunger is used, how are grooves in the lock rods cut, and how is the locking effected?

214. How is the lock rod designed, and how are grooves or holes arranged for locking the switch in the normal and reverse positions?

215. What part of the lock rod affords the means for adjusting for any variation in the throw of a switch?

216. How do the lock rod and plunger lock enter the lock casting with relation to each other?

217. How are irregularities in the travel of the plungers taken care of?

Bolt lock.

218. How is bolt lock defined by the Signal Section, A. R. A.?

219. How may the multiple unit bolt lock be assembled?

220. How is the bolt lock casting located when connected with a signal?

221. How is the lock rod connected?

222. How is the locking accomplished?

223. How does the principle of operation of the bolt lock compare with that of the facing point lock?

Switch Mechanism

224. How do the fittings for equipping a switch to be operated from an electro-mechanical machine conform with those in the description of the purely mechanical interlocking?

225. What does the electro-mechanical interlocking system usually employ rather than a directly-connected switch and facing point lock separately operated by two levers?

226. What is used in either case at the switch to provide a means for electric indication?

Switch-and-lock movement.

227. How is switch-and-lock movement defined by the Signal Section, A. R. A.?

228. For what use was the switch-and-lock movement designed?

229. How does the thrust from the pipe line compare with the movement of the switch operating rod?

230. How is the operating slide bar made?

231. How is the unlocking of switch and placing it in the operating position accomplished?

232. What action does the middle portion and the last portion of the stroke of slide bar have upon the switch?

233. How does the sequence of operation compare with the types of switch-and-lock movements?

234. How does the indication box compare with the type as used with certain power interlockings?

235. In what special cases are electric locks applied to switch-and-lock movements which operate facing point switches?

236. When is the magnet de-energized and what would be the result should the pipe line be pulled by dragging equipment?

237. If the indicating lock lever is on center, what is the result?

238. How are the switch points held in place if the pipe line should become disconnected?

Switch adjustment.

239. How is the wear of a mechanically-operated switch provided for?

240. How is the excess motion of the operating equipment taken care of?

241. What passes through the switch adjustment, and where is the adjustment attached?

242. What is the action of the operating rod through the switch adjustment?

243. What causes excessive motion to decrease?

244. What varies the pressure required to hold the nuts on operating rods against the head rod, and to what extent must the pressure be maintained?

245. How is the pressure usually determined?

246. How is the adjustment of the lock rod for locking the switch in the normal position accomplished?

247. How is the adjustment for locking the switch in the reverse position accomplished?

248. When is the adjustment complete?

Signal

249. What type mechanical signals are used in an interlocking plant, and how are they operated?

250. How is the signal connected and operated?

251. How many pipe lines are usually required to operate each working arm of a pipe-connected signal, and how many wires are usually required to operate each working arm of a wire-connected signal?

252. What is used in some instances that permits operating more than one arm from each pipe or wire line?

253. How are all appliances secured to the mast?

254. What size pipe is used for the up-and-down rod and how is it connected?

255. How are signals generally equipped to return them to the normal position in case the pipe or wire lines should fail?

256. For a signal mast equipped with more than one arm, how are cranks and up-and-down rods arranged?

Instructions

257. How must interlocking machines be maintained and tested?

258. What instructions and advice must be given to levermen when necessary?

259. What must be done at interlocking plants during snow and sleet storms?

260. What precaution must be used where snow melting oil or open flame devices are used?

261. What restrictions are there on the operation of levers or other operating appliances?

262. What must be determined by periodic inspection and tests?

263. What are the restrictions on locking changes or removal from machine?

264. What action must be taken if locking becomes disarranged or broken?

265. How must seals and padlocks, where provided, be maintained?

266. What precaution must be taken with circuits to avoid train delays?

267. What precautions must be taken in handling relays or other controlling devices that may endanger the safety of trains? How must train movements be protected?

268. What is required with reference to clearances?

269. How must foundations be maintained?

270. How often must paint be applied, and what must be done with rusty surfaces?

271. To what extent must pipe and other exposed parts be covered, and what apparatus must be kept free from paint?

272. What part of movable parts must be kept clean and lubricated?

273. To what extent must oil be used?

274. What must be done before applying lubricant, and is ordinary oil used in all cases?

275. What are the requirements in regard to the use of cotters?

276. What are the requirements in regard to gaskets for relay boxes and other housings?

277. When must movable parts be replaced?

278. In accordance with what instructions should signals be maintained and tested?

279. In accordance with what instructions should relays be inspected and tested?

280. In accordance with what instructions should electric locking be tested?

281. In accordance with what instructions should rectifiers be maintained and operated?

282. In accordance with what instructions should batteries be maintained?

283. What test must be made, in the adjustment of switch point, and how must locking edges be kept?

284. What test must be made in the adjustment of switch circuit controllers, and how must they be maintained?

285. How must fouling circuits be maintained?

286. How must wires be arranged?

287. How must wires be secured with reference to binding posts?

288. To what extent must insulated wires be protected, and what is prohibited when making tests?

289. In accordance with what specification must wire joints be made, and where must joints not be made?

290. What are the requirements in regard to maintaining lightning arresters, and what is their maximum resistance to ground?

291. How must bootlegs and conduits be maintained?

292. What are the requirements in regard to the renewal of fibre insulations?

293. What must be done before removing rails, switch points or frogs?

294. When signals have been secured in their most restrictive indication, what must be done before restoring them to regular operation?

295. What must maintainers know, that section foremen understand, before changing out rail where they are bonded for electrical circuit?

296. When may repairs be made by track forces, and what action must be taken by them after making such repairs?

297. When a signal, switch, movable point frog, derail, lock, detector bar or locking circuit is disconnected, what action must be taken by maintainer?

298. How must line wire be supported and maintained, and what attention must be given insulators?

299. What attention must be given pole lines carrying signal wires?

300. To what extent must signal wires or cable clear the top of rails?

301. How must top of rail be kept to insure proper shunting of track circuit?

302. How must cranks, compensators, etc., be maintained?

303. In what condition must pipe lines, pipe carrier tops, rollers and bases be kept?

304. How must holes or notches in lock rods be maintained?

305. What stroke must plunger of facing point lock have, and when its lever is in the normal position how much must the end of plunger clear the lock rod, and in what condition must end of plunger be kept?

306. How must bolt locks be adjusted and maintained?

307. To what extent must driving bar of switch-and-lock movement travel?

308. When circuit controller is mounted on switch-and-lock movement how must it be adjusted?

309. What are the requirements with regard to maintaining detector bar?

310. How must gage of track be kept and what must be done when rails are battered?

311. When necessary to disconnect a switch, derail or any other unit where should it be done?

312. How must switch movements be maintained and lubricated?