

DESIGN
FOR AN
INTERLOCKING SYSTEM

FOR THE
C., C., C. & ST. L. R. R. YARDS

AT
CHAMPAIGN AND URBANA, ILL.,

BY
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THESIS

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DESIGN
of an
INTERLOCKING PLANT.

The yards for the proposed design are located at the end of the division midway between Peoria and Indianapolis, within the corporation limits of Champaign and Urbana. The roundhouse, machine, car and repair shops of this division are located in Urbana. The yards proper consist of a single track 17,085 feet between extreme head-blocks, with three grade crossings, one transfer elevator, one large switch yard, two Y's, twenty-five return switches, fourteen spur tracks, three cross-overs, and the general passenger and freight depots of the two towns, with their accompanying elevators and stock yards.

The author recognizes that if this article is consulted at all it will be by students somewhat unfamiliar with the general subject, and therefore will describe some of the elementary principles before taking up the consideration of the design proper. The questions that will generally arise in the mind of the student reader are: What is an interlocking apparatus? What is interlocking?

Interlocking is a method by the use of levers operating switches and signals so interlocked that a signal of safety can not be given while danger exists, and danger can not exist until

after it has been signaled. In other words the operator can not by negligence or forgetfulness or even from malice create a danger or suffer it to exist until he has indicated this condition to an approaching train. He can not open a switch before setting a signal at danger, or having opened a switch he can not leave the switch half closed without giving a signal of this danger. All these four errors, each of which may cost many lives, are made impossible on a section of road guarded by this system.

In the language of the inventor "My device is better than a man, for it is always on hand, never sleeps, and never drinks."

Interlocking signals as used at the present time may be properly classified as follows:-

First:- Manual or those operated by mechanical power.

Second:- Power operated signals.

First:- The first includes all of those devices in which the switches and signals are operated by manual power applied to the levers in the central tower, the connections between the levers, switches, etc., being made with rods and wires. The interlocking is accomplished by complicated mechanical devices, by which levers are locked or unlocked, one with the other.

The moving of the levers in such a system is no easy task and in places where a large number of switches and signals are to be controlled and trains are frequent, so many levers are required that several men are necessary to operate them.

The form of interlocking system that is now considerably used in the United States and Europe was originally introduced by

Saxby and Farmer Limited, in 1856. At present there are in America three manufactures of a very much refined form of this style, viz:

1. Johnson Switch and Signal Co. Rahway, N. J.
2. National Switch and Signal Co. Easton, Pa.
3. Union Switch and Signal Co. Swissvale, Pa.

Figure 1, page 6 shows a very late form of a Johnson eight-lever machine, which has essentially the same features as the others. I will first give a description of the more important mechanism used in this system. *A plan of switches which said machine is arranged to operate is shown below the diagram, number 2, page 6 . 1, 2, 3, 4, 5, 6, 7, and 8, Figure 1, are wrought iron levers connected on a girder, B, attached to a stand CC. The stroke of these levers is limited by portions of the segments, W, which form in combination with the spring latch, D, the well-known means of holding the levers in their back and front positions. Said segments also answer the purpose of spacing and guiding said levers. The segments are carried by front girder, B, and back girder, B, which are supported at their ends by the stand, CC. The machine is supported by beam, E, and steadied or braced by being bolted to the floor timber, G.

"The girders, B and B, are made for spans of four and eight levers. Connections leading to switch are shown attached to one lever, No. 6, and connection leading to signal is shown attached to another lever, No. 1. The locking is in one vertical plane beneath the floor and is easy of access, as are also all

* From Johnson's Switch and Signal Co. World's Fair pamphlet.

its parts for oiling, cleaning and repairs. Its position protects it from dust; it is easy to alter in case of change of arrangement of switches and signals, and completely new interlocking can, when desired, be substituted for the old in a very short space of time and at a moderate cost, all the parts being interchangeable.

"The vertical and radial movements of the latch, D, are communicated to the locking tappet, H, by means of the connecting link, H', and rocker, H'', centered at, H''', to the brackets, H''''', one of which is secured to each lever. The locking tappets, H, are connected to the reversing rocker, H'', by a friction roller, which fits the radial slot in the rocker and is centered in the tappet jaw, H''''''.

"One lever (say No. 1.) is said to lock another lever (say No. 4.), when the moving of No. 1 from its normal position prevents the moving of No. 4 from its normal position. One lever (say No. 2.) is said to release another (say No. 1.), when No. 2 must be completely moved over from its normal position before No. 1 can be moved from its normal position. Generally, the following is understood, namely, that when 1 locks 4, 4 also locks 1, and when 2 releases 1, 1 backlocks 2.

"Locking is said to be conditional or special when the position of one lever (say No. 4.) determines whether two other levers or more (say Nos. 2 and 7.) shall lock each other or one shall release the other. In case a tappet is free, the intention of moving a main lever, as expressed by grasping the handle and raising the latch, will raise the tappet and effect all the lock-

ing of other lever latched necessarily to the safe movement of the lever in question. This movement also brings the rocker, H'', into such position that the radial slot therein becomes radial to the center of the main lever, so that there is no movement of the tappet during the movement of said lever. When the locking is reversed, the dropping of the latch communicates a farther movement of the tappet, H, hereby the releasing is affected.

"The action of one tappet is made to lock or release other tappets by transverse connections and dogs, M, M', M'', N and P, carried in places grooved in locking plate L, which also serve to guide and retain the tappets. Figure 2 shows the locking and locking plate more clearly than Figure 1. The tappets are made of steel, as are also all the other parts of the locking, and are free to slide vertically in planed recesses of the locking plate and retained by wrought-iron strips. All the tappets are shown in their home or normal position except No. 7, which is reversed. The joining of one locking dog to one or more locking dogs is effected by a rolled connecting bar of 3/8" x 3/8" section, each dog being secured to said bar by two steel machine screws. A cover plate prevents any tendency these screws may have to withdraw.

"The locking shown in this illustration applies to the safe working of a single line junction, under Figure 2.

"The action of the ordinary locking and releasing is easy to understand as illustrated in Figure 2, but the special or conditional locking may be explained. Let it be understood in the

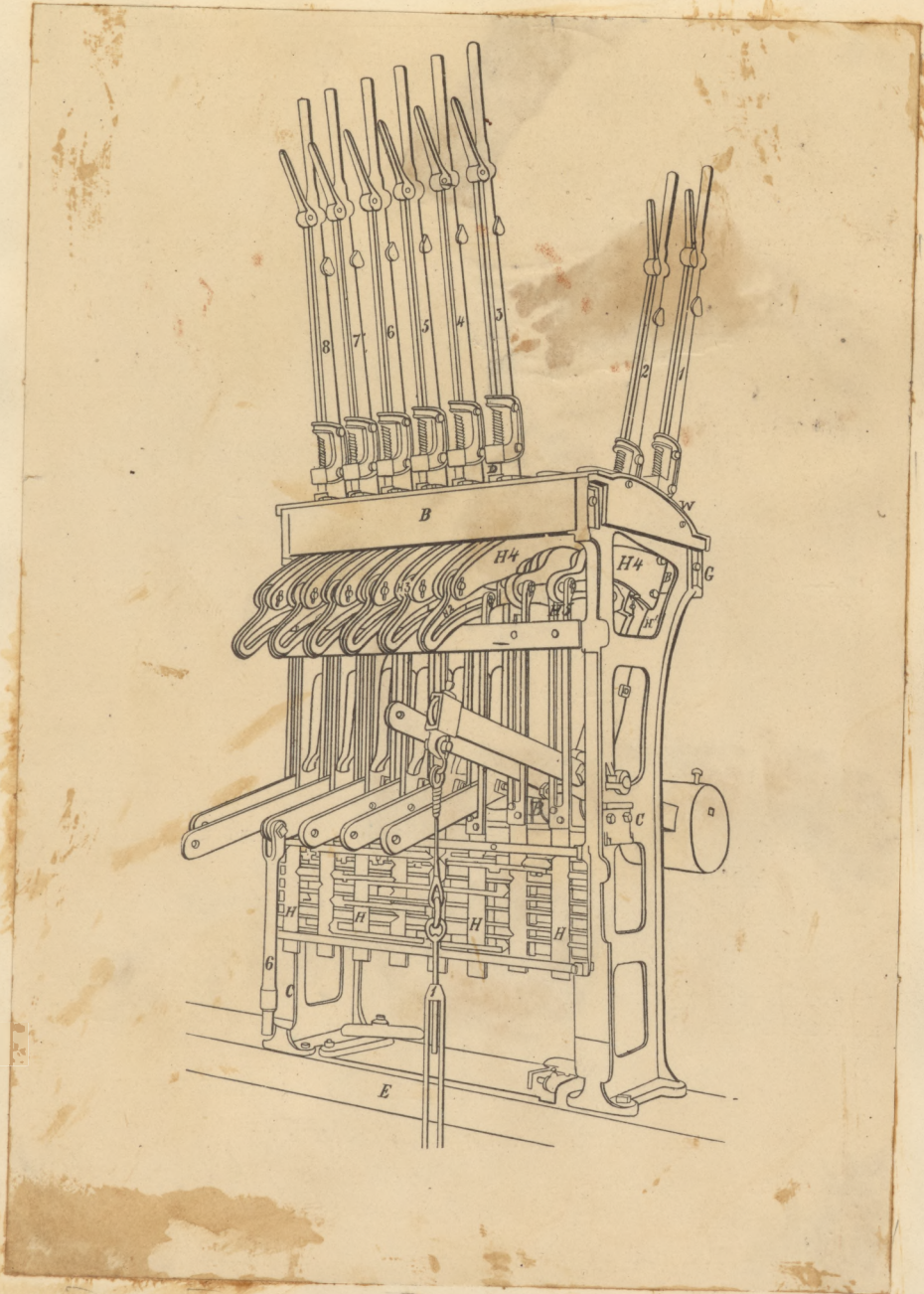


Figure 1

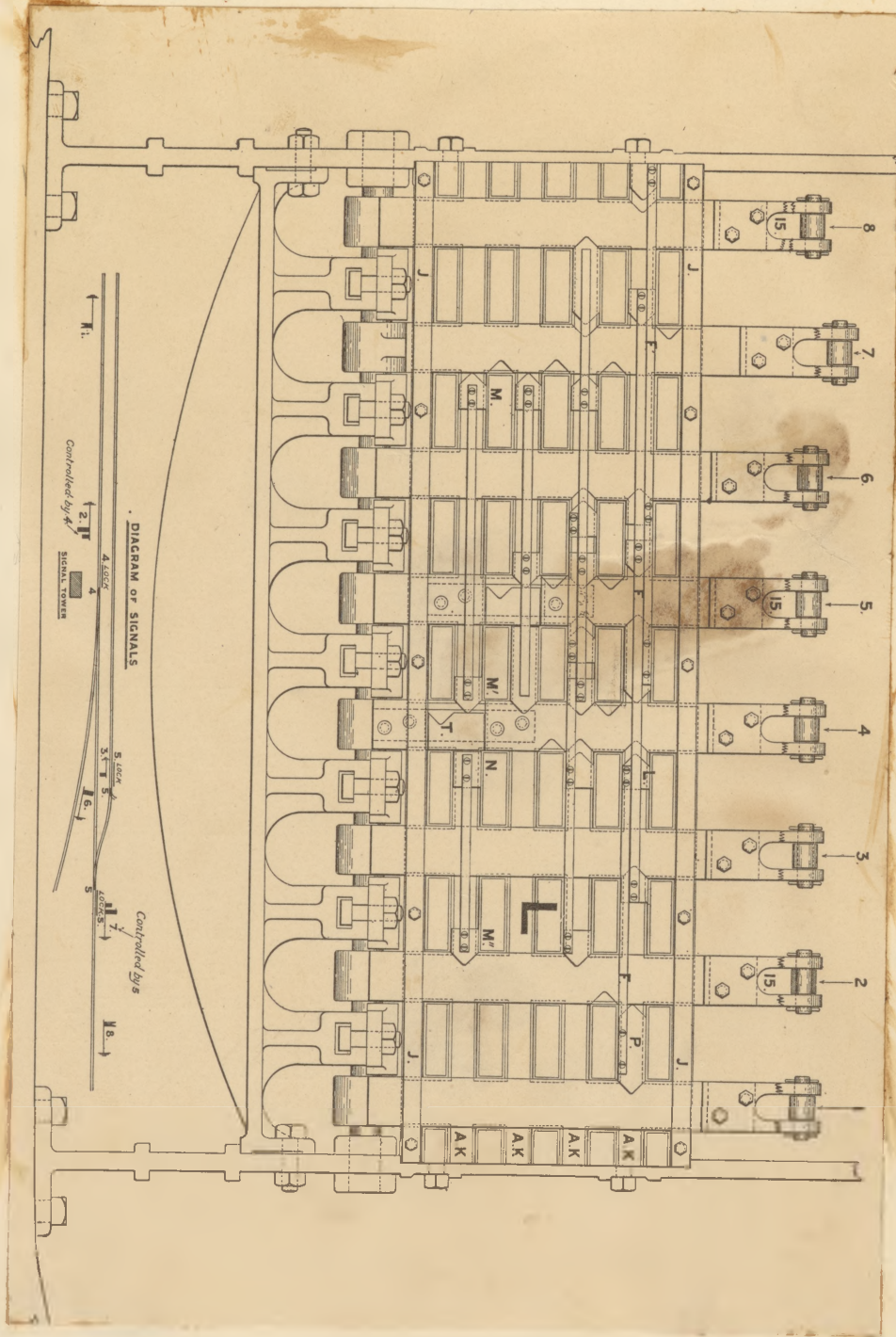


Figure 2

following description, that "tappet down" means that the lever to which such tappet is connected stands in the back or normal position, and that when such lever is intended to operate a signal, such signal stands at danger: and when such lever is intended to operate switch or Facing Point Lock, these stand in the normal position, i. e., the switch lies in either of its two positions, whichever has been determined is the better or more convenient usual position, and the Facing Point Lock lies in that position relative to the lever which frees the switch it is intended to lock. "Tappet up" means the reverse of the foregoing. Referring to Figure 2, the third space from the top contains the following special locking, viz; 7 locks 2 when 4 is home, but not when 4 is reversed. The tappets have the same numbers as their special levers. The tappet spaces are lettered, A, K, and extend from one end of the machine to the other. Tappets 2 and 4 are shown "down" and tappet 7 is shown "up." M, M', and M" and N are four locking dogs, connected as shown, T, is a traverse sliding section of the tappet No. 4, being rabbeted into that tappet which has a gap corresponding to the depth of the piece T. The two parts of the main tappet 4 are connected together by a back strap riveted thereto as shown in dotted lines. The dog M" is shown entered into the notch in No. 2 tappet and said tappet is "down." The other edge of sliding piece T is not below the locking dog M', so that tappet 4 must be raised "up" before dog M' can enter said notch. Dog M stands below the notch in No. 7 tappet which is "up", so that tappet No. 7 must be dropped "down" before said dog can enter said tappet. As shown in the figure

No. 7 being "tappet up" and No. 4 being "tappet down", No. 2 is locked. Change No. 7 to "tappet down" No. 2 becomes free: or change No. 4 to "tappet up", No. 2 becomes free, or leave No. 4 "tappet down", change No. 7 to "tappet down", No. 2 to "tappet up" and No. 7 is locked. It is therefore shown that with No. 4 "tappet down", 7 locks 2 and 2 locks 7, that with No. 4 "tappet up" 7 and 2 are free of each other." By a recent improvement three connecting rods may be used for each line of dogs as shown in top space of locking plate, and the locking consequently occupies less than one-half the space that it did formerly.

Second:- While the number of men required to run a Manual operated plant would be much less than required to operate the switches in the old way, it is desirable to still farther decrease the number of levermen. For this purpose the second class of interlocking has been devised, which may be properly denoted as Power Interlockers.

In this case some power from that of the operator is used for changing the position of switches and signals. In the Westinghouse, which is typical of this class, compressed air is used for power and electricity as a means of applying it. Interlocking in this system is obtained in the same manner as in the first, supplemented by electro-locking mechanism. While such an interlocker one man can handle a large plant easily and successfully, but the expense of erection and maintenance is somewhat greater than for manual power interlockers. From an economic point of view such a system would be used only at those points where its introduction so decreases the number of operators required under

the manual system that the decrease in capitalization by reason of the lessened expense in salary of operators, is sufficient to cover the actual cost of the plant.

The Power Interlockers may be subdivided into those which use electricity as an adjunct to the pneumatic and those which do not. The Low Pressure Pneumatic system belongs to the latter sub-class. In it the power required to operate switches and signals is transmitted by compressed air directly from the operating lever to the point of application. As a general statement it may be said that the switch or signal is operated by a simple movement of the operating lever whereby the pneumatic power is transmitted, absolutely without intervening mechanism, from the operating lever whereby the pneumatic power is transmitted, from the operating power directly to the piston which actuates the switch or signal. The power so applied is transmitted to a small gas pipe.

The certainty of action of power so applied should be considered. If compressed air is allowed to flow from a reservoir into a closed tube leading to a cylinder fitted with movable piston, its mechanical properties are such that the force due to compression is certain to be quickly and surely applied to the piston and assuming that a proper relation exists between the amount of compression, work to be done, and the area of the piston, it follows that the piston is sure to move. This is the fundamental principle upon which the Low Pressure Pneumatic system is based.

The method used by the Auto-Pneumatic Railway Signal Company, Rochester, N. Y., for interlocking switches and signals differs widely from that commonly used. For instance, the levers are

not locked in order to prevent them being operated, is such that it is impossible for conflicting routes to appear at the same time no matter how or in what position the levers may be placed. By way of presenting this method of interlocking, a description of some of the more important operating mechanism used in the system will first be given.

Switch:- For operating switches, or derailing points, use a cylinder having a piston area of fifty square inches which is fastened to the head block, with its line of action at right angles to the track, and its piston connected directly to the switch rod. Figure 3 shows a derailing cylinder in place with the cover removed, and Figure No. 4, a switch cylinder mechanism in detail. The switch is locked in either position by the weighted locking bar, A and B, Figure 4, resting in notches in the connecting rod E. The bar A locks the switch in one position and B in the other. To show the operation of this device, assume that when the mechanism is in the position shown in Figure 4, the switch is closed and it is desired to open it. By changing the position of the operating lever the air is allowed to exhaust from the pipe G, and is at the same time admitted to the pipe F, whereby forcing the piston to the right as shown in the cut, the connecting rod head is slotted in such a manner that during the first two inches of the stroke the pin, N, connecting the piston and connecting rods slides in the slot leaving the connecting rods stationary, while in the meantime the wedge-end bar L, which is rigidly connected with the piston rod, as shown, is forced under the locking bar A, lifting it out of its locking notch. For the balance

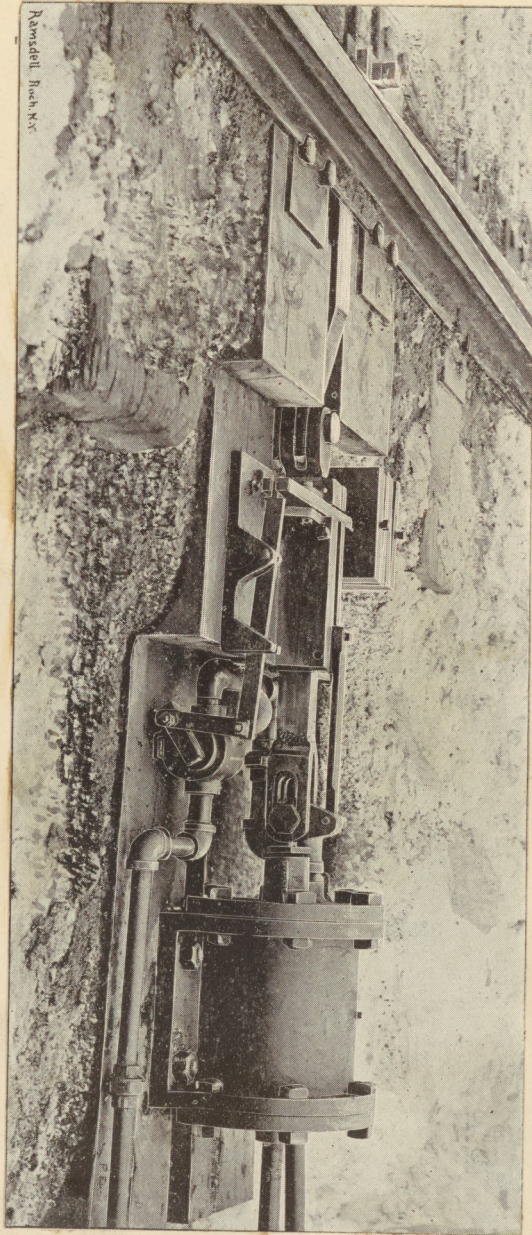


Figure 3

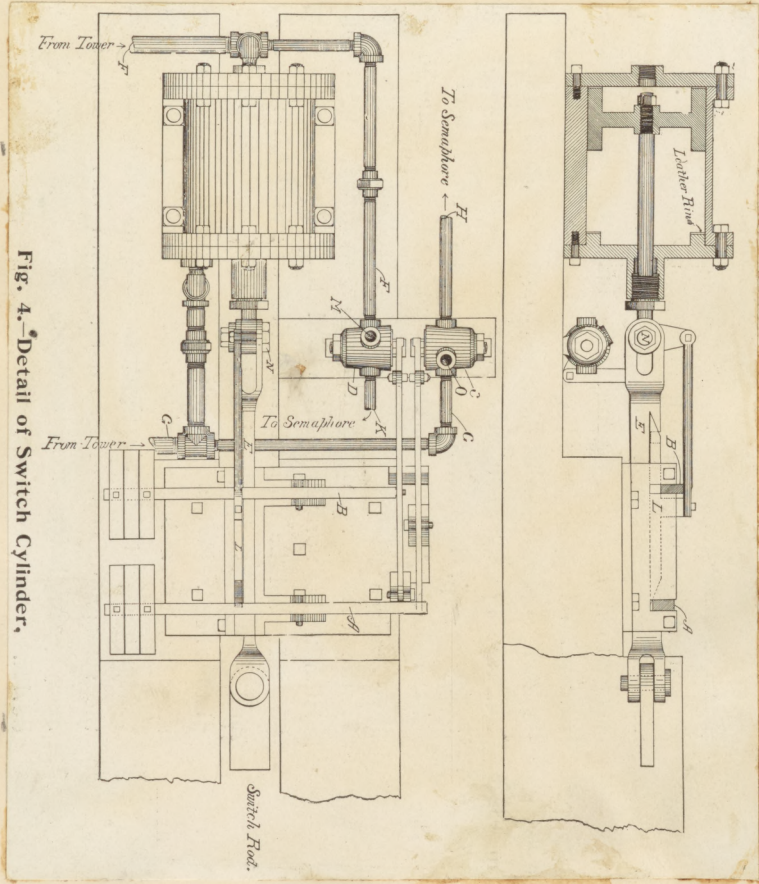


Fig. 4. Detail of Switch Cylinder.

of the stroke the piston acts upon the connecting rod to throw the switch. When the stroke is completed the bar B, drops into its notch, firmly locking the switch open, in which position it must remain until pressure is relieved from the pipe F and applied to the pipe G.

In order to insure that the semaphore or semaphores guarding the switch do not go to safety before the switch is in its proper position the semaphore controlling valves C and D are provided. Before the compressed air can reach a semaphore cylinder it must pass through one of these valves. These valves are operated by the locking bars A and B, and in such a manner that only when the bars are down and the switch locked is the passage through them open. For example, in the position shown in Figure 4, the bar A is down and the passage through the valve C open, thus connecting the pipes G and H: pipe H leads to the semaphore which, when at safety indicates that the switch is also in the position of safety. Under these conditions the valve D, operated by the bar B, remains closed, so that instead of the pipes F and K being connected, the pipe K is connected with a exhaust port M, hence the semaphore to which the pipe K leads, must be at danger. When the bar A is lifted, pipe H is immediately connected with the exhaust port O, with the result that the semaphore on the line H, if not already at danger, must take that position.

The net results of this arrangement is such that it is impossible for a semaphore to improperly indicate the position of a switch. Every switch operated in this interlocking system is

properly set before any signal is displayed by the semaphore guarding it. The switch must not only be in the position of safety, but it is securely locked there before a signal can be given to any train to pass over it.

The connections of the mechanism whereby these definite results are produced is not only exceedingly simple, but, owing to its nature, it further possesses the quality of extreme durability as well. Leather rings, against which the piston sets itself, making an airtight joint, are provided at either end of the piston's travels. Inasmuch as the loss from leakage during the short time the piston is traveling from one end of the stroke to the other is too small to be considered, this arrangement renders the use of the piston head packing and its consequent renewal unnecessary.

Selection of a System.

- Advantages of a manual system:
1. By reason of the great simplicity of working parts, the original cost of erection is less than the power system.
 2. The simplicity of the plant enables an ordinary machinist to repair and keep it in good order with minimum labor.
 3. All movements of switches and signals are positive and a failure of any part is immediately manifested to the operator by the different action of the lever.
 4. The locking and releasing of the lever is automatic.
 5. The arrangement of the machine is such that any special locking device may be provided.

Disadvantages of a manual system:-

1. The manual machine being large and heavy requires a large tower and foundation.
2. The connections between the switches and signals and machine being movable, good foundations and anti-friction rollers are necessary.
3. The effect of expansion and contraction on connecting parts is such that for all lines of pipe of 100 feet or over a compensating device must be used.

Advantage of power system:-

1. The locking of machine being between switch and signal lever only is of great simplicity and permits a construction necessarily durable.
2. Switches and signals may be operated at any desired distance from the cabin and any number of either or both may be operated at the same time, and any number of either from the one lever.
3. Any number of blades on a post may be provided with any desired number of indicators without incumbering the post with cranks, balance levers, and connections, all of which would be required by the manual system.
4. The machine occupies less than one-fourth the space required for the manual machine of the same capacity and weighing comparatively less, cabin of lighter and smaller design foundation.
5. Connections between machine and switch being of small diameter and immovable no heavy foundations or expensive anti-friction devices are necessary.

Disadvantages of power system. 1:- All pipes, valves, cylinders, etc., must be carefully made, fitted and erected so that the cost of a plant and erection are considerably greater than

that of a manual system.

2. In addition to the switches, signals and interlocking machine an engine and boiler is required for furnishing the compressed air, causing additional expense.
3. The effect of change of temperature on the pipes supplying the compressed air is such that expansion joints must be used in the line of pipes.
4. Owing to the condensation of moisture from the compressed air there is liability during severe weather of the pipe and cylinder freezing up.
5. The maintainence of the the plant requires the service of an electric as well as mechanical expert, while in the manual system a mechanic of ordinary ability can make all necessary repairs.

For the yards under consideration, it is admitted that the manual system is the better, forthe following reasons:-

1. Cost. The first cost of the manual system would be about one-third that of the power system, and could be maintained at about one-sixth the cost, while the manual can be operated as cheaply and safely as the power system.
2. There is ample room for the construction of towers and foundations for the movable connections.
3. The general form of the yards is such that it would be quite expensive to pipe the compressed air the required distance both ways from the central power house.
4. The power operating system would require the expense of a new power house and machinery.

In considering this design the laws of the State regarding interlocking which are given below must be carefully kept in mind.

Office of the Railroad and Warehouse Commission.

Springfield, Ill.

The Plan and construction of Interlocking, Signaling and Derailing Devices to be used at grade crossings of intersecting lines of Illinois must be arranged to conform with the following general rules; *

1. The normal position of all signals must indicate danger, - derail points open- and the interlocking so arranged that it will impossible for operator to give conflicting signals.
2. On level tracks, when practicable, the derail points in high speed tracks must be placed three hundred (300) feet from fouling point at intersection of crossing tracks.
3. On descending grades, the derailing point of high-speed tracks, when practicable, must be so located as to give the measure of safety three hundred (300) feet on level track.
4. The minimum distance of derail points on high-speed tracks is three hundred (300) feet from fouling point at crossing, and no less distance from crossing will be approved, on account of descending grade toward crossing.
5. On switching, storage and slow speed tracks, the position of derail points may be located to best accomodate traffic, and provide the same measure of safety indicated in foregoing rules.
6. On single track railroads, derail points, when practicable, should be on inside of curve, and when double track is used, the derail points should be in the outside rail of both tracks.
7. Home signal posts must be fifty (50) feet beyond point of derail. Distance between home and distance signal must not be less than twelve hundred (1200) feet. Signal post should be placed on engine man's side of track it governs.
8. In case but one derail is furnished in double track crossing, where the current of traffic is in one direction, detector bars must be provided on the opposite side of crossing from derails, and worked on same lever as derail, or interlock with it, so that the opposing signal can not be given until crossing is cleared. In case trains back over crossing, after having passed over it, or if current of traffic is changed, then in that case back up derail, must be provided.
9. Guard rails must be laid on inside of rail opposite derail, and commencing at least six feet (6) toward home signal from point of derail, extending from thence toward crossing, parallel with and nine (9) inches distant from traffic rail, total length two hundred (200) feet unless otherwise ordered.

* From Journal of Assoc. Engineering Society, Vol. 9, P. 545.

10. In case there are cross-overs, turn-outs, or other connecting tracks involved in the general system, the movement of cars and trains upon which present an element of danger, which danger will be enhanced by the passing of trains on main tracks over crossings without stopping, and consequently a higher speed than would be the case without the permit sought, then, and in all such cases, where such enhanced danger be of collision between different roads, it will be necessary, in addition to the protection of the main crossing, to provide the proper devices and appliance against any such increased collateral danger in the same complete manner that is required in the case of the main crossing.

11. Application for inspection of interlocking plant must be accompanied by a plain diagram, showing location of crossing and position of all main tracks, sidings, switches, turn-outs, etc. The several tracks must be indicated by letters or figures, and reference made to each explaining the manner of its use. The rate of grade on each main track must be shown together with the number of signals, derails, locks, etc., corresponding to levers in tower.

The system of derailing, signaling and interlocking must be connected and worked, and be complete in each particular before it will be approved.

Charles Hansel,
Consulting Engineer.

Approved:- By the Railroad and Warehouse Commission,
J. A. Paddock, Sec'y

Design of System.

The portion of tracks under consideration was divided into four nearly equal divisions, designated as sections No. 1, 2, 3, 4 respectively, counting from the east. Each section is controlled by a single tower. The location of the several switches and signals is shown on the plans of the several sections, and the interlocking is shown on the respective locking sheets. The method of operating the plant of the several sections is shown on the corresponding manipulation sheets.

The locking sheets and the manipulation sheets and plans of the several sections follow in succeeding pages in an easily understood order.

LOCKING SHEET, SECTION 1.

2 indicates lever 2 normal, (2) indicates lever 2 reversed.

LEVER.	LOCKS.
1	(2) W 12 - (3) - 13 - (6) W 16
2	4 W 12 (12) W 4
3	14 W 5 (14) W (5)
4	2 W 13 (13) W 2
5	15 or (15)
6	16 W 29 (16) W 29
7	(6) - (16) W 17 (6) - (17) W (16) (16) - (17) W (6)
8	16
9	10 or (10)
10	(6) W (31) W (33) W (37)
11	Spare.
14	(5)
15	(3) - (14)
16	(7) W (6) 7 W 6
17	(7) - (16) W (6)
19	(20)
20	19 W (28) (19) W (28)

21 (22)
 22 (30) W 21
 (30) W (21)
 23 34
 28 (20) W 19
 (20) W (19)
 29 20 - 16 W 19 - 28
 (20) - (28) W 19 or (19)
 30 21 - (22) - (32)
 31 22
 32 31 - 22 W 21
 (22) W 21 - (30) - 31
 33 23 - 34 - 35
 (23) - 34
 34 33 W 23
 35 23 W 34
 (23) - 33 - 34
 36 (24) or 24
 37 39 W 26 or (26)
 38 25 or (25)
 39 27 - 37 or (27) - 37
 40 (39) - (23) - (34) - (32) - (29) - (4)

LOCKING SHEET, SECTION 2.

LEVER.

LOCKS.

1	(2) W 23 - (16) W 30 - (31)
	(2) W 23 - (16) W (30) -
2	23 or (23)
3	24 or (24)
4	25 or (25)
5	26 or (26)
6	(24) W (23)
7	(25) - 24 - (23)
8	27 or (27)
9	(26) W 25 - 24.
10	(28) or 28
11	29 or (29)
12	(27) W 26 - 25 - 24
13	(28) W 27 - 26 - 25 - 24
14	(29) W 28 - 27 - 26 - 25 - 24
15	29 W 28 - 27 - 26 - 25 - 24
16	(30)
	30 W (31)
17	(30) W 23
18	(31) W 30 - 23
19	(50) W 39 - 64 - 63 - 68 - (70) W (45) - (46)
20	32 or (32)
21	32
22	(32)
31	30
39	40 - 41

40	39
41	39
44	43 F. P. L.
46	45 F. P. L.
49	40 - 42 - 39 - (41) or (39) - 40 - 41 - 42
50	(40) W 39
51	33 - 34 - 35 - 36 77 - 37
52	(33) - 34 - 35 - 36 - 77 - 37
53	(34) - 35 36 - 77- 37
54	(35) - 36 - 77 - 37
55	33 or (33)
56	(36) - 77 - 37
57	34 or 34
58	37 - (77)
59	(35) or 35
60	42 or (42)
61	(41) W 39
62	36 or (36)
63	77 or (77)
64	39 W (40)
	(39) W 40 - 41
65	40 or (40)
66	37 or (37)
67	43 or (43)
68	38 or (38)
69	43 or (43)
70	(45)
71	(45) - (46) or 45 - 46

72

74 - 78

73

(71) - (69) - (61) - (21)

(71) W (45) - (46) - (68) - (66) - (65) - (64) W (40)

74

47 or (47)

75

47

76

(75) - (71) W 45

78

48

79

(48) or 48

80

Spare.

LOCKING SHEET, SECTION 3.

Levers.

Locks

1 (4) W (24) - 2

2 (21) W 11
21 W (11)

3 (6) W (23) - 22

4 (22) W 24 - 7 - 23
22 W (24)

5 (24) W 22

6 (23) W 22

7 (22) W 23 - 4
(23) W 22

8 (13) W (28) - 26 - 50

9 (14) W 28 - 26 - 53 - 27

10 (2) W 21

11 (5) W (24)

12 (7) W 23 - (22) or (7) W 22 - (23)

13 28 - 30 or 30

14 (25) - 53

15 (26) - 16 - 29 or (29)

16 (26) W 19 - 27 or (27) - 15

17 33 or (33)

18 (16) W (17) - 33

19 (29) W 28 - 30 - 25 - 27 or (27)

20 (27) W 25 - 28 - 30 - 15
27 W 26 - 15

21 (7) W 23 - 24 or 7 W (23) - (24)

23	22
24	22
25	26 - 27 - 29
26	28 - 25 - 27 or (27) - 29 or (29) - 30
28	26 - 29 - 30 or (30)
30	37 or (37)
31	34 W (33)
32	(34) W (33)
33	34 W (31)
	(34) W (32)
34	(33)
35	(30) W (37)
36	(30) W 37
37	36 - (35) (30)
38	40 - (41)
39	(40) - (41)
40	(39) - 38
41	40 or (40)
42	(44) - (45)
43	44 - (45)
44	43 - (42) - (45)
45	44 or (44)
46	(37) W (35) or 37 - (36)
47	34 or (34)
48	(32)
49	(31)
50	(28) W 30 - 13

51 (35) W (37) - (30)
52 (36) W 37 - (30)
53 (25) - 14
54 (38) W 40 - (41)
55 (39) - (40) - (41)
56 (40) W (39)
 40 W (38)
57 41 or (41)
58 41
59 (43) W 44 - (45)
60 (42) W (44) - (45)
61 (42) W (44)
 (43) W 44
62 45
63 45 or (45)
64 45 - 57 - 50

LOCKING SHEET, SECTION 4

LEVERS.

LOCKS.

1 (7) W (8)
 7

2 (10) - (11) - (9) W - 4 - 24
 (10) W 11 - 9 - 24

3 (4) - 9 - 22

4 (9) W 10 - 22

5 Spare.

6 Spare.

7 10 W (8)

8 (7)

9 10 - 11

10 9 - 11

11 (9) - (10)

12 (13) or 13 W (10)

13 (12) - (10)

14 13 - 14 W (12)

16 (18) - 17 W (19)

17 18 - 16 W (19)

18 (19)

19 18 W (17) or (18) W (16)

20 Spare.

21 Spare.

22 (9) W 11 - 24 - 2 - 4
 (9) W (11) - 24 - 2 - 4

23 (9) W 10 - (22) - 11
 (9) W (10) - (11) - (22) - 2

24 (10) W 9 - 11 - 2
25 (10) W (12)
26 (13) - (15) - 14
13 - (14) - 15
27 (15) - (13) W (10)
28 (14) - 13 W (10)
29 (33)
30 (24) W 9 - 2
31 (16) - (18) W (19)
32 (17) - 18 W (19)
33 19
34 17 W (18)
16 W 18
35 19 or (19)
36 35

MANIPULATION SHEET, SECTION 1.

ROUTE.

LEVERS;- in order of operation.

A to B	2 - 3 - 6 - 9 - 1 - 31 - 33 - 37 - 10
A to C	12 - 2 - 1
A to D	14 - 15 - 5-3 - 2 - 1
A to E	14 - 5 - 3-2 - 1
A to F	7 - 16 - 6 - 3 - 2 - 1
A to G	17 - 7 - 16 - 6 - 3 - 2 - 1
A to H	7 - 16 - 17 - 6 - 3 - 2 - 1
A to I	18 - 9 - 6 - 3 - 2 - 1
A to L	23 - 33 - 31 - 9 - 6 - 3 - 2 - 1
A to M	24 - 23 - 36 - 33 - 31 - 9 - 6 - 3 - 2 - 1
A to N	26 - 37 - 33 - 31 - 9 - 6 - 3 - 2 - 1
A to O	25 - 38 - 36 - 33 - 23 - 31 - 9 - 6 - 3 - 2 - 1
B to L	35 - 27 - 39
B to K	21 - 30 - 22 - 32 - 37 - 39
B to J	21 - 30 - 22 - 32 - 39 - 34
B to F	28 - 20 - 29 - 32 - 39 - 34
B to G	19 - 28 - 20 - 29 - 32 - 39 - 34
B to C	13 - 4 - 29 - 32 - 39 - 34
B to A	39 - 34 - 32 - 29 - 8 - 4 - 40
C to A	12 - 2
Z to A	4
A to Z	2
Z to Y	3
Y to Z	4
Y to X	6
X to Y	8

X to W	9 - 31
W to X	32 - 29
W to L	23 - 33
L to M	24 - 36
M to L	24 - 35
L to W	23 - 35
W to V	33
U to W	34
U to N	26 - 37
N to V	26 - 37
V to B	37
B to V	39
W to O	25 - 38
O to W	25 - 38
C to Z	13 - 3
Z to C	13 - 4
Z to D	15 - 5 - 14 - 3
D to Z	15 - 14 - 5 - 3
Z to E	15 - 5 - 14 - 3
Y to H	7 - 16 - 17 - 6
Y to G	17 - 7 - 16 - 6
Y to F	7 - 16 - 6
X to I	18 - 9
W to K	21 - 30 - 22 - 32
W to J	22 - 30 - 32
W to F	28 - 20 - 29 - 32
W to G	19 - 28 - 29 - 20 - 29 - 32
F to W	20 - 31

MANIPULATION SHEET, SECTION 2

ROUTE.	LEVER.
A to B via D	2 - 30 - 16 - 32-1-20 - 41 - 49 - 74 - 78 - 72
A to B via E	2 - 31 - 16 - 1 - 40 - 50 - 45 - 46 - 70 - 19- 74 - 78 - 72.
A to F	23 - 24 - 3
A to G	23 - 25 - 4 - 3
A to H	23 - 26 - 5 - 4 - 3
A to I	23 - 27 - 8 - 5 - 4- 3
A to J	23 - 28 - 10 - 8 - 5 - 4 - 3
A to K	23 - 29 - 11 - 10 - 8 - 5 - 4 - 3
A to L	23 - 11 - 10 - 8 - 5 - 4 - 3
A to C	2 - 30 - 16 - 32 - 20
B to A via D	⁹ 79 - 75 - 76 - 71 - 69 - 41 - 61 - 21 - 30 - 17 - 73
B to A via E	79 - 75 - 76 - 45 - 46 - 71 - 68 - 66 - 65- 64 - 40 - 64 - 31 - 18 - 73.
B to O	48 - 79
B to Z	79 - 75
Z to N	47 - 74
Z to C	71 - 43 - 44 - 69
Z to M	45 - 46 - 71 - 38 - 68
Z to E	45 - 46 - 71 - 68 - 66 - 65
Z to F	45 - 46 - 71 - 68 - 37 - 66
Z to G	45 - 46 - 71 - 68 - 37 - 77 - 66
Z to H	45 - 46 - 71 - 68 - 37 - 66 - 36 - 62 -
Z to I	45 - 46 - 71 - 68 - 37 - 66 - 63 - 35 - 59
Z to J	45 - 46 - 71 - 68 - 37 - 66 - 63 - 59 - 34 - 57
Z to K	45 - 46 - 71 - 68 - 37 - 66 - 63 - 59 - 57 - 33 55
Z to L	45 - 46 - 71 - 68 - 37 - 66 - 63 - 59 - 57 - 55

L to Z	45 - 46 - 70 - 37 - 51
L to A	23 - 15
K to Z	45 - 46 - 70 - 37 - 33 - 52
K to A	23 - 29 - 14
J to Z	45 - 46 - 70 - 37 - 34 - 53
J to A	23 - 28 - 13
I to Z	45 - 46 - 70 - 37 - 35 - 54
I to A	23 - 27 - 12
H to Z	45 - 46 - 70 - 37 - 36 - 57
H to A	23 - 26 - 9
G to Z	45 - 46 - 70 - 37 - 77 - 58
G to A	23 - 25 - 7
F to Z	45 - 46 - 70 - 42 - 60
F to A	23 - 24 - 6
C to Z	43 - 44 - 67
C to A	32 - 22 - 30 - 17
D to E	39 - 49
E to D	39 - 64
M to Z	45 - 46 - 70 - 38 - 68

SECTION No. 2.
 INTERLOCKING SYSTEM
 C.C.C. & St. L. R.R. Yards
 Urbana and Champaign, Ill.

SCALE, 1 inch = 100 feet.
 June, 1895
 R. B. Carbery,
 Engineer.



PROPOSED SCHEME FOR PRESENT ARRANGEMENT
 24 LEVERS FOR 22 SWITCHES & 2 LOCKS.
 2 " " 4 F.P.L.
 1 SPARE LEVERS 80
 53 LEVERS FOR 76 SIGNALS
 80 FRAME

DETAILED BOLT LOCKED BY HOME SIGNALS.

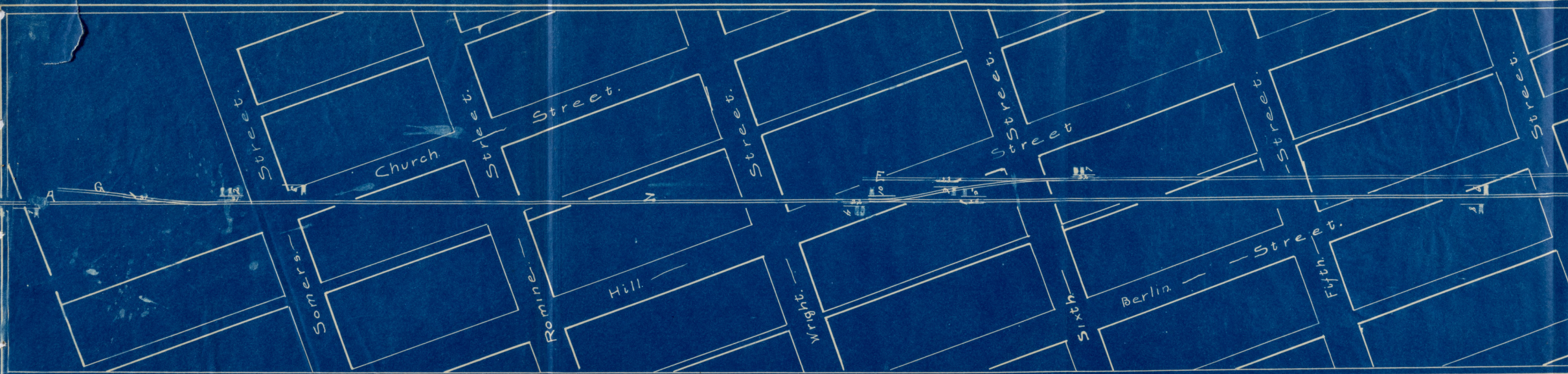
MANIPULATION SHEET, SECTION 3

ROUTE.

LEVER.

A to B	24 - 4 - 1 - 28 - 13 - 8 - 58 - 62
A on X	22 - 4 - 1
A on Y	24 - 4 - 1
Y to M	28 - 30 - 36 - 46 - 13 - 8
Y to L	28 - 37 - 35 - 30 - 46 - 13 - 8
B to A	57 - 28 - 50 - 64 - 24 - 5 - 11 - 2 - 10
B to L	44 - 42 - 61 - 45 - 63
B to M	43 - 61 - 45 - 63
B to K	63 - 38 - 56 - 41 - 57
B to J	63 - 39 - 40 - 56 - 41 - 57
C to D	26 - 16 - 17 - 18
C to J	32 - 34 - 47 - 33 - 17
C to K	31 - 47 - 33 - 17
C to H	26 - 16 - 17 - 27 - 20
D to C	26 - 15
D to I	29 - 19 - 26 - 15
I to D	29 - 19 - 26
J to C	32 - 34 - 33 - 48
K to C	31 - 33 - 49
J to B	39 - 40 - 41 - 55
K to B	38 - 41 - 54
L to Y	28 - 37 - 35 - 30 - 51
L to B	45 - 44 - 42 - 60
M to Y	28 - 36 - 30 - 52
M to B	45 - 43 - 59

E to F	23 - 6 - 25 - 14 - 9
F to E	25 - 53 - 23 - 7 - 12
E to X	23 - 6
X to E	23 - 7
Z to X	22 - 4
X to Z	22 - 7
X to F	25 - 14
F to X	25 - 53



Street.

Church

Street.

Street.

Street.

Street.

Street

-Street.

Street.

Somers.

Romine

Hill

W. 8th

Sixth

Berlin

-Street.

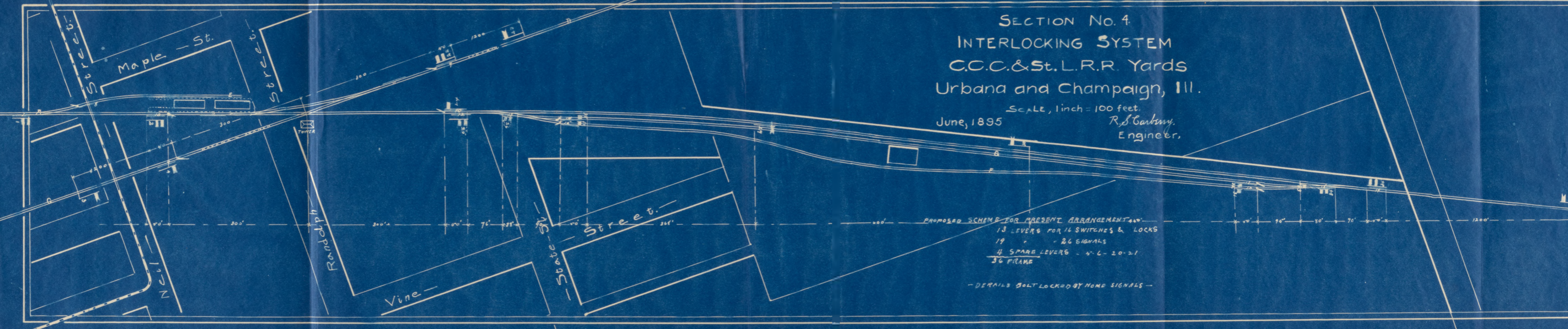
Fifth.

MANIPULATION SHEET, SECTION 4.

ROUTE.	LEVER.
A to B	1 - 10 - 2 - 25 - 33 - 29 -
A to E	8 - 7-1
A to D	1 - 10 - 11 - 9 - 2
A to F	1 - 10 - 2 - 15 - 13 - 26 - 12 - 25
A to G	1 - 10 - 2 - 14 - 26 - 12 - 25
C to D	9 - 4 - 3
D to C	9 - 22 - 23
D to A	9 - 11 - 10 - 22 - 23
B to A	10 - 24 - 30 - 35 - 36
B to F	16 - 18 - 34 - 19 - 35 - 36
B to G	17 - 34 - 19 - 35 - 36
G to A	14 - 12 - 10 - 28 - 24
G to B	17 - 19 - 32
F to A	15 - 13 - 12 - 10 - 27 - 24
F to B	16 - 18 - 19 - 31

SECTION No. 4
 INTERLOCKING SYSTEM
 C.C.C. & St. L.R.R. Yards
 Urbana and Champaign, Ill.

SCALE, 1 inch = 100 feet.
 June, 1895
 R. S. Carberry,
 Engineer.



PROPOSED SCHEME FOR PRESENT ARRANGEMENT

- 13 LEVERS FOR 14 SWITCHES & LOCKS
- 19 " " 26 SIGNALS
- 4 SPARE LEVERS - 4-6-20-21
- 36 FRAME

- DETAILS BOLT LOCKED BY HOME SIGNALS -

The normal position of levers is as follows:- Derails open, signals at danger and switches closed so as to allow safe passage on main line: in addition, on latter tracks, switches open so as to allow safe passage over latter: and for the track next to main track, closed with lever vertical.

Section No. 1, includes all tracks from east end of yards to Market St., Urbana.

Section No. 2, includes all tracks from Market St. west to Eads St, Urbana.

Section No. 3, includes all tracks from Eads St. west to Neil St., Champaign.

Section No. 4, includes all tracks from Neil St., Champaign, to western yard limits.

No attempt has been made to interlock the crossing of the Champaign and Urbana Electric Railway, on Neil St., Champaign. However in passing mention may be made of the fact that a reasonably cheap and effective interlocking device made for such a purpose by the National Switch and Signal Company, a full account of which may be found on page 189 of the April 6th, 1895, issue of the Railway Review.

DETAILS.

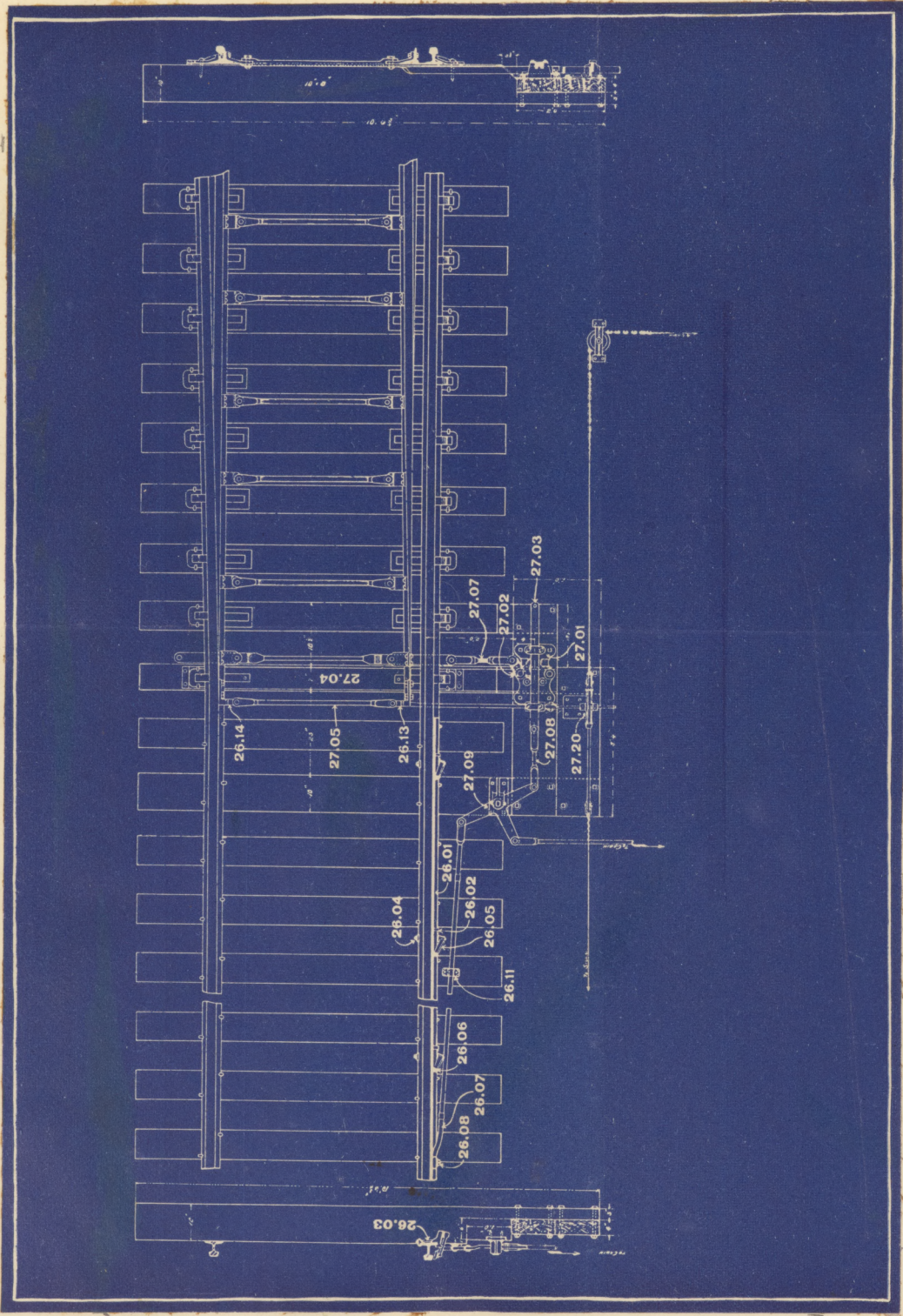
Mechanism of the switch:- Switch and lock movement. This is an ingenious arrangement by which, with one motion of the lever one, two, three or more points can be interlocked, thrown, and re-locked: that is, the detector bar, locks, and points of one or more derails or switches can be operated by a single lever.

The National Switch and Lock Movement illustrated in Figure 5, page 40, is conceded to be the simplest and best device of its kind yet placed on the market. The base plate and mechanism as a whole will interchange with the styles now in use. The movement is anti-frictional, and has but few parts, all of which are immediately accessible by simply removing the top plates. The steel dogs, being fastened to the under side of the sliding-bar are well protected from injury, and the whole design is one in which strength of parts and ease of operation have been carefully studied.

Face and Point Lock:- This differs from the switch and lock movement, namely, in that it locks the switch by use of a separate lever. Its use requires more levers than the switch and lock movement. The track plans for F. P. L. with radial arm bar made by the Johnson Railway Signal Company, is shown in Plate 1.

Advantages and Defects of Facing Point Lock, and Switch and Lock Movement. The advantages of F. P. L. is that being operated by independent lever it gives longer stroke for lock movement, and hence is more durable and more reliable. The disadvantages of the F. P. L. are it necessitates extra lever and pipe connections, and therefore increases the cost, the number of levers, and makes the interlocking more difficult.

The advantages of the S. and L. movement are that the switch and lock are both operated by the same lever and pipe line, and hence this method is the cheaper, and requires the least number of levers in the tower. The disadvantages of the S. and L. movement are that on account of the switch and lock being on same



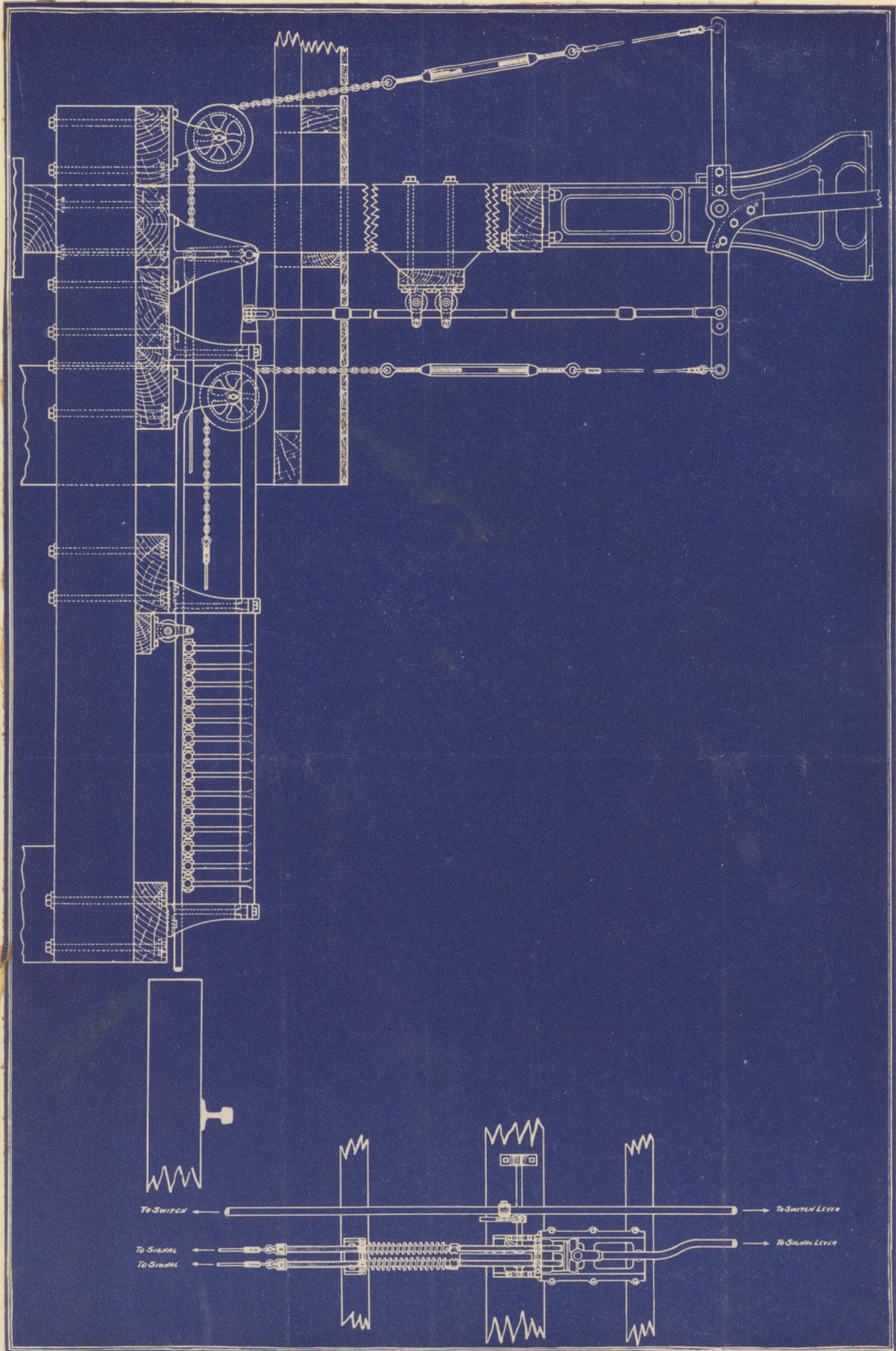
Lay-out, complete, for Double-point Switch and Lock Movement.

lever, there is only a small throw for the lock, and hence it is less reliable and apt to bind and cause trouble.

Bolt Lock:- The point locks are operated from levers in the machine the same as the points and signals: and like the latter are interlocked in such a manner that they must take their proper turn in the setting of a route, that is, first the derails must be set for the line, then locked in their position, after which the signal may be cleared. To prevent the signal from being cleared in case of lack of proper adjustment of the points through any cause, it is the custom now to apply a wire lock, or bolt lock, as it is usually called, at each derailing point. When the bolt lock is used it becomes impossible "to pull the signal off" except when the points are absolutely in place.

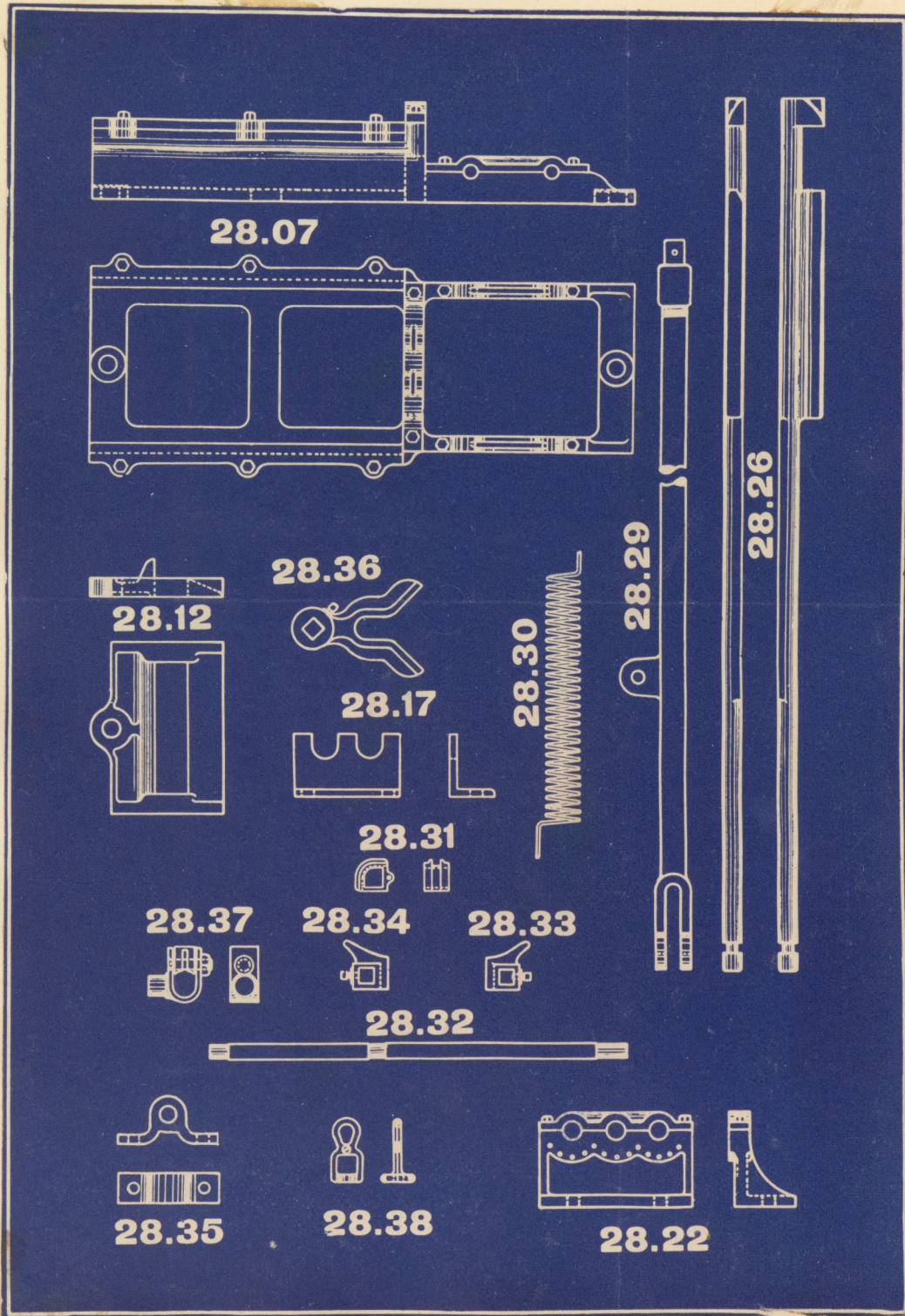
On Plate 2 is shown a derail layout for switch and lock movement, operating derail with independent lock rod for bolt lock, as made by the Union Switch and Signal Company, of Swissvale, Pa., and on Plate 3 is shown a plan of the bolt lock as made by the Johnson Railroad Signal Company, of Rahway, N. J.

Selector:- The selector is a piece of mechanism operated by the signal lever, and so actuated by the switches of the route governed by the signals that the proper blade is engaged and can be cleared while all others are locked at danger. The selector is a very ingenious contrivance, but its action not easily described and should not be attempted without more knowledge and data than possessed by the writer. However figures 6 and 7, pages 42 and 43, show some of the parts of the form made by The National Switch and Signal Company, of Easton, Pa.



Lead-out and Foundations.- Selector.

Figure 6.



Selector Fittings.

Figure 7.

TABLE I. *

Dimensions of Tower.

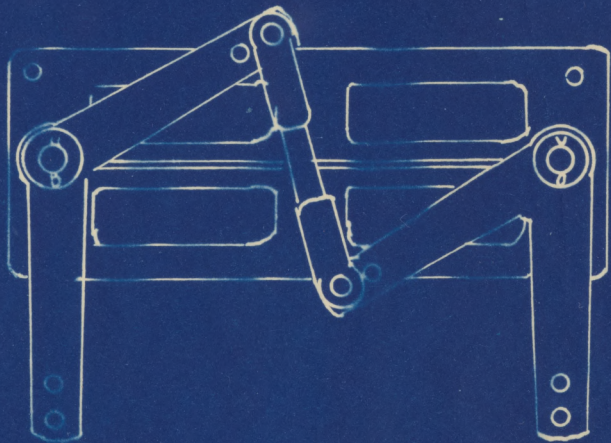
No. of Levers.	Width.	Length.
4 - 16	12'	12' 2"
20 - 24	12'	15' 0"
28	12'	17' 10"
32 - 36	12'	20' 8"
40	12'	23' 6"
44 - 48	12'	26' 4"
52 - 56	12'	29' 2"
60	12'	32' 0"
64 - 68	12'	34' 10"
72 - 76	12'	37' 8"
80	12'	40' 6"
84 - 88	12'	43' 4"
92 - 96	12'	46' 2"
100	12'	49' 0"
104 - 108	17' 10"	51' 10"
112	17' 10"	54' 8"
116 - 120	17' 10"	57' 6"
124 - 128	17' 10"	60' 4"
132 - 136	17' 10"	63' 2"
140	17' 10"	66' 0"

* Reference catalogue of The National Switch and Signal Company, of Easton, Pa., page 139.

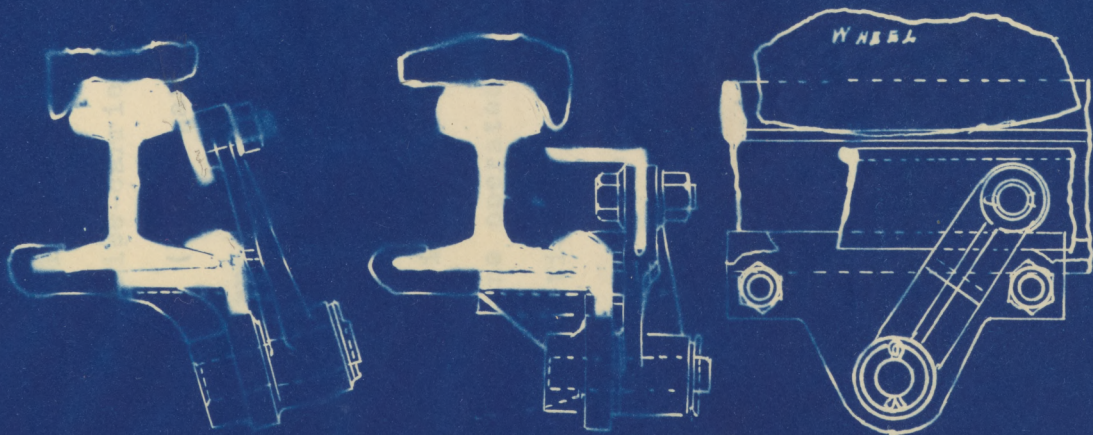
Detector bar:- To prevent the unlocking of parts during the passage of wheels over them is as important as to lock them. The tread of the wheels extends beyond the outside of the head of the rail, and the flange comes below the inside of it. The overhang of the flange is about one inch and one-eighth. If a bar of iron long enough to span between the wheels of the longest car be fastened along the rail and by proper attachments is made capable of being raised an inch or more above the rail, and is placed in such proximity to the wheels that in raising it must come in contact either with the tread or the flanges, such a bar could not be raised during the presence of any wheel or wheels on any portion of its length. By fixing such a bar to the rail and connecting it to operate in conjunction with the point lock, it will be impossible to withdraw the lock until the whole of a passing train has gone over the bar. Thus the movement of the points under a standing or passing train, or as long as any wheels are on the bar is impossible. This is known as a detector bar.

The detector bar is usually forty five (45) feet long and is fitted to the rail beginning at the point and extending its full length away from the point as looked at in the trailing direction. The detector bar occupies forty five (45) feet of the space between the signal and the switch, and the instant a movement is made past the signal at safety the wheels move on the bar and thus absolutely prevent the leverman from changing the route until the movement over the point is completed. Figure 8, page gives drawing of detector bar and attachment to rail.

Compensators:- The problem of perfect compensating for chan-



1-way Lazy Jack Compensator, complete.



DETECTOR BAR ATTACHMENT TO RAIL.

ging length of pipe due to variation in temperature, is best solved by using the Lazy Jack Compensator. Figure 8, page 46, gives detailed outline.

Anti-friction Pipe-carrier:- The National Double Anti-friction Pipe-carrier (Evans patent) has now been in use a little over two years, and there is no doubt but that the use of the "Evans roller" greatly diminishes the work required to be done by the interlocking machine and hereby lengthens its life. The part is of greater consideration in this country than in England, since here more parts are operated by a single lever than there. By reducing the friction it not only increases the life of the machine, but also the life of the operator, by tending to remove the liability to injure by strains etc.

These rollers can be ordered by the thousand sets, and be set up 3, 4, and 5 ways as required, hereby doing away with the necessity of keeping an assortment in stock. The advantages claimed over all other carriers are; 1. Reduction of friction, hereby lengthening the life of the interlocking machine, and allowing the operation of switches at a much greater distance from the tower than heretofore. 2. Perfect interchangeability. 3. Facility in adding to or reducing the number of pipeways. 4. Cheapness. Owing to the freedom from loss by breaking and the great reduction in friction wear. 5. Durability, being designed on correct mechanical principles, all strains are provided for and the life of the carrier is equal to that of any part of the interlocking.

D E T A I L E D S P E C I F I C A T I O N S . *

General.

1. All material and workmanship shall be of the best, and subject to the approval of the Chief Engineer of the Big Four Railroad.

2. When not otherwise specified all interlocking material shall conform in all respects to the standard now in use on the Pennsylvania Railroad.

3. The interlocking machine shall be Saxby and Farmer, with Stevens's locking attachment, or any other latch-locking machine equally as good.

4. All levers in the machine shall have an equal and uniform throw.

5. The machine shall be placed on separate foundation not connected with the building in any way.

Machine.

6. There shall be no difference in the size of parts for a large or small machine.

7. Levers shall be pivoted on a common center, spaced 5" center to center, and move through the same arc. Top plates and girders made in sections for four and eight levers.

8. Levers shall number from left to right:- switch and lock levers in the center, signal levers at the end, spare spaces, if any, between the lock and signal levers.

9. Locking to be preliminary latch-locking: the first action of the operation of the lever is to lock all conflicting levers.

* Compiled by the author from Illinois Central, and National Switch and Signal Co.'s specifications.

10. Machine to be supported by framed timbers 5" x 10" oak. This sill to have its ends firmly seated in walls of foundation.

Charts.

11. A manipulation chart shall be furnished with each machine, together with a sketch of the tracks showing number and normal position of the functions, for use in the tower.

Lead-Out.

12. Lead-out for pipe connections shall be by vertical and horizontal cranks, rocking shafts. They should be of uniform size, and not less than two and one-quarter (2 1/4) inches in diameter.

13. Lead-out for wire connections shall be 6", 8", or 10". Vertical and horizontal wheels. The wires shall be attached to the levers by adjustable connections.

Pipe Lines.

14. All switches, locks and lock and switch movement shall be operated by best quality of wrought iron gas pipe one (1) inch inside diameter, with pipe sleeves and joints plugged and riveted, carried on sleeves not spaced more than seven feet between centers.

15. Pipe line must be laid two and three-quarter (2 3/4) inches between centers and not be nearer than three feet from guage line of rail. They should be so arranged so arranged in order of their lengths, measured from the tower with the shortest line nearest the guage line of rail. This is for the purpose that the outside line of boxing may finish parallel with the rail.

16. Carriers to be double anti-friction, fixed to foundation by lag screws.

17. Top of pipe carrier foundation shall be six inches below base of rail.

Couplings.

18. Couplings in pipe lines must not be placed closer than ten inches to a pipe carrier when the lever is on the center.

Bends.

19. Bends shall not be allowed in pipes, but shall be placed, when necessary, in the cranks or jaws. And they must not exceed two and three-quarters ($2 \frac{3}{4}$) inches at any point.

Bell Cranks.

20. Bell cranks shall be wrought iron or steel fixed in suitable cast iron stands and secured to foundation by bolts and lag screws of suitable length: vertical cranks by $\frac{3}{4}$ " bolts. Horizontal and box cranks by $\frac{3}{4}$ " bolts and lag screws.

Chain Wheels.

21. Chain wheels to be cast iron 6", 8", or 10" outside diameter: not more than eight six-inch mounted in one frame, nor more than four ten-inch in one frame.

Wire Sleeves.

22. Wire sleeves may be in sets of one, two, or four, and shall be of cast iron.

Compensators.

23. All lengths of pipe over 100 feet shall be compensated. An additional compensator shall be provided for all lengths over 700 feet. Each switch, lock and signal (if pipe connected)

shall be properly compensated.

24. Compensators to be of lazy jack pattern, fixed to foundation by 3/4" bolts and lag screws of suitable lengths.

25. Compensating levers and bell cranks shall be used as compensators if convenient.

26. The amount of pipe pushed must equal that pulled and vice versa.

Switch and Lock Movement.

27. Switch and lock movements shall be operated by pipe and fixed to a 4" oak foundation securely bolted to three ties extending beyond the rail, and bolted through a 3/8" x 6" iron gauge plate extending under both rails to insure relative position.

28. They must lock the switch in both positions.

Detector Bars.

29. Detector bars located as shown on accompanying plan must be 45 feet long, placed outside of rail and shall work in a plane slightly inclined from the vertical toward the rail. Twelve rail clips to each regular 45 foot bar. If at switch points, clips can not clamped to base of rail they are to be fastened by bolts to flange. Bar shall rise not less than 3/4" above top of rail. End clips shall be not more than 12 feet from end of bar.

Spacing Point Locks.

30. Spacing point Locks shall be operated by pipe and fixed to tie outside of rail, bolted through a 3/8" x 6" iron gauge plate extending under both rails. Lock rods to be jointed, plunger to have a blunt end, not tapered and to clear lock rod

not less than 1" round nor more than 1 1/2" when in normal position. Stroke shall be not less than 7 3/4". Each facing point lock shall be fitted so that it will not be possible for plunger to enter hole of lock rod if switch or movable point frog is three thirty-seconds of an inch open on either direction.

Foundations.

31. Pipe carrier foundations shall be of 2 1/2"x 8" oak dovetailed, bolted together.

32. Bell crank foundations shall be of 4" x 12" oak.

33. Foundations shall be fixed in concrete, unless otherwise specified, shall be set so that center line through long way of foundation will bisect angle made by connections.

34. Switch and lock foundations shall be constructed of oak, and framed and bolted to the track ties.

35. Selector foundations shall be made of 4" x 12" oak securely bolted to pipe carrier foundations between which they are placed.

36. Lead out foundations shall be constructed of white oak dovetailed, bolted together and braced.

37. Foundations shall be laid, when required, in concrete mixed in proportion and in a manner, as dictated by the Chief Engineer.

38. The joints of all foundations shall be given one coat of paint before they are put together.

Wire Connections.

39. Each signal or indicator shall be operated by two lines of No. 9 galvanized steel wire (the back wire having in all

cases one and one-half inches more stroke than the front wire) supported on wire carriers placed at a maximum distance apart of 21 feet. When run contiguous to a line of pipe, where a carrier may be placed on the pipe carrier foundation, such may be done. Signals must be tried with the front wire only before being placed in service in order to see that they are sufficiently counterweighted.

Signals.

40. Signals shall be fixed as shown on accompanying plan and of the standard semaphore type.

Poles.

41. Standard signal poles shall be 7" square at top and not less than 10" square at bottom. Bracket signal main poles shall be 12" square, and bracket poles 7" square, and when possible not closer than seven feet from gauge line of rail.

Height of Arms.

42. The lowest arm shall not be less than twenty-four feet above top of rail. Cross-arm of bracket signals shall be not less than twenty-one feet above top of rail. One and two arm signals, standard height, shall be fixed not less than five feet, and three armed and bracket signals not less than six feet deep in ground.

Connections.

43. Home, distant, starting, and dwarf signals shall be operated with two lines of No. 9 wire. Signals shall be operated by pipe only when specified.

Lamps.

44. Lamps shall have a front lens properly focussed and a

two inch bulls-eye in the back.

Indicators.

45. Position:- Signals that can not be seen from tower shall be fitted with electric repeaters to indicate position of arm, when so specified.

46. Light:- Light indicators or perimeters to indicate light in or light out, shall be furnished when so specified.

Torpedo Signals.

47. Torpedo signals shall be furnished when specified.

Selectors.

48. Selectors shall be fixed either in tower or on ground, and operated by pipe connections, between the lever and selector.

Arms.

49. Signal arms shall be made of clear, well-seasoned ash.

Derails.

50. All facing point derails, if operated by a combination movement, shall be bolt locked through their home signals.

Switches.

51. All switches shall be locked either by a combination movement, or facing point lock.

52. Facing point switches shall always be locked by separate pipe line and never from the one used to operate switch.

Adjustment.

53. Means of adjustment shall be provided for each line of pipe and wire.

Arm Ends.

54. Arms for home signals shall have square ends, and for

distant signals forked ends. Stop for danger and safety positions shall be provided in the center castings.

Glass.

55. Colored glasses for signals shall be used in special frames.

Low Signals.

56. Low signals shall conform to the same requirements as the high signals as to colored glass and counter weights. The center of the arm shall be not more than thirty-six inches above top of rail.

Signal and F. P. Lock.

57. A signal and facing point lock shall not be operated by the same lever.

Distant and Home Signals.

58. Distant and home signals shall not be operated by the same lever.

M. P. Frogs.

59. When movable point frogs are used, they shall be connected with pipe lines, and securely locked against the stock rail.

Towers.

60. Towers shall be located with face eight feet from gauge line of rail whenever possible.

Boxing.

61. Pipe lines, cranks, pipe compensators, chain wheels, and wire line on pipe carrier foundations, shall be boxed, except across tracks, through streets and station platforms. Boxing shall be of white or yellow pine size 2" x 8", top not less than

1 1/2 inch thick. Movable covers shall be provided for all cranks, compensators, wheels, selectors, and lead outs.

Painting.

The inside of tower, except floor, shall be finished in hard oil. All outside wood work shall receive one coat priming and two coats finishing with standard building color.

All unfinished parts of the machine, except that part of the levers above the latch rod spring box, the tappets, locking bars and dogs, shall be painted two coats of asphaltum paint. The levers and latch rods between the latch rod spring box and handle shall be painted as follows:-

Switch levers-	Black.
Switch and lock levers-	upper half blue, lower half black.
Lock levers-	Blue.
Home signal levers-	Red.
Dwarf signal levers-	Red.
Distant signal levers-	Green.
Spare levers-	White.

Unfinished part of latch handle (inside) shall be painted same color as lever.

Signal arms shall be given one coat of priming and two finishing coats as follows:-

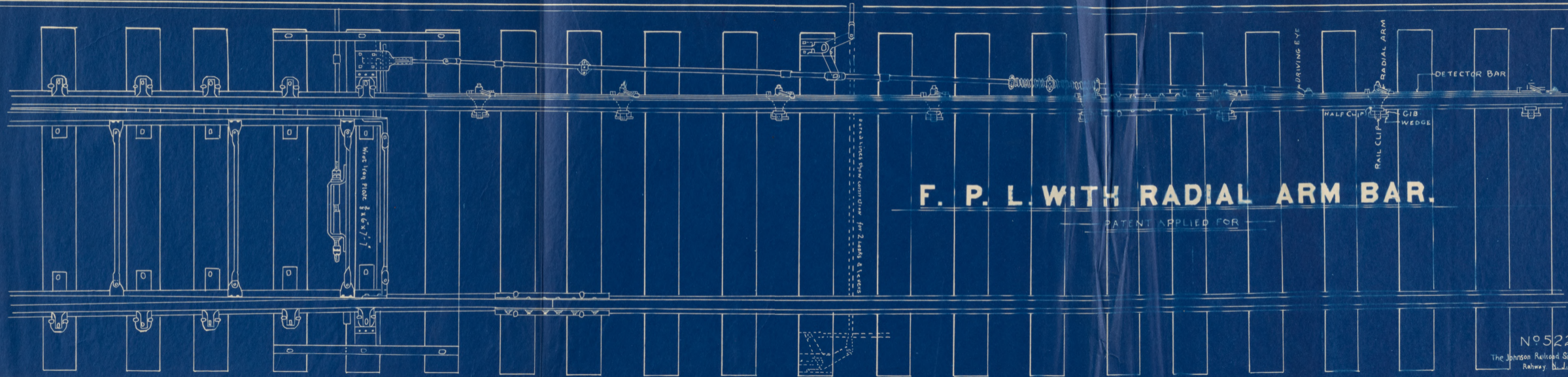
Home signals, English vermilion on face side, with white strip 6" wide, center of strip 18" from outside end. White on reverse side with black stripe, same width and location as white stripe.

Dwarf signal, English vermilion on face and white on reverse

Railroad Company.

The railroad company shall do all track work, furnish all ties in place and prepare all switches, derails, movable point frogs, etc., ready to be connected to the interlocking mechanism: shall do all preliminary grading and prepare surface of ground where connections are to be run, before the signal company is notified to commence work: shall do all ballasting: shall provide proper drainage: shall provide foundation for tower with sills and lead out timbers in place: shall furnish broken stone, sand and cement for concreting crank, compensator and wheel foundations (if concreting is required in specifications), shall provide boxing for pipe and wire line across all streets, through and under all station platforms and across tracks if desired: shall provide permits for building tower and for digging across streets (if necessary); shall furnish free transportation over its own lines, for men, tools and material, both going and returning.

THE END.



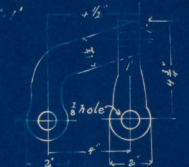
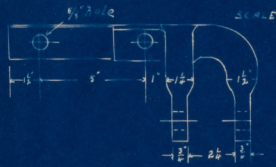
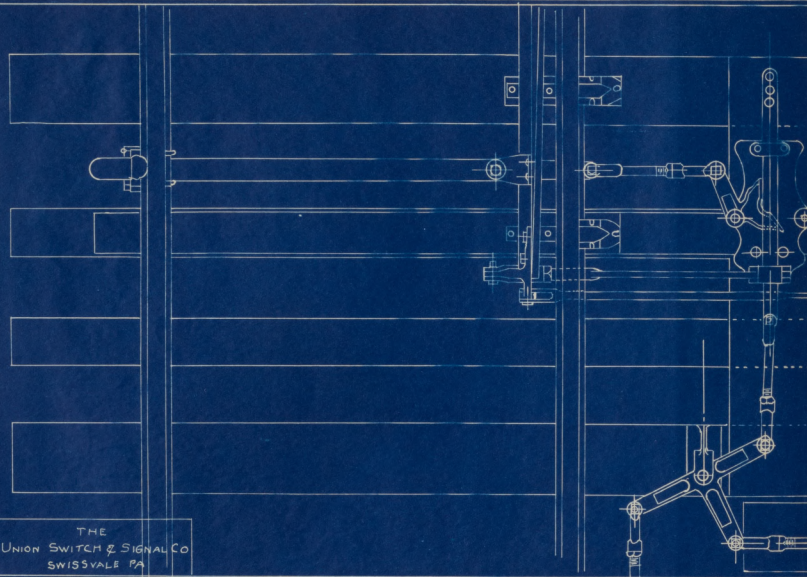
F. P. L. WITH RADIAL ARM BAR.

PATENT APPLIED FOR

LAY-OUT FOR SWITCH & LOCK MOVEMENT

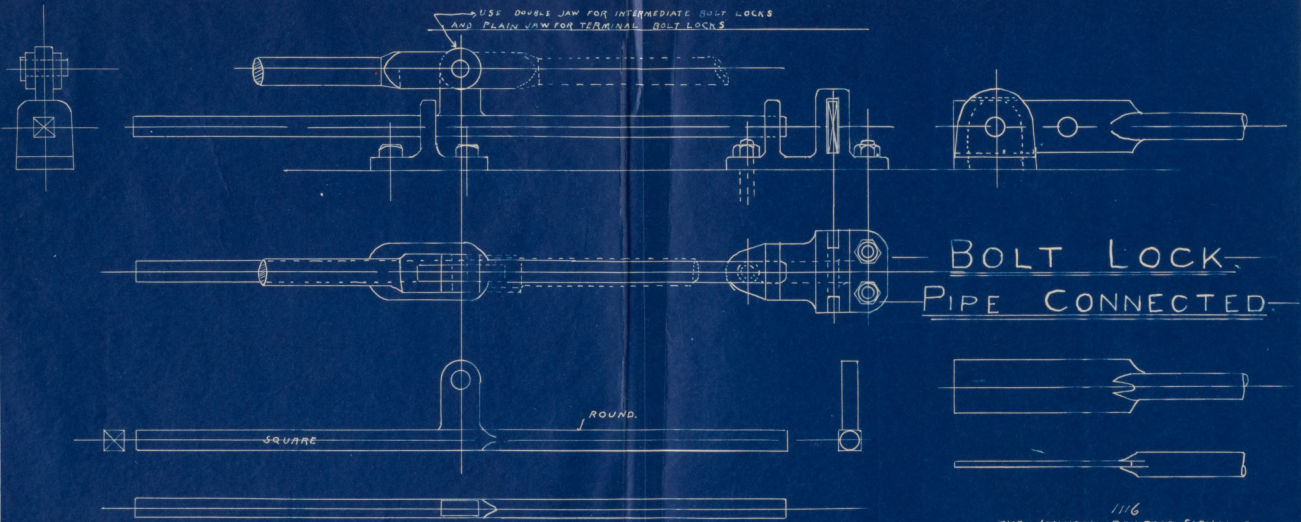
OPERATING DERAIL.

WITH INDEPENDENT LOCK ROD FOR BOLT LOCK.



THE
UNION SWITCH & SIGNAL CO
SWISSVALE PA

USE DOUBLE JAW FOR INTERMEDIATE BOLT LOCKS
AND PLAIN JAW FOR TERMINAL BOLT LOCKS



BOLT LOCK
PIPE CONNECTED

1116
THE JOHNSON RAILROAD SIGNAL Co.
RAHWAY N.J.