American Railway Signaling Principles and Practices

CHAPTER XVII

Mechanical and Electro-Mechanical Interlocking

Published by the Signal Section, A. A. R.
30 Vesey Street, New York 7, N. Y.

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MECHANICAL AND ELECTRO-MECHANICAL INTERLOCKING

General.

The first interlocking 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 locking, 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 lines
Switch mechanism
Signal.

Interlocking Station

The Standard Code of the Association of American Railroads defines Interlocking Station as: A place from which an interlocking 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, 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.

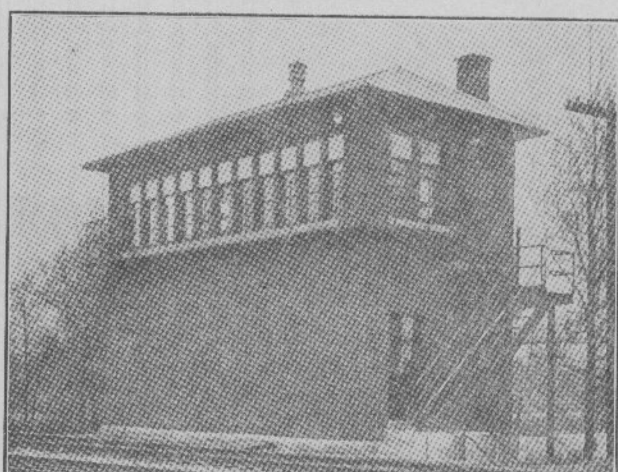


Fig. 3.
Brick Interlocking Station.

Machine

Signal Section, Association of American Railroads, 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.A.R., defines Mechanical Interlocking Machine as: An assemblage of manually operated levers for the control of mechanically operated signals, switches or other units.

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.

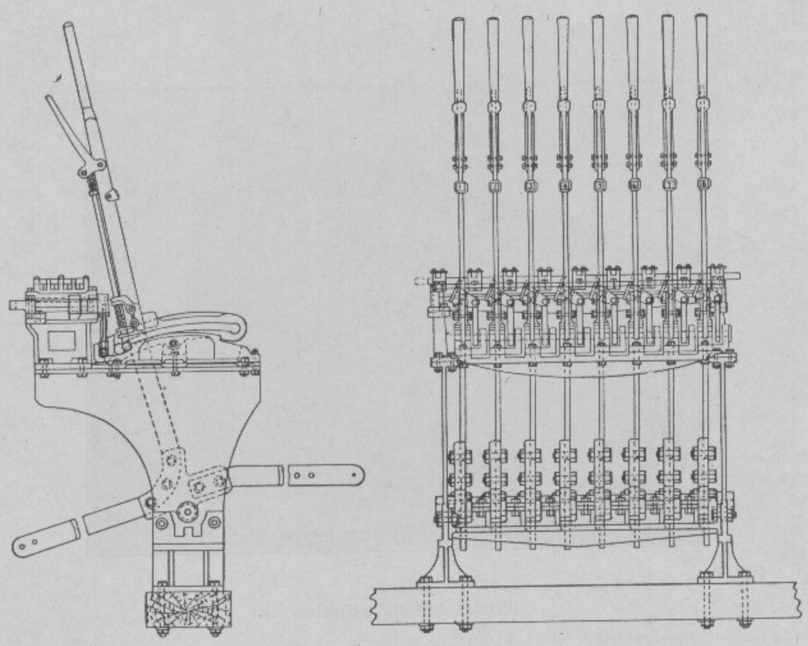


Fig. 4.
Improved Saxby & Farmer Mechanical Machine.

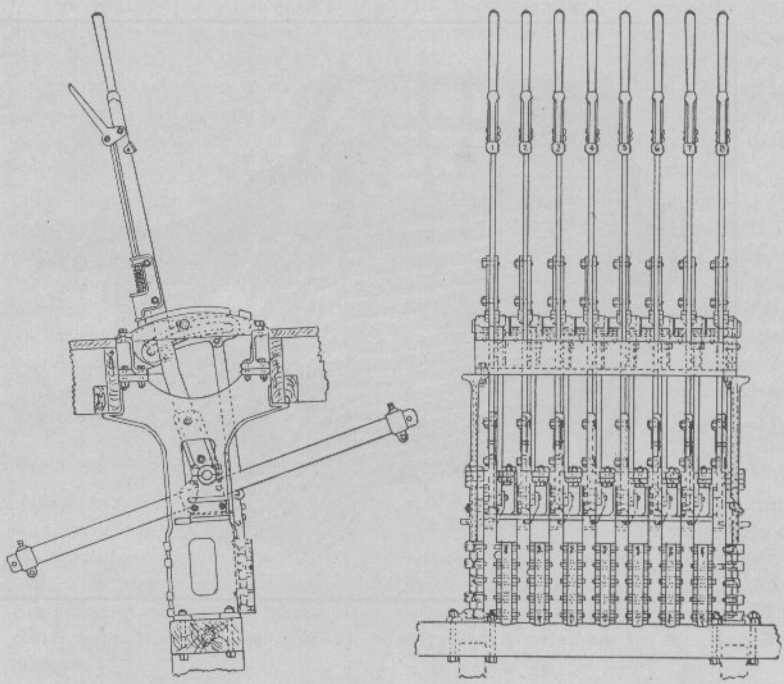


Fig. 5.
Style "A" Mechanical Machine.

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.A.R., defines Electro-Mechanical Interlocking Machine as: An assemblage of manually operated levers for the control of both power and mechanically operated signals, switches or other units.

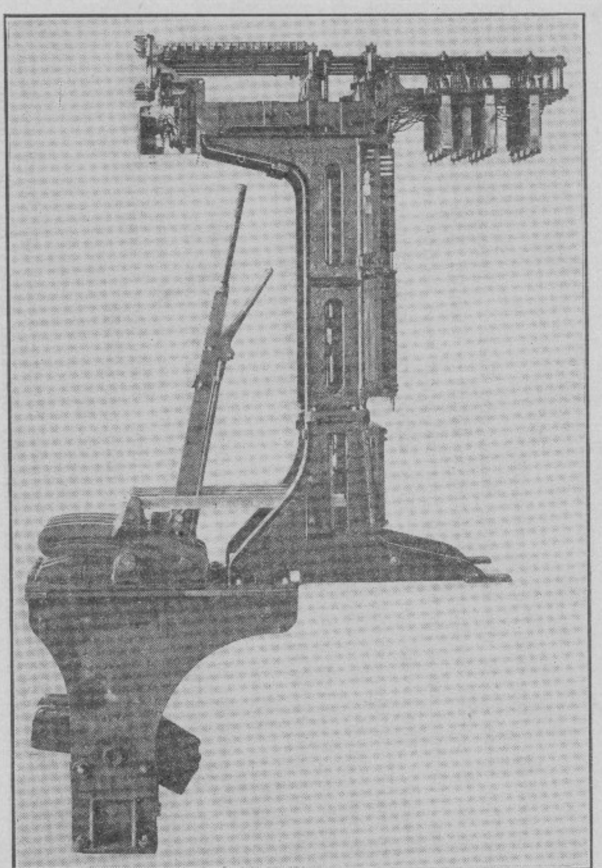


Fig. 6.
Electro-Mechanical Machine, Style P-5.

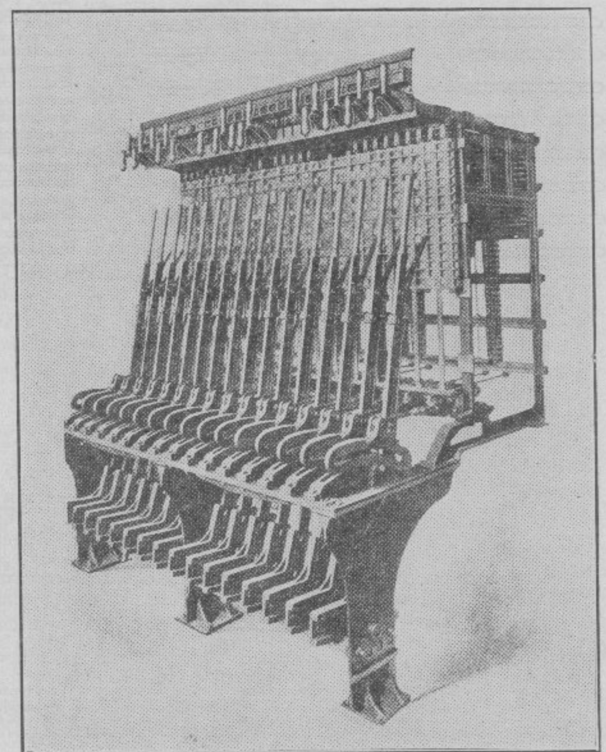


Fig. 7.
Model 2B Electro-Mechanical Machine.

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 system 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 interlockings having mechanically operated switches, and to provide for the thorough equipment of these interlockings 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 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 "restricting" signals, extra lock magnets, automatic time releases, etc., the original principles are retained in the present 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 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.

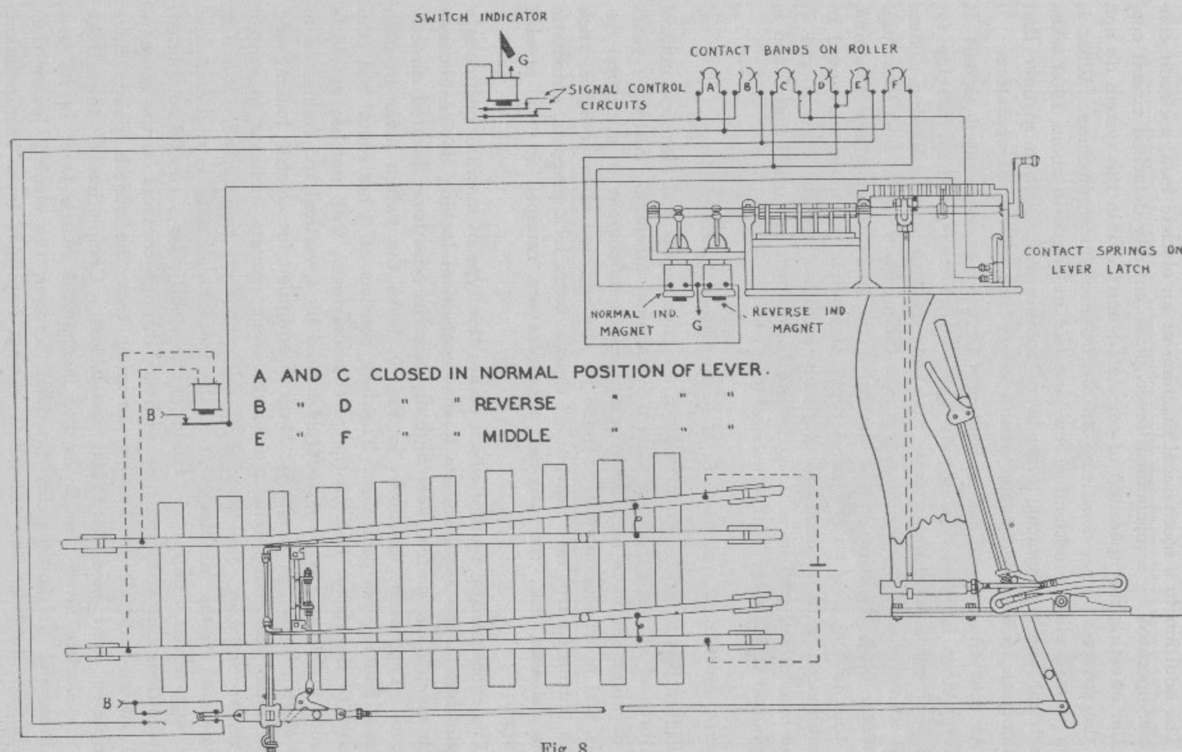


Fig. 8.
Control Features of an Early Type Electro-Mechanical Machine.

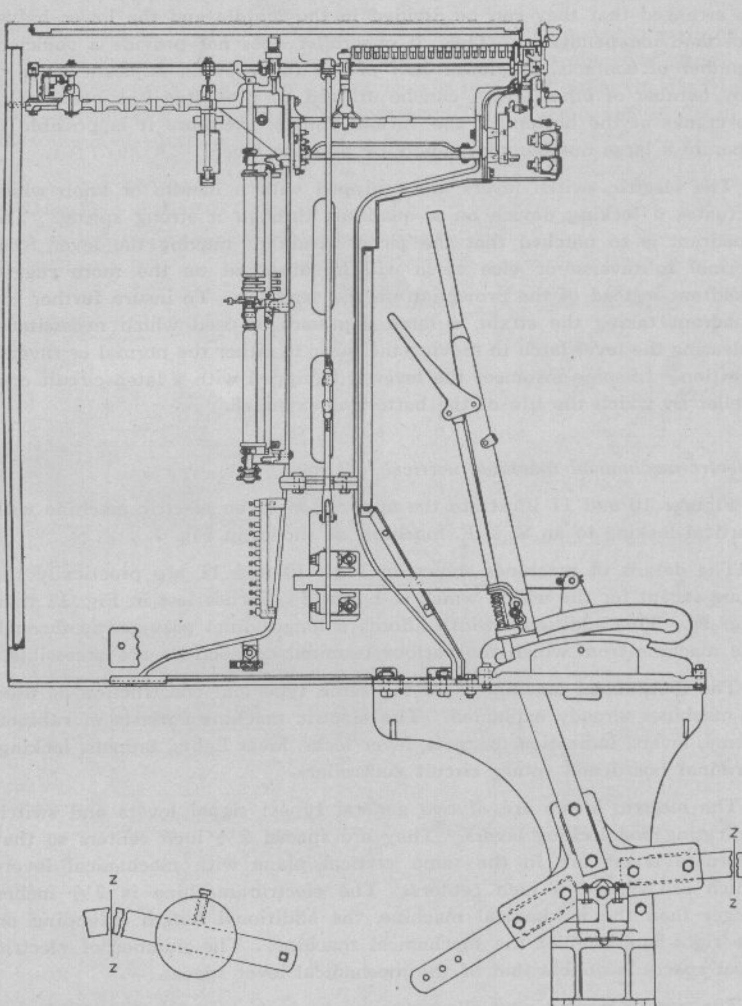


Fig. 9.
P-5 Electro-Mechanical Machine.

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 so notched 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 mechanical 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.

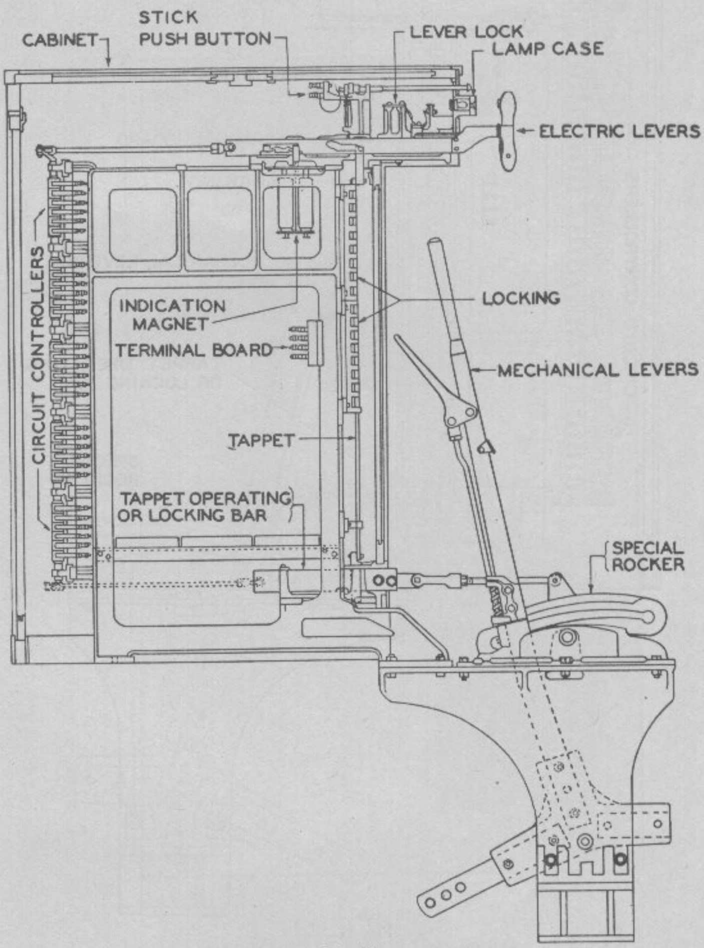


Fig. 10.
Model 2B Electro-Mechanical Machine.

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.

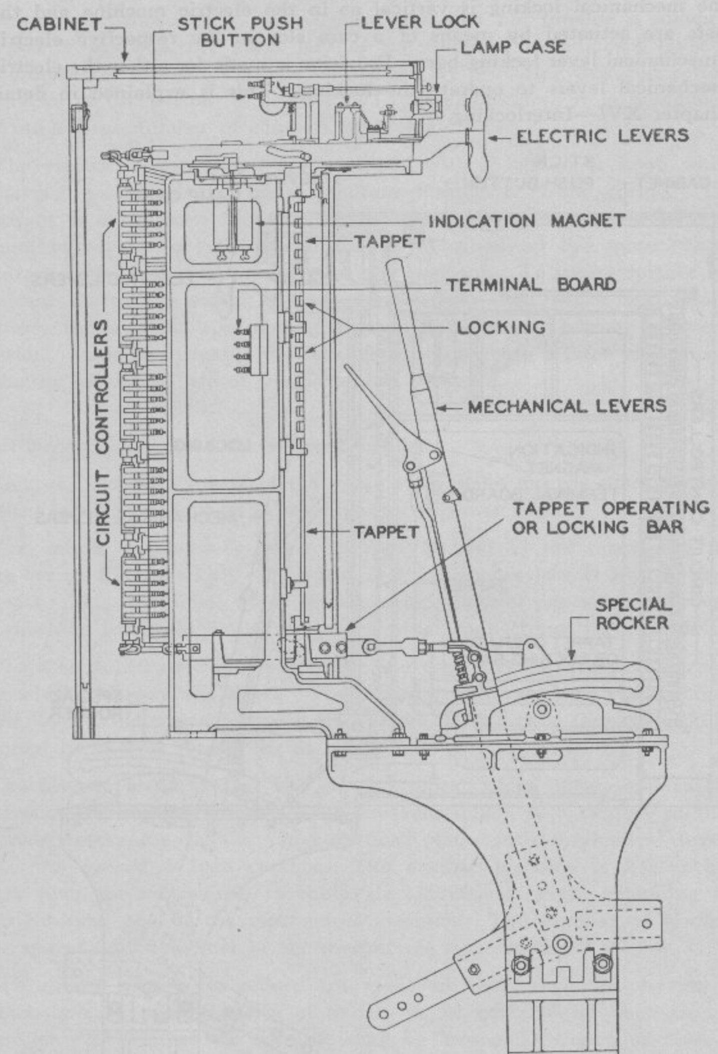


Fig. 11.
Model 2C Electro-Mechanical Machine.

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.

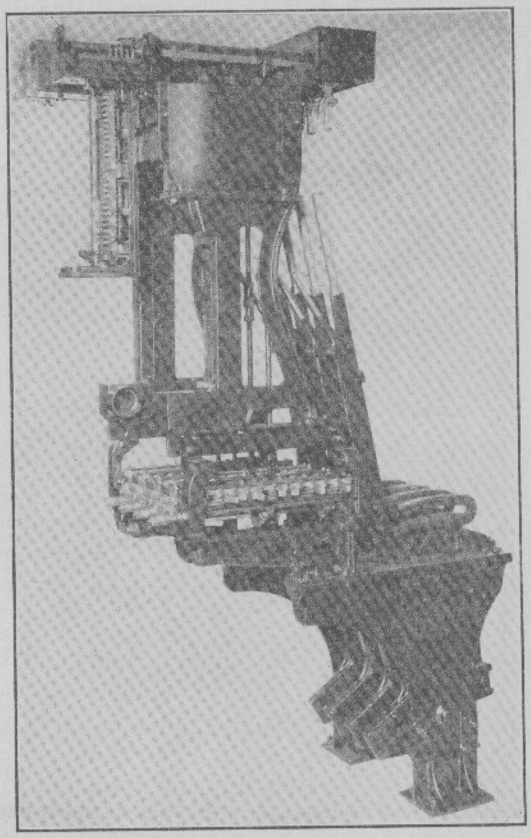


Fig. 12.
Unit Electric Levers.

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

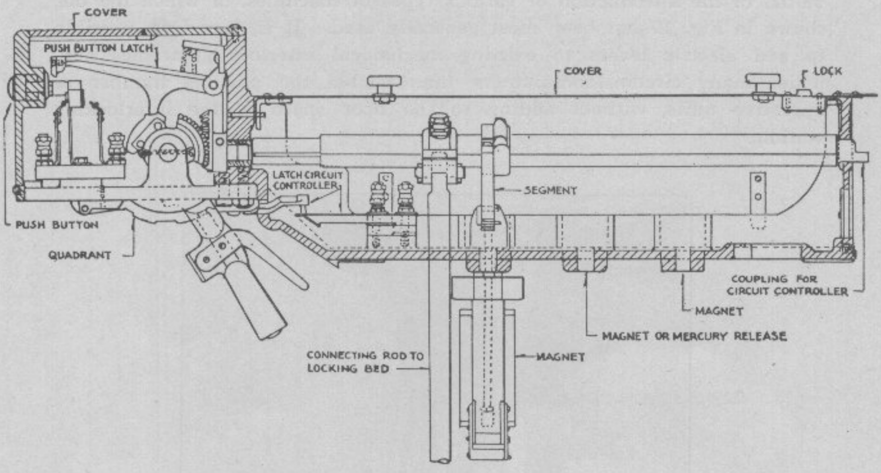


Fig. 13.
Master Unit,

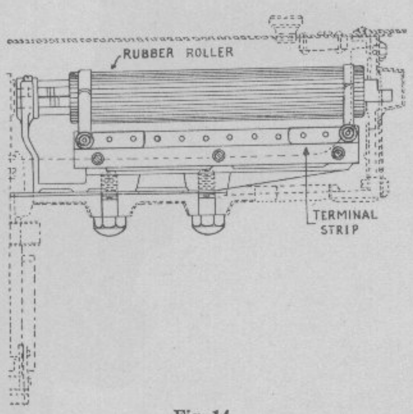


Fig. 14.
Horizontal Circuit Controller Mounted Inside the Master Unit.

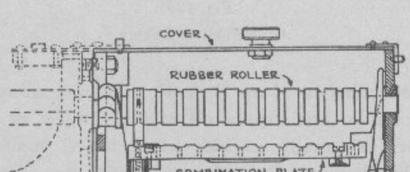


Fig. 15.
Horizontal Circuit Controller Bolted to the End of Master Unit.

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.

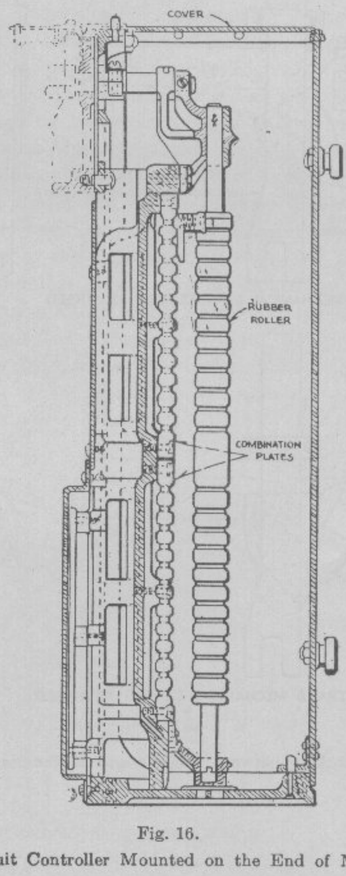


Fig. 16.
Vertical Circuit Controller Mounted on the End of Master Unit.

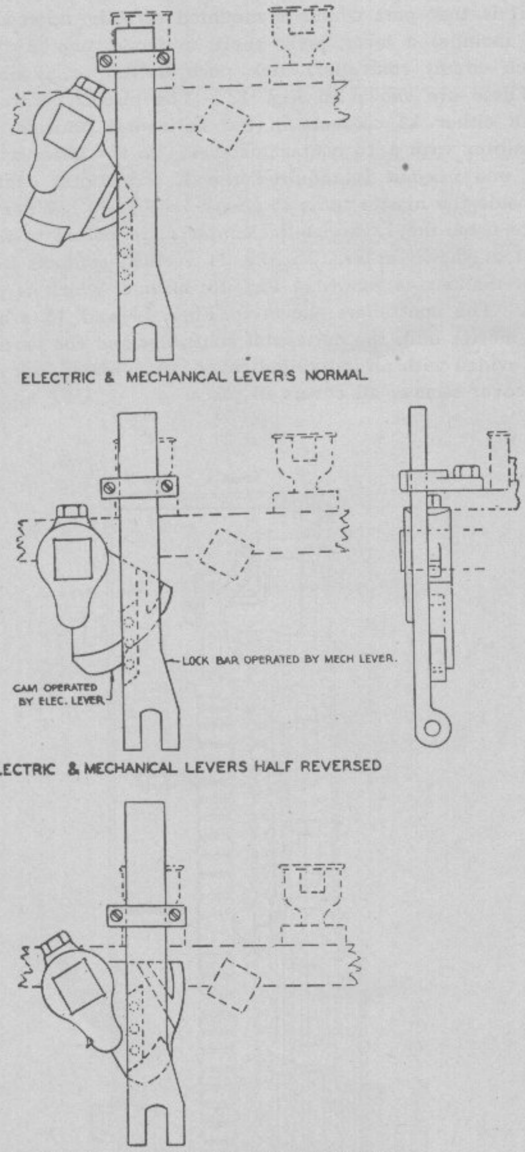


Fig. 17.

Cam Locking between Electric and Mechanical Lever.

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 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.

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.

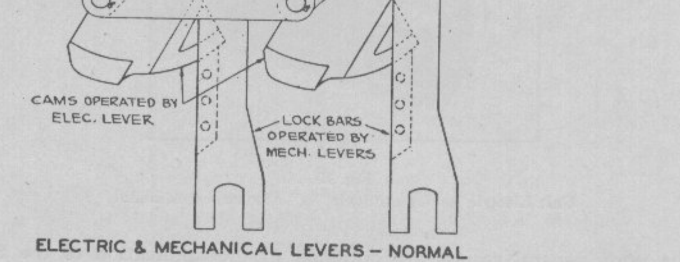


Fig. 18.
Double Cam Application for Locking Two or More Mechanical Levers by One Electric Lever.

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, 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.

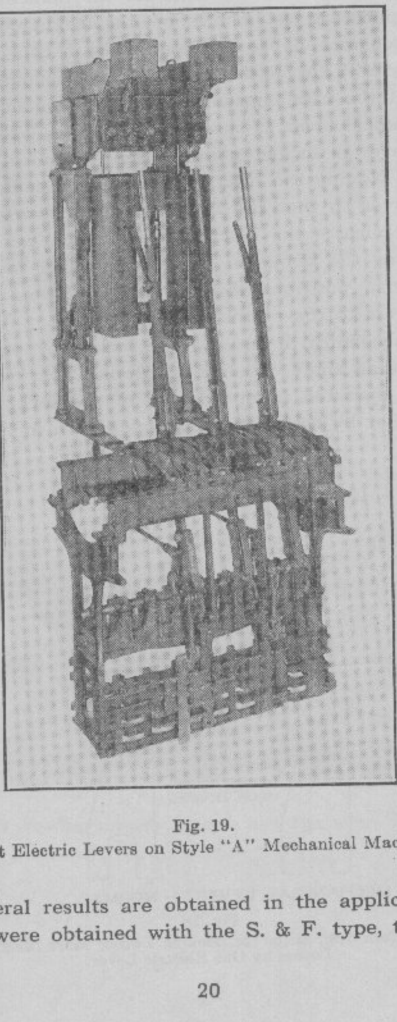


Fig. 19.
Unit Electric Levers on Style "A" Mechanical Machine.

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, 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.A.R., 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.

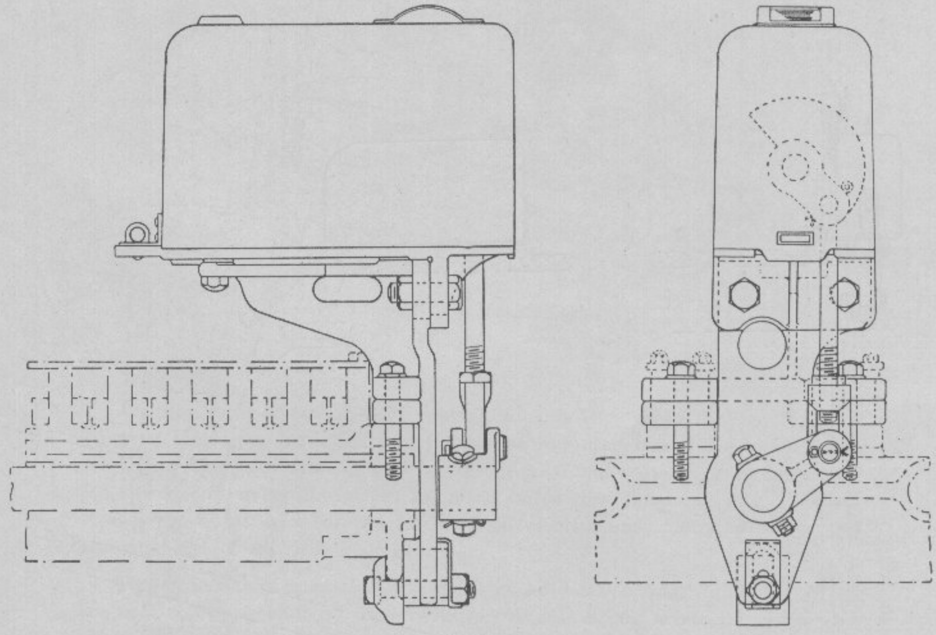


Fig. 20.
Electric Lock on Mechanical Locking Shaft, S. & F. Machine.

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 mechanical locking 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 mechanical locking 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.

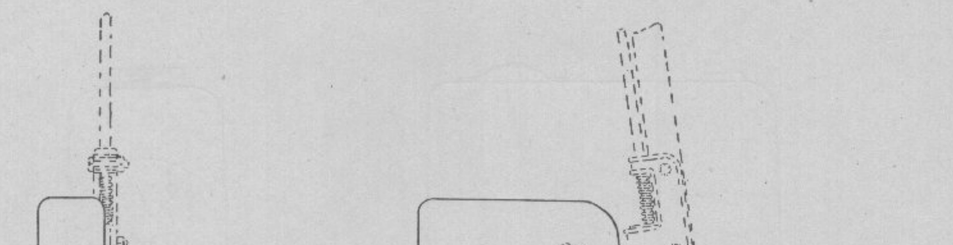


Fig. 21.
Electric Lock on Rocker Link, Style "A" Lever.

Forced drop electric lock.

The forced drop feature, as applied to the electric lock, insures that the locking device is actuated to the locked position of the lever during each movement of the lever. 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.

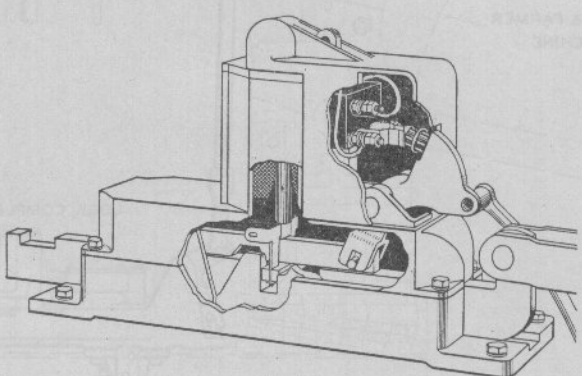


Fig. 22.
Forced Drop Electric Lock.

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

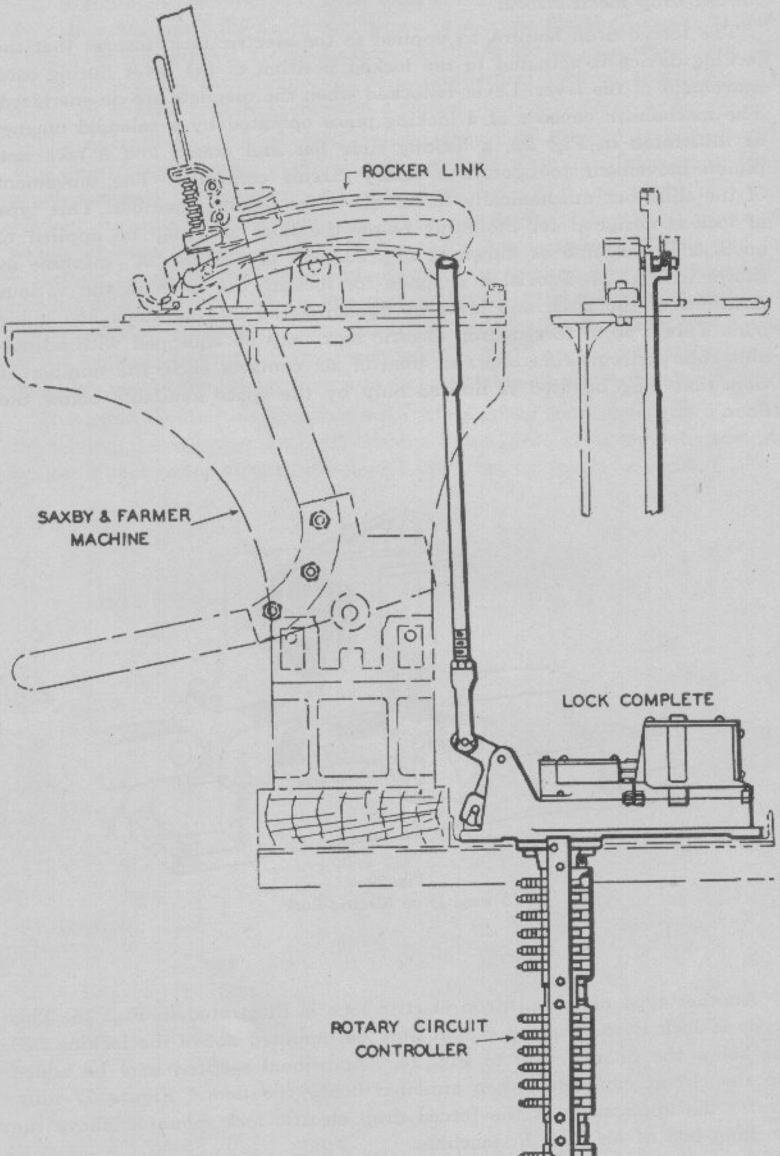


Fig. 23.
Forced Drop Electric Lock on S. & F. Machine.

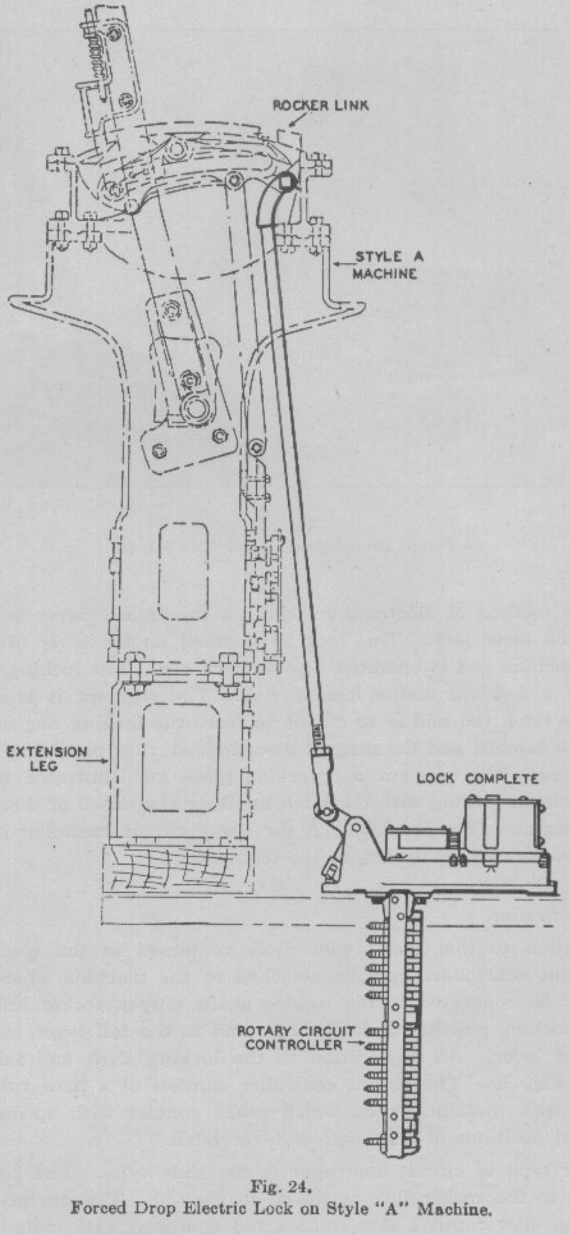


Fig. 24.
Forced Drop Electric Lock on Style "A" Machine.

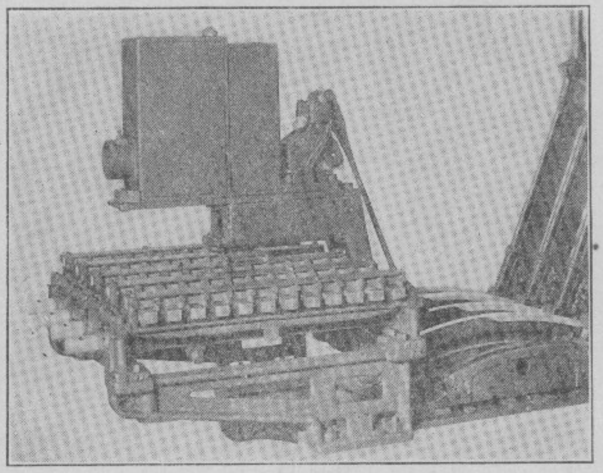


Fig. 25.
Forced Drop Electric Lock. Style ML-10.

Another 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.

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.

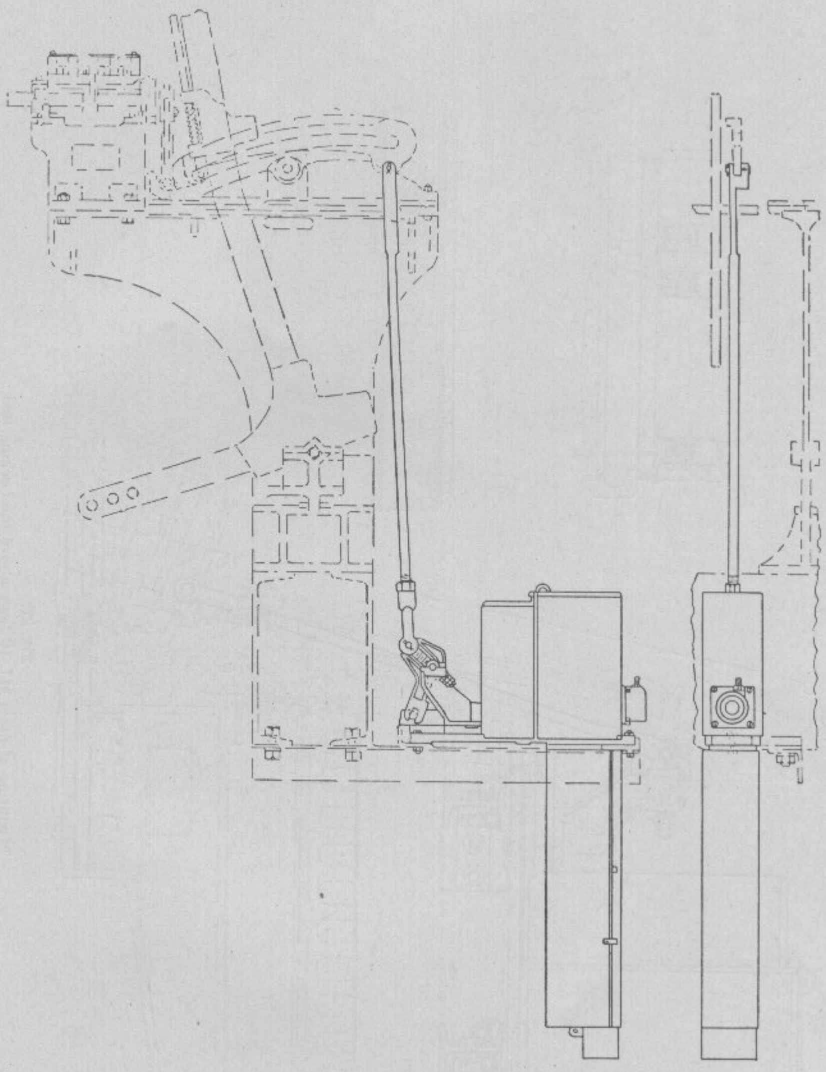


Fig. 26.
Mounting of Style ML-10 Lock below Floor.

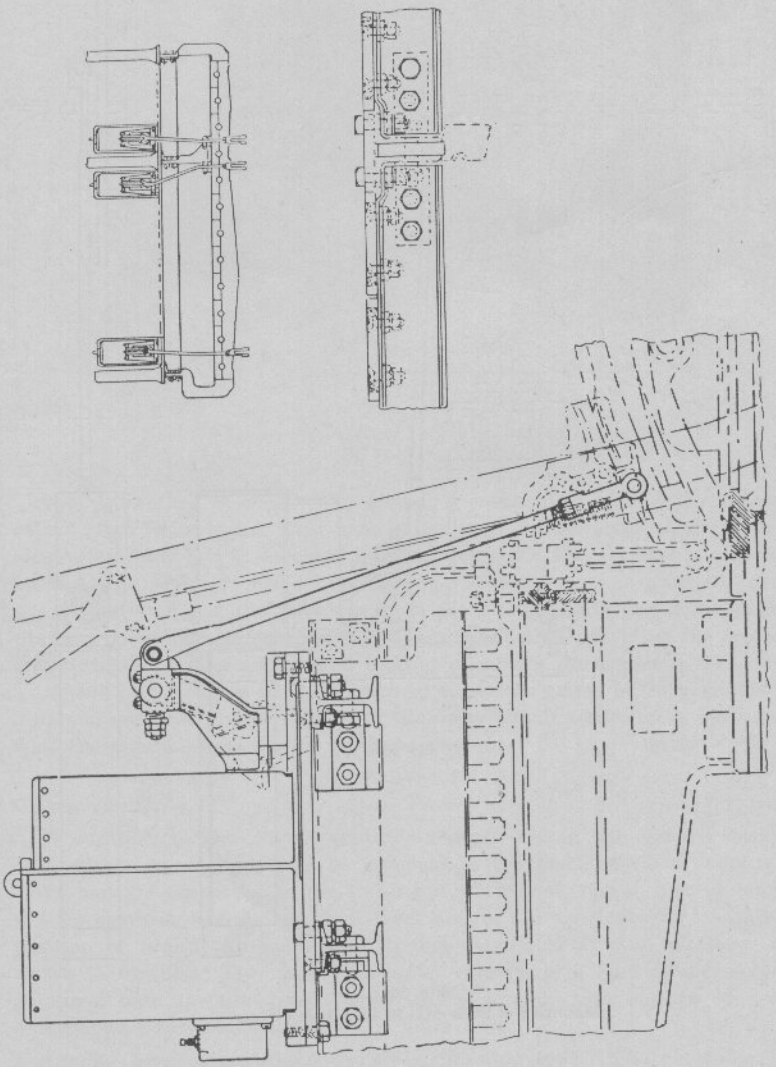


Fig. 27.
Mounting of Style ML-10 Lock above the Locking Bed.

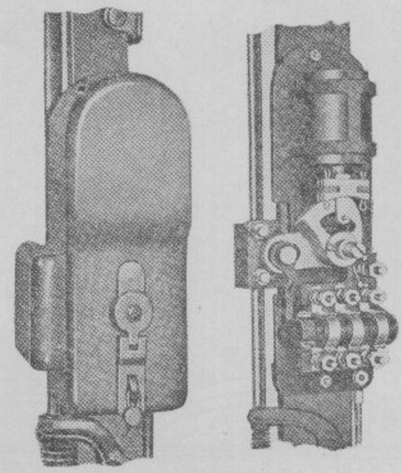


Fig. 28.
Latch Lever Lock.

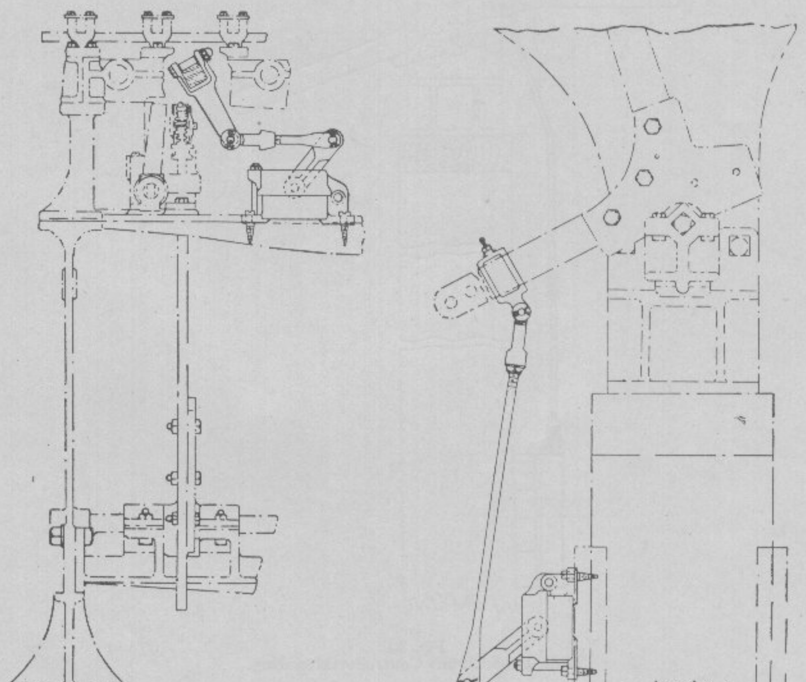


Fig. 29.
Circuit Controllers.

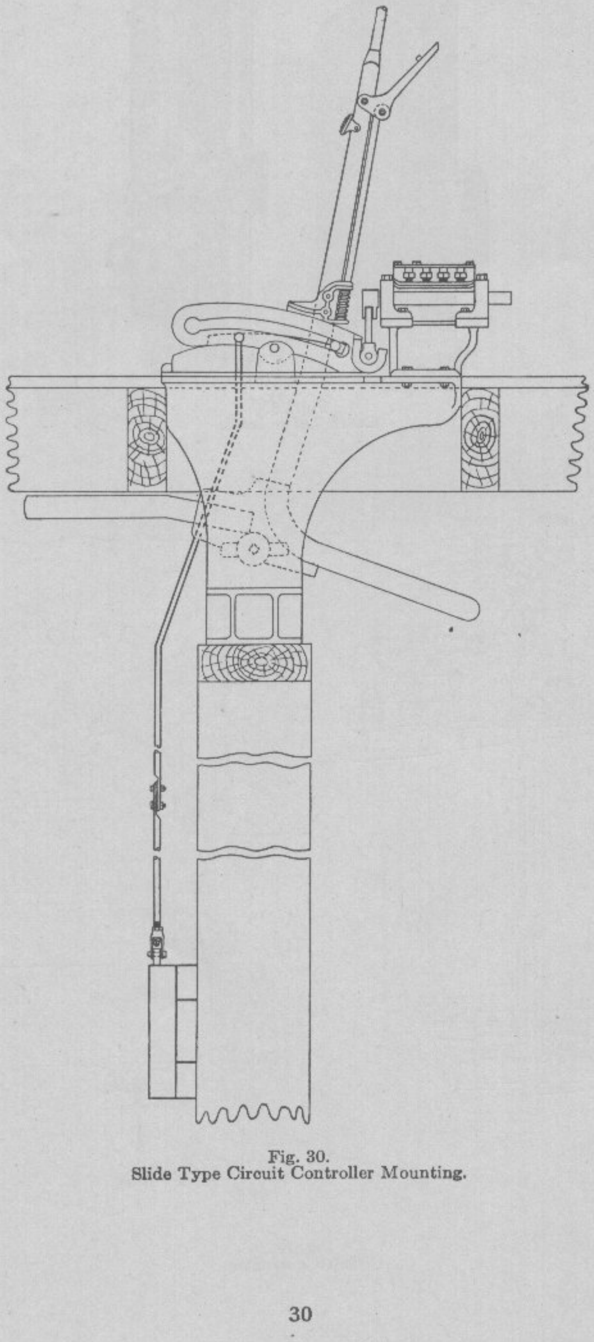


Fig. 30.
Slide Type Circuit Controller Mounting.

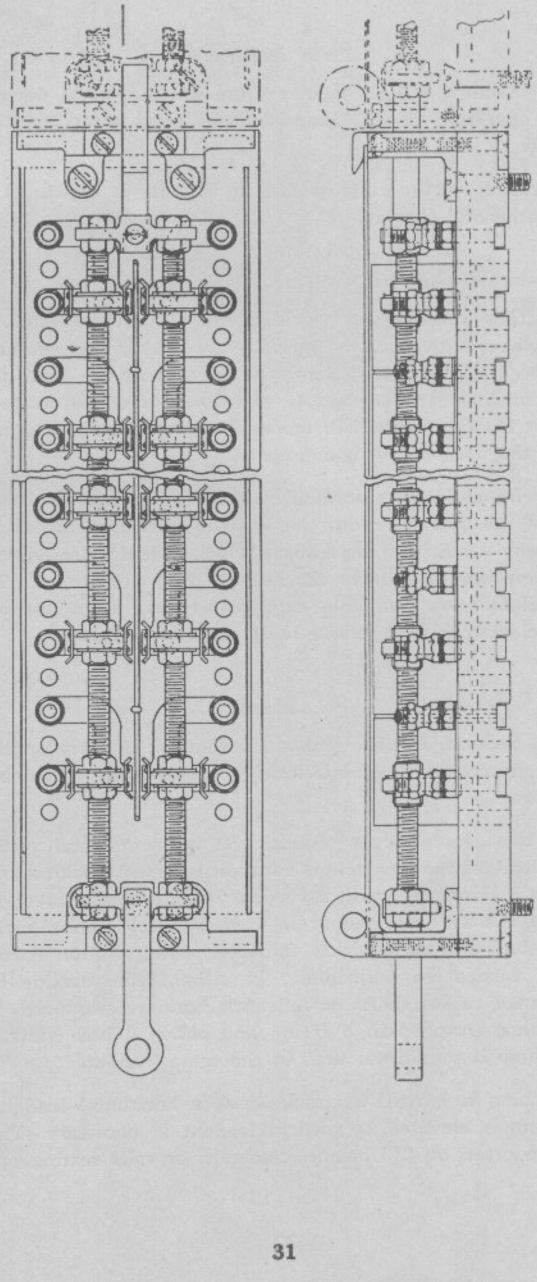


Fig. 31.
Slide Type Circuit Controller.

Indicator.

Indicators of the light type or of the relay type equipped with disc or semaphore arm operated by the armature of the relay are commonly used to reflect movement of trains in the approach to and through the interlocking and to repeat indications displayed by home and approach signals.

Time Release

The Signal Section, A.A.R., 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 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 imposed time delay can be varied by adjustment. The clockwork time release now available may be adjusted to a maximum of 8 minutes. A clockwork time release is illustrated in Fig. 32.

Leadout

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

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 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. The leadout is usually supported on "I" beams, channels, or rails resting on concrete foundations.

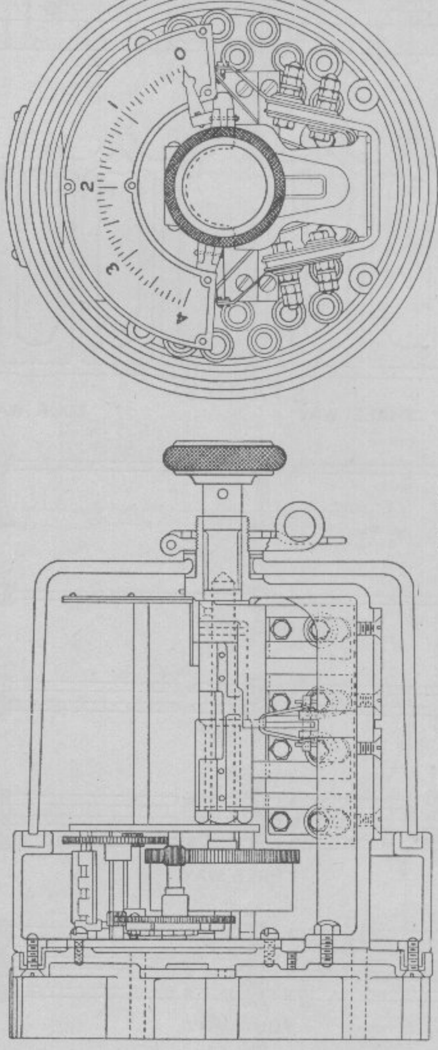


Fig. 32.
Clockwork Time Release.

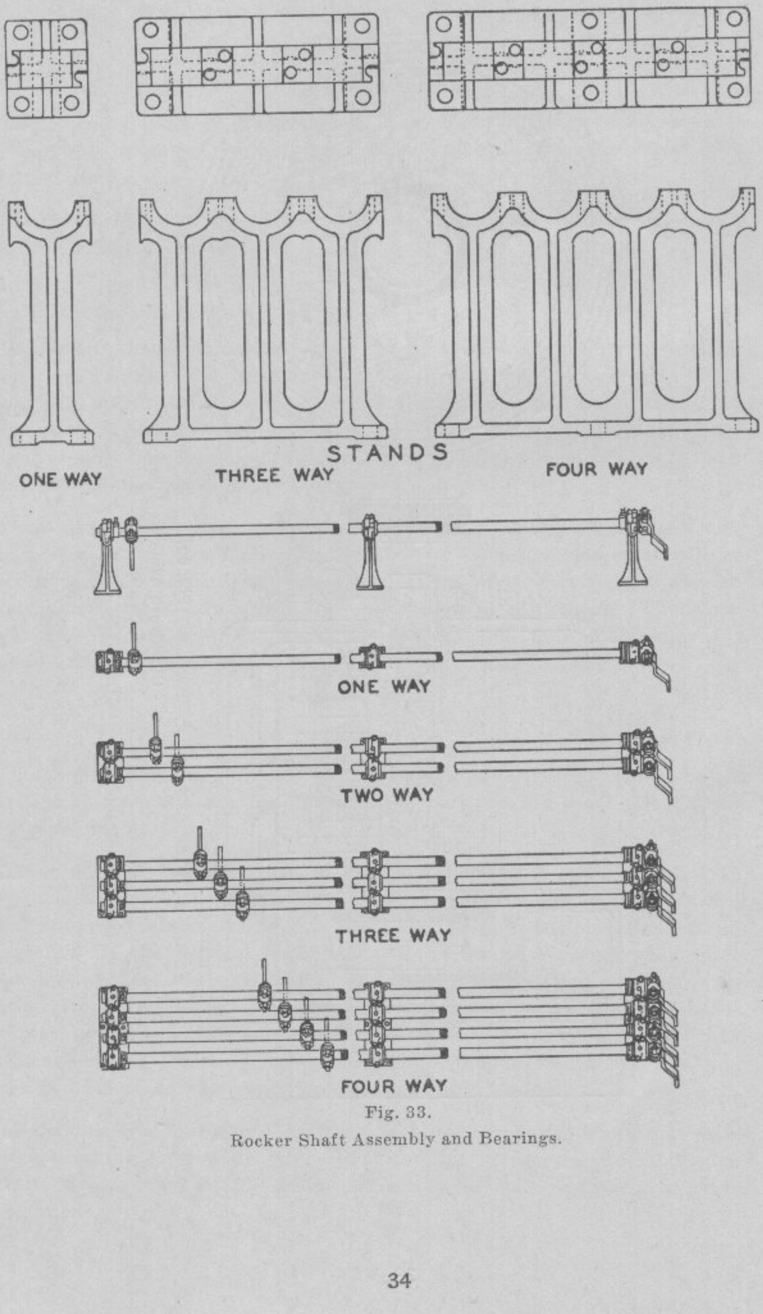


Fig. 33.

Rocker Shaft Assembly and Bearings.

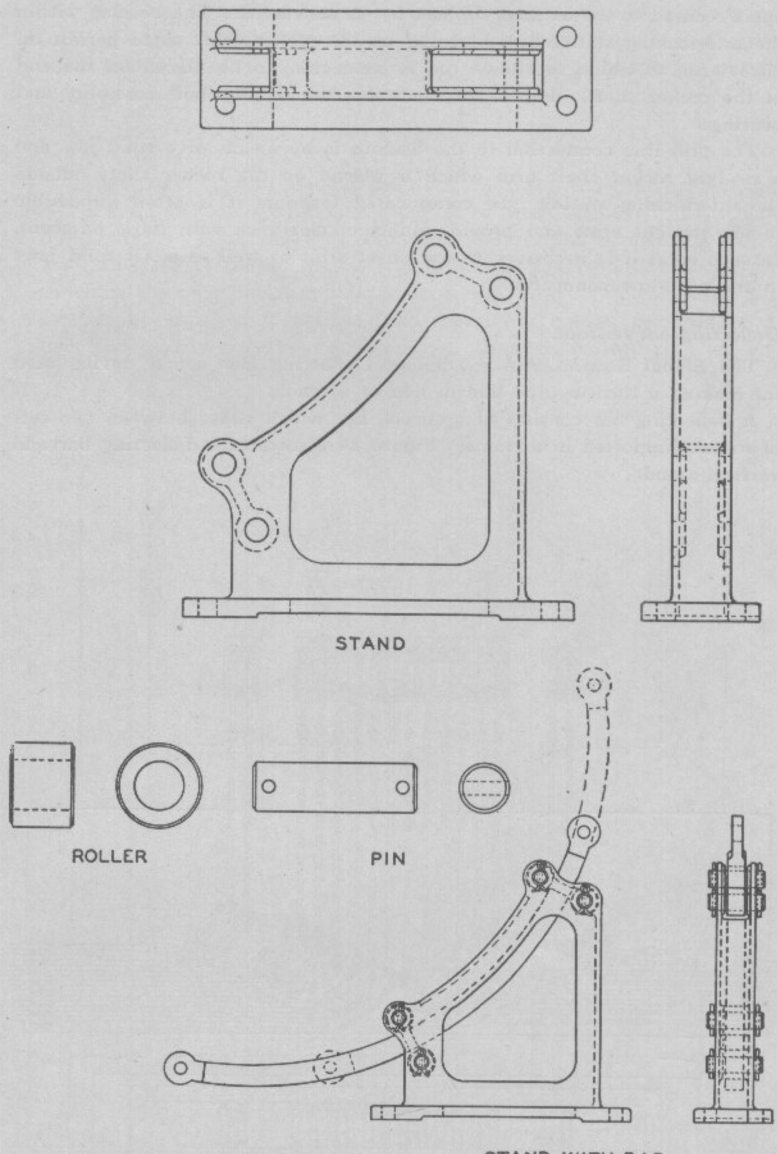


Fig. 34.
Deflecting Bar and Vertical Stand.

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 33 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.A.R., 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 34 illustrates a deflecting bar and vertical stand.

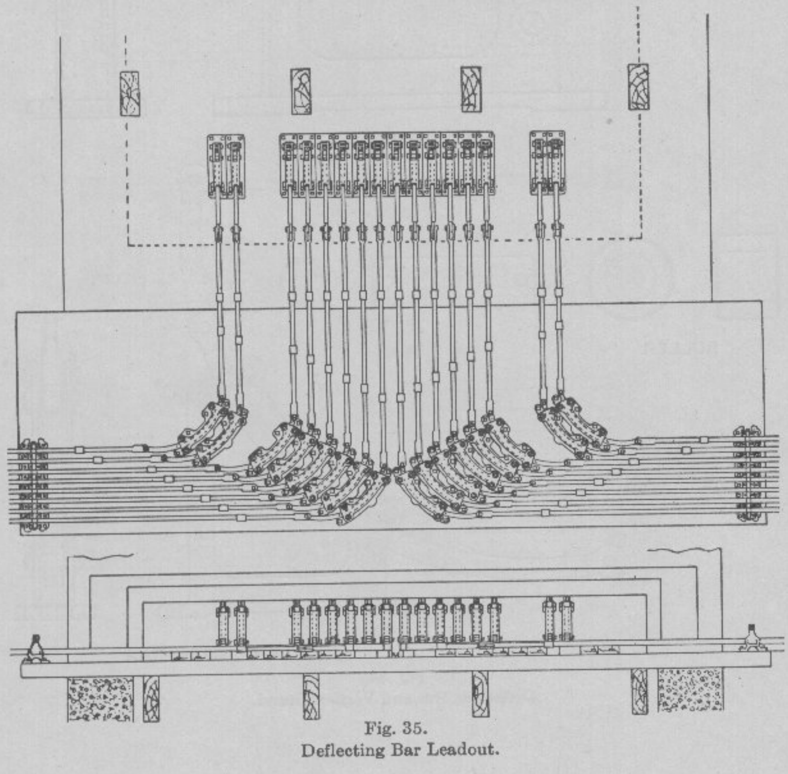


Fig. 35.
Deflecting Bar Leadout.

In a deflecting bar type of leadout the down rods are connected to vertical deflecting bars as illustrated in Fig. 35. 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 36 illustrates the layout of the crank type of leadout employing the box crank.

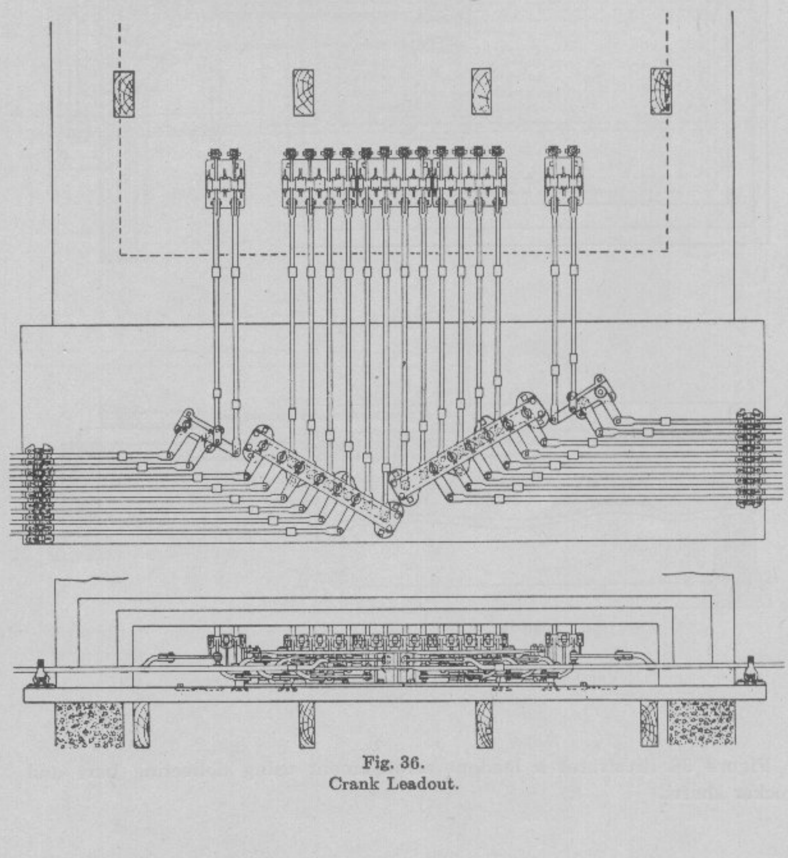


Fig. 36.
Crank Leadout.

Figure 37 illustrates an arrangement of cranks and deflecting bars employing vertical cranks within and horizontal deflecting bars outside of the interlocking station.

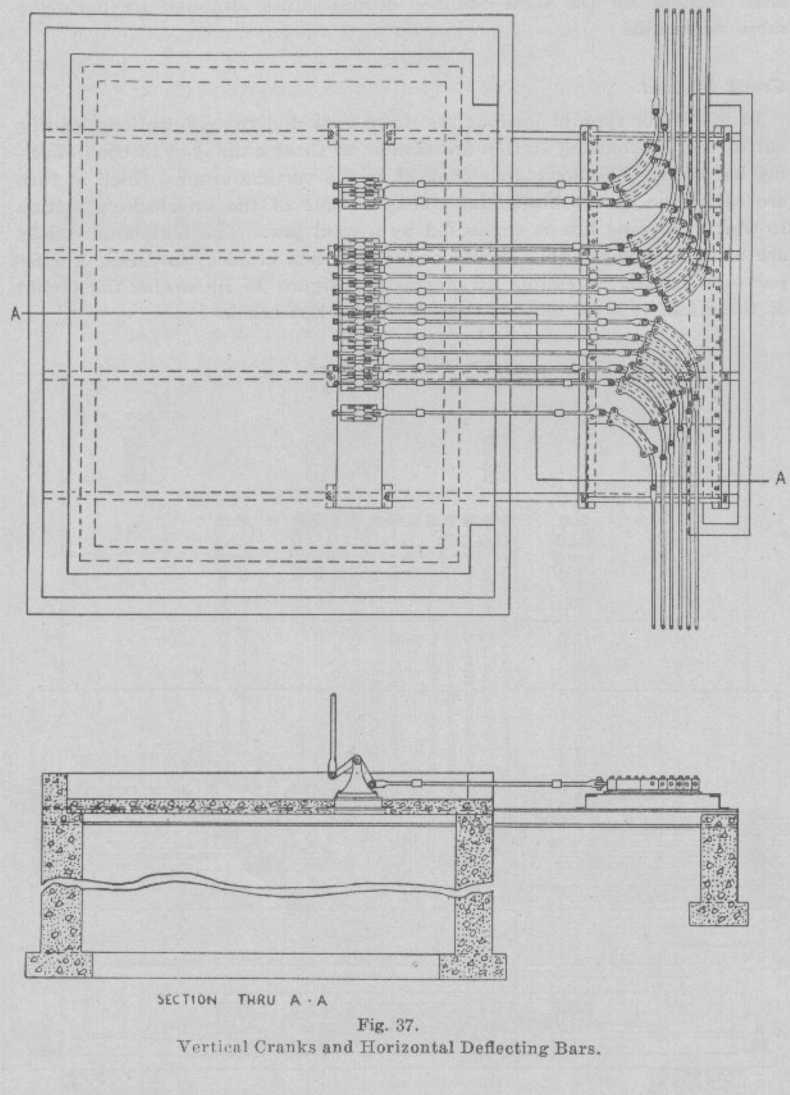


Fig. 37.
Vertical Cranks and Horizontal Deflecting Bars.

Figure 38 illustrates a leadout arrangement using deflecting bars and rocker shafts.

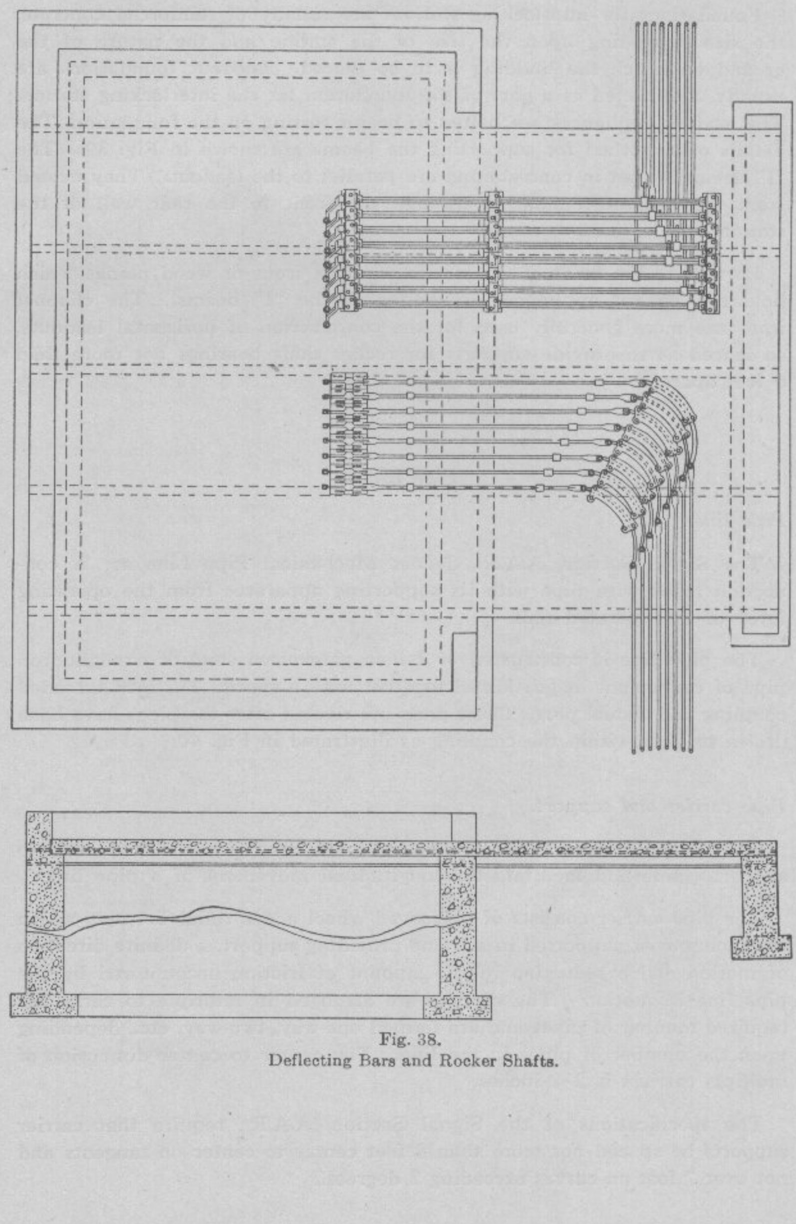


Fig. 38.
Deflecting Bars and Rocker Shafts.

Foundation

Interlocking station and leadout.

The Signal Section, A.A.R., 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. 39. 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, so spaced as to provide supports for rocker shaft bearings not more than 6 feet apart.

Pipe Lines

Pipe line.

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

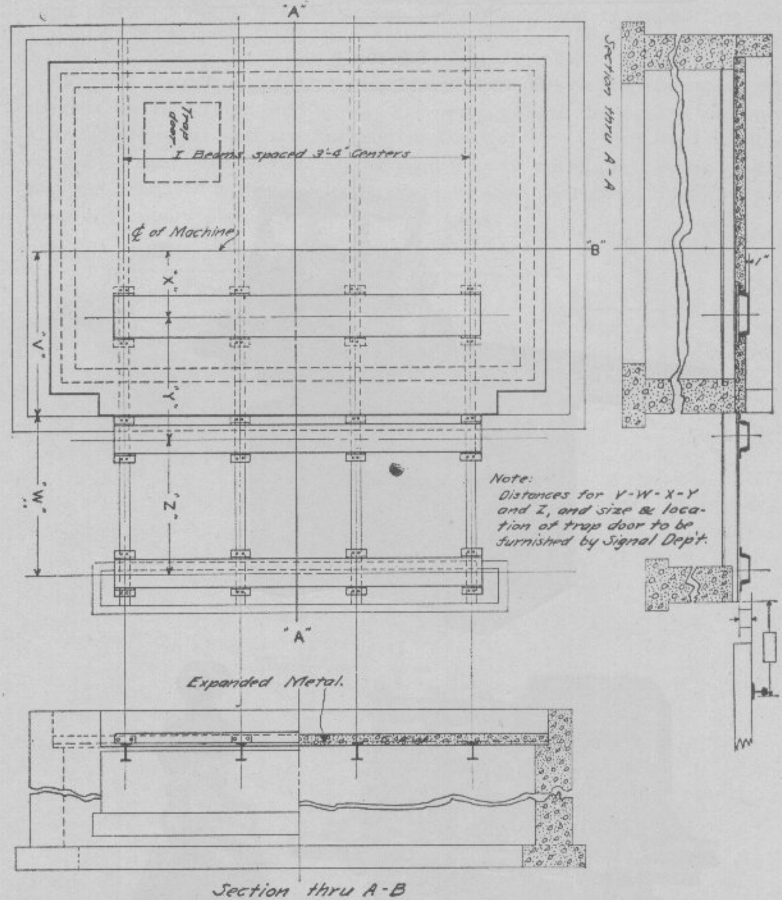
The pipe line is constructed of 1 inch galvanized steel or wrought iron pipe of convenient length joined together with a special 2¼ inch threaded coupling and a steel plug. These parts are riveted after the pipes have been drawn to abut within the coupling as illustrated in Fig. 40.

Pipe carrier and support.

The Signal Section, A.A.R., 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.A.R., require that carrier supports be spaced not more than 8 feet center to center on tangents and not over 7 feet on curves exceeding 2 degrees.



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

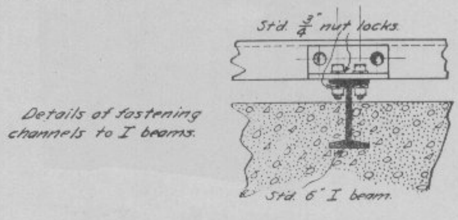


Fig. 39.
Leadout Foundations for Rocker Shafts.

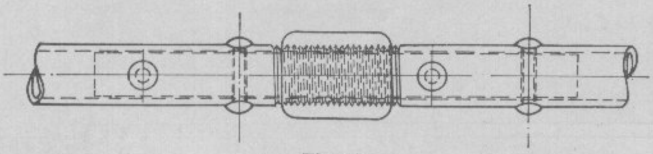


Fig. 40.
One-Inch Signal Pipe and Coupling.

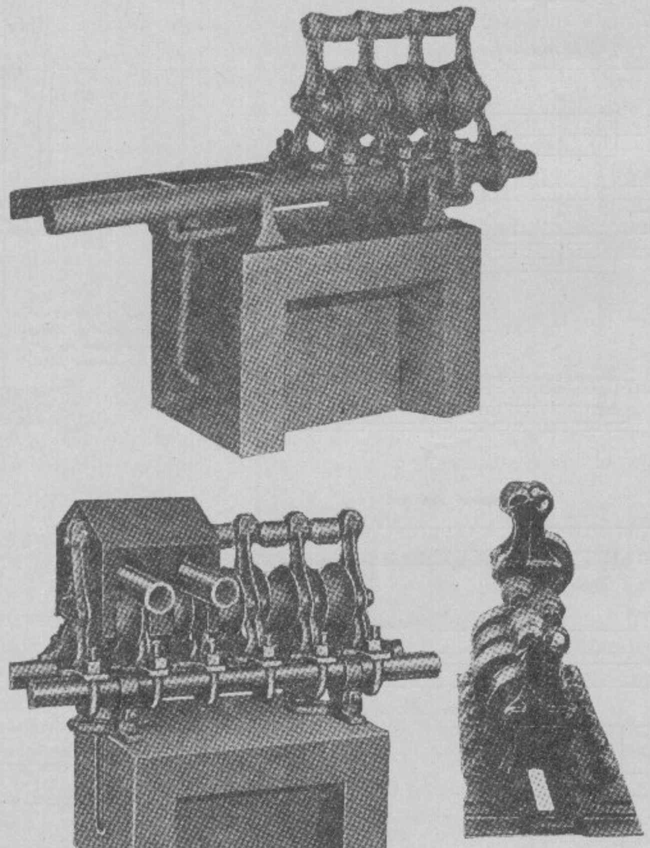
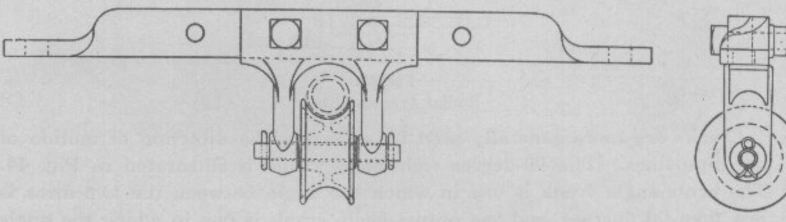


Fig. 41.
Pipe Carrier Supports.

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 41 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. 42, 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.



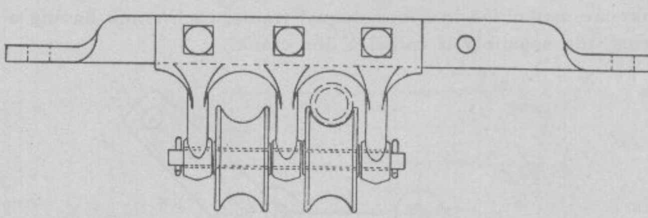


Fig. 42.
Transverse Pipe Carriers.

Crank.

The Signal Section, A.A.R., 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.

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

Deg.	Radial arms and cranks
0 to 30	15 deg. radial arm cranks
30 to 75	60 deg. acute-angle cranks
75 to 105	90 deg. right-angle cranks
105 to 140	120 deg. obtuse-angle cranks
140 to 180	180 deg. equalizing arms

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. 43. 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.

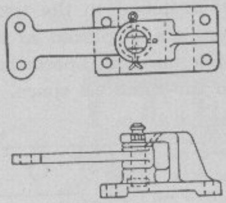


Fig. 43.
Radial Arm and Stand.

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. 44. 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.

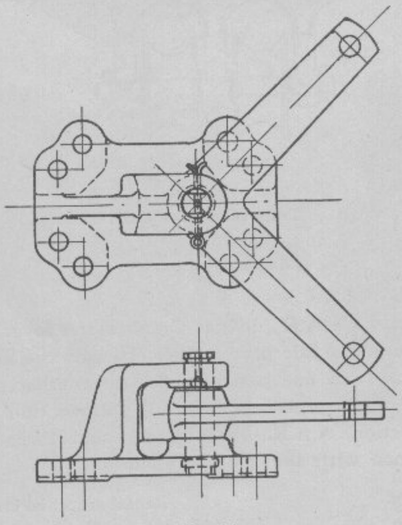


Fig. 44.
Right-Angle Crank and Stand.

Deflecting bars are also used to some extent for changing the direction of a pipe line. The specifications of the Signal Section, A.A.R., 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.A.R., 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. 45 and the screw jaw in Fig. 46. 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 47 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.

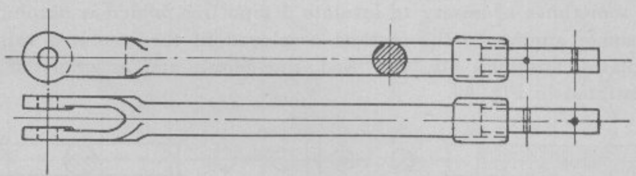


Fig. 45.
Solid Jaw.

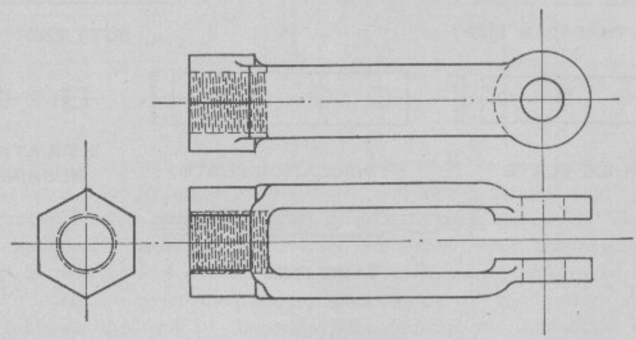


Fig. 46.
Screw Jaw.

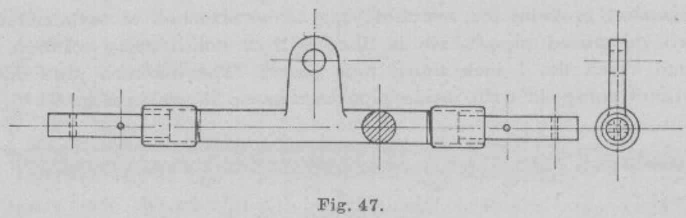


Fig. 47.
Lug.

Pipe adjusting screw.

As a means of providing adjustment in the pipe line, use has been made of an adjusting screw as illustrated in Fig. 48.

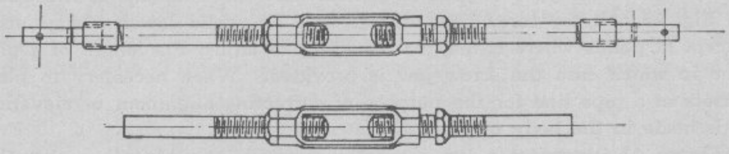


Fig. 48.
Pipe Adjusting Screw.

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. 49.

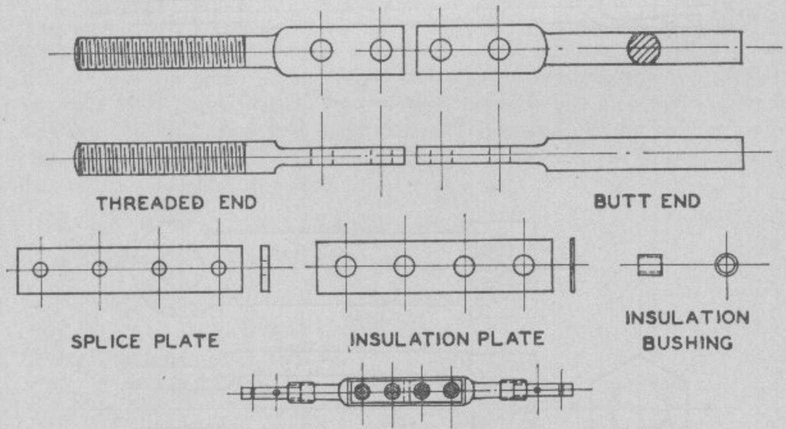


Fig. 49.
Pipe-Line Insulation.

Stuffing box.

When necessary to construct pipe lines under tracks or other obstructions, it is customary to use stuffing boxes as illustrated in Fig. 50. 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 one-inch pipe line is sometimes equipped with inside pipe carriers as shown in Fig. 50.

Fig. 50.
Stuffing Box with Inside Pipe Carrier.

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. 51.

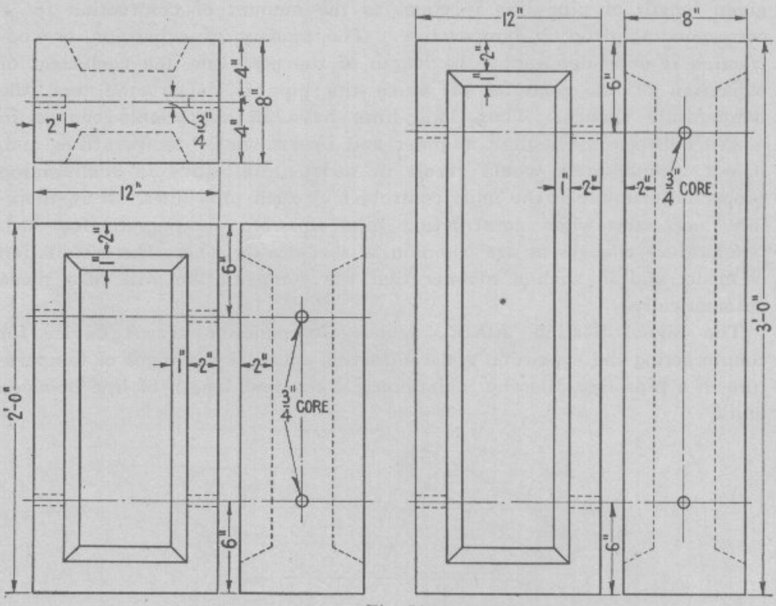


Fig. 51.
Pipe Carrier Foundations.

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 so set 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 so placed 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.

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

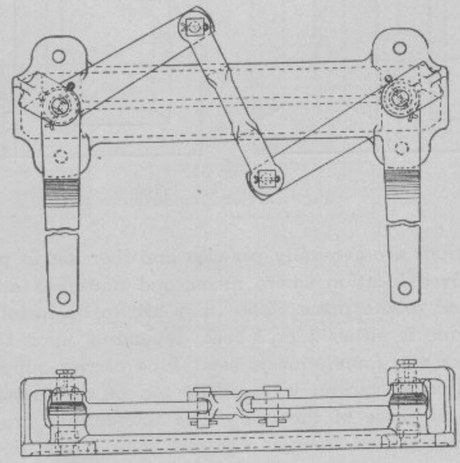


Fig. 52.
One-Way Horizontal Pipe Compensator.

Figure 52 illustrates a one-way horizontal pipe compensator which is generally used in a pipe line. 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 53 and 54 illustrate charts approved by the Signal Section, A.A.R., for finding compensator centers and the setting of cranks toward or away from the fixed point.

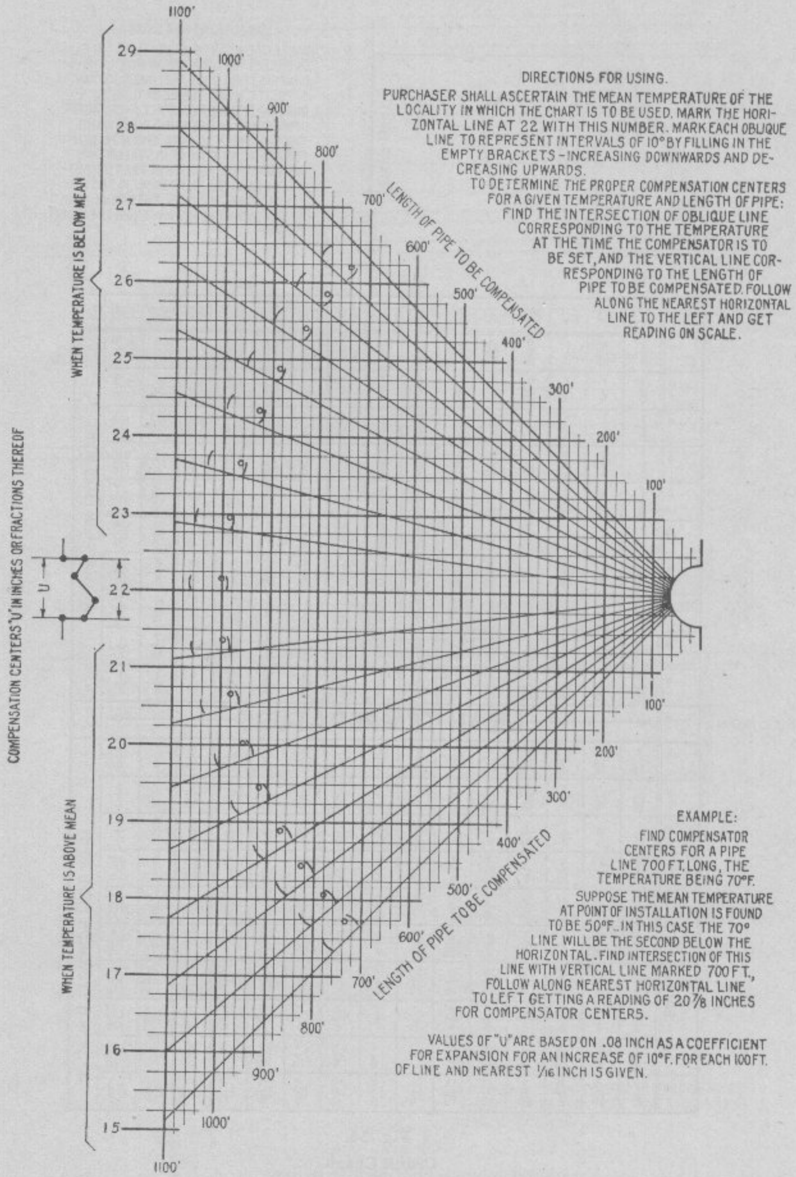
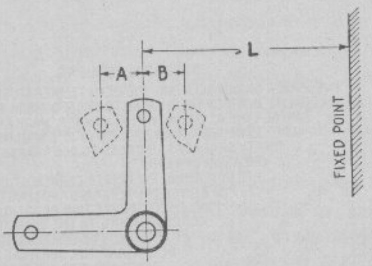


Fig. 53.
Compensation Chart.

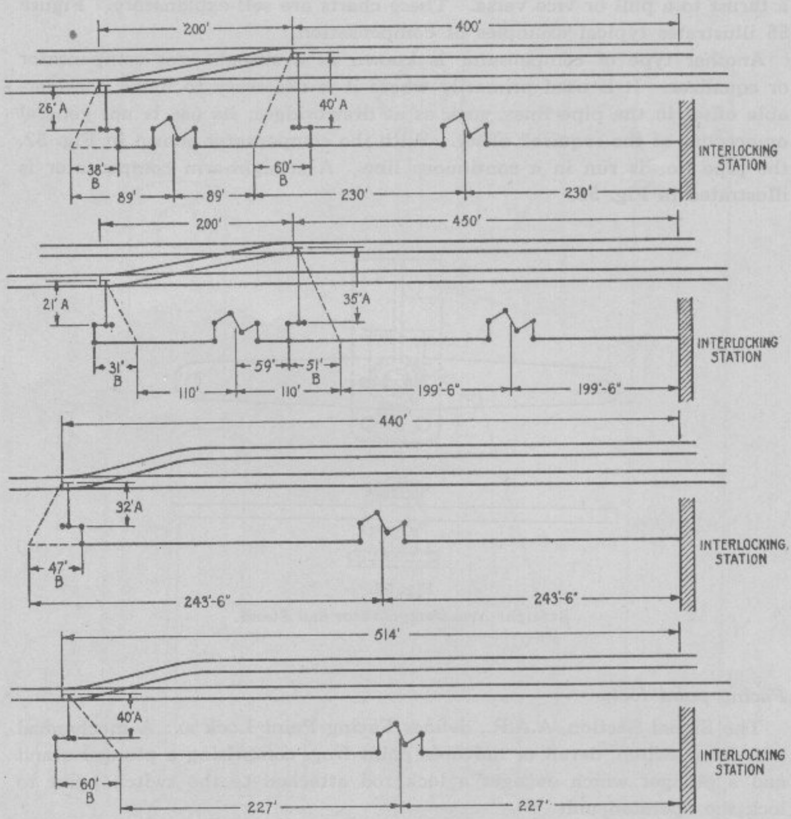


DIRECTIONS FOR USING

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	3/18	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. 54.
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"

$\frac{6 \times 11.75}{8.75} = 8"$ 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:

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

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

Fig. 55.

Method of Applying Compensation.

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. These charts are self-explanatory. Figure 55 illustrates typical examples of compensation.

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 compensator shown in Fig. 52, the pipe line is run in a continuous line. A straight-arm compensator is illustrated in Fig. 56.

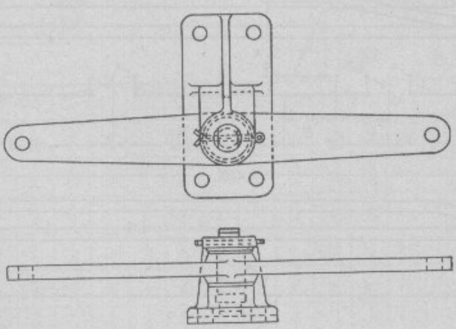


Fig. 56.
Straight-Arm Compensator and Stand.

Facing point lock.

The Signal Section, A.A.R., defines Facing Point Lock as: A mechanical lock for a switch, derail or movable point frog, comprising a plunger stand and a plunger which engages a lock rod attached to the switch point to lock the operated unit.

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

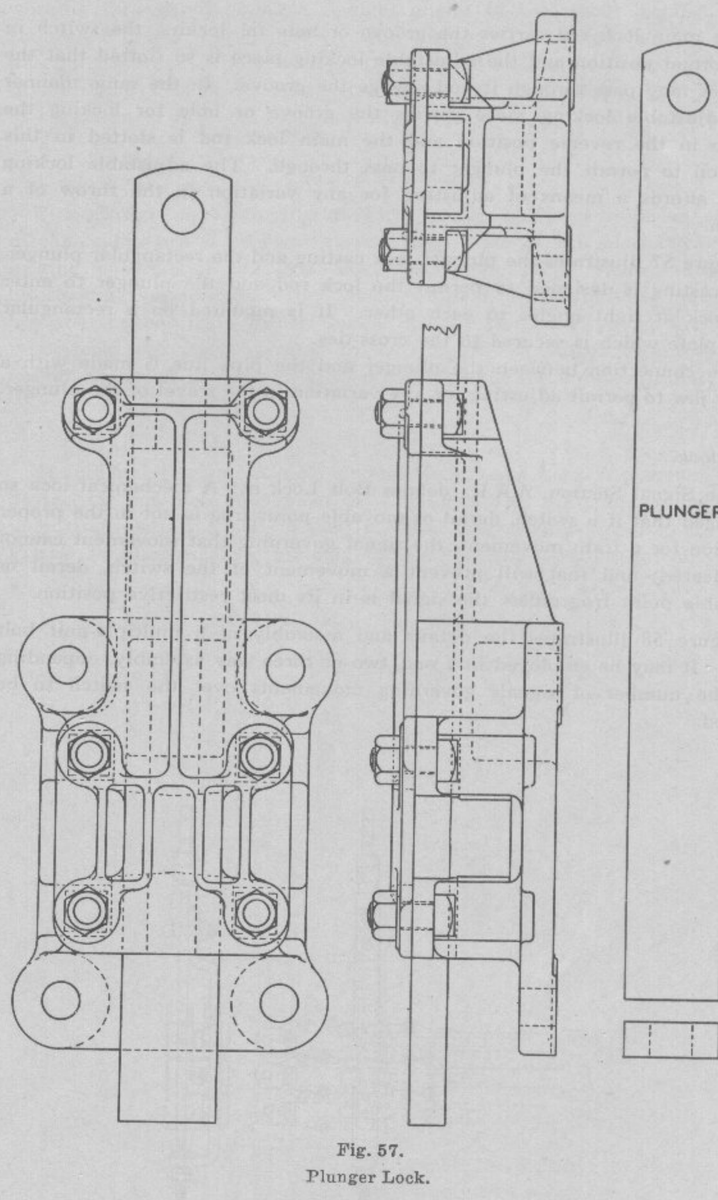


Fig. 57.
Plunger Lock.

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 so slotted 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.

Figure 57 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.A.R., 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 58 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.

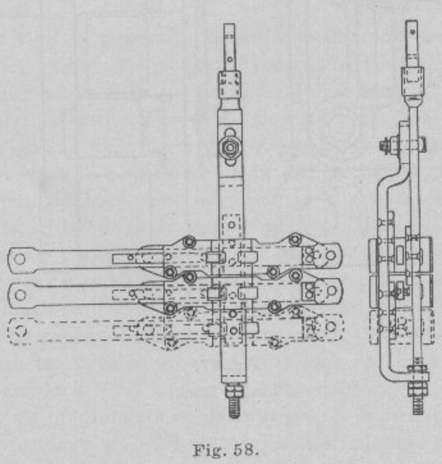


Fig. 58.
Multiple Unit Bolt Lock.

The bolt lock casting is so located that the signal locking bar may be connected in series with the pipe 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.A.R., 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 59 illustrates a commonly used switch-and-lock movement.

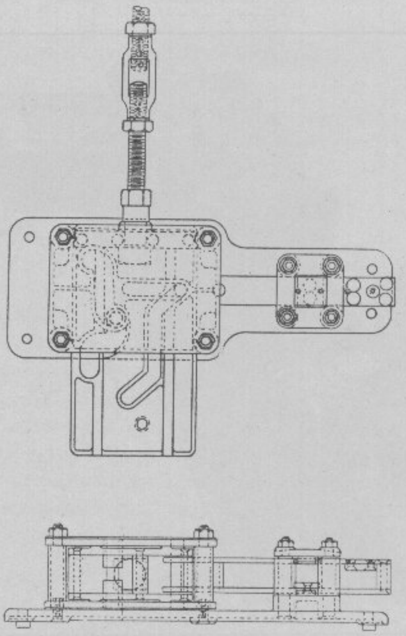


Fig. 59.
Type "G" Switch-and-Lock Movement.

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 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. 60, 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

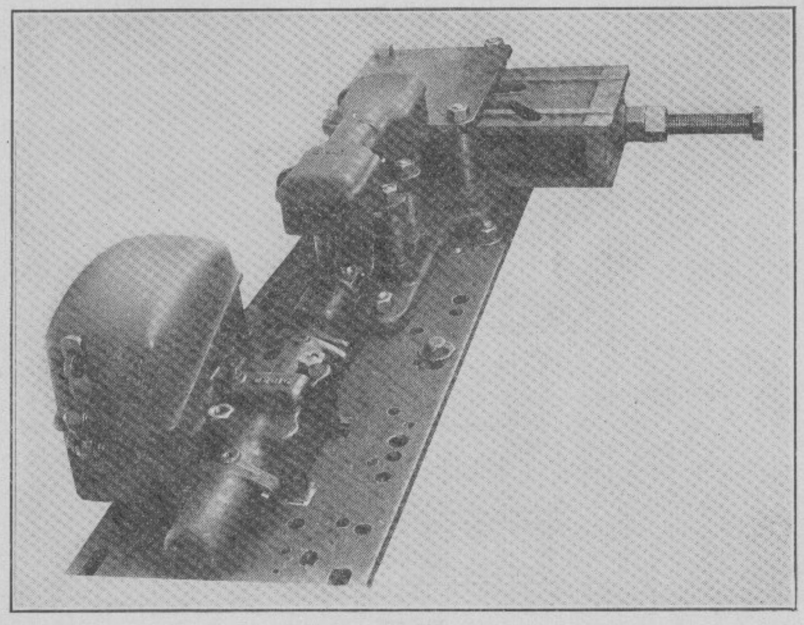


Fig. 60.
Electric Lock Applied to Type "G" Switch-and-Lock Movement.

pulling the switch open. Figure 61 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.

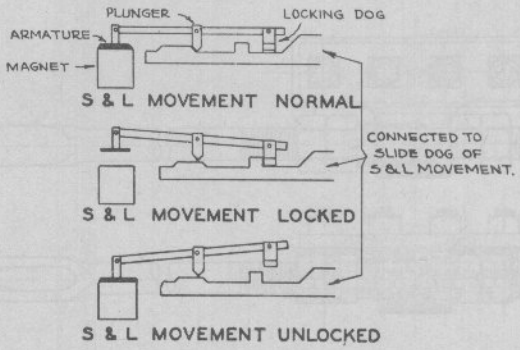


Fig. 61.

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

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. 62. 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 so shifted that the plunger will engage with the groove in the lock rod, thus permitting 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.

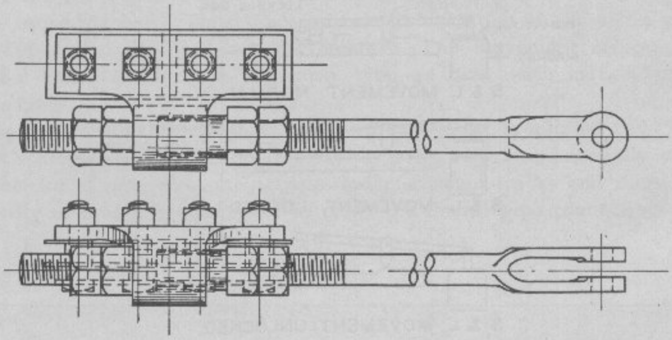


Fig. 62.
Switch Adjustment.

Signal

The mechanical signals of an interlocking system are of the semaphore type, operated by pipe lines, and are illustrated in Fig. 63.

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. In some instances a selector is used which permits operating more than one arm from each pipe line. Figure 64 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 lines should be damaged or broken. For a signal mast equipped with more than one arm a multiple arrangement of cranks and up-and-down rods is employed.

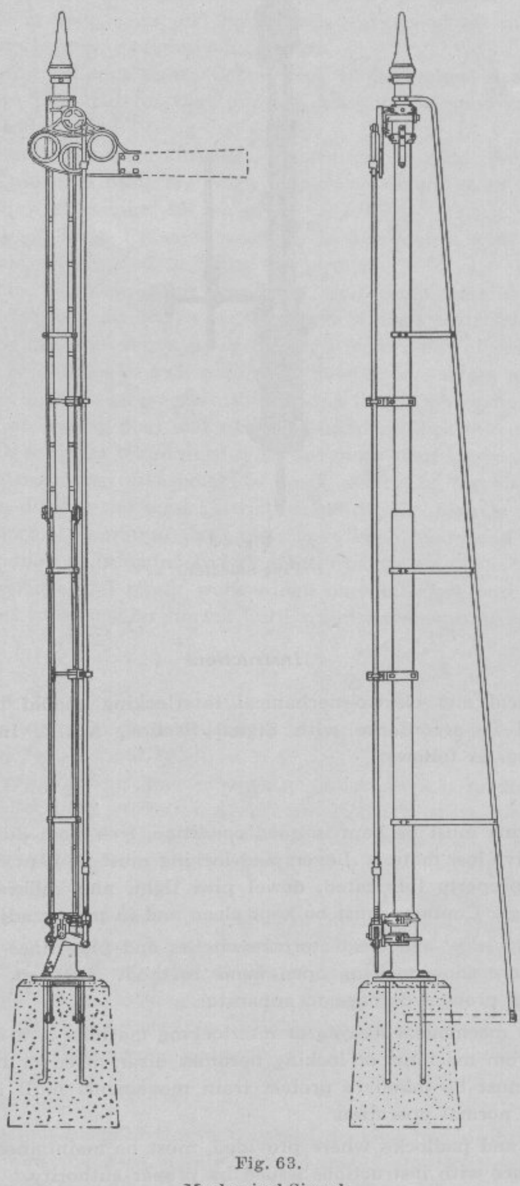


Fig. 63.
Mechanical Signal.

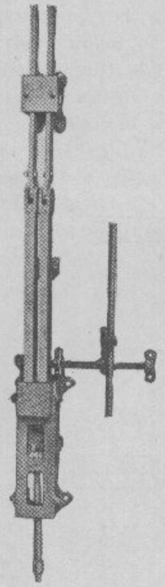


Fig. 64.
Pipe Selector.

Instructions

Mechanical and electro-mechanical interlocking should be maintained and tested in accordance with Signal Section, A.A.R. Instructions for Interlocking, as follows:

General.

1. 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 properly lubricated, dowel pins tight, and sufficient tension in latch springs. Contacts must be kept clean and in proper adjustment.

2. During snow and sleet storms switches and pipe lines must be kept clean. Where snow melting open flame methods are used, care must be exercised to prevent damage to apparatus.

3. When mechanical locking of interlocking machine is to be changed or removed from machine, or locking becomes disarranged or broken, proper measures must be taken to protect train movements until interlocking is restored to normal operation.

4. Seals and padlocks, where provided, must be maintained and handled in accordance with instructions issued by proper authority.

5. Circuits must not be opened or shunted, contacts of controlling devices bridged or any other action taken which may affect safety of train operation.

6. Clearances must be maintained as required.

7. Paint must be applied as often as required to prevent deterioration. Rusty surfaces must be cleaned before painting. Paint must not be applied to threads of screw jaws, adjustable screws, cotters or gaskets.

8. Threads of rods, jaws and bolts, and bearings of all movable parts must be kept clean and properly lubricated.

9. Bolts must be kept tight. Cotter pins of the proper size must be in place in holes provided for that purpose, must be in good condition and properly spread.

10. Gaskets for housings must be in place and in good condition.

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

12. Setting of Time Releases must be in accordance with Instructions for Time Releases Applied to Signal Apparatus.

13. Switches, movable point frogs and split point derails must be so maintained that they cannot be locked when 1/4 inch obstruction is placed between stock rail and switch point 6 inches from point of switch.

14. Holes or notches in lock rods must have square edges and must not be more than 3/16 inch larger than the locking bar or plunger.

15. Edges of locking dogs and rods of switch-and-lock movement or facing point lock must be maintained with not more than 1/16 inch wear.

16. Before removing rails, points or frogs, protecting signals must be so secured as to display the most restrictive indication. Signals must not be restored to normal operation until tests have been made and it is known that they function as intended and that the track is safe.

17. Maintenance and repair work which may interfere with safe movement of trains must not be started until train movements have been fully protected.

Tests.

18. Tests must be made periodically, as instructed, to determine that the various safety features are effective.

19. When repair, adjustment, change or replacement is made in any part which may affect the operation of the interlocking, tests must be made immediately to determine that proper operation is assured.

20. Electric locking must be tested in accordance with Instructions for Electric Locking.

21. Cross protection must be tested to insure that protective devices operate properly to prevent movement of switches, signals and other units when current is improperly applied to the circuits.

22. Movable bridge locking must be tested to insure that rail locks, bridge locks, bolt locks, circuit controllers, and electric locks are in good condition and are functioning properly.

Mechanical locking.

23. The various parts of the locking bed, locking bed supports and tappet stop rail must be kept rigidly secured and properly aligned to insure free and effective operation.

24. Driving pieces, dogs, stops and trunnions must be kept properly secured to locking bars. Swing dogs must have full and free movement.

Top plates must be in place and tight. Splices in longitudinal locking bars must be straight and properly made.

25. Locking faces must fit squarely against each other.

26. Latch shoes, rocker links, rockers and quadrants must be so maintained that lost motion will not permit the locking to release. With the S. & F. machine the locking must not release if the foot is used on the rocker while lever is in midstroke position, or the lever shoe leave its position on the rocker if the rocker is pushed to the right with the foot and at the same time the lever is forced to the left as far as it will go, making check during the complete stroke of the lever.

27. Locking bars in new locking must have full stroke as follows:

(a) Mechanical interlocking machine, S. & F. locking........1¾ inches.

(b) Mechanical interlocking machine, Style "A" locking........7/16 inch.

(c) Electro-mechanical interlocking machine, S. & F. locking.

1. Lever with full stroke having S. & F. driver............1¾ inches.

2. Lever normally center having rack driver................2⅝ inches.

(d) Electro-mechanical interlocking machine, S. & F. miniature locking ....1 1/16 inches.

(e) Electro-mechanical interlocking machine (Style "A" miniature locking).

1. Vertical locking ....¼ inch.

2. Horizontal locking ....11/32 inch.

(f) Power interlocking machine, S. & F. miniature locking..1 1/16 inches.

(g) Power interlocking machine (Style "A" miniature locking).

1. Vertical locking ....¼ inch.

2. Horizontal locking ....11/32 inch.

(h) Table interlocking machines.

1. Type "A."

(a) Vertical locking ....7/32 inch.

(b) Horizontal locking ....1½ inches.

2. Type "TC" ....1 1/16 inches.

28. When lever or latch which should be locked can be moved more than shown below, it must be considered as having too much lost motion and lost motion must be removed.

(a) Mechanical machine.

1. Latch operated locking. When lever latch block can be lifted more than 7/16 inch from the bottom of the notch on levers not fitted with electric locks. On levers fitted with electric locks, when lever latch block can be lifted more than 5/16 inch from the bottom of the notch.

2. Lever operated locking. When lever latch block can be moved more than ⅜ inch on top of quadrant.

3. Latch block adjustment as follows:

(a) Latch block must not lift more than ⅛ inch above top of quadrant.

(b) Latch block lift to permit operation of lever must be not less than ¾ inch.

(b) Electro-mechanical machine.

1. Lever moving in horizontal plane. When lever can be moved more than $\frac{3}{16}$ inch when in normal position or $\frac{7}{16}$ inch when in reversed position.

2. Lever moving in an arc. When lever can be moved more than 5 degrees, equivalent to $\frac{1}{4}$ inch movement of the latch on the quadrant.

(c) Power machine.

1. Latch operated locking. When lever latch block can be raised to within $\frac{7}{32}$ inch of top of quadrant.

2. Lever moving in horizontal plane. When lever can be moved more than $\frac{5}{16}$ inch when in normal position or $\frac{9}{16}$ inch when in reversed position.

3. Lever moving in an arc. When lever can be moved more than 3 degrees, equivalent to $\frac{7}{64}$ inch movement of the lever latch on quadrant.

29. On electro-mechanical interlocking machines, the locking between the electric and its mechanical levers must be maintained to insure that mechanical levers cannot be operated except when properly released by the electric levers.

30. When new locking is to be placed in service or a change in locking is made, a complete check and test must be made of the locking as follows:

(a) With all levers normal see that locking agrees with the dog chart.

(b) Levers must be tested to see that each lever when reversed and latch down, locks all other levers in the position as required by the locking sheet.

(c) Complete test of the locking from a signal layout or interlocking plan must be made as follows:

1. Test locking between switch, derail and movable point frog levers.

2. Test locking between facing point lock and switch, derail and movable point frog levers.

3. Set up each route and endeavor to reverse each signal lever that should be locked by that route; then reverse signal lever, governing movements over route and endeavor to operate each lever that should be locked by the signal lever; then restore lever to normal position and make similar test with lever for the opposing signal.

4. Parallel routes or other routes must be set up and signal levers operated for movements in both directions on each route to insure that the locking of one route does not interfere with other routes.

5. These tests require that the lever latch must be fully down with lever in proper position.

Mechanical.

31. Cranks, compensators, and other mechanical connections must work freely, but must not have excessive lost motion. They must be kept clean, properly centered, lubricated and in alignment.

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

33. 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.

34. Bolt lock must be so maintained that signals governing movements over switch or derail cannot be cleared when derail is in derailing position, or when switch point is open 1/4 inch or more when bolt lock is used in lieu of facing point lock, and 1/2 inch or more when switch or derail is otherwise protected. Signal bar must be against the stop when signal lever is normal. Notches must have square edges.

35. Driving bar of switch-and-lock movement must travel both normal and reverse so that locking dog will enter lock rod 1/2 inch or more.

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