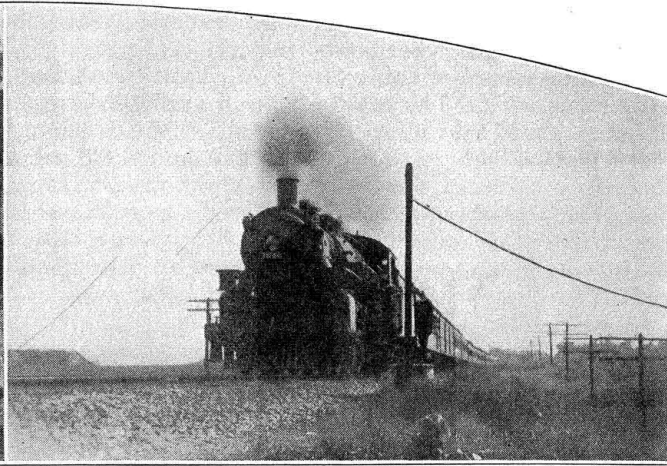


The automatic signals were the Hall disc type, the signals being located at the left, as the C. & N. W. operates left-handed on double track.



A recent picture showing a train passing a former signal location and what might now be termed a phantom location. Many train stops have thus been eliminated.

Automatic Train Control on the Chicago & North Western*

Continuous inductive system used with cab-signals, but without wayside automatic signals—Token and key, and the recurrent acknowledgment are features of systems

By J. A. Peabody

Signal Engineer, Chicago & North Western, Chicago

HARDLY had the running of trains been started than it was found necessary to devise means of stopping them, these studies resulting in the automatic air brake. All of the practical train control devices of today are based on using the air brakes to do the actual work of stopping the trains. Long before the air brake had been perfected, patent applications were made for devices to stop trains when about to get into trouble. With all this enthusiasm to save lives and property a great deal of which was by men who knew little, if anything, about the practical requirements of a railroad, the government was bound to be and it was called on to make investigations and pass legislation.

One of these early stopping devices called for a hook to be installed between the rails which would be raised when necessary and catch on an axle. The fact that if the hook held, it would probably pull the truck from under the car did not seem to trouble the inventor.

By 1900, the inventions had become very numerous, and railroad executives were flooded with suggestions and devices, backed often by men of prominence, particularly shippers, making necessary the giving of serious consideration, even though the device was considered not only impractical but absurd. One of the first devices given a practical test consisted of an arm attached to an automatic signal which would project over the track when the signal was in the stop position.

A pipe, connected to the air brakes, projected above the top of the train and on this was erected a glass tube of sufficient length to come in contact with the arm when in the horizontal position. If the signal was not obeyed, the tube would be broken by the arm on the signal and the brake set. Unfortunately icicles formed in a tunnel, broke the tube on a passenger train and the passengers were almost suffocated before they could be released.

Commission Starts Investigation

In 1906, by congressional enactment, the Interstate Commerce Commission was directed to investigate and report on automatic train control. The Block Signal and Train Control Board was appointed, consisting of five disinterested men, and tests and investigations were made at government expense. It is reported that this board investigated over 1,000 devices.

Up to about this time the only devices showing practical possibilities required the opening of a valve in the train air line by a device on the roadside. Signaling had been developed so that the mechanical means originally used for operating the automatic block signals, that is, a treadle hit by the wheels of a train as it passed by, had been superseded by the track circuits. The automatic signal was being rapidly installed for the protection of trains and with this development, signal departments of the railroads were coming into more prominence, and as every train control device that showed practical possibilities depended primarily on some connection with a signal system, it was natural

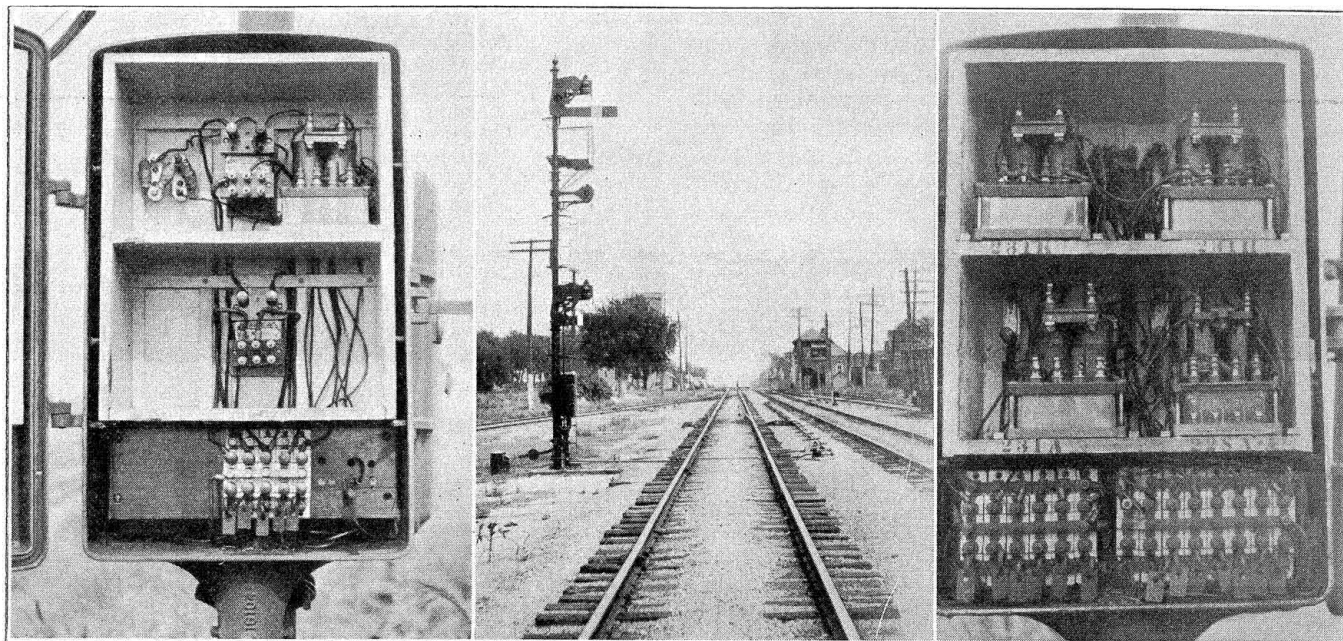
*This article is an abstract of a paper presented by Mr. Peabody before a recent meeting of the Western Railway Club in Chicago. The lecture was illustrated by lantern slides thrown on the screen, which were explained by Mr. Peabody.

that the signal men of the railroads of the country were called on to follow up the train control progress. The signalmen realized early that direct mechanical means could not be reliable, being subjected to weather conditions and shock which would unquestionably put them out of commission in a short time.

The more progressive of those interested in train control development started the use of electricity by direct

tal of 94 roads and 141 passenger locomotive divisions on which installations were to be made. Later, however, the commission released a number of the new roads on the second order from having to comply with the second order for the time being, and it has not yet re-instated this order against them.

Practically speaking, up to that time all of the developments had been with the idea of stopping a train, and



Relays and transformers at cut section to feed train control current to track The wayside signals at interlocking plants are retained as "stop and stay" signals A typical instrument case with relays and arresters

contact, resulting in the so-called ramp devices which required a rail or "T" iron approximately 50 ft. or 60 ft. long with sloping ends, to be installed a short distance outside and parallel to the rail, this ramp being energized whenever the block that the train was about to enter was clear. On the locomotive, a shoe was placed which, when it came in contact with this ramp, would be raised, and at the same time if the ramp were energized current would pass from the ramp through the shoe, through an electrical coil to the frame of the engine, back to the main rails and to the source of energy. When this occurred, an electric magnet would hold an air valve closed when the shoe was raised by the ramp. If, however, the current were not present, the valve would be opened by the raising of the shoe and the brakes on the train applied. Three such devices were installed, there being considerable variation in them, one device having speed control in connection with it.

While some studies and work had been done on inductive devices, the ramp installations practically represented the progress in train control up to 1920, when a clause was inserted in the Transportation Act, passed that year, which called for further activities on the part of the Interstate Commerce Commission in safety matters.

After investigations and hearings, the Interstate Commerce Commission, on June 13, 1922, issued its order 13413 requiring 49 roads to install automatic train control apparatus on one full passenger locomotive division each, and on June 14, 1924, the commission issued an extension of this order whereby 47 of the original 49 roads were required to install train control on a second division and 45 additional roads were required to install train control on one division, thus making a to-

failed to recognize the fact that the primary object of a railroad is to give service, and in order to give service it must keep its trains in motion so long as the train can proceed safely.

Forestalling a Brake Application

The order of the commission provided that the railroads might install either train control or train stop devices, the original order being such that if a train stop device were installed, no release could be obtained when once an application of the brakes had been made, until the train had been brought to a complete stop. The commission later amplified its original order so as to allow forestalling a brake application provided the engineer took action at the proper time.

The ramp devices that I have already described would come under the general heading of "intermittent contact." The devices installed after order 13413 was issued were all of the inductive type.

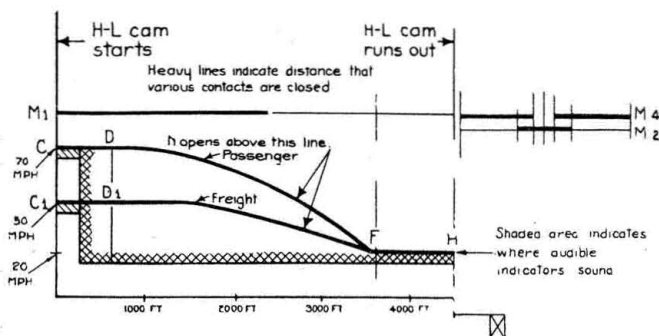
Several forms of continuous control were developed and installed and are in practical operation. These are classified as the stop, the one-speed, the two-speed and the three-speed devices, a great many of the so-called two-speed devices have only one-speed control and should be so classified. With all continuous control devices, cab signals giving continuous indications are feasible, and most of these devices can be changed from one classification to the other.

Two methods of use of track circuits have already developed, one as used by the North Western to be described later more in detail, using the commercial 60-cycle current, this same idea also being used by others. The other idea requires the use of a code, this being developed for some of the eastern roads. Before going on with the detail description of the installation

on the North Western, I pause to state that it seems unfortunate that developments could not have gone further before so much money was required to be spent by the railroads so that at least some basic principles might have been put forth toward which all could work, in order that equipped engines of one railroad might operate in the equipped territory of another.

C. & N. W. Made Early Test of Intermittent System With Tapered Speed Control

The Chicago & North Western first made a test installation of an intermittent inductive, tapered speed, device, feeling that speed control was essential, in fact, absolutely necessary, because at that time the change in



Operating curves established by train control

the order of the commission, which allowed forestalling, had not yet been made. This installation worked as intended, but estimates proved it would cost considerable more than continuous control in congested territory, without giving the flexibility of operation.

The signaling on the North Western was of an old type and there was a great deal of agitation for improvement. Estimates indicated that a modern system

Extent of Train Control Installations at Present Date

Number of roads on which train control is installed.....	44
Miles of road equipped under order.....	8,393
Miles of road voluntarily equipped.....	3,412
Total	11,805
Miles of track equipped under order.....	15,158
Miles of track equipped voluntarily.....	6,344
Total	21,502
Total miles intermittent.....	15,012
Total miles continuous.....	6,490
Locomotives equipped—Intermittent	5,105
Locomotives equipped—Continuous	3,189
Total Locomotives	8,294
Amount of money spent to date for train control, approximately	\$26,000,000
Amount of money spent to date, including re-signaling	30,000,000
C. & N. W. Railway	
Miles of road.....	511
Miles of track.....	1,122
Locomotives	378
Cost	About \$2,700,000

of signaling with the simplest form of train stop would cost at least 10 per cent more than continuous control, which would sufficiently amplify the existing signaling. If the cab signals proved satisfactory, and the wayside signals could be removed, economies such as a reduction in maintenance cost of wayside equipment and in coal consumption on account of eliminating the stopping of trains for signals would be effected, which could not be done with intermittent devices. Our experience indicates that we were right, and also that freight train speeds have been somewhat increased. It was also felt

that some form of device which gave continuous protection was the only one that would last beyond a few years. The signal companies were already developing such devices, the operation of which required the estab-

Speed Limitations Adopted for C. & N. W. Train Control

PASSENGER TRAINS

Maximum speed, 70 m.p.h.
Warning speed, 67 m.p.h.
Operating speed, 65 m.p.h.
Medium speed graduated, 70 to 20 m.p.h.

FREIGHT TRAINS

Maximum speed, 50 m.p.h.
Warning speed, 47 m.p.h.
Operating speed, 45 m.p.h.
Medium speed graduated, 50 to 20 m.p.h.

ALL TRAINS

Slow speed limit, 20 m.p.h.
Warning slow speed, 17 m.p.h.
Operating slow speed, 15 m.p.h.

lishing of an alternating current through the track rails when the block was clear, and the receiving of the induced current through coils on the locomotive.

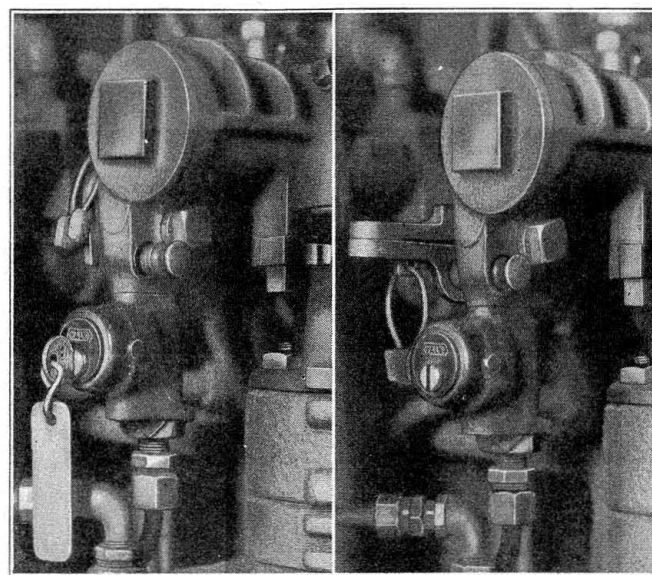
The development of radio and with it the plotron vacuum tubes by means of which the influence of a faint current could be used positively to obtain definite results made this possible. The device actually selected is known as the General Railway Signal Company's two-speed continuous train control. This equipment is installed on 511 miles of road, or 1,122 miles of track, and on 378 locomotives, the cost of the entire project being about \$2,700,000.

The Interstate Commerce Commission, in its order 13413, laid down the following requirements:

Automatic Train Control or Speed Control

(a) Automatic stop, after which a train may proceed under low-speed restriction until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the stop operation.

(b) Low-speed restriction, automatic-brake application under control of the engineman, who may, if alert, forestall application at a stop-indication point, or when entering a danger



Two views of special actuator cutout lock

Left—View shows key in lock which is unlocked, the plunger above is pulled out and the lever at left is turned up to vertical position, cutting the actuator out of service. Right—View shows lever horizontal, cutting the actuator in service. Note that the two halves of this lever are held together by a seal. The plunger is pushed in, holding lever in position and key is removed thus locking plunger in place.

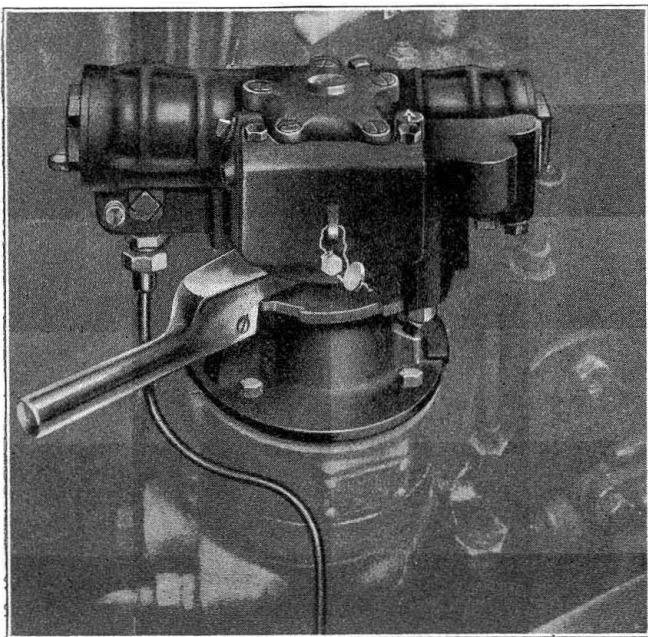
zone and proceed under the prescribed speed limit, until the apparatus is automatically restored to normal or clear condition by reason of the removal of the condition which caused the low-speed restriction.

(c) Medium-speed restriction requiring the speed of a train to be below a prescribed rate when passing a caution signal, or when approaching a stop signal or a danger zone in order to forestall an automatic-brake application.

(d) Maximum-speed restriction, providing for an automatic brake application if the prescribed maximum speed limit is exceeded at any point.

GENERAL REQUIREMENTS

An automatic train-control or speed-control device shall be effective when the train is not being properly controlled by the engineman.



Actuator applied to engineman's brake valve

An automatic train-stop, train-control, or speed-control device shall be operative at braking distance from the stop-signal location if signals are not overlapped, or at the stop-signal location if an adequate overlap is provided.

To these features the Chicago & North Western added recurrent acknowledgment making it necessary for the engineman to operate the acknowledging lever every half-mile when proceeding under a slow-speed indication. This road also added the token with the key by means of which the train control is locked in operating condition. The operating requisites were charted to insure that nothing was left out and that there was no conflict.

Problems in Connection With the Wayside Control

In order that the greatest train capacity can be obtained, the circuits by means of which the trains are controlled had to be laid out carefully for each foot of track. On the North Western, the braking distances of each class of trains for each grade, both up and down were determined which disclosed that, with the maximum speeds we had settled on, namely, 70 m.p.h. for passenger and 50 m.p.h. for freight, the freight trains governed. This resulted in a minimum headway of four minutes for passenger trains in high-speed territory where mixed traffic is operated. Near Chicago the passenger trains operate at not to exceed 35 m.p.h. and the freight trains at not to exceed 25. Here, on account of reduced braking distances, we were able to obtain a headway of two minutes.

At each place where current is received from power companies, switching equipment is provided so that

when the current supply fails at one or more places, the adjacent stations will pick up the load automatically. These feeding points are located from 5 to 25 miles apart. Current is received from the service companies at 110 or 220 volts a-c. and transformed to 440 volts a-c. for transmission along the line. It is transformed down again to 110 volts for each train control circuit and from this to 2 to 4 volts for each track circuit, which, in the final analysis, is what controls the train. The train control current on the track, when the train is in the circuit, is approximately one ampere a-c.; when there is no train in the circuit, there is practically no flow of a-c. current. The train control circuits are all controlled by d-c. circuits, the same as are used for regular automatic block signaling with approximately 10 volts on the line and 1 volt on the track, the track circuits using about 320 m.a.

Thus we have two different currents on the track, one a-c. and the other d-c., both of very low voltage—each doing its own work and not interfering with the other, nor will either do the work of the other if it is not present. The control of these circuits is through the regular automatic block signal apparatus.

The locomotive devices used in connection with the operation of trains are:

The audible warning speed indication is a high pitched horn mounted on the back wall of cab. When this horn is sounded it indicates that the speed of the train is above the warning speed limits. This horn will stop sounding as soon as the speed has been properly reduced.



Conductor of C. & N. W. train receiving train control "token" from the engineman

The audible acknowledging indication is a low pitched horn mounted on the back wall of cab. When this horn sounds the engineman should immediately acknowledge same by means of the acknowledging lever. When properly acknowledged this horn will immediately stop sounding.

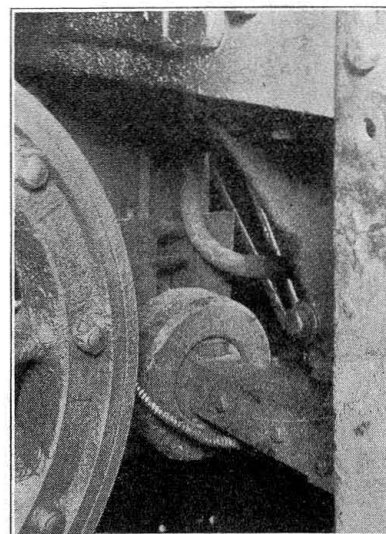
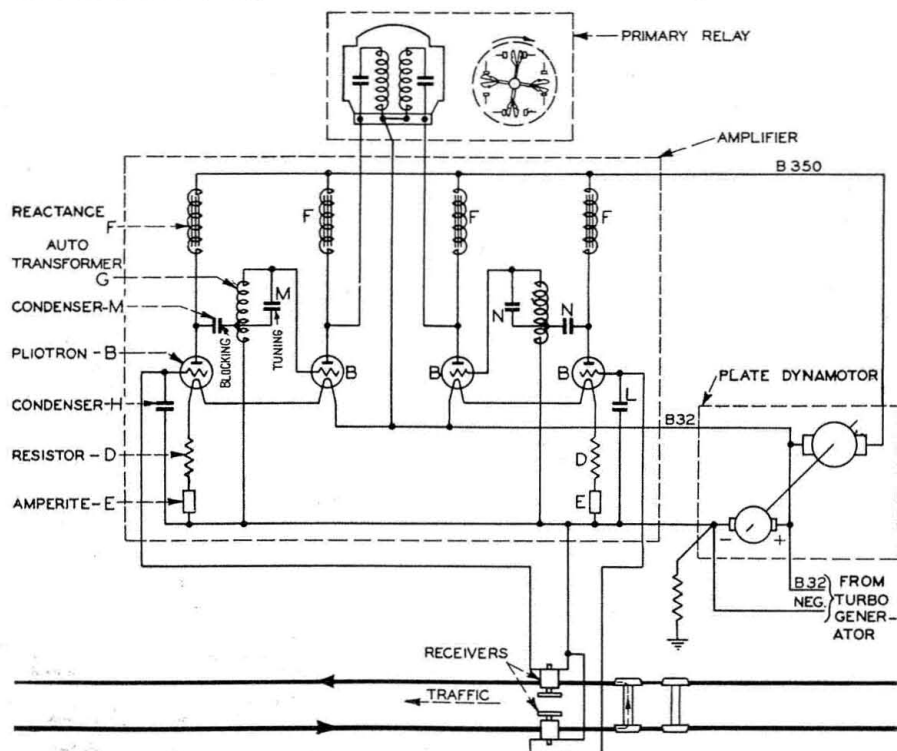
The acknowledging lever, which extends upward from a box which is mounted on the right side of the cab below the window directly in front of the engineman. To acknowledge the acknowledging indication, the en-

gineman should pull this lever back as far as it will go and immediately release it. If the engineman does not pull the lever as far as it will go or holds it too long, the brakes will be applied.

A *single stroke gong* is mounted on the inside of the back wall of the cab, and when this gong sounds it indicates that the slow speed restriction is removed.

indicates that the current on the engine is "Cut In" for train control operation and the actuator can then be cut in.

Transmission clutch lever is in a box located on the outside of the frame of tender on the fireman's side near the center, and is used to couple together the two parts of the transmission which extends from the ten-



Top—Receiver mounted under pilot

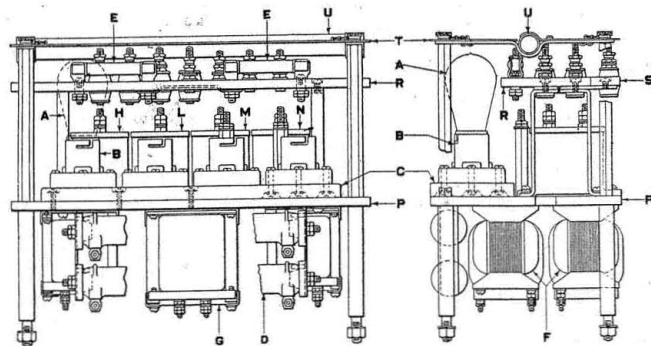
Left—Circuit of the receiving and amplifying apparatus

Visual indication or cab signal is a box mounted on the inside front wall of the cab on the right side containing two lights:

Green—Indicating "Proceed."

Yellow—Indicating "Proceed at Slow Speed Prepared to Stop."

The change from the green light to the yellow light will precede the horn indications by 175 to 200 ft. when the speed of the train is over 20 m.p.h. and will precede the horn indications one-fourth of a mile when the speed is under 20 m.p.h. Acknowledgment should not be made until the acknowledging horn sounds. The change from the yellow light to the green light will be accompanied by a single stroke of the bell.



Two views of amplifier units

When passing over short sections of track where current may not be picked up for a distance of less than 175 ft., such as staggered joints at the end of a track circuit or at a railroad crossing, the light may flash from green to yellow and back to green without the horns or bell sounding. No attention need be paid to these flashes. When either visual indication light shows, it

der wheel axle to the mechanism case on top of the tender and also to connect the electric current from the turbo generator to the train control circuits. To operate the clutch lever, the box should be opened and the lever moved outward and downward to the right or left as desired and then inward to engage with the proper slot and the cover closed. The positions are marked in raised letters, "In" for transmission "Cut In," and "Out" for transmission "Cut Out." The operation of the lever to the "In" position must precede the cutting in service of the actuator; and after the actuator is cut out of service this lever should be put in the "Out" position.

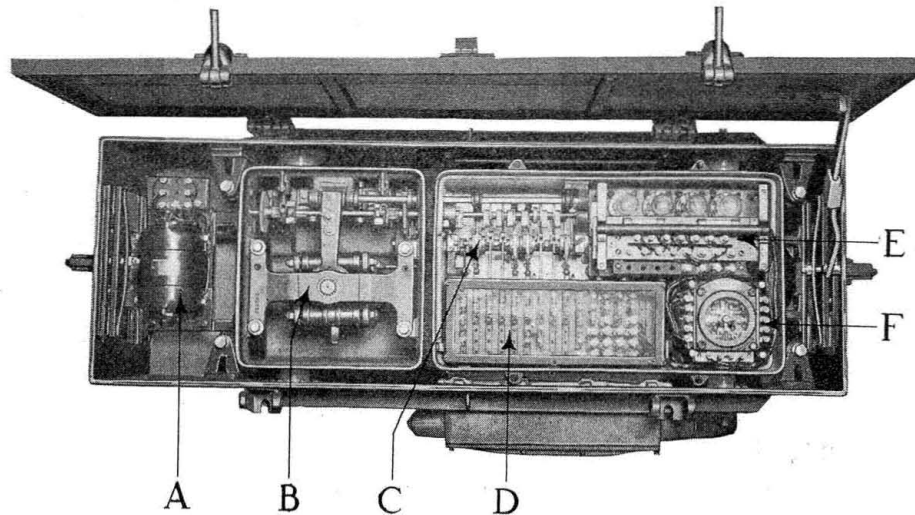
The *actuator* is the connection between the train control apparatus and the air brakes, and is mounted on top of the automatic brake valve. The actuator consists of two air cylinders directly connected to the main reservoir when not in service. When in service the small cylinder is connected directly and the large one through an electrically controlled air valve. On the top of the actuator, there is an arrow which normally points to the letter "R" (Release) and when in that position the engineman retains control of the automatic brake valve in the regular manner. When the train control device operates to apply the brakes, the arrow will turn away from the "R" and a brake application will be made the same as if the engineman had put the brake valve handle to the service position.

When an automatic brake application is made by the train control device, the engineman may, if necessary, put the brake valve handle to the emergency position and obtain an emergency application, but as long as the arrow points away from the "R" the engineman cannot release the brakes. When the arrow returns to the position pointing towards the "R" the engineman by first placing the brake valve handle in the full service position may again take control of the brakes and release

same, if he so desires. The air brakes are never automatically released by the train control device.

Actuator cut-out cock is an air valve located at the lower left side of the actuator. By means of it, the actuator is cut out of service or cut in service. When

tion. When the lock is unlocked the key cannot be withdrawn. The lever of the cut-out cock is also provided with a seal. Breaking this seal and removing the wire will release part of the lever so it may be moved from the cut-in service position to the cut-out of serv-



View looking down into the control mechanism case mounted on top of the tender. A—The dynamotor. B—The governor. C—The cams controlling movement of contacts in compartment D. E—The amplifying unit and F—the primary relay

the lever of this cock stands in the vertical or up position the actuator is cut out of service. When the lever of this cock stands in the horizontal position the actuator is cut in service.

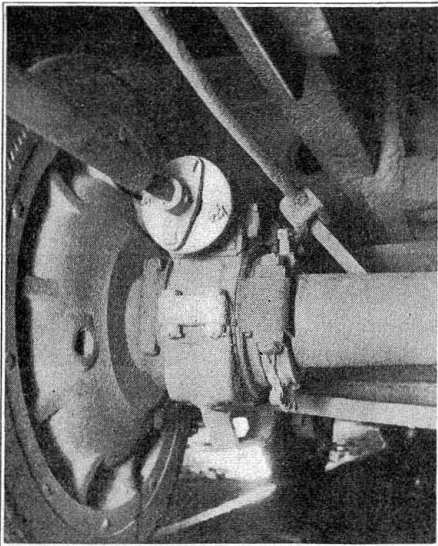
This lever may be locked in the horizontal or cut in service position. A brass plunger located near the cut-out cock can be pushed inward about $\frac{1}{2}$ in. to enter a hole in the lever, and this plunger can be locked in this position with a lock (provided with a key) located just below the cut-out cock.

To lock the cut-out cock in the cut-in service position, the lever must be placed in the horizontal position, the plunger pushed into the hole in the lever and the key

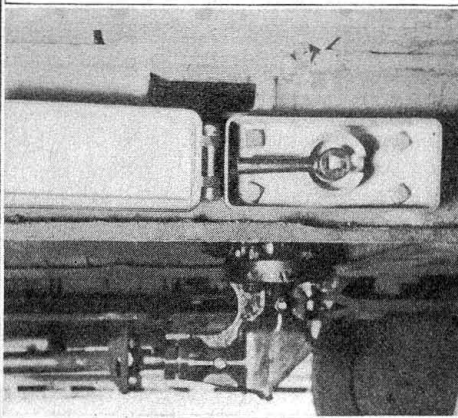
ice position in case the key is lost or broken. The reason for breaking a seal must be reported.

The Token a Feature of the Installation

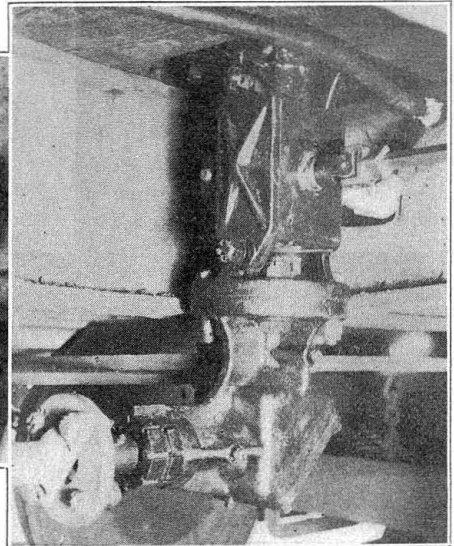
The key for the actuator cut-out cock lock is special for each engine, and is attached to a tag marked with the engine number. This key and tag together are called a *token*. When the actuator is cut out of service the token will be in the engine, because the key is in the actuator cut-out cock lock and cannot be removed. When the actuator is cut in service the token can be removed from the engine because the key will be released by the actuator cut-out cock lock. A duplicate



The axle transmission is mounted on a tender truck axle



The disconnecting clutch lever mounted on the channel of tank



Bevel gear unit and disconnecting clutch mounted under tank

of the lock turned to the vertical position. Only when in this position can the key be removed from the lock. To put the cut-out cock in the cut-out of service position the lock must be unlocked by turning the key to the horizontal position, the plunger then pulled out, and the lever is then free to be moved to the vertical posi-

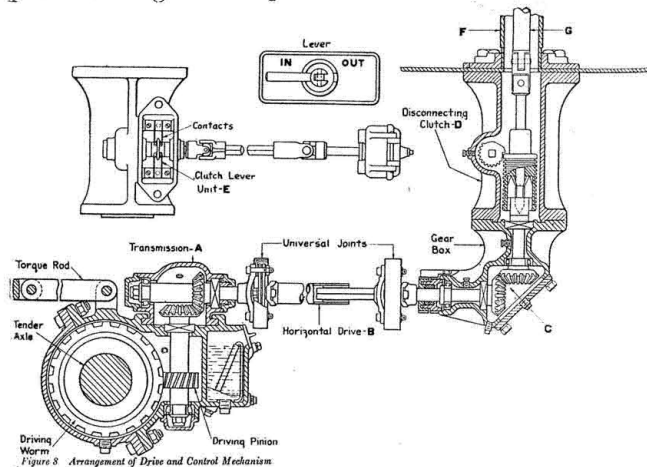
tion key for each engine is provided in a sealed box in engine cab. This is to be used only as a last resort.

The receivers are coils located over each rail of track forward of the front wheels of the engine, to collect electric current inductively from current passing through the rails.

The *mechanism* case is a box located on top of the tender, containing the amplifiers, relay, governor and cams.

The *amplifier*, for amplifying the current, received by the receiver coils, consists of four tubes of the pliotron type and has two distinct phases, each phase having two stages of amplification. There are also used the necessary resistors and inter-stage transformers.

The *relay* is the device which is operated by the current collected by the receivers from the rails after it passes through the amplifiers.



Mechanism for driving the cams and governor

The *governor* is the device for indicating and controlling the speed of the train.

The *cams* measure the distances and are used in combination with the governor to give warnings and speed limits when operating under restricted speed.

The *transmission* is a connection between an axle and one of the tender trucks to the mechanism case and is used to transmit motion to the governor and cams.

The *turbo-generator* is used for train control and for engine lighting. Before the train control can be put in operation, this turbo-generator must be started and properly connected into the train control circuit with the "turbo" switch.

The *dynamotor* is a motor-generator which receives current from the "turbo" at 32 volts and furnishes energy for the plate circuit of the amplifier at 350 volts. All engines are equipped for both freight and passenger service, and a switch, which is sealed in position for service before the engine leaves the roundhouse, indicates in which service the engine is to be used. All of the engines are equipped with control for operating forward in the direction of traffic, but a few in suburban service are also equipped for operation either forward or backward. When a locomotive is equipped for forward operation only and is operating backward it is restricted to a maximum of 20 m.p.h. by the train control device.

The Use of the Token

The North Western is the only road using definite mechanical means of insuring that other members of the train crew beside the engineman know that the train control is in service. This is accomplished by the token and key by means of which the train control is cut into or out of service. This key is individual for each engine, and must be removed from the lock and given to the conductor by the engineman, and it is required that the conductor have this in his possession before he allows his train to proceed from the terminal. The instructions to the trainmen are as follows:

Before leaving the terminal the engine must be cut into service. To cut in the train control we will assume that the

engine is standing, and air is pumped up, and the turbo-generator is running at full speed. See that "Freight"- "Passenger" switch is in proper position for the service the engine is to be used in.

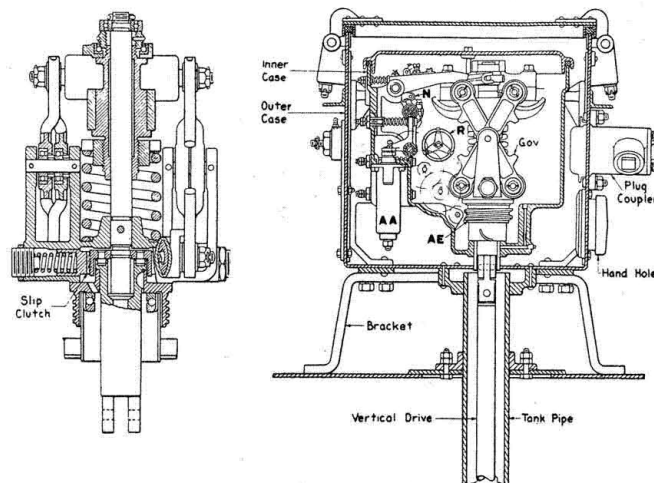
Place the turbo-generator switch for train control to the closed position. Put transmission clutch lever to the "IN" position. Place actuator cut-out cock lever to the "Cut in Service" position and lock it. The token key may then be removed from lock.

An engine equipped with train control must have same cut in service before passing the fouling point of main tracks equipped with train control or before entering train control territory. The above does not apply to the second engine of a double header or to a helper engine which is pushing a train. Engines not equipped with train control may be operated on main tracks within yard limits, but must not exceed 20 m.p.h.

When a train is in a train control territory, the conductor must have in his possession the token from the engine of his train, except when in emergency it becomes necessary to cut out of service the automatic train control to clear the main track. Then the conductor will return the token to the engineman and report to the dispatcher.

When a train is ready to start with the train control device cut in, either the green or yellow light will show, and the engineman may start his train without train control interference. The train control should not be cut out on account of a failure of either or both visual indicator lights if the device is otherwise operating properly, and train may proceed. When the green light is showing, if the train speed is increased and if the engineman is warned by the warning speed horn sounding, he should operate so as to prevent the train control brake application.

If the engineman allows the speed of the train to continue to increase until it exceeds the maximum speed limit, the actuator will operate and the brakes will be applied. When the speed of the train has been reduced below the maximum speed limit the actuator will indi-



Speed governor which is mounted in the mechanism case on top of the tender

cate release and the engineman, by putting the brake valve handle to the service position, resumes control of the air brakes and he can then release them if he so desires. If the engineman does not release the brakes after the brake application has been made as above described, the train will be brought to a stop.

As long as clear conditions exist ahead of the train, and there are no time table or other speed restrictions, the maximum speed restriction will be that allowed by the automatic control apparatus. When the speed of the train is above 20 m.p.h. and it enters an occupied block or a zone in which there is a slow speed restric-

tion due to an open switch, broken rail, or other cause, the light will change from green to yellow, after which the speed horn and acknowledging horn will both sound. After the horns sound, the engineman must immediately take action by pulling the acknowledging lever toward himself as far as it will go and immediately release it when the acknowledging horn stops sounding, and will also take necessary steps to reduce the speed of the train below 17 m.p.h. and to a stop if necessary. The speed horn will continue to sound until the speed of the train has been reduced below 17 m.p.h. If the acknowledging lever is not operated when the acknowledging

of only one-third of the brake pipe pressure, this resulting from the use of a reduction limiting reservoir.

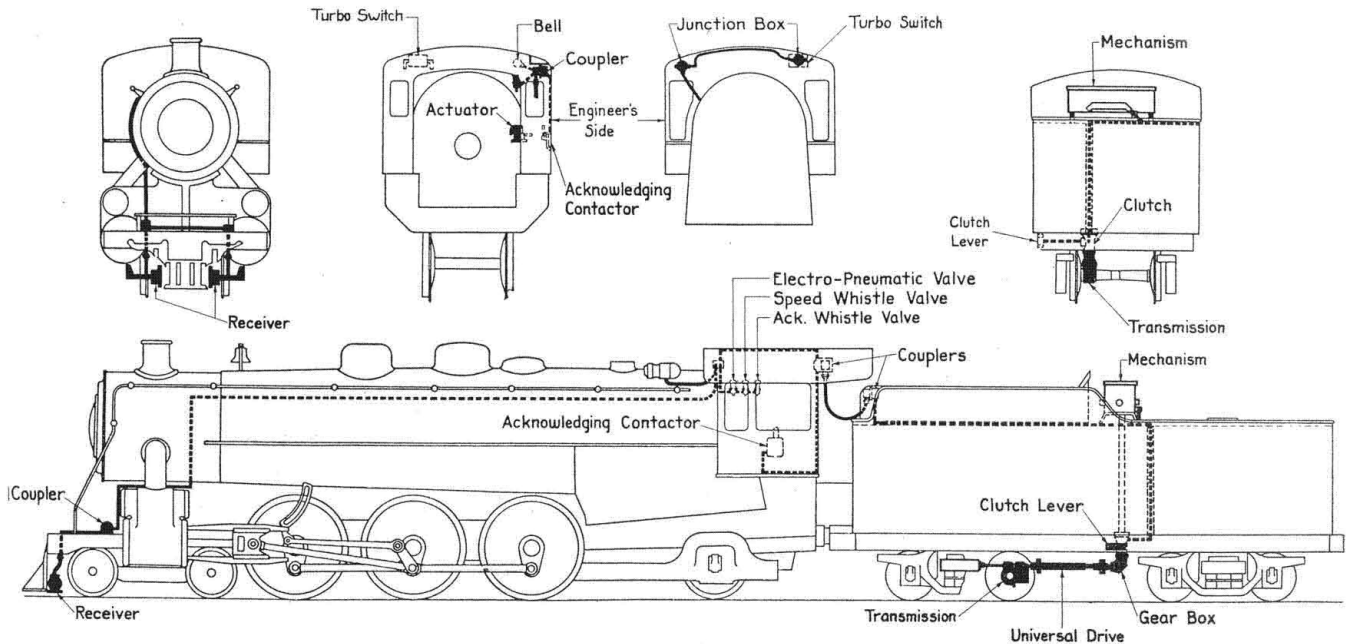
Slow-speed restrictions are also enforced at all times:

(A) When running against the normal direction of traffic (engine running forward or backward).

(B) When the engine is running backward in the normal direction of traffic unless the locomotive is equipped for running backward.

(C) When running on tracks not equipped with train control, such as passing tracks, yard tracks, etc.

(D) When running in the direction of traffic and pushing one or more cars ahead.



Location of various units of engine train control equipment

horn sounds, an automatic train control application of the brakes will result and the train brought to a stop.

Upon entering the occupied zone above described, apparatus on the locomotive is set in motion which gradually reduces the speed limits from maximum to minimum. If this gradually reducing limit is exceeded, the brakes will be automatically applied. The distance provided for reducing is ample if proper action is taken, but it is desirable to bring the speed of the train below 17 m.p.h. as rapidly as possible, consistent with smooth operation.

If the speed of the train was below 20 m.p.h. when it entered the occupied zone, and the speed is above 17 m.p.h., or is increased to above 17 m.p.h., the speed horn will sound. This can be stopped by reducing the speed of the train. If, however, the speed is increased to above 20 m.p.h., the brakes will be applied automatically and cannot again be released until the speed of the train has been reduced below 20 m.p.h.

A train operating under slow-speed restrictions may continue at under 20 m.p.h., providing the engineman acknowledges whenever the acknowledging horn sounds, which will occur approximately every half mile. In case of a power failure this still applies. When the train is being operated under this slow-speed restriction the engineman must operate his train prepared to stop short of signal, train or obstruction. When the train is operating under slow or medium-speed restriction, and the block ahead clears, the green light will show and the bell will sound.

After a brake application by the device, the engineman can always make a further reduction to cause an emergency application. The device causes a reduction

By visual and audible indications the enginemen are informed as to conditions ahead. The device is so designed and installed that the control of the train is left entirely in the hands of the engineman so long as he operates the train safely, and applies the brakes only when he fails to control the train in accordance with the requirements of the system.

This train control is in full operation on the Chicago & North Western between Chicago and Omaha, Neb. Troubles have been experienced, but one after another they have been or are being overcome. That the installation is a success is demonstrated daily by the fact that all trains are protected by it and the enginemen governed by its indications. All of the devices and materials required to equip one locomotive are on exhibit at the east end of the train concourse of the Madison street passenger terminal, Chicago.

Two Bonding Suggestions

By A. G. Turner

Signal Maintainer, Oregon Short Line, McCammon, Idaho

IF a 9/32-in. hole is drilled through the end of a hammer handle, bond wires may be slipped through this hole to give them their final bend before bonding them into the rail with channel pins. This method is quicker and easier than using a regular wire bender and does away with the need for carrying another tool when bonding rail.

To prevent channel pins from becoming dirty when carried on a motor car it is a good plan to keep them in a metal can. It is also a good practice to pour a little oil over them occasionally.