American Railway Signaling Principles and Practices

CHAPTER XVI

INTERLOCKING

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INTERLOCKING

The Signal Section, Association of American Railroads, defines

Interlocking, as: An arrangement of signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect. It may be operated manually or automatically. (Standard Code)

Interlocking, Automatic, as: An arrangement of signals, with or without other signal appliances, which functions through the exercise of inherent powers as distinguished from those whose functions are controlled manually and which are so interconnected by means of electric circuits that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication. (I.C.C.)

Interlocking, Manual, as: An arrangement of signals and signal appliances operated from an interlocking machine and so interconnected by means of mechanical and/or electric locking that their movements must succeed each other in proper sequence, train movements over all routes being governed by signal indication. (I.C.C.)

Types.

The various types of interlockings are described in the following chapters:

Mechanical and electro-mechanical—Chapter XVII
Electro-pneumatic—Chapter XVIII
Electric (including automatic)—Chapter XIX
All-relay—Chapter XXVI

A limited number of pneumatic interlockings remain in service, but no attempt has been made to describe this type as it is obsolete.

Historical.

Interlocking is of English origin, numerous patents having been granted in England for manually operated interlocking devices from 1856 to 1867, when, at the later date a means for obtaining what is now known as "preliminary latch locking" was first disclosed by Saxby. The rapidity with which this valuable system was adopted in England is indicated by the fact that 6 years later, in 1873, 13,000 mechanical interlocking levers were employed on the London & Northwestern Ry. alone.

In 1870, the first interlocking machine was installed in the United States at Top-of-the-Hill, a junction at Hamilton Ave., Trenton, N. J., on the old Camden and Amboy Division of the Pennsylvania R. R. This was of the mechanical type and employed locking of the "spring catch" type. Saxby & Farmer, of London, England, furnished the material and a man was sent from England to supervise the installation.

An experimental installation of a mechanical machine, built in this country by Messrs. Toucey and Buchanan, was made at Spuyten Duyvil Junction, New York City, during 1874. A machine of the latch locking type obtained from Saxby & Farmer, England, was put in service on the Pennsylvania R. R. at East Newark Junction, N. J., early in 1875. The locking on this machine and on the one at Top-of-the-Hill was known as "flop locking."

The first important installation of mechanical interlocking machines with what is known as "preliminary latch locking" was made during 1877-78 on the Manhattan Elevated Lines of New York City with machines of the Saxby & Farmer type, built by the Jackson Manufacturing Co. of Harrisburg, Pa.

The early mechanical interlocking systems in the United States employed pipe for connecting switches, and wire for connecting signals, to the levers in the interlocking machine which was housed in the interlocking station. A switch was operated and locked by one interlocking lever by means of a switch-and-lock movement. The requirement of moving levers in a predetermined order was accomplished by an arrangement of dogs and notched bars termed "mechanical locking." It is a noteworthy fact that the Saxby & Farmer machine as produced at present is not materially changed from the original in principle of design, except in the development of the mechanical locking.

As mechanical interlocking came into general use, various improvements were made to provide the security demanded by the increase in speed and traffic. One of the first improvements was the separation of the operating and locking features at facing point switches. This separation required two independent levers, one to operate the switch and the other to lock it.

Wire-connected signals were changed to pipe-connected, track circuits introduced, electro-mechanical slots and power signals were installed and the signals made semi-automatic or automatic in their operation. Detector bars have been replaced by the application of electric locks controlled through track circuits, to the lock and switch levers, although a few remain in service.

Time and approach locking were introduced with the advent of high-speed train schedules, when it became advisable to transfer to automatic devices the protection of trains approaching an interlocking formerly intrusted to the signalman or operator in charge. Approach locking through electrical and mechanical devices prevents a route being changed when a train nearing an interlocking has reached a predetermined point from the home signal.

Route locking was introduced at about the same time as approach locking and is accomplished in practically the same manner. To some extent it performs the same function as approach locking, and its use is now considered essential at the more important interlockings. Its virtue lies in its ability to maintain a switch, or series of switches, in position until the train has passed over it, and to release the switch so it may be used for other train movements.

Soon after American railroads had gained experience with mechanical interlocking systems, it was felt that there were many situations where great economies could be effected and more satisfactory operation obtained if switches and signals could be successfully worked by power instead of manually. For precisely the same reason, viz: saving of labor—that English railways were first led to concentrate in a single frame theretofore widely separated levers for the operation of switches and signals—thus leading up to the idea of interlocking, so the much higher cost of labor in the United

States than in England caused the American railways to demand an interlocking that would afford means for operating switches and signals over greater distances and with fewer operators than were required under the English method. The first concrete response of the American inventor to this demand was the installation of a pneumatic plant under the patents of Prall and Burr at Mantua 'Y', Philadelphia, Pa., on the Pennsylvania R.R. in 1876. It was followed in 1882 by the first hydraulic interlockings, installed by the Union Switch & Signal Co., at East St. Louis, Ill. and at Wellington, Ohio. The first hydro-pneumatic interlocking was installed in 1883 at Bound Brook, N. J., on the Philadelphia & Reading R. R. by the Union Switch & Signal Co. for a crossing with the Lehigh Valley R. R. From 1884 to 1891, 18 hydro-pneumatic plants, having 482 levers, were installed on 6 railroads, but this system having developed many serious defects, its inventors devised and in 1891 installed the first electro-pneumatic interlocking at the Chicago & Northern Pacific Drawbridge, Chicago, Ill. In the following 10 years, there were ordered, up to June 1, 1900, 54 electro-pneumatic interlockings, having 1,864 levers, for use on 13 railroads.

The first electric interlocking was built in 1889 by Mr. J. D. Taylor and installed at East Norwood, Ohio, at the crossing of the Baltimore & Ohio Southwestern R. R. and the Cincinnati Northern R. R. In 1901, the Taylor Switch & Signal Co. installed the first electric interlocking employing dynamic indication at Eau Claire, Wis., on the Chicago, St. Paul, Minneapolis & Omaha Ry. Shortly after this the Taylor Co. became the General Railway Signal Co.

While many mechanical and electro-mechanical interlockings are still in service, power interlockings, either electric or electro-pneumatic, have superseded the mechanical type and, in turn, to a great extent, power interlockings are now being superseded by the all-relay type of interlocking described in Chapters XIX—Electric Interlocking and XXVI—All-Relay Interlocking.

Application.

Interlockings are in general use at terminals, junction points, railroad grade crossings, movable bridges and other points where traffic conditions require the expeditious movement of trains. The necessity for an interlocking is largely determined by the nature and volume of the traffic. In designing an interlocking, consideration should first be given to the track layout and the frequency of train movements. The type of interlocking to be installed is generally determined by the territory over which the interlocking extends, that is, distance of the switch and signal units to be operated from the interlocking station, as well as local conditions.

Track layout.

The track layout of an interlocking is the arrangement of tracks and one or more of the following: switches, movable point frogs, rigid frogs, single-slip switches with rigid or movable point frogs, double-slip switches with rigid or movable point frogs; sometimes derails, movable bridges and turn-tables are included. The track layout and local conditions determine the arrangement and location of signals that govern train movements. A typical four-track interlocking layout is illustrated in Fig. 1, the detailed description of which is given later.

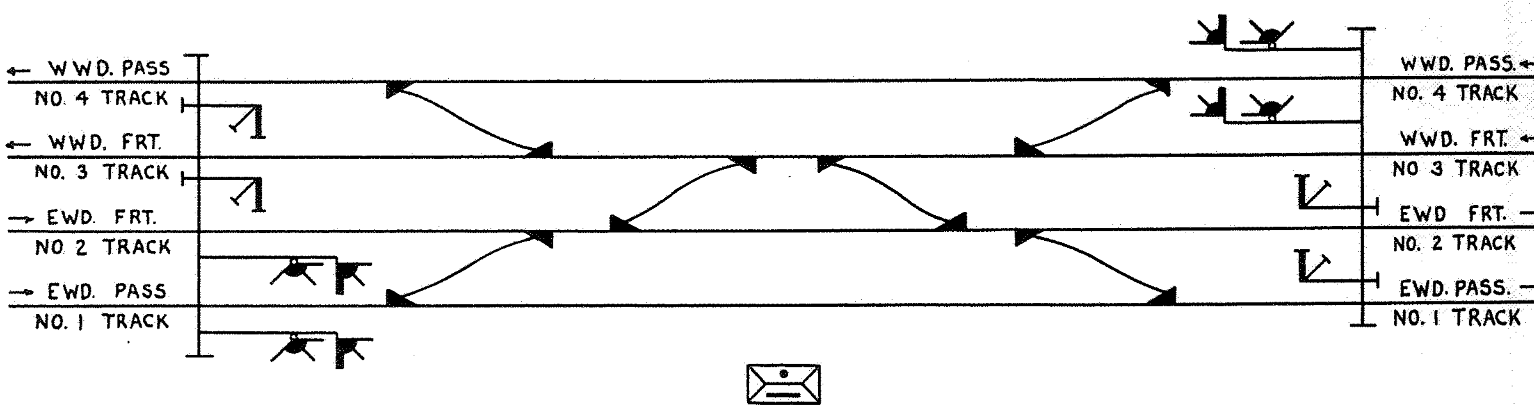


Fig. 1.
Typical Four-Track Interlocking Layout.

For convenience, the description of the interlocking will be divided into two major parts, one classed as inside apparatus, the other as outside apparatus.

Inside Apparatus

General.

The Signal Section, A.A.R., defines Interlocking Station as: A place from which an interlocking is operated. (Standard Code)

The station houses certain apparatus that is common to any type of interlocking in addition to the interlocking machine, such as track model or track diagram, time releases, indicators, annunciators, relays and batteries. Relays are described in Chapters VI and X, and batteries are described in Chapter V. The function of releases, indicators, annunciators and similar apparatus is described in Chapter XX—Interlocking Circuits.

Track model.

As the name implies, this is a miniature representation of the arrangement of tracks, switches, signals, etc., of the particular interlocking involved. In some cases a working model is used so that as a route is set up the switches on the model move to correspond to the position of the operating lever and indicate the route as set up on the tracks. Some models have a mechanical connection from the lever to its switch on the model, while on other models the movement is accomplished electrically by the use of electromagnets operated by contacts on the respective levers. These working models are ordinarily used at power-operated interlockings where the track layout is quite involved, such as at large terminals. In other cases a similar track model is used; however, the switches are inoperative and the diverging routes as set up are not reflected on the track model. In still other cases the track arrangement is indicated by a diagram usually placed above the interlocking machine. This diagram shows the arrangement of switches and signals with the number of the controlling lever indicated.

Generally, miniature lights that show track occupancy are located on track models or diagrams. In some cases they are contained in a separate or special indicator cabinet. No standard arrangement can be shown, as each railroad adopts its own standard.

Machine.

The Signal Section, A.A.R., defines Interlocking Machine as: An assemblage of manually operated levers or equivalent devices, for the control of signals, switches or other units, and including mechanical or circuit locking or both to establish proper sequence of movements. The number of levers depends upon the size of the interlocking and type of machine, and the numbering is from left to right. A mechanical machine generally requires more levers than a power machine for the same number of switch, signal or other units.

A detailed description of each type of machine in general use, except the parts that are common to all types of interlocking machines, the principal item of which is the mechanical locking, is given in the separate chapters describing the different types of interlocking.

Mechanical locking.

The Signal Section, A.A.R., defines Mechanical Locking as: An arrangement of locking bars, dogs, tappets, cross-locking and other apparatus by means of which the interlocking is effected between the levers of an interlocking machine and so interconnected that their movements must succeed each other in a predetermined order. (I.C.C.)

By referring to Fig. 1, it may be seen that before a signal is cleared for train movement over any given route there should be the assurance that the desired route is set up, and that after the proper signal has been cleared, the route cannot be changed or any signals cleared that would conflict with that route. The method of locking the various levers depends on the type of machine used. Figure 2 illustrates the same track layout as shown in Fig. 1, and it will be assumed that a mechanical interlocking machine is to be used. After the track layout has been signaled, the various switches, locks and signals are each given a number corresponding to the numbers of the levers in the machine which will operate them. Each signal arm is given a separate number in Fig. 2 on the assumption that these are mechanically operated. At many mechanical interlockings, the signals are power-operated, and it is possible to control more than one arm by the same lever by selecting the signal control circuits through switch lever circuit controllers in the different positions so that as the signal lever is reversed the arm governing movements over the particular route set up is the only one that will operate. The circuits controlling the signals are explained in Chapter XX—Interlocking Circuits. The mechanical locking for this track arrangement will be shown later in this chapter. After the layout plan has been numbered, it is then necessary to prepare another plan showing under what conditions the various levers are locked. This is known as the locking sheet and is illustrated in Fig. 3, which shows the locking necessary for the track layout illustrated in Fig. 2.

In a mechanical interlocking it is customary to have separate levers for locking each switch, movable point frog or crossover in both the normal and reverse positions. Derails, generally, are not locked in the derailing position. Plans are drawn on the assumption that the various levers are in their normal position, and to lock a switch in either position the lock lever must be reversed. In practice the lock levers are usually kept in the reverse position and the switches locked. In reading the locking plans it must be assumed that all levers are in their normal position. The locking sheet arranges the levers in consecutive order and indicates how and when the various levers are locked. A lever locked in the reverse position is indicated by placing the lever number in a circle. Those not so placed are locked in the normal position. Referring to Fig. 3 and reading the locking for lever 1, it can be said that when lever 1 is reversed, it locks 23 and 24 normal, 11 reversed, 13 reversed when 12 is reversed, 15 reversed when 12 is reversed (14 is not included as no matter what position 14 is in, the movement will be over lock 15), 17 reversed when 12 is normal, 17 reversed when 12 is reversed and 14 normal, 18 normal when 12 is normal, 19 reversed when 12 and 14 are both reversed, 26 normal when 12 is reversed, 27 normal when 12 and 14 are reversed, 28 normal when 12, 14 and 20 are reversed. By checking this locking sheet it will be found each route and conflicting route is locked either directly or indirectly.

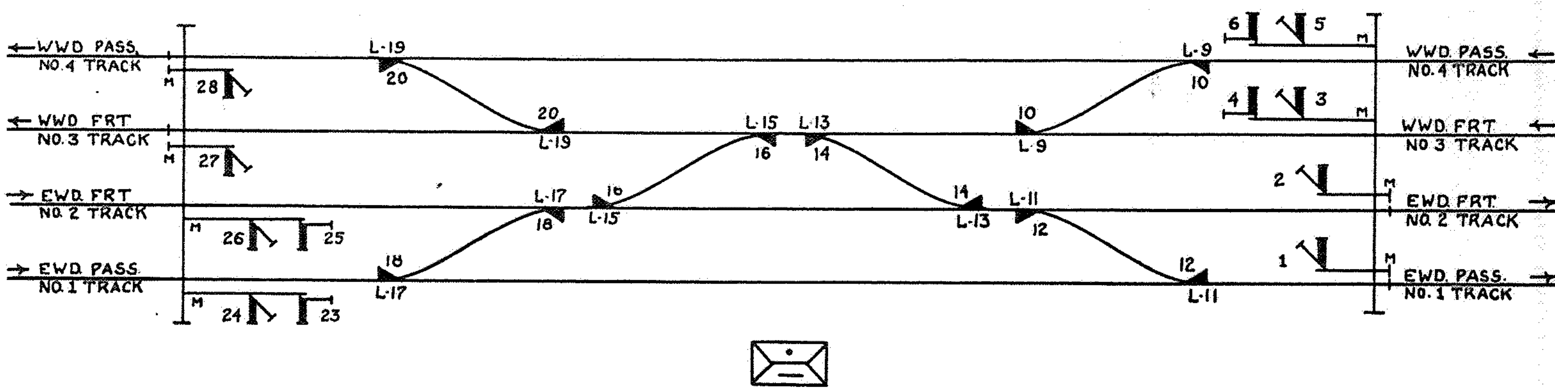


Fig. 2.

Track Layout with Mechanical Interlocking Machine.

LEVER	WHEN	LOCKS
1		(11)-23-24
	12	(17)-18
	(12)	(13)-(15)-26
	(12)-14	(17)
	(12)-(14)	(19)-27
	(12)-(14)-(20)	28
2		(11)-12-(13)-(15)-16-24-25
	14	(17)
	(14)	(19)-27
	(14)-(20)	28
3		(9)-10-(13)-14-(15)
	16	(19)-(20)-28
	(16)	(17)-26
	(16)-(18)	24
4		(9)-10-(13)-14-(15)-16-(19)
		20-27
5		(9)-(10)-(13)-(15)-27-28
	16	(19)
	(16)	(17)-26
	(16) (18)	24
6		(9)-(19)-10-20-28
7		SPARE
8		SPARE
9		10 (10)

LEVER	WHEN	LOCKS
10		14
11		12 (12)
12		16
13		14 (14)
14		16-18
15		16 (16)
16		20
17		18 (18)
18		—
19		20 (20)
20		—
21		SPARE
22		SPARE
23		(11)-12-(17)-18
24		(13)-(15)-(17)-(18)
	16	(11)
	(16)	(9)

LEVER	WHEN	LOCKS
25		(11)-(13)-12-14-(15)-16-(17)
		18
26		(13)-14-(15)-(17)-18
	16	(11)-(12)
	(16)	(9)
27		(13)-(15)-16-(19)-20
	14	(9)
	(14)	(11)
28		(19)
	14-(20)	(9)
	(14)-(20)	(11)
	20	(9)-10
	(20)	(13)-(15)

Fig. 3.
Locking Sheet for Mechanical Interlocking Machine.

For example, when lever 12 is reversed, 1 locks 2 indirectly, as in order to be able to reverse 2, lever 12 must be normal. Lever 1 locks 26 normal directly as either signal could be displayed with 12 reversed. The locking for the other signal levers is indicated on the locking sheet for the various routes over which they govern. It will be noted the lock levers lock the switch levers in both normal and reverse positions as, regardless of what position the switch may be in, it is necessary that the points fit the stock rail properly and that they be locked in that position. It will also be noted that certain switch levers lock other switch levers normal. This frequently saves locking, as otherwise it would be necessary that each signal, governing over the switch reverse, lock the other switch normal. For example, if a move were being made with 10 reversed, 14 should be normal, so 10 reversed is made to lock 14 normal. The locking sheet generally shows the low-numbered levers locking the high-numbered levers, although as far as the locking is concerned, the high-numbered lever also locks the low-numbered lever.

After the preparation of the locking sheet it is necessary to prepare the dog chart which represents the arrangement of the mechanical locking which locks the levers as indicated on the locking sheet. Before describing this feature it is desirable that the mechanical machine and connections to the mechanical locking be illustrated.

Saxby & Farmer interlocking machine.

Figure 4 illustrates an improved Saxby & Farmer mechanical interlocking machine, using what is called S. & F. type of locking. The locking is contained in a horizontal locking bed placed behind the levers above the floor.

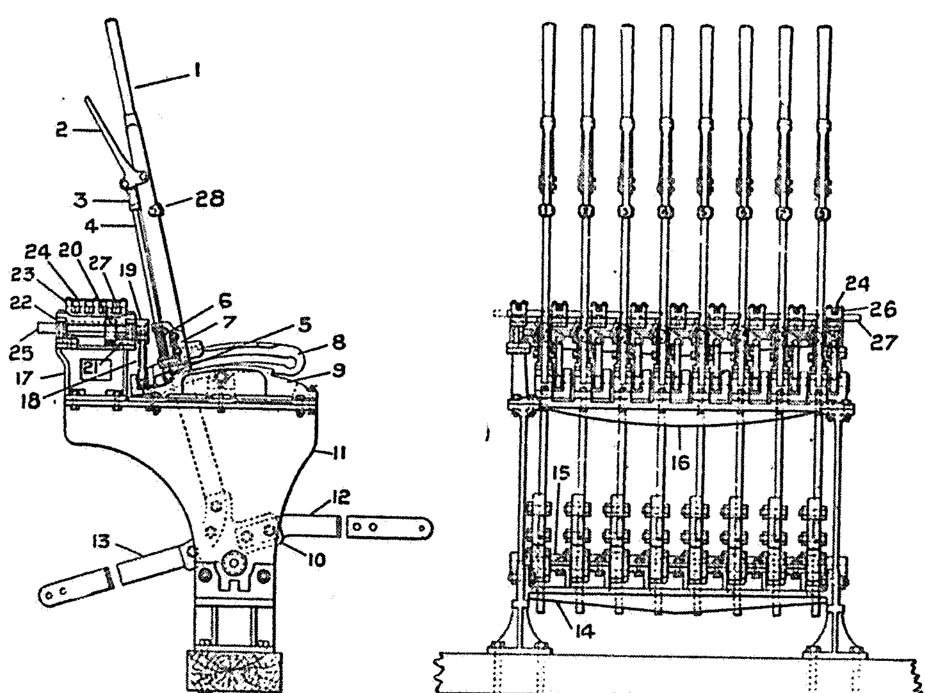


Fig. 4.
Improved S. & F. Mechanical Interlocking Machine.

The various parts of this machine are numbered and named as follows:

1. Lever.
2. Latch handle.
3. Latch rod thimble.
4. Latch rod.
5. Rocker die.
6. Latch spring.
7. Latch shoe.
8. Rocker.
9. Quadrant.
10. Lever shoe.
11. Machine leg.
12. Back tail.
13. Front tail (part of lever 1).
14. Bottom girder.
15. Cap for bottom girder.
16. Top plate.
17. Locking bearing.
18. Universal link.
19. Crank.
20. Locking bar driver.
21. Front rail with cap.
22. Back rail.
23. Locking bracket.
24. Locking bracket cap.
25. Locking shaft.
26. Cross-locking.
27. Longitudinal locking bar or tappet.
28. Number plate.

The movement of the latch handle 2 operates the mechanical locking as follows: the latch handle is pivoted on the lever 1 and latch rod thimble 3. As the latch handle is raised it transmits motion to the latch rod 4 and rocker die 5, which makes the connection between the latch rod and rocker 8. The rocker is pivoted on quadrant 9, and as it is raised it moves universal link 18, the upper end of which is attached to crank 19. This crank is attached to locking shaft 25, and as the crank is moved it causes the locking shaft to turn in locking bearing 17. Connected to the locking shaft is another crank called the locking bar driver 20, which crank is located to one side of the longitudinal locking bar or tappet 27 that is to be operated by lever 1. Riveted to the under part of the longitudinal locking bar is a locking bar driver block which fits into the locking bar driver and as the locking shaft is turned it moves the longitudinal locking bar to the right. More than one longitudinal locking bar may be operated from the same lever by attaching additional drivers to the locking shaft under the desired locking bars. Dogs are riveted to this locking bar at the various locking brackets 23, and as these dogs are moved they operate the cross-locking 26, which locks or releases dogs on other locking bars, which in turn lock or release the levers that operate these longitudinal bars. The first movement of the latch rod also releases the lever, so that it may be moved to the reverse position by raising the bottom of the latch rod out of its position at the front or normal side of the quadrant. As the lever is being moved to the reverse position the latch is held in the raised position by the latch block passing along the top of quadrant 9, which prevents any movement of the locking bar. When the lever reaches the reverse position the latch rod drops into position at the back or reverse side of the quadrant and the latch handle moves away from the lever to its position as shown in Fig. 4 due to the action of latch spring 6. As the lever has been moved, the rocker die, which moves in the slot shown in the quadrant, is now at the opposite end of the quadrant, and as the latch rod is forced down in the reversed side of the quadrant, the rocker die moves the rocker in the same direction as it did when the latch handle was raised with lever in normal position. This last movement of the rocker then drives the locking bar to its final position.

It is to be noted that the locking is actuated entirely by the operation of the latch handle and not by the movement of the lever between normal and reverse positions. This is known as preliminary latch locking. The first movement of the latch drives the locking bar or tappet one-half of its stroke, which locks all conflicting levers. After this lever has been operated, the final movement of the latch completes the last half stroke of the locking bar or tappet, which then releases non-conflicting levers and also holds the lever in the reverse position.

Figure 5 illustrates more clearly how the locking between two levers is accomplished, the same numbers being used for the respective parts as shown in Fig. 4.

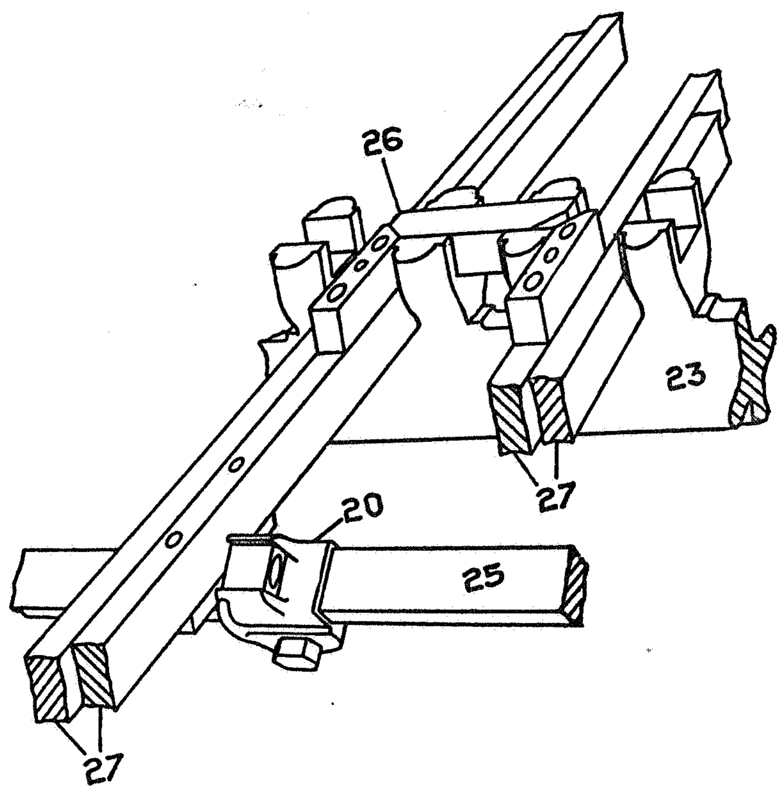


Fig. 5.
Mechanical Locking Between Two Levers.

When the latch to which shaft 25 is connected is raised, it turns locking bar driver 20 which drives locking bar 27, to which it is attached, to the right. On the first movement of this bar the dog riveted on locking bar near locking bracket 23 forces cross-locking 26 against dog riveted to the next locking bar, which is connected to another lever. The final stroke of the locking bar drives the dog further through the cross-locking, the dog being long enough not to pass by or entirely through the cross-locking. The latch to which the dog at the bottom of cross-locking is attached could not then be raised, as the locking bar could not be moved due to this dog being unable to force the cross-locking back to its original position. After the first lever is restored to its normal position the second lever is then free to be moved. The first part of the stroke forces the cross-locking back and prevents the first lever from being moved. The locking for the arrangement would read "lever 1 reversed locks 2 normal." Conversely, lever 2 reversed locks 1 normal.

The locking bars, cross-locking and dogs are usually made of cold-drawn steel, the locking bars being ½ inch by ¾ inch with length depending on size of machine, the cross-locking being ¾ inch by ¾ inch with length depending on size of machine, and location of dogs to be locked. The dogs are of various sizes and shapes, depending on how the locking is arranged.

Figure 6 illustrates a dog chart for the mechanical locking necessary for the track layout as shown in Fig. 2.

This plan indicates the arrangement as seen by standing in back of the machine looking toward the front, which places the low-numbered levers to the right. The heavy vertical lines represent the locking shafts of the various levers, the numbers of which are shown at the top. The heavy horizontal lines represent the longitudinal locking bars which are numbered from top to bottom or front to back. The dogs are shown on the locking bars and the cross-locking is parallel to the locking shafts and is contained in the locking brackets shown in Figs. 4 and 5. The heavy circle or dot where the locking shaft crosses the locking bar indicates that this lever drives that particular bar, the number of the lever being shown at the connection. The locking is stenciled to correspond with the plan.

By referring to the locking sheet the various moves may be checked, remembering that every lever is shown in its normal position and as it is reversed it drives the locking bars to the left (facing front of machine), the complete stroke of which is 1¾ inches.

Studying the dog chart, Fig. 6, further, there will be seen a number of dogs of different shapes and sizes. They may be divided into two general groups: locking dogs and swing dogs. The locking dogs may be further divided into driving, normal locking, reverse releasing and between-stroke. The swing dogs may be grouped as locking or releasing, normal or reverse. The locking dogs are riveted and doweled to the longitudinal bars. The swing dogs are placed on a trunnion which is riveted to the longitudinal bar. The swing dogs not only move in the same direction as the longitudinal bars, but also in the same direction as the cross-locking. These dogs are frequently called "when" dogs, as they lock the various levers when certain switches are normal or reverse, as conditions may require. Generally, they are located on the longitudinal bars that are connected to levers that operate switches. Keeping in mind that all levers and dogs are represented as being in the normal position, it will be seen that where the swing dog is shown as extending through the cross-locking, should the cross-locking below the dog be moved upward the swing dog is moved and transmits motion to the cross-locking above the swing dog, which locks any dogs in this piece of cross-locking. In other cases the swing dog is shown out of the cross-locking and does not transmit motion to the cross-locking until the lever is reversed. Referring to the locking sheet, the swing dogs that are shown as extending through the cross-locking might be designated as the "normal when dogs," while those shown out of the cross-locking might be called the "reverse when dogs." The driving dogs are those that are shown with the straight line through the cross-locking above or below them, this indicating that the cross-locking is cut so that when the dog is moved it will drive the cross-locking in one direction or the other, depending on the way in which the end of dog is beveled. The

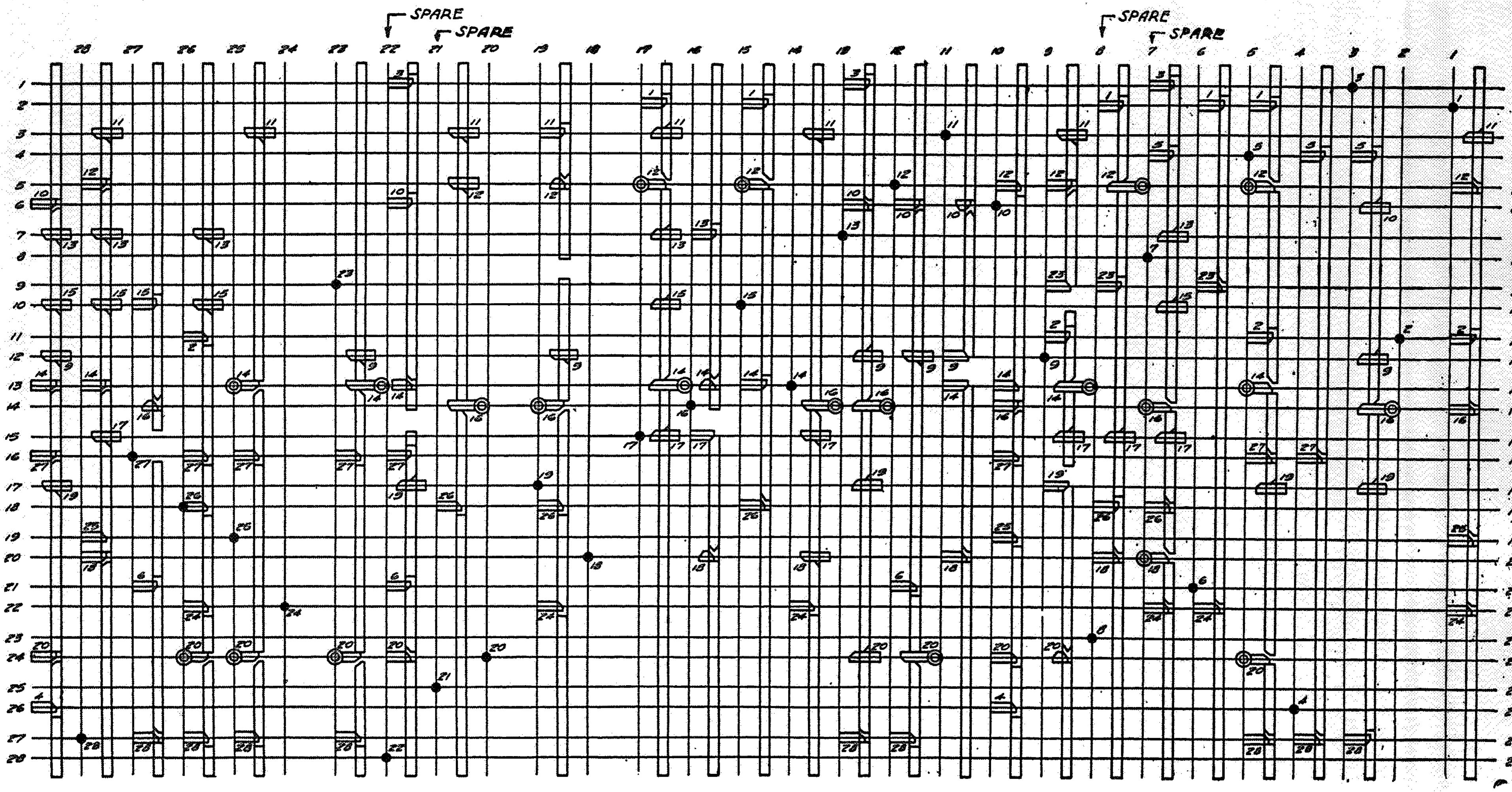
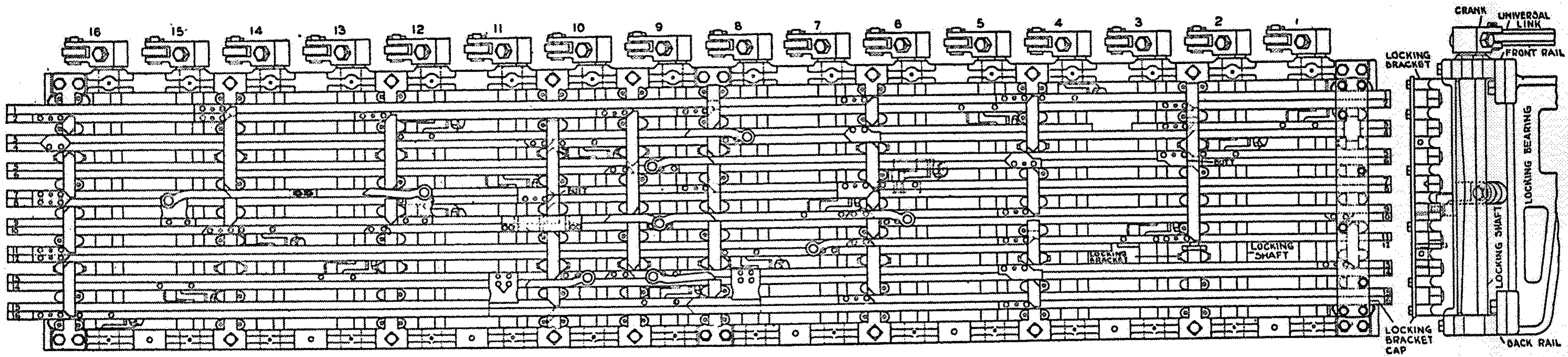
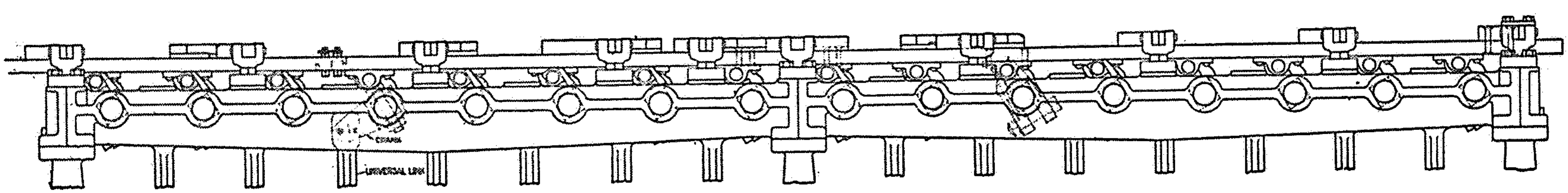


Fig. 6.
Dog Chart, Improved S. & F. Mechanical Interlocking Machine.





LOCKING SHEET

LEVER	WHEN	LOCKS
1		
2		1
3		(2) 1-13-12-6
4		11 (11) 12 (12)
	(7)	(14)
5		11 (11) 10 (10) 1
	7	14 (14)
	14	13 (13)
	10 (11)	6
	10 (11) (14) (13)	(15)
6		10 (10) (12) 7 (7)
	14	3 (3)
	14 (8)	9
7		(11)
8		12-6
9		
10		
11		
12		10 (10)
13		14 (14)
14		
15		
	13-14	12-10 (10)
16		(13) 8

Fig. 7.
Mechanical Locking Bed, Improved S. & F. Mechanical Interlocking Machine.

dogs shown part way through the cross-locking with a beveled cut in the cross-locking are designated as the normal locking dogs, as they are locked as soon as the cross-locking is moved against them. Those shown in the cross-locking are designated as the reverse releasing dogs, as the cross-locking cannot be moved until these dogs are moved, which is done when the lever to which they are attached is reversed. The dogs shown beveled on each end are called "between-stroke dogs," which lock the lever to which they are attached in either the normal or reverse position. There are a large number of other shaped dogs for special conditions, but their function may be readily determined by observing the bevel on the dog, as well as the cross-locking. The cross-locking fits in the locking brackets and is prevented from being forced out of the brackets by locking bracket caps which are screwed to the brackets.

Figure 7 illustrates a locking bed of the type just described, with the locking bracket caps removed and also shows locking sheet for this particular track layout.

Usually the locking is distributed in the locking bed as uniformly as possible, without crowding, and so arranged as to be easily accessible. It is also good practice that the machine be fully equipped with locking brackets and bars. Machines that do not have much locking are equipped with blank cross-locking placed in a number of the locking brackets, so that the locking bars cannot be forced up far enough to permit the locking bar to be forced out of the driver. Blank bars and cross-locking are generally secured in place by studs so that they cannot move out of position and possibly tie up the locking.

Saxby & Farmer (English) interlocking machine.

Figure 8 illustrates another S. & F. interlocking machine, known as the English type. Many of these machines are in use, principally in Canada.

The various parts of this machine are numbered and named as follows:

1. Lever.
2. Latch handle.
3. Latch rod thimble.
4. Latch rod.
5. Latch die.
6. Latch spring.
7. Latch shoe.
8. Quadrant.
9. Lever shoe.
10. Machine leg.
11. Front tail (part of lever 1).
12. Crank arm for attaching back tail.
13. Locking crank.
14. Tappet link (latch).
15. Tappet link (lever).
16. Top tappet.
17. Bottom tappet.
18. Locking bed.
19. Bottom locking bars.
20. Top locking bars.
21. Locking cover.
22. Front rail.
23. Back rail.
24. Number plate.

A study of Fig. 8 will show that this machine employs no rocker, link, etc., to actuate the locking, this being done by both the latch handle and the lever, the latch rod being extended downward and attached through crank 13 to upper or thicker plunger or tappet (the tappet of each lever consisting of two pieces in this machine), the lower tappet being attached directly to the lever.

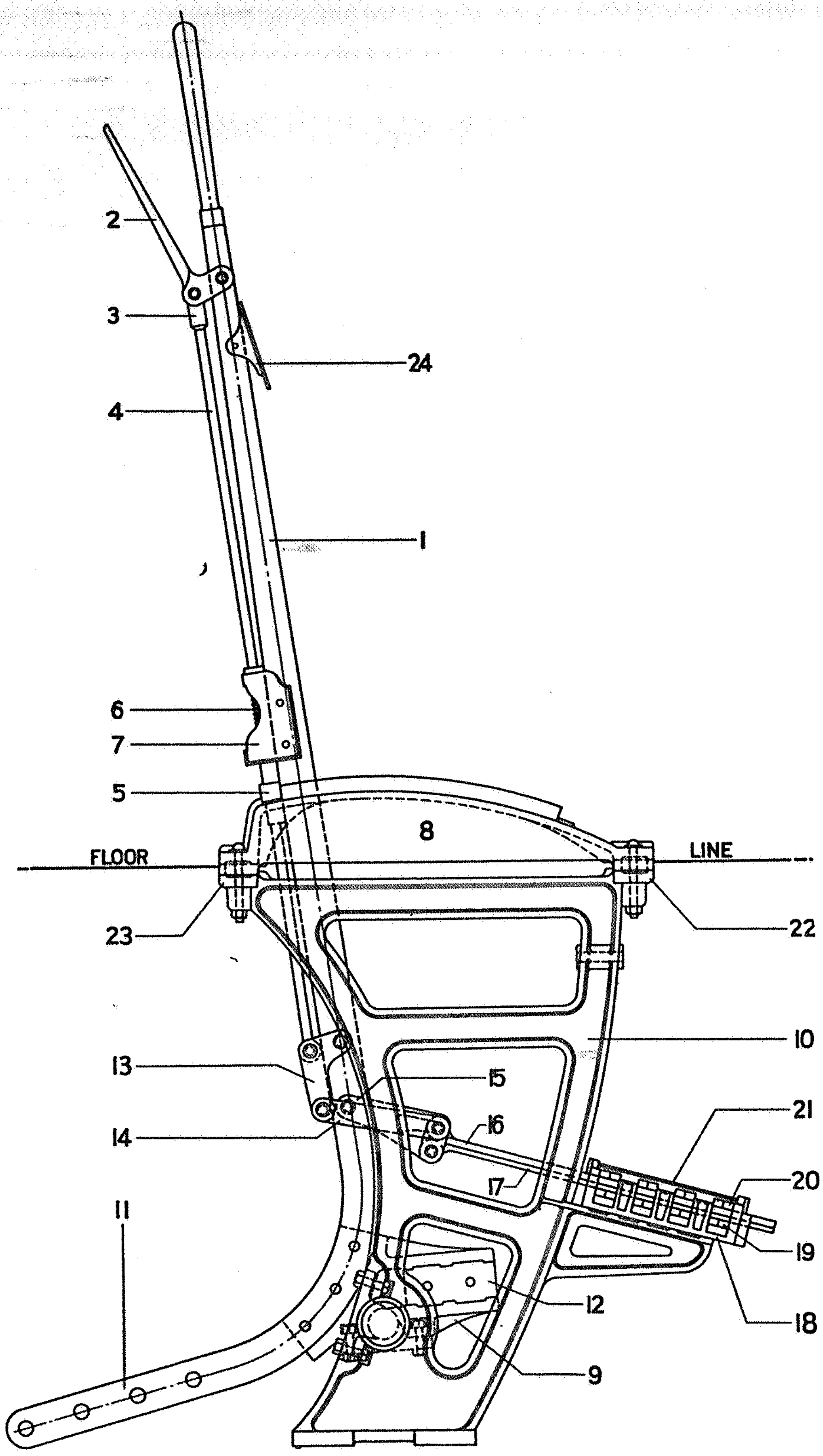


Fig. 8.
English Type S. & F. Interlocking Machine.

The action of raising the latch handle to disengage the latch die 5 from the quadrant and thereby to permit the movement of the lever, is to displace the two pieces comprising the tappet relatively to one another, and thereby make coincident notches in the tappet edge no longer coincident. Therefore the raising of the latch handle locks any other lever desired before the movement of the lever itself.

The locking bars, dogs, etc., are similar to those used in the Style A type of machine, in that it is possible to place four locking bars in each trough with the dogs placed on top or bottom of same, known as top and bottom locking, conserving to some extent the size of the locking bed. The location of the latter, it will be noted, is lower on the machine than in the improved type, in order to obtain the desired amount of movements in upper tappet.

The operation of this machine accomplishes the same results as the improved S. & F. machine and is as follows: when the operator wishes to move a lever he raises the latch handle, which in turn raises the latch rod and compresses the latch spring. This releases the lever and at the same time moves the locking by means of the crank 13, Fig. 8, moving upper tappet upward and forcing the locking dogs out of their normal notches. The operation of the lever moves the tappets downward to a position which, when the latch handle has been released, lines up reverse notches for any necessary movement of dogs to lock lever reversed.

The mechanical construction of the locking consists of bars or tappets locked by a dog moving at right angles to it and engaging a notch cut in the edge of the tappets, these dogs being riveted to horizontal locking bars placed either above or below the tappets except in the case of one or more bars driving the same dog, a stud (represented in the dog chart by a solid portion of a dog) is then riveted to the bar and this stud, working in a recessed portion of the dog, drives dog in direction desired. Each space (trough) has a capacity of four locking bars, two above the tappets and two below, the dogs lying in the same plane as the tappets. When two tappets which are adjacent to each other are to be interlocked a double-faced dog or "web lock" which is longer than the space between the tappets accomplishes the desired result. The locking bed 18, Fig. 8, is made up with the number of spaces (troughs) required, and locking plates are fastened over the locking to hold it in place.

Where special or "when" locking is necessary it is accomplished by the use of a special plate placed underneath the tappets, spanning any required number of troughs. The horizontal locking bar from which it is desired to drive this special locking has riveted to its under side a driving piece, which drives this special plate through a circular disc, when direct locking is held by the position of any particular lever, into any other tappet which may be desired, by means of another driving piece attached to the desired horizontal locking bar. Should the first mentioned horizontal bar not be held by another tappet, the circular disc is free to move, allowing the direct locking to be accomplished and without actuating the special locking.

Figure 9 illustrates a typical track layout and Fig. 10 shows the locking sheet and dog chart necessary for such a track layout. The locking sheet is made in a manner to conform to standard practice. The dog chart indicates the arrangement as seen from the front of the machine. The locking bed is under the floor in front of the machine. The locking as viewed from a position in front of the machine places the low-numbered levers to the left. The tappets are represented by double lines with the locking notches shown. The horizontal locking bars are represented by a line, which for the sake of clearness is shown some distance away from the dog which is attached to it, a connecting line being drawn from the dog to the bar to which it is attached, except that when special locking is involved the locking bar with its special driving pieces is shown. These bars and the troughs in which they are placed are numbered down the side of the dog chart, the trough numbers being shown larger than the numbers on the bars. The bar num-

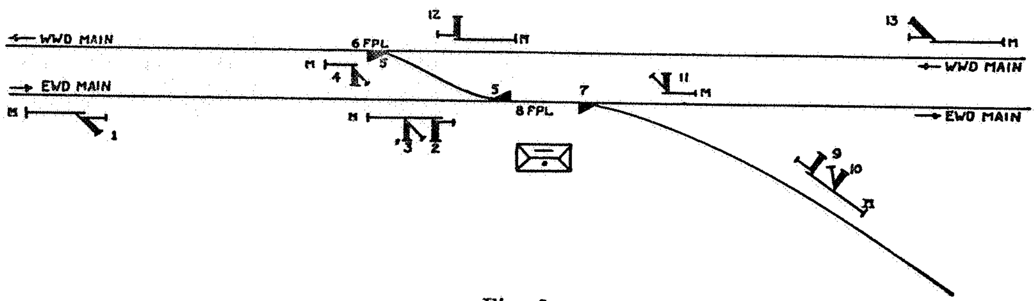
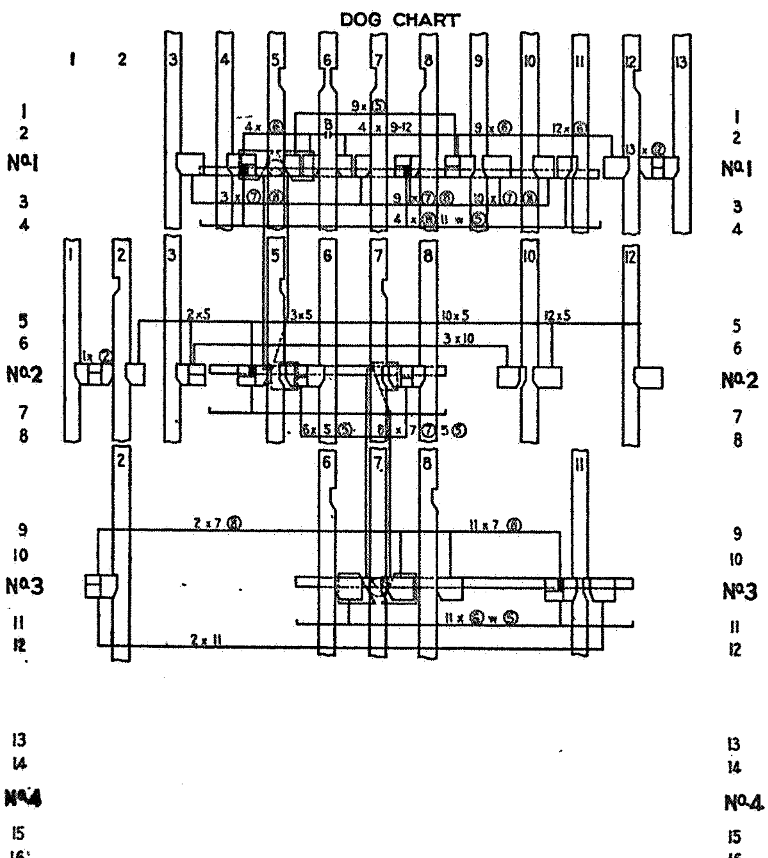


Fig. 9.
Typical Track Layout Using English Type S. & F. Interlocking Machine.



LOCKING SHEET

LEVER	WHEN	LOCKS
1		②
2		5 7 ⑧ 11
3		5·⑦·⑧·10
4		⑥·9 12
	⑤	⑧·11
5		
6		5·⑤
7		
8		7·⑦ 5 ⑤
9		⑤⑥⑦⑧
10		⑦⑧·5
11		7 ⑧
	⑤	⑥
12		5 ⑥
13		⑫

Fig. 10.
Locking Sheet and Dog Chart for English Type S. & F. Interlocking Machine.

bers shown above the trough number are top locking bars and those below are bottom locking bars. Tappets, dogs, etc., are shown in their normal position.

Style A interlocking machine.

Another type of mechanical interlocking machine in use, known as the Style A, is illustrated in Fig. 11. From a study of this figure it will be seen that many parts of this machine are similar to the S. & F. types, the most radical difference being in the arrangement of the mechanical locking. The locking bed is mounted vertically below the floor and to the front of the levers.

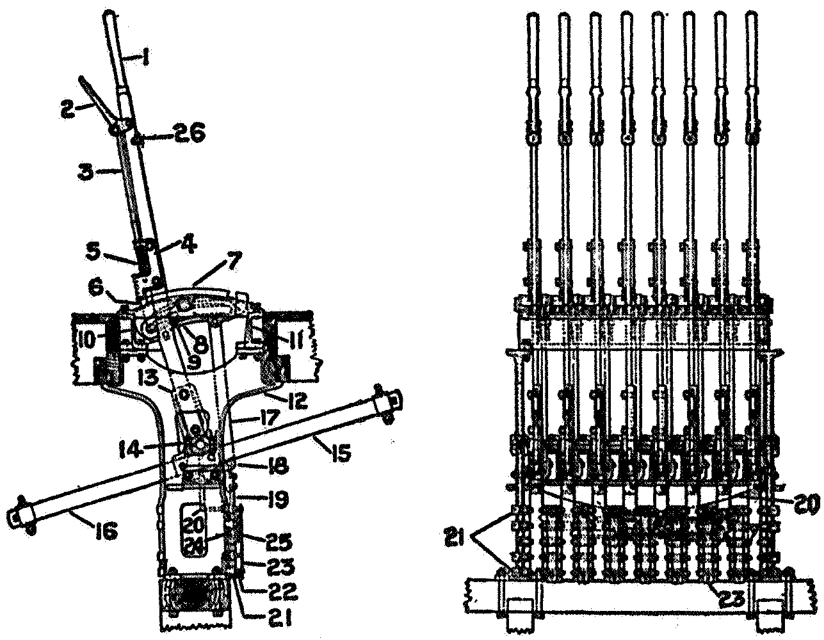


Fig. 11.
Style A Mechanical Interlocking Machine.

The levers in the Style A machine have the same spacing as is used in the S. & F. machine. The parts constituting a Style A machine are as follows, the numbers corresponding to those shown in Fig. 11:

1. Lever.
2. Latch handle.
3. Latch rod.
4. Latch shoe.
5. Latch spring.
6. Latch block.
7. Segment.
8. Rocker.
9. Rocker guide.
10. Back girder.
11. Front girder.
12. Machine leg.
13. Lever shoe.
14. Cap for bottom girder.
15. Back tail.
16. Front tail.
17. Tappet connecting link.
18. Tappet jaw.
19. Tappet.
20. Bottom girder.
21. Locking plate.
22. Front locking guides.
23. Locking plate strip.
24. Back locking.
25. Front locking.
26. Number plate.

The interlocking shown in Fig. 12 is operated by a Style A machine. The locking sheet and dog chart for it are illustrated in Figs. 13a and 13b.

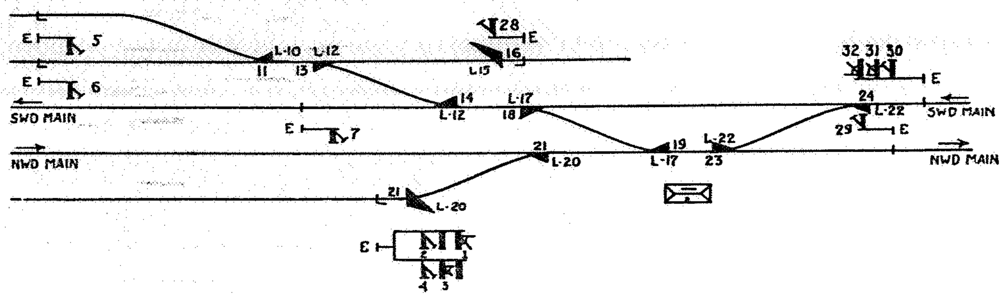


Fig. 12.
Track Layout Using Style A Interlocking Machine.

LEVER	WHEN	LOCKS	LEVER	WHEN	LOCKS
1		2 (17) 19 (20) 21 (22) 23 29	18		21
2		(17) 19 (20) 21 (22) 29	19		
	(23)	30	20		21 (21)
			21		
3		4 (17) (20) (21) (22) 23 29	22		23 (23) 24 (24)
4		(17) (20) (21) (22) 29		23	24
	(23)	30		(23)	(24)
			23		
5		(10) (11) (12) 28 31	24		
	13	(15)	25		SPARE SPACE
	(13)	(17) (22) 24 30	26		" "
	(13) (18)	29	27		" "
			28		(10) (12) (15)
6		(10) 11 (12) 28	29		(17) (22) 24
	13	(15)		18	(20)
	(13)	(17) (22) 24 30		(18)	(12)
	(13) (18)	29		(18) (13)	(10)
7		(12) 14 (17) (22) 24 30 32	30		(17) 19 (22) 31 32
	(18)	29		23	(12)
				23 (13)	(10)
8		SPARE SPACE		(23)	(20)
9		" "	31		(10) 11 (12) (14) (17) 19 (22) 24
10		11 (11)	32		(12) 14 (17) 19 (22) 24
11					
12		13 (13) 14 (14)			
	13	14			
	(13)	(14)			
13		16			
14					
15		(16)			
16					
17		18 (18) 19 (19)			
	18	19			
	(18)	(19)			

Fig. 13a.
Locking Sheet for Style A Interlocking Machine.

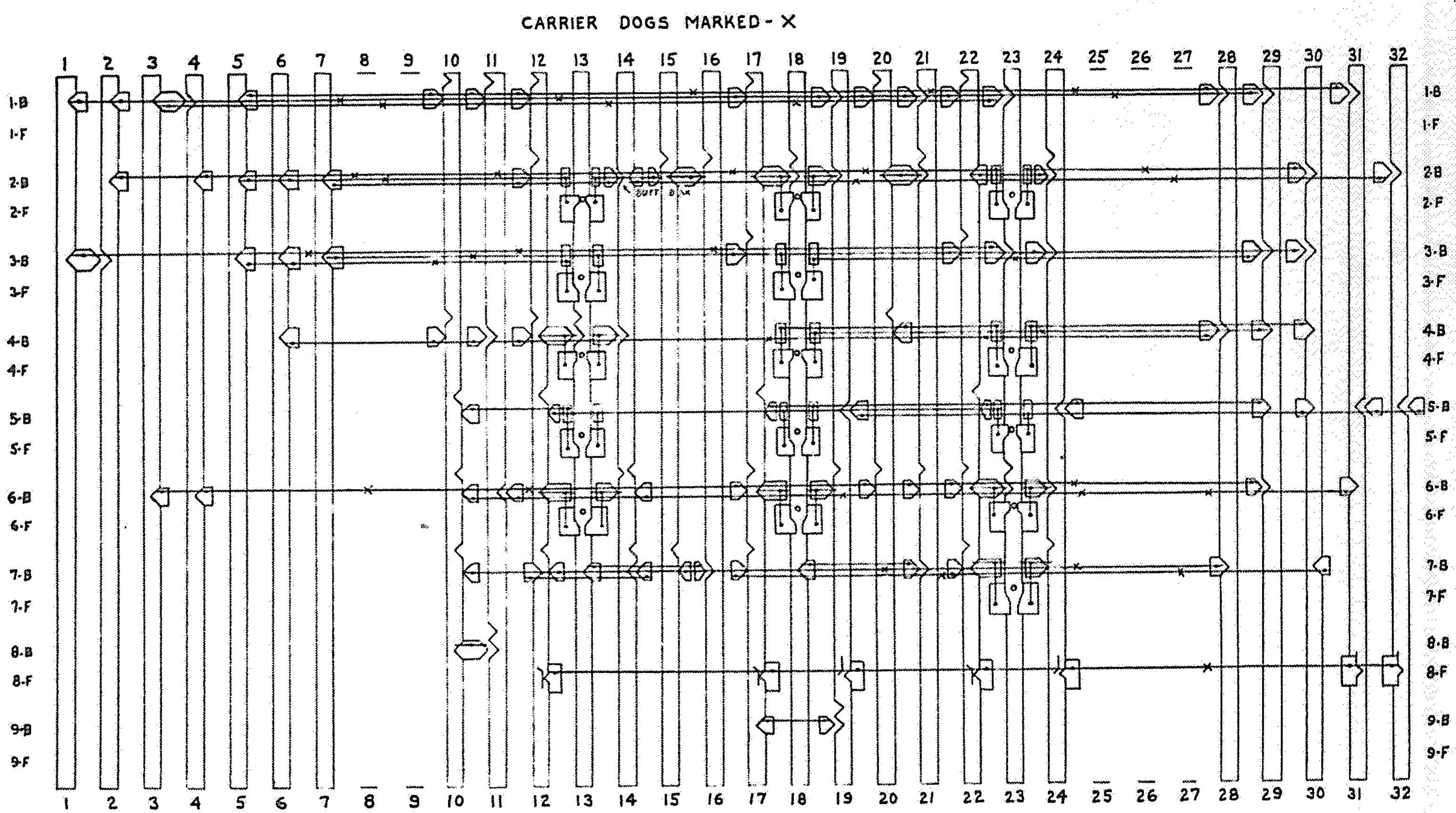


Fig. 13b.

Dog Chart for Style A Interlocking Machine.

With the Style A machine, the latch block and a roller do the same work as the foot of the latch rods and rocker die in the improved S. & F. machine. The latch block is used to adjust the length of the latch rod. The segment, while of slightly different design from the quadrant used on the improved S. & F. machine, performs the same function.

The rocker has a lug cast on one end. This extends through and above the segment, and the operator may if he wishes press down on this lug with his foot, and thereby with less effort raise the latch handle. The rocker guide riveted to the lever acts as a guide for the rocker.

The tappet connecting link connects the rocker to the tappet. The tappet jaw is rigidly fastened to the tappet which directly actuates the front and back locking.

The locking plate supports the front and back locking and guides the tappets. The back locking is placed in the same plane as the tappets between which such locking is accomplished. The front locking is placed in front of the back locking, and the front locking guides are screwed to the locking plate to serve as supports and guides. Locking plate strips are placed in front of the front locking to hold it in place.

The locking plates which are attached to and supported by the machine legs are constructed with four separate spaces for locking, the upper space being designated as space 1, the next space as 2, etc. The plates are made in four and eight-lever sections to correspond with the machine sections. Two tiers of locking may be placed in each space, the back tier being called the back locking and the front tier the front locking. It is possible to place three bars side by side in the space provided for the back locking bars, and five bars side by side in the space provided for the front locking bars. Cross-locking bars of back locking are lettered A, B and C, beginning at the top. Cross-locking bars of front locking are lettered A, B, C, D and E. The different widths identify their location.

When there is insufficient space in one tier of locking plates to hold the locking for the machine to be used, additional tiers of plates are added. This is done by bolting to the bottom of the machine legs extension legs upon which to fasten the added locking plates. When more than one tier of locking plates are required each tier added provides five additional spaces for locking. For example, one tier provides four spaces, two tiers nine spaces and three tiers fourteen spaces for locking. This is explained as follows: when two locking plates are joined together the space between the lower space of the upper plate and the upper space of the lower plate combine to provide an additional locking space.

In extreme cases locking plates may also be placed on the opposite side of the machine legs and beneath the front tail levers. The tappets in this arrangement are connected to the front end of the rocker.

The operation of this machine accomplishes practically the same result as the improved S. & F. machine and is as follows: when the operator wishes to move a lever, he first raises the latch handle, which in turn raises the latch rod and block and compresses the latch spring. This releases the lever and at the same time gives the rocker one half of its throw. The rocker in turn transmits its throw by means of the connecting link to the tappet and locking. When the lever has been moved to the opposite position, the latch spring forces the latch block into engagement with the stop on the segment and in doing so imparts the other half of the throw to the rocker and through it to the tappet and locking.

The mechanical construction consists of the locking of a bar or tappet locked by a dog moving at right angles to it and fitting in a notch cut in the edge of the tappet.

In space 2-B between tappets 15 and 16, Fig. 13b, it will be noted that the two adjacent tappets are interlocked by the locking dog which is longer than the space between the two tappets, and that tappet 15 is free to move only when the dog can enter the notch cut in tappet 16. Consequently, if lever 16 is not moved to the reverse position, lever 15 is locked and cannot be moved.

When tappets to be interlocked are not adjacent to each other, the locking dogs are connected together by means of small locking bars as shown in space 1-B, Fig. 13b, extending between tappets 1 and 29.

The tappets, longitudinal locking bars, tappet connecting links, locking dogs and all pins are usually made of cold-drawn steel. The locking and carrier dogs are of various sizes and shapes, depending upon where they are to be used and the locking to be effected. They are usually fastened to locking bars with two steel screws, as shown on the dog chart in Fig. 13b by the dots on the various locking bars. Carrier dogs are located at certain points to prevent the longitudinal bars from being forced out of place.

Locking bars are ⅜ inch by ⅜ inch stock and tappet pieces are ½ inch by 2 inches and of a length necessary for the number of locking tiers used.

The tappets move downward when levers are reversed, the full stroke being 1$\frac{1}{16}$ inches. The longitudinal bars or dogs used in front and back locking travel $\frac{7}{16}$ inch for the complete movement. The dog chart, Fig. 13b, illustrates the method used to show clearly the arrangement of front and back locking, the back locking for each space being shown above its respective front locking.

In front locking small lugs designated as tappet pieces shown in space 8-F, Fig. 13b, are fastened to the tappets and the dogs strike against these as they would against the side of the notch in tappet in back locking.

Where special or "when" locking is necessary, it is accomplished by use of a swing dog as shown in spaces 2-F, 3-F, 4-F, 5-F and 6-F on tappet 13, Fig. 13b. These swing dogs are pivoted on the tappet and the locking necessary between certain tappets becomes effective, depending upon the position of the lever to which the tappet is fastened.

In the operation of the complete interlocking machine, such lever movement as may be required to move switches to proper positions and to clear necessary signals for movement of trains must be made in the sequence dependent upon the arrangement of locking, and for the signal layout, Fig. 12, the locking effects as stated in locking sheet, Fig. 13a, would obtain. The description of how these results are achieved in the S. & F. types applies equally well to the Style A machine.

However, attention is again called to the movement of the levers with tappets attached. When lever is reversed the tappet moves downward and in doing so forces the dogs with which it engages to the right or left to lock or release other levers in the combination. At the same time any swing dogs on the tappet move into combination to release or lock other tappets.

Certain modifications to mechanical machines are in effect in different localities, but generally they are all arranged along the principles covering the three types of mechanical machines described.

Power interlocking.

Power interlocking may be divided into two types: electro-pneumatic and electric.

There are several different types of machines that may be used for both electro-pneumatic and electric interlockings, but only those machines involving mechanical locking between levers will be illustrated in this chap-

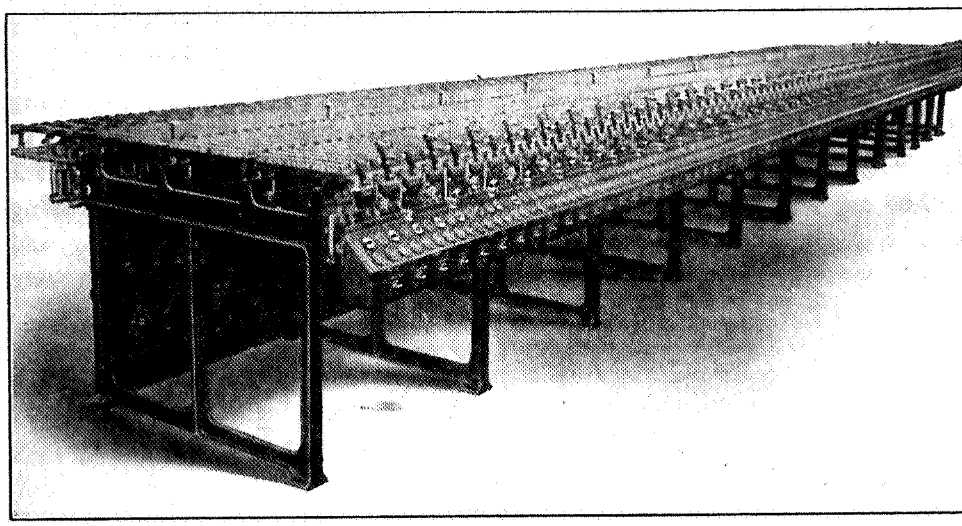


Fig. 14.
Electro-Pneumatic Interlocking Machine (Case Removed).

ter. The machine shown in Fig. 14 has been used more than any other type for electro-pneumatic interlockings. Another machine used strictly for electric interlocking is shown in Fig. 15. Table interlocking machines have also

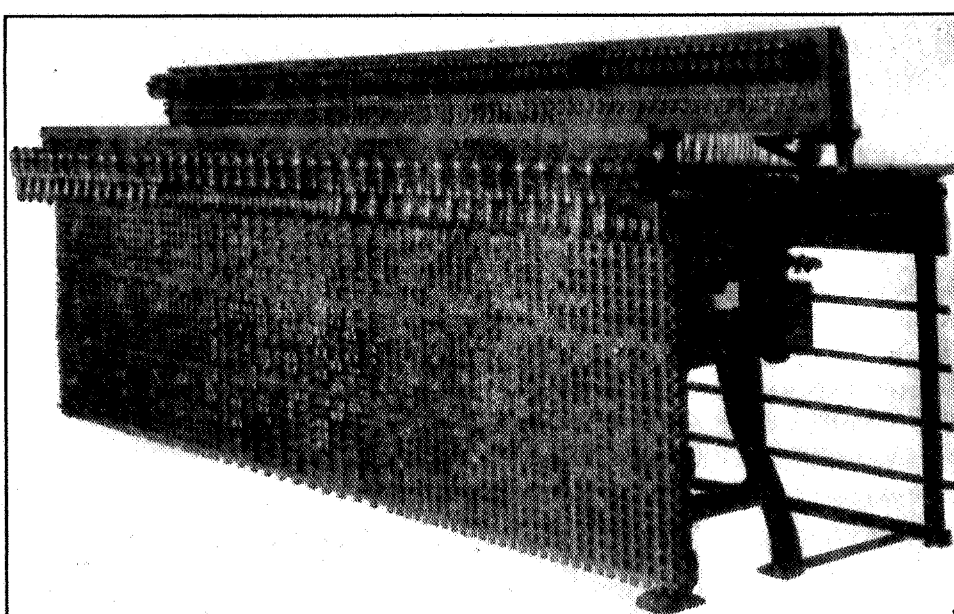


Fig. 15.
Electric Interlocking Machine.

been used extensively for both electric and electro-pneumatic interlockings.

The details of machine shown in Fig. 14 are described in Chapter XVIII—Electro-Pneumatic Interlocking, while those for machine illustrated in Figs. 15 and 26 to 30, inclusive, are described in Chapter XIX—Electric Interlocking.

Electric or electro-pneumatic interlocking machine.

In using the machine illustrated in Fig. 14, the switches and signals for a certain track layout are as illustrated in Fig. 16, the same numbering applying for an electro-pneumatic or electric interlocking machine.

The locking sheet and dog chart for the machine in Fig. 14 are illustrated in Fig. 17. This locking is the same for an electro-pneumatic or electric interlocking using this type of machine.

As the dog chart indicates, the locking is very much like the improved S. & F. mechanical locking, except that it is miniature in size. It is not operated by the lever latch, but by the lever itself. The driver is attached to the lever shaft and consists of a clamp and gear which fits into grooves on the underneath part of the locking bar driving same to the right or left depending upon which direction the lever is moved. A section of locking with driver fastened to lever shaft is illustrated in Fig. 18. More than one locking bar may be operated from the same lever by installing another driver to the lever shaft under the desired locking bar.

The dog chart illustrated in Fig. 17 has the arrangement of levers reversed from that illustrated in Fig. 6, as it represents the layout as seen facing the machine, the locking being at the front of the machine instead of the rear as is the case in the improved S. & F. machine.

The switch levers when in the normal position are inclined to the left, while in the reverse position they are inclined to the right, which means that the dogs attached to locking bars operated by switch levers move the same as mentioned in the description of the locking in an improved S. & F. machine.

There is a different arrangement required in the case of signal levers, as their normal position is in the center and they can be moved to the right or left. It is therefore necessary to have the dogs that are attached to bars operated by signal levers so arranged that they will lock the other dogs when the signal lever is moved to the right or left, depending on what particular route is being set up.

By referring to the dog chart, Fig. 17, it can be seen that the signal lever dogs are shown wide on one side of the cross-locking, the narrow portion being an extension to prevent the release of the cross-locking. If the wide part of the dog is to the right of the cross-locking it means that this dog will go through the cross-locking when the lever is moved to the right, while those with the wide part to the left would be effective when the lever was moved to the left. The swing, between-stroke and other switch lever dogs are practically the same as those shown for the improved S. & F. mechanical machine. It will also be noted that between-stroke and swing dogs are shown on the same locking bar and in the same bracket. In these cases the swing dog is over the between-stroke dog and the cross-locking is cut accordingly.

The locking bars, cross-locking and dogs are usually made of cold-drawn steel, the locking bars being ¼ inch by ⅝ inch, with length depending on

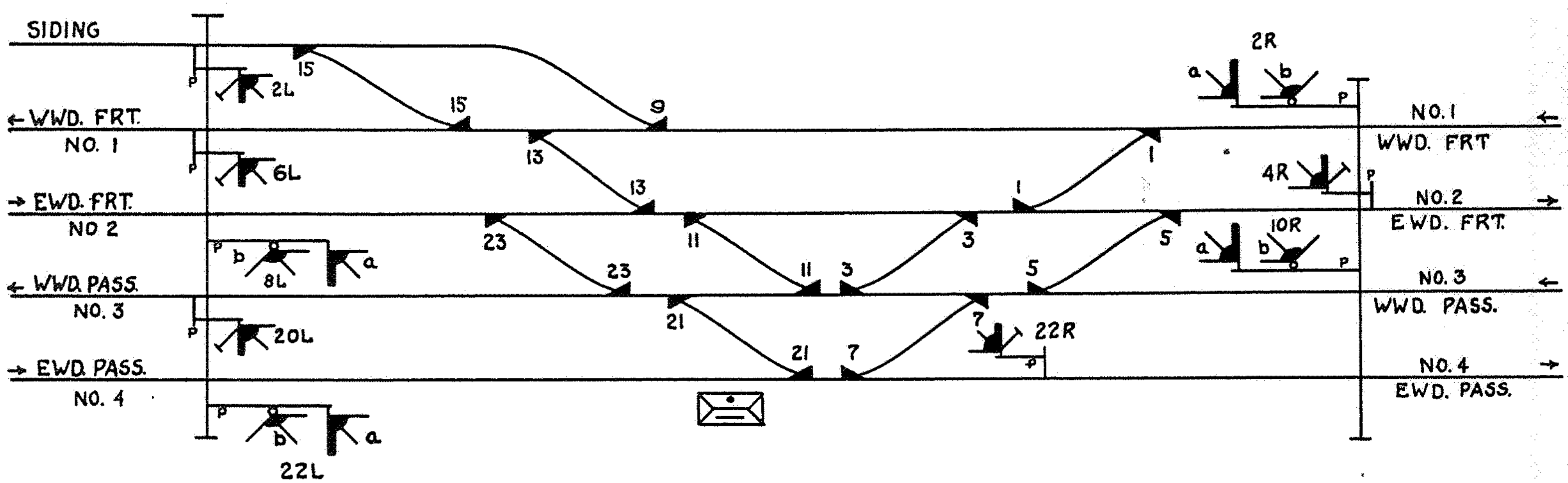


Fig. 16.

Track Layout Using Electric or Electro-Pneumatic Interlocking Machine.

LEVER	WHEN	LOCKS
1		11
2R		1 (1)
	1	9 (9)
	1 9	6L 13 15 (15)
	1 (9)	15
	(1)	3 (3) 6L
	(1) 3	13 (13)
	(1) 3 13	8L 23
	(1) (3)	8L 20L 21 23 (23)
	(1) (13)	15 (15)
2L		15 (15)
	15	1 (9)
	(15)	13 (13)
	(15) 13	1 9
	(15) (13)	11 (11)
	(15) (13) 11	1 (1)
	(15) (13) 11 1	4R 5
	(15) (13) (11)	4R 5 (5) 7 10R
3		13
4R		5 (5)
	5	1 3 (3) 11
	5 3	13 (13)
	5 3 13	8L 23
	5 (3)	8L 20L 21 23 (23)
	5 (13)	6L 15 (15)
	(5)	7 (7)
	(5) 7	3 11 (11)
	(5) 7 11	20L 21 23 (23)
	(5) 7 11 (23)	8L
	(5) 7 (11)	13 (13)
	(5) 7 (11) 13	23
	(5) 7 (11) (13)	15 (15)
	(5) (7)	21 22L

LEVER	WHEN	LOCKS
4R	(11) (13)	6L
	(11) 23	8L
5		–
6L		13 (13) 15
	13	1 9
	(13)	11 (11)
	(13) 11	1 (1)
	(13) 11 1	5
	(13) (11)	5 (5) 7 10R
7		–
8L		23 (23)
	23	3 11 (11) 13
	23 11	1 (1)
	23 11 1	5
	23 (11)	5 (5) 7 10R
	(23)	21 (21)
	(23) 21	3 (3) 11
	(23) 21 3	5 (5) 7
	(23) 11 7	10R
	(23) 21 (3)	1 (1)
	(23) 21 (3) 1	5
	(23) (21)	7 22R
9		–
10R		5 7 (7)
	7	3 11 (11)
	7 11	20L 21 23 (23)
	7 (11)	13 (13)
	7 (11) 13	23
	7 (11) (13)	15 (15)
	(7)	21 22L

LEVER	WHEN	LOCKS
11		–
12		SPARE SPACE
13		–
14		SPARE SPACE
15		–
16		SPARE SPACE
17		" "
18		" "
19		" "
20L		21 (21) 23
	21	3 (3) 11
	21 3	5 (5) 7
	21 (3)	1 (1)
	21 (3) 1	5
	(21)	7 22R
21		–
22R		7 21 (21)
	(21)	23 (23)
22L		7 (7) 21
	(7)	5 (5)
23		–

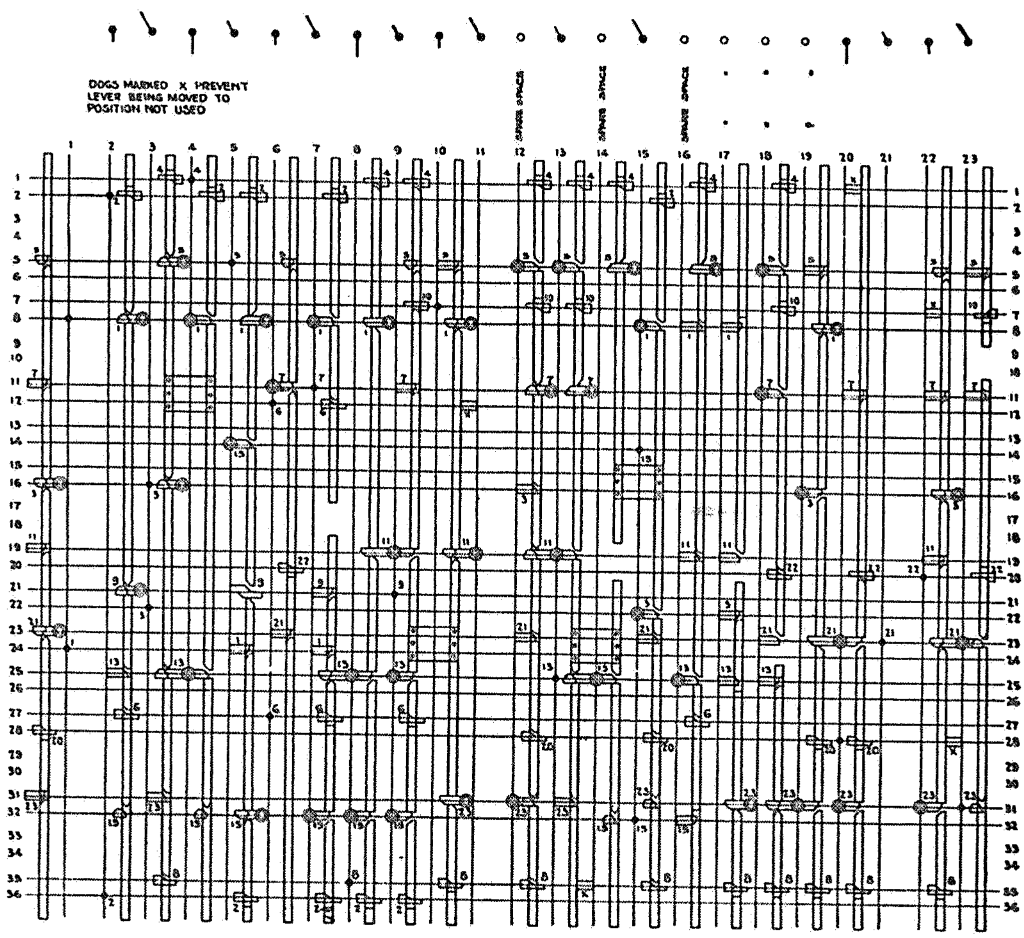


Fig. 17.

Locking Sheet and Dog Chart for Electric or Electro-Pneumatic Interlocking Machine.

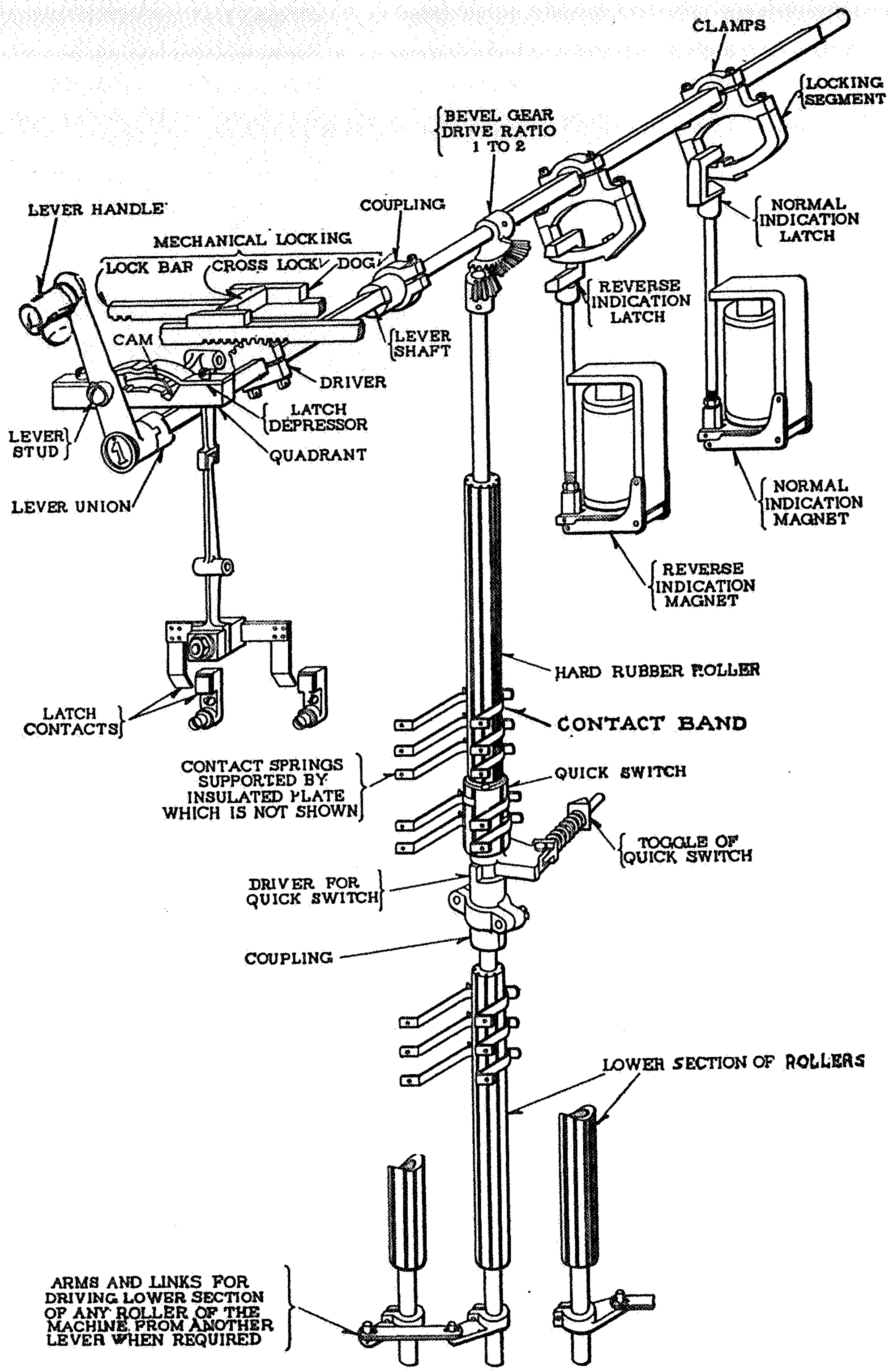


Fig. 18.

Section of Locking with Driver Fastened to Lever Shaft for Machine, Fig. 14.

size of machine; cross-locking is 3/8 inch by 3/8 inch, and the length also depends on size of machine and location of dogs to be arranged. The dogs are of various sizes and shapes depending on how the locking must be arranged. The full stroke of the locking bars operated by switch levers is 1 1/16 inches. Thus, it will be seen that when a signal lever is moved from normal to the right or left, the locking bar moves one-half this distance. The cross-locking stroke is 1/4 inch, which is the width of the locking bar.

By studying the arrangement of locking as illustrated in Fig. 17, it will be seen that as levers are moved from one position to the other the locking bars are driven in much the same manner as described in the improved S. & F. locking. The between-stroke and swing dogs shown on the same bar and in the same bracket are separate and distinct dogs, the between-stroke dogs being riveted directly to the locking bar, the swing dogs being placed over the between-stroke dog and attached to the tappet which is riveted to the same locking bar. The combined thickness of these two dogs is the same as the cross-locking. Locking bracket caps are screwed to the top of the locking bracket so as to hold the cross-locking in place. When not much cross-locking is used it is necessary to place blank cross-locking in various brackets to prevent the locking bars from being forced out of the brackets.

Electric interlocking machine.

Figure 19 illustrates a track layout operated by the electric machine in Fig. 15, and Figs. 20a and 20b illustrate the locking sheet and dog chart necessary for this layout.

This type of locking, while somewhat similar to the Style A locking used in mechanical machines, is of a miniature size. It is used principally by one of the large signal companies in their all-electric and electro-mechanical interlocking machines.

In many of the machines now in service the locking between levers becomes effective only by movement of the lever itself, the so-called preliminary latch locking not being provided. However, with the later type of machines the design of lever has been so modified that the movement of the lever latch itself operates the tappet and accomplishes the locking desired.

In the first machines using this type of locking, two longitudinal bars 1/4 inch thick and 3/8 inch wide were placed in each locking space and had a horizontal movement of 1/4 inch, the tappet bars were 1/4 inch thick and 3/4 inch wide and moved 3/4 inch vertically. In the later machines four longitudinal bars 1/4 inch by 1/4 inch are used in each locking space and the new tappets are 3/8 inch thick and 3/4 inch wide, the movement of each being the same as in the earlier machines of this type. The four longitudinal bars are lettered A, B, C and D from top to bottom.

Eight locking spaces are obtainable in each locking plate (tier), these plates being made in four and eight-lever sections. In the first machines the tappets were riveted directly to the connection from the lever.

On the later machines the connection from lever to tappet is accomplished by use of a specially designed end on each member, the two then being secured together by use of a special key piece and tap bolt with locking device. This arrangement permits tappet to be removed from locking plate without disturbing the lever. However, the connection occurs at a point over the first slot or space on the top locking plate, and conse-

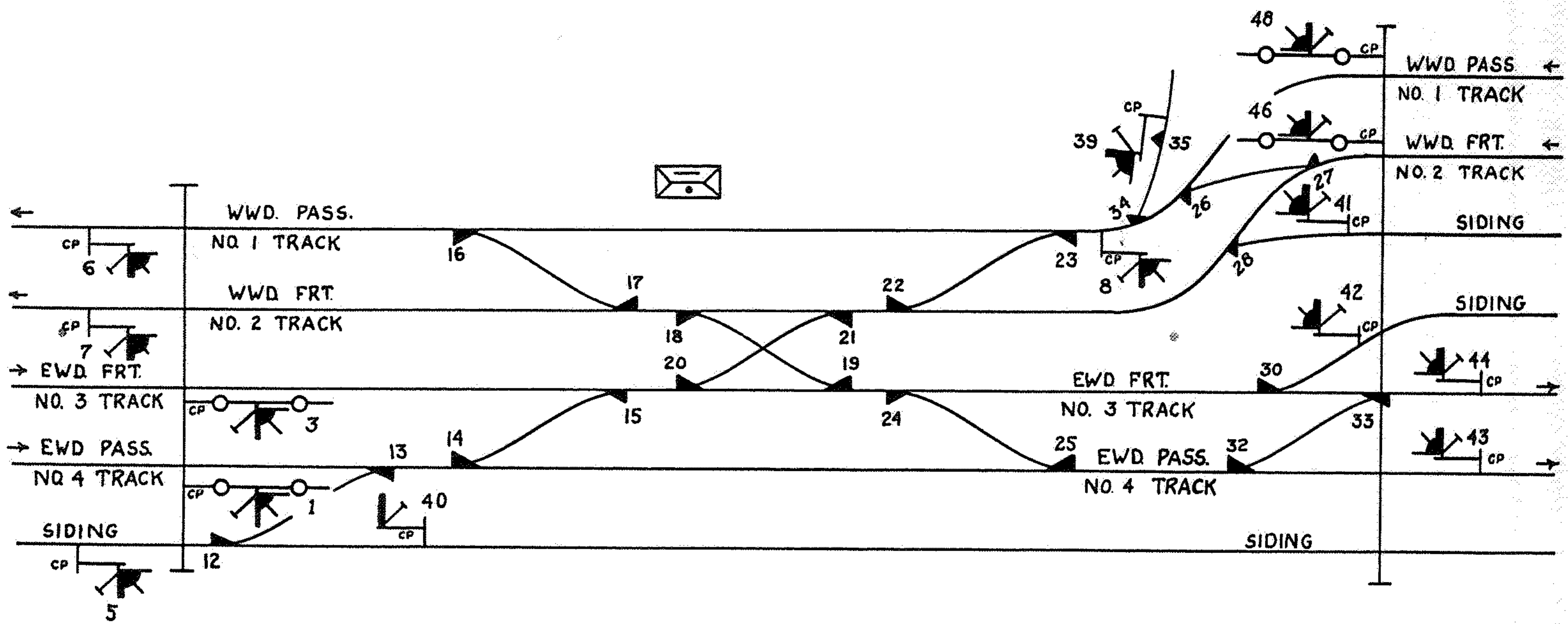


Fig. 19.

Track Layout Using Electric Interlocking Machine.

LEVER	WHEN	LOCKS
1		14 (14) 12
	14	24 32 (32) 43
	14 (32)	44
	(14)	20 (20) 18
	(14) 20	24 (24)
	(14) 20 24	30 (30) 42
	(14) 20 24 30	32 44
	(14) 20 (24)	32 (32) 43 44
	(14) (20)	22 (22)
	(14) (20) 22	28 (28) 41
	(14) (20) 22 28	26 46
	(14) (20) (22)	39 46 48
2	SPARE SPACE	
3		14 20 (20) 18
	20	24 (24)
	20 24	30 (30) 42
	20 24 30	32 44
	20 (24)	32 (32) 43 44
	(20)	22 (22)
	(20) 22	28 (28) 41
	(20) 22 28	26 46
	(20) (22)	39 46 48
4	SPARE SPACE	
5		12 (12) 40
	(12)	14 (14)
	(12) 14	24 32 (32) 43
	(12) 14 (32)	44
	(12) (14)	20 (20) 18
	(12) (14) 20	24 (24)
	(12) (14) 20 24	30 (30) 42
	(12) (14) 20 24 30	32 44
	(12) (14) 20 (24)	32 (32) 43 44
	(12) (14) (20)	22 (22)
	(12) (14) (20) 22	28 (28) 41
	(12) (14) (20) 22 28	26 46
	(12) (14) (20) (22)	39 46 48
6		16 (16)
	16	22 39 48
	16 (26)	46
	(16)	18 (18) 20
	(16) 18	22 (22)
	(16) 18 22	28 (28) 41
	(16) 18 22 28	26 46
	(16) 18 (22)	39 46 48
	(16) (18)	24 (24)
	(16) (18) 24	30 (30) 42
	(16) (18) 24 30	32 44
	(16) (18) (24)	32 (32) 43 44
7		16 18 (18) 20
	18	22 (22)
	18 22	28 (28) 41
	18 22 28	26 46
	18 (22)	39 46 48
	(18)	24 (24)
	(18) 24	30 (30) 42
	(18) 24 30	32 44
	(18) (24)	32 (32) 43 44
8		22 (22) 34 (34) 26 (26)
	(26)	46 39 48
9	SPARE SPACE	
10	" "	
11	" "	
12	–	
13		
14		18
15	–	
16		20
17	–	
18		20 22
19	–	

LEVER	WHEN	LOCKS
20		24
21	–	
22	–	
23	–	
24	–	
25	–	
26		34
27	–	
28	–	
29	SPARE SPACE	
30	–	
31	SPARE SPACE	
32	–	
33	–	
34	–	
35	–	
36	SPARE SPACE	
37	" "	
38	" "	
39		(34) 22 (22)
	22	16
	(22)	20 (20) 18
	(22) 20	16 (16)
	(22) (20)	14 (14)
	(22) (20) (14)	12 (12)
40		12
41		(28) 22 20 (20) 18
	20	16 (16)
	(20)	14 (14)
	(20) (14)	12 (12)
42		(30) 24 20 18 (18)
	18	14 (14)
	18 (14)	12 (12)
	(18)	16 (16)
43		32 24 (24)
	24	14 12 (12)
	(24)	18 (18) 20
	(24) 18	14 (14)
	(24) 18 (14)	12 (12)
	(24) (18)	16 (16)
44		32 (32)
	32	30 24 18 (18) 20
	32 18	14 (14)
	32 18 (14)	12 (12)
	32 (18)	16 (16)
	(32)	24 (24)
	(32) 24	14 12 (12)
	(32) (24)	18 (18) 20
	(32) (24) 18	14 (14)
	(32) (24) 18 (14)	12 (12)
	(32) (24) (18)	16 (16)
45	SPARE SPACE	
46		26 (26)
	26	28 22 20 (20) 18
	26 20	16 (16)
	26 (20)	14 (14)
	26 (20) (14)	12 (12)
	(26)	22 (22)
	(26) 22	16
	(26) (22)	20 (20) 18
	(26) (22) 20	16 (16)
	(26) (22) (20)	14 (14)
	(26) (22) (20) (14)	12 (12)
47	SPARE SPACE	
48		26 34 22 (22)
	22	16
	(22)	20 (20) 18
	(22) 20	16 (16)
	(22) (20)	14 (14)
	(22) (20) (14)	12 (12)

Fig. 20a.

Locking Sheet for Electric Interlocking Machine.

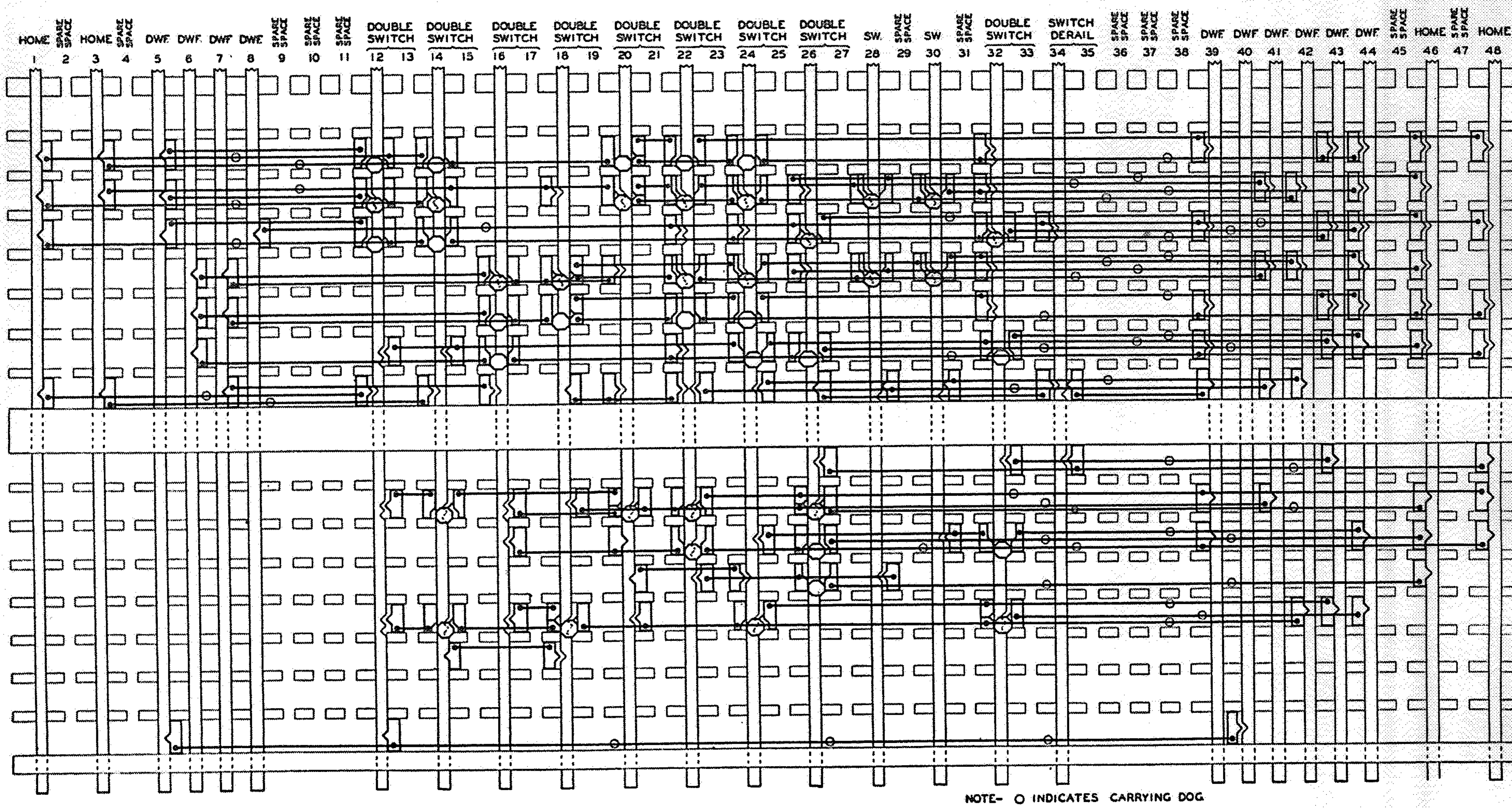


Fig. 20b.

Dog Chart for Electric Interlocking Machine.

quently no longitudinal bars or locking dogs are installed in this slot (space).

The locking plates are attached to the front of the machine legs or supports beneath the levers. With the present-day efficient arrangement of locking it is seldom necessary to use more than two, or at the most three, sections of plates.

The locking bar slots (spaces) in original and modified locking plates are ½ inch by ¾ inch and ⅝ inch by 1⅛ inches, respectively. The longitudinal bars are placed beneath the tappet bars in the slots, the locking dogs are riveted or screwed to the top of the longitudinal bars and except in cases where special locking occurs, are driven by or lock into notches (cut to fit end of locking dog) in sides of tappet bars.

Special locking dogs are fastened directly to the front face of the tappet, and consist of a special guide block of steel cut out on the under side to hold and carry the loose locking dog as it moves sideways to engage with the locking dogs on the bars on either or both sides of the controlling tappet when in normal or reverse positions.

Where the arrangement of locking is such that locking dogs are not applied to longitudinal bars frequently enough to insure proper rigidity and alignment of bars, then square-end carrier dogs are attached at the desired points.

The tappets are secured in place by locking plates by use of retaining plates attached at the junction of each pair of plates and at the bottom of the last plate.

Where the locking necessary between certain levers is more than can readily be accomplished in the regular slots, special "bridges" are used to reach from a bar in one slot to the proper bar in another slot. This arrangement is used in modified machines. In the older machines similar results are obtained by use of an additional longitudinal bar which is first attached to a locking dog in one slot and then bent upward, downward or side set to clear intervening obstacles in reaching the desired slot and tappet in which the locking desired may be effected; in such cases these additional bars are supported on and secured to the locking plates with special locking bar guides.

In this type of locking, as in other types, various shapes of locking dogs are necessary to obtain the results desired. A study of the dog charts and locking sheets of machines in service will be found of great assistance in becoming familiar with the types used and the results obtained.

There are other types of machines used with power interlockings that have certain modifications in the mechanical locking from that described, but the same general principles will apply, and a study along the lines previously mentioned will no doubt suffice in arriving at an understanding as to how the mechanical locking operates.

Electro-mechanical interlocking machine.

As the name suggests, an electro-mechanical machine is the combination of an electric and a mechanical machine. Two types have been furnished in which the mechanical locking and locking bed have been omitted from the mechanical section and handled by the miniature type locking in the electric section. In these two types the electric section has been either as shown in Fig. 14 or 15. These combinations as an electro-mechanical machine are shown in Figs. 21 and 22, respectively.

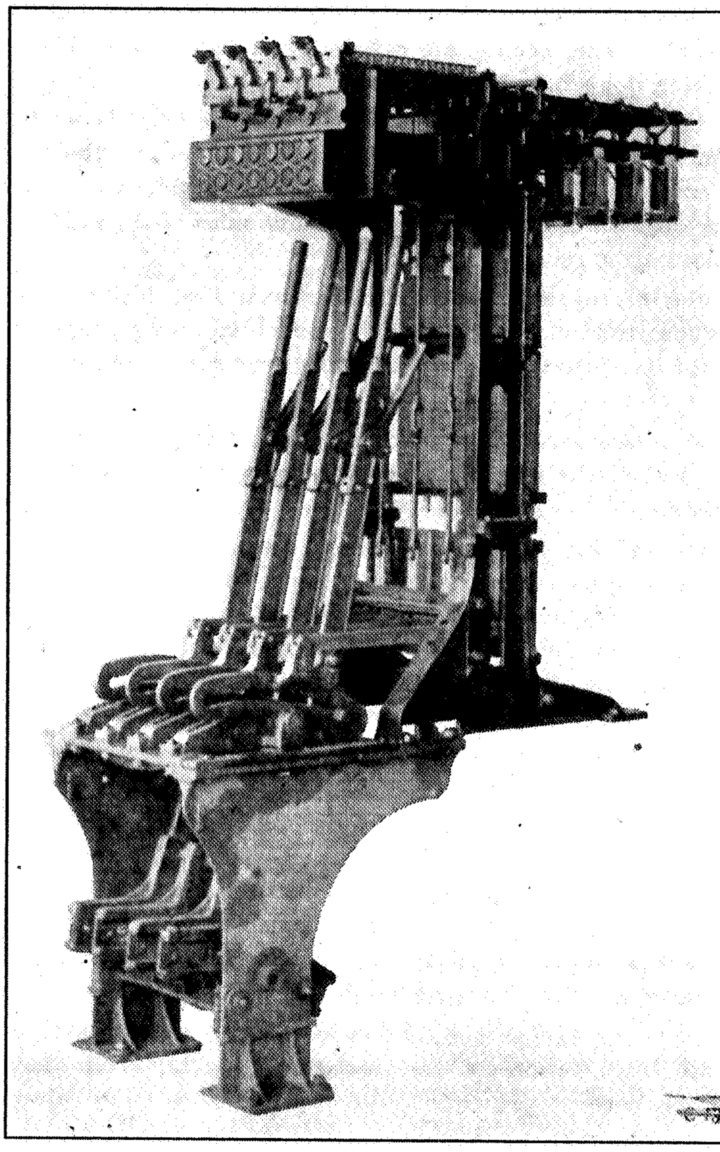


Fig. 21.

Electro-Mechanical Interlocking Machine, Style P-5.

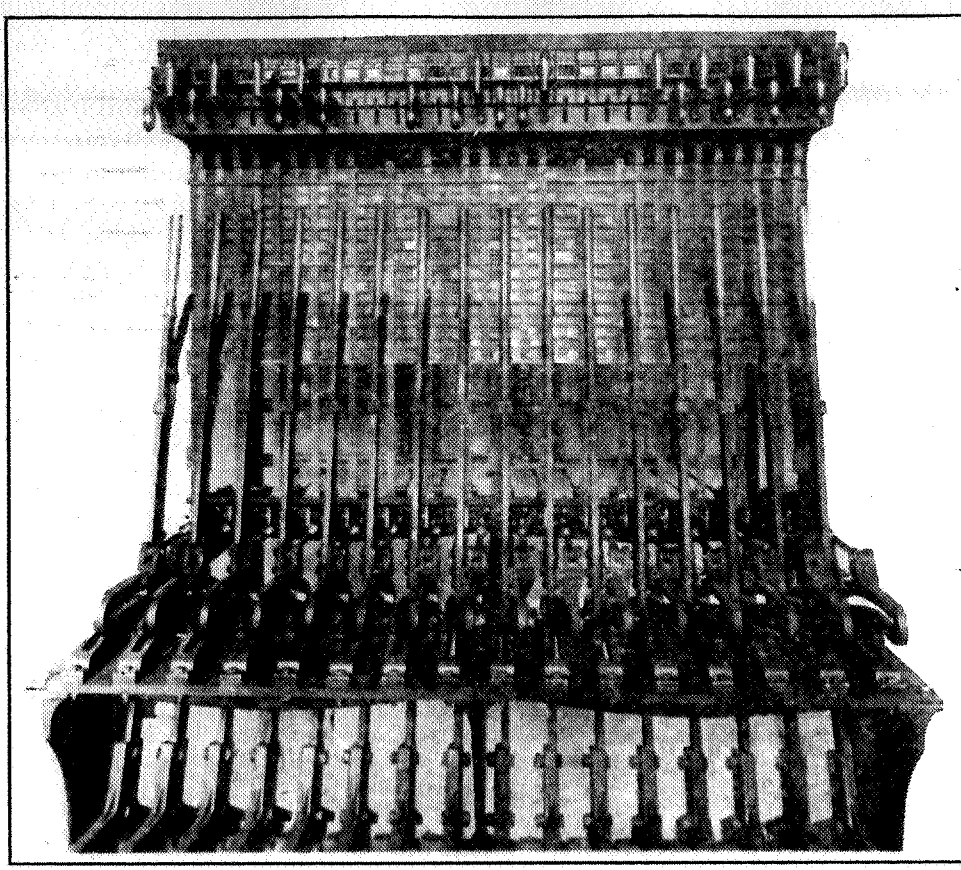


Fig. 22.

Electro-Mechanical Interlocking Machine, Model 2B.

A third type electro-mechanical machine which has quite generally superseded the previous two types mentioned is illustrated in Fig. 23. In this arrangement, the mechanical locking bed and locking in the mechanical section are retained completely and the electric section consists of a frame containing independent and self-contained lever units, similar in design and operation to the levers in a power machine.

The rod in Fig. 23, shown extending between the electric unit and mechanical machine, is connected at the top to a crank attached to the shaft of the small electric lever. The lower end is connected direct to the locking shaft, or to a loose-sleeve driver around the locking shaft, and then by a driver to the proper locking bar. As the electric lever is moved from one position to the other the locking bar is moved, making certain mechanical locking effective, as described under the improved S. & F. mechanical machine locking.

Chapter XVII—Mechanical and Electro-Mechanical Interlocking describes more fully the details of each of these machines.

Figure 24 illustrates a track layout using an electro-mechanical machine, in which the machine shown in Fig. 23 is used.

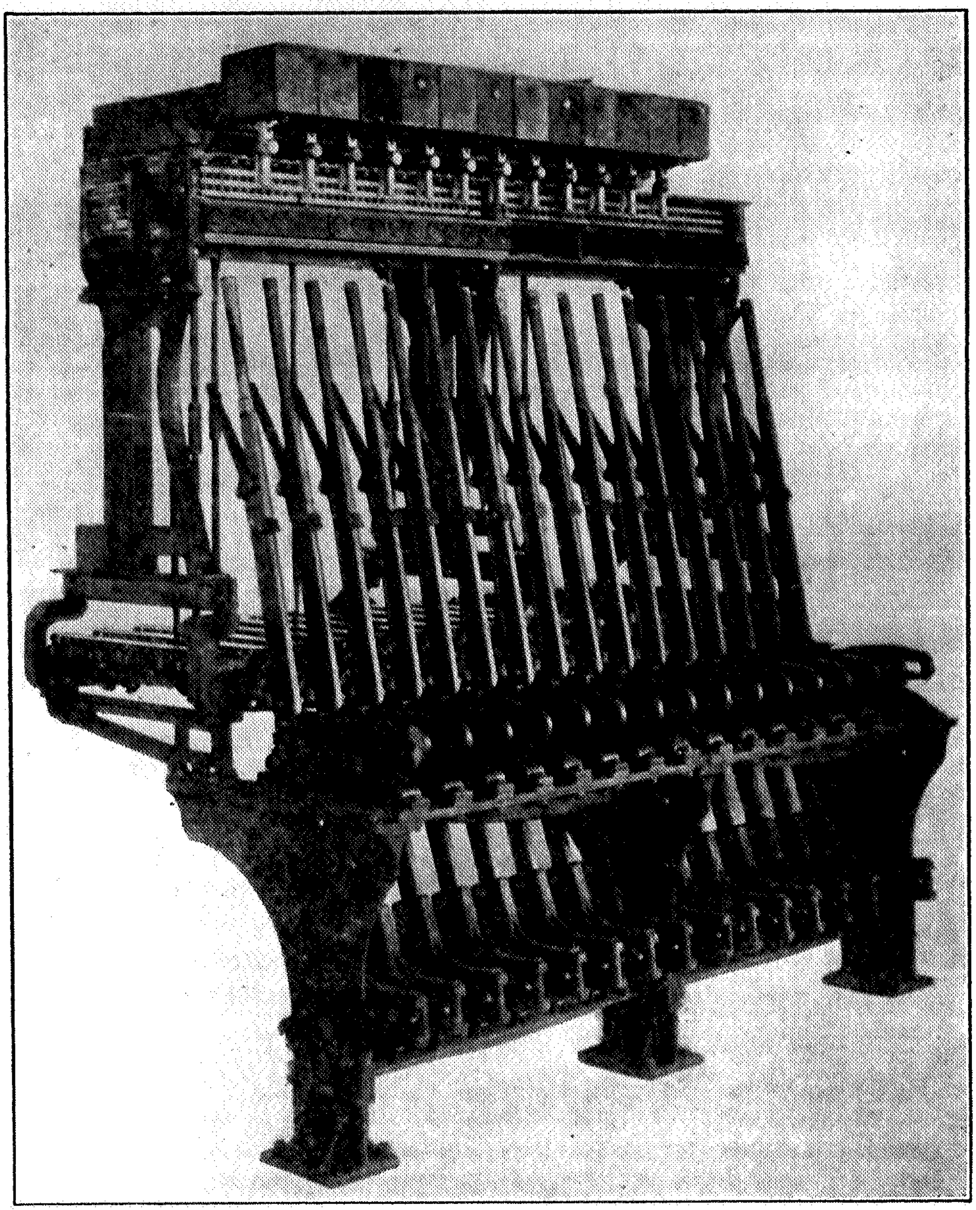


Fig. 23.

Electro-Mechanical Interlocking Machine Using Electric Lever Units (Self-Contained), Style S-8.

Figure 25 illustrates the locking sheet and dog chart necessary for the track arrangement as shown in Fig. 24.

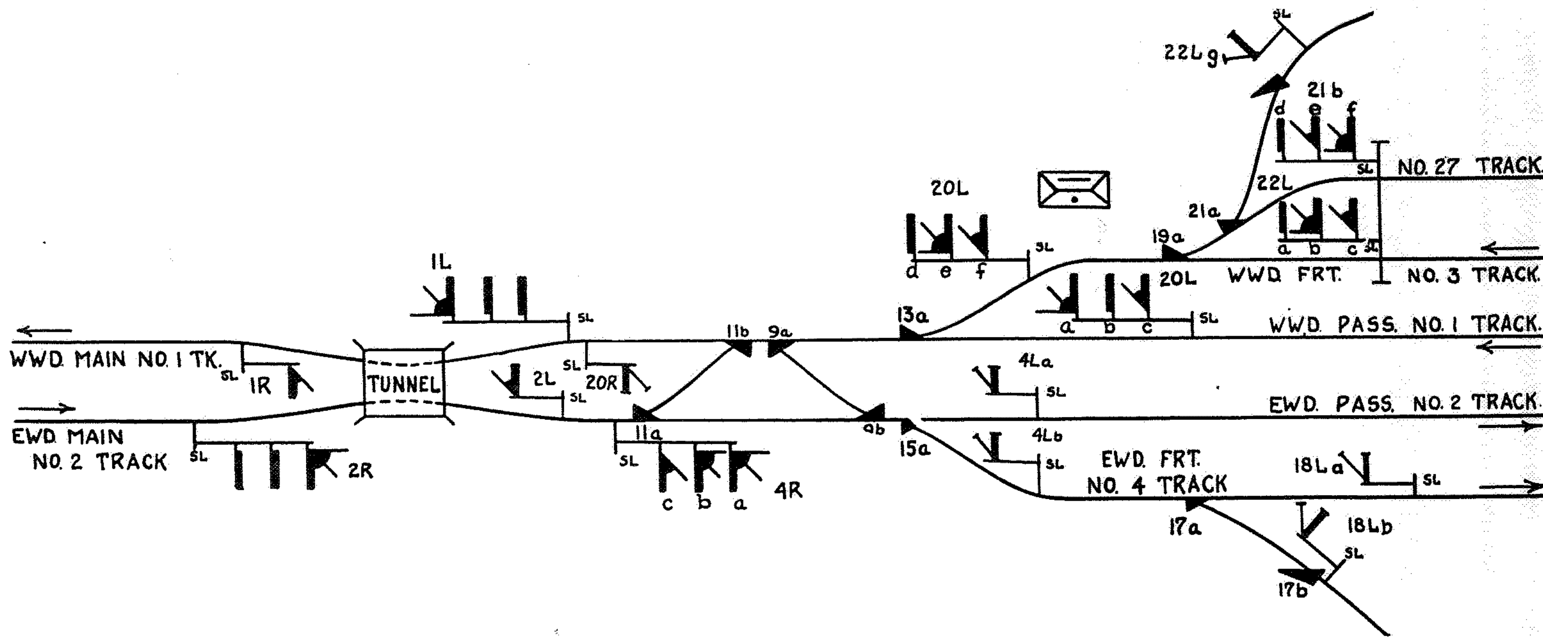
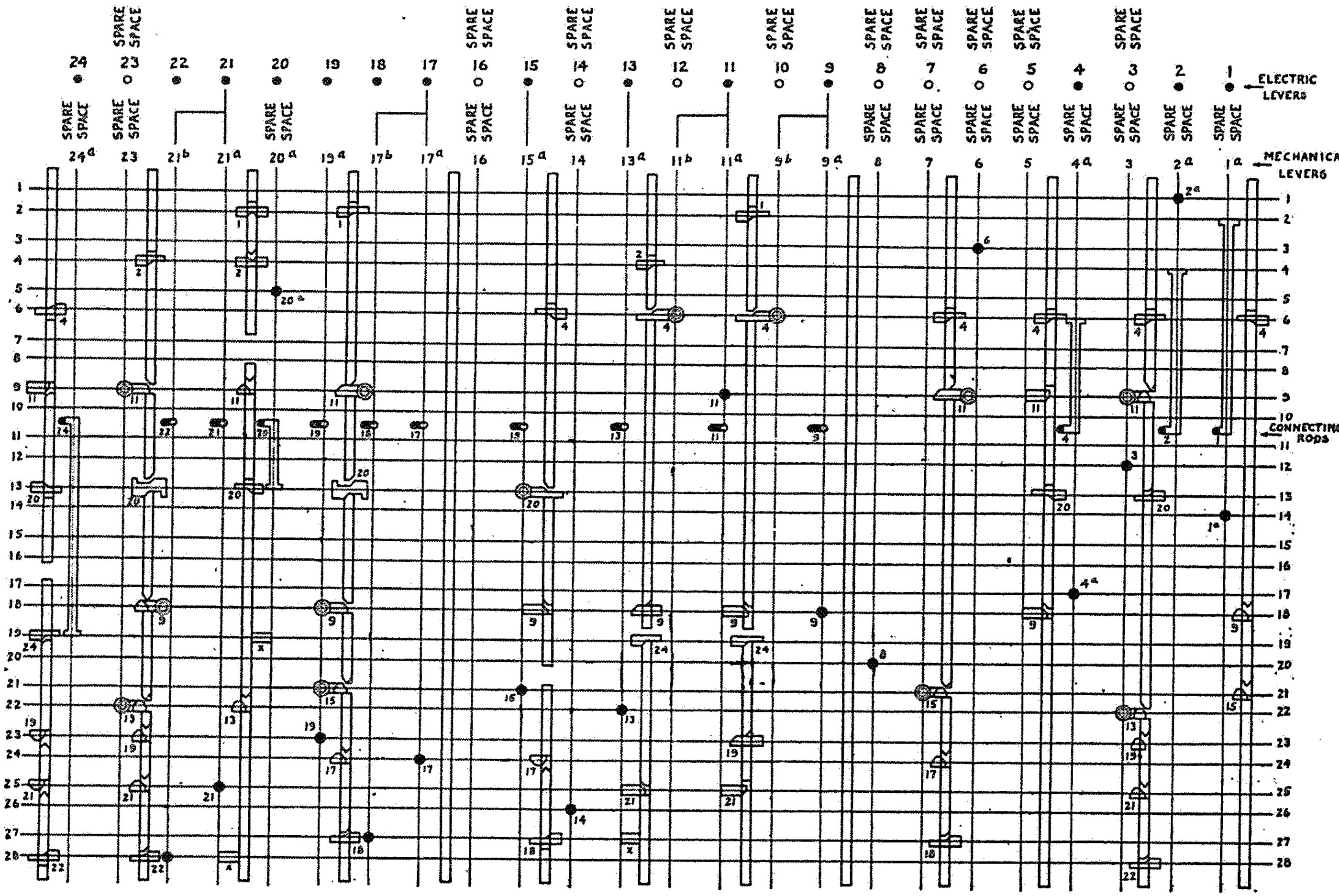


Fig. 24.

Track Layout with Electro-Mechanical Interlocking Machine.



LEV.	WHEN	LOCKS	LEV.	WHEN	LOCKS
1R		2R - 2L	11		–
	11	20L			
	(9)	4L	12		SPARE SPACE
1L		2R - 2L	13		–
1a		SPARE SPACE	14		SPARE SPACE
2R	9	4L	15		–
	(11)	20L			
			16		SPARE SPACE
2L					
			17		–
2a		SPARE SPACE			
			18L		17 - (17)
3		" "		(9)(15)	20R
4R		9 - 11 - (11)	19		–
	11	15 - (15)			
	11-(15)	17 - (17) - 18L	20R		9 - (9) - 11
	(11)	13 - (13) - 20L		9	13 - (13)
	(11)(13)	19 - (19) - 21 - (21) - 22L		9-(13)	19 - (19) - 21 - (21) - 22L
				(9)	15 - (15)
4L		9 - (9) - 11 - 15 - (15)		(9)(15)	17 - (17)
	(9)	20R			
			20L		9 - 11 - (11) - 13 - (13)
4a		SPARE SPACE			
			20a		SPARE SPACE
5		" "			
			21		(19)
6		" "			
			22L		19 - (19) - 21 - (21) - 24R
7		" "			
			23		SPARE SPACE
8		" "			
			24R		(19) - 21
9		11			
			24a		SPARE SPACE
10		SPARE SPACE			

Fig. 25.
Locking Sheet and Dog Chart for Electro-Mechanical Interlocking Machine.

This locking is practically the same as that shown in Fig. 6, except it will be noted the connections from the electric levers are shown between locking bars 10 and 11, and from there connection is made to the proper locking bar; levers 9, 11, 13, 15, 17, 18, 19, 21 and 22 are connected direct to the locking shaft, while levers 1, 2, 4, 20 and 24 utilize the loose-sleeve collar arrangement. It will also be noted in Fig. 24 that the signals are numbered either R or L; the normal position of the signal lever is in the center. The electric lever units shown in Fig. 23 move forward and backward instead of right and left. However, the signals are numbered R and L for uniformity. The R position corresponds to moving the electric lever forward and the L position to moving the lever backward. On account of the signal lever being normal in the center position, the dogs in the mechanical locking are so arranged that they will lock the route set up, as well as conflicting moves when the lever is moved either forward or backward. With the regular mechanical machine the locking bars all move in the same direction when moving the levers from normal to reverse, but with the electric units it is necessary for the locking bars operated by the signal levers to move to the right or left. The locking bars operated by the switch levers all move in the same direction as the electric switch lever is moved from normal (forward position) to reverse (backward position). The stroke of the locking bars operated by switch or two-position levers and equipped with the regular S. & F. driver is 1¾ inches, while three-position levers using a rack driver have a stroke of 2⅝ inches so that the locking bars operated by signal levers that are normally in the center and move from the center position to the front or back have a stroke of 1$\frac{5}{16}$ inches either way. The dogs shown on the locking bars for switch levers are therefore the same as already shown for the mechanical machine. The dogs shown on the locking bars operated by signal levers that have the wide portion extending to the left of the cross-locking are R dogs, those extending to the right are L dogs, while those that have the wide projection on both sides are R and L dogs. When a signal lever is used only in the R or L position, from the center position, a square locking dog is attached to the locking bar operated by that lever at a point which prevents moving this lever to the opposite position and are generally marked with the letter "X."

The numbering of the various units to be operated, illustrated in Fig. 24, would be about the same should either of the two machines illustrated in Figs. 14 and 15 be used.

Table interlocking machine.

The table interlocking machine is used for the control and operation of electric and electro-pneumatic interlockings. It generally is used for controlling a small number of units at locations where the space available for the control machine is limited. As the name implies, it is a small interlocking machine that may be placed on a desk or table and is composed of one or more unit-lever assemblies approximately 6½ inches wide mounted side by side with the levers interlocked, if required. When more than one unit-lever assembly is used, they are mounted on sub-bases and the bases bolted together.

Generally, each assembly comprises the following apparatus in addition to the lever: a lever-operated circuit controller usually with 10 or 12 contacts, a forced-drop electric lock, and four indicators which may be either magnetic or light type. Some table machines are supplied with a track model as illustrated in Fig. 26.

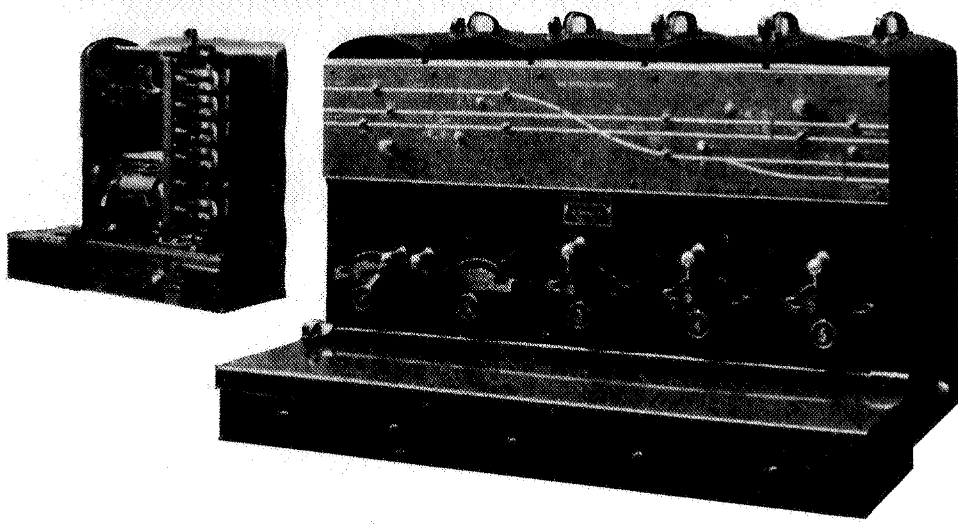


Fig. 26.

Table Interlocking Machine, Style TC, with Five Units, Track Model and Extended Locking Bed.

The switch and signal levers operate in practically the same manner as those of the electric and electro-pneumatic interlocking machine shown in Fig. 14, and as described in Chapter XVIII—Electro-Pneumatic Interlocking.

The locking is miniature Saxby & Farmer and operated by the lever directly and in all details is essentially as described for the electric and electro-pneumatic machine in Fig. 14. In the earlier machines of this type, the locking was placed in the sub-base. In later machines the locking is in an extention of the sub-base located in front of the machine, as shown in Fig. 27, or in a vertical position, as shown in Fig. 28.

Figure 29 shows the track layout for the machine illustrated in Fig. 26, and Fig. 30 shows the locking sheet and dog chart. It will be noted that the locking sheet and dog chart are essentially the same as Fig. 17, except much smaller in extent.

These machines are more fully described in Chapter XIX—Electric Interlocking.

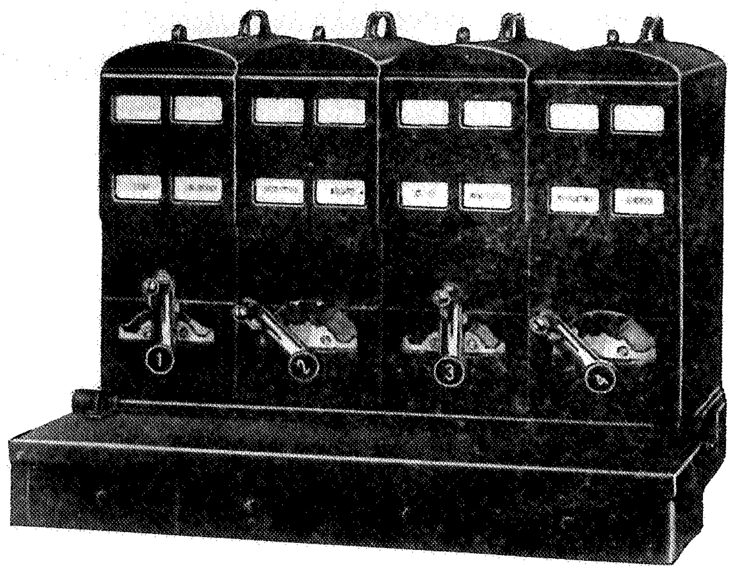


Fig. 27.

Table Interlocking Machine, Style TC, with Four Units, Magnetic Type Indicator and Extended Locking Bed.

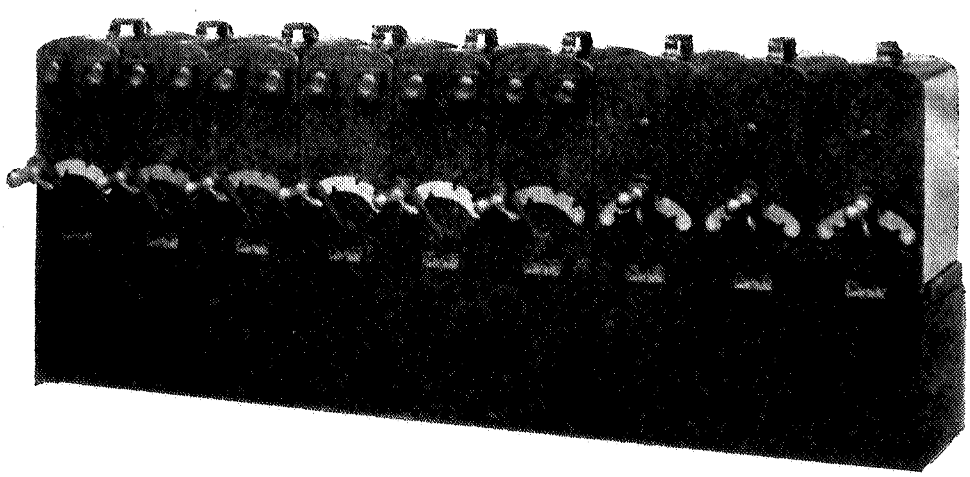


Fig. 28.

Table Interlocking Machine, Type A, with Nine Units, Light Type Indicators and Vertical Locking Bed.

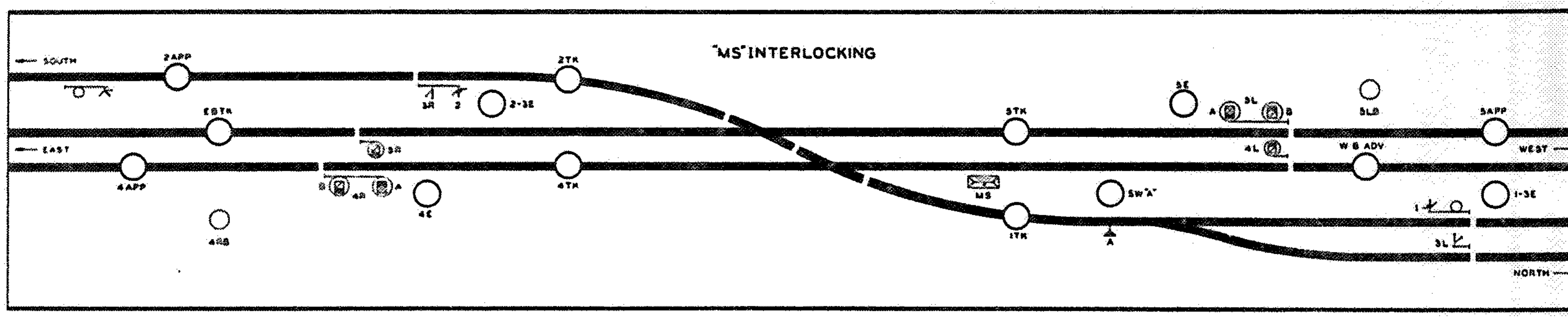
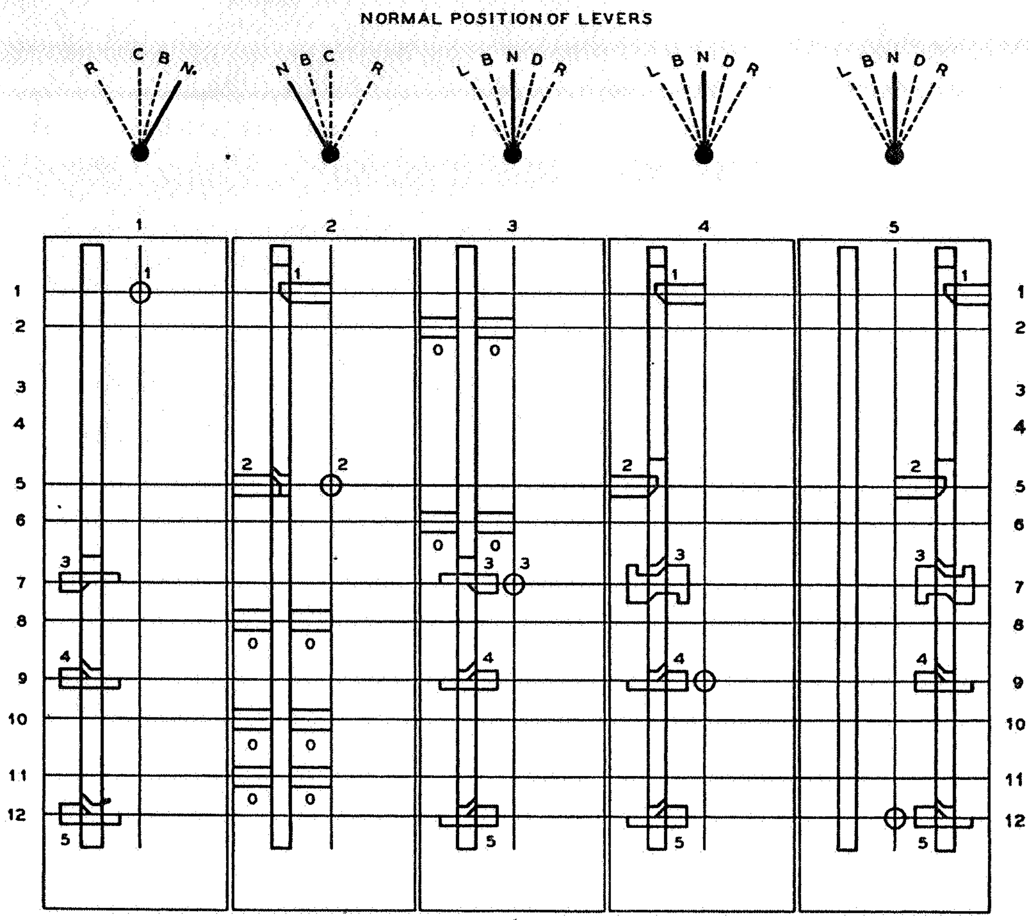


Fig. 29.

Track Layout Using Table Interlocking Machine Shown in Fig. 26.



LOCKING SHEET	
LEVER	LOCKS
1	2-3R-3L-4R-4L-5R-5L
2	3R-3L-4R-4L-5R-5L
3R	4R-4L-5R-5L
3L	4R-4L-5R-5L
4R	–
4L	–
5R	–
5L	–

Fig. 30.
Locking Sheet and Dog Chart for Table Interlocking Machine Shown in Fig. 26.

Instructions for mechanical locking.

Mechanical locking of an interlocking machine should be inspected and tested in accordance with the following instructions:

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

2. 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.

3. Locking faces must fit squarely against each other with a minimum engagement, when locked, of at least one-half the designed locking face.

4. Latch shoes, rocker links, rockers and quadrants must be maintained and tested to determine that lost motion will not permit the locking to release. Latch shoes, rocker links, and quadrants of S. & F. machines must be so maintained that locking will not release if a downward force not exceeding a man's weight is exerted on the rocker while the lever is in the 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.

5. 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. Style TC .... 1 1/16 inches.

6. On mechanical interlocking machines the latch block adjustment must be 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.

7. Locking and connections must be so maintained that when a lever or latch is mechanically locked the following will be prevented:

(a) Mechanical interlocking machine.

1. Latch operated locking.

(a) On levers not fitted with electric locks, raising lever latch block so that bottom thereof is within ⅜ inch from top of quadrant.

(b) On levers fitted with electric locks, raising lever latch block so that bottom thereof is within 7/16 inch from top of quadrant.

2. Lever operated locking.

(a) Moving lever latch block more than 3/8 inch on top of quadrant.

(b) Electro-mechanical interlocking machine.

1. Lever moving in horizontal plane. Moving lever more than 3/16 inch when in normal position or more than 7/16 inch when in reverse position.

2. Lever moving in an arc. Moving lever more than 5 degrees.

(c) Power interlocking machine.

1. Latch operated locking. Raising lever latch block so that bottom thereof is within 7/32 inch of top of quadrant.

2. Lever moving in horizontal plane. Moving lever more than 5/16 inch when in normal position or more than 9/16 inch when in reverse position.

3. Lever moving in an arc. Moving lever more than 5 degrees.

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

9. 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. Where route or traffic levers are used, locking tests must be made as outlined for signal levers in Instruction 9-c-3.

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

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

All-relay interlocking machine.

All-relay interlockings are used for systems designed without mechanical locking. These machines operate two types of all-relay systems: namely, what is known as relay type interlocking and what is known as route type interlocking. Detail description is covered in Chapter XIX—Electric Interlocking, and circuit details illustrating the electric locking principles are described in Chapter XXVI—All-Relay Interlocking.

Outside Apparatus

Figure 1 indicates a typical four-track interlocking, and from a study of this diagram, it will be seen that the arrangement is such that movements may be made from any one track to any other track.

In the typical four-track interlocking illustrated in Fig. 1 crossovers only are shown. However, at most interlockings there are local conditions requiring turnouts, slip switches, derails and other special devices.

Signals are located at each end of the interlocking limits; high signals being used for movements with the current of traffic, and dwarf signals against the current of traffic, on sidings or other restricted speed tracks. The high signals may be located on ground masts, bracket masts or signal bridges, depending on the arrangement of tracks or other local conditions. The signals may be of the semaphore, color light, position light or color position light type depending on the standard of the particular railroad. The details of signals are covered in Chapters XII—Semaphore Signals and XIII—Light Signals and Light Signal Lamps; the control circuits are covered in Chapter XX—Interlocking Circuits.

The indications displayed by the various interlocking signals are illustrated in Chapter II—Symbols, Aspects and Indications. Approach indications to interlockings are generally provided and where automatic signals are in service this feature is usually made part of the automatic block system. The aspects displayed by the approach signals, whether part of the automatic signal system or separate signals, are likewise illustrated in Chapter II, and the control circuits are covered in Chapter XX.

Turnouts and crossovers.

The Signal Section, A.A.R., defines Turnout as: An arrangement of a switch and a frog with closure rails by means of which rolling stock may be diverted from one track to another.

Figure 31 illustrates a turnout which will permit a movement from the main track to a siding or from two tracks to a single track.

The Signal Section, A.A.R., defines Crossover as: Two turnouts with the track between the frogs arranged to form a continuous passage between two nearby and generally parallel tracks.

A crossover is illustrated in Fig. 32.

Slip switches.

There are two kinds of slip switches: single and double. The Signal Section, A.A.R. defines them as follows:

Single-Slip Switch: A combination of a crossing and a single connecting track, located within the limits of the crossing, and made up of a right-hand switch from the one track and a left-hand switch from the other track, which unite to form the connecting track without additional frogs.

Double-Slip Switch: A combination of a crossing and two connecting tracks, located within the limits of the crossing, each being made up of a right-hand switch from the one track and a left-hand switch from the other track, which unite to form the respective connecting tracks without additional frogs.

Slip switches are generally used at terminals and in districts where room is not available to install two crossovers or the equivalent of a crossover and turnout.

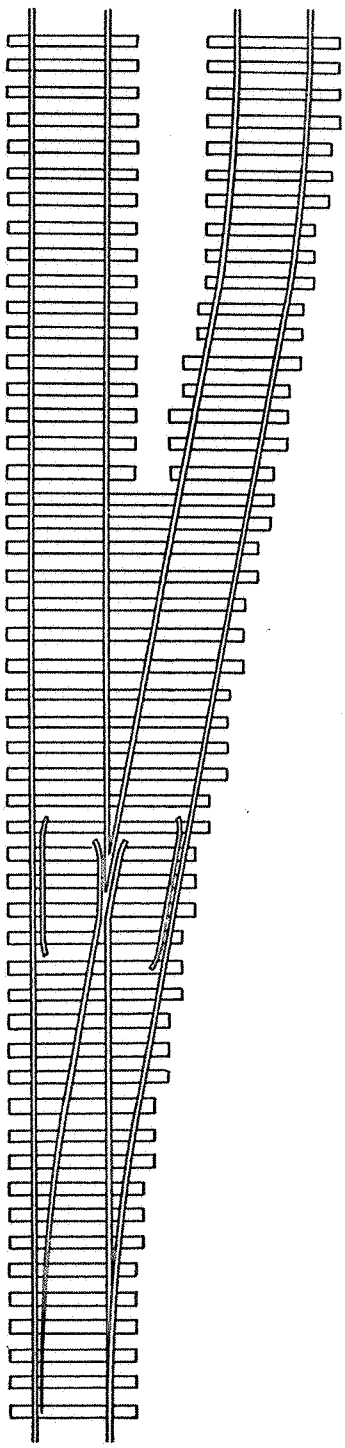


Fig. 31.
Turnout.

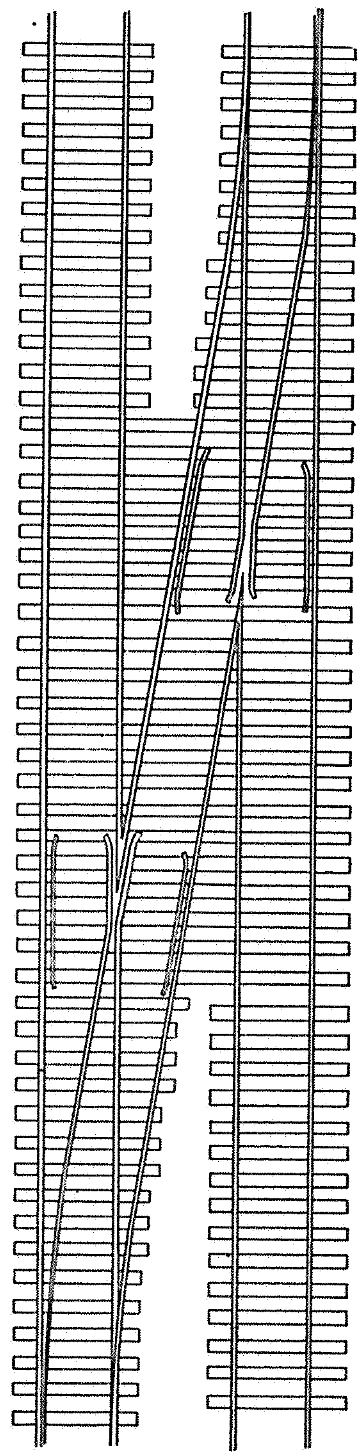


Fig. 32.
Crossover.

In certain slip switches it is desirable to use movable point frogs, due to the flat angle, while in others rigid frogs are used. The Signal Section, A.A.R., defines Movable Point Frog as: A frog equipped with points which are movable in the same manner as the points of a switch.

Figures 33, 34, 35 and 36 illustrate slip switches with movable point frogs and those with rigid frogs.

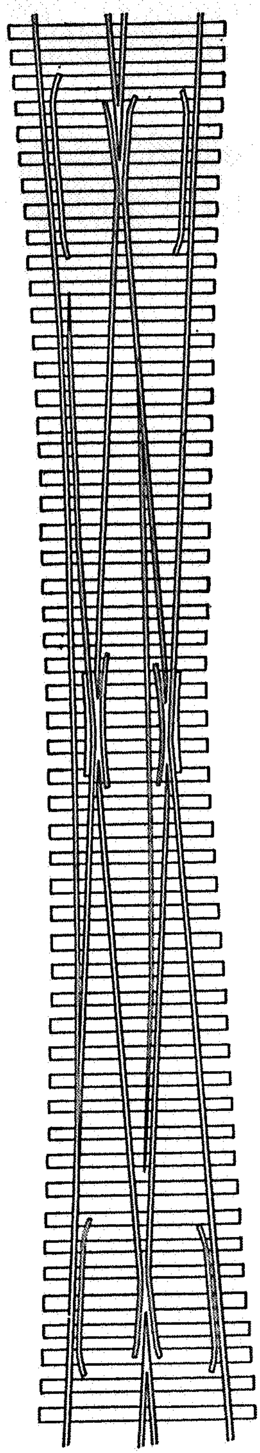


Fig. 33.
Single-Slip—Rigid Frogs.

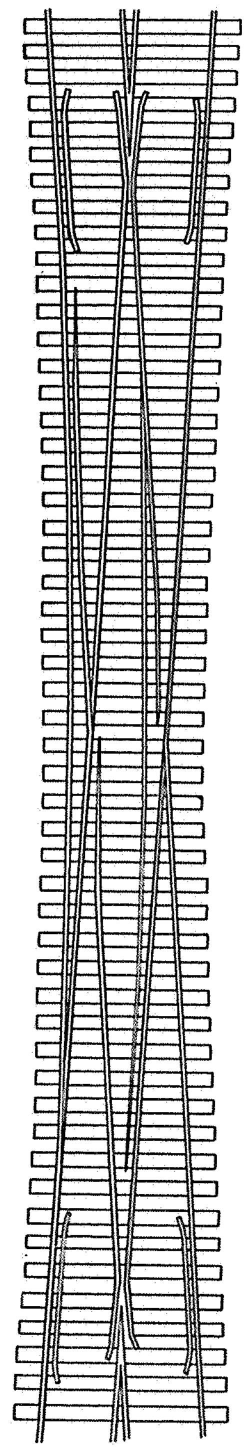


Fig. 34.
Single-Slip—Movable Point Frogs.

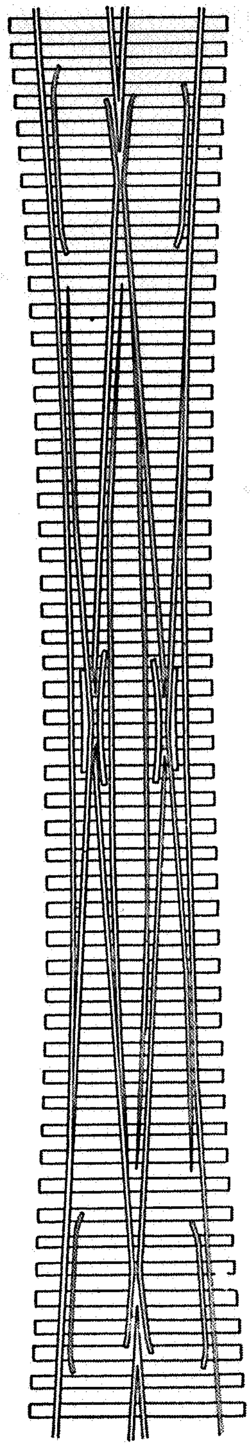


Fig. 35.
Double-Slip—Rigid Frogs.

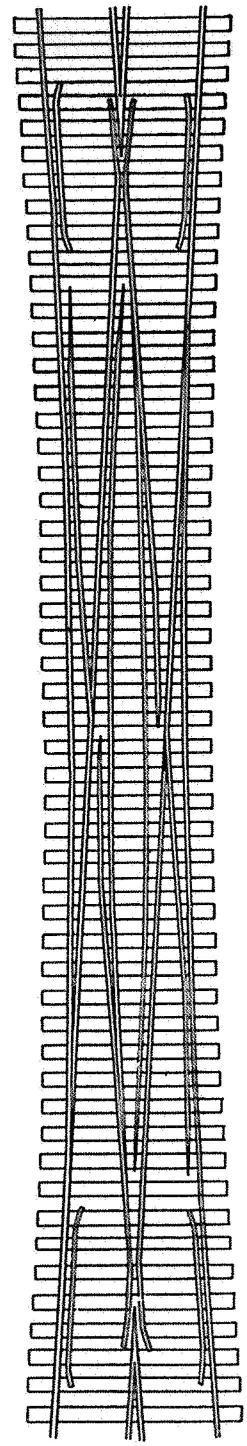


Fig. 36.
Double-Slip—Movable Point Frogs.

Derails.

The Signal Section, A.A.R., defines Derail as: A device designed to cause rolling equipment to leave the rails.

There are various types of derails, but those most generally used are known as single point, lifting block and lifting rail, one of each being illustrated in Figs. 37, 38 and 39. The use of derails under present-day practice is reduced to a minimum and they are not recommended for use in main tracks.

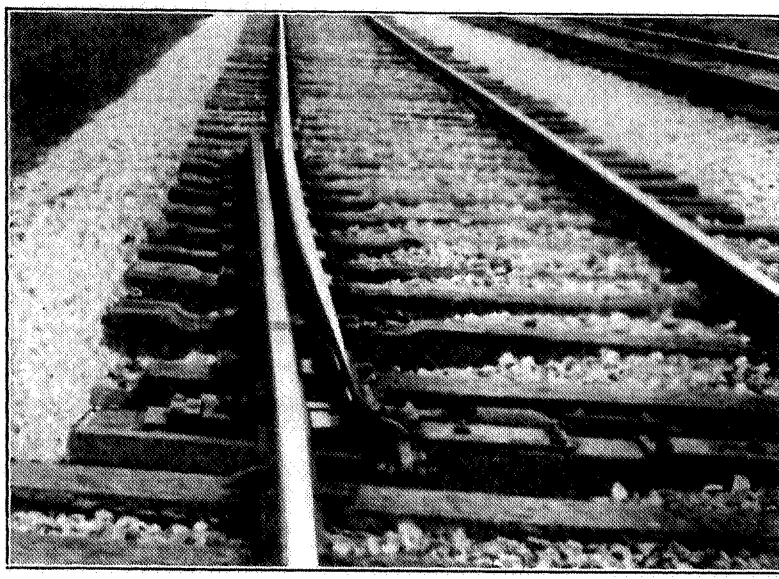


Fig. 37.

Single Point Derail.

Fig. 38.

Lifting Block Derail.

Fig. 39.
Lifting Rail Derail.

Switch rods and plates.

The various types of switch and slip layouts have a number of rods between the switch points or extending therefrom. These may be generally classed as front, lock, head, operating, No. 2, No. 3, etc., and are insulated when necessary to prevent shunting of track circuits.

The Signal Section, A.A.R., defines Front Rod as: A rod connecting the points of a switch or movable point frog, by means of which the relative location of the points is maintained and to which the lock rod is attached. The front rod is connected at the very end of the switch points, hence its name.

The Signal Section, A.A.R., defines Lock Rod as: A rod, attached to the front rod or lug of a switch, movable point frog, or derail, through which a locking plunger may extend when the switch points or derail are in the normal or reverse position. There are various types of lock rods. They are equipped with slots or holes through which a plunger passes when the switch points are within a specified distance of the stock rail in either the normal or reverse position. The adjustment of the lock rod is very important, as it insures that the switch point is against the stock rail and is in proper position for train movement to be made over it. If a switch point should stand open, the locking dog or plunger would be unable to enter the slot or hole in lock rod, thus preventing completion of movement of lever, which in turn would prevent clearing a signal.

The Signal Section, A.A.R., defines Head Rod as: A rod connecting the points of a switch or movable point frog, by means of which the relative location of the points is maintained and to which the operating rod is attached. This rod is generally located next to the front rod and is sometimes called No. 1 rod.

The Signal Section, A.A.R., defines Operating Rod as: The rod by means of which motion is transmitted to apparatus. This rod is attached to the head rod, and is usually so arranged that it will have more stroke than the throw of the switch points. This excess throw is called overthrow, which is defined by the Signal Section as: The excess stroke of a switch operating rod.

The travel of the switch points while passing from normal to reverse position, and vice versa, is known as switch throw and is measured at the head rod. This varies from 3½ to 6 inches, and is in accord with the standard of the particular railroad.

The remaining rods on a switch are generally numbered 2, 3, etc., depending on length of switch point; their particular function is to keep the switch points properly gaged and supported.

Each switch is equipped with tie plates, rail braces and sometimes gage plates. The tie plates give strength and rigidity to the switch and insure a permanent relative position between the switch and operating mechanism. They are of metal, usually about 7 inches wide and ¾ inch thick, placed on top of ties for rail and switch point supports. Riser plates and gage blocks are riveted to the plate. The riser plates are attached to the gage or tie plates, support and raise the switch point above the base of rail and maintain minimum gage. Sometimes the gage plates are milled to a sufficient depth to accommodate the base of the rail and the riser plates are eliminated.

The gage blocks are used as supports for the rail braces which hold the stock rail to gage for proper fitting of the switch points.

The various methods of operating switches are explained in chapters for the particular type of interlocking.

Movable Bridges

The Signal Section, A.A.R., defines Movable Bridge as: That section of a structure bridging a navigable waterway so designed that it may be displaced to permit passage of traffic on the waterway.

In localities where railroads cross navigable waterways, it is necessary to install movable bridges so that ship navigation may be permitted as required.

There are a number of types of movable bridges in service. Some are pivoted at one end, some in the center so as to make a complete turn, while others make only one-half turn; others are of the lift type, some of which lift from one end, some from both ends, the opening occurring at the middle of the bridge span; while with others the entire span lifts. Various methods of operating these bridges apply; some are manually operated, while others are steam, electric or gasoline operated. No attempt will be made to explain the various methods of operating or turning the bridge span, the essential point from a signaling standpoint being the method of locking the span to make it safe for rail traffic.

An interlocking including protective devices is generally necessary to insure that the bridge and rail ends are properly surfaced and aligned, also that the bridge operating mechanism is locked before it is possible to display a signal for train movement over the bridge. This requires locking in the interlocking machine so designed that a predetermined order must be followed to open or close the bridge. This order may be expressed briefly as follows:

(a) To open movable span:

1. Signal levers normal, home signals at Stop.
2. Signal levers normal, smashboards at Stop.
3. Derail levers normal, derails in derailing position.
4. Devices for checking the surface and alignment of rail ends in non-checking position.
5. Movable bridge circuit controllers and pipe couplers open.
6. Bridge operating mechanism mechanically or electrically released, master lever reversed.

(b) To establish rail traffic:

1. Bridge operating mechanism mechanically or electrically locked, master lever normal.
2. Movable bridge circuit controllers and pipe couplers closed.
3. Devices for checking the surface and alignment of rail ends in checking position.
4. Derail levers reversed, derails in non-derailing position.
5. Signal levers reversed, smashboards clear.
6. Signal levers reversed, home signals clear.

The power controllers are usually manually operated devices that control the power to the motor or motors that move the span itself and other auxiliary bridge devices such as span locks and wedges, and are usually located in a control tower on the movable span or on an adjacent fixed span. By means of these controllers the movable span may be moved from its closed position to full open position for boat traffic and returned again to the fully closed position, with the span structure properly seated, aligned and locked and the rails accurately aligned and locked. With this accomplished, then by circuit intercheck with the interlocking machine, the latter can take control and after cutting power from the bridge controllers, can by means of additional bridge and rail detector devices (or locks) prove that the bridge structure and rails are properly seated and aligned following which derails, if used, may be placed in position for rail traffic and finally, the signals cleared. The interlocking machine is frequently located in the same control tower as the bridge power controllers, but may be in a separate tower, depending upon the nature of the layout and other circumstances.

Interlocking system.

The use of mechanical interlocking for movable bridge protection has been superseded, generally, by power interlocking, either electro-pneumatic or electric. In power interlocking, either electro-pneumatic or electric, switch movements are used to operate the various functions. In a typical arrangement, one power movement will operate the span lock and bridge lock (detecting) device, or both, and a second movement would operate the rail locks and electric circuit coupler, Fig. 40. Generally, the equipment on one end of the span is duplicated at the other end. As mentioned previously, derails are sometimes used in approach to the spans and when used are generally of the single or double point type and are operated by separate power movements.

Smashboard signals are sometimes employed instead of derails. The Signal Section, A.A.R., defines Smashboard Signal as: A signal so designed that the arm will be broken when passed in the Stop position. They are generally located on the signal mast or signal bridge on which the signal protecting the movable bridge is located. They extend over the rail or the center of track, and are low enough that should a train pass the smashboard signal in the Stop position the cab or smoke stack will strike and break it and draw the engineman's attention to it as well as leave a mark on the engine as evidence that the train had passed the signal in the Stop position.

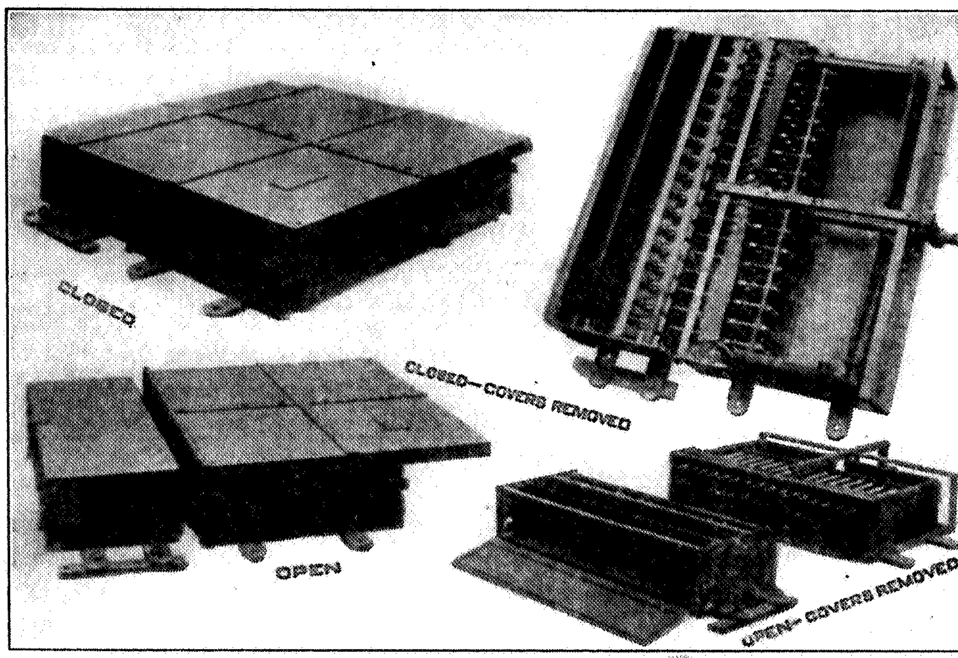


Fig. 40.
Electric Bridge Coupler.

Several forms of smashboard signals are in use, one of which is illustrated in Fig. 41. This particular smashboard includes a long wooden arm, disc-shaped at outer end, which suspends from a bridge over the tracks or extends from the signal mast at the side of track. Another form is a long semaphore arm usually extending from the signal mast at the side of track. Smashboards may be power or mechanically operated, as desired.

Torpedo placing machines have also been employed at movable bridges in lieu of derails. These devices are so arranged that upon approaching the signal protecting the span in the Stop position, a torpedo will be exploded to give an audible warning to the engineman. The torpedo placing machine is a power-driven device designed to place or withdraw a conventional torpedo, as conditions require.

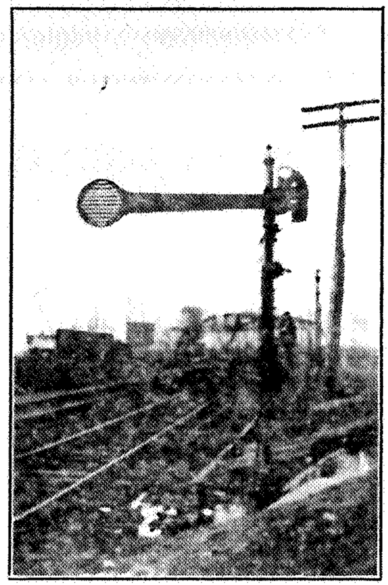


Fig. 41.
Smashboard Signal.

Rail locking.

Rail ends, where the bridge and fixed spans adjoin, are mitered or cut square. Where lapped mitered rails are used, the full thickness of the web is retained to the points and the points so arranged that they are trailing to normal traffic. In the case of a single-track movable bridge, the points are generally trailing to traffic entering the movable span. When rail ends are cut square or miter is not lapped, the ends are generally connected by a sliding sleeve, joint bar or by "easer rails" to carry the wheels over the opening between the ends of the bridge and the approach rails.

There are a number of methods used to lock the rail ends, bridge wedges, etc., but space will not permit of illustrating all of them. Three types of bridges are illustrated as representative.

Figure 42 illustrates a center pivot swing bridge and Fig. 43 illustrates one method of locking the rail ends on this type of span. In this instance, the rail ends are mitered and lapped and of necessity before the bridge can swing, the rail ends on the swing span must be raised. In Fig. 43, the rails are in the raised position and the locking is so arranged that if an obstruction of a specified thickness is placed under the rail end as it is lowered into place in the rail shoe, the locking dog on horizontal locking bar will foul on the vertical tongue attached to the rail, preventing the stroke of the rail lock lever from being completed. In this rail locking device, the horizontal locking bar is operated mechanically or by power. The vertical tongues simply move up and down with the rails, there being a tongue attached to each rail. When the rails are properly seated, the locking dogs on the locking bar will pass freely through the notches in the tongue.

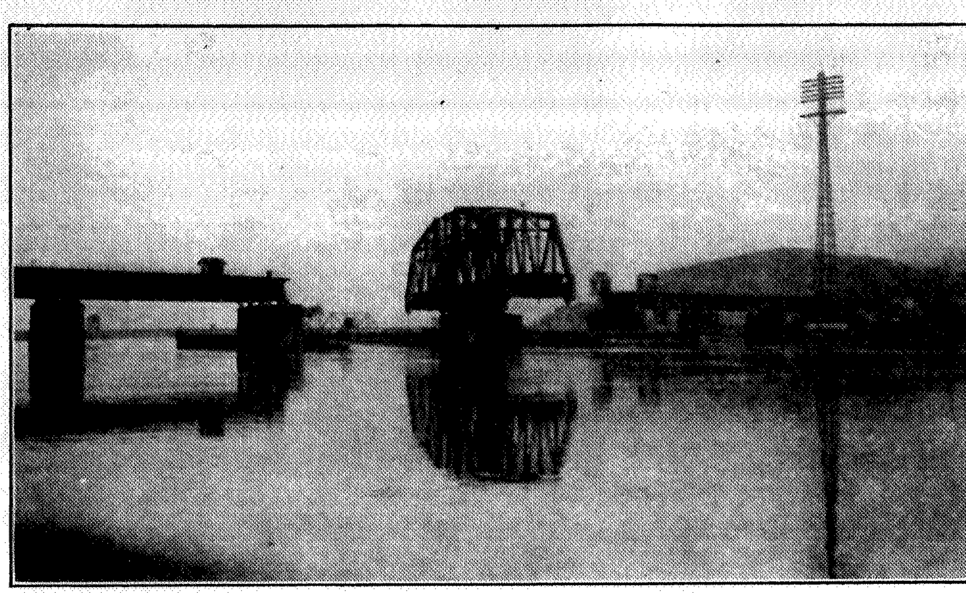


Fig. 42.
Center Pivot Swing Movable Bridge.

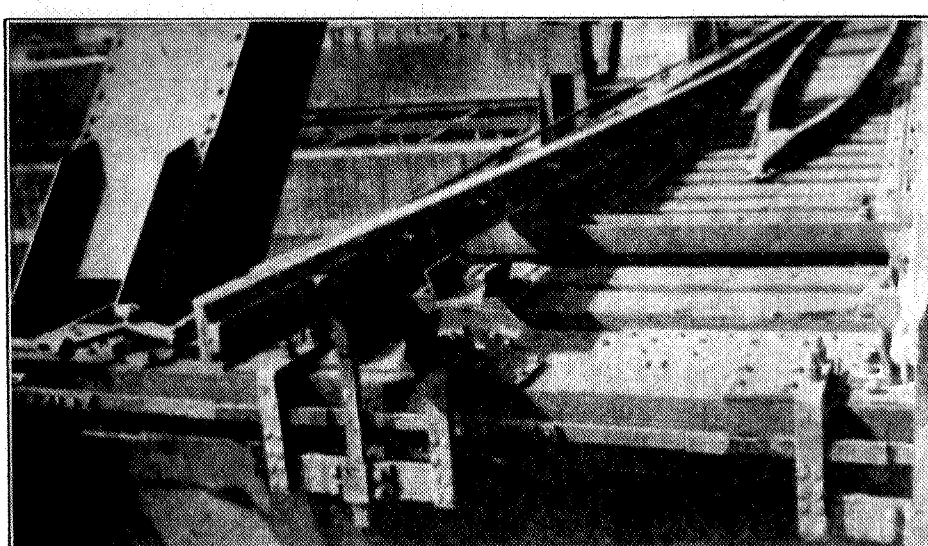


Fig. 43.
Method of Locking Rail Ends on Swing Movable Span.

Figure 44 illustrates a bascule lift type movable bridge. The rail locking is accomplished through the use of circuit controllers connected to the rails to insure that the rails are in proper position before signals can be displayed for movements over the bridge.

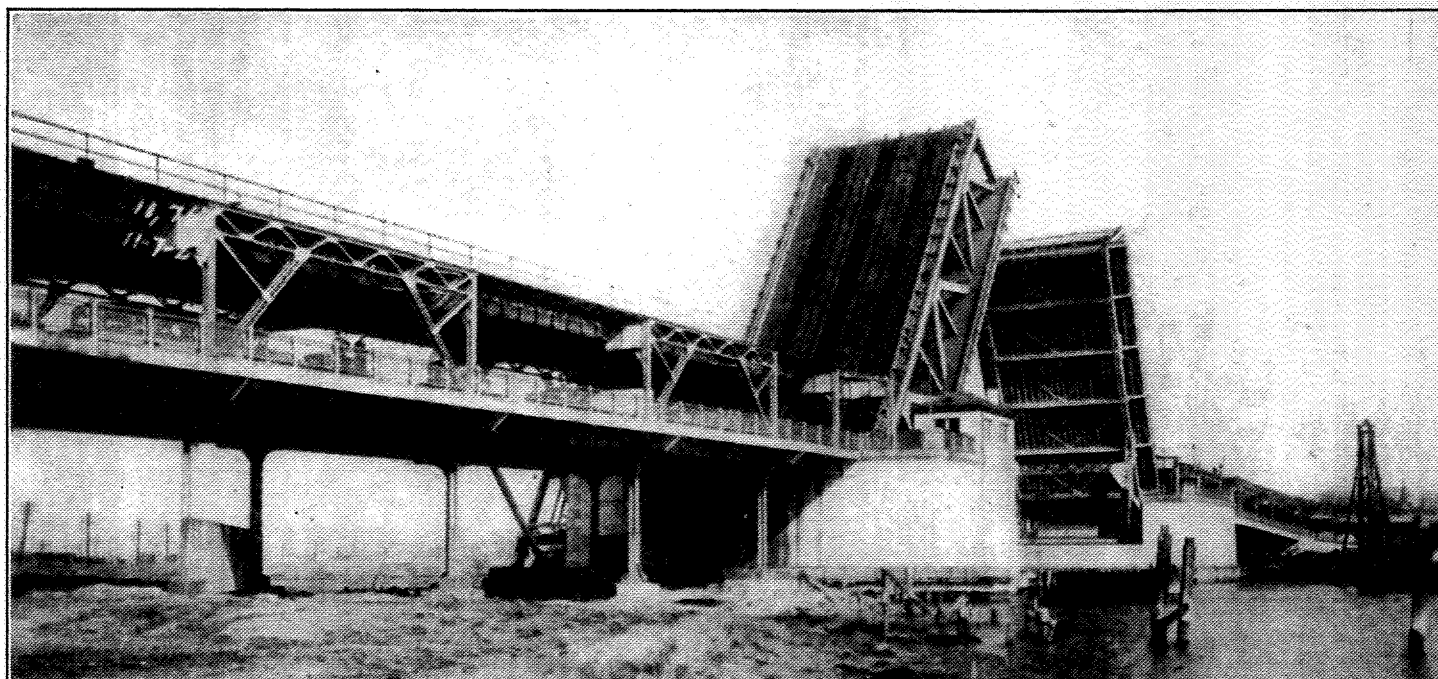


Fig. 44.
Double Leaf Bascule Lift Type Movable Bridge.

Figure 45 illustrates a vertical lift movable bridge, and Fig. 46 illustrates a method used to lock the rail ends. An electro-pneumatic switch movement in the foreground of upper view with associated control valve operates the rail locking devices for both tracks and also the electric circuit coupler through the medium of a mechanical pipe line coupler shown immediately to left of control valve. This coupler connects the operating rod from the switch movement on the shore span to the rocker shaft on the lift span, that drives the locking plungers. A duplicate arrangement of equipment is used at the other end of the movable span. A modern rail detecting and locking device is shown in Fig. 47. When the individual rails seat properly, individual jaws release a locking means which will permit the electro-pneumatic movement on the right of bridge, to move the longitudinal locking bar to the right to secure the rails in position. A circuit controller attached to the left end of locking bar checks the bar as to proper operation.

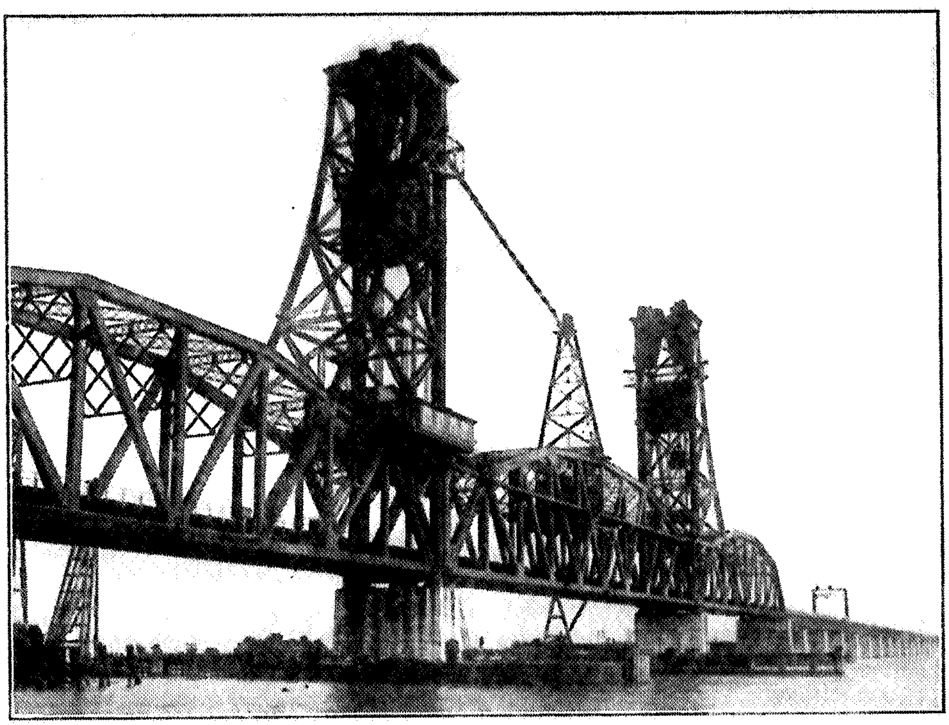


Fig. 45.

Vertical Lift Type Movable Bridge.

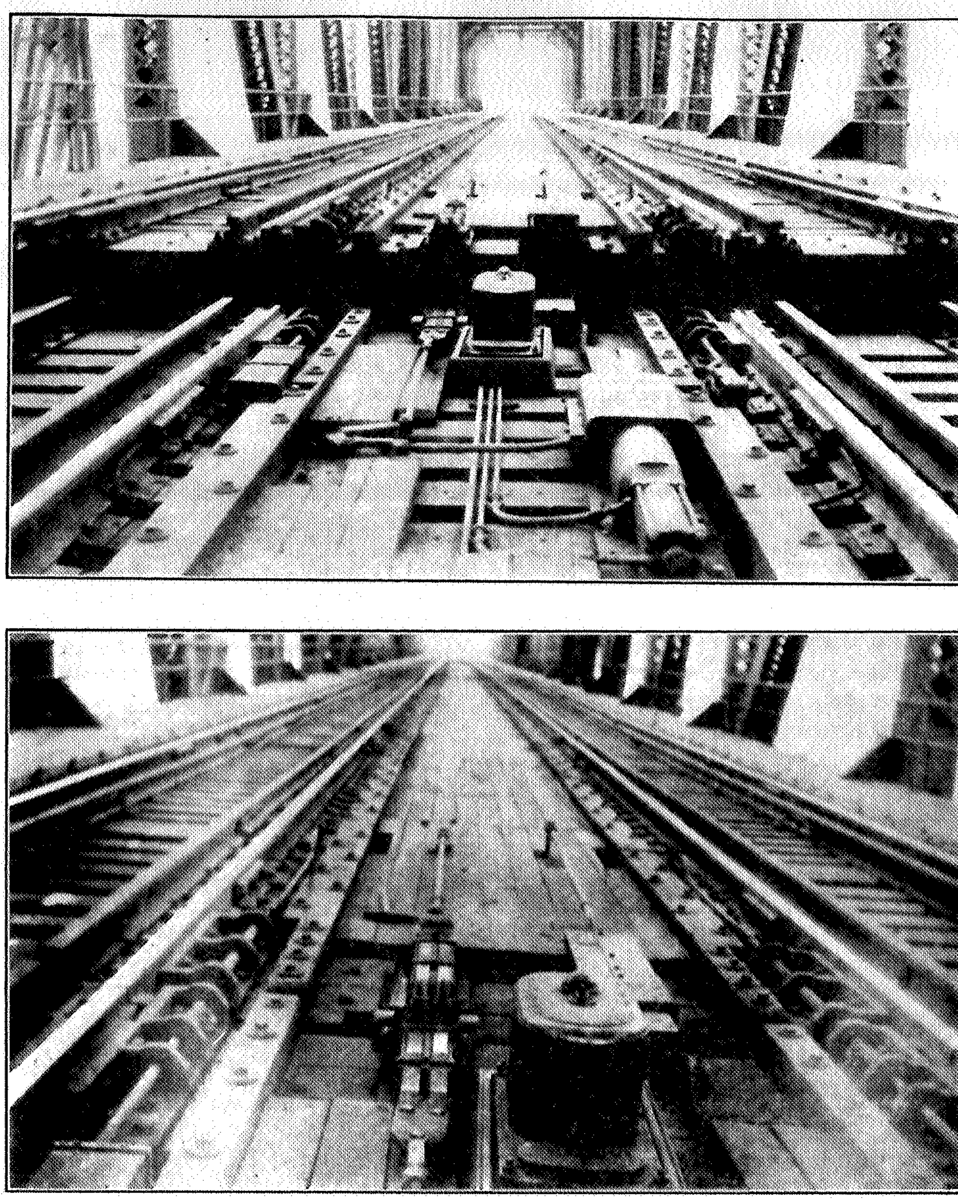


Fig. 46.
Method of Locking Rail Ends on Vertical Lift Span.
(Unlocked, above; Locked, below)

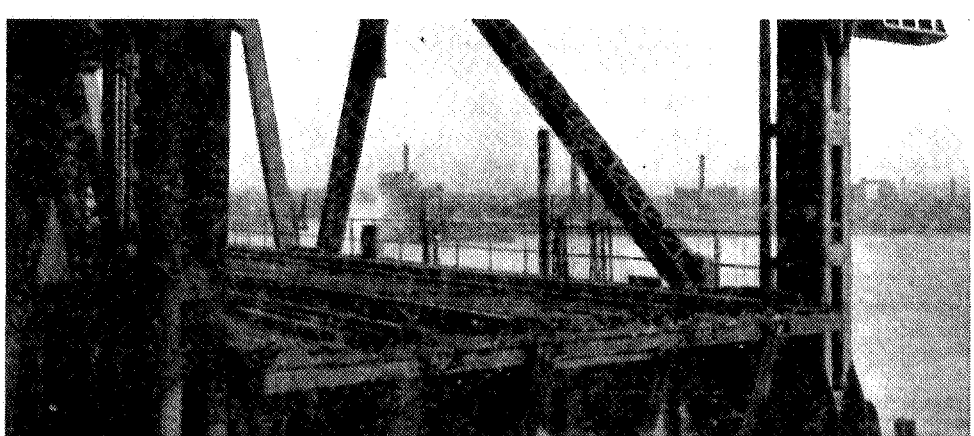


Fig. 47.
Method of Locking Rail Ends on Vertical Lift Span.

Mechanical and electrical couplers.

It is frequently necessary to continue mechanical pipe lines and circuits from the movable span to the shore ends, or vice versa. Figure 46 illustrates an application in an electro-pneumatic movable bridge interlocking of both the mechanical and electrical couplers. They are clearly shown on either side of the valve in the lower view. The use of the mechanical coupler, in this instance, permits keeping the electro-pneumatic movement and its air piping all on the shore span. Figure 48 illustrates one method for continuing mechanical pipe lines to or from a movable span and this device is known as a mechanical bridge coupler.

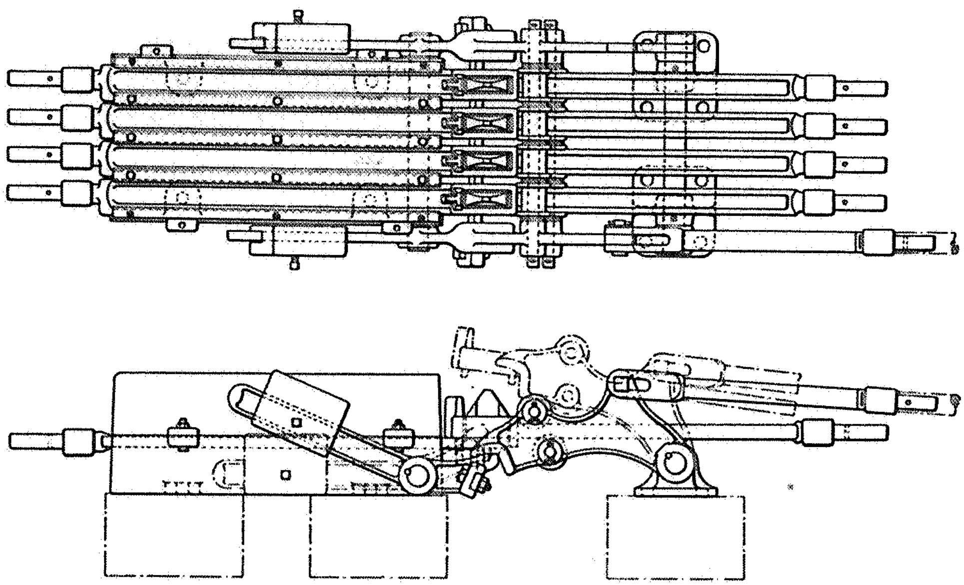


Fig. 48.
Mechanical Bridge Coupler.
(Uncoupled, above; Coupled, below)

Figure 40 illustrates an electric bridge coupler used to carry circuits on or off the movable span. One part is fastened to the movable span, the other to the shore span. One part has fixed contact receptacles, the other has movable contact plungers. The several contact plungers move as a unit and are generally motivated by the same lever and mechanism that operates the rail locks. When the plungers have moved into the receptacles the circuits carried through the coupler will be completed. Rail shoes, lock bars, etc., are insulated so that track circuits may be continuous over the movable span.

Detailed circuits for a movable bridge are illustrated and explained in Chapter XX—Interlocking Circuits.

*Instructions**

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

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* The term "as instructed" as used herein refers to individual railroad instructions.

General.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Before removing rails, switch points or frogs, protecting signals must be secured to display their 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 for train operation.

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 as instructed to protect train movements until interlocking is restored to normal operation. In all cases inspection and tests must be made in accordance with instructions for mechanical locking, page 45.

4. Dragging equipment or landslide-detecting devices and other similar protective devices must be maintained and tested as instructed.

5. In case of severe storm, inspection must be made as soon as practicable, and trouble corrected as instructed. Where snow-melting open flame devices are used, care must be exercised to prevent damage to interlocking apparatus.

6. Each circuit, the functioning of which affects the safety of train operation, except circuit which includes any track rail must be kept free of any ground or combination of grounds as instructed. In no case shall a flow of current be permitted which is equal to or in excess of 75 per cent of the release value of any relay or other electromagnetic device in the circuit.

7. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

8. Outdoor signal and instrument housings must be locked, except signal mechanism housings where maintenance forces are continuously on duty. Power interlocking machine cabinets, time releases, and electric locks exposed on interlocking machines must be locked or sealed. All locks or seals must be maintained as instructed.

9. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.

10. Contacts must be kept clean and in proper adjustment as instructed.

11. Lightning arresters and made grounds must be properly connected, maintained and tested as instructed.

12. Movable parts must be kept clean, properly adjusted and lubricated as instructed.

13. Parts which fail to perform their intended functions must be promptly adjusted, repaired or replaced.

14. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.

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

16. Paint must be applied as often as required. Rusty surfaces must be cleaned before painting. Paint must not be applied to padlocks, threads of screw jaws, adjusting screws, or gaskets.

17. Signal apparatus must be maintained as instructed so as to conform to established clearances for equipment.

18. Threads of rods, jaws and bolts must be kept clean and properly lubricated.

19. Locking dog of switch-and-lock movement shall enter the lock rod $\frac{1}{2}$ inch or more before circuit controller can indicate lock position either normal or reverse.

20. Switches, movable point frogs and split point derails must be so maintained that they cannot be locked if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ inch.

21. Point detector must be so maintained that when switch mechanism is locked in normal or reverse position, contacts cannot be opened by manually applying force at the closed switch point. Point detector circuit controller must be so maintained that the contacts will not assume the position corresponding to switch point closure if the switch point is prevented by an obstruction from closing to within $\frac{1}{4}$ inch where latch-out device is not used, and to within $\frac{3}{8}$ inch where latch-out device is used.

22. Holes or notches in lock rods must have square edges and must not be more than $\frac{3}{16}$ inch larger than the locking bar or plunger.

23. Edges of locking dogs and rods of switch-and-lock movement or facing point lock must be maintained with not more than $\frac{1}{16}$ inch wear.

24. Cells and batteries must be maintained and tested in accordance with Instructions for Cells and Batteries.

25. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps.

26. Insulated rail joints must be maintained and tested in accordance with Instructions for Insulated Rail Joints.

27. Rectifiers and motor-generators must be maintained and tested in accordance with Instructions for Rectifiers and Motor-Generators.

28. Relays must be maintained and tested in accordance with Instructions for Relays.

29. Time releases and timing relays must be maintained and tested in accordance with Instructions for Time Releases Applied to Signal Apparatus.

30. Electric locks must be maintained in accordance with Instructions for Electric Locks for Interlocking Machines.

31. Signals must be maintained and tested in accordance with Instructions for Light and Semaphore Signals.

32. Switch circuit controllers must be maintained and tested in accordance with Instructions for Switch Circuit Controllers.

33. Track circuits must be maintained and tested in accordance with Instructions for Track Circuits.

34. Wire and cable must be maintained and handled in accordance with Instructions for Wire and Cable.

35. Ground resistance must be maintained and tests made in accordance with Instructions for Made Grounds.

36. Insulation resistance tests must be made in accordance with Instructions for Insulation Resistance.

37. Spring switches must be maintained and tested in accordance with Instructions for Spring Switches.

38. Facing point locks applied to spring switches must be maintained and tested in accordance with Instructions for Facing Point Locks Applied to Spring Switches.

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

40. Movable bridge locking must be maintained and tested in accordance with Instructions for Signal Protection for Movable Bridges.

41. Time recorder, where used, must be tested to determine that it operates properly.

42. Cross protection must be tested to determine that protective devices operate properly.

43. Restoring feature on power switches must be tested to determine that power will restore switch movements to normal or reverse position.

44. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Mechanical interlocking.

45. 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.

46. Pipe lines must be kept 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.

47. Plunger of facing point lock must have at least 8-inch stroke when operated by its lever. It must extend through and beyond the lock rod ½ inch or more when lever is in locked position and must clear lock rod 1 inch when lever is in unlocked position. The end of the plunger must have equare edges.

48. Bolt lock must be so maintained that signals governing movements over switch or derail cannot display a less restrictive aspect than Stop when derail is in derailing position, or when switch point is open ¼ inch or more when bolt lock is used in lieu of facing point lock, and ½ 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.

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

Electro-pneumatic interlocking.

50. When necessary to work on operating mechanisms, energy must be cut off the control magnets by disconnecting the circuit until the work is completed.

51. Air compressor intakes must be kept clean and free from dirt and moisture. Intake must not be close to the ground, inside of buildings or where moisture accumulates. Nothing should be done which might obstruct or increase the resistance of air intakes.

52. Condensers, tanks, reservoirs and air distribution lines must be drained frequently to avoid overflow of condensation into branch lines and apparatus. Means of draining condensation out of distribution system must be provided and maintained at low points.

53. Special attention must be given to drainage of condensation from air systems throughout the period of the year when temperatures are above freezing so as to avoid interruptions during cold weather.

54. Air distribution systems must be so maintained that leakage in any section of the system will not exceed 1 pound in 1 minute at normal pressure with all apparatus connected and at rest.

55. Inside of pipe and fittings must be kept free from iron cuttings, scale, dirt, paints or pipe joint compounds.

56. Air strainers used between air distribution system and air apparatus must be cleaned frequently to avoid air pressure reduction.

57. Oil used in piping system or internal parts of valves, cylinders and other apparatus, must be of a grade which will not disintegrate nor injure leather and similar packing.

58. Pick-up and release of valve magnets must be tested as instructed and values maintained within the limits recommended by manufacturer.

59. Valves and cylinders must be tested to determine that parts are clean, packing tight, air supply unrestricted and apparatus functions properly.

60. When necessary to clean or repair valves and cylinders they must be removed from service and the work performed as instructed.

Electric interlocking.

61. When necessary to work on operating mechanisms, energy must be cut off the motor. Where facilities are not provided to open motor circuit, motor brushes must be lifted and fuse at interlocking machine removed until the work on operating mechanism is completed.

62. Operating mechanism must be operated by hand after making adjustments to see that they operate properly and without undue strain on any part before being operated by power and then by power from the control point for checking operation after making adjustments.

63. Contactors must not be operated manually, except when out of service.

64. Commutator must be smooth, clean and have a glossy appearance. To clean, lift brushes from commutator and use chamois or cloth free from lint and abrasives, moistened, if necessary, with Specification 102 or 103 oil, then dry with chamois or cloth. Abrasives or files must not be used on commutators.

65. Brushes must be kept clean, fitted to commutator, free in brush

holder, or brush holder free on stud. Springs must be in place and so maintained that brushes will have proper bearing and pressure. When installing new brushes they should be placed in position and carefully seated on the commutator by placing No. 000 or finer sandpaper under the brush with smooth side against the commutator, and while pressing brush oscillate sandpaper with commutator. Burrs must be removed from the brush. When finished, all sand and dust must be removed.

66. Friction clutch in operating mechanism must be adjusted in accordance with manufacturer's instructions.

67. Magnetic brake and overload relays must be checked for proper operation as instructed.

All-relay interlocking.

68. Where protection afforded by circuits is equivalent to mechanical locking, tests must be made in accordance with Instruction 9 under instructions for mechanical locking, page 45, in so far as they apply.

Automatic interlocking.

69. Tests must be made as instructed to determine that:

(a) A loss of shunt for 5 seconds or less will not permit an established route to be changed.

(b) When any track circuit between home signals on any route is occupied, home signals for all conflicting routes, and for the route occupied, cannot be cleared.

(c) Where protection afforded by circuits is equivalent to mechanical locking, tests must be made in accordance with Instruction 9 under instructions for mechanical locking, page 45, in so far as they apply.