New Interlocking Plant in Milwaukee

Complete Electric Installation Near Allis Station Protects Crossing of C. & N. W. and C., M. & St. P.

By R. M. Phinney,
Asst. Eng., Signal Dept., C. & N. W.

JUST south of the Allis stations in the city of Milwaukee, the Chicago & North Western line from Madison crosses the main tracks of the Chicago, Milwaukee & St. Paul from Chicago, and joins the main tracks of the C. & N. W. from Chicago. This crossing and junction was formerly protected by two mechanical interlocking plants, one operated by each road and mechanically interlocked together. Following the recent elevation of the tracks in this territory extensive track changes were made which necessitated a new and up-to-date plant.

As will be seen from the track diagram, the C. M. & St. P. has four main tracks, two used for passenger service and two for freight. There is a set of cross-overs in each direction. The C. & N. W. has two two-track lines joining just south of the station. In addition, there are three C. & N. W. yards which have connections into the plant and several industrial tracks connect into the plant on both roads.

On account of the desirability of allowing a Northwestern passenger train bound for Madison to stop at the station while a northbound train from Chicago or a St. Paul train is crossing the plant, signals 125-124 were located over the center of the slip switch, this being the first practical place north of the junction switch 106. The automatic control of these signals begins in the Q section. The routes leading up to these signals are locked mechanically by them and the slip switch cannot be moved while a train is standing ahead of the signals. Signal 123 governs over both tracks leading away from the slip switch, but the track to be used must be determined before passing the last signal.

On account of the track on which signals 64, 85, 110 and 122 are located being practically a yard track, there is no locking between these signals and they are left clear a good part of the time and only changed when it is desired to change a route. It will be noticed from one of the illustrations that at the time the picture was taken the tracks had not been brought up to final grade, which accounts for the down sets necessary in the trunking.

The Tower

The tower, as shown in the illustrations, is of brick with concrete basement, floors and roof. The foundation rests on piles, as the original ground is marshy and has very little supporting power. There is a bay window on the operating floor on the side overlooking the C. & N. W. tracks to provide space for the leverman's table, as well as to improve the view. The building is 36 ft. by 20 ft., outside dimensions, allowing ample working space on all sides of the interlocking machine. A spiral stairway, enclosed below the top floor, provides access to the different floors. The first floor is occupied by the battery room, toilet room and power room, in which is also located the relay rack. The steam heating plant is located in the basement, together with concrete coal and ash storage bins. The power service and terminal boards for the field wires are also located in the basement. The operating room is illuminated with six indirect fixtures. No special lamps are required to illuminate any of the apparatus, sufficient illumination being obtained from the 25-watt lamps in the indirect fixtures.

A one-story building, 15 ft. by 30 ft., is located just north of the tower, which is used for a shop and material storage, there being a tile partition dividing the building. Double doors are provided at each end. Instead of supporting this bulding on piles, the foundation was made in the form of a concrete slab, which acts as a float.

Interlocking Machine

The interlocking machine is of the G. R. S. model 2, unit type, with 128 spaces and 100 working levers distributed as follows: 42 for signals, 40 for switches, 18 for derails. It will be noticed that each unit has a separate lever. The fuses and polarized relays are located on top within easy access of the leverman. Vertical rollers connected to the levers carry contacts necessary for the various auxiliary circuits required in a plant of this size. The so-called slot indicators, which show the conditions of the automatic blocks leaving the plant, are mounted on the machine in the form of electric lights over the signal levers. These lights give the following information:

No route lined up—no light.
Route lined up and unoccupied—green light.
Route lined up and occupied—red light.

In practice, the leverman will pull the high signal lever if the light is green and the "call on" signal lever if the light is red. The levers for the low speed signals on the C. & N. W. are equipped with time locks, which prevent the levers being put full normal until after the predetermined time has elapsed. With one exception, these locks are set to 25 seconds. The purpose is to allow time for a train to shunt the track circuit after having received a clear signal before the leverman can move a derail or switch. The time of the lock on lever 123 is 45 seconds on account of the longer distance a train must travel to reach track circuit Q. The interlocking machine case, together with the woodwork on all apparatus in the tower, is finished in mission.

Track Diagram and Manipulation Chart

An illuminated track diagram is mounted on the wall back of the machine. This diagram consists of a black line Van Dyke print pasted to a transite board, which forms the cover of a metal box. Opalescent caps are secured to this board with lamps mounted behind in brass boxes. At least two lamps are provided for each track circuit so that the failure of one lamp does not interfere with furnishing information. These lamps are operated from the track relays and are lighted when the track sections are unoccupied.

For each of the main tracks approaching the plant, a lamp with a red cap is used which acts as an annunciator and is normally dark, lighting upon the approach of a train. At the same time a bell, located just below the diagram, rings—there being one bell for all C. & N. W. annunciators and one for those on the C. M. & St. P. The lamps used on the diagram, as well as on the levers, are 8-volt Mazda in candelabra bases. Manipulation charts printed to match the diagram are mounted on each side of the diagram.

Auxiliary Apparatus

The remaining bells shown in the illustration are for communicating purposes, there being push buttons for these bells in the adjacent towers. There is a corresponding circuit outward from the plant, the push but-

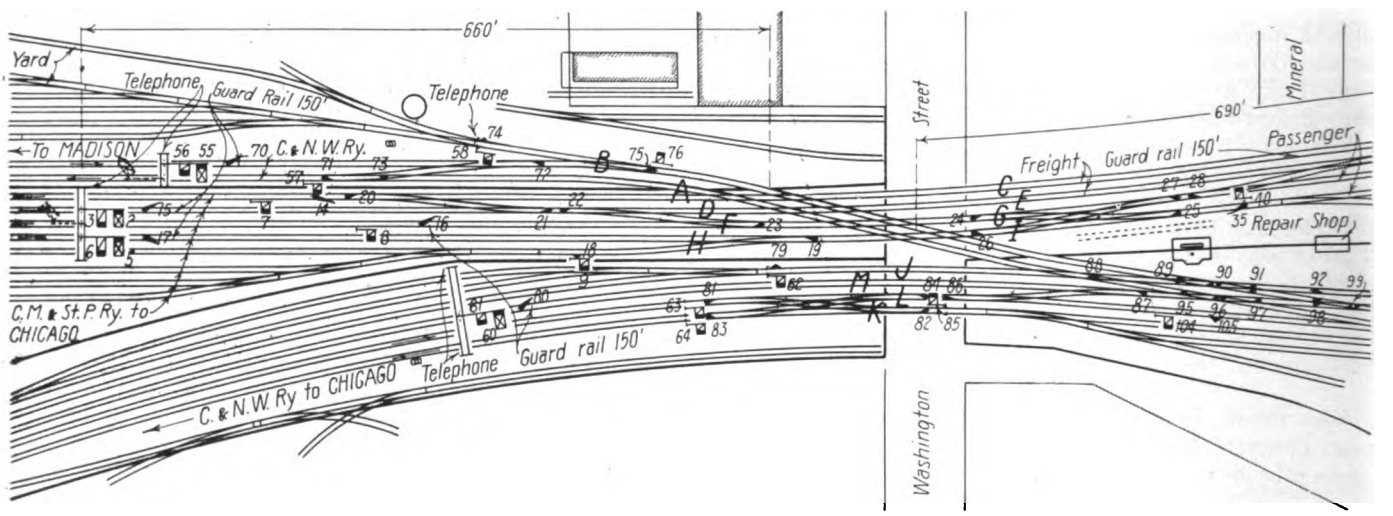
tons being located on the leverman's table, with bells in the adjacent towers. On account of the large amount of current required for these bells, they are operated through a small telephone line relay. Each bell has a distinct tone.

The time releases and emergency switches are located just below the bells. The releases are of the U. S. & S. clockwork design. The emergency switches are of a special design supplying eight contacts and located in glass front compartments. Each compartment is arranged for individual sealing. These switches are made of the sliding button type, each contact being adjustable to any position. The cover can only be closed and sealed when the switch is normal. The use of the releases and emergency switches will be explained later in the description of the electric locking.

The meter is mounted over the track diagram. In this position it can readily be seen from any part of the machine.

Operating Switchboard

The operating switchboard, on account of not having any meters which must be seen from the machine, is set in a convenient but out of the way place. On it are located the switches controlling the signal lights, including an emergency switch. Five cross protection circuit breakers are used. One is for switches, derails and dwarf signals on the C. M. & St. P. tracks and the C. & N. W. Madison division, and one for remaining switches, derails and dwarf signals. The other three are for the high-speed signals, so divided that not more than two signals can be cleared through a circuit breaker at one time. It has been determined that two signals are the maximum



Track and Signal Layout South of the Tower

which can safely be held clear with the circuit breaker open. If provision were made for more the resistance used would allow enough current to flow to clear one signal. A resistance of 300 ohms is used around the break on those circuit breakers for high speed signals, whereas no resistance is provided for those circuit breakers used for switches, derails and dwarf signals. Of course, if a circuit breaker should open, any dwarf signals which are clear would go to stop.

Telephones

On account of the number of telephone circuits entering the tower, the circuits were consolidated into one telephone instrument by the use of jacks and drops. Provision was made for 12 lines, of which 8 are at present in use. There is an independent line to each of the adjacent towers and several so-called yard lines. In addition, telephones are located on the signal bridges and other convenient places for the use of trainmen and maintainer. On the yard lines, which have a number of phones connected, the "drops" ring the local buzzer only when energized. On those lines on which there is only one other phone, the "drops" ring the local buzzer until restored. The C. M. & St. P. dispatcher's telephone is also in the tower, but not connected in any way with the other phones.

The problem of calling the maintainer was solved by locating 10-in. double Schwarze magneto bells on the various signal bridges. These bells are operated by the generator used for the telephone and connected to one of the jacks in the jack box. The telephone jacks and drops are located on the leverman's table in the bay window.

Power

Storage battery of the chloride accumulator type was furnished as follows:

1 set, 57 cells, for operation of switches and signals.

2 sets, 2 cells each, for operation of auxiliary apparatus.

2 sets, 2 cells each, for operation of C. & N. W. automatic signal circuits.

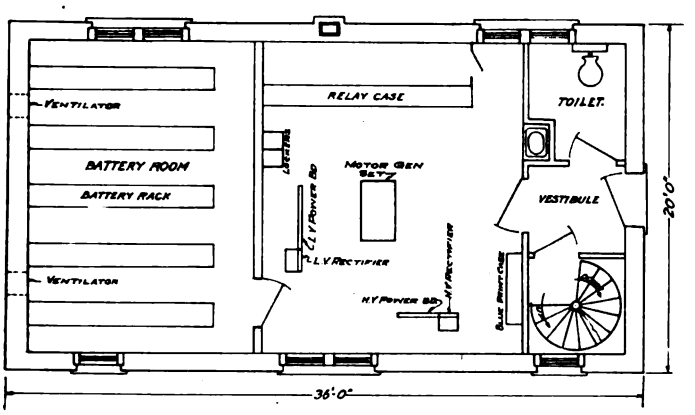
2 sets, 5 cells each, for operation of C. M. & St. P. automatic signal circuits.

2 sets, 10 cells each, for operation of track circuits and low-voltage signals.

The batteries for operation of switches and signals and track circuit purposes have a capacity of 320 ampere hours and the rest a capacity of 120 ampere hours. No primary battery of any kind is used in the vicinity of the plant. The batteries are mounted on oak racks painted with acid-proof paint, with access on both sides. The battery room has four wooden louvres with inside wooden shutters for ventilation in addition to the windows. The low-voltage sets are provided in duplicate so that one set may be charged while the other is serving, as the sets are charged in series, provision being made to charge in any combination of sets from one up.

Power is purchased from the Milwaukee Electric Railway & Light Company at 220 volts, three-phase. The 110-volt battery is normally charged by a mercury arc rectifier with a range of 75 to 175 volts at 50 amperes, which is connected to one phase of the service through a one to one transformer in order to prevent the ground which the service company put on its secondary from affecting the plant when battery is being charged. The battery may also be charged from a three-phase, a.c.

motor generator, generating 110 to 180 volts d.c. at 40 amperes. This motor generator will be used as emergency, not only for charging the battery when there is no mercury tube on hand, but for carrying the plant while the battery is being overhauled if at any time this becomes necessary. In charging the various low-voltage batteries, a mercury arc rectifier operating on 110 volts a.c. single-phase, and delivering 10 to 75 volts d.c. at 50 amperes, is used. This receives power from a second



Main Floor Plan of the Allis Tower

phase of the service through a two to one transformer, which gives the necessary insulation. In case of emergency, the motor generator set may be used for charging the low-voltage sets by connecting the two switchboards with temporary wires. No permanent provision was made for this.

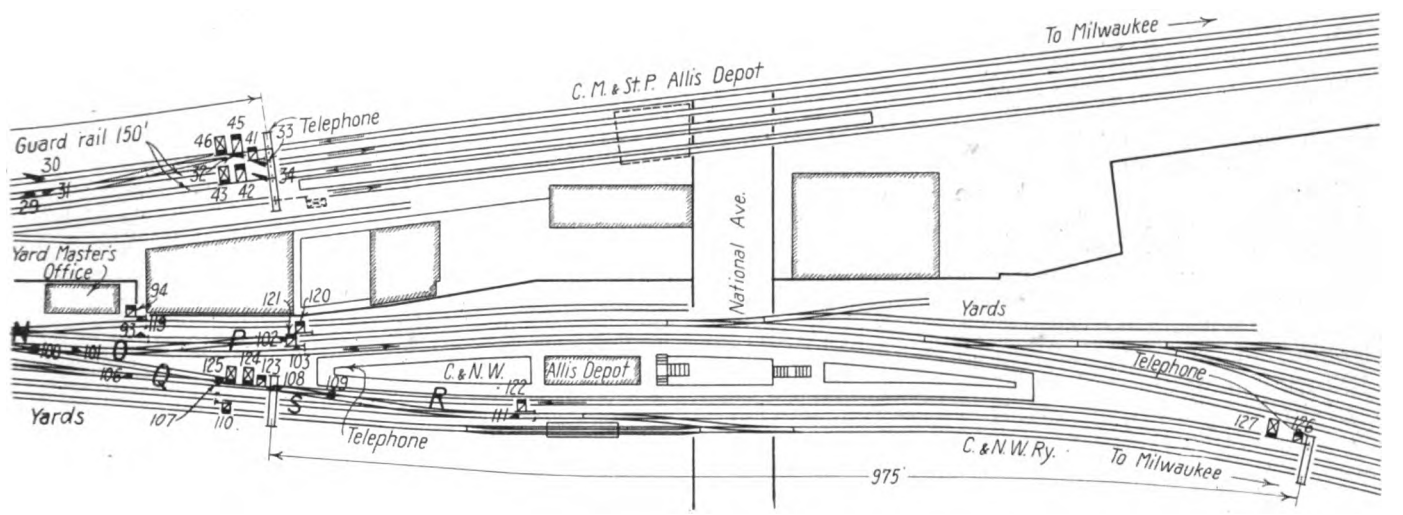
As the regular load is single-phase and the three-phase requirements are exceptional, the power company put in an open delta arrangement with the regular load distributed over the two physical phases. A switch is provided so that the high-voltage rectifier and the motor-generator set cannot be operated at the same time in order to keep the maximum demand rate as low as possible. Provision is made on the voltmeter switch for reading voltage to ground from both positive and negative sides of all circuits.

Relays

All track relays whose connection to the rails are within 500 ft. of the tower are located on the relay rack on the first floor of the tower, together with all other relays in the tower. All relays are of the indicator type to assist the maintainer in quickly locating trouble. The grouping of the relays is as follows: The track relays and repeaters of those track relays which are not in the tower are located in the fourth row from the bottom. The row below contains repeaters of these relays where required. The second row from the bottom contains the stick relays, each of which is directly below the track relays with which it is associated. The bottom row contais tnhe locking relays of model 1 type and they are also directly below the track relays with which they belong. The two top rows contain the relays which are associated with the high signals arranged above the track relays with which they belong, the top row containing the annunciator and 90-deg. control relays and the second row the 45-deg. control and stick relays. Each door of the case is individually sealed so as to allow access to the least number of relays with the breaking of a seal. The wiring is done on the back of the case, the wires being carried in insulated bridle rings familiar in telephone construction work. A ladder is provided for easy access to any relay.

Track Circuits

The track circuits are fed from a 20-volt battery through two loops, each of which is provided with a rheostat for varying the current to the loops in accordance with weather conditions. The loops run in dry weather on about 12 volts at the switchboard. The loop wires form a duplicate source of power to any track circuit. The track circuits are fed from these loops through resistance units on each side through duplicate wires. The relays in the short sections are 16.5 ohms, while those on the longer sections outside the



Track and Signal Layout North of the Tower

home signal limits are 4 ohms. A complete description of the method to be used in working out this arrangement is given in the General Railway Signal Company's bulletin No. 127, which gives a description of a similar installation in the five plants on the Chicago terminal of the C. & N. W., the only modification being the changing of relay resistance on account of redesign by the manufacturers and the addition of a low reading voltmeter which is connected to a pilot relay on each loop. With this voltmeter the loop voltage is adjusted to the voltage required on the relay. A novel feature of the track circuits is that they are practically continuous over the crossings for both roads. This was made possible by the construction of the crossings and the flat angle at which the roads cross.

Automatic Signals

The automatic signals located on the signal bridges are operated from the same battery which operates the track

circuits, the wire to these signals being figured to have about 10 volts drop when operating, a resistance being put in series with the hold-clear coils to cut down the current while clear.

Wires and Wiring

Okonite wire was used throughout. Outside the tower is an underground conduit system consisting of 3-inch fiber conduit imbedded in concrete. The number of ducts varies with the requirements, one spare duct being added for interlocking purposes and one duct for telegraph and telephone service. Manholes are located at convenient distributing points from which the wires are carried in cedar trunking filled with R. S. A. petroleum asphaltum. The manholes are oval in shape, 4 ft. by 6 ft., with bottom of concrete and sides of brick. No trunking larger than 4 in. by 4 in. was used. The wires pass from the manholes to trunking via 2-inch metal conduit elbows with special adjustable connection between trunking and conduit plainly seen in one of the illustrations. In the tower, all wires are carried in metal conduit. No. 16 flexible wire with a single braid was used in all tower conduit and connections to relays wherever conductivity would permit. Other than this, no wire smaller than No. 14 was used. The No. 16 wire has 2-64 in. wall of insulation and all other sizes have 3-64 in. wall. The wires in the underground cables have no braid, and no jute was used, as is customary, for filing, as considerable difficulty has been experienced in the past with the moisture which the jute absorbs by causing swelling of the jute and injury to the insulation. Each cable was ordered of a size and length to fit the conduit it was to go in, the maximum cable being 2½ in. diameter.

The cables were spliced with lead sleeves and local wires brought out through bells filled with paraffin and turned down to minimize the possibility of moisture entering the cables. Single braid wire was used in bringing the wires out of the bells, as it has been found by experience that wires exposed to mechanical injury must have mechanical protection for the insulation. The cable ends were treated in the same way as the intermediate cable bells. Low-voltage wires were carried in sparate trunking and tower conduit from the 110-volt wires with the exception of the battery feed wires for track circuits, which were considered high voltage wires. The wiring in the tower connects with the lead-covered cables at two terminal boards located in the basement directly opposite the two conduit entrances. A view of one of these boards can be seen in one of the illustrations showing R. S. A. terminals mounted on vertical boards with ample distance between boards for convenient handling of the wires. The whole is enclosed in an oak case. All wires used for power purposes up to the distributing wires leaving the switchboards have double braid and each braid is installed in a separate conduit to comply with the underwriters' rules.

Lighting

All lights are normally supplied with alternating current. The signal lights may be connected by the leverman to the 110-volt storage battery by the switch on the operating board, previously mentioned. The tower and shop lights can be connected to the storage battery by a switch on the power board. This switch is also used when the maintainer needs direct current in the shop for operating a motor connected to his drill press. The lights on the track diagram have an emergency switch on the power board which connects the lights to the 10-volt storage battery with a suitable resistance in series.

Switches and Signals

All single switches and derails are operated by model 2 switch machines, while the slip switches and movable point frogs are operated by model 4 switch machines. No detector bars were installed. All home signals were mounted on signal bridges and are operated by model 2A signal mechanisms. Each arm not readily reached from the bridge deck has an extension platform which is regular equipment on all C. & N. W. signals, allowing easy access to the special lamps used on the C. & N. W. as well as furnishing room for two men to work conveniently and safely. Model 2 solenoid dwarf signals are used on the ground. The home signals of the adjacent interlocking plants are used as the approach signals for this plant. There being no plant on the C. M. & St. P. on the north, low-voltage signals are used. Battery indication is used for all approach signals which have separate levers and the indication is received on the regular indication magnets, low-resistance coils being used operating from primary battery located near the signals.

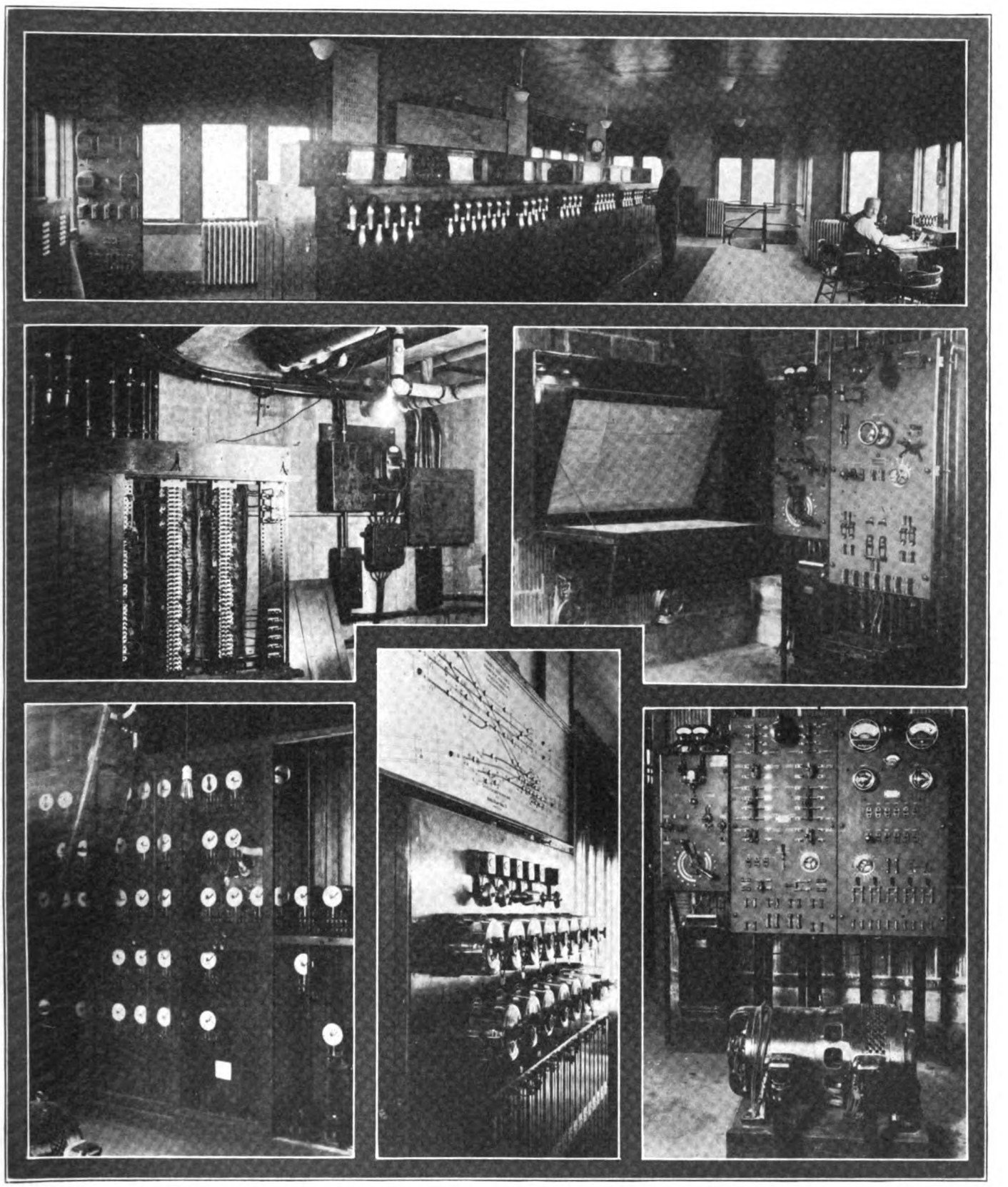
Electric Locking

Complete electric locking is provided. The electric and mechanical locking were designed so that each supplements the other and the required results were accomplished in the simplest manner. On the C. M. & St. P. release locking is in effect. Each route is electrically locked when a signal governing over it is cleared, with the exception of those signals governing from a main track in the direction of traffic which require the presence of a train in the annunciated circuit to lock the route with the signal clear. Each derail and trailing switch is unlocked when the train leaves the track section in which the unit is located. Facing switches are released by throwing the next trailing switch when it is released. The mechanical locking to effect this is as follows: The proper selection being assumed, each derail lever locks the trailing switch levers in the route; each signal lever locks the derail levers in the route; each high signal lever in addition locks sufficient switch levers to insure the proper route.

The electrical locking is effected as follows: The positive bus bars supplying current to the switch and derail fuses are subdivided and current to these subdivisions is controlled by magnetic blowout relays of the model 1 type, called the locking relays, which in turn are controlled by track relays connected to the track section in which the units are located. In this manner "section" or "detector" locking is accomplished. The advance and route locking is accomplished by the addition of a normally energized stick relay for each track section which controls the locking relays. These stick relays are dropped by the reversing of the signal levers governing over them with the exception of those signals governing from a main track in the direction of traffic which in addition require the presence of a train in the annunciator circuit. These stick relays are again energized by the dropping of the track relays. It will be noted that in addition to the regular function of the stick relays, they prevent the moving of a derail or switch if the track circuit should fail to shunt properly. In order to restore the stick relays to the normal position, in case it is desired to change the route without having been used, a clockwork time release, adjusted for one minute operation, was provided for each stick relay. The releases are normally unwound and the locking relays and high signals are controlled through normal contacts.

To provide against delays due to track circuit failures, emergency switches were provided which cut out the ef-

fect of the track relays on the locking relays. To insure that these switches are placed normal after each use, the control of all signals high and dwarf were carried through normal contacts. To accomplish this the special switches previously mentioned were designed. It was desired to require two minutes to release a route of a high-speed signal in case the route was not used and to accomplish this an additional stick relay and time release was installed for each high-speed signal. These relays are normally energized, dropping on the approach of a



Interior of the Second Floor of the Tower

One of the Terminal Boards in the Basement of the Tower

Rectifier and Motor Generator Panel and Plan Rack

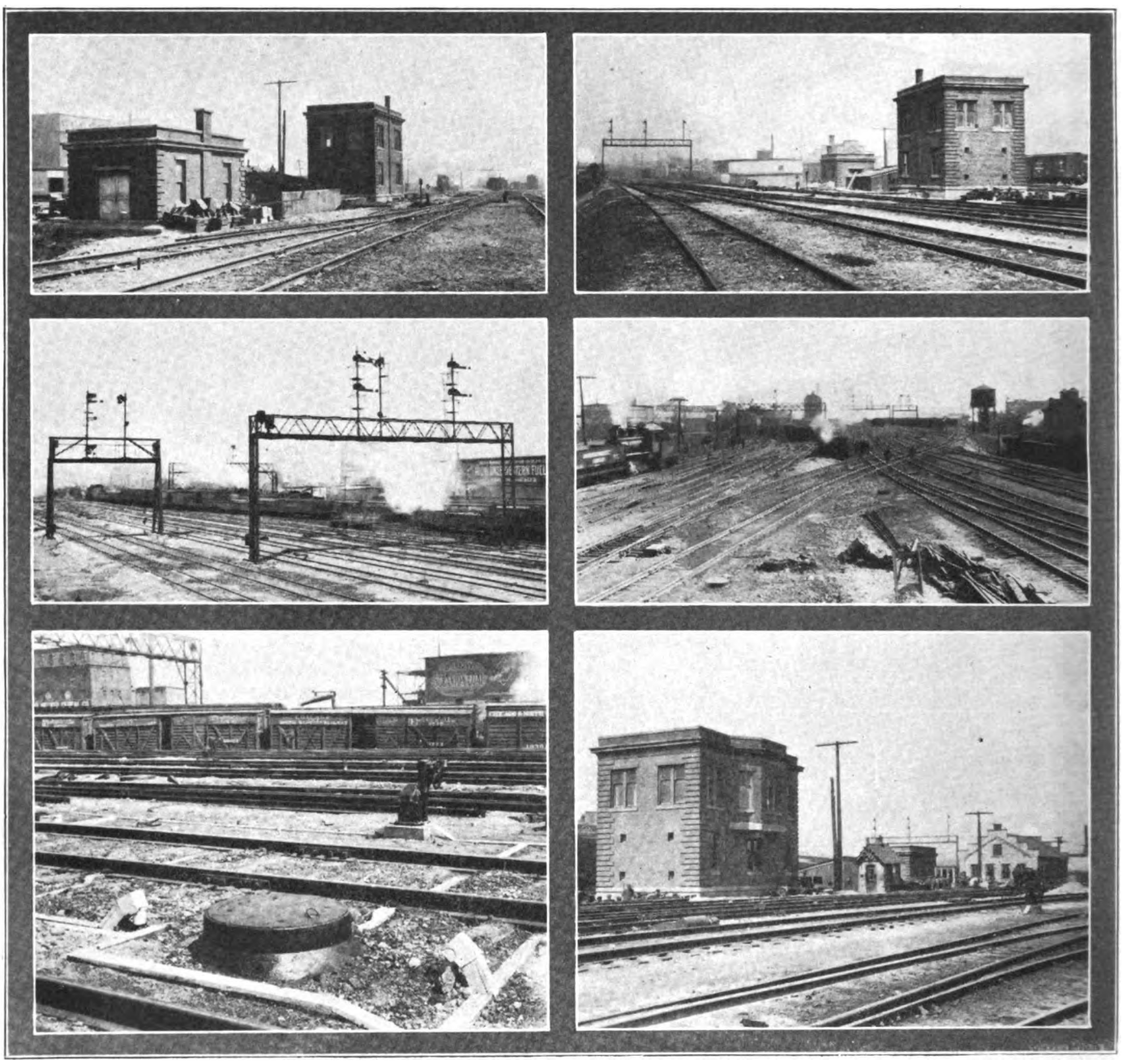
Portion of the Relay Rack on the Main Floor of the Tower

Time Releases, Emergency Switches and Bells

Motor Generator Set, Rectifier Set, Charging and Track Circuit Feed Switchboards

train with the signal lever reversed and are restored to the normal position after the signal lever has been placed normal with the train in the first track section of the route. The locking relays in the route are controlled through the relays and release, the release when reversed picking up the stick relay in the same manner as for the low speed routes.

On the C. & N. W. the electric locking with but one exception is so arranged that a route is kept locked until a train has passed a signal governing in the opposite direction. High-speed routes are locked up on the reversing of the signal lever, whereas low-speed routes are not locked until the first track relay is shunted. The time locks previously mentioned bridge the gap between the time that a low-speed signal is accepted and the time when the track relay is shunted. The electric circuits were simplified somewhat by having the derails at one end of the plant mechanically lock the routes, including the opposing derail as far as was practical. "Section" or "detector" locking was accomplished with locking relays as on the C. M. & St. P. In addition, the locking relay circuits were selected as required to keep the routes locked up. The emergency switches are used in the same way. The advance locking is accomplished without the use of stick relays. The high-speed signals indicate through a back point of the track relays in the route, consequently if the track relays do not drop, the high signal lever cannot be put normal. Time releases set at two minutes are provided to release these signals if required. These releases are normally wound up and held with a retaining pawl. The locking relay and signal circuits are controlled through normal contacts. In order to release the C. M. & St. P. tracks as soon as protection could be obtained, a special release was provided for trains from the line to Madison so that when they pass out of track circuit N, switch 91 and movable point



The Shop and Tower from the C. M. & St. P. Tracks
The Three Northbound Home Signal Bridges
Trunking Runs, Special Caps, and a Dwarf Signal

The Tower and Bridge on C. M. & St. P. Tracks
Looking South from the Tower
Near View of the Tower from the North Western Tracks

frog 90 may be put normal and the routes on the C. M. & St. P. released at once. On this account it was necessary to provide a stick relay to give proper route locking for routes over 91 reversed in the opposite direction. This stick relay is dropped by reversing any signal lever governing over 91 reversed when 91 is reversed and is picked up again when train enters the N track section. A time release is provided to restore this relay if the route is not used after having been given. This stick relay controls the proper locking relays to lock the routes up to the N section.

Plans

As is customary at C. & N. W. plants, a complete set of plans is kept in the tower in a glass frame. On account of the number of plans at this plant the prints were put back to back with glass on both sides, the frames being hinged at the bottom and enclosed in a case. It can be seen from the illustration that the frame when open forms a convenient desk.

The interlocking plant was completed and placed in service on April 1, 1917. The installation was made by the General Railway Signal Company under the direction of A. N. Gregory. The foundations for the tower and shop were built by the track elevation department of the railway. The remainder of the tower and shop was built by the Gindele Company, a local contracting firm. The conduit system was built by the track elevation departments of the two roads, each road building that on its own right of way. The lead-covered cables were installed by the signal department of the C. & N. W.

LABOR SAVING DEVICES FOR THE CONSTRUCTION GANG

By A. Gemmell
New York, New Haven & Hartford

MANY signal construction gangs are handicapped by a lack of proper equipment or of men, and it is frequently necessary to devise new methods of handling details of installing switch and signal apparatus to offset these handicaps. The following suggestions taken from experience may be of benefit to men engaged in this class of work:

Fig. 1 shows a folding cement mixing board. The hinges are set in the face of the board, level with the surface, but if the cleats are placed nearer together, the hinges can be attached to them if preferred. This board can be easily handled and takes up little room.

Trouble is often experienced in finding a place to support reels of wire so they will stand steadily. A folding horse of the type shown in Fig. 2 will be found to meet this difficulty very satisfactorily. The wooden frames are held in place by metal strips attached to both ends, and to fold up the horse it is only necessary to remove the center bolts which connect the two metal strips.

When battery chutes have to be moved, they are difficult things to handle, especially the double ones. Fig. 3 shows a handy rigging for lifting the chutes out of their holes. With this method it is unnecessary to remove all of the dirt from around the chute. As soon as it can be moved from side to side easily a chain or rope is thrown around it and passed through the eye bolts in the lifting frame, by which two men can pull it out. The use of this rigging eliminates about half the time necessary for taking out battery chutes. The lifting frame can also be used for a skid in loading the chutes on hand or push cars.

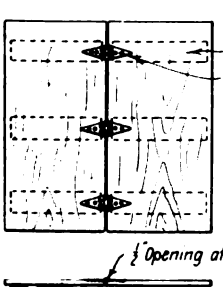


Fig. 1 Folding Cement Board

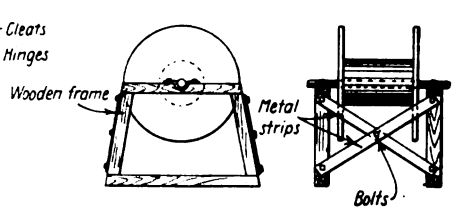


Fig. 2. Folding Horse for Wire Reels

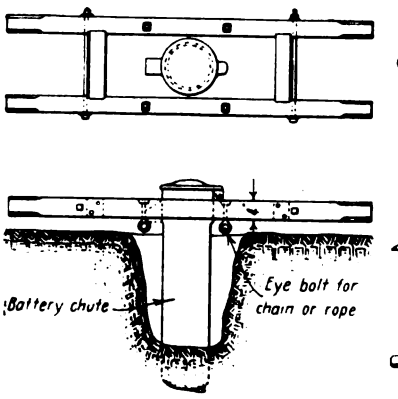


Fig. 3. Method of Lifting Battery Chutes

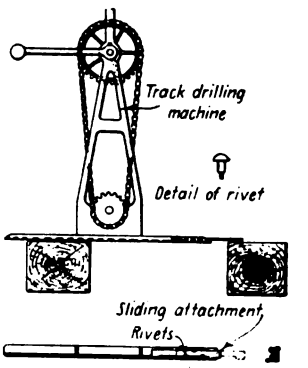


Fig. 4. Attachment for Track Drill

Fig. 4 illustrates an attachment to be put on each end of a track drill in order to extend the wings when necessary. Long pieces of wood are occasionally fastened to the bottom of the wings, but this makes the machine too clumsy. The sliding pieces shown in the drawing should be made to extend out about 3 or 3½ in., and if they are made ¼ in. thick they will answer the purpose very well.

A handy frame for carrying small heavy articles, such as transformers and motors, is shown in Fig. 5. It is frequently necessary to carry such articles a considerable distance, and it is not uncommon to see a rope or wire thrown around them and a bar put through it to distribute the weight between two men. This is an unhandy method and may result in dropping the load with resulting damage. The carrier shown has two cleats on the bottom in order to allow plenty of room for the hands when lifting up or setting it down. The handles can be made of 2 in. by 2 in. material, and the cross-boards of ⅞-in. capping. No dimensions are given in the sketch as they can readily be varied to suit the requirements.

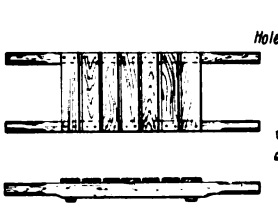


Fig. 5. A Handy Carrier

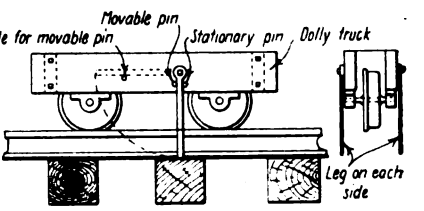


Fig. 6. Legs for a Dolly Truck

Difficulty is often experienced when loading material on a dolly truck to keep the truck level, particularly if only two men are available. The leg attachment illustrated in Fig. 6 will eliminate this difficulty very easily. The legs can be held out of the way on pins in the side of the truck when not in use, and can be put down in place when needed. There being one leg on each side, they will hold the truck in position, allowing the men to devote all their attention to handling the load. The holes in which the movable pins rest should be bored on