American Railway Signaling Principles and Practices

CHAPTER XVI

INTERLOCKING

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

American Railway Signaling Principles and Practices

CHAPTER XVI

INTERLOCKING

CHAPTER XVI

INTERLOCKING

Definitions.

The Standard Code of the American Railway Association defines Interlocking as: An arrangement of switch, lock and/or signal appliances so interconnected that their movements must succeed each other in a predetermined order.

It also defines Interlocking Plant as: An assemblage of switch, lock and/or signal appliances interlocked.

Types.

Interlocking plants are designated as mechanical, electro-mechanical, electro-pneumatic and electric types. There remain in service a limited number of pneumatic interlocking plants. No attempt has been made to describe this type, as it is obsolete. The details of each respective type of interlocking are covered in separate chapters. The automatic type of interlocking plant, which is of recent development, is described in Chapter XIX—Electric Interlocking.

Historical.

The first interlocking plant used in America was of the mechanical type. Saxby and Farmer, of London, England, furnished the material, and men were sent from England to install it. The locking was of the spring catch type, which was the forerunner of what is known as preliminary latch locking now in general use. The switches were connected by pipes and the signals by wires to their respective 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 the 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 and Farmer machine as produced at present is not materially changed from the original in principal 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 are still used but many have been replaced by the application of electric locks controlled through track circuits, to the lock and/or switch levers.

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 plant 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 plant 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 interlocking plants. 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.

After American railways had gained experience with mechanical interlocking plants, it was found that there were many situations where economies could be effected and more satisfactory operation obtained if switches were power operated.

The most prominent endeavor by an American inventor to this demand was the hydro-pneumatic system, wherein water and air under pressure provided the medium for moving the switches and signals by means of a system of pipes between the interlocking machine and the various interlocked units. The same inventor, in the light of experience, next devised the electro-pneumatic interlocking. Meanwhile the pneumatic interlocking had been developed, but this type did not become popular. Later developments were the electric and electro-mechanical interlockings, followed by the more recent automatic interlocking.

Application.

Interlocking plants are in general use at terminals, junction points, railroad grade crossings, drawbridges 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 plant 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 plant is the arrangement of tracks and one or more of the following for diverting traffic: switches, movable point frogs, rigid frogs, single-slip switches with rigid or movable point frogs, double-slip switches with rigid or movable

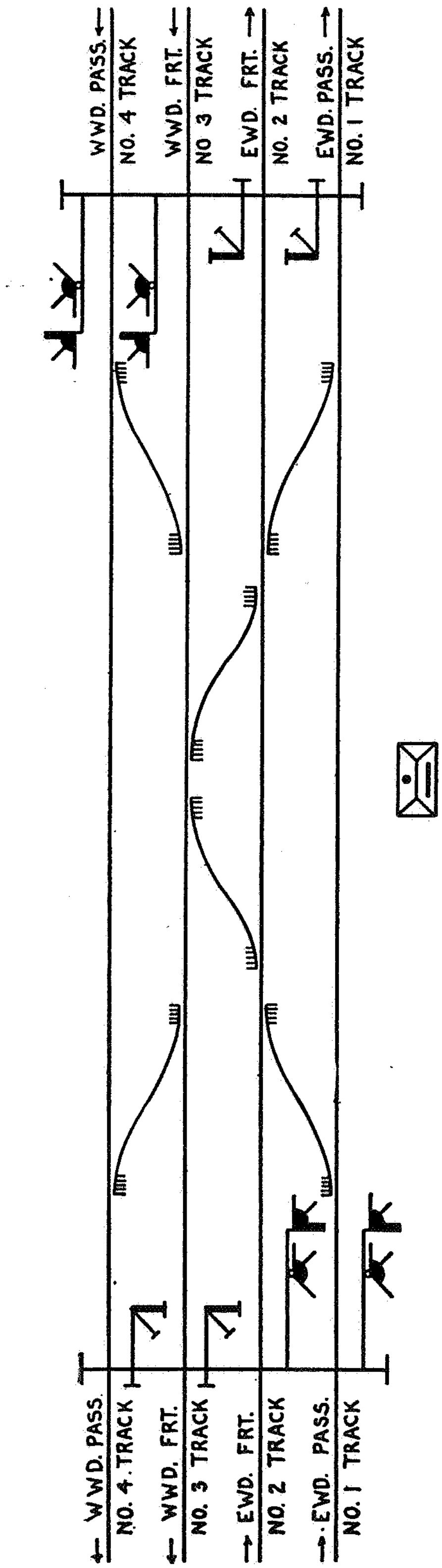


Fig. 1.
Typical Four-Track Interlocking Layout.

point frogs; sometimes derails, drawbridges and turntables 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.

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

Inside Apparatus

General.

The Standard Code defines Interlocking Station as: A place from which an interlocking plant is operated.

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 of the arrangement of tracks, switches, signals, etc., of the particular interlocking plant 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 interlocking plants 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.

Frequently, track models or diagrams are supplemented by manipulation charts, which are referred to more generally by men unfamiliar with the layout, when posting or upon assuming charge of an interlocking plant.

In a number of cases lights that show track occupancy are located on these track models or diagrams, while in other cases they are contained in a separate or special indicator cabinet. No standard arrangement can be shown, as each railway adopts its own standard.

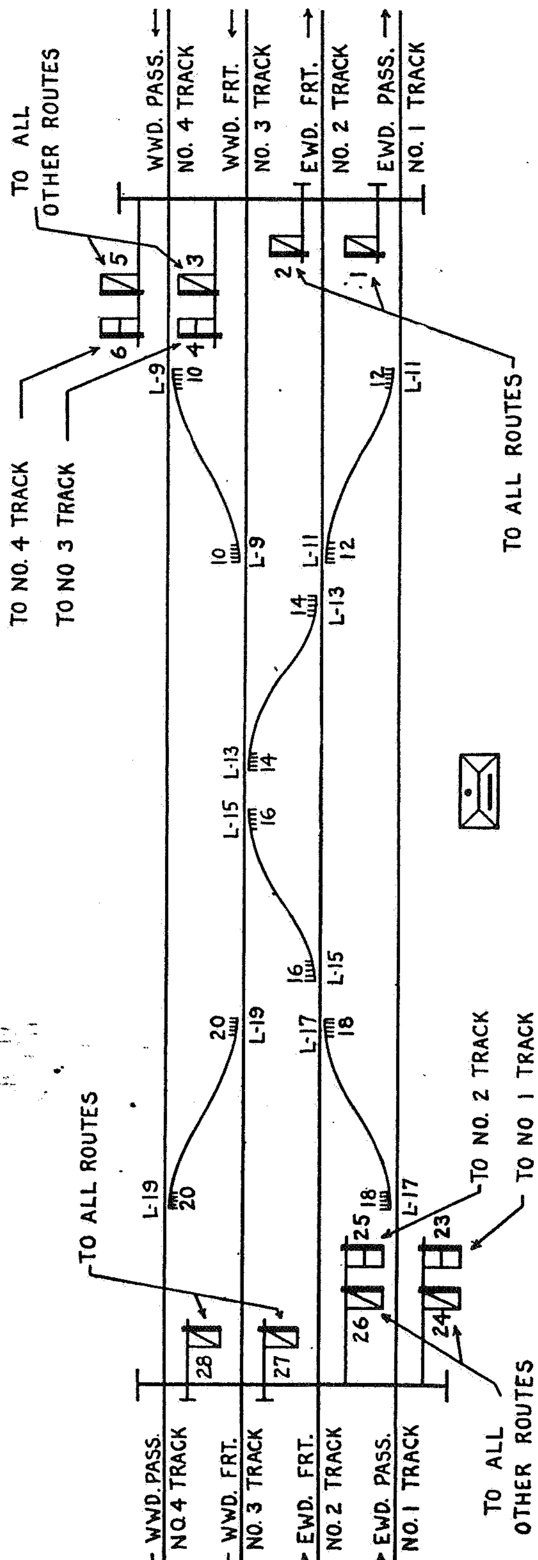


Fig. 2.
Track Layout with Mechanical Interlocking Machine.

Machine.

The interlocking machine is an assemblage of levers in a common frame, the number of levers depending upon the size of the interlocking plant and type of machine; the numbering is from left to right. A mechanical machine sometimes requires more levers than a power machine for the same number of switch and signal units.

Different types of machines are required for the various types of interlocking plants, except that in some cases the same kind of machine is used for an electro-pneumatic interlocking plant as with an electric interlocking plant.

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.

In the definition for interlocking it is stated that the appliances are so interconnected that their movements must succeed each other in a predetermined order. It is through the medium of the mechanical locking (more commonly known as "locking") that this sequence is accomplished.

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 interlocking plants 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 switches and/or levers 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.

Lever	When	Locks	Lever	When	Locks	Lever	When	Locks
1		(11) – 23 – 24	10		14	25		(11)-(13)-12- 14-(15)-16-(17)
	12	(17) - 18						18
	(12)	(13)-(15) - 26	11		12 (12)			
	(12) - 14	(17)				26		(13)-14-(15)-(17)-18
	(12) - (14)	(19) - 27	12		16		16	(11)-(12)
	(12) - (14) - (20)	28					(16)	(9)
			13		14 (14)			
2		(11)-12-(13)-(15)-16-24-25				27		(13)-(15)-16-(19)-20
	14	(17)	14		16 - 18		14	(9)
	(14)	(19) -27					(14)	(11)
	(14)-(20)	28	15		16 (16)			
						28		(19)
3		(9)- 10 - (13) -14- (15)	16		20		14-(20)	(9)
	16	(19)-(20) - 28					(14)-(20)	(11)
	(16)	(17) - 26	17		18 (18)		20	(9) - 10
	(16)-(18)	24					(20)	(13)-(15)
			18		–			
4		(9) -10 - (13) -14 - (15) -16 - (19)						
		20-27	19		20 (20)			
5		(9)-(10)-(13)-(15)-27-28	20		–			
	16	(19)						
	(16)	(17)-26	21		Spare			
	(16) (18)	24						
			22		Spare			
6		(9)-(19)- 10 - 20 - 28						
			23		(11) -12 - (17) - 18			
7		Spare						
			24		(13)-(15)-(17)-(18)			
8		Spare		16	(11)			
				(16)	(9)			
9		10 (10)						

Fig. 3.
Locking Sheet for Mechanical Interlocking Machine.

In a mechanical interlocking plant 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 No. 1 it can be said that when lever No. 1 is reversed it locks Nos. 23 and 24 normal and No. 11 reversed, No. 13 reversed when No. 12 is reversed, No. 15 reversed when No. 12 is reversed (No. 14 is not included as no matter what position No. 14 is in, the movement will be over No. 15 lock), No. 17 reversed when No. 12 is normal, No. 17 reversed when No. 12 is reversed and No. 14 normal, No. 18 normal when No. 12 is normal, No. 19 reversed when Nos. 12 and 14 are both reversed, No. 26 normal when No. 12 is reversed, No. 27 normal when Nos. 12 and 14 are reversed, No. 28 normal when Nos. 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. For example, when No. 12 is reversed No. 1 lever locks No. 2 lever indirectly, as in order to be able to reverse No. 2 lever No. 12 must be normal. No. 1 lever locks No. 26 normal directly as either signal could be displayed with No. 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 over No. 10 reversed No. 14 should be normal, so No. 10 reversed is made to lock No. 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 and Farmer machine.

Figure 4 illustrates a mechanical machine, using what is called the Saxby and Farmer (hereinafter referred to as "S. & F.") type of locking. The locking is contained in a horizontal locking bed placed behind the levers. This machine is in general use and is known as the "improved" Saxby and Farmer machine.

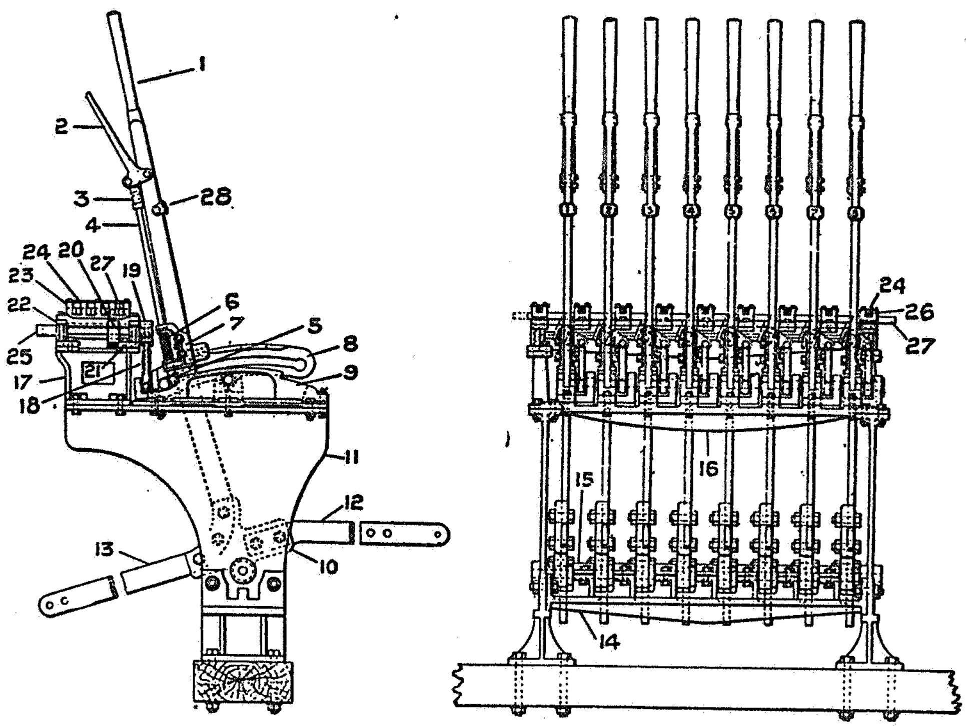


Fig. 4.
Improved S. & F. Mechanical Machine.

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 lever
13. Front tail lever
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 the 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 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; as the lever reaches the reverse position the latch rod drops into position at the back or reverse side of the quadrant; the latch spring 6 then forces the latch handle away from the lever to its position as shown in Fig. 4. 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 reverse 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.

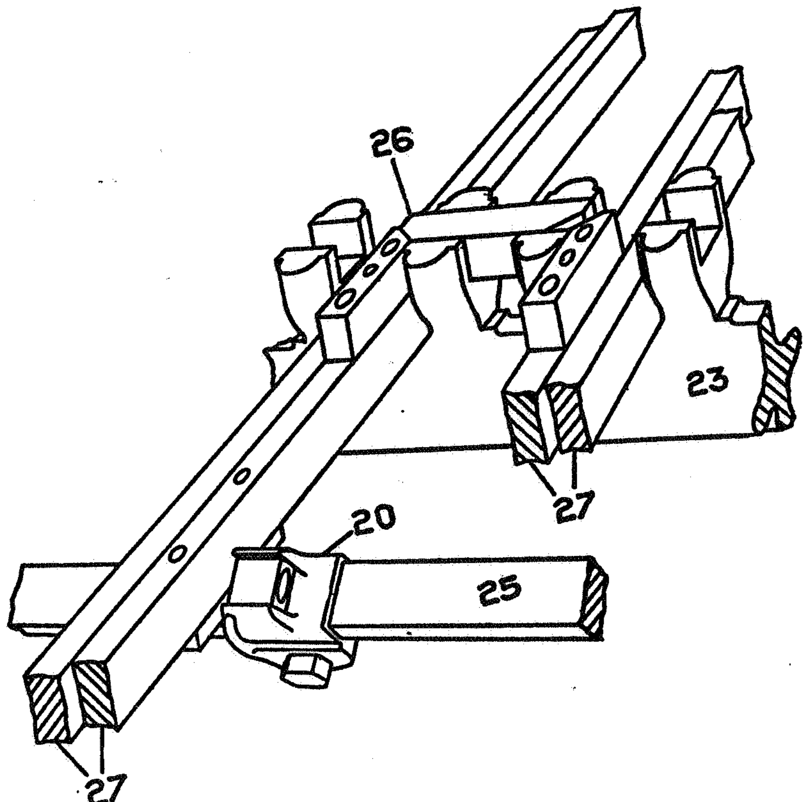


Fig. 5.
Mechanical Locking Between Two Levers.

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 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 No. 1 reversed locks lever No. 2 normal." Conversely, lever No. 2 reversed locks lever No. 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

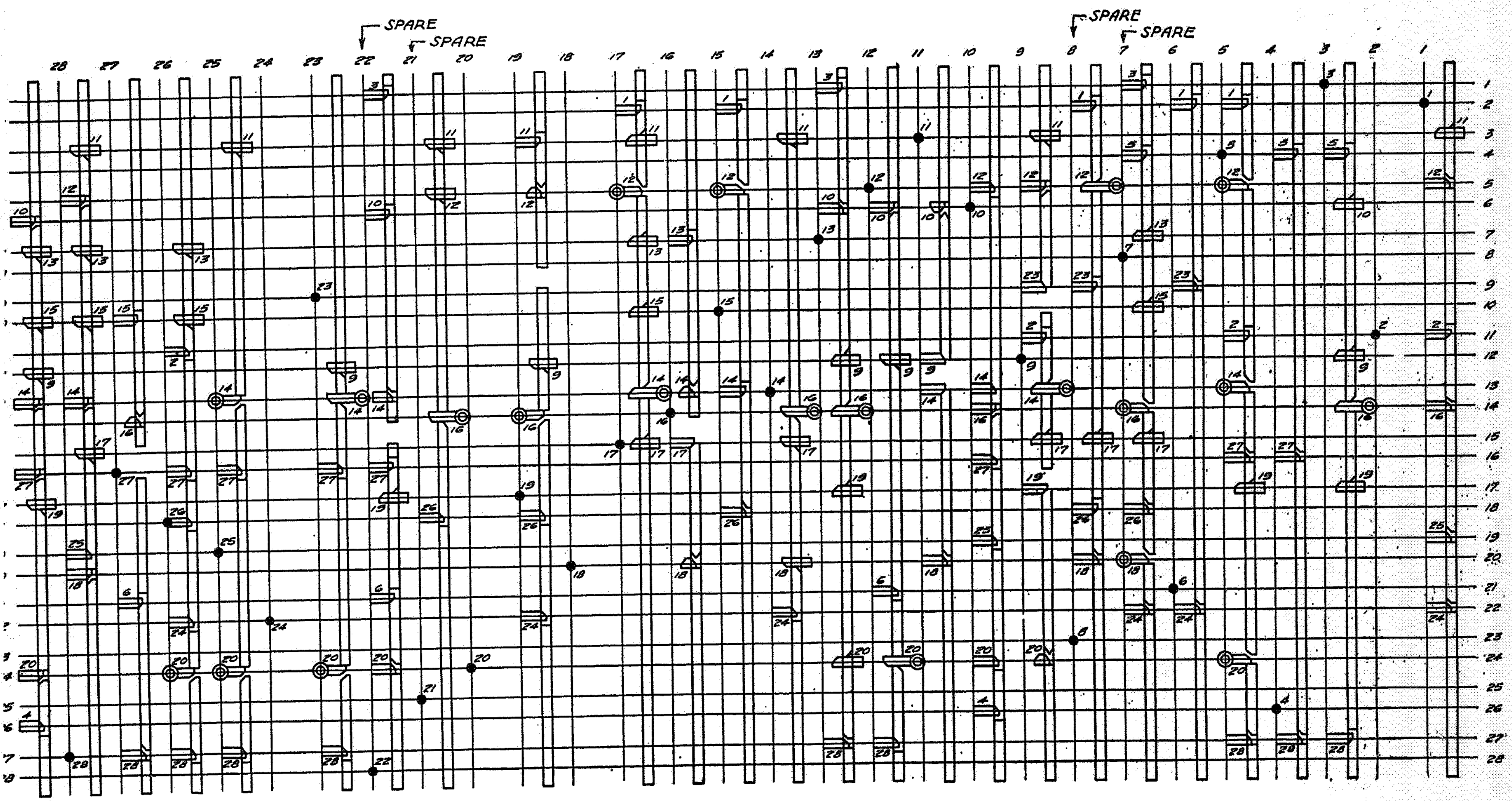


Fig. 6.
Dog Chart, Improved S. & F. Mechanical Machine.

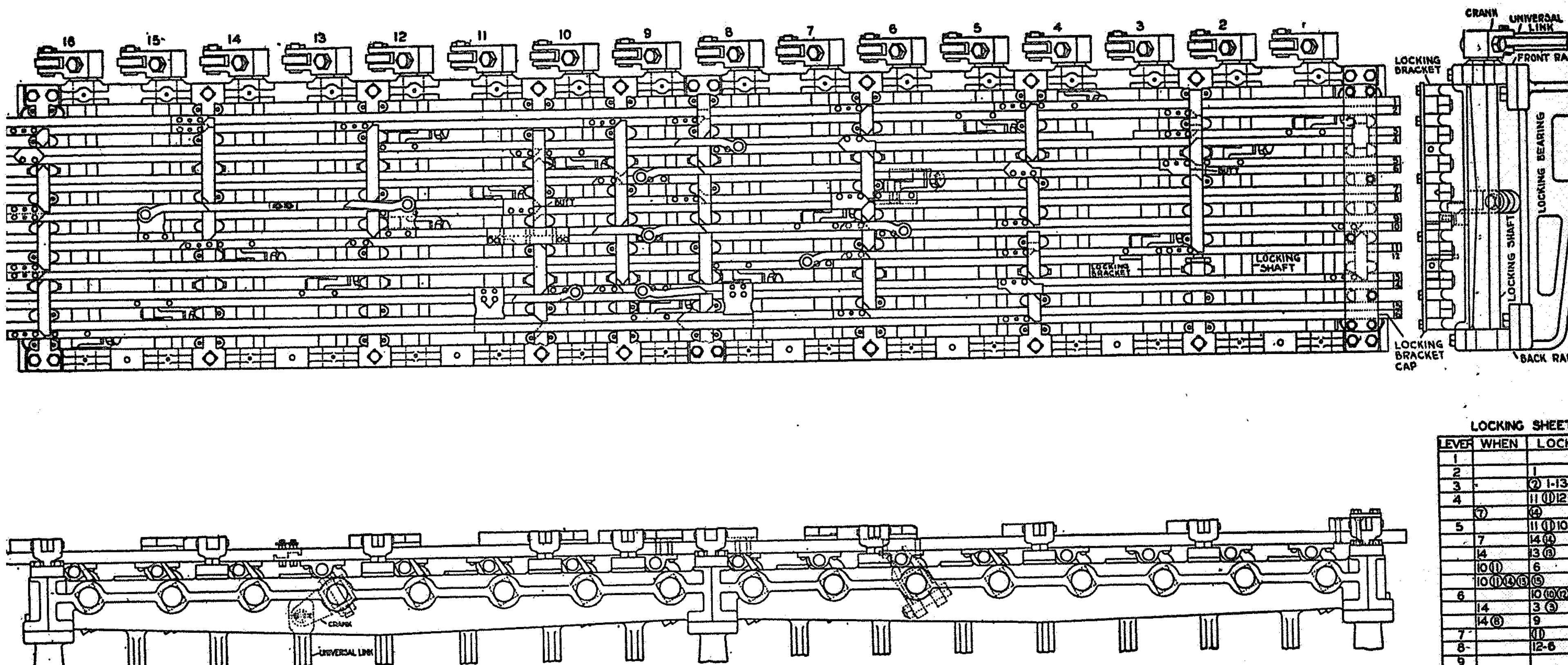
depending on size of machine, the cross-locking being ¾ inch by ¾ inch with length depending on size of machine and location of dogs to be locked. The dogs are of various sizes and shapes, depending on how the locking is arranged.

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 different shaped and sized dogs. They may be divided into two general groups: locking 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



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.

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 dogs shown part way through the cross-locking and a beveled cut shown in the cross-locking may be classed 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 may be 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.

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 and Farmer (English) machine.

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

The various parts 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 No. 1)
12. Back tail (not shown)
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

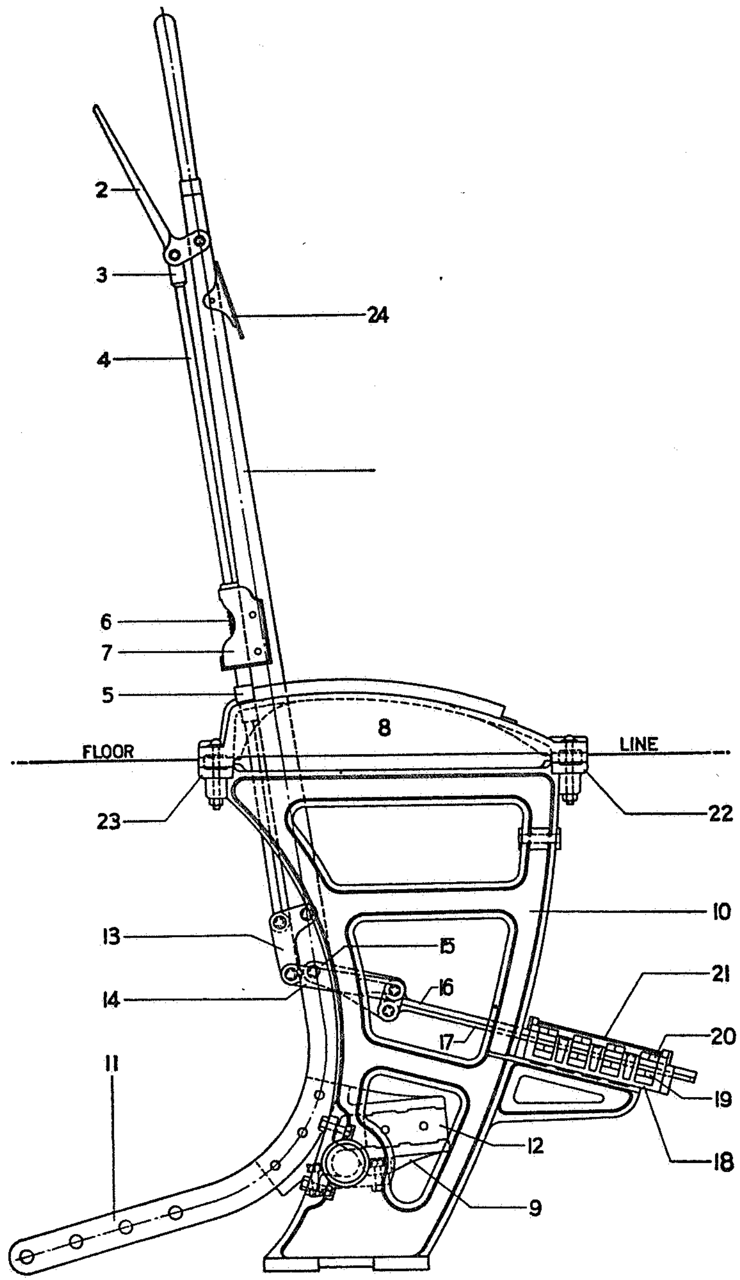


Fig. 8.
English Type S. & F. Machine.

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.

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.

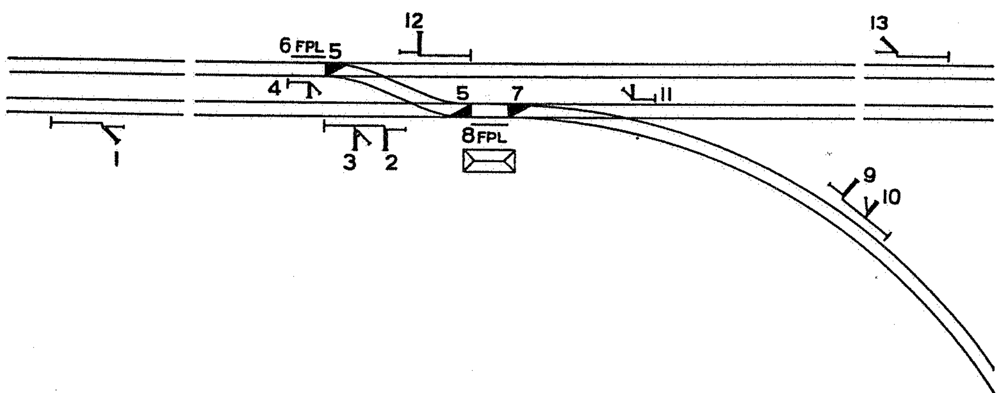
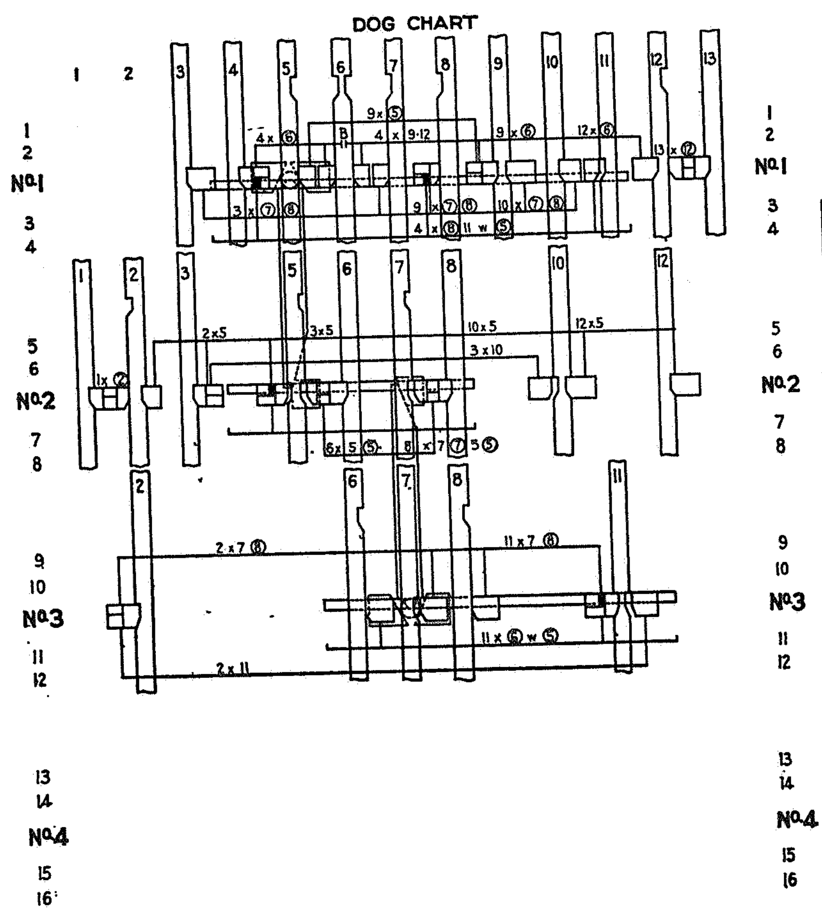


Fig. 9.
Typical Track Layout Using English Type S. & F. Machine.

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.



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. Machine.

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 numbers 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" machine.

Another type of mechanical 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. With the improved S. & F. the locking is contained in a horizontal locking bed placed behind the levers; with the Style "A" the locking bed is mounted vertically below the floor and to the front of the levers.

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:

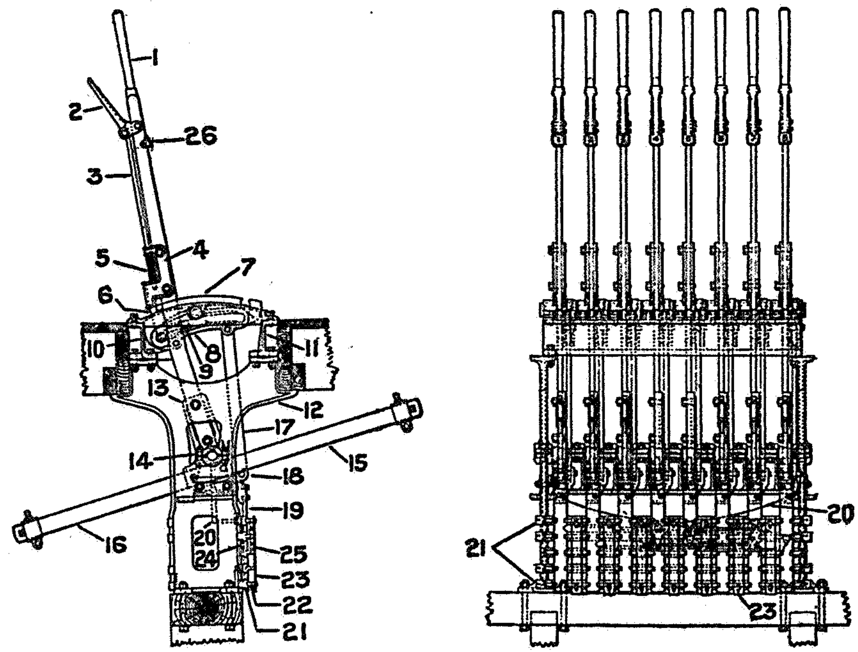


Fig. 11.
Style "A" Mechanical Machine.

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 b.

With the Style "A" machine the latch block and 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.

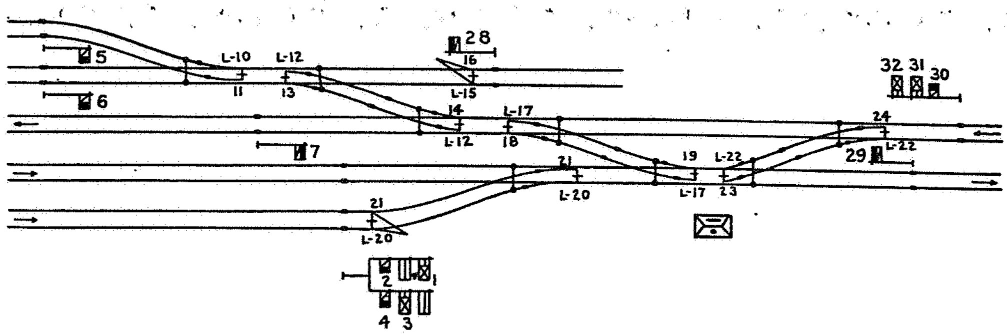


Fig. 12.
Track Layout Using Style "A" Machine.

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

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

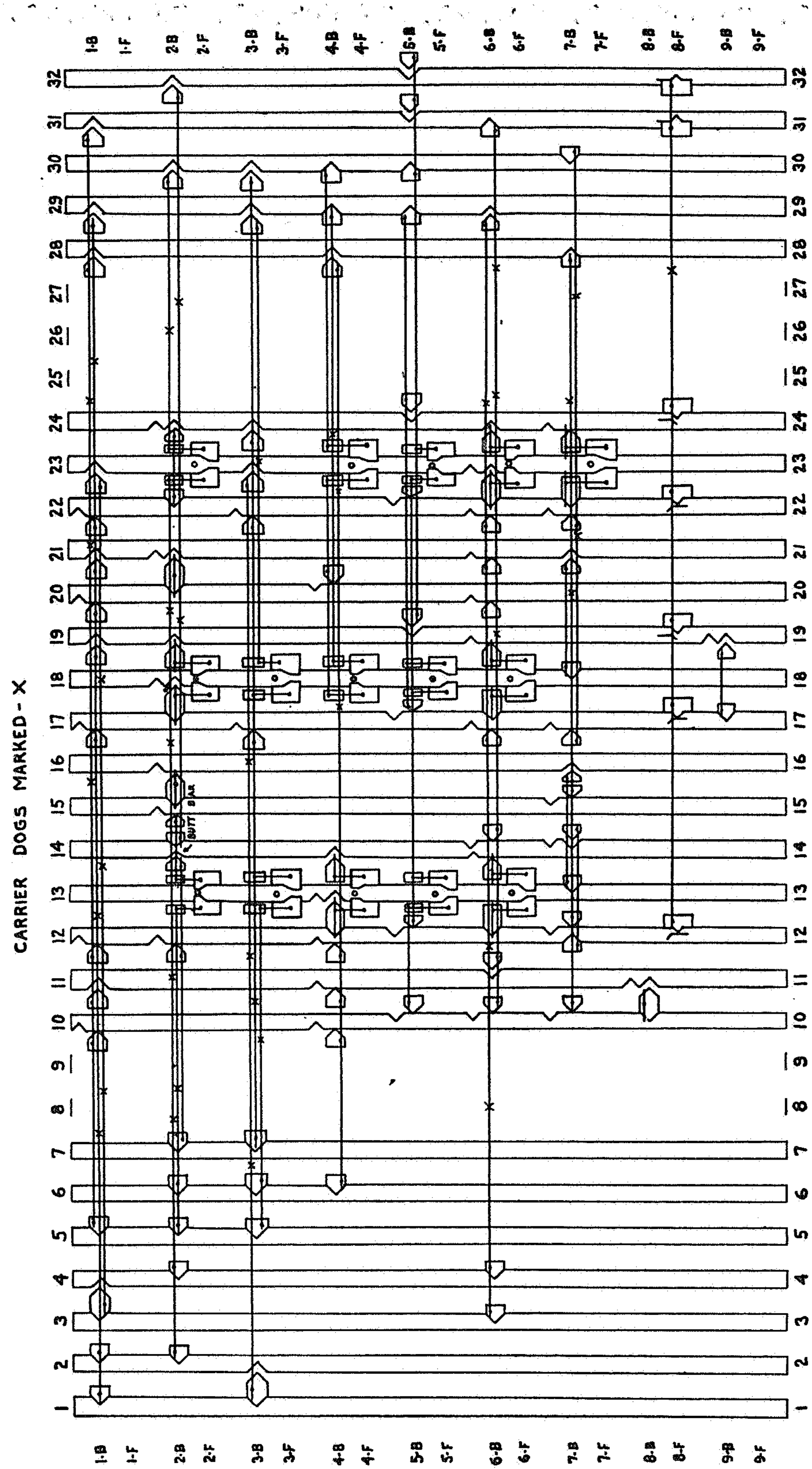


Fig. 13b.
Dog Chart for Style "A" Machine.

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 No. 16 is not moved to the proper position, lever No. 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 $\frac{3}{8}$ inch by $\frac{3}{8}$ inch stock and tappet pieces are $\frac{1}{2}$ 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.

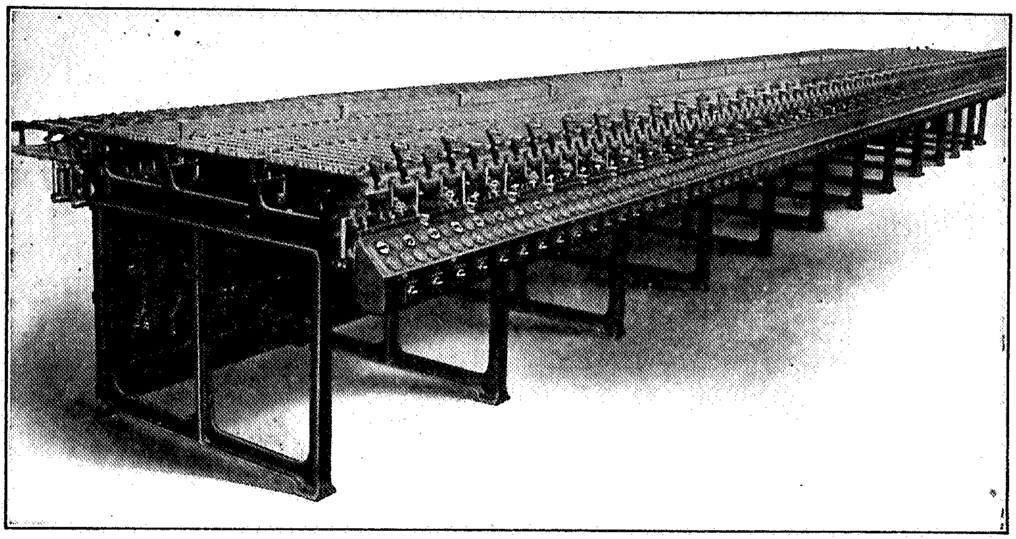


Fig. 14.
Electro-Pneumatic Machine.

Power interlocking.

Power interlocking may be divided into two classes: electro-pneumatic and electric. There is only one general type of machine used at an electro-pneumatic interlocking plant and it is illustrated in Fig. 14. For an electric interlocking there are several types of machine. Two of the more generally used types will be illustrated in this chapter: one of them is the same type as illustrated in Fig. 14 and the other type is illustrated in Fig. 15.

The details of machine shown in Fig. 14 are described in Chapter XVIII—Electro-Pneumatic Interlocking, while those illustrated in Fig. 15 are described in Chapter XIX—Electric Interlocking.

4

Electro-pneumatic 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.

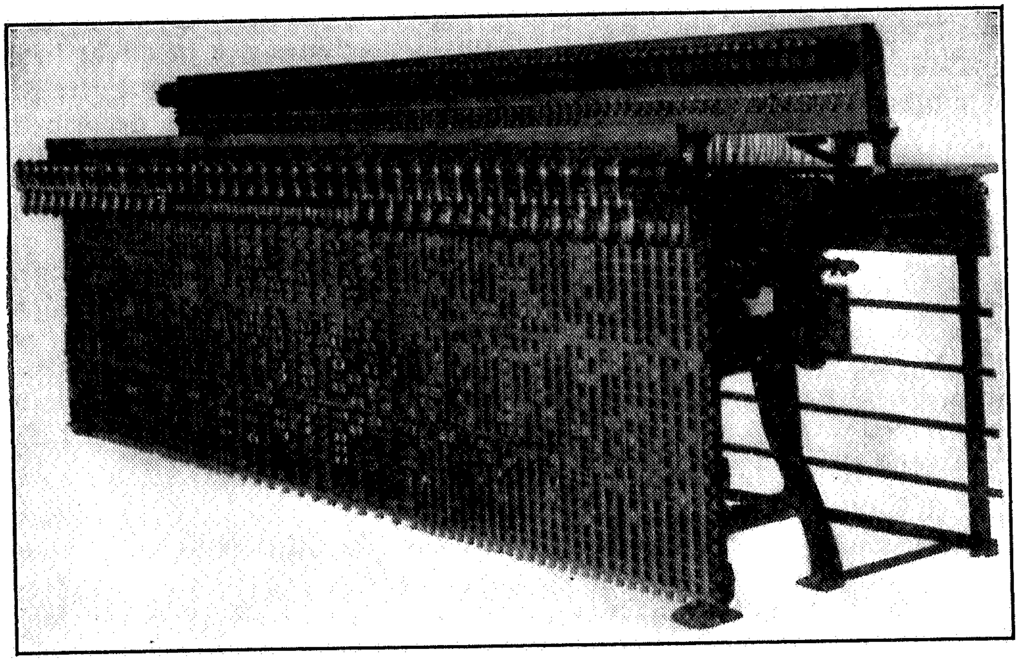


Fig. 15.
Electric Machine.

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.

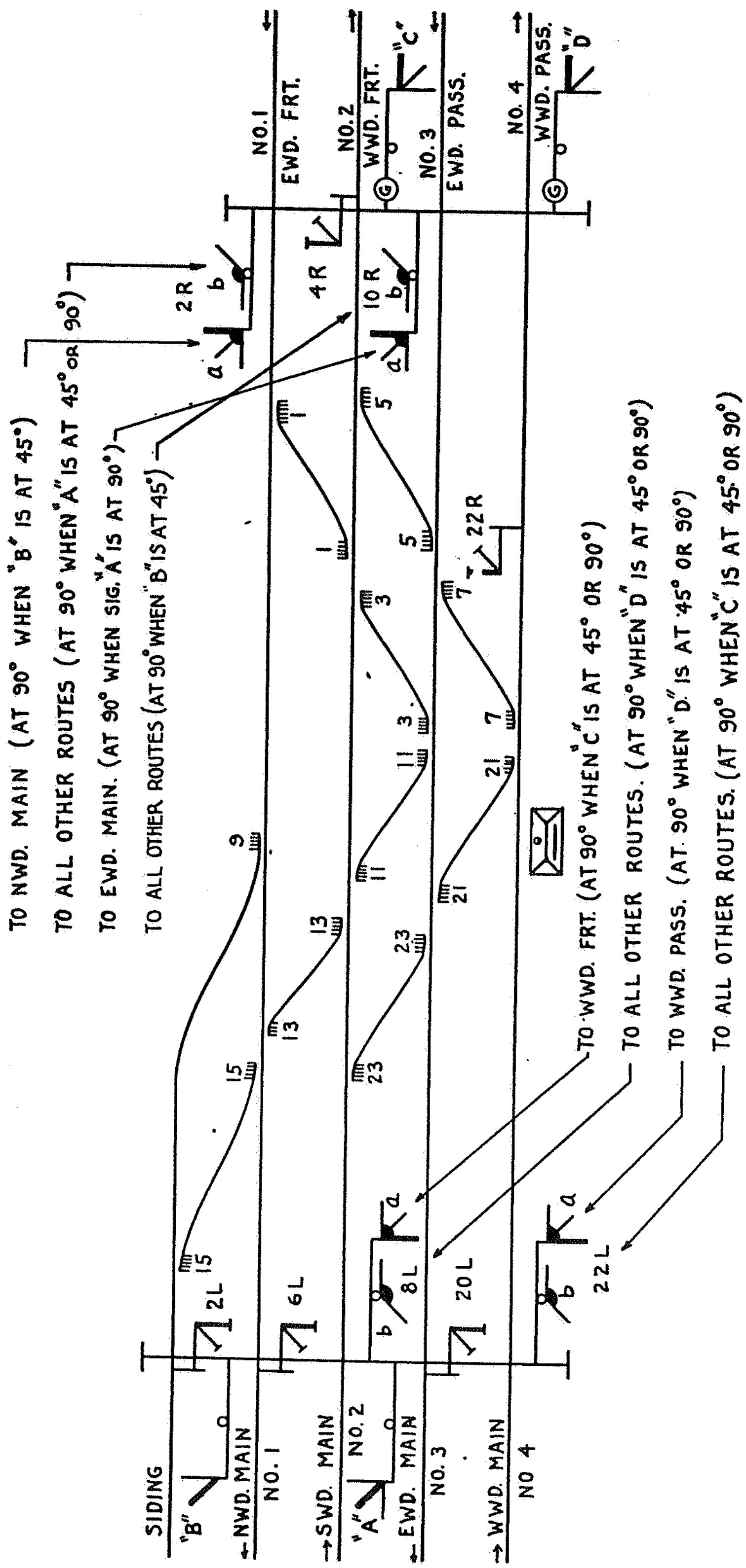


Fig. 16.
Track Layout Using Electric or Electro-Pneumatic Machine.

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		–

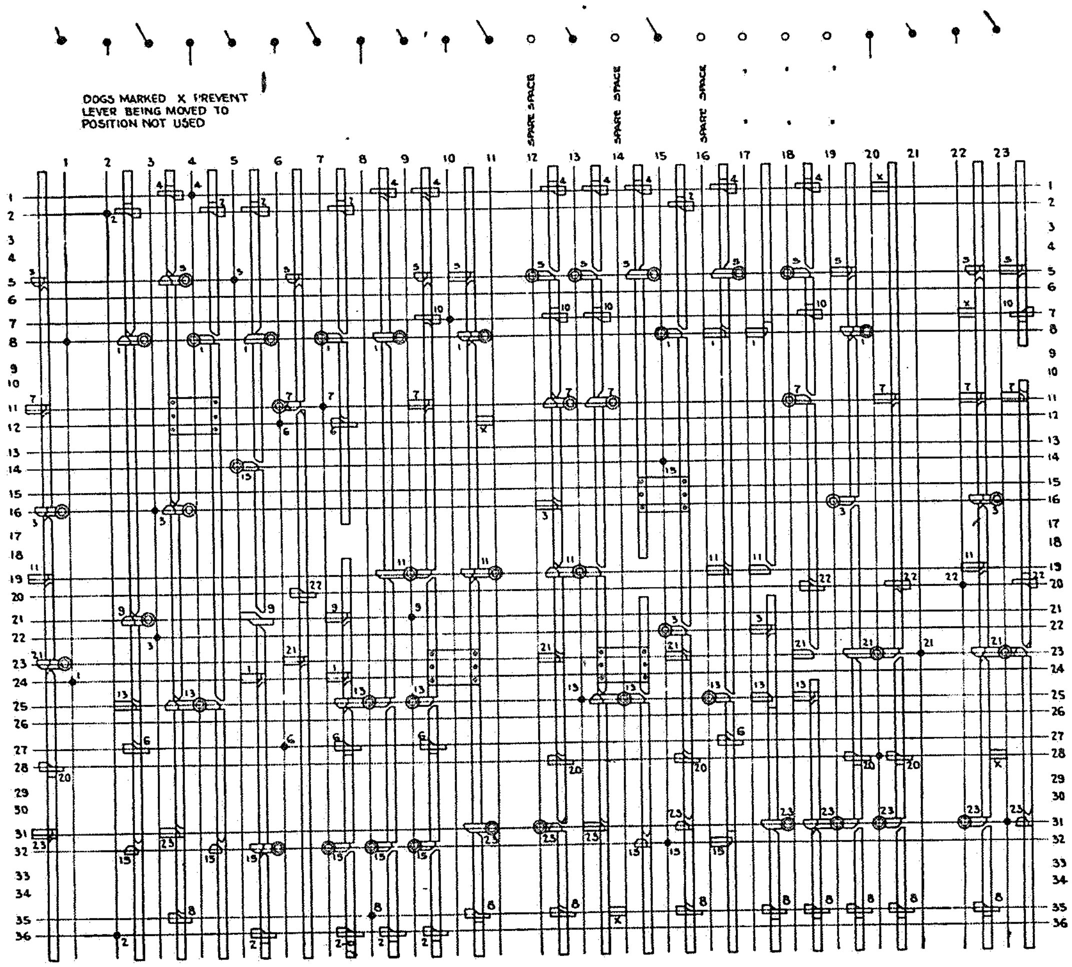


Fig. 17.
Locking Sheet and Dog Chart for Electric or Electro-Pneumatic Machine.

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 arranged so 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 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 size of machine; cross-locking is ⅜ inch by ⅜ inch, and the length also depends on size of machine and location of dogs to be locked. 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 inch. 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 ¼ 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.

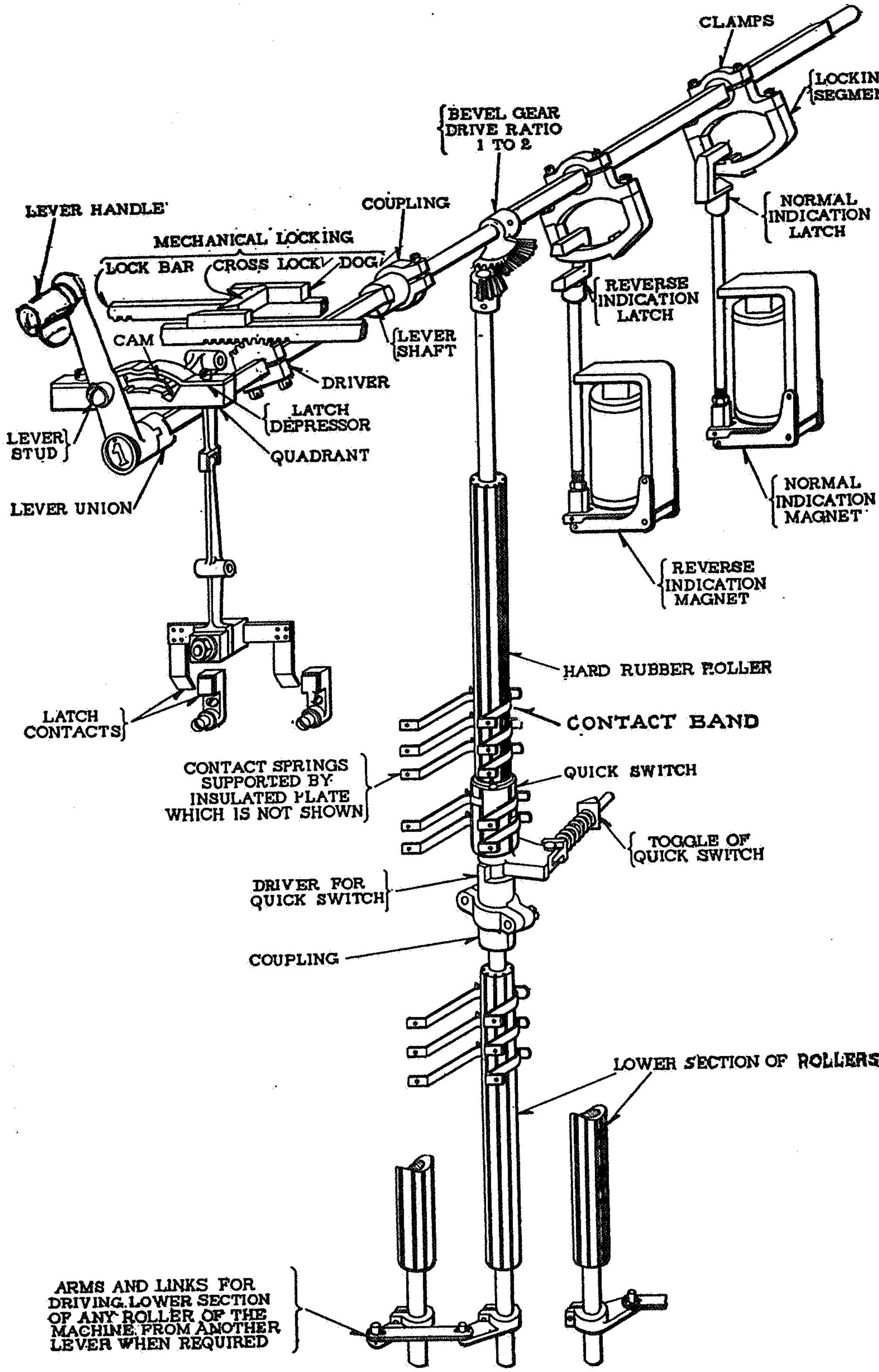


Fig. 18.
Section of Locking with Driver Fastened to Lever Shaft.

Electric machine.

Figure 19 illustrates a track layout operated by the electric machine in Fig. 15, and Fig. 20 illustrates 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 ¼ inch thick and ⅜ inch wide were placed in each locking space and had a horizontal movement of ¼ inch, the tappet bars were ¼ inch thick and ¾ inch wide and moved ¾ inch vertically. In the later machines four longitudinal bars ¼ inch by ¼ inch are used in each locking space and the new tappets are ⅜ inch thick and ¾ 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 consequently 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.

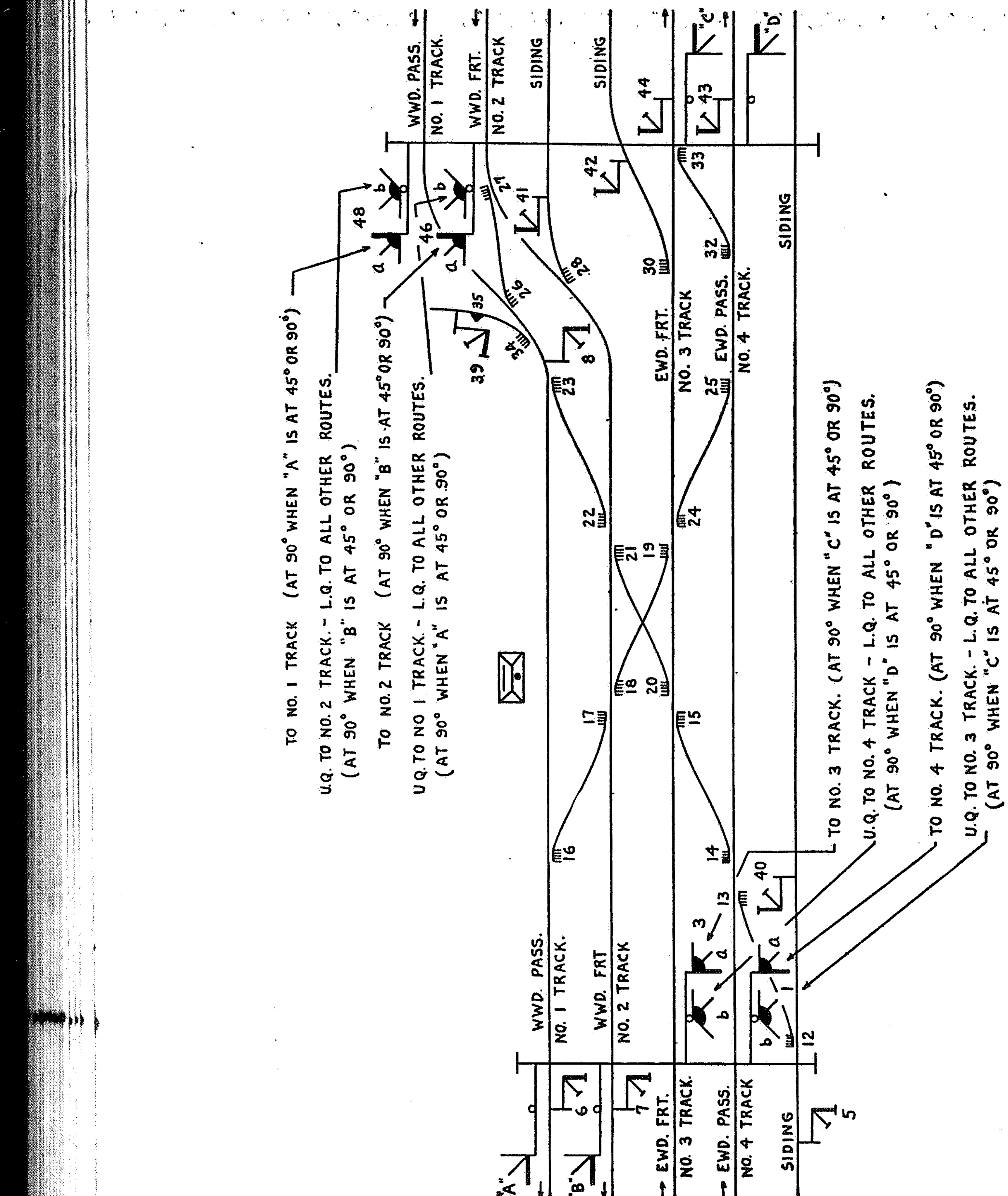


Fig. 19.
Track Layout Using Electric Machine.

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	—	
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)

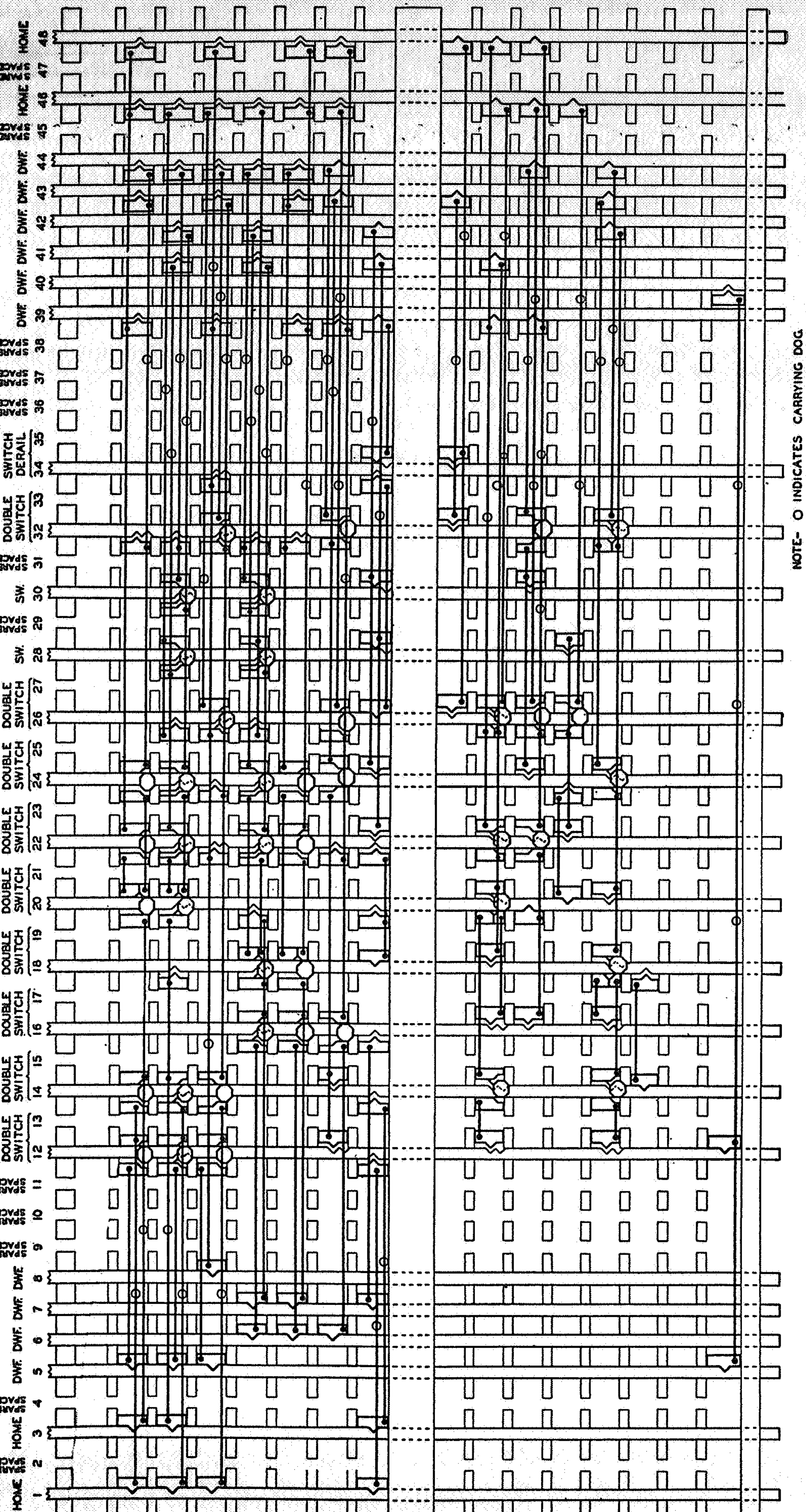

HOME 1
SPARE SPACE 2
HOME 3
SPARE SPACE 4
DWF. 5
DWF. 6
DWF. 7
DWF. 8
SPARE SPACE 9
SPARE SPACE 10
SPARE SPACE 11
DOUBLE SWITCH 12 13
DOUBLE SWITCH 14 15
DOUBLE SWITCH 16 17
DOUBLE SWITCH 18 19
DOUBLE SWITCH 20 21
DOUBLE SWITCH 22 23
DOUBLE SWITCH 24 25
DOUBLE SWITCH 26 27
SW. 28
SPARE SPACE 29
SW. 30
SPARE SPACE 31
DOUBLE SWITCH 32 33
SWITCH DERAIL 34 35
SPARE SPACE 36
SPARE SPACE 37
SPARE SPACE 38
DWF. 39
DWF. 40
DWF. 41
DWF. 42
DWF. 43
DWF. 44
SPARE SPACE 45
HOME 46
SPARE SPACE 47
HOME 48
NOTE- O INDICATES CARRYING DOG.

Fig. 20. (2 of 2)

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 in 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 machine.

As the name suggests, an electro-mechanical machine is the combination of an electric and mechanical machine. There are two general types of electric machines used in combination with mechanical machines: one is the same as illustrated in Fig. 14 and the other as illustrated in Fig. 15. The mechanical machine part is the same as described under mechanical machines.

Figure 21 illustrates an electro-mechanical machine in which the electric machine, as shown in Fig. 14, is used, while Fig. 22 illustrates the one in which the electric machine, as shown in Fig. 15, is used.

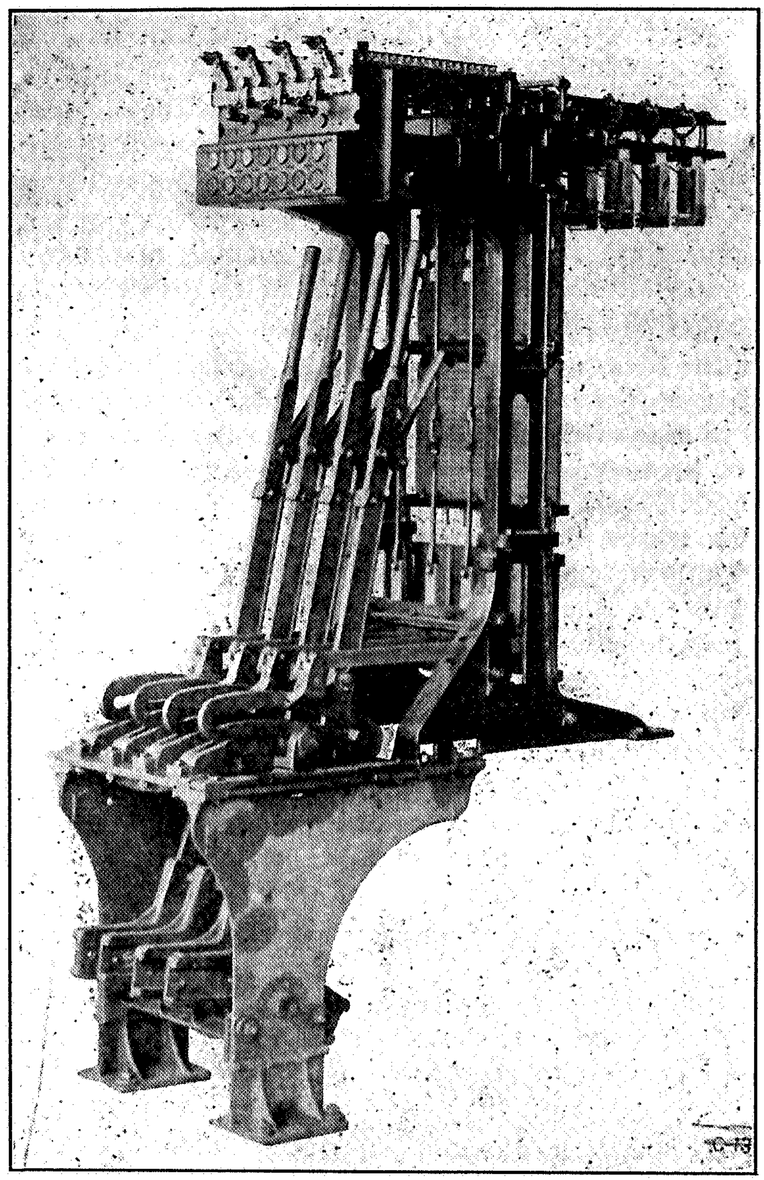


Fig. 21.
Electro-Mechanical Machine.

Chapter XVII—Mechanical and Electro-Mechanical Interlocking describes the details of the machines, and the mechanical locking is the same as for power machines described in this chapter.

Another arrangement of electro-mechanical machine has been used, which is illustrated in Fig. 23. This consists of adding a frame above the mechanical machine, this frame containing units which are similar in principle to the levers in a power machine. The details of this

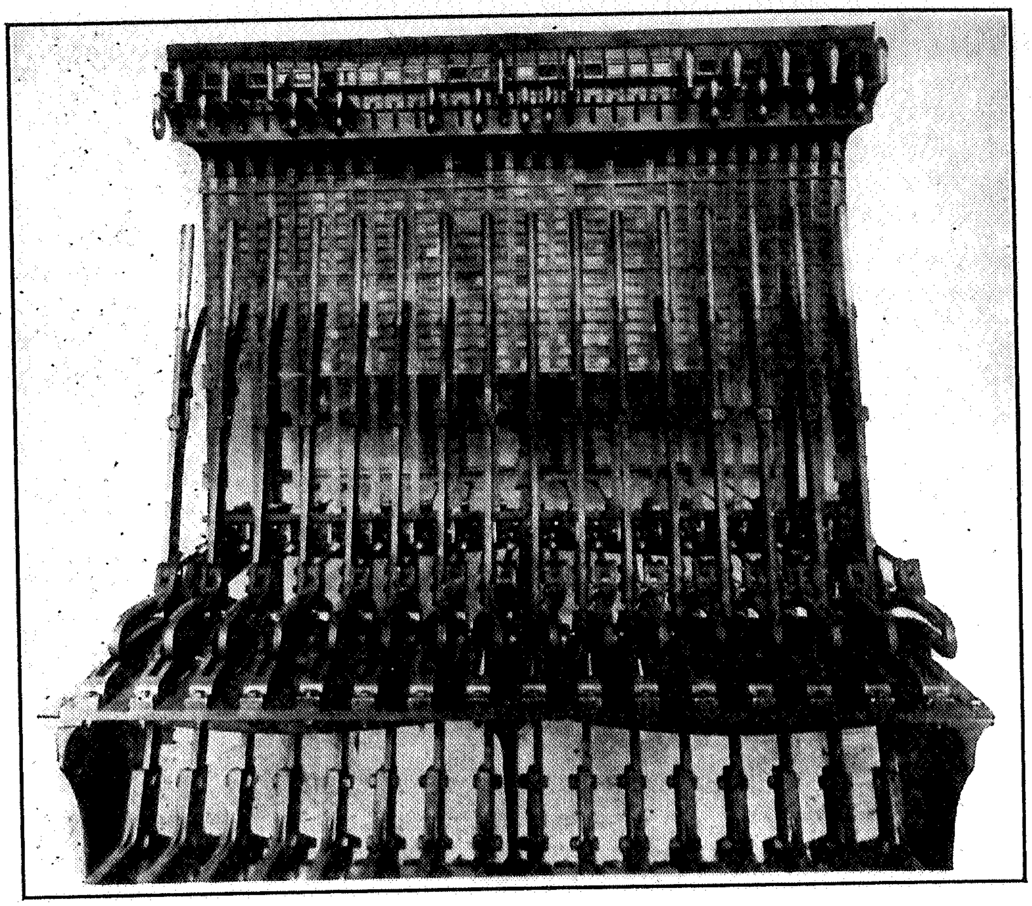


Fig. 22.
Electro-Mechanical Machine.

machine will likewise be found in Chapter XVII. The mechanical locking is practically the same as described in the improved S. & F. mechanical machine, but its operation is somewhat different.

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.

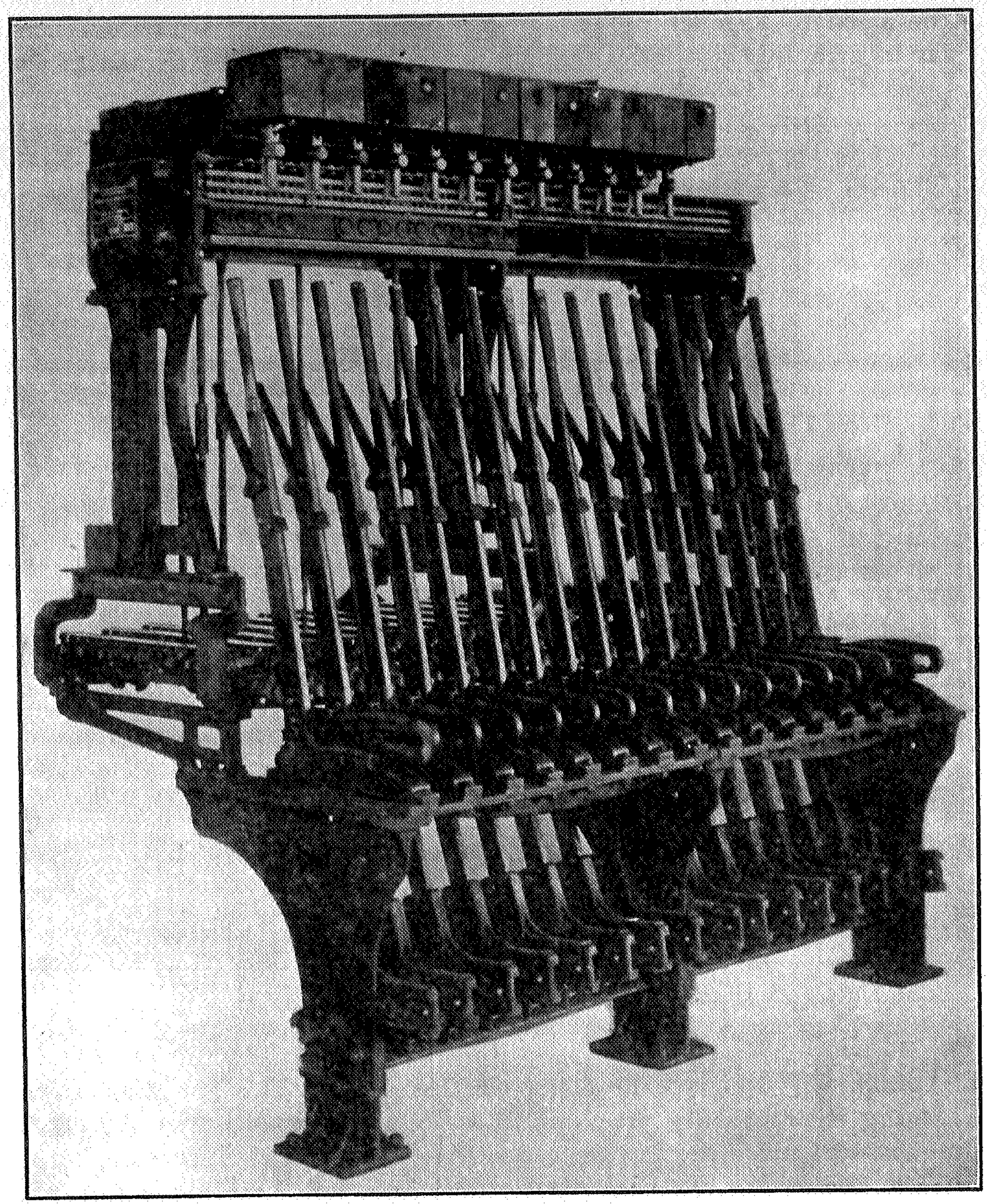


Fig. 23.
Electro-Mechanical Machine Using Electric Lever Units.

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

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

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 Nos. 9, 11, 13, 15, 17, 18, 19, 21 and 22 are connected direct to the locking shaft, while levers Nos. 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 arranged so 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 1⁵⁄₁₆ 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 L dogs, those extending to the right are R 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.

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.

There are various other pieces of inside apparatus, the more important of which are explained in different chapters.

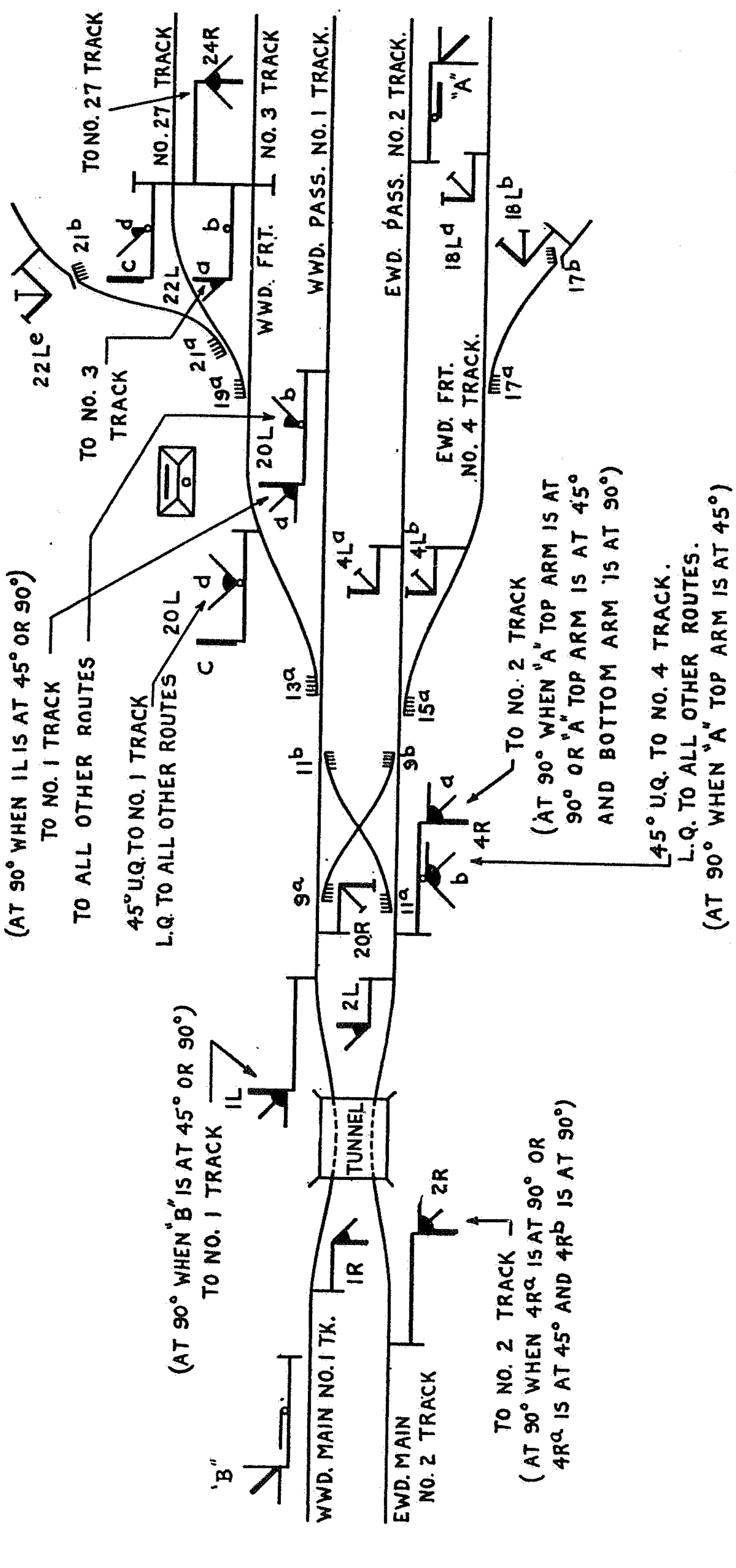
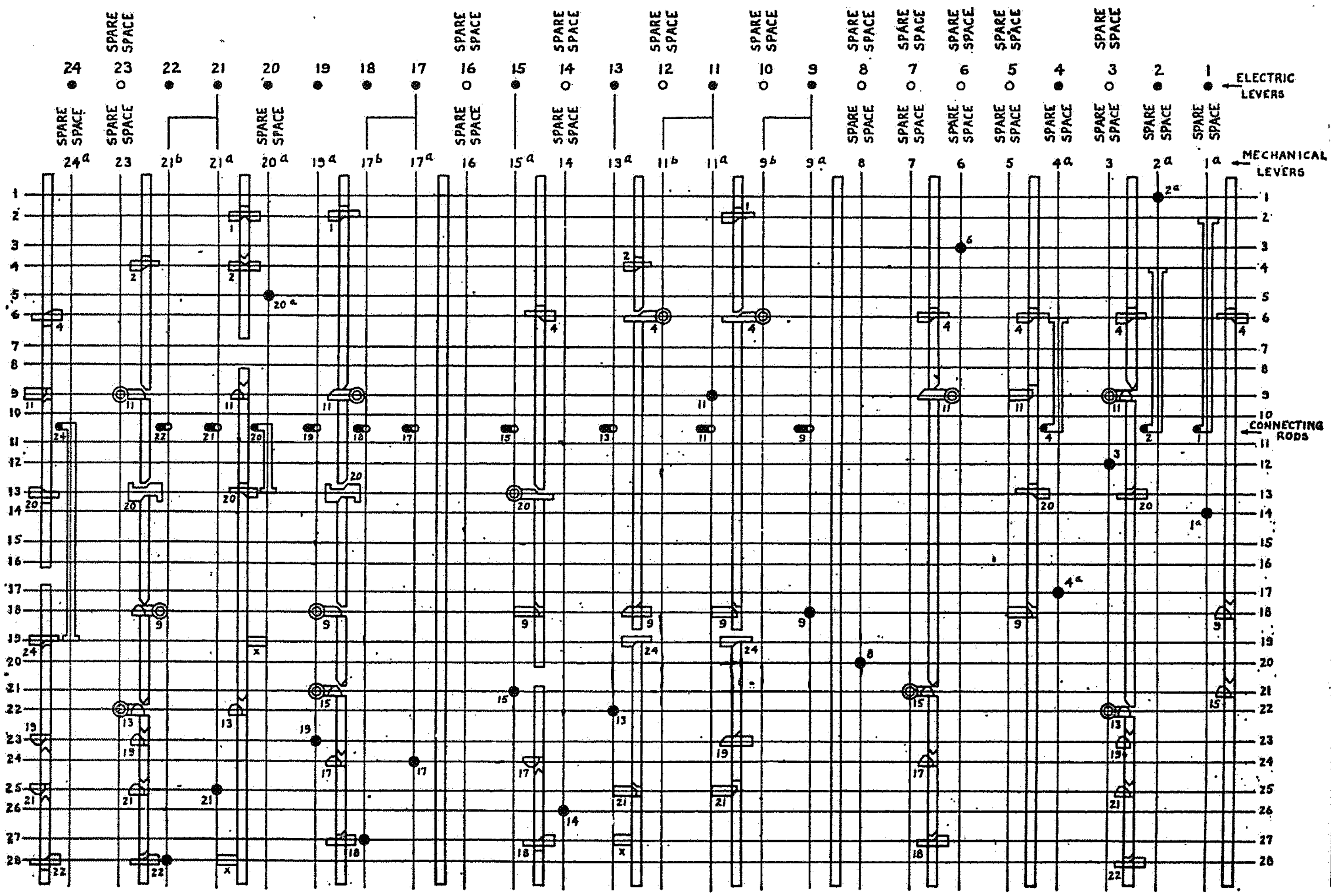


Fig. 24.
Track Layout with Electro-Mechanical Machine.



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.

Instructions.

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

Inspection.

1. The various parts of the locking bed, locking bed supports and connections must be inspected to see that they are properly secured.

2. Driving pieces, dogs, stops and trunnions must be inspected to see that they are properly secured to the locking bars.

3. 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 inch.

(e) Electro-mechanical interlocking machine,
(Style "A" miniature locking):
1. Vertical locking .... ¼ inch.
2. Horizontal locking .... 1 1/32 inch.

(f) Power interlocking machine,
S. & F. miniature locking .... 1 inch.

(g) Power interlocking machine,
(Style "A" miniature locking):
1. Vertical locking .... ¼ inch.
2. Horizontal locking .... 1 1/32 inch.

(h) Table interlocking machines:
1. General .... 1½ inches.
2. Union .... 1 inch.

4. Splices in longitudinal locking bars must be inspected to see that they are straight and properly made.

5. Where new locking is to be placed in service or a change in locking is made, the locking must be compared with the dog chart to see that they agree.

Testing.

6. Locking must be tested before interlocking machine is placed in service, when a change in locking is made, and at least annually as outlined in Instructions 7, 8, 9 and 11.

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

(a) Mechanical machine.

1. Latch operated locking. When lever latch block can be raised to within 3/8 inch of top of quadrant.

2. Lever operated locking. When lever latch block can be moved more than 3/8 inch on top of quadrant.

(b) Electro-mechanical machine.

1. Lever moving in horizontal plane. When lever can be moved more than 1/8 inch when in normal position or 3/8 inch when in reverse position.

2. Lever moving in an arc. When lever can be moved more than 3 degrees.

(c) Power machine.

1. Latch operated locking. When lever latch block can be raised to within 7/32 inch of top of quadrant.

2. Lever moving in horizontal plane. When lever can be moved more than 1/8 inch when in normal position or 3/8 inch when in reverse position.

3. Lever moving in an arc. When lever can be moved more than 3 degrees.

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

9. Latch shoes, rocker links and quadrants of S. & F. machines must be inspected and tested for lost motion that would permit locking to release if the foot is used on the rocker while lever is in mid-stroke position.

10. Where new locking is to be placed in service or a change in locking is made, a complete test must be made of the locking from the locking sheet by placing all levers normal, when practicable, then testing levers consecutively, commencing with lever with lowest number to see that each lever locks all other levers in the position required by the locking sheet.

11. Complete test of the locking from a signal layout or interlocking plan must be made as follows:

(a) Test locking between switch, derail and movable frog levers.

(b) Test locking between facing point lock and switch, derail and movable frog levers.

---

* These requirements are for interlocking machines in service. For new machines there should be practically no lost motion in locking or connections.

(c) Set up each route and endeavor to release latch or operate each signal lever that should be locked by that route; then raise latch on signal lever, or reverse signal lever, governing movements over route, endeavor to release latch or operate each lever that should be locked by the signal lever; then restore latch or lever to normal position and make similar test with lever or latch for the opposing signal.

(d) Where route or traffic levers are used, make test as outlined for signal levers in Instruction 11-c.

12. When new locking is to be placed in service or a change in locking is made, to insure that locking of a route does not interfere with parallel routes, the parallel routes must be set up and signal levers operated for movements in both directions on each route.

Outside Apparatus

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

Trains generally move at normal speed on the straight track through an interlocking plant, at medium speed, from one track to the other in the direction of traffic, and at restricted speed between all other tracks. To accomplish this several arrangements of signals are used, depending on the signal system in use. Generally, the top arm governs the normal speed route; where three arms are used the middle one generally governs the medium speed route, and the bottom arm the restricted speed routes. Where only two arms are used, the clear position of the bottom arm governs the medium speed route and the restricted speed position the restricted speed routes. Where only one arm is used, the clear position governs the high-speed route and the approach position all other routes. Signals are located at either 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 are 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 and XIII, Semaphore and Light Signals, respectively; 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; therefore no further explanation need be made in this chapter. Approach indications to interlockings are generally provided and where auto-

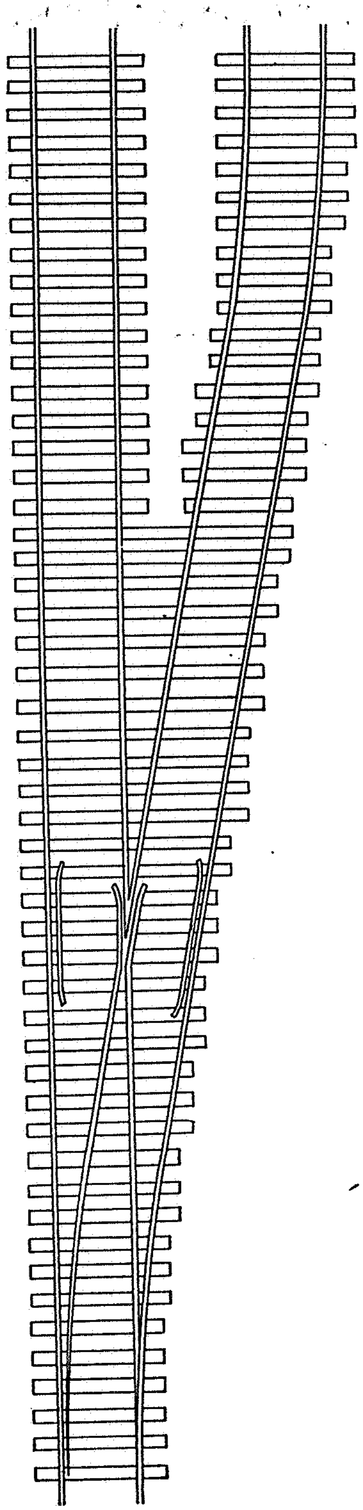


Fig. 26.
Turnout.

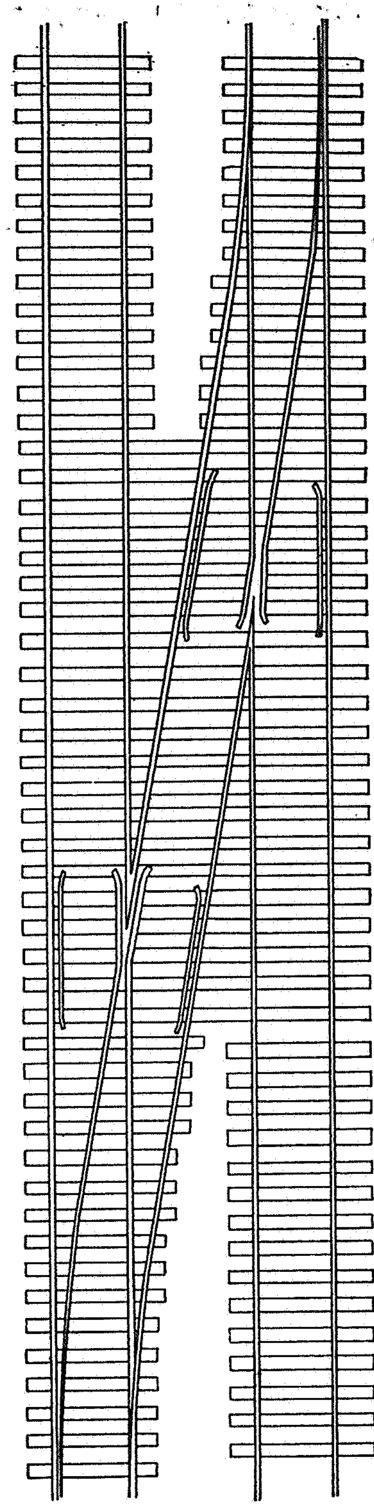


Fig. 27.
Crossover.

matic 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.

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.

Turnouts and crossovers.

The American Railway Engineering Association defines Turnout as: A track arrangement consisting of a switch and frog with connecting and operating parts, and extending from the point of the switch to the heel of the frog, by means of which engines and cars may pass from one track to the other.

Figure 26 illustrates a turnout which will permit a movement from the main track to a siding, from a double to single track, etc.

The American Railway Engineering Association defines Crossover as: Two turnouts with the track between their frogs, arranged to form a continuous passage between two nearby and generally parallel tracks.

A crossover is illustrated in Fig. 27.

Slip switches.

There are two kinds of slip switches: single and double. The Signal Section, A.R.A., defines Single-slip Switch as: A combination of a crossing and a single connecting track, 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.

The Signal Section, A.R.A., defines Double-slip Switch as: 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.

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.R.A., defines Movable Point Frog as: A frog equipped with points which are movable in the same manner as the points of a switch.

Figures 28, 29, 30 and 31 illustrate slip switches with movable frogs and those with rigid frogs.

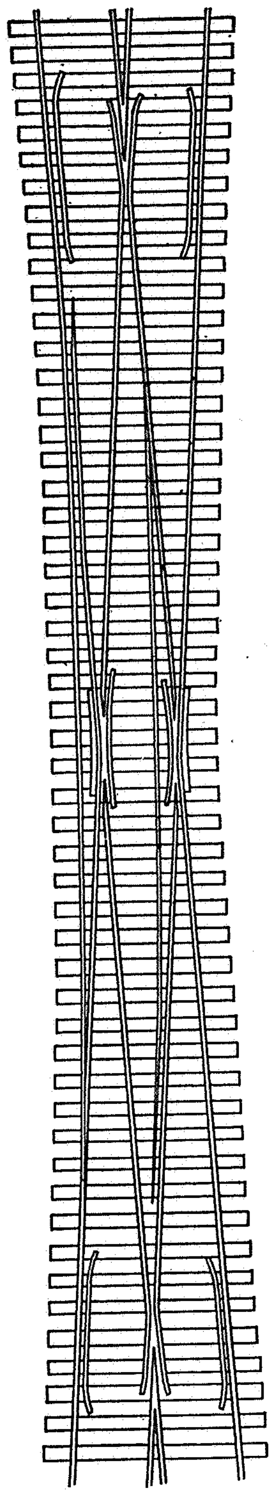


Fig. 28.
Single-Slip—Rigid Frogs.

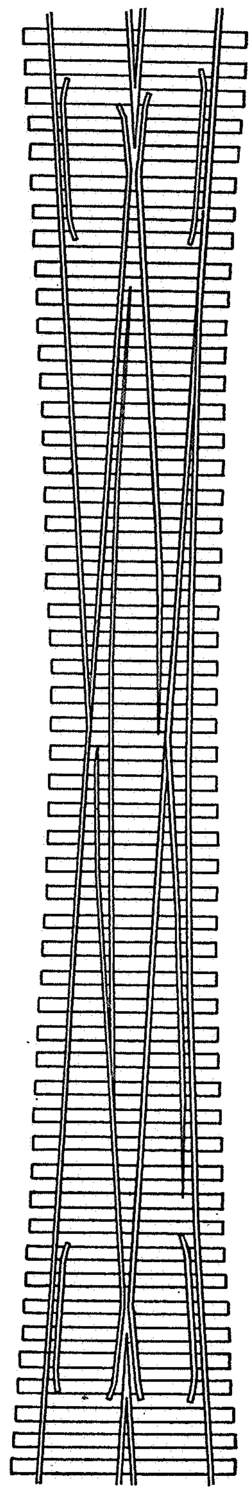


Fig. 29.
Single-Slip—Movable Point Frogs.

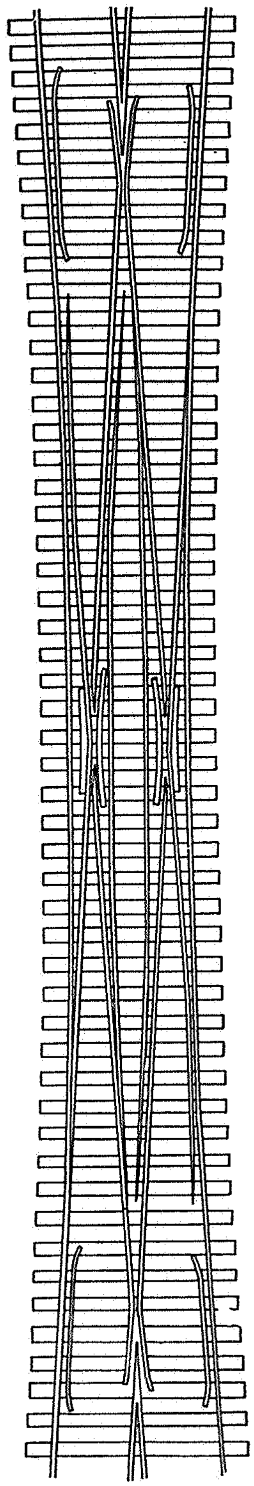


Fig. 30.
Double-Slip—Rigid Frogs.

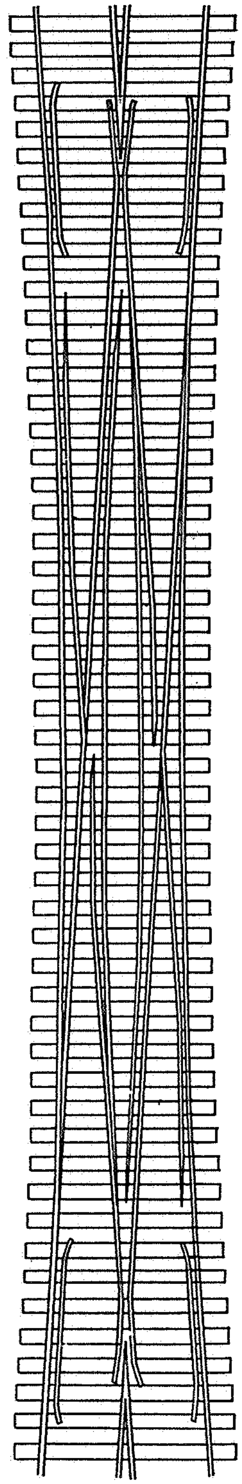


Fig. 31.
Double-Slip—Movable Point Frogs.

Derails..

The Signal Section, A.R.A., defines Derail as: **A device for throwing wheels of rolling equipment off the rails.**

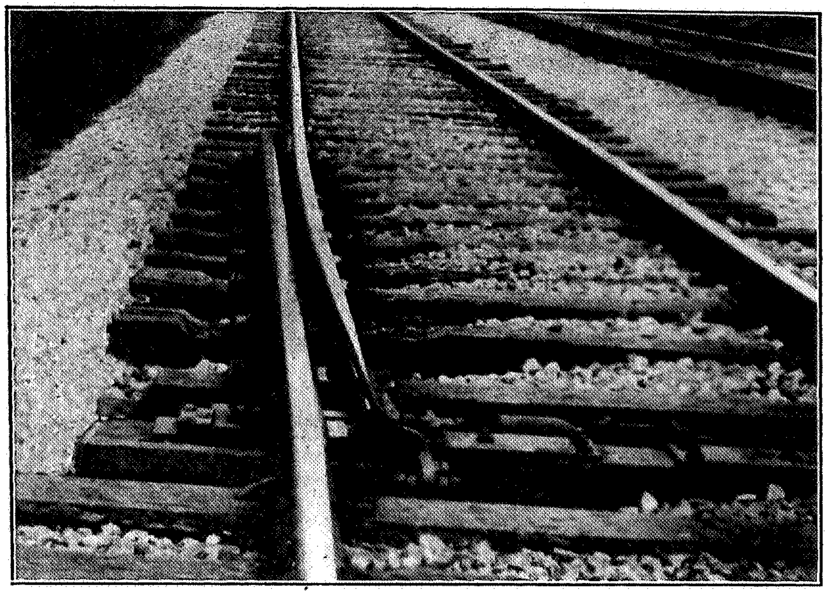


Fig. 32.
Single Point Derail.

Fig. 33.
Lifting Rail Derail.

There are various types of derails, but those most generally used are known as single point, lifting rail and lifting block, one of each being illustrated in Figs. 32, 33 and 34. The use of derails under present day practice is reduced to a minimum.

Detector bars.

Detector bars generally consist of long flat pieces of iron ½ inch thick, 2¼ inches wide and generally 53 feet in length. Specially designed plates designated as motion plates are attached to the bar at desired points and for each plate attached to the bar a corresponding clip is attached to the rail. Through the medium of the motion plates and clips the bar is held against the outside head of rail. When

Fig. 34.
Lifting Block Derail.

the operating connections are moved, the bar (due to design of plates and clips) is caused to move longitudinally and rise upward until it is approximately ¾ inch above the top of rail before switch, movable point frog or derail is unlocked. Should there be a car standing or passing over the switch, movable point frog or derail at the time it was attempted to unlock the switch, movable point frog or derail, the wheels would prevent the bar from rising above the top of rail

which in turn would prevent unlocking the switch until the car had passed off it.

A typical detector bar layout is illustrated in Fig. 35. Its use has been practically eliminated by electric switch lever locking due to the protection for which these bars were designed being more or less unreliable account of the increase in weight of rails.

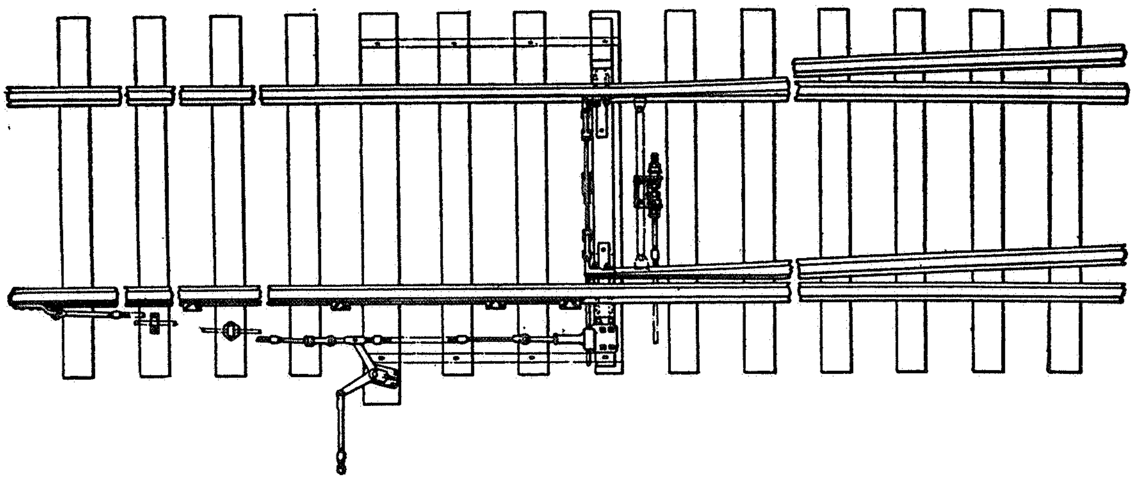


Fig. 35.
Typical Detector Bar Layout.

Switch rods and plates.

The various types of switch and slip layouts have a number of rods between the switch points and extending therefrom. These may be generally classed as front, lock, head, operating, No. 2, No. 3, etc.

The Signal Section, A.R.A., 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. There are various designs of front rods, and they are usually insulated so that they will not shunt the track circuit.

The Signal Section, A.R.A., defines Lock Rod as: A rod, attached to the front rod or lug, through which a locking plunger may extend when the points or derail are in the normal and/or reverse position.

There are various types of lock rods. They are equipped with slots or holes through which a plunger will pass 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 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. Generally, mechanically-operated switches are adjusted so that the locking dog or plunger will foul the lock rod with points open in normal or reverse position 3/16 inch, while with power-operated switches this is made 1/4 inch.

The Signal Section, A.R.A., 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 likewise of various designs. It is also usually insulated from the switch point so that it will not shunt the track circuit.

The Signal Section, A.R.A., 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 arranged so 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, A.R.A., as: The excess stroke of a switch operating rod.

This overthrow is necessary for adjustments due to lost motion, which decreases the throw of the operating rod. When the overthrow is about used up, it is necessary to renew the worn parts. Ordinarily there should be a minimum of 1/2 inch overthrow in each 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 3 1/2 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 3/4 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.

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.

Drawbridges

In localities where railroads cross navigable streams, it is necessary to install drawbridges so that boats may have unimpeded use of the stream.

The Signal Section, A.R.A., defines Drawbridge as: A structure connecting land traffic lanes over a navigable waterway, so designed that a section of it may be displaced to permit passage of traffic on the waterway.

There are a number of types of drawbridges in service. Some are pivoted at one end, some in the center and will 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 draw span; while with others the entire span lifts. Various methods of operating these bridges apply;

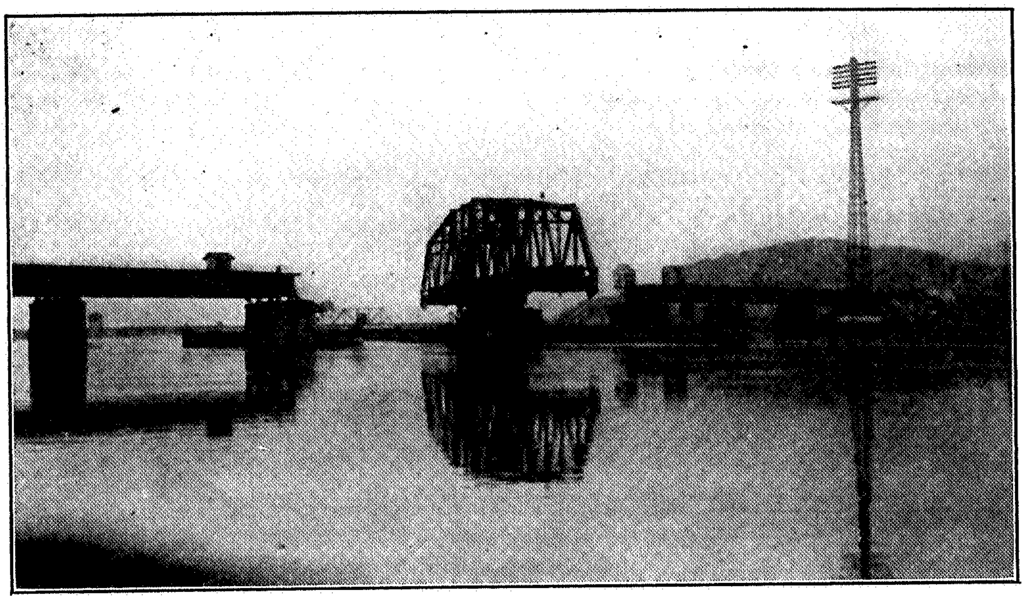


Fig. 36.
Center Pivot Drawbridge.

some are manually operated, while others are steam, electric or gasoline operated. No attempt, however, will be made to explain the various methods of operating or turning the draw span, as the essential point from a signaling standpoint is the method of locking the drawbridge span.

Protective devices are 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 movement over the bridge. This requires locking in the machine so that a predetermined order must be followed to open or close the bridge, which may be expressed briefly as follows: To open draw, display Stop signals, then unlock rail and bridge devices; to restore traffic, lock bridge and rail devices, and then display a signal to proceed.

Rail ends, where the draw 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 arranged so that they are trailing to normal traffic. In the case of a single-track drawbridge 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.

When the drawbridge is within the limits of an interlocking, the machine on the draw span for operating the drawbridge locking devices is frequently locked by the interlocking machine so that before

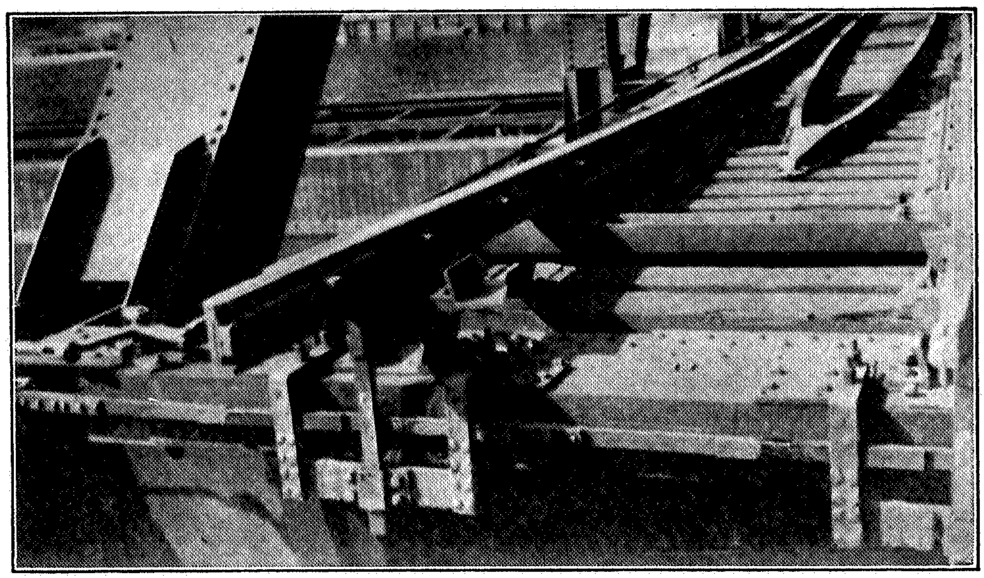


Fig. 37.
Method of Locking Rail Ends on Draw Span.

the drawbridge can be operated it is necessary for the interlocking attendant to release the draw machine, but before this is done all signals governing movements over the draw span must be in Stop position. After the release has been accepted the interlocking attendant cannot display Proceed signals until the draw attendant has locked the draw span in proper position and released the interlocking machine. Usually the machine on the draw span is a standard interlocking machine and the levers operate the devices for locking bridge wedges, rail wedges or locks, operating mechanism for turning or lifting the draw span, etc.

At other drawbridge locations the interlocking machine is located on the draw span, in which case the signals and drawbridge locking devices are controlled by this machine equipped with regular

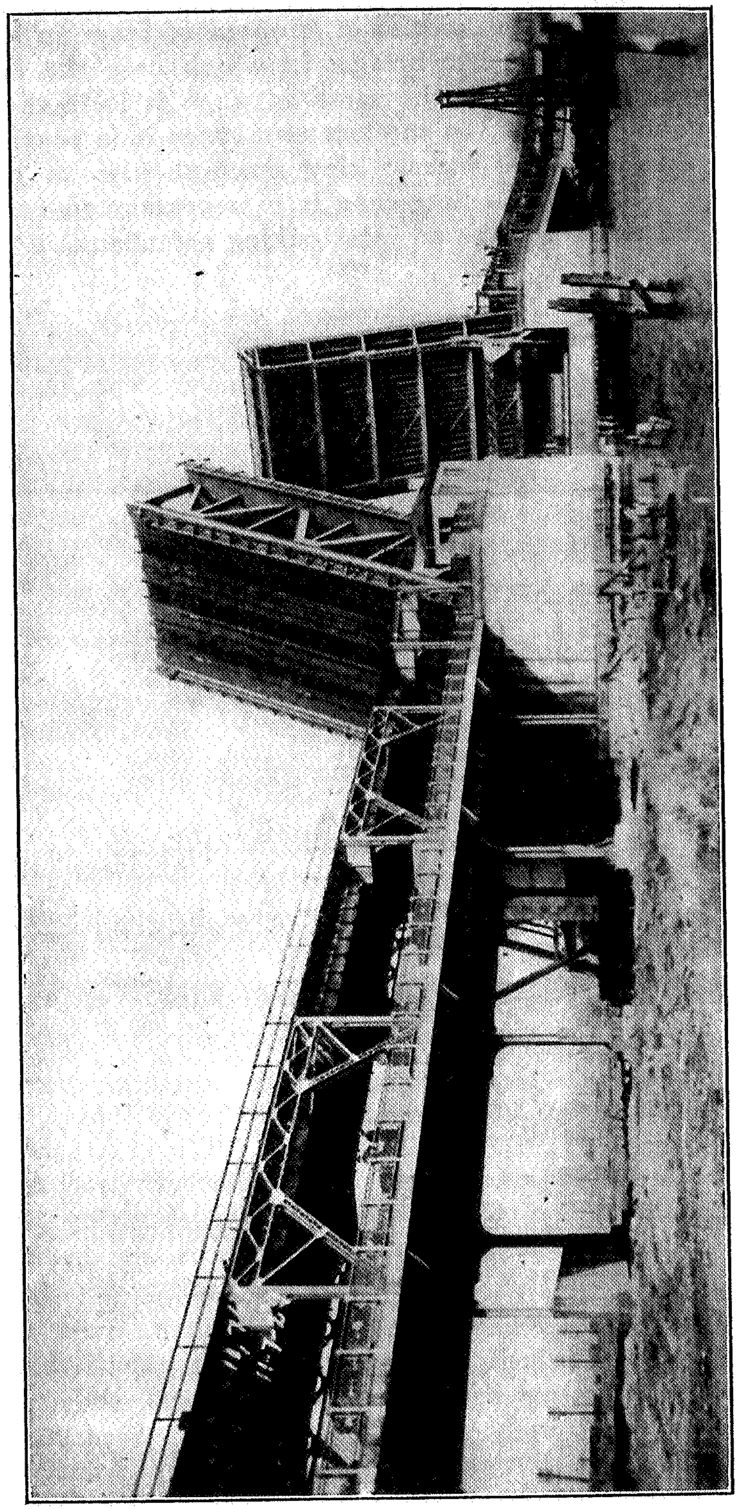


Fig. 38.
Lift Type Drawbridge.

mechanical locking so that the lever movements must precede each other in a predetermined order similar to any other interlocking.

At other locations the draw span is operated from an interlocking station located off the drawbridge, in which case the interlocking machine is arranged about the same as when it is in the operating room of the draw span. In the last two cases it is possible for the attendant operating the interlocking machine also to operate the drawbridge, while in the first case it is necessary to have a drawbridge attendant as well as an interlocking attendant.

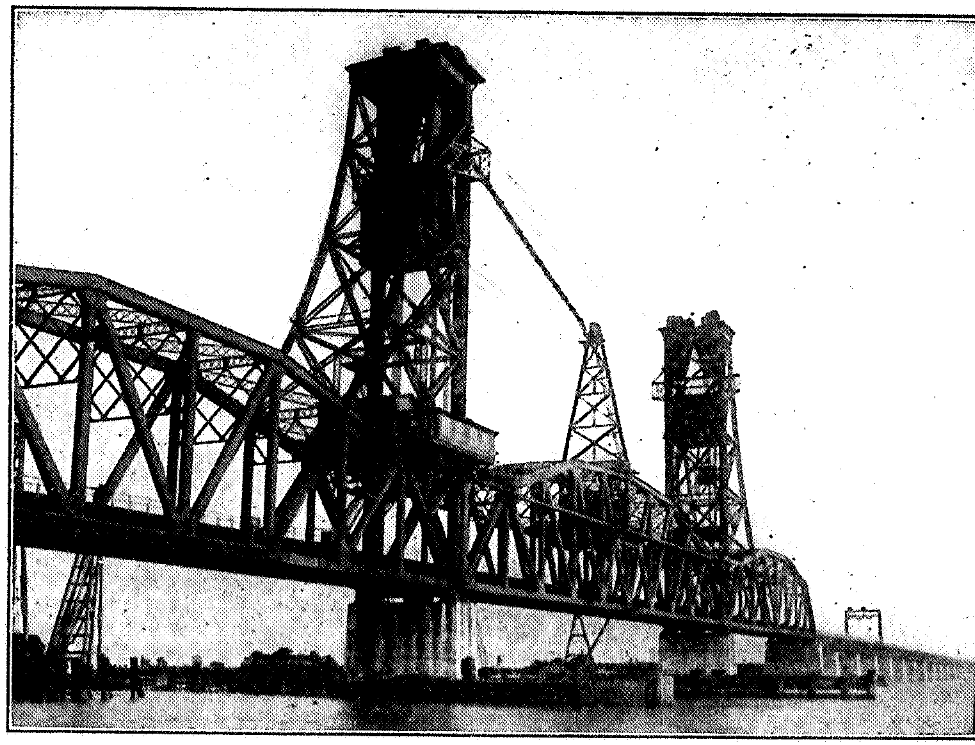


Fig. 39.
Lift Type Drawbridge.

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 36 illustrates a center pivot drawbridge and Fig. 37 illustrates one method of locking the rail ends on the draw span. This locking is arranged that if an obstruction of ¼ inch is placed under the rail end as it is lowered into place in the rail shoe, the locking dog will foul on the tongue attached to the rail, preventing the stroke of lever from being completed, which in turn prevents any signal lever from being operated.

Figure 38 illustrates a lift type drawbridge. 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.

Figure 39 illustrates another type of lift drawbridge. Figure 40 illustrates a method used to lock the rail ends.

It is frequently necessary to continue mechanical pipe lines and circuits from the draw span to the shore ends, or vice versa. Figure 41 illustrates one method for mechanical pipe lines and this device is known as a mechanical bridge coupler.

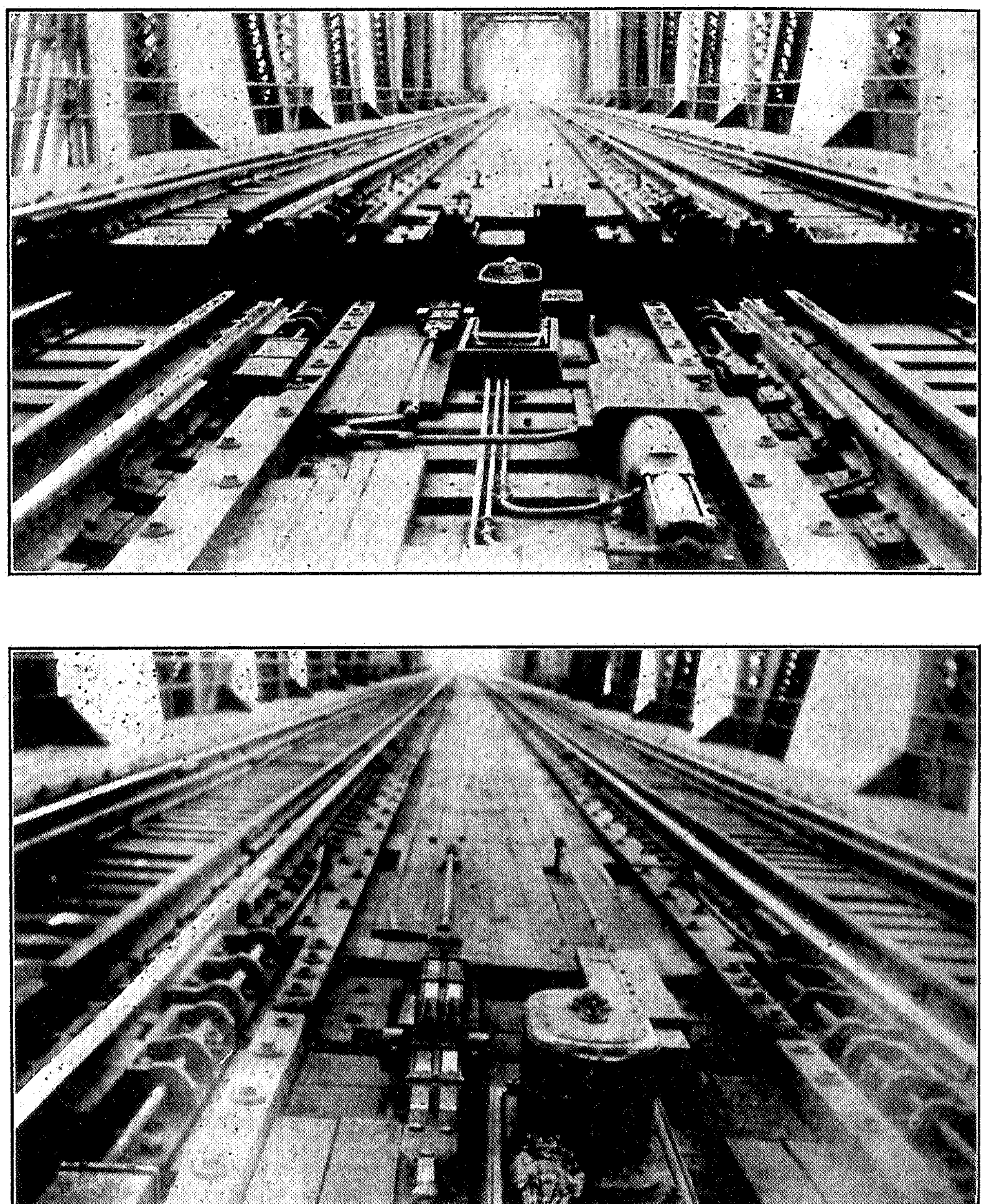


Fig. 40.
Method of Locking Rail Ends.

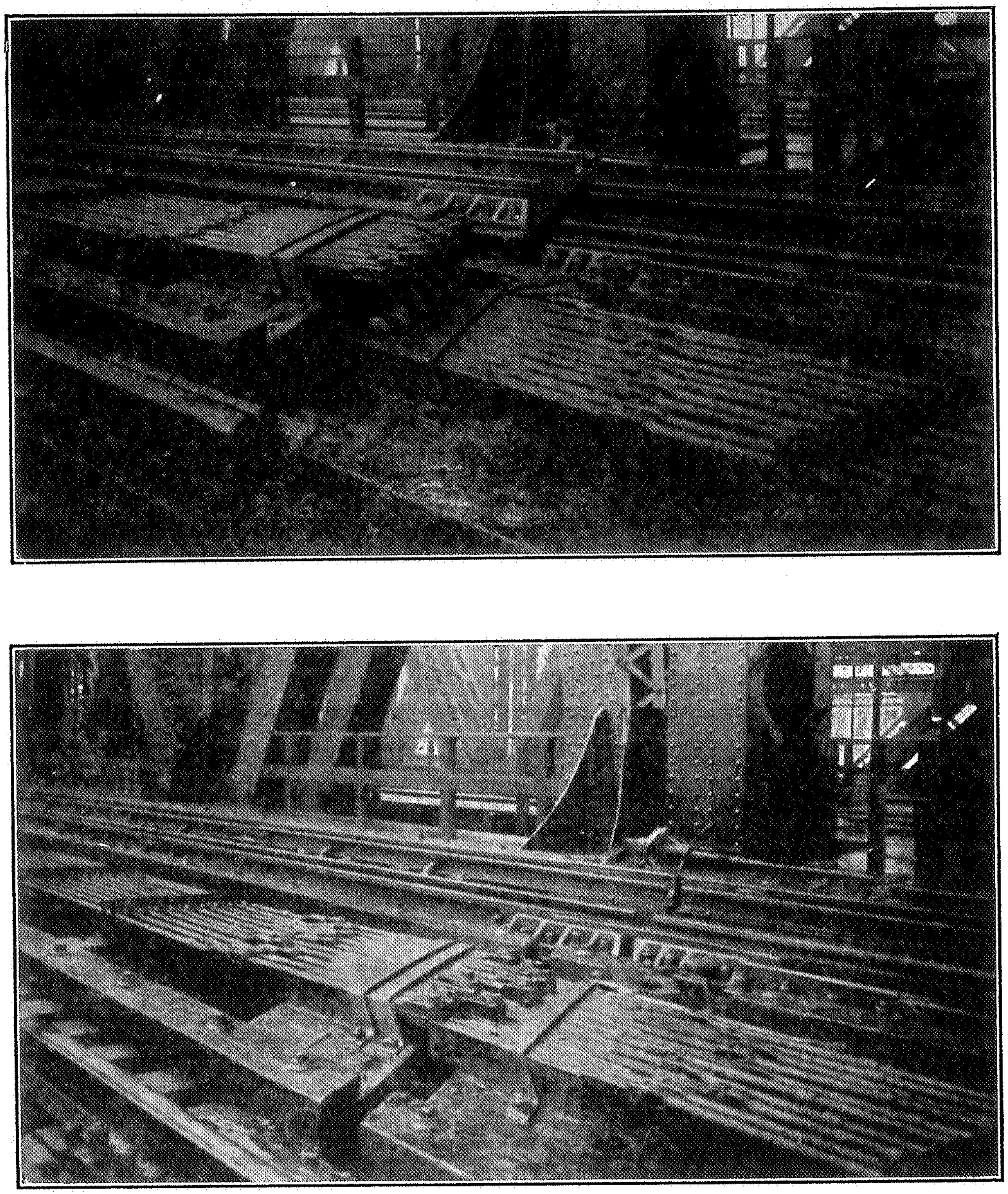


Fig. 41.
Mechanical Bridge Coupler.

Figure 42 illustrates an electric bridge coupler used to carry circuits on or off the movable span. One end is fastened to the draw end, the other to the shore end. One end is stationary and the other end is generally operated by the lever that locks the rails or wedges, or by a separate lever. This causes the contact plunger on the movable end to enter the metal cylinder on the stationary end, thus completing the circuit. The rail shoes, locks, etc., are insulated so that track circuits may be continuous over the draw span.

At a number of drawbridges smashboard signals are provided. This signal is defined by the Signal Section, A.R.A., as: A signal so designed that the arm will be broken when passed in the Stop position.

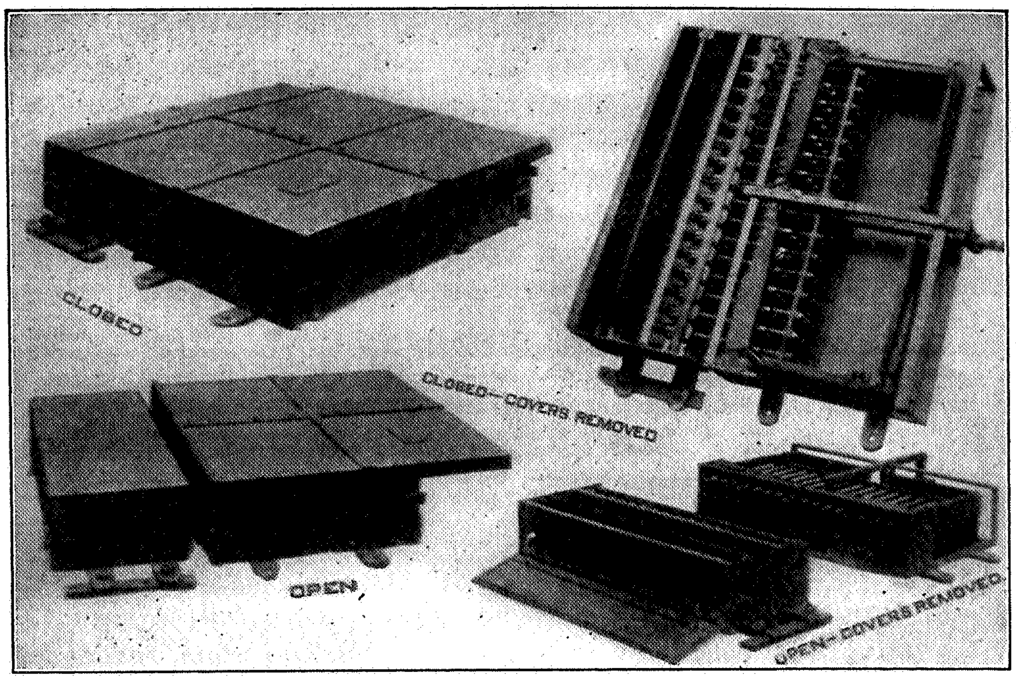


Fig. 42.
Electric Bridge Coupler.

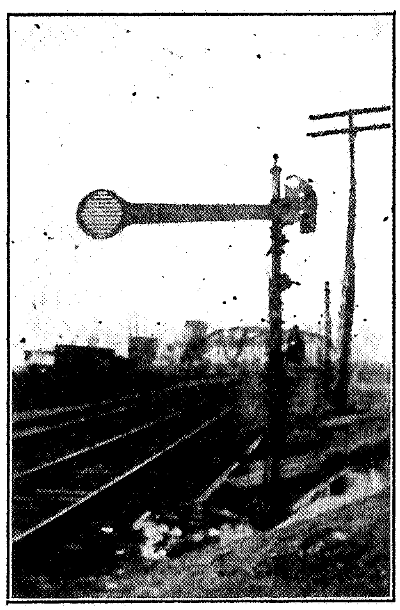


Fig. 43.
Smashboard Signal.

They are generally located on the signal mast or signal bridge on which the signal protecting the drawbridge is located. They extend over the rail or the center of track, and are low enough that should an engineman pass the smashboard signal in the Stop position the cab or smoke stack would 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 engineman had passed the signal in the Stop position.

Several forms of smashboard signals are in use, one of which is illustrated in Fig. 43. The disc is usually a plank frame at the end of an arm suspended from a bridge over the tracks or extending 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 are power or mechanically operated, depending on local conditions.

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

Instructions

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

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

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

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

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

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

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

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

3. During snow and sleet storms, interlocking plants must be carefully watched to see that switches, pipe lines, etc., are kept clean and in operation, that the leverman operates levers from time to time to keep movable parts from freezing, and that sufficient forces are available to keep switches, etc., free from obstruction. Snow and ice

must be removed from signal blades, roundels and other apparatus to maintain proper operation and indication. Where snow melting oil, or open flame devices are used, care must be exercised to prevent damage to wires, wire conduits, insulations, etc.

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

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

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

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

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

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

10. Standard clearances must be maintained.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

American Railway Signaling Principles and Practices

QUESTIONS ON

CHAPTER XVI

INTERLOCKING

QUESTIONS ON CHAPTER XVI

INTERLOCKING

Definitions.

1. How does the Standard Code of the American Railway Association define Interlocking?
2. How does it define Interlocking Plant?

Types.

3. How are interlocking plants designated?
4. What type interlocking still in service is limited in number?
5. What type interlocking is of recent development?

Historical.

6. Of what type was the first interlocking plant used in America?
7. How does the Saxby and Farmer machine, as produced at present, compare with the original design?
8. What was one of the improvements in mechanical interlocking and what did it require?
9. What changes were made in the operation of signals and what circuits were introduced?
10. What was used to replace detector bars?
11. What improvement was introduced when it became advisable to transfer to automatic devices the protection of trains approaching an interlocking?
12. What prevents a route being changed when a train nearing an interlocking plant has reached a predetermined point from the home signal?
13. When was route locking introduced and how is it accomplished?
14. Where is route locking now considered essential?
15. What is the virtue of route locking?
16. What are the advantages in operating switches with power?
17. What system was first used for power operation of switches and signals and how was it accomplished?
18. What type of interlocking was next devised?
19. What type of interlocking did not become popular?
20. In what order did later development of interlocking follow?

Application.

21. Where are interlocking plants in general use?
22. How is the necessity of an interlocking largely determined?
23. In designing an interlocking, what should be given consideration first?
24. How is the type of interlocking plant to be installed generally determined?

Track layout.

25. What is the track layout of an interlocking plant?

26. What determines the arrangement and location of signals that govern train movements?

27. Into what two major parts is the interlocking plant divided?

Inside Apparatus

General.

28. How does the Standard Code define Interlocking Station?

29. What does the station house in addition to the interlocking machine?

Track model.

30. What is a track model?

31. How are switches on model connected with the levers?

32. Where are track models ordinarily used?

33. How is the same kind of model board used in other cases?

34. What is frequently added to track models or diagrams to be referred to by men unfamiliar with the layout when posting or upon assuming charge of an interlocking plant?

35. What is used, in a number of cases, on the track models or diagrams to show track occupancy and how are they arranged?

Machine.

36. What is the interlocking machine?

37. Upon what does the number of levers depend?

38. How is the lever numbering arranged?

39. How does the number of levers for a mechanical machine compare with the number for a power machine for the same number of switch and signal units?

40. May the same type machine be used with the various types of interlocking plants?

41. With what types of interlockings may the same types of machine be used in some cases?

42. What principal item is common to all types of interlocking machines?

Mechanical locking.

43. In the definition for interlocking, how is it stated that the appliances are interconnected?

44. Through what medium is the predetermined order of the movement of appliances accomplished?

45. What does Fig. 1 show before a signal is cleared for train movement over any given route?

46. Upon what does the method of locking the various levers depend?

47. After a track layout has been signaled and the various switches, locks and signals given a number, with what do they correspond?

48. Why is each signal arm given a separate number?

49. How is it possible to control more than one arm by the same lever with mechanical interlocking plants?

50. After the layout plan has been numbered, what other plan is it necessary to prepare, and what is it known as?

51. How is it customary to lock each switch, movable point frog or crossover in a mechanical interlocking plant?

52. In what position are derails generally not locked?

53. On all plans drawn, in what position is it assumed the various levers are?

54. In order to lock a switch in either position, in what position must the lock lever be?

55. In what position are the lock levers usually kept?

56. In reading the locking plans, in what position must it be assumed that all the levers are?

57. How does the locking sheet arrange the levers and what does it indicate?

58. How is a lever that is locked in the reverse position indicated?

59. What do the numbers not placed in circles indicate?

60. How are the levers locked in Fig. 3?

61. How is each route or conflicting route locked in Fig. 3?

62. How is the locking for the other signal levers indicated on the locking sheet?

63. How are the lock levers shown as locking the switch?

64. Why is it necessary to look the switch in either position?

65. How do certain switch levers lock other switch levers in Fig. 3?

66. How does it frequently save locking to make certain switch levers lock other switch levers normal?

67. How does the locking sheet generally show the low and high-numbered levers locking each other?

68. If a low-numbered lever is shown locking a high-numbered lever, what will be the effect when the high-numbered lever is reversed?

69. After the preparation of the locking sheet, what is it necessary to prepare next?

70. What does the dog chart represent?

Saxby and Farmer machine.

71. How does the movement of latch handles operate the mechanical locking?

72. How may more than one longitudinal locking bar be operated from the same lever?

73. How are dogs placed and how do they function?

74. How does the first movement of the latch rod affect the lever?

75. How is the latch held in the raised position while the lever is being moved to the reverse position?

76. When the lever reaches the reverse position, what action does the latch rod take?

77. What forces the latch handle away from the lever to its position?

78. How does the rocker drive the locking bar to its final position?

79. What part of the lever actuates the locking, and does the movement of the lever between the normal and reverse positions affect it?

80. What is the locking described known as?

81. To what extent does the first movement of the latch drive the locking bar or tappet and what is the effect on conflicting levers?

82. When and how is the last half stroke of the locking bar or tappet accomplished?

83. What effect does the final movement of the locking bar or tappet have on non-conflicting levers and what holds the lever in the reverse position?

84. How does the latch, when raised, drive the locking bar to the right?

85. On the first movement of the locking bar, what is the effect on the cross-locking and how is it accomplished?

86. What is the effect of the final stroke of the locking bar?

87. What prevents the latch to which the dog at bottom of cross-locking is attached being raised?

88. If lever No. 1 reversed locked lever No. 2 normal, what effect would lever No. 2 reversed have upon lever No. 1?

89. Of what material are locking bars, cross-locking and dogs usually made?

90. Of what size are locking bars and cross-locking?

91. What causes various shapes and sizes of locking dogs to be used?

92. How does the plan shown in Fig. 6 indicate the arrangement with relation to the machine?

93. What do the heavy vertical lines represent and where are the numbers shown?

94. What do the heavy horizontal lines represent and how are they numbered?

95. How are the dogs shown with relation to the locking bars and locking shafts?

96. How is it indicated what shaft a particular lever operates?

97. How is the locking marked?

98. In what position are levers shown on locking sheets?

99. In which direction is locking bar moved when lever is reversed and what is the complete stroke of the bar?

100. Into how many general groups may dogs be divided and what are they known as?

101. Into what groups may locking dogs be further divided?

102. How may the swing dogs be grouped?

103. How are the locking dogs fastened to the longitudinal bars?

104. How are the swing dogs placed?

105. In what directions do the swing dogs move?

106. What are the swing dogs frequently called, and why?

107. On what longitudinal bars are swing dogs generally located?

108. With the swing dog as shown extending through the cross-locking, should the cross-locking below the dog be moved upward, what would be the effect on any dogs in this piece of cross-locking?

109. When swing dog is shown out of the cross-locking, when does it transmit motion to the cross-locking?

110. What may swing dogs shown as extending through the cross-locking be designated as?

111. What may swing dogs shown out of the cross-locking be designated as?

112. How are the driving dogs shown and how is it determined which way they move the cross-locking?

113. What may the dogs shown part way through the cross-locking and a beveled cut shown in the cross-locking be classed and when are they locked?

114. How may the dogs shown in the cross-locking be designated, and why?

115. What are the dogs shown beveled on each end called and how do they lock the lever to which they are attached?

116. How is the cross-locking prevented from being forced out of the locking brackets?

117. When machines are not fully equipped with locking brackets and bars, what is done to prevent locking bars being forced up far enough to permit the locking bar to be forced out of the driver?

118. How are blank bars and cross-locking generally secured in place?

Saxby and Farmer (English) machine.

119. What are the names of the parts of the English type S. & F. machine?

120. How is the locking actuated in this machine?

121. What is accomplished by the action of raising the latch handle?

122. Does the raising of the latch handle lock other levers?

123. In what way are the locking bars, dogs, etc., similar to those used in the Style "A" type machine?

124. How does the position of the locking bed in this machine compare with the position of the bed in the improved type?

125. In operation, does this machine accomplish the same results as the improved type S. & F. machine?

126. Describe in detail the operation of the machine.

127. Of what does the mechanical construction of the locking consist?

128. What is used for direct locking between adjacent tappets?

129. How is the locking bed made up?

130. What is used where special or "when" locking is necessary?

131. How is this special locking accomplished?

132. Describe the arrangement of locking in this type of machine.

Style "A" machine.

133. What radical difference exists between the Style "A" machine and the improved S. & F. machine?

134. What are the names of the parts of the Style "A" machine?

135. What is the purpose of the latch block and roller?

136. What is the purpose of the segment?

137. Why is the lug cast on one end of the rocker?

138. What is the purpose of the tappet connecting link and tappet jaw?

139. How is the locking held in place?

140. How are the locking plates constructed?

141. When there is insufficient space to hold the locking for a machine, what is done?

142. How are additional tiers of plates added?

143. In extreme cases, how may locking plates be located?

144. Describe the operation of the machine.

145. Of what does the mechanical construction consist?

146. How are adjacent tappets interlocked?

147. How are tappets which are not adjacent interlocked?

148. Of what are locking parts made and how are they fastened?

149. Of what size are locking bars and tappet pieces?

150. What is the travel of tappets, bars and dogs when levers are reversed?

151. What are tappet pieces?

152. What are swing dogs and how are they applied?

153. How does the arrangement of locking effect the sequence of lever movements in the operation of the complete interlocking machine?

154. When a lever is reversed, what takes place?

Power interlocking.

155. Into what classes may power interlocking be divided?

156. How many general types of machine are used for electro-pneumatic interlocking?

157. How many types of machine are used for electric interlocking?

Electro-pneumatic machine.

158. Is the numbering of the levers the same for a certain track layout whether electric or electro-pneumatic interlocking is used?

159. Is the locking the same?

160. How does the locking in the electro-pneumatic machine compare with that in the S. & F. machine?

161. How is it operated?

162. How is the locking located in the machine as compared with the location of the locking in the S. & F. machine?

163. What are the normal and reverse positions of switch levers?

164. How are dogs attached to locking bars operated by switch levers moved?

165. What is the normal position of signal levers and how can they be moved?

166. How are the dogs attached to bars operated by signal levers arranged?

167. How are the signal lever dogs shown on the dog chart and how can those which are effective with a right-hand movement be distinguished from those which are effective with a left-hand movement?

168. How are the between-stroke and swing dogs shown?

169. Of what are the locking parts made?

170. What is the size of the bars, dogs and cross-locking?

171. What is the length of stroke of locking bars operated by switch levers?

172. What is the length of stroke of locking bars operated by signal levers?

173. How are the dogs driven from one position to another?

174. How is the locking assembled?

Electric machine.

175. How does this type of locking compare with the locking used with the Style "A" machine?

176. With what types of machines is it used principally by one of the large signal companies?

177. In many of the machines now in service, when does the locking between levers become effective?

178. With the later type of machine, how is the locking accomplished?

179. In the first machines using this type of locking, how many bars were used in each locking space, and what was their dimension and horizontal movement?

180. What was the dimension of the tappet bars, how much did they move, and in what direction?

181. In the later machines, how many bars are used in each locking space, how are they arranged, and what are their dimensions?

182. What are the dimensions of the new tappets and what is their movement?

183. How are the four longitudinal bars lettered and in what order?

184. How many locking spaces are obtainable in each locking plate (tier)?

185. In what lever sections are the locking plates made?

186. How were the tappets attached in the first machines?

187. On the later machines, how is the connection from lever to tappet accomplished?

188. What is the advantage in the later arrangement?

189. Where are the locking plates attached?

190. With the present day efficient arrangement of locking, to what extent are sections of plates necessary?

191. What are the dimensions of locking bar slots (spaces) in the original and modified locking plates?

192. Where are the longitudinal bars placed?

193. How are the locking dogs fastened to the longitudinal bars, how are they driven, and how do they lock?

194. Where are special locking dogs placed, of what do they consist, and how do they operate?

195. When 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, what is done?

196. How are tappets secured in place?

197. Where the locking necessary between certain levers is more than can be accomplished in the regular slots, how is it taken care of with the modern machines?

198. In the older machines, how were similar results obtained?

199. In this type of locking, are various shapes of locking dogs necessary to obtain results desired?

200. How do other types of machines used with power interlockings compare with the type described?

Electro-mechanical machine.

201. What is an electro-mechanical machine?

202. How many general types of electric machines are there used in combination with mechanical machines and where are they illustrated?

203. How does the mechanical machine part compare with that already described under mechanical machines?

204. How does the electro-mechanical machine shown in Fig. 23 compare with the improved mechanical machine?

205. How does the locking shown in Fig. 25 compare with that shown in Fig. 6?

206. How are the signals numbered in Fig. 24, and what is the normal position of the signal lever?

207. How do the electric lever units, shown in Fig. 23, move?

208. Why are they numbered R and L?

209. How do the R and L positions correspond to the movements of electric lever?

210. With the signal lever being normal in the central position, how is locking accomplished?

211. How does the movement of locking bars compare between the mechanical machine and the electric units?

212. How do the locking bars operated by the switch levers in the mechanical machine move compared with the electric switch lever in the electric machine?

213. What is the stroke of the locking bars?

214. How far do the locking bars operated by signal levers move either way?

215. What are the dogs shown on the locking bars operated by signal levers that have the wide portion extending to the left of the cross-locking, known as?

216. What are the dogs with wide portion extending to the right known as?

217. What are the dogs with wide portion extending both ways known as?

218. When a signal lever is used only in the R or L position from the center, what type dog is used and how is it arranged?

219. If either of the machines illustrated in Fig. 14 or 15 was used, how would the number of the various units compare with Fig. 24?

Instructions

Inspection.

220. How must the various parts of locking bed, locking bed supports and connections be maintained?

221. How must driving pieces, dogs, stops and trunnions be maintained?

222. What is the full stroke of locking bars in new locking:

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

(b) Mechanical interlocking machine, Style "A" locking.

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

1. Lever with full stroke having S. & F. driver.
2. Lever normally center having rack driver.

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

(e) Electro-mechanical interlocking machine (Style "A" miniture locking):

1. Vertical locking.
2. Horizontal locking.

(f) Power interlocking machine, S. &. F. miniature locking.

(g) Power interlocking machine (Style "A" miniature locking):
1. Vertical locking.
2. Horizontal locking.

(h) Table interlocking machines:
1. General.
2. Union.

223. How must splices in longitudinal locking bars be maintained?

224. When new locking is placed in service or a change in locking is made, what must be done?

Testing.

225. When must locking be tested?

226. When must lost motion be removed and what is the allowable lost motion for:

(a) Mechanical machine:
1. Latch operated locking?
2. Lever operated locking?

(b) Electro-mechanical machine:
1. Lever moving in horizontal plane?
2. Lever moving in an arc?

(c) Power machine:
1. Latch operated locking?
2. Lever moving in horizontal plane?
3. Lever moving in an arc?

227. On an electro-mechanical interlocking machine, how must the locking between the electric and its mechanical levers be maintained?

228. How must the latch shoes, rocker links and quadrants of S. & F. machines be maintained?

229. What must be done when new locking is placed in service or a change in locking is made?

230. How must a complete test of the locking from a signal layout or interlocking plan be made?

231. What tests must be made when new locking is to be placed in service or when a change in locking is made to insure that the locking of a route does not interfere with parallel routes?

Outside Apparatus

232. At what speed do trains generally move on straight track through an interlocking plant?

233. At what speed do they move from one track to another in the direction of traffic?

234. At what speed do they move between all other tracks?

235. What signals are generally used to govern the three speeds where three-arm signals are used?

236. What signals are generally used to govern the three speeds where two-arm signals are used?

237. What signals are generally used to govern the three speeds where one-arm signals are used?
238. Where are signals located with reference to the interlocking limits?
239. What signals are generally used for movements with the current of traffic and what signals against the current?
240. How are high signals generally located?
241. What type of signals may be used?
242. Are approach indications to interlockings generally provided and what is the general practice where automatic signals are in service?

Turnouts and crossovers.

243. How is a turnout defined by the American Railway Engineering Association?
244. How is a crossover defined by the American Railway Engineering Association?

Slip switches.

245. How many kinds of slip switches are there and how are they classed?
246. How is a single-slip switch defined by the Signal Section, A.R.A.?
247. How is a double-slip switch defined by the Signal Section, A.R.A.?
248. Where are slip switches generally used?
249. Why is it desirable to use movable point frogs in certain slip switches?
250. How is a movable point frog defined by the Signal Section, A.R.A.?

Derails.

251. How is a derail defined by the Signal Section, A.R.A.?
252. What are the types of derails most generally used known as?
253. To what extent is the use of derails under present day practice reduced?

Detector bars.

254. Of what do detector bars generally consist?
255. How are detector bars held against the outside head of the rail?
256. When the operating connections are moved, what action does the bar take?
257. To what extent does the bar travel above the top of rail?
258. Does the bar move above the top of rail before the switch, movable point frog or derail is unlocked?

259. If a car was standing or passing over the switch, movable point frog or derail at the time an attempt was made to unlock them, what would be the result?

Switch rods and plates.

260. How are the rods used between switch points and extending therefrom generally classed?

261. How is a front rod defined by the Signal Section, A.R.A.?

262. Where does the front rod connect?

263. Does the design of front rods vary, and how are they usually designed so they can be used with track circuits?

264. How is lock rod defined by the Signal Section, A.R.A.?

265. Are there more than one type lock rod and how are they designed to check switch points?

266. Why is the adjustment of lock rod very important?

267. What would be the result if a switch point should stand open, and what final effect would it have on clearing a signal?

268. To what extent are adjustments generally made so that if switch points in the normal or reverse position are open will the locking dog or plunger foul the lock rod? Mechanically-operated switches? Power-operated switches?

269. How is a head rod defined by the Signal Section, A.R.A.?

270. Where is the head rod generally located?

271. Does the design of head rods vary and how are they usually designed so they can be used with track circuits?

272. How is an operating rod defined by the Signal Section, A.R.A.?

273. Where is the operating rod attached?

274. How does the stroke of the operating rod compare with the throw of the switch points?

275. What is the excess throw of the switch operating rod called and how is it defined by the Signal Section, A.R.A.?

276. Why is the overthrow necessary?

277. When the overthrow of the operating rod is about used up, what is it necessary to do?

278. What should be the minimum overthrow in operating rods?

279. What is the travel of switch points while passing from normal to reverse position and vice versa, known as and where is it measured?

280. What is the travel of switch points and with what is it in accord?

281. How are the remaining rods on a switch generally numbered?

282. What determines the number of rods and what is their particular function?

283. With what signal apparatus is each switch equipped?

284. What is the function of the tie plates?

285. Of what are tie plates made and what is their usual thickness and width?

286. Where are tie plates placed and what is their function?

287. How are riser plates and gage blocks attached to tie plates and what are their functions?

288. Why are gage blocks used and what is the function of rail braces?

Drawbridges

289. How is a drawbridge defined by the Signal Section, A.R.A.?

290. Describe some of the various types of drawbridges in service.

291. What methods are used to operate them?

292. Why are protective devices necessary?

293. What provision must be made in the interlocking machine so a predetermined order must be followed to open or close the bridge?

294. How may the order of procedure in handling a drawbridge be expressed?

295. How are rail ends shaped where the draw and fixed spans adjoin?

296. Where lapped mitered rails are used, to what extent is the full thickness of the web retained?

297. How are the rail points arranged with respect to traffic?

298. In the case of single-track drawbridge, how are the points generally arranged with respect to traffic?

299. When rail ends are cut square or miter is not lapped, how are the ends generally connected to carry the wheels over the opening between the ends of the bridge and the approach rails?

300. When the drawbridge is within the limits of an interlocking, what is frequently done so that the interlocking attendant must release the draw machine?

301. What must be done with respect to signals before the draw machine can be released?

302. After the draw machine is released, what must be done before Proceed signals can be displayed?

303. What type machine is usually used on the draw span?

304. What do the levers used in the machine on draw span operate?

305. How are machines for handling drawbridge locking devices arranged at other locations?

306. What is the advantage in having the interlocking machine located on the draw span, or the draw span operated from an interlocking station located off the drawbridge?

307. How does the method used to lock rail ends, bridge wedges, etc., shown in Fig. 37, prevent any signal lever from being operated if an obstruction of ¼ inch is placed under the rail end as it is lowered into place in the rail shoe?

308. What is a mechanical bridge coupler?

309. Where is an electric bridge coupler used?

310. How does the bridge coupler operate?

311. How is a circuit completed with the electric bridge coupler?

312. What is done with rail shoes, locks, etc., so that track circuits may be continuous over the draw span?
313. How is a smashboard signal defined by the Signal Section, A.R.A.?
314. Where is the smashboard signal generally located when used at a drawbridge?
315. How are the smashboards located with reference to the track, and how do they function?
316. What principal forms of smashboards are generally used and how are they operated?

Instructions

317. How must interlocking machines be maintained and tested?
318. What instructions and advice must be given to levermen when necessary?
319. What must be done at interlocking plants during snow and sleet storms?
320. What precaution must be used where snow melting oil or open flame devices are used?
321. What restrictions are there on the operation of levers or other operating appliances?
322. What must be determined by periodic inspection and tests?
323. What are the restrictions on locking changes or removal from machine?
324. What action must be taken if locking becomes disarranged or broken?
325. How must seals and padlocks, where provided, be maintained?
326. What precaution must be taken with circuits to avoid train delays?
327. What precautions must be taken in handling relays or other controlling devices that may endanger the safety of trains? How must train movements be protected?
328. What is required with reference to clearances?
329. How must foundations be maintained?
330. How often must paint be applied and what must be done with rusty surfaces?
331. To what extent must pipe and other exposed parts be covered and what apparatus must be kept free from paint?
332. What part of movable parts must be kept clean and lubricated?
333. To what extent must oil be used?
334. What must be done before applying lubricant, and is ordinary oil used in all cases?
335. What are the requirements in regard to the use of cotters?
336. What are the requirements in regard to gaskets for relay boxes and other housings?
337. When must movable parts be replaced?

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

339. In accordance with what instructions should relays be maintained and tested?

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

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

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

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

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

345. How must fouling circuits be maintained?

346. How must wires be arranged?

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

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

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

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

351. How must bootlegs and conduits be maintained?

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

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

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

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

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

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

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

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

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

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