Interlocking Facilities of the St. Louis Terminal Railroad Assn. of St. Louis

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In 1902 the Terminal Railroad Association of St. Louis, realizing that its facilities, which were even then heavily taxed by current business, would prove utterly inadequate to handle the great volume of traffic expected in connection with the World's Fair in 1904, decided upon extensive improvements. It was foreseen that the natural increase from year to year in the business of the Terminal would soon overtake any excess of facilities which might be necessary for temporary use during the Fair. The rebuilding, therfore, was planned with a view to permanency as a reasonable provision for the future.

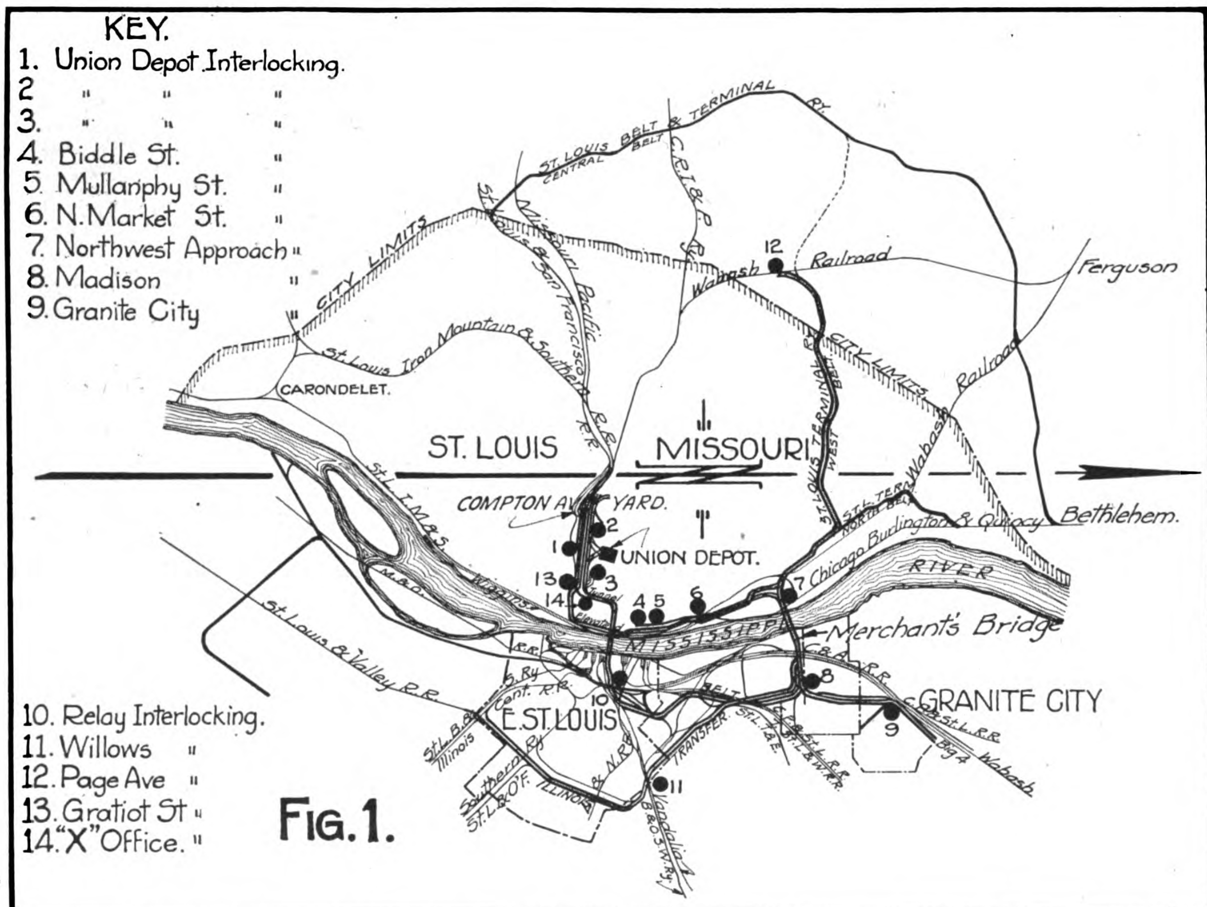


FIG. 1.

The problem of reconstruction resolved itself into four equally important main divisions. There were found necessary: First, main tracks which would admit of a free "internal circulation" of business; second, large additional switching and storage room; third, increased motive power and provision for its care, and, fourth, the improvement of all facilities in connection with the Union Passenger Station. This latter division admitted of nine subdivisions. We are, however, concerned in our consideration of the Terminal interlocking with but four of them, as follows:

First, an improved track arrangement for the better handling of trains in and out of the station; second, the proper interlocking of this arrangement; third, improved methods of transmitting information from the dispatcher's office in the main interlocking tower to the various departments in and around the station, and, fourth, increased facilities at the Union Station power house.

The first division of the problem, the "securing of tracks which would admit of a free internal circulation," was solved by the construction of the system of main lines shown in Fig. 1. In the report of the chief engineer of the Terminal Railroad Association in 1905 the new main lines are given as comprising "the double tracking of a complete belt encircling the city, utilizing by arrangement a portion of the Wabash double tracks to complete the circuit, which begins and ends at the Union Station; double tracks all the way to Granite City, via the Merchants' bridge, a portion of this route having three and a portion four main lines; double tracks via the Merchants' bridge and the Illinois Transfer Railroad to the limits of the Terminal property at the Valley Junction yard; double track connections between the Merchants' bridge and Eads' bridge on the east side of the river, the large Madison yards and the East St. Louis yards

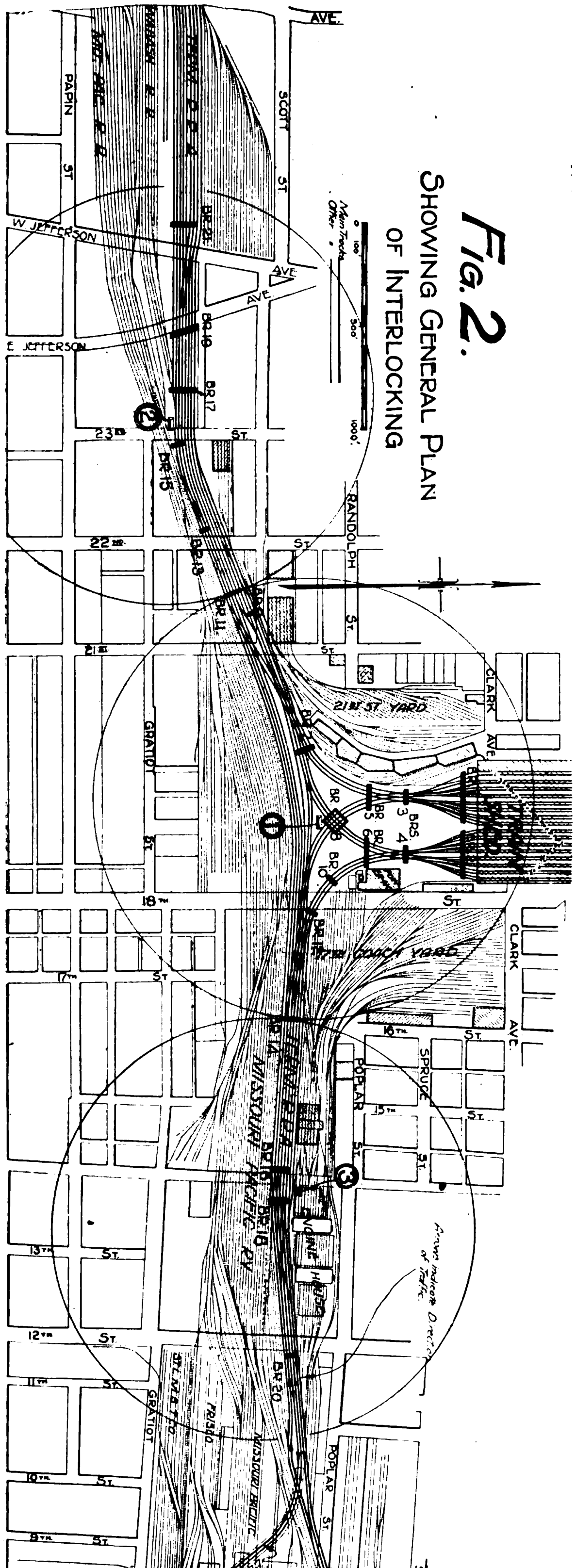


FIG. 2. SHOWING GENERAL PLAN OF INTERLOCKING

being situated on this double track line; a single track belt, sixteen miles long, to the northward of the city of St. Louis, connecting the various railroads which approach the city from the west and northwest; and, in addition to this, seven main lines, six passenger and one freight, in the Mill Creek Valley in St. Louis, from the Merchants' bridge junction on the east to the Wabash and Frisco junction on the west." The capacity of the yard and storage tracks was increased, and switching leads and connections were placed where they were most convenient and accessible.

This track arrangement afforded the desired "free internal circulation." The main lines permitted an unimpeded flow of traffic; there were no obstructions in the "channels of commerce." But the circulatory system thus obtained, complete as it was, had to be controlled. A nervous system was required to contract or expand the blood vessels of this railroad organism, as a greater or less supply of blood was needed here or there, just as the human nerves conspire to pour the life-giving fluid into those organs which demand it, and check the flow into the quiescent members of the body.

The property, therefore, was thoroughly equipped with the signals and interlocking, and means of intercommunication which we are pleased to call the "nervous system." Thirty-nine miles of main line are controlled by normal danger, three position automatic signals. Twelve interlocking plants, ten of them having new towers, and with levers to the number of 968 (696 working and 272 spare) were erected at the junction and crossing points. Lines of telephone and telegraph stretched between them, a great network of nerves, with each tower a nerve center.

A description of the Terminal interlocking facilities would be incomplete without a more detailed mention of these twelve towers. But, as such mention would consist largely of figures somewhat in the nature of statistics, which are to most of us of doubtful interest, let us proceed to the next main divisions of the problem. An outline of the construction of each tower is, however, appended to this article.

The second and third divisions we need not dwell upon. The former was, for our purposes, sufficiently mentioned in the review of the first division, while the latter is out of our province, being but indirectly related to interlocking. The fourth, viz., "the improvement of all facilities in connection with the Union Passenger Station," is worth our extended notice.

The first and greatest difficulty encountered in the improvement was the track layout. It was evident from the beginning that the old track arrangement and the interlocking plant, which had in its time been regarded as one of the largest and most complete in the world, must be torn out entirely. A radical rearrangement of everything about the station was necessary. But the limitations imposed upon the new work, limitations which were absolutely unavoidable, made it impossible to more than approximate an ideal track scheme. The most rigid of these was the smallness of the territory within which the tracks must be confined. Bounded, as it was, on the north by the Union Station and on the south by property belonging to an individual railroad, it was impossible to obtain more room in either direction. The distance between these boundaries was found to be unchangeable. It was but 1,103 feet, of which 180 feet were to be used by the southward extension of the train shed, leaving but scant space, indeed, for the proposed improvements. Equally hard were the restrictions in the other directions. On the east the 18th street viaduct and on the west the 21st street viaduct limited the number of tracks which could pass them, and also determined to some extent the directions these tracks must take.

If it had been possible to secure the ground, an arrangement of eight approach tracks would probably have been constructed to serve the thirty-two tracks in the train shed. But the restrictions were too severe. In the words of the chief engineer: "All the study and ingenuity at our command failed to develop a plan which would give us the desired ratio"; that is, the eight approaches to thirty-two tracks. The best that could be done was a ratio of five and one-third, or six approaches to the thirty-two station tracks. Therefore, the plan followed was that shown in Figs. 2 and 3. For various reasons of economy and ease in operation, peculiar to the Terminal, it was decided to back all trains into the station. This, too, was a factor in determining the track arrangement, especially that part of it behind Tower No. 1 (see Fig. 3). Sharp curves, of 15 and 16, and sometimes of 20 degrees, were necessary in securing the track scheme shown; and special frogs, curved from the frog point, were put into some of the turnouts. Experience has shown, however, that the curvature and special features required because of the lack of proper area, are well within the limits of safe operation.

The general working of this layout is about as follows: "The seven tracks south of Tower No. 1 are kept open for the movement of trains. The most southerly of these is for freight movements in both directions. It will be seen (Fig. 4) that the freight movement is separated from the passenger movement at the west end of the tunnel, which leads to the Eads Bridge. (See Figs. 2 and 18.) The freight movement itself branches here, the north track tapping the freight houses, passes by the delivery track for the large coaling plant, and reaches the 16th street freight yard and warehouse. The south branch passes under the Merchants' elevated viaduct, reaching the 12th street freight yard, the freight connections with the Missouri Pacific, Wabash and 'Frisco roads, and, after proceeding westward far enough to allow for the clearance of all back-up passenger train movements from the east, crosses the main passenger line and enters the Compton avenue freight yard (see Fig. 1). The two tracks just north of this freight track are used for admitting trains from the west to the train shed. These trains are routed past Tower No. 1 and to the point at which the back-up movement begins, as may be easily traced on the map (see Fig. 3).

"The next two tracks are used by trains from the east to reach the station, it being necessary for them to go to a point west of 21st street before beginning their back-up movement into the shed.

"The next two tracks, completing the seven, are used for outbound eastward and westward passenger trains. Trains departing from the train shed for the east run to the left hand on double track and trains departing for the west, run to the right hand on double track. The result is that theoretically—and this is approximated in practice—the tracks under the shed are assigned as follows: Tracks 1 to 8 inclusive are for departing westbound trains, tracks 9 to 16 inclusive are for arriving trains from the east, tracks 17 to 24 inclusive are for arriving

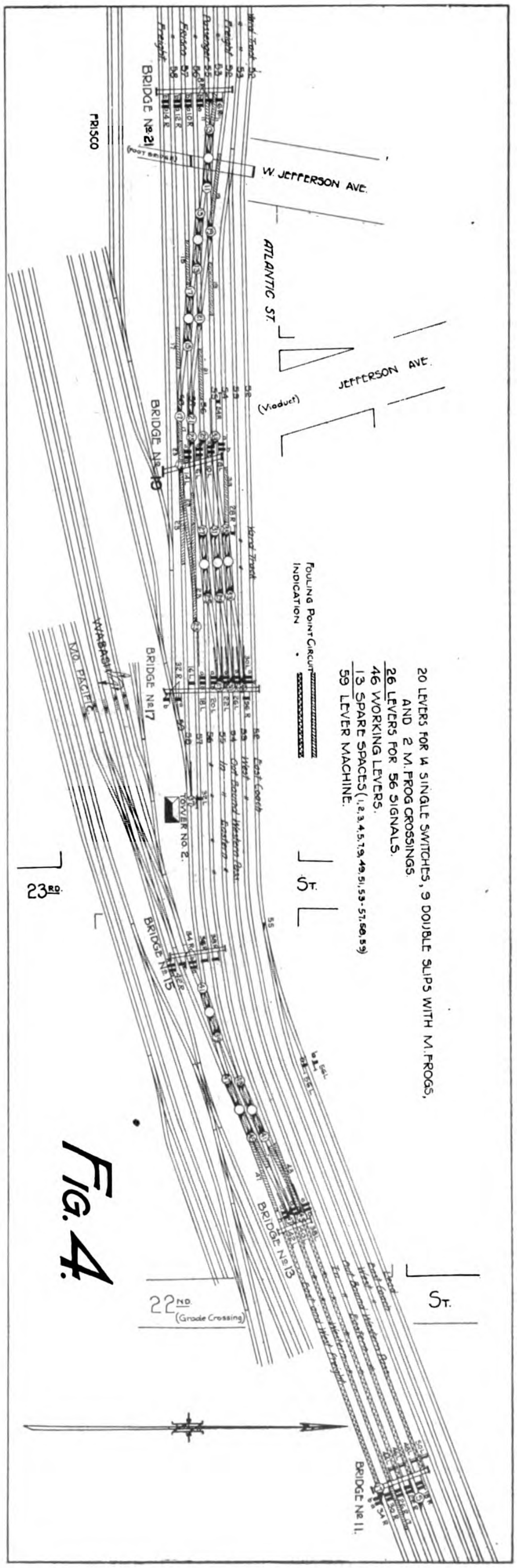
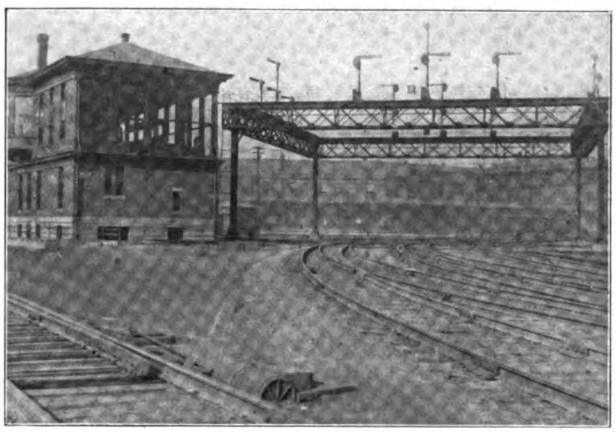


Fig. 4.

trains from the west, and tracks 25 to 32 inclusive are for departing eastbound trains. By following roughly this classification, the minimum of interference between the different lines of movement is secured (see Figs. 2 and 3)."

Now we come to the second subdivision, the interlocking of this complicated track arrangement. It was decided that the interlocking should be handled from three towers, it being impossible to concentrate the movements into one. Tower No. 1, therefore, in the center of the layout, overlooks the yard in the rear of the train shed, and two auxiliary towers govern the ends of the installation, Tower No. 2 on the west and Tower No. 3 on the east. The territory controlled by Tower No. 1 lies between Signal Bridges No. 11 and No. 14 (see Figs. 2 and 3). Tower No. 2 governs the tracks from Bridge 11 westward past Bridge 21 (see Figs. 2 and 3), and Tower No. 3 the tracks from Bridge 14 eastward to the "X" office (Fig. 2), near the entrance to the tunnel. Let us visit the most important of these towers first.

Tower No. 1 is a substantial structure of brick, 24'x56', situated directly south of the station and commanding the entire territory. The basement is

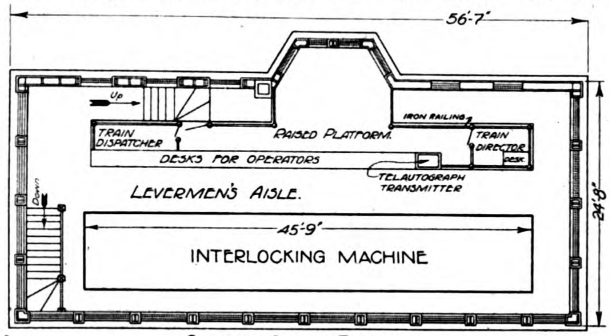


Tower No. 1—Looking West.

devoted to repair shop purposes, the first floor to the power plant and lockers, and the second floor to the machine and the train directors' desks. The machine occupies the north half of the floor, the directors being upon a raised platform, six or eight feet wide, extending almost the whole length of the south side of the tower. The second story plan and the arrangement of desks and machines are shown in Fig. 6.

Climbing the stairs and reaching the machine floor, we enter upon a scene of seeming chaos. Our ears are assailed by a turmoil of sound and our eyes become weary of trying to interpret the myriads of movements we behold. Men upon the raised platform are shouting numbers or writing furiously, gongs are clanging, telephones ring incessantly, a score of invisible buzzers each try to buzz the loudest, while the telegraph instruments with their ceaseless clicking, form a steady background of sound. Indicators jerk up and down, little numbered cards flap into view and disappear with astonishing rapidity, and buttons are pushed here and there with great haste, but with no apparent attempt at order. All the while the levers in the great machine snap back and forth under the hands of the restless operators. The whole picture is one of confusion, and we hear naught but a babel of undistinguishable noises. Outside the disorder seems even greater. Through the windows, so numerous that the walls seem almost all of glass, we behold trains stopping, starting, backing, pushed and pulled by snorting, steaming engines, every one of which proclaims its presence by whistle and bell.

As we watch the busy scenes inside and out, it gradually becomes evident that each sound has its



SECOND STORY PLAN.
FIG. 6.

purpose and each indication its use. We find after a little that what we thought was haste on the part of the operators is in reality great dexterity; we have mistaken familiarity for carelessness, and have confounded system with confusion. We are looking into the greatest nerve center of the whole organism, where the messages from the outlying towers are turned into the impulses which govern and direct the vital "internal circulation."

Of tremendous volume is this circulation as it surges about the tower. Some idea of its magnitude may be gathered from the fact that a daily average of 2,200 train movements is cared for by the interlocking. The machine in Tower No. 1 alone governs 1,827 possible routes, and one of its levers controls over 146 various combinations. Six outbound or six inbound movements may occur simultaneously. Between the hours of 7 and 8 a. m. the train movements average

Tower No. 1—Looking North.

three per minute; between 8 and 9, 145 to 150 per hour; and during the evening rush, from 7 to 9, about 130 per hour. The Terminal time card shows three trains leaving at 8:59 a. m., four at 9, three at 9:01, and two at 9:02.

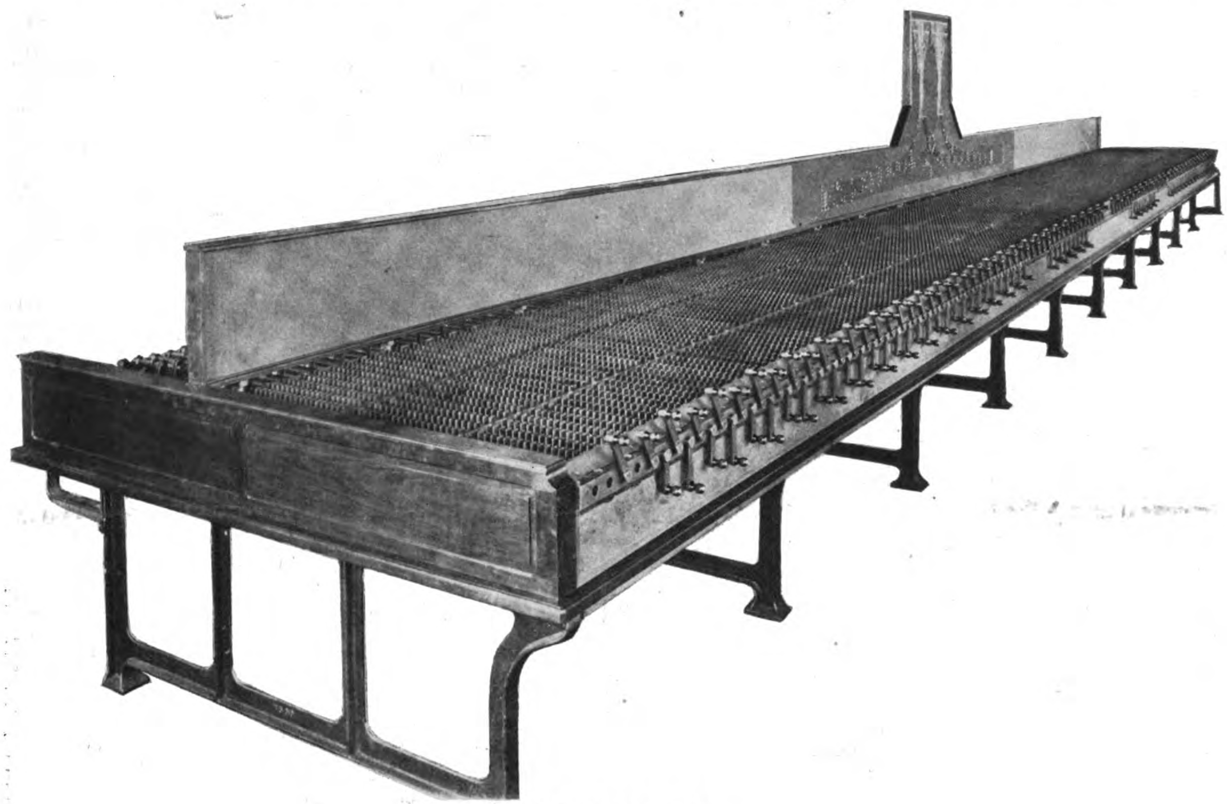
So it is small wonder that the system which, day after day and night after night, lets trains from all parts of the country into and out of the Mound City with never a halt, appears somewhat intricate at first sight. But like all systems it admits of analysis and study, piece by piece.

Let us begin the analysis with the directors' desks. Here there are four directors during the evening and morning rush hours, two chiefs and two assistants. One chief and one assistant have split tricks, the other chief and assistant are on "straight" duty. These are the men whom we heard shouting numbers so peremptorily. They were calling to the four men at the machine the tracks for which routes were to be lined up. As shown in Fig. 3, the tracks are designated throughout by numbers, and the machine is divided into four sections which correspond in a general way to the track arrangement in the train shed, previously noted. So certain track numbers being governed by a certain section only of the machine, the operators, familiar alike with levers and track, from long apprenticeship in this and other towers, set up the routes as directed by the men at the board. It will be noted that there are *four* directors, *four* men to *four* sections of the machine and *four* divisions of the track layout. This sectional arrangement is followed whenever possible.

A telegraph operator, whom we see seated at the board beside the directors, is in touch with all the outlying towers, and the arrival of trains upon Terminal property is immediately reported to him. The telephones at his side also communicate with the other towers, but are used mostly between Nos. 1, 2 and 3. And at the west end of the directors' board or desks is the telautograph operator, who is the tenth and last man in the personnel of the tower force. His work falls properly under subdivision 3 of the station improvements so we shall leave him for the moment.

The rows of miniature semaphores next claim our attention. Each of the thirty-two tracks in the train shed is provided with a circuit which connects with one of the indicators in Tower No. 1, so that the directors can tell at a glance which tracks are empty and which are occupied. A second set of indicators, located here in the tower and governed by push buttons adjacent to each track in the train shed, is used by conductors to signify to the train director their readiness to depart. And all the main lines between Tower No. 1 and Towers No. 2 and No. 3 are represented by indicators which report the presence of a train, in both the towers between which the train happens to be. Certain signals, hereafter noted, are connected through these indicators, making them semi-automatic. Chloride accumulators, wired so that any one or all of them may be charged at one time, and placed at varioius points about the yard, feed the track circuits. One particular accumulator energizes as many as thirty-two track circuits.

The buzzers and buttons and flapping cards we behold are part of a complete system of communication between the three main towers. By means of the system the operators are enabled to signify to the director in Tower 1 what train is approaching them and upon which track it is, and the director then has but to press a button to denote to Towers 2 and 3 by what track he wants the train to be sent toward him. Each time any tower receives one of these indications a buzzer is energized, and it continues buzzing until the sender of the indication receives an answer to his message, or, if no answer is required, until stopped by hand. We shall later inspect more closely the operation of these indicators by following a train in and out



The Machine in Tower 1.

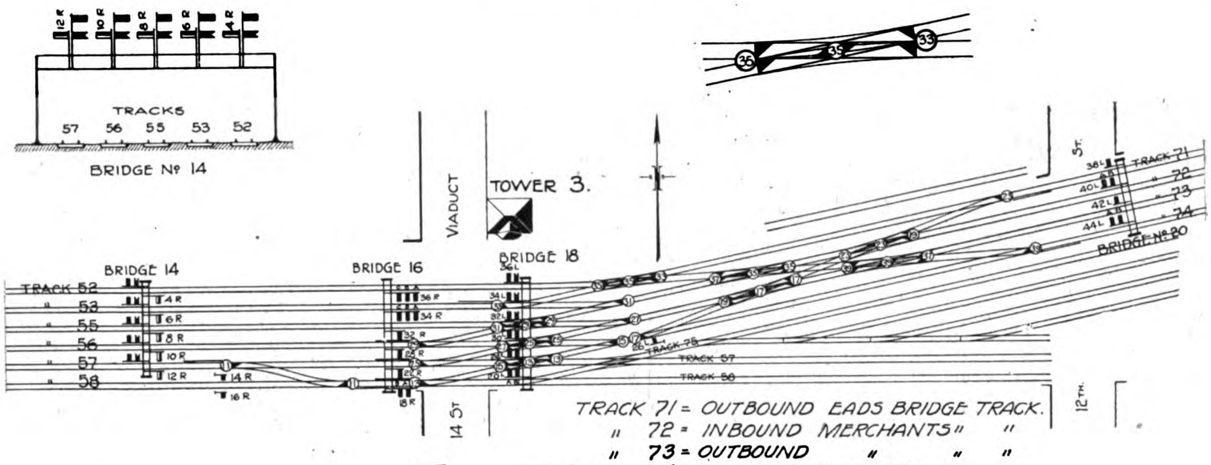


FIG. 5.

of the station. Figs. 19, 20, 21 and 22 show in general the devices used.

The three plants comprising the Union Station interlocking represent a total of 260 working levers controlling 65 double slips, 90 switches and 283 signals. The arrangement of the functions in each of the towers at the time they were installed is as follows:

Functions of Tower No. 1.

1 arm home signal............................ 9
2 arm home signal............................ 1
1 arm bridge signal..........................21
2 arm bridge signal..........................37
3 arm bridge signal.......................... 2
1 arm suspended signal.......................20
2 arm suspended signal.......................12
Dwarf signal.................................37
Single switches..............................35
Crossovers 15
Double slips with M. P. F....................48

(35 single switches.
103 levers (15 crossovers.
(48 double slips with M. P. F.
78 levers, 193 signals.

—

181 working levers.
34 spare spaces.

—

215 lever frame.

Functions of Tower No. 2.

1 arm bridge signal..........................14
2 arm bridge signal..........................18
Dwarf signals................................ 3
Single switches 11
Crossovers 1
Movable point frogs.......................... 2
Double slips with M. P. F.................... 9

(11 single switches.
19 levers (1 crossover.
(2 movable point frogs.
(9 double slips with M. P. F.
25 levers, 53 signals.

—

44 working levers.
15 spare spaces.

—

59 lever frame.

Functions of Tower No. 3.

1 arm bridge signal..........................10
2 arm bridge signal.......................... 9
Dwarf signals................................ 3
3 arm bridge signal.......................... 2
Single switches 10
Crossovers 1
Double slip with M. P. F..................... 8

(10 single switches.
14 levers (1 crossover.
(8 double slips with M. P. F.
21 levers, 37 signals.

—

35 working levers.
12 spare spaces.

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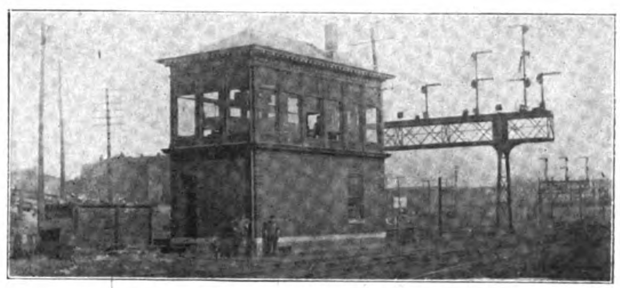
47 lever frame.

With the exception of a few minor changes, the interlocking is the same as when it was constructed.

The machine, of 215 levers capacity, and 45 feet 9 inches in length, was a few years ago the largest



Tower 2—Looking East.

electro-pneumatic machine in existence. It was built and installed by the Union Switch and Signal Company. As it is standard in all important respects we shall not pause to describe it minutely.

The details of wiring and indication, of switch movement and signal movement, of pipe and trunking and of bar, bolt, valve and cylinder for a plant of this size are, generally speaking, a repetition, over and over, of certain standard details and devices. Learning from study or observation the intricacies of one lever and the switch, or double slip, or single slip, or signal which it governs, and the devices it brings into play, there remains but to multiply it by a number and it is an interlocking plant. Multiply it by 183 and we have the machine in Tower 1, operating and controlling in correct sequence all the functions of the layout shown in Fig. 3. Of course, in every plant, of whatever character, there is likely to be a certain amount of departure from customary standards, on account of local conditions. So on this system we may expect to, and do, encounter a few special features owing to the restrictions imposed upon the construction. The sharp curves have already been mentioned as one of them. There are several others, which shall be touched upon. However, we omit the strictly standard details, which may be found fully explained in numerous books and catalogues, and forbear to mention the sizes and kinds and lengths of wires and trunking and pistons, etc., etc., which, hav-

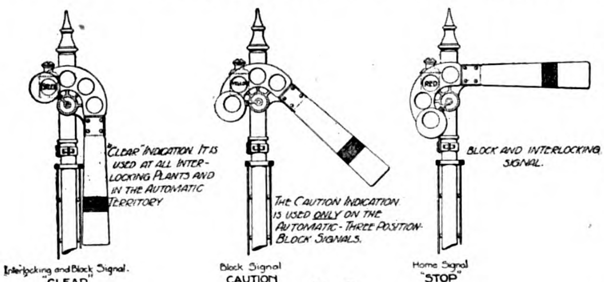
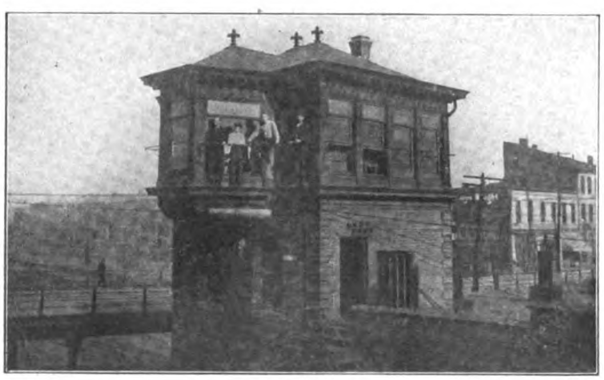


FIG. 8.

ing been thoroughly discussed in their applications to standard mechanism at other plants, it seems superfluous to consider here.

Let us then observe some of the signals, bridges and accessories which we see upon all sides from our vantage point in the tower. First, the semaphores; they are all two position, indicating clear at 90 degrees. Where two or more blades are upon the same mast the upper blade indicates for a movement to the right and the lower blade for a movement to the left. The night indications are red for danger and green for clear. A white light is regarded as a danger signal. Lenses of solid color Kopp glass are used, and the signals are lighted by two candle power, 115 volt, incandescent globes set in the lanterns, and interchangeable, in case of failure of the current, with oil founts. One switch, located in Tower No. 2, controls all the lamps at that plant, and only one switch

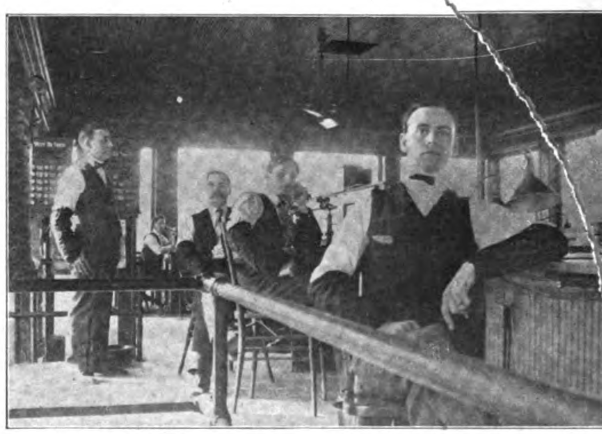


Tower 3.

is needed in Tower No. 3 for its complement of lights, but five are required at Tower No. 1. All signal posts are of iron, and all signals are electro-pneumatic. Home blades are red with white stripe, and the notched blades are yellow with black stripe.

Bridges 1 and 2, each about 260 feet long, are situated immediately south of the station and carry suspended starting signals and several dwarf signals, the latter governing only the express and switching leads. A few starting indications are repeated by dwarfs located beside the tracks under the train shed. (See Fig. 3.) Bridges 3 and 4 control the throatways in both directions, while bridges 5 and 6 govern inbound movements only. The notched blades on 5 and 6 are connected through points on the relays which are operated by the station track circuits. If a station track is occupied and it is desired to send a second train into the shed upon that track, this second train will receive a clear indication of the upper blade, but the notched arm will remain in the horizontal position. Were the track under the shed unoccupied, both arms would indicate "clear." These notched blades are not operated by the interlocking machine. Each one of them "clears" automatically when the home blade above it is in the "clear" position, and the track this home blade governs is not in use. Their circuits are cut through front contacts on the station track circuit relays, and contact points on the home signal arms which are closed only when the blades are in the 90 degree position.

On account of the Eighteenth street viaduct the signals on Bridge 10 are repeated by notched blades



The Director's Desk in Tower 1.

on Bridge 12. These blades have no other significance. But on Bridges 9, 11, and 14 the notched blades indicate, when down, that the tracks and signals are set to give the route "clear through to the bumping posts," in the north end of the station. The operating circuits for these signals are closed only when all the home signals on the route set up are at "clear."

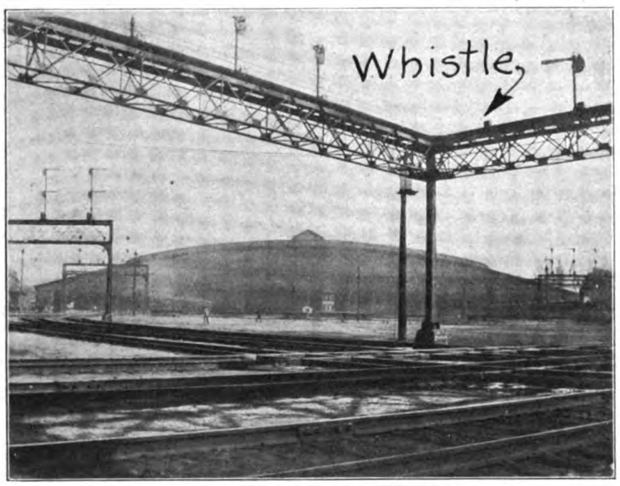
East bound signals on Bridge 14 are semi-automatic and are controlled by both Towers 1 and 3. This bridge is so close to the end of the double slip "puzzle" switches (see Fig. 2) that all trains heading east must pass it before backing in to the station. Such movements as these are facilitated by leaving the east bound signals at clear. But before the operator at Tower 3 can send a train toward Tower 1 he must first get permission from the directors to use a track and then must reverse the lever which governs the east bound signal for that track. In so doing he puts the signal on Bridge 14 at danger, after which Tower 1 can not clear it, without the aid of Tower 3. Of course this aid will not be forthcoming until Tower 1 acknowledges in some manner the train to which

Tower 3 gave the right to proceed. This prevents a "back up," as a train preparing to back into the station is called, from passing Bridge 14 in the face of a train west bound from Tower 3 on the same track. A similar arrangement exists between Towers 1 and 2, involving those signals on Bridges 9 and 11 which are shown in Fig. 3 as semi-automatic. The signal controlling circuits are looped through the track indicator relays, holding the signal "up" until all train wheels are out of its particular track section.

Several special dwarf signals are provided at various points to govern switching leads, a few of them on the bridges and the remainder on the ground.

Switching and yard connections are, as a rule, kept out of the interlocking as much as possible, for reasons chiefly having to do with simplicity and economy.

The bridges supporting the signals for the three plants are twenty-one in number and have a combined length of 2,045 feet and a total weight of 313 tons. They are of riveted steel construction and were designed for a uniform live load of 100 pounds per lineal foot of bridge, a dead weight depending upon the length of the span, and a concentrated load of 1,500 pounds for each signal and its mechanism. The wind load on the signals was assumed at 300 pounds



Looking Toward the Train Shed from the Grand Crossing.

and on the truss at 150 pounds per lineal foot of truss. The minimum vertical clearance above the top of rail is 22 feet 6 inches and the inner faces of the bents on tangents are 7 feet and on curves 8 feet from the center of the nearest track. All bents rest upon concrete piers. Bridge No. 8 is of a special construction. It is built in the form of a square with sides 75 feet in length, and supports signals governing the tracks at what is called "the Grand Crossing."

Deep throated, far sounding air whistles are located upon many of the bridges. They are operated by push buttons in the towers and serve to call attention to the signal indications and to summon repair men. The whistle code is as follows: One blast means "Stop"; two blasts, "Go ahead"; three blasts, "Back up"; four blasts call repair men, five blasts signify "O K on interlocking repairs" and six blasts summon the track men. Telephones scattered about the yard at convenient points assist the maintainers, of whom there are five on duty during the day and three at night, in locating trouble.

All main line rail within the interlocking limits is 100 pound. The sixty-five double slip switches have movable point center frogs and are operated by switch and lock movements, connected in the standard manner and driven by the electrically controlled pneumatic "power unit."

Fig. 17 shows the standard cylinder and valve arrangement used at all the ground movements within the limits of the three plants which comprise the interlocking. Detector bars, used at the single switches, are 50 feet long, as nearly as may be, and are of the

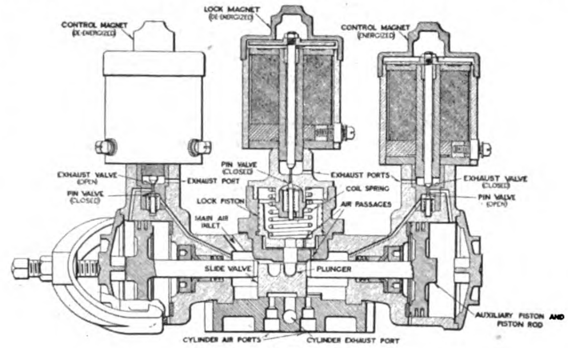


FIG. 17.

motion plate type. In addition to the operating mechanism an auxiliary tank is located at every switch, slip and ground signal (and also at the low points in the air pipe line) for the double purpose of acting as a storage reservoir and to collect any moisture which may be precipitated. The air is supplied from the power house at an initial pressure of between 80 and 90 pounds and is conducted to the movements through a 3 inch main which encircles the layout. The signal mechanisms are supplied by 2 inch branches from the main pipe. The current for controlling the air is furnished by chloride accumulators of 600 ampere hours capacity. The accumulators are in duplicate and are charged by 4½ K. W. motor generator sets which occupy the first floor of Tower 1 and are driven by current from the power house. A gasoline engine set is provided for use in emergencies.

At Tower 3 there is but one operator. The same standards of construction are used here as elsewhere within the interlocking limits. On Bridge 18 the

Tower 2—Looking West.

notched lower arms clear automatically when the track is clear between Bridges 14 and 18 and when the upper signal blades are at "Clear."

Trains on any of the tracks shown on Fig. 3 as 52, 53, 55, 56, and 57, and between Bridges 18 and 14, denote their presence by indicators in Tower 3, and as was before noted, in Tower 1.

Tower 3 is situated upon the southwest corner of engine house 1 at the east end of the yards. (See Figs. 3 and 5.)

One operator and an assistant are required at Tower 2. Here also the construction is similar to that at 23 lever frame. The signal levers operate from one to six signals apiece, according to the route, and here also, as at Towers 3 and 1, the storage batteries which energize the track circuits and which furnish current to the movements are charged from the generating sets in Tower 1.

Various locking and fouling point circuits which

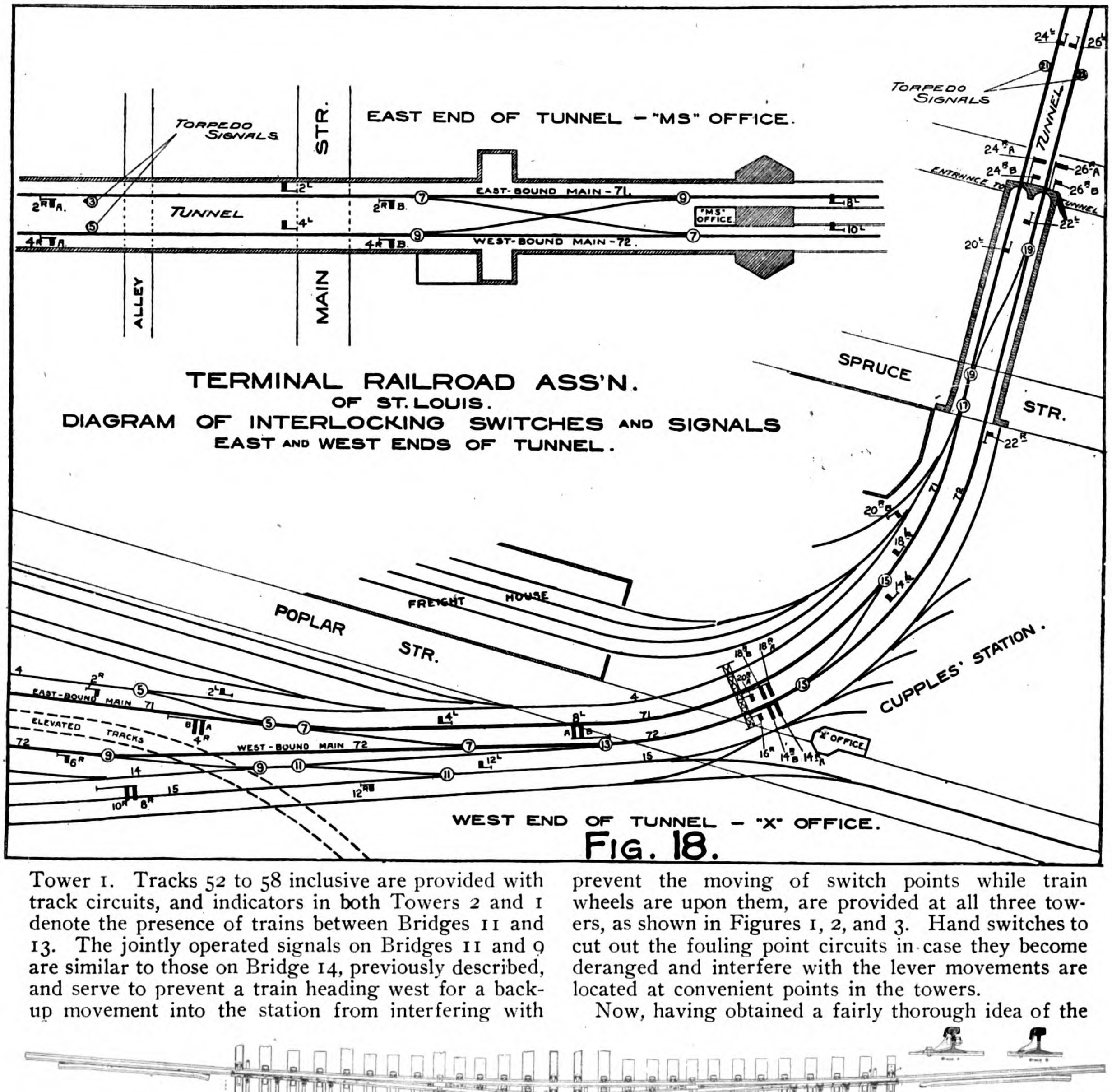


FIG. 18.

Tower 1. Tracks 52 to 58 inclusive are provided with track circuits, and indicators in both Towers 2 and 1 denote the presence of trains between Bridges 11 and 13. The jointly operated signals on Bridges 11 and 9 are similar to those on Bridge 14, previously described, and serve to prevent a train heading west for a back-up movement into the station from interfering with prevent the moving of switch points while train wheels are upon them, are provided at all three towers, as shown in Figures 1, 2, and 3. Hand switches to cut out the fouling point circuits in case they become deranged and interfere with the lever movements are located at convenient points in the towers.

Now, having obtained a fairly thorough idea of the

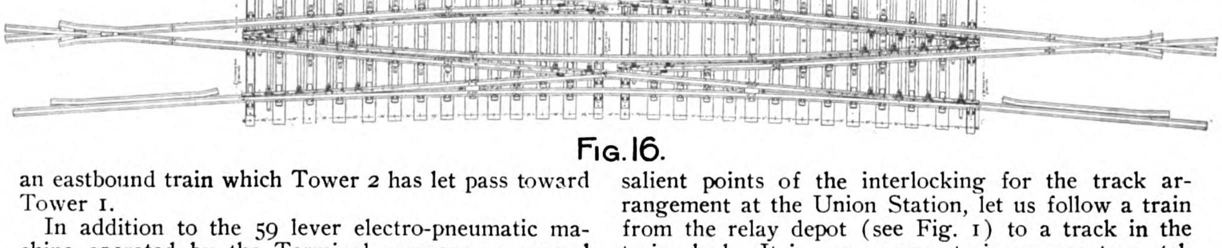


FIG. 16.

an eastbound train which Tower 2 has let pass toward Tower 1.

In addition to the 59 lever electro-pneumatic machine operated by the Terminal company, a second machine, also electro-pneumatic and owned jointly by the Terminal and the Wabash, is located in this tower. It has 16 working levers—9 switch and 7 signal—in a salient points of the interlocking for the track arrangement at the Union Station, let us follow a train from the relay depot (see Fig. 1) to a track in the train shed. It is a passenger train we are to watch (for we have found that the freights are diverted into the yards from track 58, which is their main line), and it has started across the Eads bridge. The train directors in Tower 1 were informed as soon as our train entered terminal property and when it passed the relay station in East St. Louis. Over the bridge it goes, stopping at Washington street depot (see Fig. 18), and then on into the tunnel. Washington street meanwhile reports its passage to Towers 1 and 3. It will be observed from Figs. 2 and 19 that a train can take one of two routes after leaving the tunnel. As this one is a passenger, it takes the southerly route, which is shown as track 74. (See Fig. 5.) "X" office near

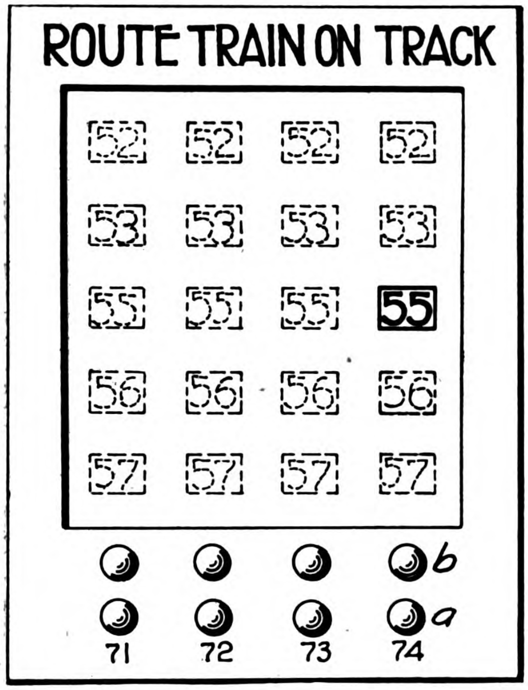


FIG. 19.

the tunnel again reports the train to Tower 1 and Tower 3 is also apprised of its coming. On account of the character of the train, Tower 3 knows that it must be on track 74, which is used only by west bound Eads bridge trains. Fig. 5 shows the tracks which the various trains use. All trains which pass over the Eads bridge are known in terminal parlance as "Eads bridge trains," and all trains which go over the "elevated" (see Fig. 2) are called "Merchants' bridge trains," whether they intend to use the upper bridge or not.

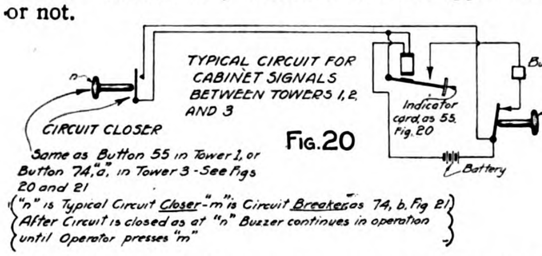


FIG. 20

A cabinet push button arrangement shown in Fig. 19 is located above the machine in Tower 3, and the device shown in Fig. 21 is fastened to the wall near the director's desk in Tower 1. The operator in Tower 3 is able to direct the approaching train to any of the tracks shown in Fig. 5 as 52 to 57 inclusive. But he must first learn from Tower 1 from which of these tracks it will be most convenient to direct the train into the depot. So he pushes button 74a, which corresponds to track 74, on which the train is coming. Then in Tower 1 the number 74 appears as shown in Fig. 21. This says to the train director, "There is a train approaching Tower 3 on track 74. Upon what track do you want it routed?" A buzzer announces the appearance of the card 74, and it does not cease buzzing until the director presses his answering button, which he does when he has decided upon the track he wants the train to take. In this case it is track 55, so he pushes button 55 under the number 74. Simultaneously the number 55 appears in the cabinet at Tower 3 and the operator there reads the message thus: "Route train which is approaching you on track 74 to me over track 55." When the card appears, here, too, a buzzer calls his attention to it, and it is necessary for him to press the upper button, 74b, to stop the buzzer. He then pulls the levers which line up the route from track 74 to track 55 (see Fig. 5) and the train passes on toward Tower 1. All this has taken much less time than is required to tell it.

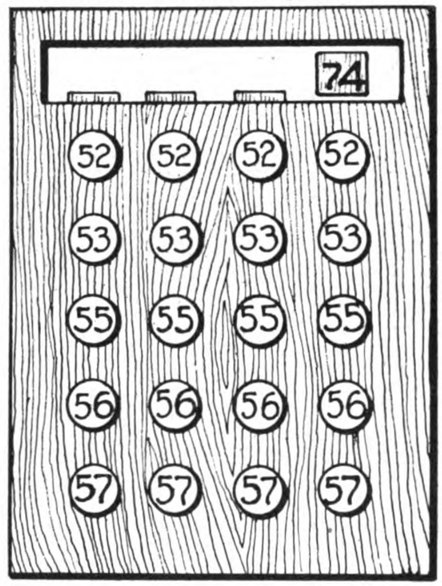


FIG. 21.

The director in the meantime has been figuring out a location for the train in the depot. As he desires to follow the general classification before mentioned, he decides upon a track between 9 and 16. Suppose that it is track 12. Accordingly, at his direction, the operators at the machine arrange a route which sends the train westward, back of Tower 1. Then the "back up" route is lined up. As there was no train standing on track 12 the signals indicate clear all the way to the station, the home blades because of the machine, and the forked blades automatically, through the circuits closed by the upper arms. The train then backs into the station on track 12 and the movement is completed.

Following a train from the train shed to the Eads or Merchants' bridge we find the announcing arrangement much simpler. The operator, having set up the route from, say station track 31 to track 56, the director announces to Tower 3 the fact that he is sending the train over that track, by pressing a button which causes a card to appear in a second cabinet in the latter tower. Such a cabinet is shown in Fig. 22. Operator in Tower 3 then must press the button under the number to stop the buzzer that started when the number appeared, which act also causes the number to disappear and the cabinet to assume its normal condition. The second cabinet is lettered as shown in the figure. In this case Tower 3 lines up the switches to direct the train which is approaching him on track 56 over the Merchants' bridge route; that is, over the "elevated." The train may be going to leave the terminal tracks before it reaches the Merchants' bridge, as do the C., B. & Q. trains, but nevertheless it will be called a Merchants' bridge train. Likewise all trains east bound on track 73 are so designated. An Eads bridge train is announced to Tower 3 in the same manner.

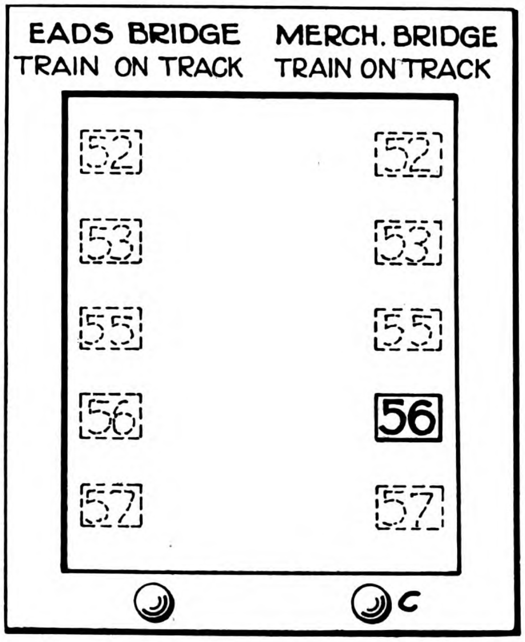


FIG. 22.

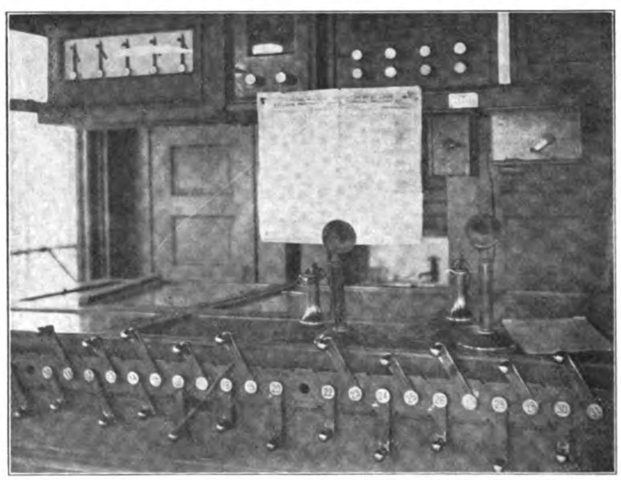
Thus we find that from any track in the station a train may be sent to any track on the main line layout and vice versa, and the interlocking and the cabinet signaling scheme enable every possible routing of trains to be effected between the different towers.

A similar but much simpler cabinet was installed between Towers 1 and 2, but it is used to only a limited extent.

So we pass from the second subdivision of the fourth main division of the problem to the third, the "simplifying of the means of communication," etc. This was accomplished by the telautograph, which is an instrument for electrically and automatically reproducing handwriting. The telautograph operator in Tower 1 grasps a sending pencil, which is connected to sliding contacts, and writes, upon an automatically adjusted strip of paper beneath his hand, notice of the arrival of all trains, as soon as they are reported to Tower 1. And, since the out bound movements also are handled by this tower, he records the exact time of the setting of each train for departure, and the number of the track on which it is set. In the receivers at the other end of the line pencils, operated by magnets energized by the variable current from the transmitter, faithfully copy each movement of the sending pencils. The receivers are incased in glass covered boxes and include rolls of paper which are electrically advanced to receive each new message. The records made by the receivers are permanent, rapidly written, and are absolutely exact reproductions of the record penned by the operator at the seat of information. The receiving instruments are placed at the following points: (1) In the baggage subway pneumatic tube central exchange for the information of the handlers of baggage checks; (2) at the south end of the train shed, for the use of baggage and express men and mail delivery; (3) at the baggage check room; (4) in the bureau of information, and (5) in the station master's office. Those who are concerned in the arrival and departure of trains are thus put in possession of all available information simultaneously and at the earliest possible moment.

A sixth receiver near the transmitting instrument keeps the operator posted as to the condition of other receivers. The telautograph system is fed from the direct current lighting circuit, and consumes the same amount of electricity as two ordinary incandescent lamps.

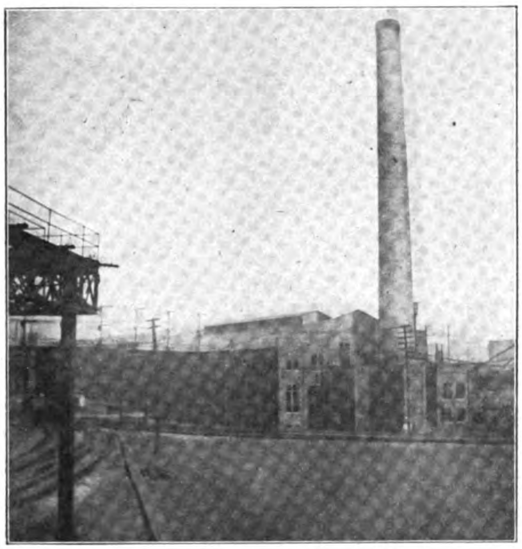
The fifth subdivision, and the last which we shall consider, comprises the erection of a new power plant. A structure 143x96 feet was erected on the site of the old power house (see Fig. 3) and arrangements were made to center the lighting for the depot and interlocking tower and other buildings on terminal property, along with the air plant for the pneumatic switch movements at the various plants, in this building. So we find there two sets of two 350 K. W. units for the electrical work and two air compressors, steam driven, and consuming 2,100 cubic feet of free air a minute for the pneumatic purposes. The generators produce current at 1,150 volts A. C., and two converters lower the voltage of part of it to 500 D. C. for elevators and power in and around the station. The rest of the current is stepped down for the signal lighting and other usages in connection with machine shop and car repair operations by transformers which are located near the various current consuming functions. The air compressors furnish the air for operating the interlocking system, the pneumatic tube system, and for cleaning cars. The Grand avenue interlocking plant and the plants at both ends of the tunnel are also furnished with air from the power house. The compressor supply is taken from the atmosphere at a height of 35 feet above the grade of the tracks, through a vertical shaft of brick into the condenser house. In this house are two air storage tanks 30 inches by 15 feet each, and



The Interior of Tower 3.

four sets of condensers which cool the air and precipitate the moisture therein. A 3 inch main pipe leading from the condensers encircles the yard and feeds the interlocking functions. A gasoline driven generator is located here for use in case all other means of supplying the current for the interlocking should fail.

With this hasty description of the last subdivision we end our discussion of the terminal interlocking facilities. However, in order to round out our knowledge and to obtain some additional idea of the standard practice on this road where the securing of the very best, both in material and construction, was the



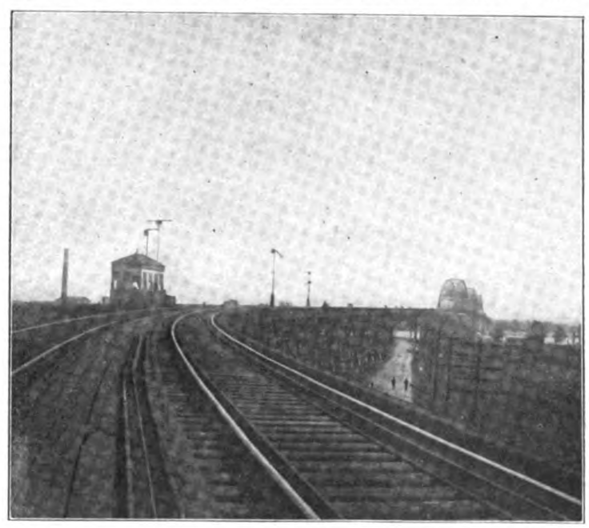
The Power House.

aim of the engineers in charge of the improvements, we attach a list of the towers which are shown in Fig. 1 and a short description of each.

The plant shown as 4 (Fig. 1) is the Biddle street interlocking plant, protecting the switching in the Biddle street freight yard. The tower house is a two story brick structure, 13 feet 7 inches by 26 feet 2 inches, with the interlocking machine on the upper floor and the power plant on the lower floor. It is heated by furnace and lighted by electricity from the power plant. The machine is a Taylor, all electric, with 23 working levers in a 40 lever frame. It controls 14 switches, 17 high signals, all on signal bridges, and 3 dwarf signals. On account of the pavement in Main street seven track circuits displace detector bars on ten switches. Each circuit has an indicator in the tower and is so arranged that the control wire is broken when a train is passing over a switch. The power plant is in duplicate throughout, consists of two 2½ H. P. Fairbanks-Morse vertical gasoline engines, two 1 K. W. Taylor generators and two sets of 45 ampere hour Willard storage batteries, 55 cells to each set, and furnishes current for operating the functions and lighting both tower and signals at an E. M. F. of 110 volts. Five signal bridges, two of 40 feet, two of 29 feet ½ inch and one of 30 feet 6½ inches span carry the signals. Wires are laid in vitrified clay conduits incased in concrete, and entering brick manholes.

A few blocks north of Tower 4, Fig. 1, is Tower 5, located at Mullanphy St., and governing the connection with a freight track which the Terminal and the C., B. & Q. R. R. use jointly. The tower is of brick and of the same dimensions as the one at Biddle street. It is heated and lighted in a similar manner. The second story contains a Taylor machine of 36 levers capacity. Working levers to the number of 22 operate 5 crossovers, 4 single switches and 5 high and 7 dwarf signals. Eight track circuits serve for detector bars at as many switches, for the same reason and in the same manner as at the Biddle street Tower. Two signal bridges, one of 29 feet ½ inch span, a two-track bridge, and one of 51 feet 4¾ inch span, a four-track bridge carry respectively two and three of the high signals. The power plant is in duplicate, and is exactly the same as is used at Biddle street.

Still further north is Tower 6—the North Market St. Interlocking Plant. This is a three story brick tower—16 feet 8 inches by 29 feet 4 inches, heated by furnace and lighted from the power plant, which is on the first floor. The storage batteries occupy the second floor and the interlocking machine, of the Taylor type, is located on the third. This machine has 65 working levers in a 96 lever frame, and controls one double-slip switch, one single slip switch, one movable point crossing, 27 switches, 40 high signals, and 12 dwarf signals, a total of 130 functions. The crossover switches are equipped with track circuits two in number, in place of detector bars, each circuit having its indicator in the tower and being arranged to break the switch control wire when a train is on the crossover. The power plant consists of duplicate 5 H. P. Fairbanks Morse gasoline engines, duplicate 2 K. W. Taylor generators, duplicate sets of 90 ampere hour Willard storage batteries, 55 cells each, and a single 3½ H. P. Westinghouse motor driven air compressor with a piston displacement of 11 cubic feet of free air per minute. A 20 inch by 60 inch reservoir is provided for the storage of the air. An air whistle, easily distinguishable above all the noises of trains and traffic, and used for signaling and calling repair men, etc., explains the presence of the compressor and its accessories. Here as at the towers 4 and 5, the signals are electric lighted. Current for all operations is furnished at 110 volts. Six bridges carry 25 high signals and 1 dwarf. Two of these bridges are 29 feet ½ inch, one is 54 feet 1¾ inches, one 63 feet 8 inches, one 63 feet 7 inches and one 55 feet 8 inches in length. Conduits of wood and vitrified clay laid in concrete, house the wires.



The Northwest Approach Interlocking at West End of Mechants Bridge.

This plant governs the junction of the Terminal with the Wiggins Ferry and Burlington tracks, the junction of the Second street tracks of the Terminal system, and also the Wabash crossing.

The Northwest Approach Interlocking Plant, (Tower No. 7, Fig. 1) may be best described in the words of the Chief Engineer of the Terminal Railroad Association. "This is a high grade mechanical plant, installed with unusual care, governing the divergence of the two northwest approach main lines on the high viaducts at the west end of the Merchants' bridge. It has 16 levers, 13 working, governing 2 switches and one movable point frog, 3 facing point locks, 4 high signals, and 3 dwarf signals." Special electrical and mechanical features render this plant very effective.

Across the river, at the important junction of Terminal lines is the Madison Interlocking Plant, shown as 8 in Fig. 1. Here we find a three story tower; the lower story of concrete, contains the power plant, the second story of brick, the storage batteries, and the third story, also of brick, the interlocking machine. Switches, 19 in number, 21 derails, 3 one-arm, 8 two-arm and 1 three-arm high signals and 13 dwarf signals are controlled by 52 working levers in an 88 lever Taylor frame. The power plant consists of duplicate 5 H. P. engines, two 2 K. W. generators, 2 sets 90 ampere hour storage batteries, 55 cells to each set, and furnishes current for tower, signals, and switches at 110 volts. The same make of engine, generator and battery are used here as in the plants previously described. Two bridges of 55 feet 8 inches span, each, carry 5 signals.

At Granite City, is installed a U. S. & S. Co. Electro-pneumatic plant, having a 71 lever frame with 54 working levers, operating 2 double and 2 single slips, 3 movable point crossings, 21 switches, 19 derails, 5 one-arm, 9 two-arm, 1 three-arm, 1 four-arm, 1 five-arm, and 13 dwarf, signals. Fouling point track circuits as well as detector bars protect the extreme outlying switches and derails. The distant signals are semi-automatic; and the whole plant is protected by route locking. The tower is a two story frame structure 12 feet by 37 feet. It is heated with stoves, and is electric lighted. The upper story contains the machine, while the lower is used for the storage batteries and repair shop purposes. The power plant is housed in a separate building, a one story frame, 16 feet by 24 feet adjacent to the tower. The power equipment is in duplicate and comprises two horizontal 12 H. P. Fairbanks Morse vertical gasoline engines driving two 1 K. W. D. C. generators for charging battery, and two sets 150 ampere hour chloride accumulators, 6 cells per set, giving off an E. M. F. of 12 volts. The main air pipe is 2 inches in diameter and is laid in grooved yellow pine trunking on the surface of the ground along side the wire conduits which are constructed of wood.

The Granite City Plant is especially designed for high speed movements. Light curvature and small frog angles are the rule wherever it is possible to use them.

Tower 10, Fig. 1, the next one under consideration is situated at a very important point and controls an exceedingly complicated layout. Fourteen roads use this plant. It is their gateway to the Mound City. The tower is a two story frame building, 19 feet by 44 feet 6 inches, with a Taylor machine of 105 working levers in a 144 lever frame on the second floor and the power plant below. The machine controls 1 double slip, 42 switches, 2 crossing bars, 56 high and 17 dwarf signals, the total number of functions being 171. The main wire conduit for the movements is a subway. Branch conduits of wood are laid between tracks where possible and where the tracks will not permit of this, the wires are run through vitrified clay ducts laid in concrete. Eight signal bridges varying in length from 29 feet 1 inch to 63 feet 8½ inches, carry the signals. The Power Plant here, as elsewhere, is in duplicate throughout. It includes two 5 H. P. vertical Fairbanks Morse gasoline engines, two 2½ K. W. Generators, and 2 sets of 120 ampere hour Willard storage batteries, 55 cells each. The current, delivered at 110 volts, lights both tower and signals. This plant is called the "Relay Tower."

Tower 11, Fig. 1, is known as Willows Interlocking plant, and is situated at the crossing of the Illinois Transfer main lines and the Southern V. & C. Belt with the three main lines of the Vandalia and the double track mains of the B. & O. S. W. The machine is of the Taylor type and has 67 working levers in a 112 lever frame. Thirty-five switches, 21 derails, 5 crossing bars and 34 signals are operated from the Willows Tower.

And finally, Tower 12, Fig. 1, the Page Arc Interlocking Plant, is reached. It controls the junction of the West Belt main lines with the Wabash double tracks northwest of St. Louis. Thirty-five working levers in a mechanical frame of 44 lever capacity govern 89 switches, 9 derails, 1 movable point frog, 8 facing point locks, and 14 signals. This completes the list.

We are enabled to publish many of the foregoing facts and figures through the courtesy of Mr. H. J. Pfeifer, Engineer Maintenance of Way, and Mr. George B. Ross, Signal and Electrical Engineer, of the St. Louis Terminal Railroad Association.

Electric railroad managers are well aware of the difficulty in maintaining a standard color for car bodies. The general practice is to obtain a paint of a satisfactory shade, and to require that all future shipments match this shade. Frequently the original sample is lost or used up, and even if carefully preserved the difficulty of determining slight changes in shade and the probable change due to fading results in a gradual alteration in the standard color. Where specifications are in use the trouble caused in this way is considerable, as differences of opinion are bound to arise. A very interesting instrument is in use at the Arthur D. Little Laboratory in Boston, for maintaining a desired shade of paint. This instrument, recently invented by Frederick E. Ives, is called a "colorimeter," and accurately measures the shades of any color. The method of procedure is as follows: The standard paint being determined, a board is carefully painted in the same manner as a car body and the color measured on the colorimeter. This instrument gives a certain scale reading, and by setting the instrument again at this same reading the original shade is at any time reproduced in the field of the instrument. On subsequent shipments a sample board is prepared in a similar manner and the exact shade measured on the instrument. This method does away with any need of preserving the original sample and eliminates any possibility of change from fading, as the standard is defined by certain scale readings on the instrument which give the exact color value of the different components which together make up the composite color under examination.—(Electric Ry. Journal, Dec. 5, 1908.)

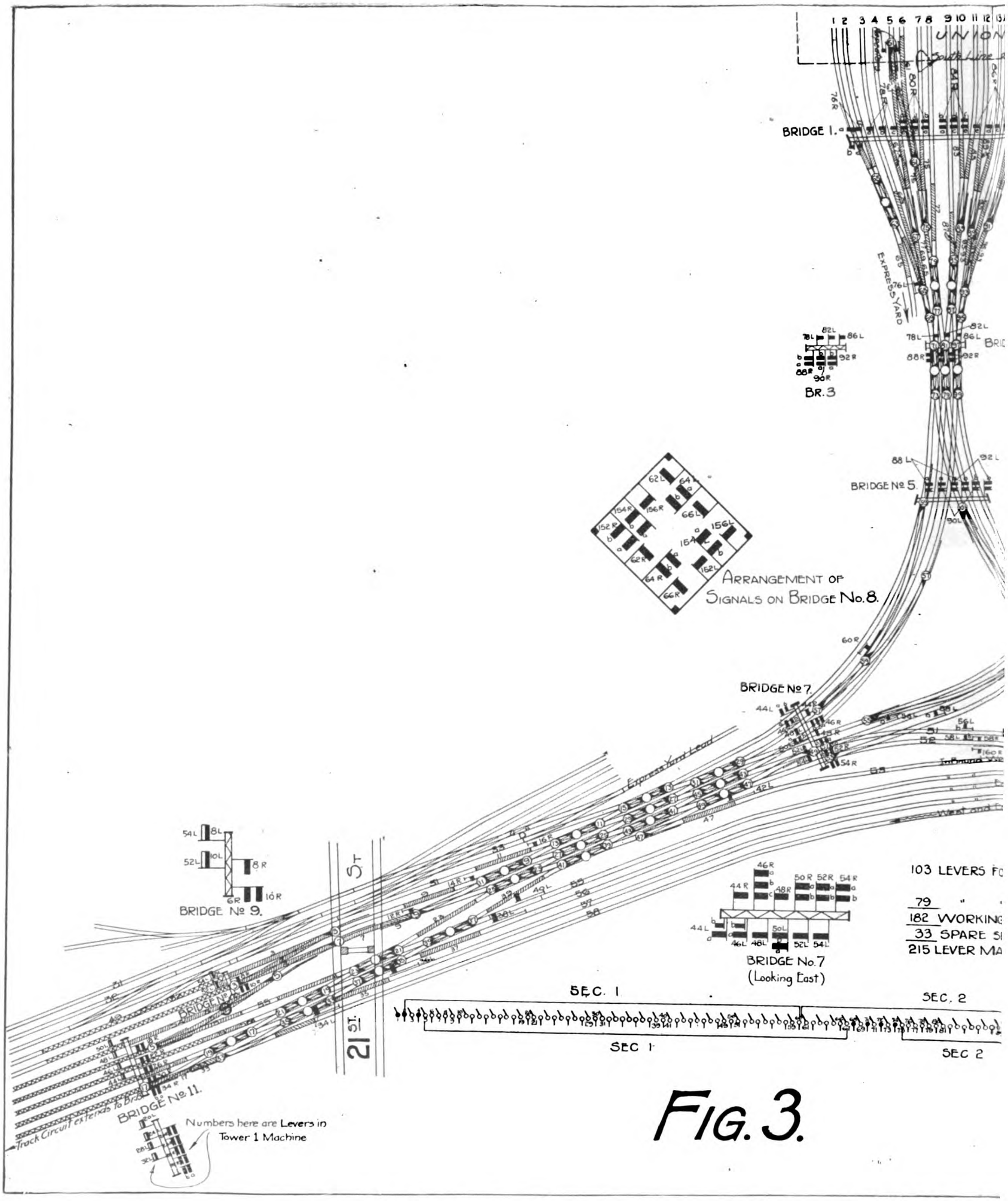
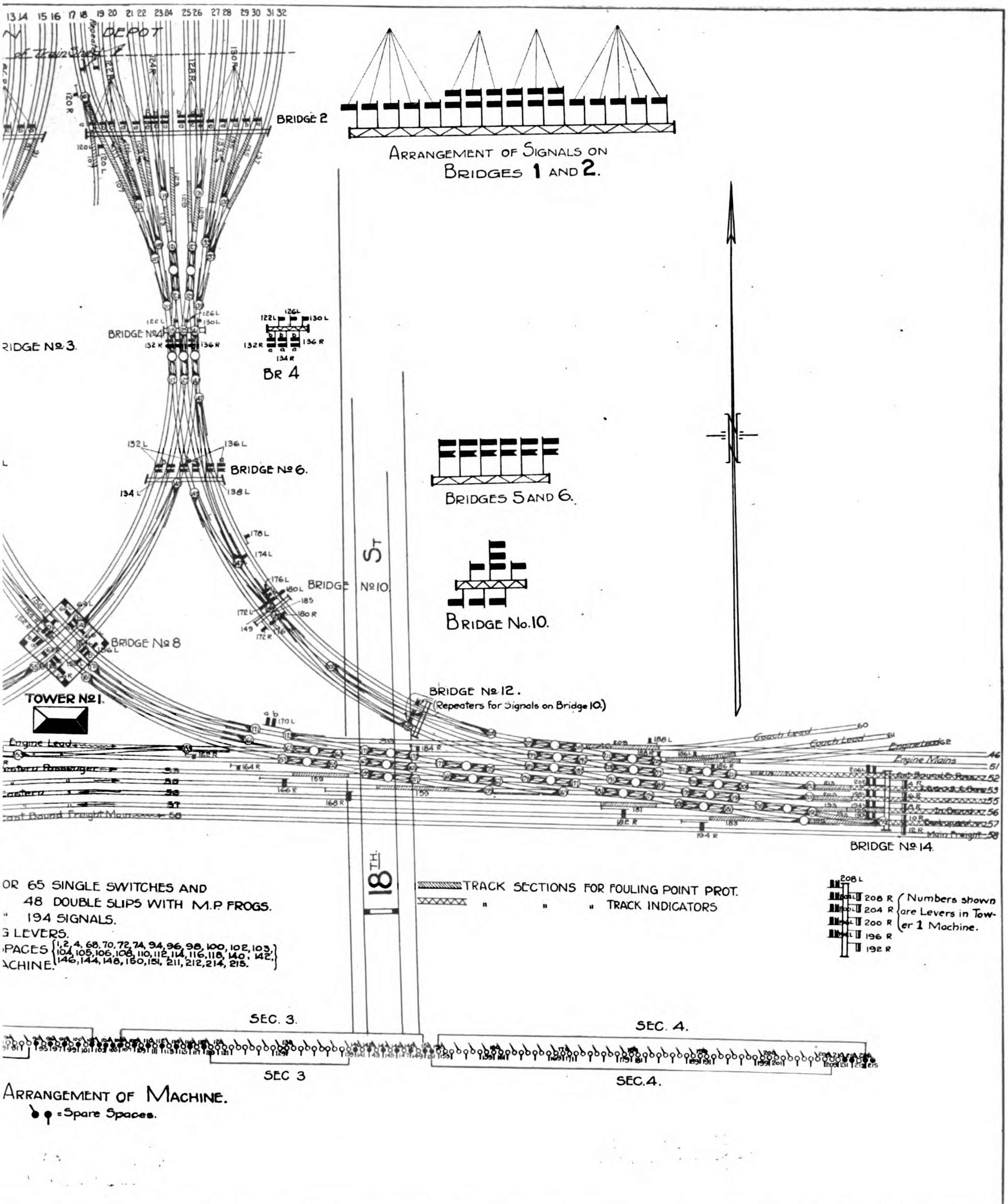


FIG. 3.

SUPPLEMENT TO THE SIGNAL



ENGINEER OF JANUARY, 1909.