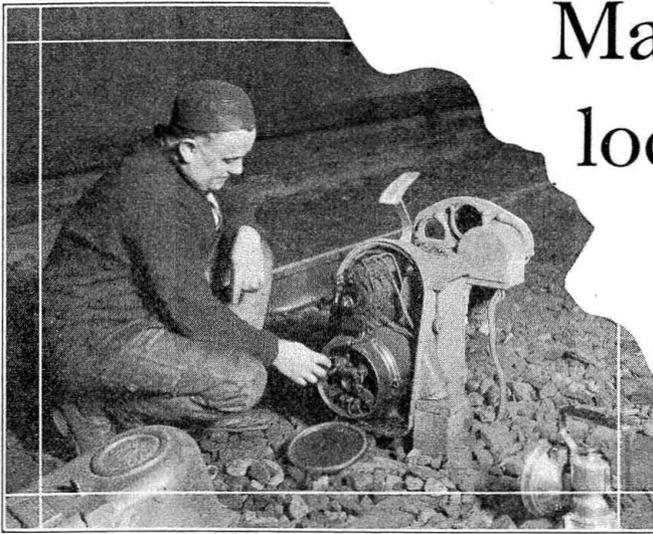


Maintenance of Interlockings in the Grand Central Terminal



Signals are inspected on the second track

THE maintenance of the five electric interlocking plants at the Grand Central Terminal, New York, totaling 2,022 operating units or levers, requires a force of 18 maintainers, 15 assistants, helpers, oilers, etc., in addition to a foreman, two assistant supervisors and one signal supervisor. All work on the entire terminal has to be done under artificial light as the terminal has been completely covered over with streets, avenues, large hotels, apartment houses and office buildings. Electric propulsion is used for all train movements.

Heavy Traffic Permits No Delays on Account of Defective Maintenance

The present train schedule includes the movement of 719 trains on week-days and 414 on Sundays. During the past year this number has been greatly increased due to many of the trains being run in two

Extensive layout, all underground, involves special problems to eliminate delay on account of heavy traffic

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or more sections to take care of the heavy travel; some trains having as high as 18 sections on special occasions. Of the 719 week-day trains, 390 are scheduled to the upper level and 329 to the lower level, the upper level handling all through passenger, mail and express service, while the lower level handles all suburban and local service. All through trains are sent to Mott Haven Yard, five miles away, for cleaning and inspection, and the suburban and local trains are held on the lower level for inspection and cleaning.

The Grand Central Terminal covers the area extending from 42nd street on the south to 59th street on the north, Lexington avenue on the east and Madison avenue on the west and consists of two track levels. The upper level consists of 42 tracks, 27 of which are station platform tracks, the balance being used for mail, express and storage purposes. The



lower level consists of 25 tracks, 17 of which are used for station platform tracks and the balance for storage purposes. A large number of storage tracks also are located on both levels other than those mentioned above. Loop tracks on both levels connect the east and west sides of the yards at the extreme south end under the main station building. Five all-electric interlocking machines, with a total of 2,022 operating units, are used for the operation of switches and signals.

General Layout of Each Plant

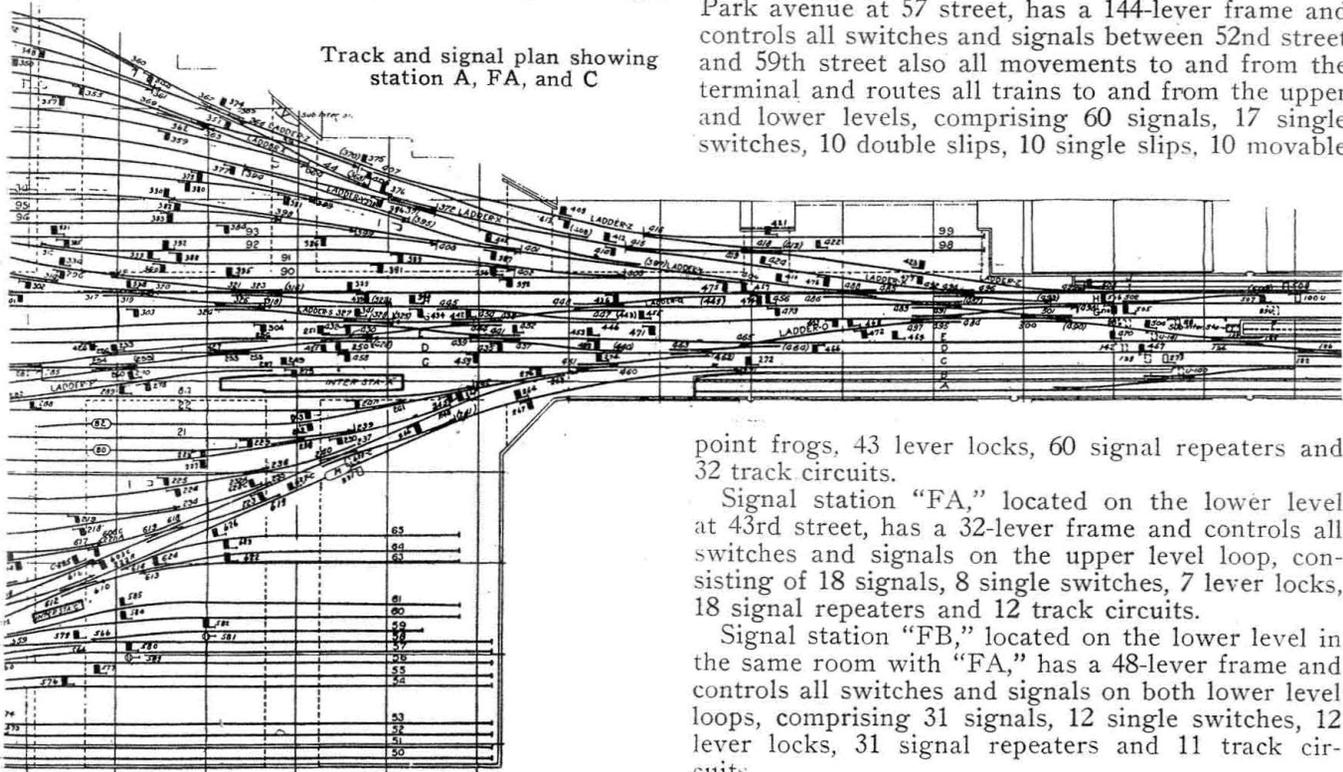
Signal station "A," located on the upper level under 49th street and Park avenue, has a 360-lever



Switch machines are inspected on the first trick

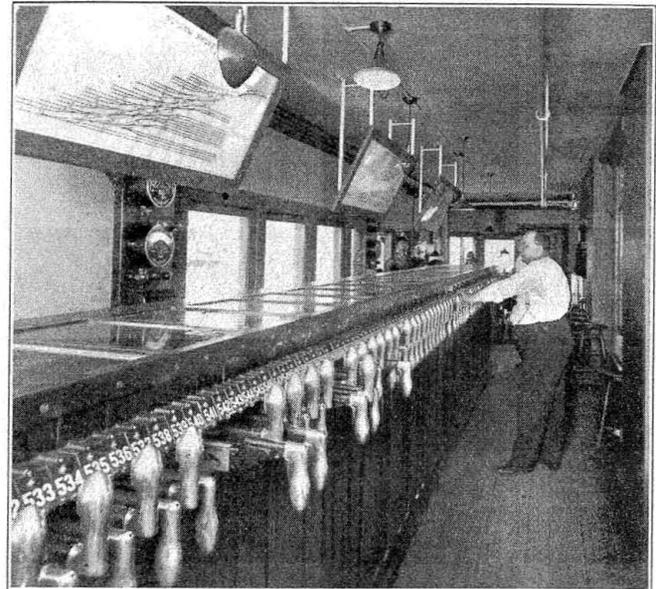
frame machine and operated all switches and signals on the upper level south of 52nd street to the loop tracks north and south, and tracks 16 to 42 east and west, which includes 142 signals, 54 signal switches, 46 double slips, 2 single slips, 20 movable point frogs,

Track and signal plan showing station A, FA, and C



93 lever locks, 142 signal repeaters and 126 track circuits.

Signal station "B," located on the lower level under 49th street and Park avenue, has a 400-lever



Interior of signal station C, 162-lever machine

frame machine and operates all signals and switches on the lower level except around the loop tracks, comprising 188 signals, 60 single switches, 52 double slips, 2 single switches, 27 movable point frogs, 122 lever locks, 188 signal repeaters and 143 track circuits.

Signal station "C," located on the upper level, has a 120-lever frame and operates all switches and signals from track 1 to track 15 inclusive, consisting of 58 signals, 25 single switches, 10 double slips, 37 lever locks, 58 signal repeaters and 25 track circuits.

Signal station "U," located under the east side of Park avenue at 57 street, has a 144-lever frame and controls all switches and signals between 52nd street and 59th street also all movements to and from the terminal and routes all trains to and from the upper and lower levels, comprising 60 signals, 17 single switches, 10 double slips, 10 single slips, 10 movable

point frogs, 43 lever locks, 60 signal repeaters and 32 track circuits.

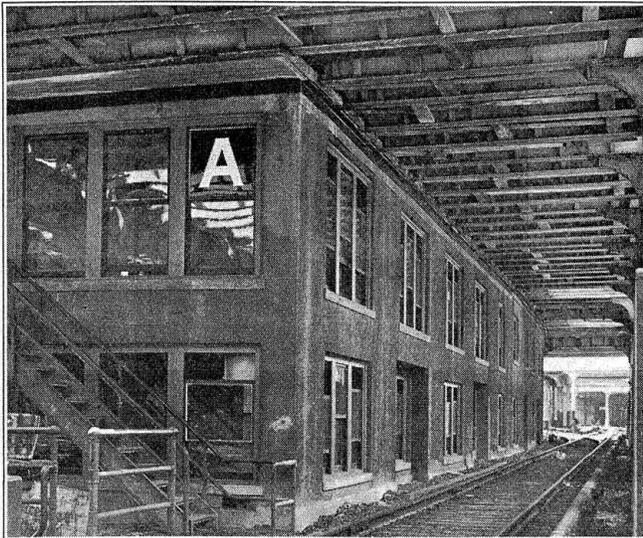
Signal station "FA," located on the lower level at 43rd street, has a 32-lever frame and controls all switches and signals on the upper level loop, consisting of 18 signals, 8 single switches, 7 lever locks, 18 signal repeaters and 12 track circuits.

Signal station "FB," located on the lower level in the same room with "FA," has a 48-lever frame and controls all switches and signals on both lower level loops, comprising 31 signals, 12 single switches, 12 lever locks, 31 signal repeaters and 11 track circuits.

All signals are of the dwarf upper-quadrant type and all track circuits of the single rail a-c. type. Both "F" machines are operated by one towerman. The track relays are of the polyphase type and all other relays are of the line type and controlled by 55 volts a-c. The apparatus, except the signals and switch machines, are operated by a-c. stepped down through transformers from 300 volts to 55 volts for locks, lights, line relays and intercommunication system and 5, 6.5, 7 and 10 volts for track circuits and track relays. The signals and switch machines are 110-volt d-c. operated from storage batteries.

Method of Directing Trains

The operation of all trains is handled by a director in each signal station and due to the many obstructions to hinder his view, he is obliged to work altogether from the lights on a model board located on the back of his desk. The model board is de-



All of the interlocking towers are underground

signed to show the location of each switch, signal and track circuit. Each track circuit is colored and equipped with a small light operated by a track relay to show when a track circuit is occupied or empty. No illuminated diagrams are supplied for the levermen, the track circuit indications consisting of small lights in the lever lamp cases, located over the switch levers, furnishing information to them as to the condition of the track.

Signal stations communicate with each other as to the movement of trains by means of a system of push buttons and lights. Loud speaking phones are also used between stations, but only in case of unusual movements or a quick change in the movement of a train.

Maintenance Force and Division of Work

All construction, renewal, and maintenance work is done by company forces consisting of the following:

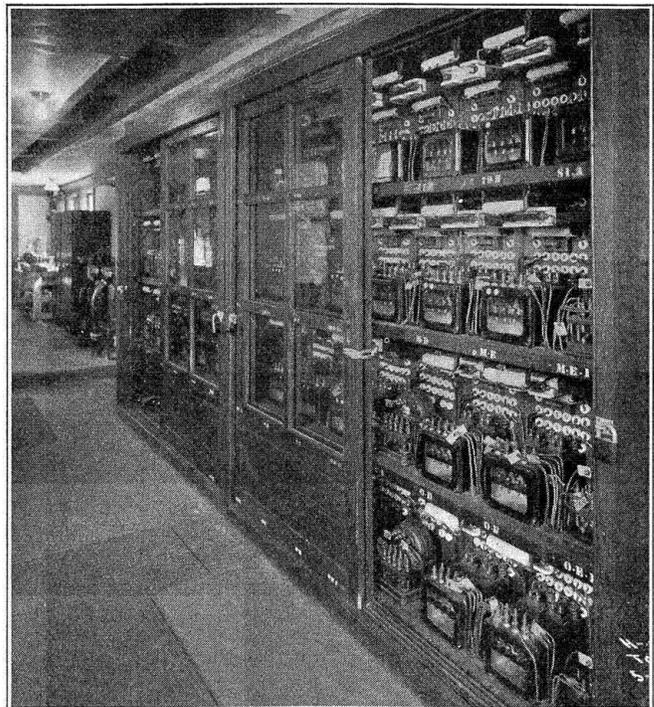
- 1 supervisor of signals.
- 1 day and 1 night assistant supervisor of signals
- 1 signal foreman.
- 18 maintainers.
- 3 assistant maintainers.
- 2 switch oilers.
- 2 signalmen.
- 4 assistant signalmen.
- 4 helpers.

All of the men work eight hours per day, six days per week. Each station is covered by one maintainer on each of the three tricks with an assistant and oiler on the first trick at "A" and "B" and a third assistant assisting at "C," "F" and "U" on the first trick. Two of the maintainers are used exclusively for relieving the regular men every seventh day and two for relieving men off duty or filling temporary vacancies. No third trick man is furnished at "FA" and "FB" and no men are on duty at "FA," "FB" and "C" on Sundays, these plants being covered by "A" and "B" men on that day.

Each Man Has Certain Work to Do

Each maintainer is held equally responsible for the proper maintenance and upkeep of his plant, and work is performed as follows: The first trick or day man attends to all switch and track work and the proper cleaning of switch machines and adjustment of switches. The second trick or afternoon man does all of the cleaning and oiling of signals, inspecting and testing of relays, etc. The third trick or night man does all of the cleaning, adjusting and renewing on the interlocking machine, and attends to the charging of the storage batteries. On account of the heavy traffic most of the large jobs of renewing timbers, plates and cables are done at night by the construction force, but if not too large are done by maintainers on duty.

All wires and cables are tested periodically by the maintainers for insulation resistance. Each maintainer when coming on duty tests the adjustments of all the switch points and lock rods. The lamps are inspected daily by the assistant maintainers or by maintainers where no assistants are on duty. All of the relays are taken apart, cleaned, oiled, adjusted,



Every relay is taken apart, cleaned, oiled and worn parts replaced every two years

and worn or defective parts renewed every two years. Mechanical locking is inspected, cleaned and oiled by each maintainer and tested by one of the assistant supervisors of signals each month. The relays and lever locks are tested weekly and all other appara-

tus or special circuits are tested monthly by maintainers or assistant supervisors of signals.

All changes in mechanical locking are made exclusively by one man who is assigned to that work and no changes or alterations are made in any of the apparatus or circuits except under the direct supervision of the supervisor of signals or an assistant supervisor.

Power Supply and Storage Battery Equipment

A number of signal sub-stations are located about the yard to support the main signal station. In these sub-stations are located transformers, relays and terminal boards. Large cables are run direct from the signal station to the signal sub-station terminal boards and connections are there made to the switches, signals, and track circuits by the use of three-conductor cables and single wires. The three-conductor cable, which runs to each signal and switch, provides a separate return for each function; single wires being used for all track connections.

The capacity of the 110-volt batteries for the "A" and "B" machines is 340 a.h. For the "C" and "U" interlockings, the capacity is 160 a.h., and for the "F" machine, 80 a.h. The "A" and "B" batteries are located in a sub-station and are charged and maintained by the sub-station forces. The "U" battery is charged by a motor-generator set and maintained by the "U" maintainers. The same is true of the batteries at "C" and "F."

Train Stop on Lehigh Valley

THE Interstate Commerce Commission, Division 1, has issued a report approving with exceptions the installation of the automatic train-stop system of the General Railway Signal Company on the New Jersey & Lehigh and the New York divisions of the Lehigh Valley, from Easton, Pa., to Newark, N. J., 65.6 miles. This includes 0.92 miles of single track, 32.34 miles of double track, 19.94 miles of three tracks and 12.4 miles of four tracks, a total of 175.02 track miles, and there are 150 locomotives equipped.

The exceptions and requirements are as follows:

1. Non-equipped locomotives must not be operated in road service in train-stop territory unless double heading behind a locomotive the train-stop equipment of which is in service.

Locomotives with the device cut out must not be run in road service from terminals in train-stop territory unless double heading behind a locomotive the train-stop equipment of which is in service.

When necessary to operate locomotives through to terminals with the train-stop device cut out account failure enroute, special-protection should be provided.

2. Pusher, and other locomotives operated backward in road service, with the current of traffic must be equipped with the train stop device for such movements.

Maintenance, Tests, Inspection, etc.

The Lehigh Valley is expected to comply with the following requirements as to maintenance, tests, inspection, etc.

1. The report forms for roundhouse inspection and tests appear to be adequate for the purpose intended except that no test for grounds is included. If the inspection and tests called for, including one for grounds, are efficiently made, the irregularities in adjustment or operation promptly corrected, and the information accurately recorded, these reports, properly signed, should be satisfactory. There was ground for criticism with respect to these points at the time of the inspection.

2. Thorough and complete tests of the locomotive train-

stop equipment should be made periodically. The condition of the forestalling mechanism on locomotives 2032 and 704, and of the reset mechanism on locomotives 736 and 817 indicated serious neglect in this respect.

3. The double-heading cocks not yet so modified that they will cut out the engineman's automatic brake valve before they cut out the train-stop device should promptly be so modified. It is reported that this change is now actively under way.

4. Automatic brake valves should be so assembled and maintained that all parts will accurately register as intended when the rotary is moved either manually or automatically.

During the locomotive tests and observations, it was noted that this was not the case on all locomotives, apparently due to lost motion between the actuator driver and the valve spindle, and between the key of the valve spindle and the slot in the rotary valve.

Rotary valves and rotary valve keys worn beyond allowable limits should be replaced by new ones, and in all cases proper adjustment of the actuator cylinder cap stops should be made and these stops fully secured. Locomotives 1620, 767, 750, and 747 are cases in point.

5. Whistles should be so located and maintained as to insure their being readily heard by both the engineman and the fireman on double-cab locomotives as well as on others.

6. Since crosses in some of the locomotive circuits will produce false-clear operations, it is obvious that the integrity of these circuits must be adequately protected. Grounds were found during the inspection on the head-light generator circuits of locomotives 800, 1642, 731, 785, 1451, and 1610.

7. The generators employ to furnish current for the train-stop and lighting system should be of proper design and ample capacity. It is not believed that the type used before the super-imposition of the train-stop system will prove to be adequate.

8. It is stated that since the inspection, steps have been taken to prevent water from entering and lodging inside of the electro-pneumatic valve housings. This should be carefully checked to make sure that no locomotives have been overlooked in this respect.

9. The mechanism boxes on locomotives 786, 729, 1678, 713, 707, 1610, and 766 were neither locked nor sealed at the time of inspection.

10. Signal maintainers should be provided with written instructions covering the inspection, test, and maintenance of the inductor and its circuit, and arrangements should be enforced for the periodical inspection and test of all road-side inductors and their circuits in accordance with these instructions; reports to be made on suitable forms and promptly forwarded to a designated officer. During the inspection, four inductors were found to be too low, due to failure to properly tamp their supporting ties.

11. The proper relationship between the locomotive receiver and the rail should be rigidly maintained. This should be frequently checked, on level track, with a substantial and accurate gauge.

During the inspection receivers, which were too high and inductors which were too low were found. This might result in false-clear failures.

12. The closing of the inductor winding in this device results in a clear operation; hence a cross in the wires leading to the inductor would result in a false-clear condition. The installation and maintenance of the track inductor circuit must be such as to protect the integrity of this circuit at all times.

13. The conditions attendant upon the use of two-position signals at certain points in the three-position signal system in train-stop territory may warrant preferential consideration in the signal program, and the matter is here brought to the attention of the carrier accordingly.

14. It is suggested that the braking distance for freight trains between signals 764 and PG 48, and that beyond the inductor at signal 261, be checked with a view to making sure that adequate distance is provided.

15. It is suggested that information which trainmen and enginemen should have with regard to this installation be included in the current operating time tables.