American Railway Signaling Principles and Practices

CHAPTER XXI

Hump Yard Systems

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General.

In the early days of railroading, freight cars were not classified except by picking them up from and delivering them to sidings at various points on the line. As traffic increased yards were built and freight cars were classified by flat switching, as is still done where the traffic density is light. Next, hump and gravity yards were built so that gravity would do a large part of the work formerly done by the switch-engine. The application of power-operated switches controlled from a central point was then instituted. The latest improvement for effecting economies is the car retarder system.

Power-Operated Switch Systems

The first installation of power-operated switches in a hump yard was made by the Pennsylvania R. R., in 1891, at Altoona, Pa. Later, hump yards were equipped with power-operated switches on the Baltimore & Ohio; Central of Georgia; Chesapeake & Ohio; Chicago & Western Indiana; Illinois Central; Missouri-Kansas-Texas; Missouri Pacific; New York Central; New York, New Haven & Hartford; Pennsylvania; Reading; Richmond, Fredericksburg & Potomac; and the Union railroads.

Since the invention of the car retarder a few hump yards have been equipped with power-operated switches (but not with car retarders), but in these cases the switch machines, signals, control machines and circuits have followed the practices of car retarder installations.

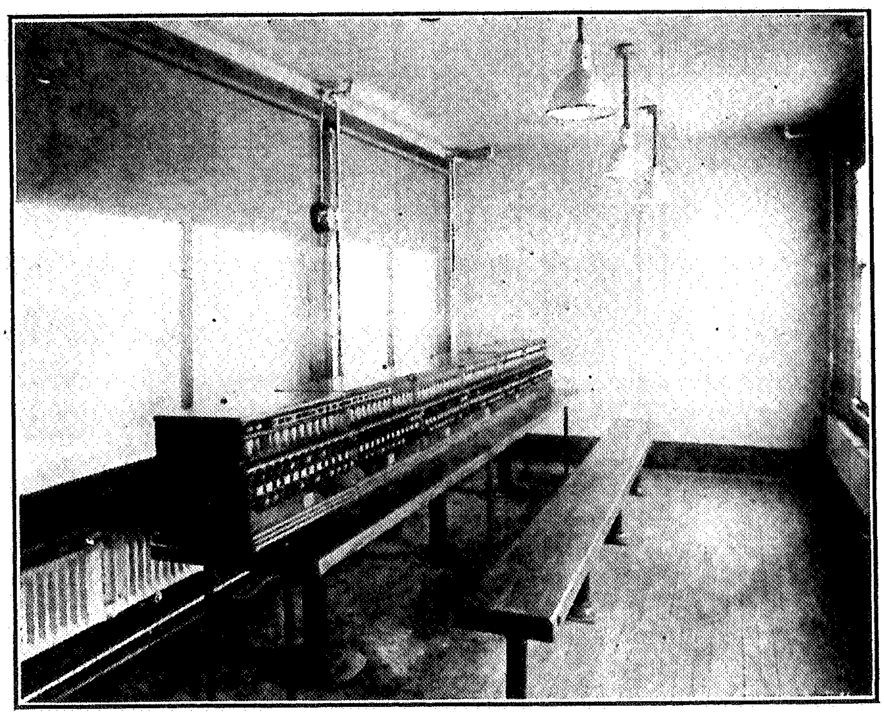


Fig. 1.
Push Button Machine.

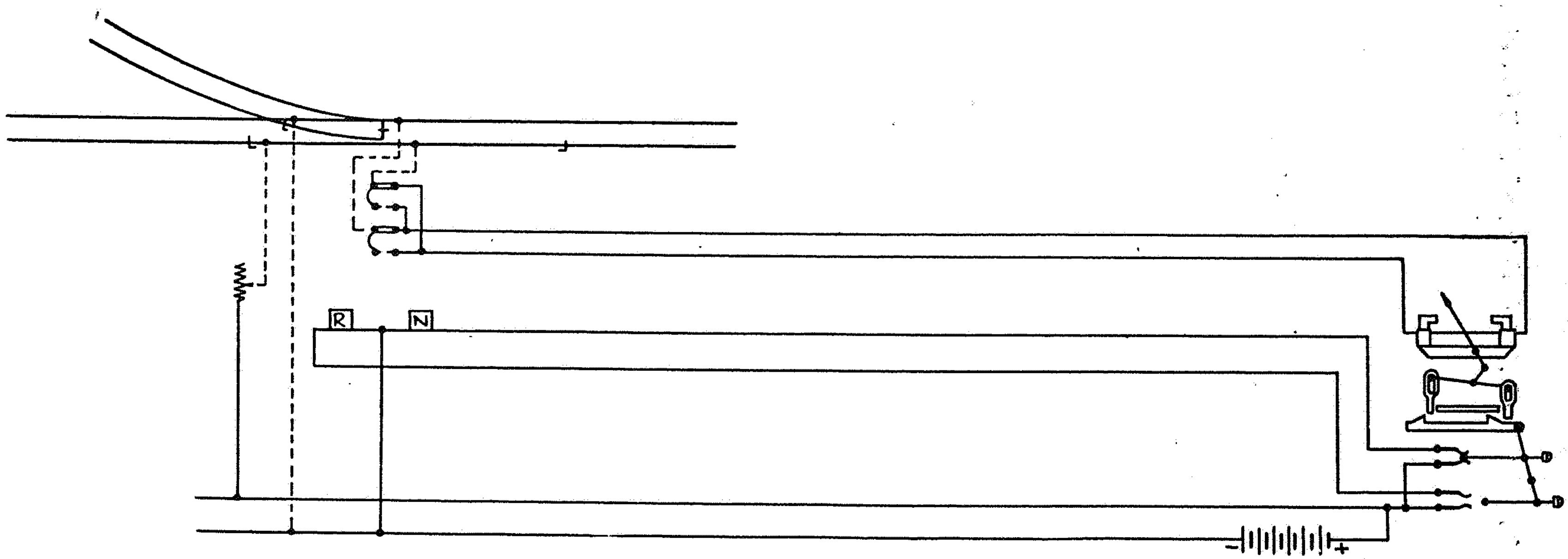


Fig. 2.
Circuits for a Single Switch Controlled from a Push Button Machine.

The usual operation involves providing the operator with a schedule of the movements required to classify the cars. He is then able to follow the movement of the different cars by the successive operations of the track indicators.

Electro-pneumatic.

The push button machine illustrated in Fig. 1 is similar to that installed in 1891. The upper row of buttons is termed the "normal" and the lower row the "reverse." Pressing in a normal button on the machine forces out its corresponding reverse button, and vice versa; the two buttons, relating to a switch, are joined at the back of the front board by a walking beam or contact arm which is pivoted at its center. The indicators above the buttons are controlled by track circuits. If the track circuit is unoccupied the position of the switch is indicated. If the track circuit is occupied the indicator takes a mid-position, in which position locking dogs engage with a locking bar so that the position of the buttons, and hence of the switch, cannot be changed until the track circuit is unoccupied. Figure 2 illustrates the circuits for the control of a single switch.

The switch cylinders and valves are similar to those used in the control of switches in electro-pneumatic interlocking installations and are described under the heading "Power Switch Machines."

The push buttons are electrically connected to their respective switch valve magnets so that by pushing the button in the upper or normal row the switch assumes the normal position, and by pushing the lower or reverse button the switch assumes the reverse position.

Electric.

The lever machine for controlling switches consists of a cabinet with a vertical panel through which levers project. The upper position of the lever is normal and the lower position is reverse. Indication lights show the position of the switch and the occupancy of track circuits. Figure 3 illustrates a lever of this type.

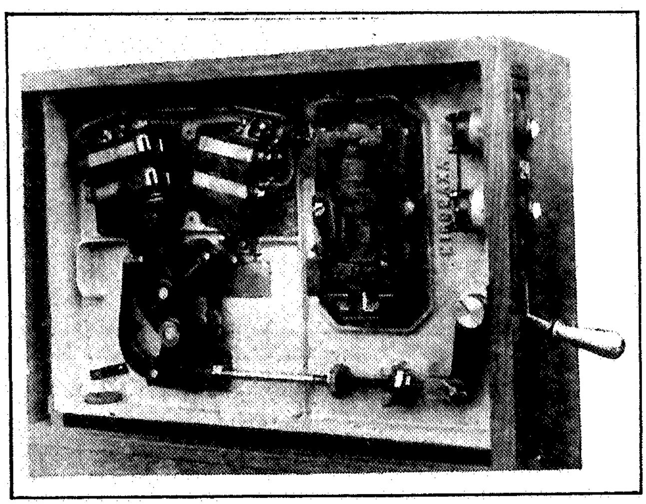


Fig. 3.
Machine Lever for Electric Switches.

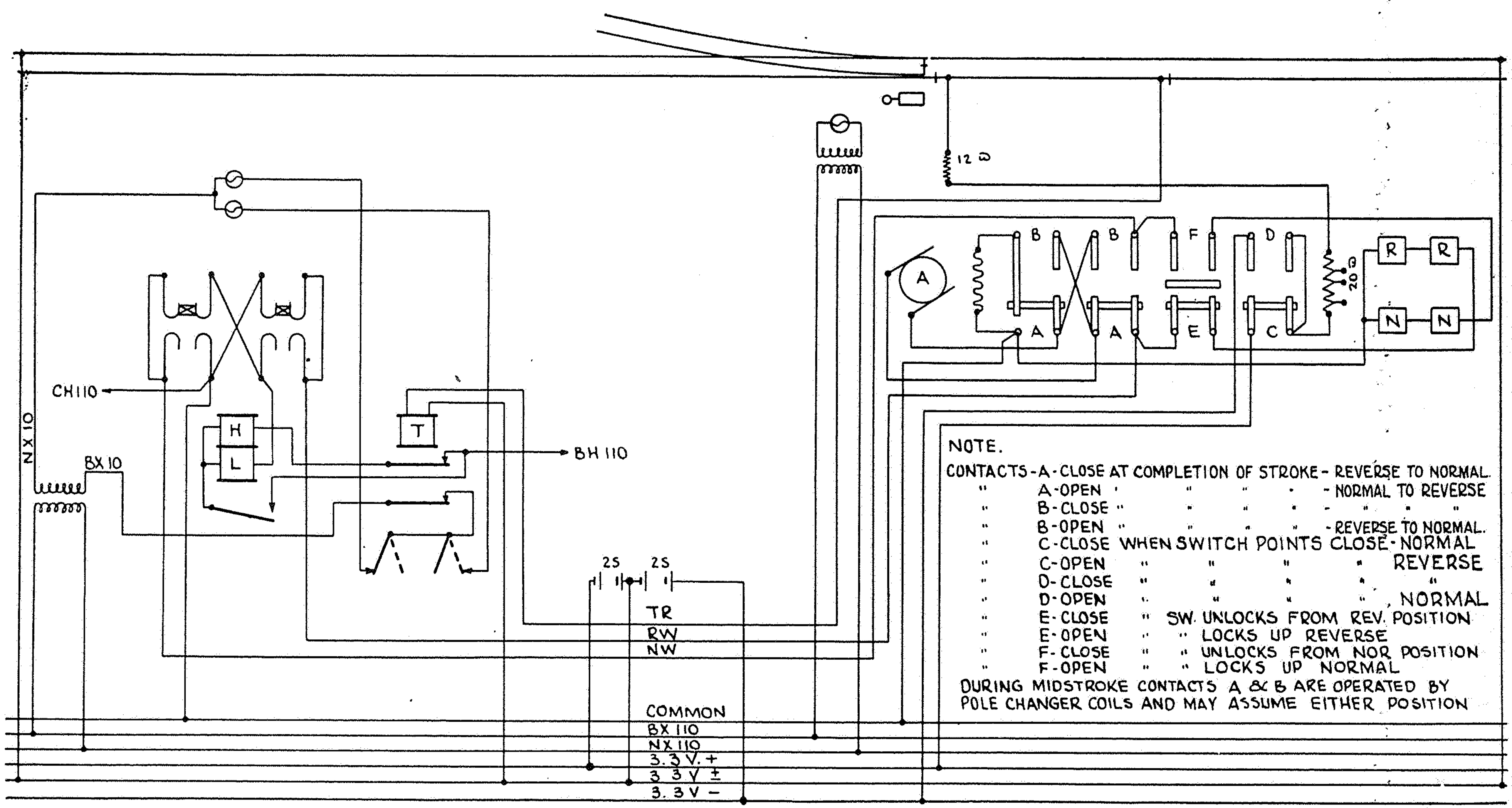


Fig. 4.
Circuits for Single Switch Controlled from a Lever Machine.

Figure 4 illustrates the control circuits for a single switch operated from this type of control machine. A relay is built into each lever and is connected into the control circuit of the switch machine to insure the completion of the movement of the switch once it has been started.

Track circuits while occupied are used to prevent the operation of switches. Model 6 switch machines are used for operating switches. This type of machine is similar to that illustrated in Fig. 31, the only difference being that an electric pole changer is used permitting a reversal at midstroke.

Car Retarder Systems

Prior to the use of car retarders, and in many freight yards at present, the classification of cars is handled over humps where men ride the cars and use hand brakes to control their speed and where switchmen throw the switches to set up the proper routes and place skates on the rails to stop cars not properly retarded by the hand brakes. The cost of such operation is expensive, principally because of the large number of men involved, the necessity of returning the riders to the hump and the waiting of engines for the riders to return. In many cases the riders walk back but at large yards they ride back on motor cars.

The greatest loss of time is either due to the engine waiting for riders or riders waiting for cars. The arrival of trains in most yards is such that a large number of cars must be handled in a short time, thus leaving periods when work is slack. It is difficult to provide the proper balance between motive power and riders, which balance is essential in order to obtain the maximum efficiency.

The car retarder system provides for handling cars at a hump yard using a minimum number of men and engines and provides ample capacity for handling peak periods of traffic without the delays attendant with calling out additional riders and switchmen.

The system includes the following devices:

Car retarders for controlling the speed of cars from the crest of the hump to the classification track.

Switch machines, for throwing the switches, to select the proper route.

Skate machines, for placing a skate on the rail, to stop cars which have not been properly retarded.

Control machines for controlling the above units.

Power plant for converting the main source of power into power of the proper type, whether it be air, direct or alternating current.

Signal system for controlling the movements of trains to and over the hump and the movement of engines through the switching area.

Communicating system for transmitting car lists from the yard office to the hump office and the individual towers and for verbal communication between the humpmaster and the operator.

Flood lights, for providing the proper illumination, for night operation.

Hot oil plant for lubricating journals in the winter, providing for easier rolling cars.

Historical.

In September 1923, Mr. George Hannauer, then Vice-President, and Mr. E. M. Wilcox, Master Car Builder, of the Indiana Harbor Belt R. R., invented, installed and tested two 40-foot sections of retarder, now known as the Hannauer retarder, on that portion of the New York Central R. R., operated by the Indiana Harbor Belt R. R., at Gibson, Ind. The results were so satisfactory that they proceeded to install additional units until in December 1924 the yard was completely equipped. Patents were taken out by Messrs. Hannauer and Wilcox, covering the type of retarder they had found successful. Since then many different types have been tested here and abroad, using various kinds of power for operation; these types are: electro-pneumatic, electric, magnetic, and hydraulic. In America the electro-pneumatic and electric types prevail whereas in Great Britain and on the Continent, where conditions relative to the design of rolling stock, wheel tolerances and methods of operation differ, the hydraulic has been used most extensively.

Track layout and gradients.

It is important that the track layout and gradients be designed and the retarders located properly, since they affect the efficiency and first cost of the installation. When retarders were first installed, a minimum of track change was considered desirable and consequently the only changes were to cut every other track into an adjacent track instead of into the ladder and install retarders at that point on the ladder, as well as on the hump lead and on each of the classification tracks. The East St. Louis Yard on the Illinois Central R. R., Fig. 5, is of this type.

As the art developed, it seemed advisable to make more track changes and install fewer retarders, and, therefore, in reconstructing the Mechanicville Yard at Mechanicville, N. Y., on the Boston & Maine R. R., Fig. 6, tracks were brought together in groups of six each and then connected within the shortest possible distance to the hump lead, one retarder being used in advance of each group as well as on the sub-leads and hump lead. This design of yard is still being used; two of the latest installations are illustrated in Figs. 7 and 8.

The average gradient from the crest of the hump, usually, is sufficient to cause the slow rolling car to move from the crest into any of the classification tracks under adverse weather conditions. Retarders are installed at intervals to permit controlling the speed of the heavy and fast rolling car so that it will not enter the classification tracks at too high a speed. The gradient in the classification track usually is designed so that the heavy and fast rolling car will not accelerate to speeds which are in excess of the maximum permissible coupling speed.

The ideal arrangement of track layout, gradients and retarders is such that the time required for handling a car from the crest to the clearance point on any classification track is the same for each car, regardless of its weight or rolling condition, which means that the lightweight and slow rolling car will be moving at approximately the same speed as the heavy and fast rolling car when retarded, but not necessarily when released from the last retarder.

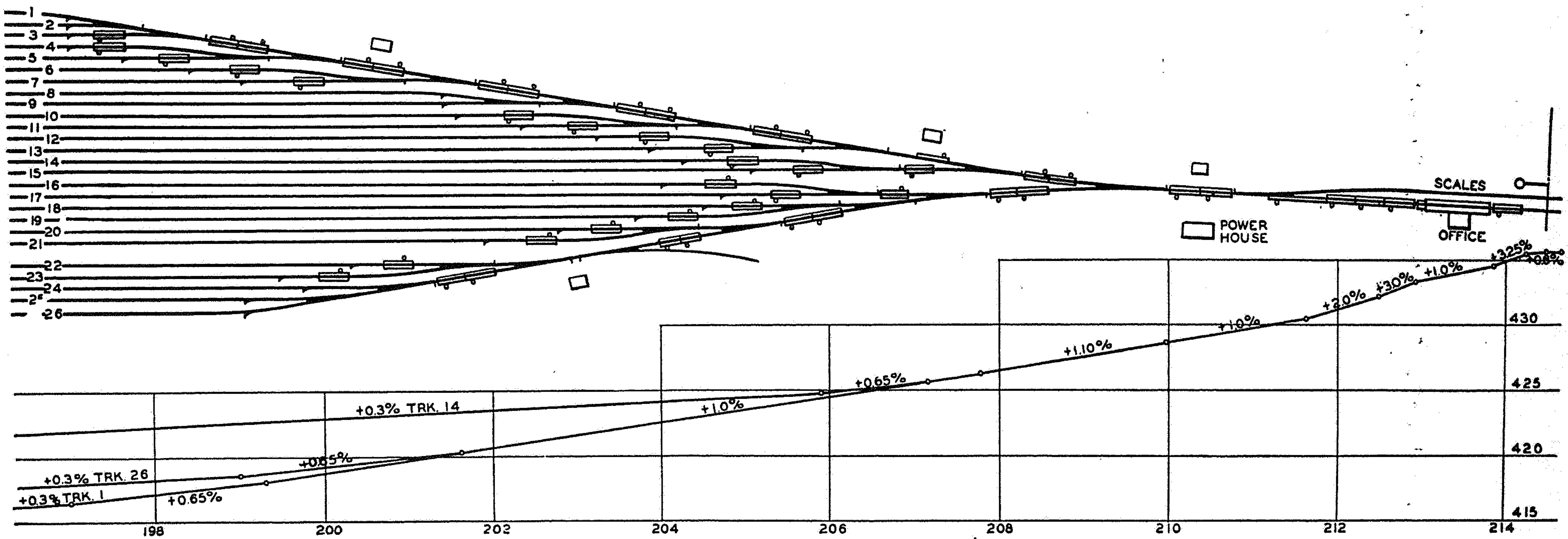


Fig. 5.
East St. Louis Yard, Illinois Central R. R.

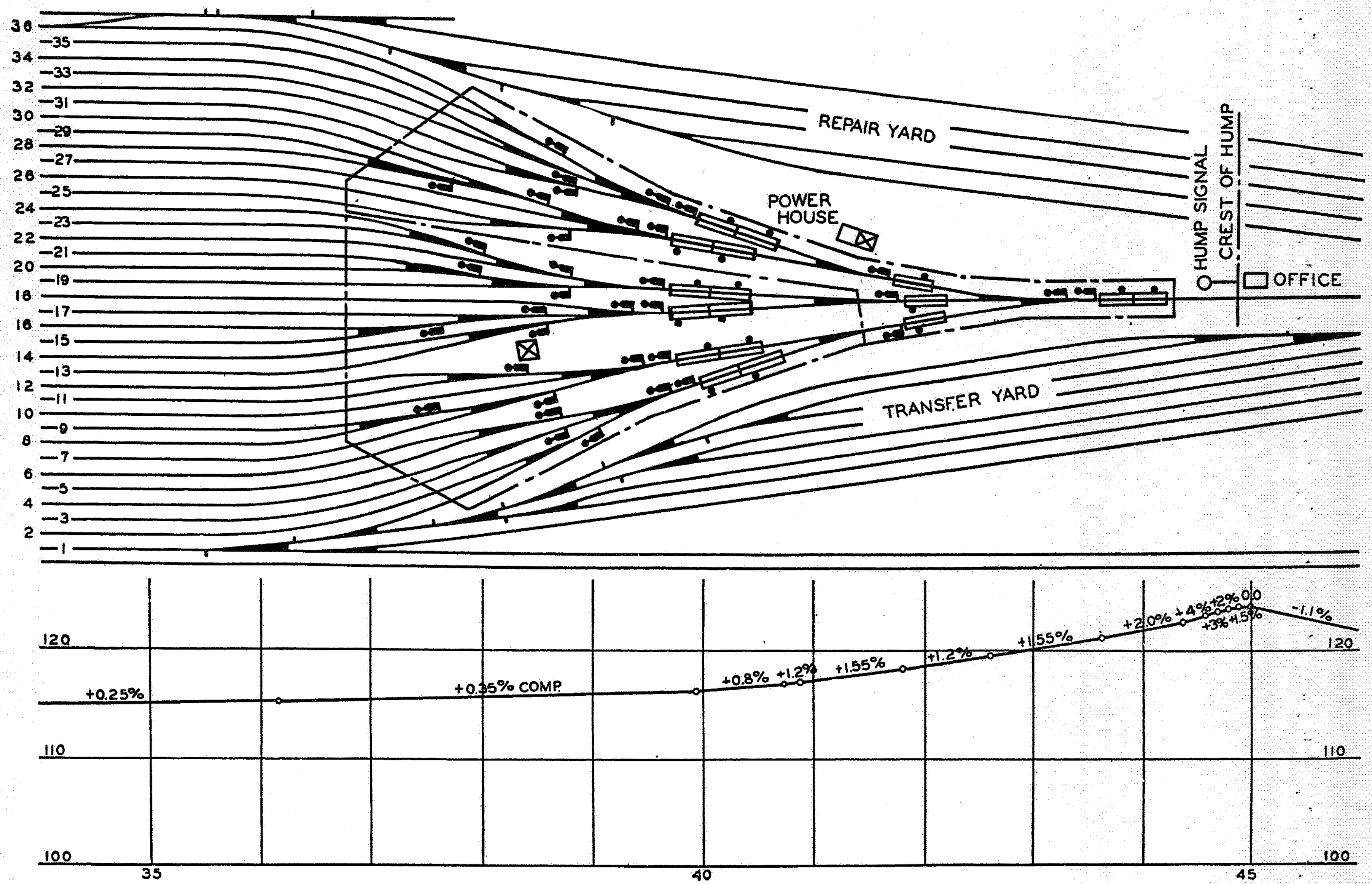


Fig. 6.
Mechanicville Yard, Boston & Maine R. R.

Fig. 7.
Stanley Yard, New York Central Lines.

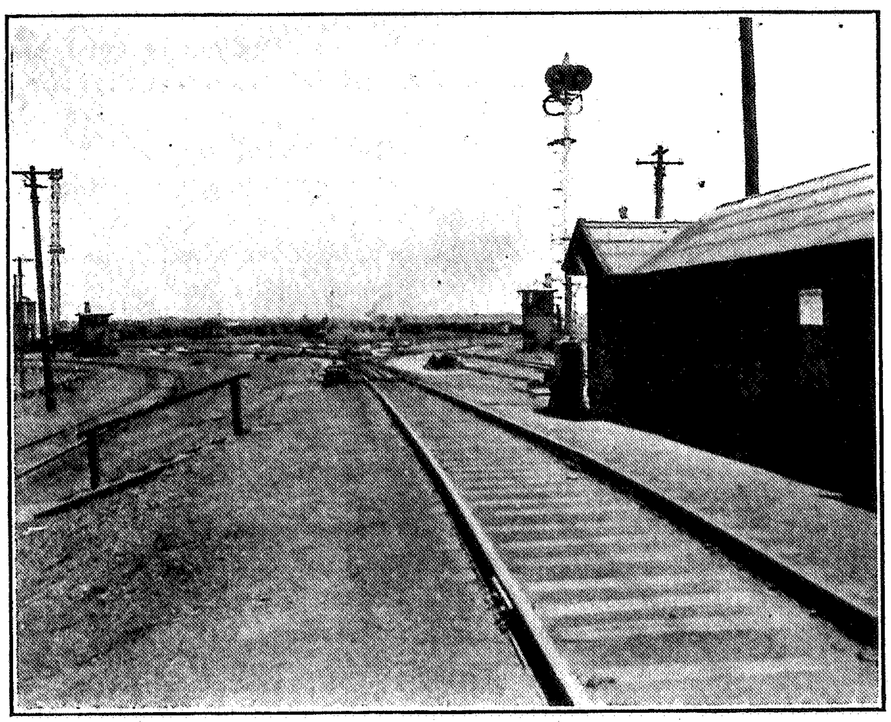


Fig. 8.
Eastward Galesburg Yard, Chicago, Burlington & Quincy R. R.

Such an operation provides for an even spacing of cars which allows ample time for the operation of switches between cars and insures a maximum humping capacity.

Track circuits for protection against the operation of switches under cars were not used in the earlier installations, since it was believed they would slow up operation. In designing the more recent track layouts and gradients, it was found that track circuits could be used to advantage and that the running of cars at a higher speed provided a sufficient spacing for the operation of switches between cars. The use of track circuits has resulted in economy by preventing damage to cars and contents as well as to roadway equipment, by eliminating derailments due to switches being operated between trucks.

Car Retarders

General principles.

Retardation is secured by applying pressure to shoes which contact with both the inside and outside faces of the car wheel, thus providing friction which opposes the turning of the wheel; this pressure is cushioned by springs or some other means.

Retardation is obtained in proportion to the pressure applied, the coefficient of friction, the height of the contact between the shoe and the wheel and the length of the retarder.

Means is provided for varying the amount of pressure so as to vary the degree of retardation and also to move the shoes to an open position, thus allowing cars to run free without retardation.

Smoothness in retarding is considered important in the retarders used in Great Britain and on the Continent since the cars to be handled are lightweight and more easily retarded, and, therefore, if the retardation is too severe the contents of the cars might be shifted, thus causing damage.

In America the ratio of retardation to the weight of car is much lower and, therefore, there is practically no possibility of shifting the contents in the car.

Since the height at which the shoe bears against the wheel is low there is a chance of lifting a car if too much pressure is applied and when the car is lifted a derailment may occur. Equalized shoe pressure is used, generally, so that a maximum average pressure can be secured without having pressures, per wheel, in excess of that at which wheels will lift. There is a variation in the spacing of wheels on axles as well as thickness of wheels, therefore equalized shoe pressure is of advantage in compensating for this variation. The forces throughout the retarder are self-contained and the design is usually such that the parts will adjust to compensate for uneven surfacing. Adjustment is provided to compensate for the wear of shoes and bearings. The construction is sufficiently strong to withstand heavy shock. Provision is made in the design so that ties can be tamped.

Types of retarders.

Two general types of retarders have been developed and installed, in America. One, the "electric," uses electricity for both control and operation;

while the other, the "electro-pneumatic," uses electricity for control and compressed air for operation. Both provide four steps of retardation as well as the open or free position. These are usually used as follows:

Open position..no retardation.
First position..empty cars.
Second position..light loads.
Third position..medium loads.
Fourth position..heavy loads.

Electric retarder, Type A.

This type, Fig. 9, was first installed at East St. Louis, Ill., on the Illinois Central R. R., February 1926, and later at South Markham Yard on the same road, May 1926; at Blue Island, Ill., Indiana Harbor Belt R. R., August 1926; and at Hartford, Conn., on the New York, New Haven & Hartford R. R., October 1926.

The foundation consists of a series of ties held together by tie bars, one on one end, one in the middle and by an angle bar and crank bar on the other end. The mechanism is attached rigidly to the angle bar and is supported on three ties. The rails are held in position by chairs which are formed to fit the rail contour and which also space the rail from the tie.

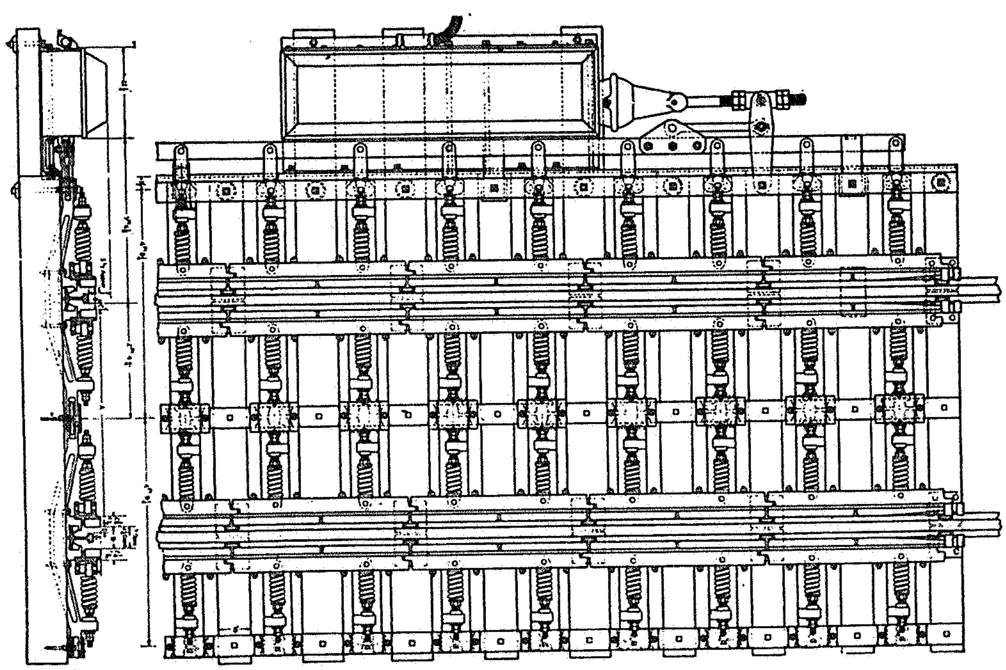


Fig. 9.
Electric Retarder, Type A.

The shoes are bolted to the shoe beams which slide back and forth in grooves in the chairs and which interlock with the chairs to prevent their lifting. The shoe beams are 3 feet 8 inches in length and are articulated by a tongue and groove arrangement so that pressure is transmitted from one beam to the other and so that there is a flexing of the assembly to compensate for variation in the thickness and the spacing of wheels.

The pressure between the shoe and the wheel is provided by springs which are backed up by a lug on a cross member or girder which in turn is operated and held in position by a T-crank, driven by a longitudinal operating bar and eventually the mechanism. The spring is kept in line by a spring rod which is pinned to the shoe beam at one end and which slides in a bearing in the girder lug. Adjustment for the initial spring pressure is provided by adjusting nuts on the spring rod and the position of the shoe is obtained by adjusting nuts on the spring rod which shift the beam with relation to the lug on the girder. Guides keep the girders in line at both the outer and center tie bars. Two pairs of girders are assembled in the space between ties, one pair being connected end to end in the center by a link and to one side of a T-crank and the other pair to the other side.

Movement of the T-crank provides a push on one pair of girders and a pull on the other pair and it will be noted in Fig. 9 that one pair of girders is connected through the medium of the springs to shoe beams on the side of the rail nearest the mechanism and the other pair to the shoe beams on the side of the rail furthest from the mechanism. Since the spacing of the holes between the pivot for the T-crank and the pin connecting the crank to the girders is the same for both pairs of girders, any movement of the crank provides equal movement as between the inside and outside shoes to and from the rails.

A large lever is pivoted in the crank and angle bar and a link between this lever and a lug on the operating bar provides a connection to the mechanism throw rod, the latter being moved out and in from the mechanism because of its connection at a point eccentric to the axis of a large gear. The gear is driven by a motor and gearing, through an angular movement of less than 180 degrees. The motor is equipped with a magnetic brake which is released when current is flowing through the motor and applied by spring pressure otherwise.

The operation consists of running the motor until the proper position of the shoes is obtained and then cutting off power from the motor, automatically, by means of a limit switch or master controller at which time the brake is applied. This holds the operating bar, the T-crank and girders in a fixed position and as wheels pass through the retarder the shoe beams are pressed away from the rail by the wheel since the wheel is thicker than the space between the shoes and thus the springs are compressed to provide the pressure necessary for retardation. Any change in the spacing of shoes provides for a variation in the pressure against the wheel and, therefore, a variation in the degree of retardation. The retarder may be used for its full length or may be closed or opened at the will of the operator to secure more or less retardation but the usual practice is to close the retarder before the car enters and then open it when the car speed is correct.

Two or more retarders may be assembled end to end and joined together at the point where the shoe beams articulate, thus forming one long retarding surface operated by two or more individual mechanisms which are operated from separate control levers so as to secure various degrees of retardation on each of the units independent of the other units.

An adjustment is provided on the throw rod to compensate for wear of shoes and bearings. Occasionally it is necessary to adjust the position of the shoes to obtain proper alignment and this is done individually at the spring rod.

This retarder is used in lengths varying from 14 feet 8 inches to 40 feet 4 inches in multiples of 3 feet 8 inches and in some cases is used on one rail only, where it is necessary to locate it opposite the frog of a switch.

Electro-pneumatic retarder, Markham type.

This type of retarder, Fig. 10, was first installed at Northbound Markham Yard on the Illinois Central R. R. in March 1926 and in the South Yard at Gibson, Ind., on the Indiana Harbor Belt R. R. in August 1926.

Fig. 10.
Electro-Pneumatic Retarder, Markham Type.

This retarder is a refined design of the retarders used in the North Yard at Gibson, Ind., on the Indiana Harbor Belt R. R. The operating mechanism and control devices were entirely new in design.

Figure 11 is a diagrammatic sketch of the arrangement of the Markham type retarder. When air is admitted in back of the piston in the cylinder the piston and its piston rod move outwardly (toward the left), the various levers moving in the direction shown by arrows, and bringing the brake shoes to their closed position. As the car wheel enters the retarder, springs, shown in Fig. 10, take up the initial shock and compensate for the variation in the wheel thickness and spacing on the axle, the retardation being effected by the compressed air in the cylinder resisting the reverse action of the levers caused by the car wheels spreading the position of the brake shoes. The four degrees of retardation are obtained by varying the pressure in the cylinder and thus varying the resistance to the reverse action of the linkage. To open the retarder air is admitted to the reverse side of the piston and exhausted from the operating side. There are, thus, just two positions of the brake shoes, closed and open. The entire structure is mounted on ties.

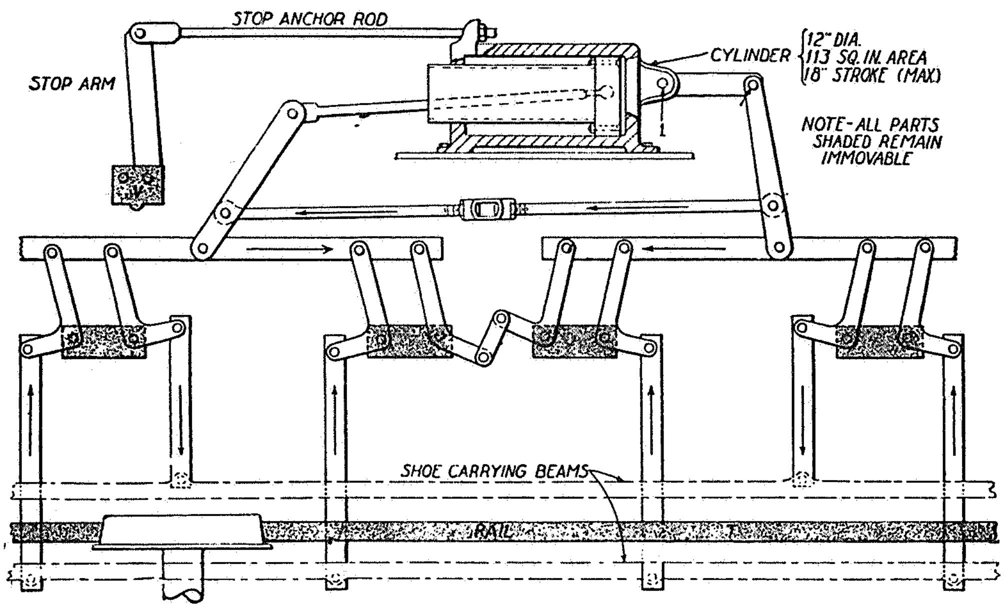


Fig. 11.
Diagrammatic Sketch of Markham Type Retarder.

Electro-pneumatic retarder, Boston type.

In the reconstruction of the Mystic Junction Yards at Boston, Mass., on the Boston & Maine R. R., less space was available which necessitated the design of a sturdier and more powerful retarder than the Markham type. The Boston type, shown in Fig. 12, was installed September 1927 at Mystic Junction Yard and subsequently at Allentown, Pa., on the Central R. R. of New Jersey, and at Portsmouth, Ohio, on the Norfolk & Western Ry.

The Boston type retarder is similar to the Markham type in the use of springs to take care of the variations in wheel thicknesses and spacing on axles and the first shock on the entrance of a car and in the use of the air cushion to provide the various degrees of retardation. The linkage from the operating cylinder to the cranks is also very similar. The remainder of the linkage is, however, quite different. The outer ends of the springs are fixed.

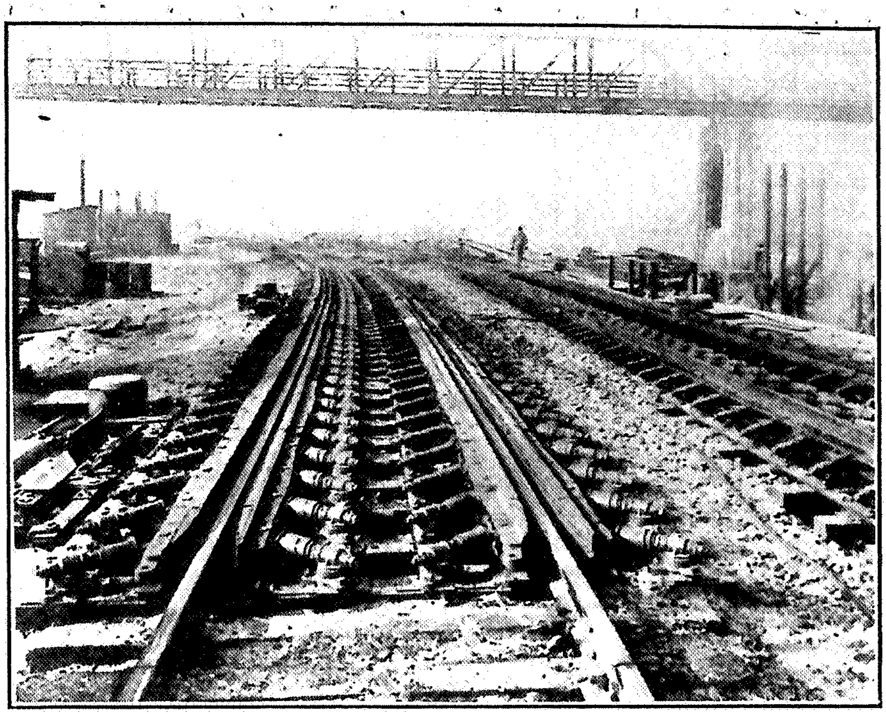


Fig. 12.
Electro-Pneumatic Retarder, Boston Type.

The inner ends of the springs are fastened to the brake beams (which carry the brake shoes). The brake beams are moved by a driving bar, located beneath them and parallel to the rail. To close the retarder air is admitted to the operating cylinder causing the piston and rod to move out. The linkage then moves the driving bar in a direction opposite to the direction of traffic with result that each brake beam, due to the fixed pivot of the springs, moves toward the rail, but in an arc, rather than at right angles.

Electric retarder, Type B.

The first Type B retarder, Fig. 13, was installed in December 1927, at Mechanicville, N. Y., on the Boston & Maine R. R., and later at Selkirk (near Albany, N. Y.), DeWitt (near Syracuse, N. Y.) and Gardenville (near Buffalo, N. Y.) on the New York Central R. R.; Lancaster (Fort Worth, Tex.) on the Texas & Pacific Ry.; Coxton (near Pittston, Pa.) and Oak Island (near Newark, N. J.) on the Lehigh Valley R. R.; Proviso (Chicago, Ill.) on the Chicago & North Western Ry.; Northrup Avenue (Providence, R. I.) on the New York, New Haven & Hartford R. R.; West Detroit, Mich., on the Michigan Central R. R.; Toledo and Stanley (near Toledo, Ohio) on the Ohio Central Lines.

Mechanicville Yard was among the first yards to be built with the tracks arranged in groups of six and with one group of retarders serving each group of tracks. The track space available for retarders was much less than in

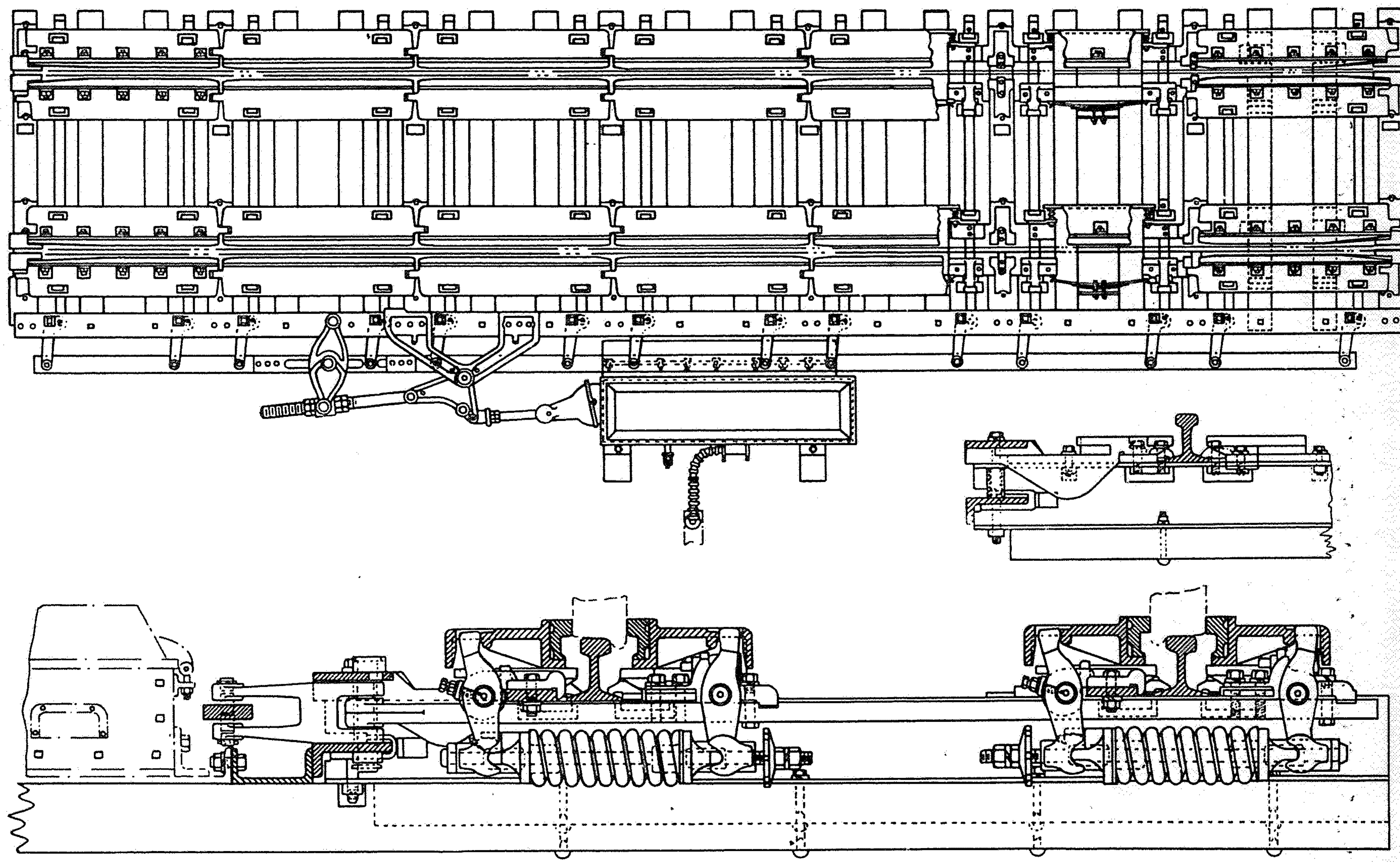


Fig. 13.
Electric Retarder, Type B.

former yards which necessitated the designing of a retarder which had about twice the capacity for retardation of the Type A.

The foundation of the Type B retarder consists of H-section steel cross-ties located at 5 feet 6 inch centers, or at every third tie spacing, and on 9 inch by 12 inch wood ties set on edge. These steel ties or beams transmit all the forces necessary to oppose the forces set up in the crossbars, this differing from the Type A retarder where the opposing forces were carried in the girders. The tie spacing is maintained by two tie bars located one along each rail but on the side nearest to the mechanism. The chairs which support and guide the shoe beams are bolted to the steel ties. The rails are supported by the steel ties and by tie plates on the wood ties and are held in place by rail clips.

The crossbars are located between the steel tie and the next adjacent wood tie and are supported by wings projecting from the chairs and from the tie plates on adjacent wood ties. The fixed levers are supported in brackets bolted rigidly to the tie bars whereas the floating levers are supported by brackets bolted rigidly to the crossbars. The spring is suspended between the two lower ends of the fixed and floating levers and contact with the levers through a modified knife-edge bearing. The upper ends of the levers contact with the shoe beam at as high a point as is possible when considering clearances. This point is very nearly opposite the point where the wheels contact with the shoes, thus providing for nearly a straight line transmission of force to minimize the pressures between the shoe beam and chair.

The crossbars are connected to an L-type crank which is pivoted on a pin projecting through the crank bar and angle bar which are bolted rigidly to the steel tie as well as the wood tie. The operating bar is supported and connected to the outer ends of the L-type cranks and is driven through the medium of a lever which has one end pivoted in the crank bar and angle bar and the other end connected, by a trunnion and adjusting rod, to the toggle crank. The toggle crank is driven by the throw rod which (the same as in the Type A retarder) is moved back and forth by the mechanism.

Figure 14 is a diagrammatic sketch illustrating the closed and open positions for the Type B retarder. The full lines show the open position and the dotted lines the closed position. It will be noted, in the open position, that the pin connecting the throw rod to the drive gear is at the extreme point of the stroke from the toggle crank and that, as this gear turns, the throw rod is moved toward the toggle crank, thus moving the toggle crank, lever and operating bar away from the mechanism. This pivots the operating crank and pulls the crossbar crosswise to the track and toward the mechanism side of the track.

A centering spring (leaf spring, not shown), attached to the shoe beam and having a bearing on brackets attached to the tie bar, takes up all play starting with the shoe beam on the fixed lever side pressing against the upper end of the fixed lever which tends to pivot the fixed lever, thus transmitting pressure from the lower end of the lever to the spring seats and spring and then to the lower end of the floating lever, thus tending to pivot the floating lever against a stop which is part of the floating lever bracket. This pressure

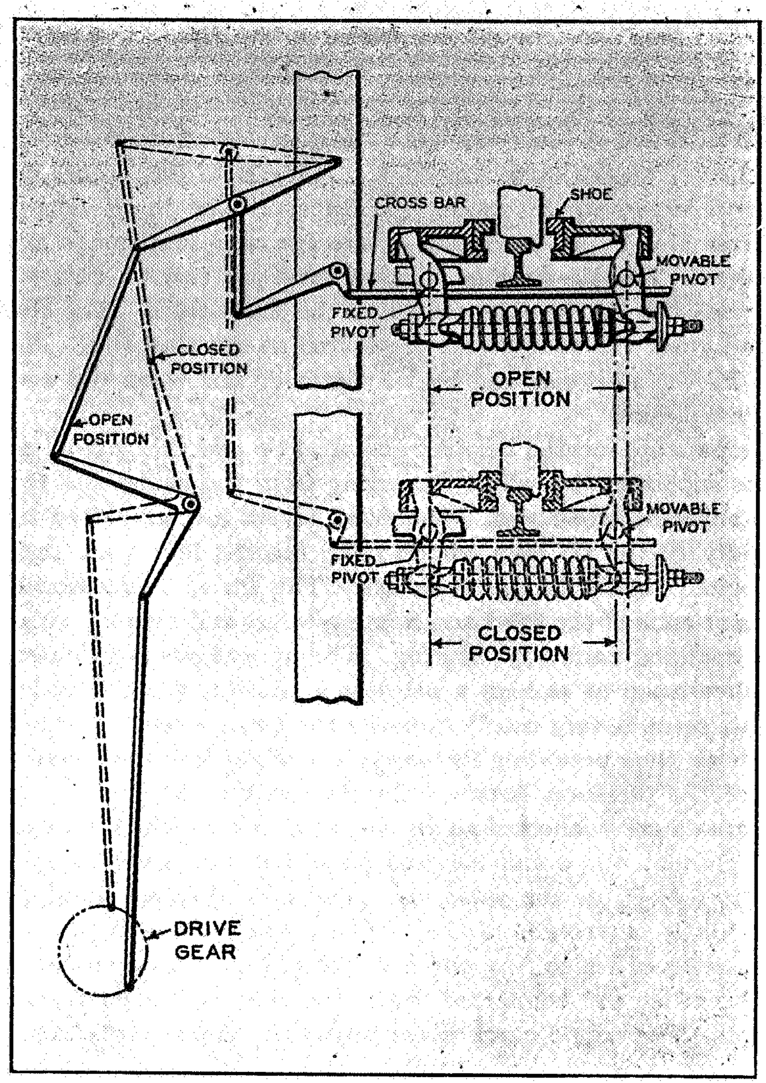


Fig. 14.
Diagrammatic Sketch, Type B Retarder.

maintains a fixed angular relation between the floating lever and the crossbar, unless a car wheel moves in between the shoes, and also takes up all lost motion in bearings.

The lever ratio for both the fixed and floating levers is one to one: for example, when the crossbar is moved one inch, the upper end of the floating lever and the shoe beam with which it contacts also is moved one inch toward the rail. The spring and spring seat are moved crosswise underneath the rail which pivots the fixed lever, causing a one-inch movement of its upper end. This moves the shoe beam on the fixed lever side one inch toward the rail and when the crossbar is moved in a direction away from the mechanism, the operation of the parts mentioned is exactly the reverse, therefore any movement of the crossbar provides a movement of the shoe beams on both sides of the rail, toward and away from the rail, each being moved an equal distance.

As described for the Type A retarder, the brake attached to the motor holds in a fixed position all parts except the two shoe beams, the fixed and floating levers and the spring and its spring seats. As the wheel moves in between the shoes, the shoe beams are moved back against the upper ends of the levers, thus forcing the lower ends together compressing the large spring. Consequently the pressures resulting on either side of the wheel are equal since one spring is responsible for both pressures.

The Type B retarder is positioned to four definite distances between the shoes to secure a variation in retardation. For example, the maximum retardation is obtained with a 3⅞ inch spacing of shoes (without the wheel between the shoes). The minimum retardation is obtained with a spacing of 5 inches between the shoes. Since the wheel thickness is approximately 5½ inches this provides for a compression of the spring of 1⅝ inches for the maximum retardation and approximately ½ inch for the minimum retardation.

Figure 15 is a simplified sketch representing the parts adjacent to a wheel and Fig. 14 illustrates the actual parts represented in Fig. 15. The hand in Fig. 15 represents the mechanism and other parts holding a crossbar in a fixed position.

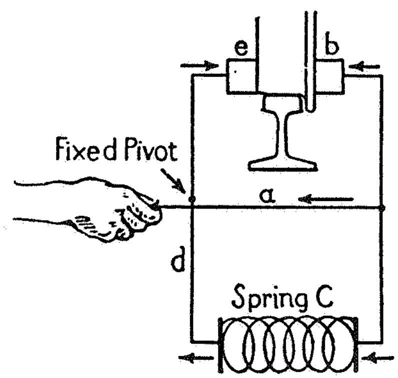


Fig. 15.
Principle of Operation, Type B Retarder.

It will be seen that, with a wheel between shoes E and B, the pressure from spring C is transmitted through the levers to the wheel through shoes E and B. Any additional pull on the crossbar will tend to move crossbar A further compressing spring C which increases the pressure applied to the wheel. Decreasing the pull on the crossbar will permit it to move, and lessen the spring pressure, thus reducing the pressure applied between the shoes and the wheel.

The shoes are L-shaped and attached to the shoe beam by means of five bolts. The outside shoes are made so that the top edge is 2 inches above the top of the rail whereas the inside shoes have a height of 2½ inches above the top of the rail. The outside shoes are made of steel, specially treated, to provide long wear as they contact with the roughest and greasiest side of the wheel. The inside shoes are made of softer steel as the inside of the wheel generally is clean and fairly smooth. The extra height of the shoe above the top of the rail provides for extra retardation.

The combination of high inside and low outside shoes assists in preventing derailments since if a wheel is lifted the face of the wheel rides the outside shoe and is guided by the inside shoes, due to their extra height, until the wheel reaches the end of the retarder and then drops on the rail.

As the face of the shoes wears off it is necessary to move them in toward the rail so as to provide the required spacing. The adjustment is made by moving the trunnion outward on the adjusting rod, this being sufficient for all shoes in the retarder.

Excessive wear in bearings is taken up by applying horse-shoe shaped shims so as to interlock with each other, between the spring and the spring seat thus moving the lower ends of the levers apart and moving the upper ends of the levers and the shoe beams toward the rail. Additional adjustment facilities are provided in the shoe beam at the point where the lever contacts with the beam, where shims are placed between a wearing block and the main part of the shoe beam so as to shift the beam toward the rail. All the adjustment facilities taken together compensate for a large amount of wear in bearings.

A large number of the bolts in the retarder can be tightened without the removal of parts. However, some of them cannot be reached without removing the shoe beams. The shoe beams are opened to the removable position by changing the connection between the adjusting rod and the toggle crank so that it will be connected in the fourth hole in the toggle crank which is very close to the connection to the throw rod and then operating the mechanism to produce an opening between the shoes, wider than normal, to a point where the beams can be lifted vertically from the retarder. After the shoe beams are removed all parts in the retarder are easily reached for maintenance purposes.

A pressure lubricating system is used throughout for all pin type bearings, most of the pins being drilled through the center and outward to each bearing to transmit the grease. Oil is used to lubricate all sliding surfaces.

It will be noted that the toggle crank is supported from the angle bar and crank bar with its pivot outside the path of travel of the operating bar. The design of this crank and its position gives enough additional mechanical advantage to permit the use of the same mechanism used on the Type A retarder, minor changes being made in the adjustment of the mechanism controller to secure the proper shoe spacing for the various degrees of retardation.

The mechanism, Fig. 16, consists of a train of specially heat-treated gears, the large gear being the one to which the throw rod is connected, the pin, reference 14, being used for this purpose. The horizontal shaft, carrying a bevel pinion meshed with the bevel gear, runs in roller bearings whereas the other shafts run in bronze bearings. The lower half of the gear case is filled with a splash lubricant for lubricating the lower bearings and the gear teeth while the upper bearings are lubricated by a pressure system.

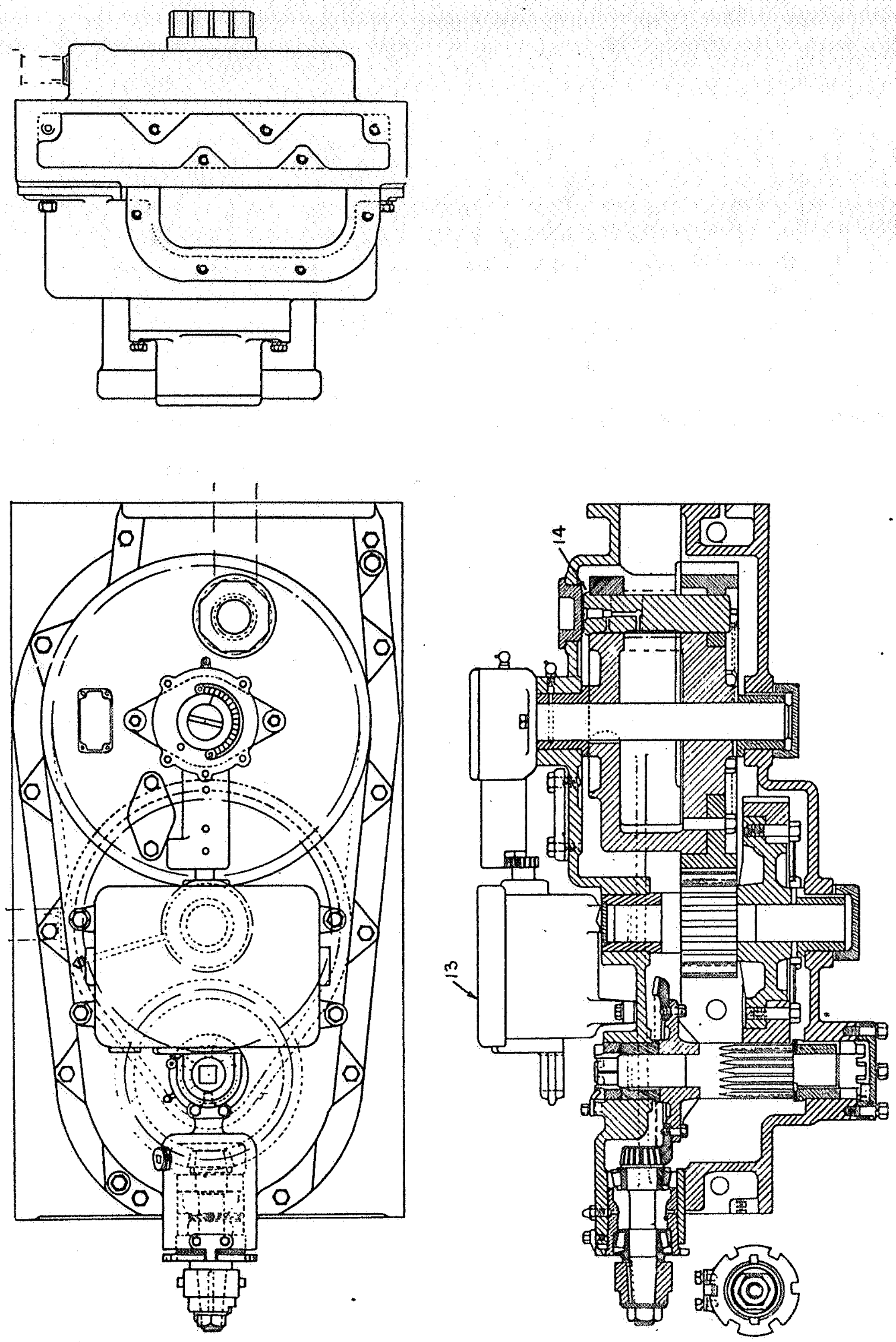


Fig. 16.
Mechanism for Types A and B Electric Retarders.

The mechanism controller, reference 13, Fig. 16, is driven by bevel gears and pinion gears from the large gear shaft, and as shown in Fig. 17, consists of a cam shaft upon which five cams are assembled. These cams contact with an idler finger to which the control contacts are linked. The operation and function of the mechanism controller contacts will be explained later.

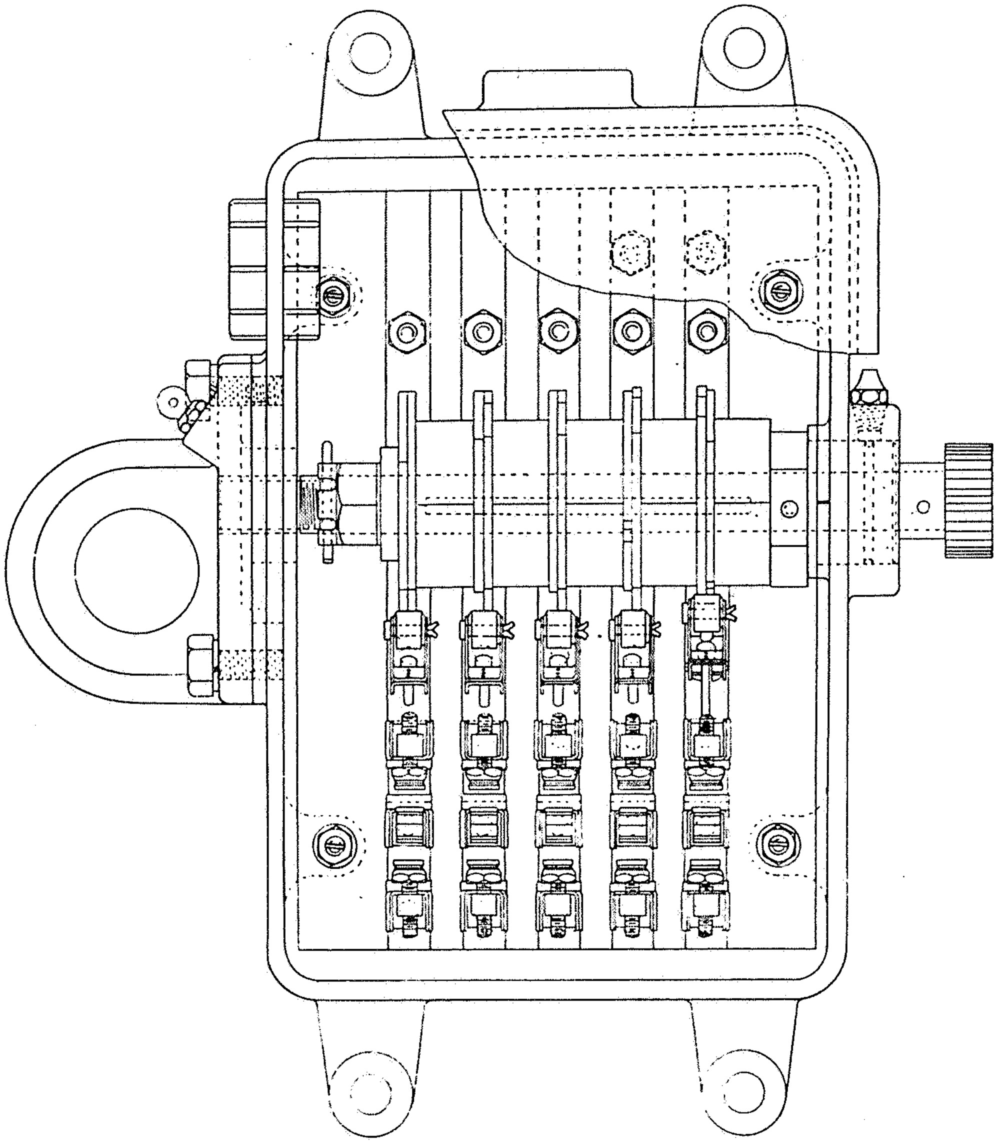


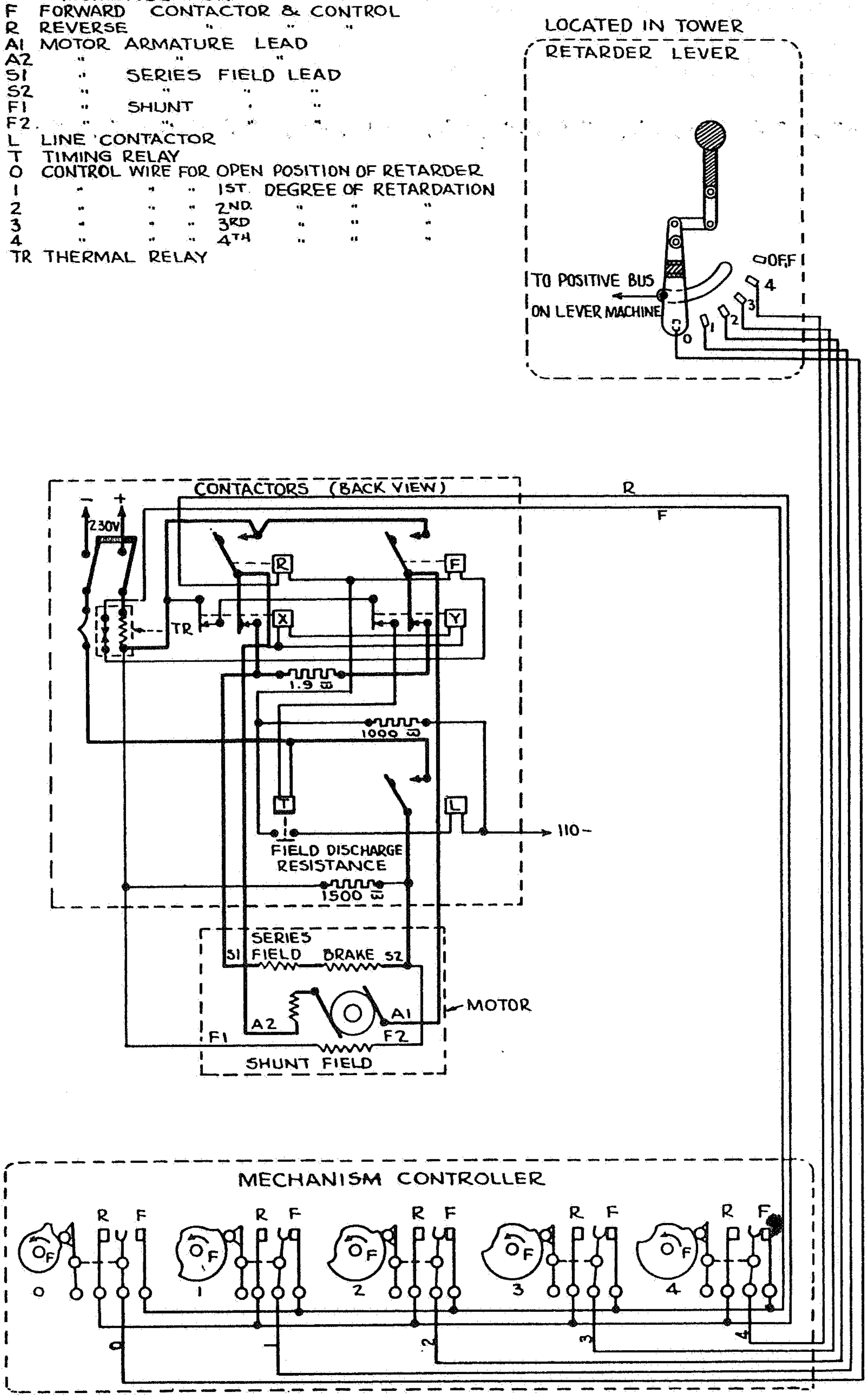
Fig. 17.
Master Controller for Types A and B Mechanism.

A 5 horse power, 230-volt compound wound crane type motor is assembled in the main housing and connected to the mechanism by means of a short universal coupling. The brake is of a disc type, permanently attached to the motor.

The control circuit for the retarder is shown in Fig. 18. Five wires are used from the retarder lever to the mechanism controller of the retarder mechanism, one being connected to the center contact of each group of contacts. Two control wires, one for closing and one for opening, are connected to the outside contacts and extend from the mechanism controller to the contactor panel which is located in a sheet steel housing near the retarder.

NOMENCLATURE

F FORWARD CONTACTOR & CONTROL
R REVERSE " "
A1 MOTOR ARMATURE LEAD
A2 " " "
S1 " SERIES FIELD LEAD
S2 " " "
F1 " SHUNT " "
F2 " " " "
L LINE CONTACTOR
T TIMING RELAY
O CONTROL WIRE FOR OPEN POSITION OF RETARDER
1 " " " 1ST DEGREE OF RETARDATION
2 " " " 2ND " " "
3 " " " 3RD " " "
4 " " " 4TH " " "
TR THERMAL RELAY



RETARDER MOVES FORWARD OR REVERSE TO ANY POSITION 0-1-2-3 OR 4 DEPENDING UPON POSITION OF LEVER. EITHER "F" OR "R" IS ENERGIZED DEPENDING UPON POSITION OF RETARDER WHEN LEVER IS MOVED TO A NEW POSITION & DE-ENERGIZED WHEN RETARDER HAS MOVED TO A NEW POSITION & THE MECHANISM CONTROLLER CONTACT FOR THAT POSITION HAS BEEN MOVED TO NEUTRAL.

L LINE CONTACTOR CONTROLLED THROUGH TIMING RELAY T.

T TIMING RELAY CAUSES POWER TO BE CUT OFF FROM MOTOR IF IT SHOULD BECOME STALLED TOO LONG.

TR THERMAL RELAY PROVIDES OVERLOAD PROTECTION FOR MOTOR.

X & Y - WHEN ENERGIZED, INSURE GOOD CONTACT PRESSURE IN CONTACTS X & Y

Fig. 18

When the control lever is moved to any one of the five positions, current flows over the corresponding control wire to the mechanism controller and through contact F or R, depending upon which is closed over wire F or R to contactor F or R. If contactor F is energized, the front contact is closed and the line contactor is energized, since it is in series with either one of the contactors, depending upon which is energized, thus completing the operating circuit.

In operating, current flows from a positive local bus wire, through a knife switch and the heating element of a thermal relay, through the front contact of contactor F, through the armature and the commutating field of the motor; through the back contact of contactor R, through the series field of the motor and brake coil, through the contact of the line contactor; to the negative side of the line. For opening the retarder, contactor R is energized and current flows in almost the same path as already described except that it is through the armature in the reverse direction which causes a reversal of the motor.

As the mechanism is moved, the cams of the mechanism controller are rotated and at a definite point in each cam there is a dwell at which time the center finger is moved free of both contacts F and R, thus de-energizing whichever contactor may be energized, cutting off current from the motor and applying the brake. The de-energizing of both contactors F and R shorts the armature through a 1.9 ohm resistor which, in combination with the residual remaining in the field cores, provides dynamic braking to assist the brake in stopping the motor. After passing through the dwell on the cam, one or other contacts in the mechanism controller are closed which selects the contactor which must be energized to obtain the proper rotation of the motor. Therefore, regardless of the position in which the control lever is placed, the mechanism will follow immediately to that position and stop, thus positioning the shoes for a definite spacing and consequently a definite degree of retardation.

Protective devices are used: first, a time relay so as to limit the time in which the motor is energized for any given movement; and second, a thermal relay which opens in case the motor is heated excessively. The time relay normally is energized through back contacts on relays F and R and is de-energized when either of these relays is energized. The timing is obtained by a lag in the breaking down of the flux; a 5 to 7 second timing is obtained.

Electro-pneumatic retarder, Model 28.

The Model 28 retarder, Fig. 19, was designed to make available a retarder even more powerful, more rugged and more flexible than the Boston type. Complete installations were made at the Sharonville Yard (near Cincinnati, Ohio) of the Cleveland, Cincinnati, Chicago & St. Louis Ry.; the Cedar Hill Yards (near New Haven, Conn.) of the New York, New Haven & Hartford R. R.; the Pitcairn Yard (near Pittsburgh, Pa.) of the Pennsylvania R. R.; the Russel, Ky. Yard of the Chesapeake & Ohio Ry.; the Potomac Yard (near Washington, D. C.) of the Richmond, Fredericksburg & Potomac R. R.; the Marion, Ohio Yard of the Erie R. R.; and the Galesburg, Ill. Yard of the Chicago, Burlington & Quincy R. R. Additional installations were made in the Gibson Yard of the Indiana Harbor Belt R. R.; the Portsmouth, Ohio Yard of the Norfolk & Western Ry.; the Allentown, Pa. Yard of the Central Railroad of New Jersey; and the Mystic Junction Yards (Boston, Mass.) of the Boston & Maine R. R.

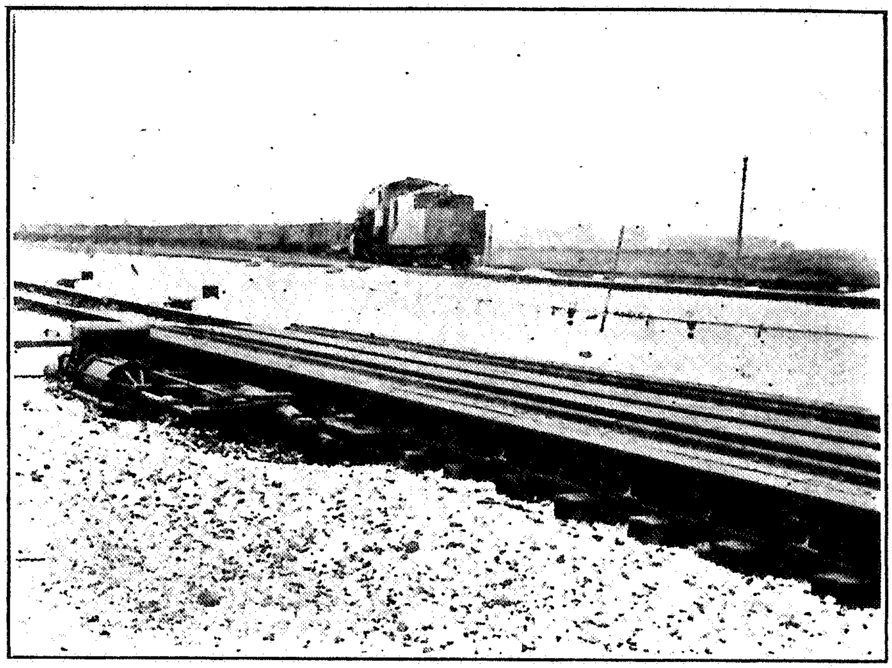


Fig. 19.
Electro-Pneumatic Retarder, Model 28.

The Model 28 retarder may be said to be divided into three parts: the brake cylinder assembly, the driving linkage and the radius rod brake beam assembly.

The brake cylinder, used for operating the Model 28 retarder, is anchored to a bearing plate in such a manner that the reaction through the bearing plate and driving cranks forms a closed system of forces. This cylinder has two pistons, a main and an auxiliary.

The piston rod of the brake cylinder is connected to the floating toggle lever by means of the piston connecting link. One side of the floating toggle lever drives the inside brake shoe beams through the associated connections; the other side of the toggle drives the outside brake shoe beams through similar parts.

Connected to the floating toggle is a centering unit. This is a spring mechanism which exerts enough resistance to maintain the floating toggle lever in such a position that, when the retarder is either being opened or closed, the brake shoe beams take the proper position with relation to the rail.

Figure 20 shows the linkage in the open position. With the control lever in either the first, second or third position, the toggle lever moves until it makes a slight angle with the toggle connecting rods as illustrated in Fig. 21.

This angle is great enough to permit the reaction caused by a car entering the retarder to tend to drive the piston back. Thus, in these three positions the general principles of the earlier designs of electro-pneumatic retarders are followed, using springs for the initial shock and wheel variation compensation and an air cushion for the retardation.

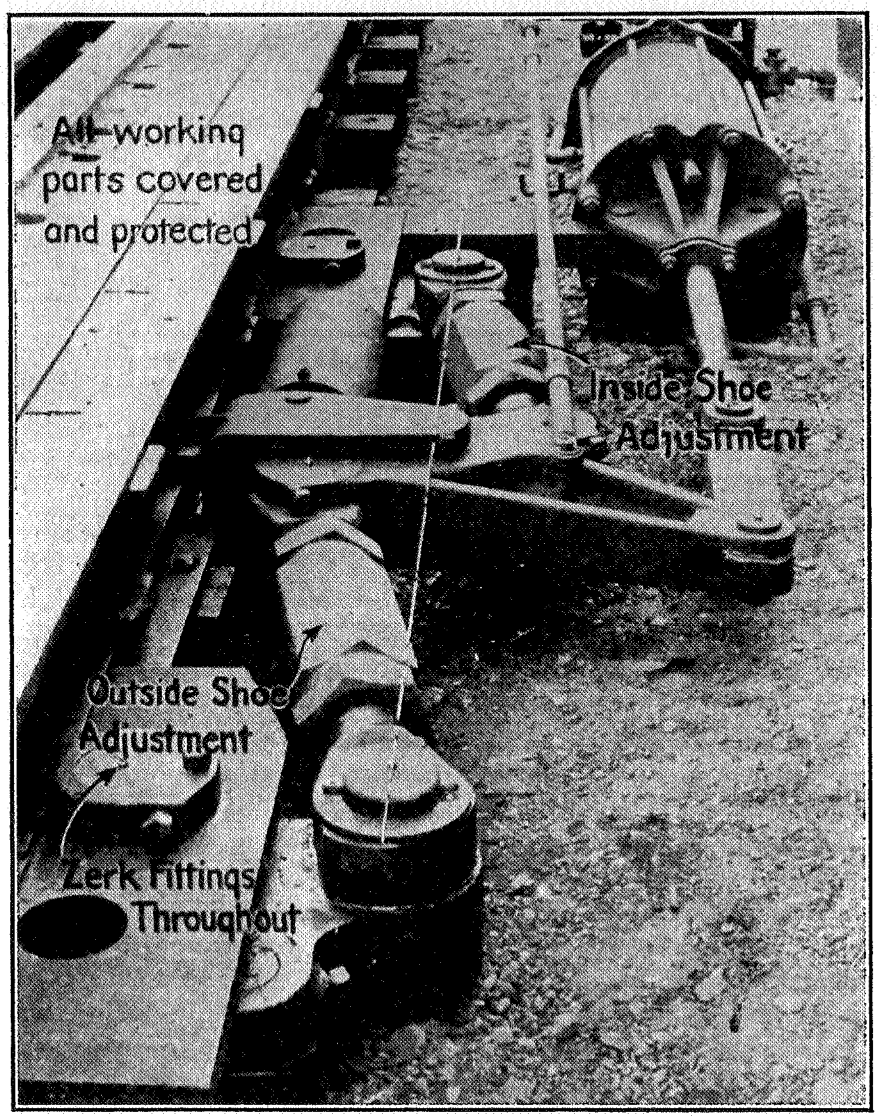


Fig. 20.
Linkage of Model 28 Retarder in Open Position.

With the control lever in the fourth position, however, the toggle lever forms nearly a straight line with the outer driving links as shown in Fig. 22. Thus, although it does not come into a dead center position, its position will be close enough to dead center so that with the air pressure applied (regulated by the control circuit), there will be no movement of the piston during retard-

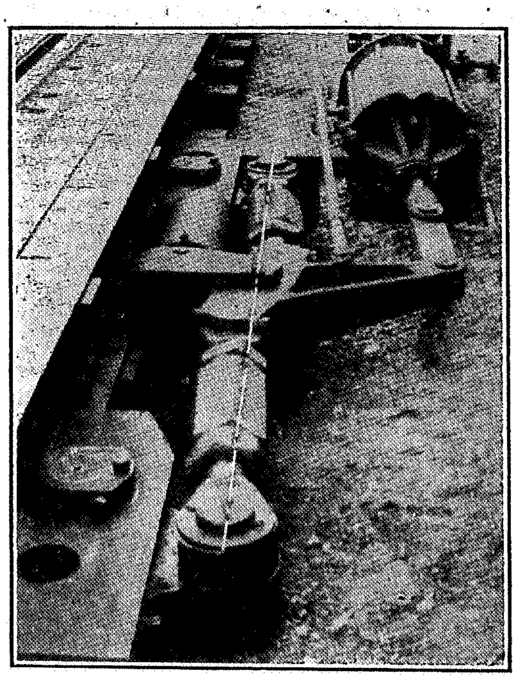


Fig. 21.
Linkage of Model 28 Retarder in First, Second or Third Position.

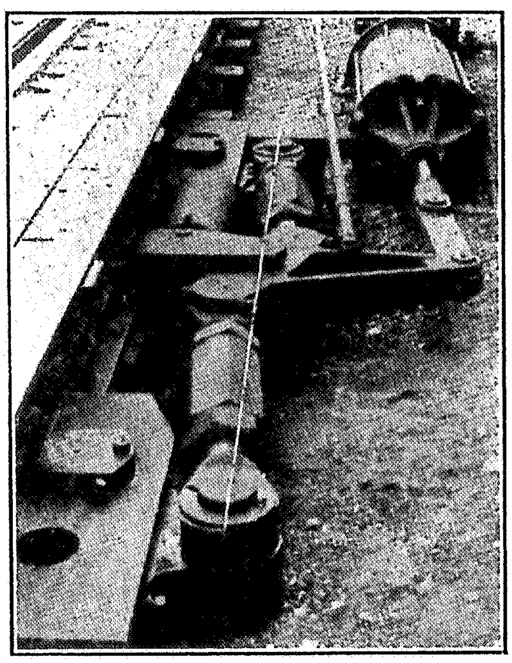


Fig. 22.
Linkage of Model 28 Retarder in Fourth Position.

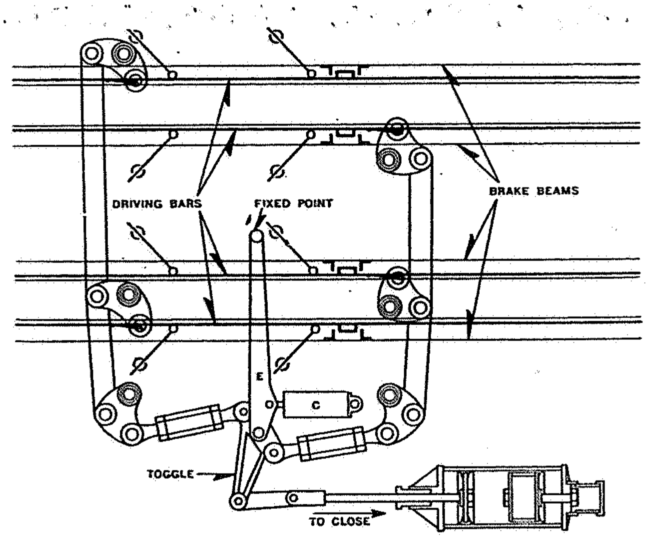


Fig. 23.
Diagrammatic Sketch of Model 28 Retarder.

ation. Therefore, in the fourth position the retardation is obtained by the deflection of the springs, and the air is used only to hold the toggle in place. If a locomotive, with its comparatively wide driving wheels, should move through a closed retarder, the greater movement of the brake shoes and the consequent greater deflection of the springs causes the toggle to "break" and the parts take the position shown in Fig. 21.

Referring to Fig. 23, note that the centering unit C, consisting of a double-acting spring and housing, tends to keep the brake shoes always in proper relation to the rails as it opposes movement of lever E. The initial compression adjusted into the centering spring is sufficient to overcome any ordinary friction which would tend to prevent the shoes from closing or opening properly with relation to the rail.

When a car enters the retarder, the reaction of the two inside sets of brake shoe beams is opposed to the reaction of the two outside sets of beams. This construction equalizes the pressures of the brake shoe beams and at the same time provides a centering force which maintains the center line of the trucks over the center line of the track. This condition of balance or equalization holds because the floating toggle lever is free to move, relatively speaking, lengthwise of the retarder.

When too great a retardation pressure is applied to light cars the wheels may be forced out from between the brake shoes. In such a case the wheels will ride the brake shoes to the end of the retarder and then drop back on the rail. The guide rails which are built into the end of the retarder insure that the wheels always drop back on the rail.

The turnbuckles in the toggle connecting rods provide adjustment to compensate for normal brake shoe wear and reasonable wear in the parts of the driving linkage. One adjustment is provided for the outside shoes and another for the inside shoes. If it is necessary to adjust any particular shoes independent of the others or to compensate for wear in the driving linkage, this can be done by means of the self-locking radius rod adjusting nut.

Again referring to Fig. 23, note that the arms of the outer and inner driving cranks are constructed at obtuse and acute angles respectively, instead of right angles. This provides a linkage that maintains a nearly constant mechanical advantage whether the retarder is adjusted for new or worn shoes and results in practically the same open dimension being maintained for the various conditions of shoe wear without the necessity of changing the piston stroke.

The cranks are mounted in heavy "H" beam structures securely riveted together. (See Fig. 19.)

In detail, the radius rod brake beam assembly has been changed from that in the Boston type retarders although it is the same in principle. The radius rod assembly is composed of a radius rod shaped to form a pin at the brake beam end; a helical coil spring; a self-locking radius rod adjusting nut that adjusts the effective length of the radius rod without affecting spring adjustment; a spring adjustment nut and a trunnion which is supported top and bottom.

The heavy top flange of the brake beam and the heavy top plate of the trunnion bearing plate assembly practically cover and protect the radius rod assembly from damage. A sectional removable radius rod cover plate closes the space between the top flange of the brake beam and the top plate of the trunnion bearing plate assembly. With the retarder in its closed position and this plate removed, space is provided for tie tamping. The trunnion bearing plate assembly, supporting the brake beams and driving bars and the trunnion ends of the radius rod assemblies, is composed of two pairs of heavy plates, one pair on either side of a given rail; all four plates securely tied together in their proper position by cast steel yokes.

The arrangement of the radius rods and the relation between the brake beams and the driving bars allows the inner edge of both the outside and inside brake beams, which carry the brake shoes, to rise about an inch as the brake shoes engage the car wheels, thus providing a higher grip (3 inches above top of rail) on the car wheels and greater retardation. Since the shoes lift only when a wheel engages the retarder, the usual clearance limitations exist.

The brake beams at each end of the retarder are flared out from the rail to provide for the customary wider opening between shoes at both ends of the retarder which gives a smooth entrance condition. The entire structure is securely fastened to ties which act as a foundation.

Connected to and mounted with the brake cylinder is an electro-pneumatic valve by means of which the desired control of the retarder is obtained. This control valve assembly, Fig. 24, consists of the control valve, a three-step pressure regulator, a single-step pressure regulator, a circuit controller and a rectifier.

The control valve consists of four electromagnets, A, N, R and X, together with their associated valves and pistons. They are similar in construction to those described in Chapter XVIII—Electro-Pneumatic Interlocking under the heading "Switch valves."

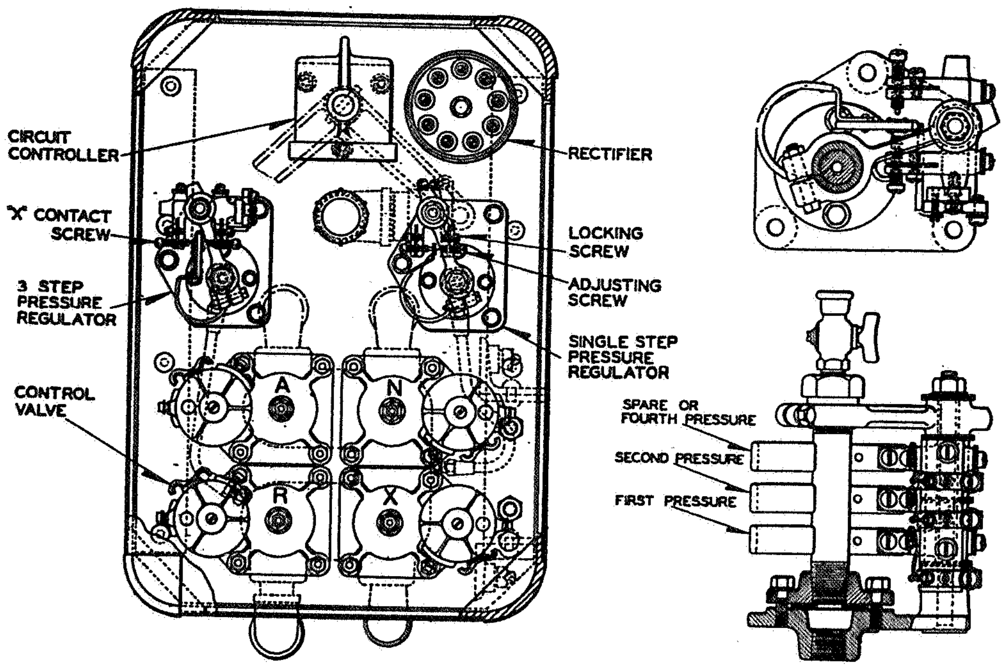


Fig. 24.
Control Valve Assembly for Model 28 Retarder.

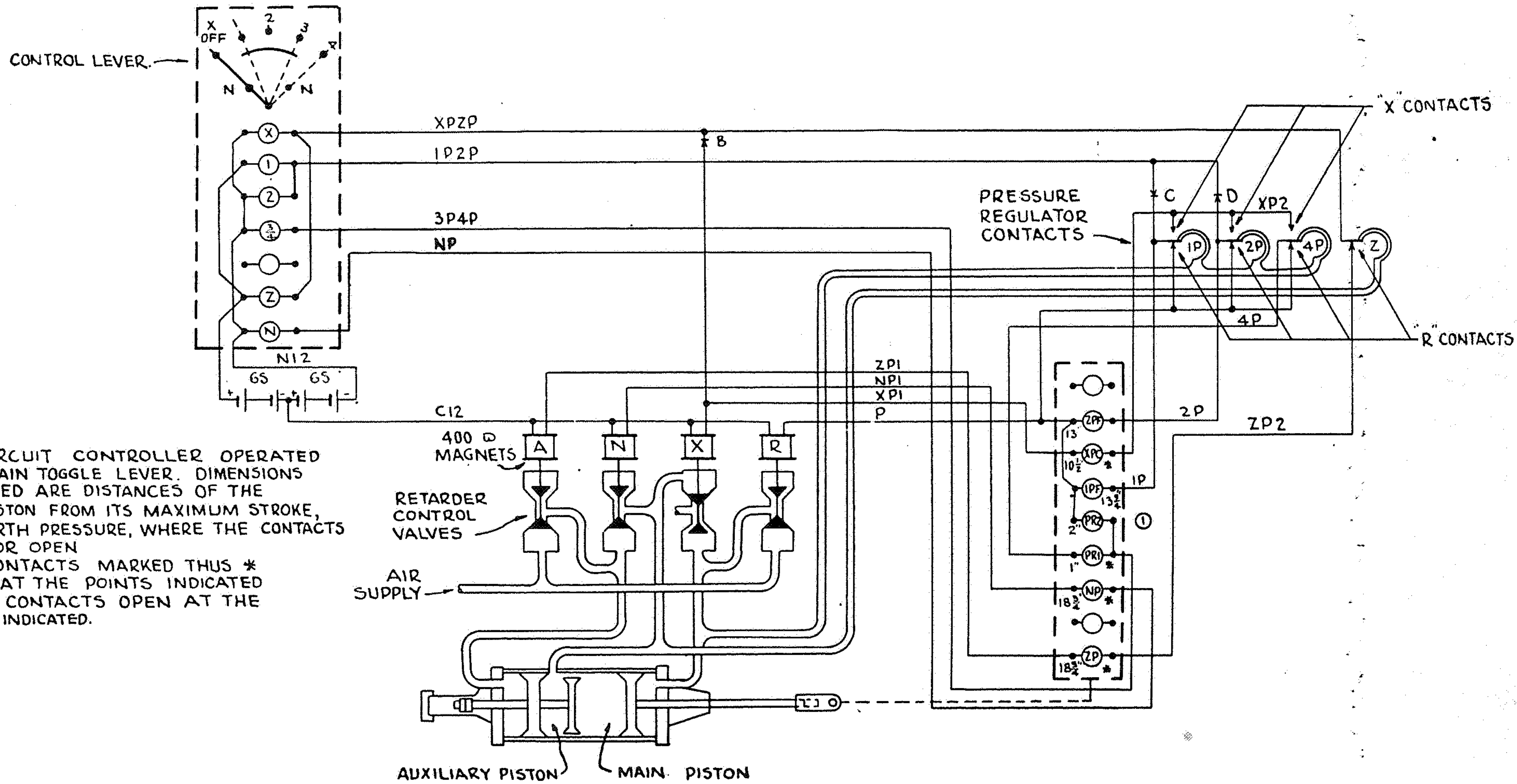
The three-step pressure regulator, Fig. 24, is used with all types of electro-pneumatic retarders. It consists essentially of a small pipe to which are fastened three Bourdon tubes such as used in pressure gauges of various kinds. The pipe is connected to the operating portion of the brake cylinder to the right of the main piston so that the air pressure in the brake cylinder is always the same as in the pipe and the Bourdon tubes. The characteristic of these tubes is that they tend to straighten out as the pressure in them increases. They are provided, on the end, with a contact finger which, in conjunction with adjustable contact screws, close or open certain circuits depending on the pressure in the tube.

The single-step pressure regulator, Fig. 24, is the same as the three-step regulator except that it has only one tube and is connected to the non-operating portion of the brake cylinder to the left of the main piston.

The circuit controller is similar to those used on electro-pneumatic interlocking machines and is actuated by the movement of the main piston by means of a mechanical connection to the floating toggle lever.

The rectifier, Fig. 24, of the copper-oxide type, is used simply as an electrical check valve to permit reducing the number of wires required between the control machine and the retarder.

Figure 25 illustrates the control circuit for the Model 28 retarder. As shown, magnets A, N and R are de-energized, magnet X energized. In all closed positions air is admitted to the rod side of the main piston.



NOTES

① CIRCUIT CONTROLLER OPERATED FROM MAIN TOGGLE LEVER. DIMENSIONS INDICATED ARE DISTANCES OF THE MAIN PISTON FROM ITS MAXIMUM STROKE, AT FOURTH PRESSURE, WHERE THE CONTACTS CLOSE OR OPEN

CONTACTS MARKED THUS * CLOSE AT THE POINTS INDICATED OTHER CONTACTS OPEN AT THE POINTS INDICATED.

Fig. 25.

Control Circuits for Model 28 Electro-Pneumatic Retarder.

In first, second and third positions, air at full pressure is admitted to the rod side of the auxiliary piston. The auxiliary piston is thus held at the inner end of its stroke in these positions and acts as a stop for the main piston, to limit its travel. In fourth position the air is vented from the rod side of the auxiliary piston and the auxiliary piston is then pushed back by the main piston so that the opening between the brake shoes is slightly less in fourth position than in the others, and also the toggle is almost in its dead center position.

In fourth position, air at full pressure is applied to close the retarder until the piston comes within an inch of the end of its travel while moving toward fourth position. Between this point and the end of the stroke the air is governed by the setting of the pressure regulator 4P.

In third position, air at full pressure is admitted to the rod side of the main piston and to the rod side of the auxiliary piston.

In moving from fourth to third position, air at full pressure is applied to the rod side of the auxiliary piston which moves both pistons back to the third position. When the main piston reaches third position a contact in the circuit controller is closed, admitting air at full pressure to the rod side of the main piston.

In moving from open to the first and second positions, the pressure regulator is shunted and air at full pressure is admitted for about one-third of the stroke, the air is then allowed to expand or is maintained above the setting of contact R until the piston is within from 6½ to 9½ inches of its final position when contact X is closed and the pressure is controlled to a value between the setting of contacts X and R, where it is maintained.

In opening the retarder, air on the rod side of the main piston is vented and air admitted through valve A to the rod side of the auxiliary piston and to the space between the two pistons. The single-step pressure regulator controls valve A when opening the retarder and thus regulates the pressure used. When the retarder has almost reached its full opened position magnet X remains energized although magnets A and N are de-energized. The air between the two pistons is thus retained and the retarder is moved to its full opened position by the expansive power of the air.

Assuming that the retarder is open, as in Fig. 25, all magnets except magnet X de-energized, and the air vented, the principle of the circuit may be illustrated by following through the operation of one circuit in second position. The control lever is moved to second position, positive battery over wire C12, through coils of magnet R, over wire P, through contact 2PF on circuit controller, over wire 2P, through rectifier D, over wire 1P2P, through contact on control lever closed in second position, over wire N12 to negative battery. Magnet R is energized and air at full pressure flows to the rod side of the main piston starting the retarder toward the closed position. As soon as the piston has moved enough to close circuit controller contact ZP circuit *Z* is completed, energizing magnet A and admitting air at full pressure to the rod side of the auxiliary piston, moving it to the inner end of its travel.

When the piston has moved to within about 9 inches of its final position, contact 2PF on the circuit controller is opened, de-energizing magnet R thereby cutting off air at full pressure and removing the shunt from contact 2P on the pressure regulator. The piston continues to move under the expansive power of the air already admitted, until the pressure drops to the value at which contact R on the pressure regulator is adjusted to close. Contact 2P on the pressure regulator is set at 28 pounds, so that this pressure is maintained in the cylinder. If the pressure should rise above 40 pounds (because of the movement of the piston as a car goes through the retarder or because of leakage into the cylinder) contact X of 2P will be closed and the excess air vented through valve X. Other circuits produce approximately the same operation of the magnet valves but differ slightly in arrangement of rectifier and contacts. The operation of these circuits may be followed in much the same manner.

The Model 28 retarder is equipped throughout with pressure grease fittings and is manufactured in two lengths, 38 feet 6 inches and 31 feet 2 inches.

Electro-pneumatic retarder, Model 31.

The Model 31 retarder shown in Fig. 26 was designed to make available a retarder that would be at least as powerful as the Model 28, that could be utilized in any lengths required, that could be economically used as either a single or double-rail retarder and that would not require tangent track for its installation.

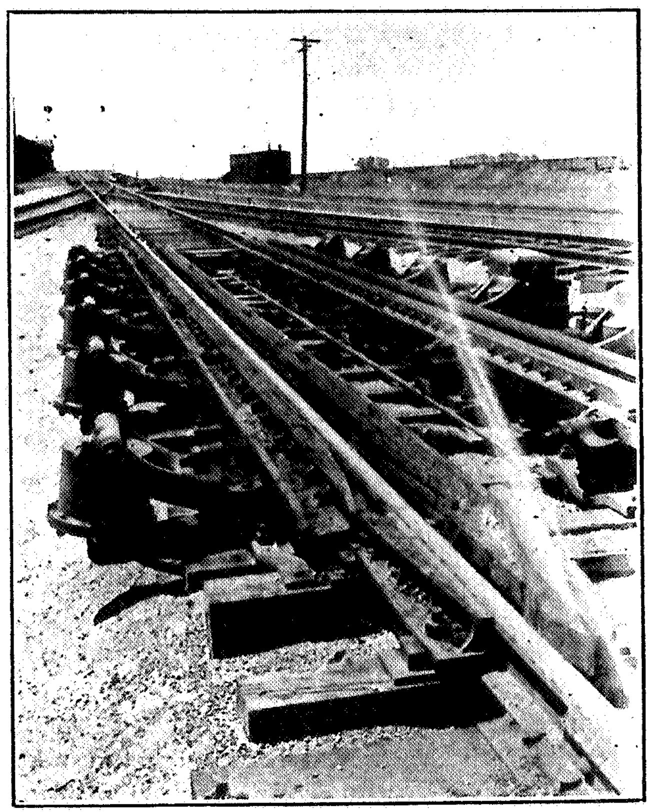


Fig. 26.
Electro-Pneumatic Retarder—Model 31.

No new yards have been equipped with retarders since the Model 31 was designed. However, a six-section single-rail retarder is in service on a curve in the Portsmouth, Ohio Yard of the Norfolk & Western Ry., and a ten-section double-rail retarder is in service in the Galesburg, Ill. Yard of the Chicago, Burlington & Quincy R. R.

The Model 31 retarder is built on the unit or sectional principle, each section being 6 feet 3 inches long. It is composed of a series of simple self-contained interchangeable cylinder units, spaced every third tie (in a double-rail retarder, on each side of the track), to which the brake beams and their associated brake shoes are attached.

The air to each cylinder unit is supplied through pipes and hose connections from one electro-pneumatic control valve. The retarder moves to its open position by a combination of gravity and spring pressure.

No springs are required to either obtain retardation or take up initial shock and the retarder adjusts itself to the various car wheel thicknesses and spacing on axles so that the pressure exerted on the wheels is uniform and equalized. The tendency of empty cars to be raised, when too great a retardation pressure is applied, is unusually small. However, guide rails are provided to prevent derailment of any cars which might be raised.

The cylinder units, Fig. 27, consist essentially of a pneumatic cylinder and a pair of levers which are connected together and which separately, and as a unit, swing around a common pin, called the lever fulcrum pin. This pin is supported at each end in rail support bearings which also support the rail and are fastened on the ties. The levers are centered with relation to the rail by means of a spring bolt assembly which is mounted in a housing formed in the lower lever.

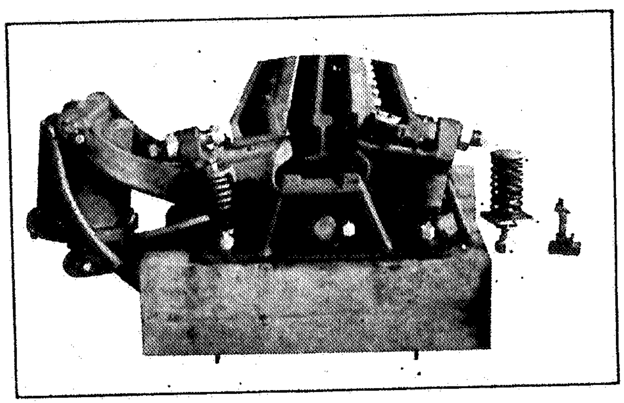


Fig. 27.
Cross-Section of Model 31 Retarder.

When air is admitted to the cylinder, the levers move the brake beams and shoes into engagement with the car wheels in a manner similar to the action of a nutcracker. When air is vented from the cylinder, the upper lever, which carries the outside brake beams, moves to its open position by gravity and comes to rest when the upper lever spring nuts hit bosses provided on

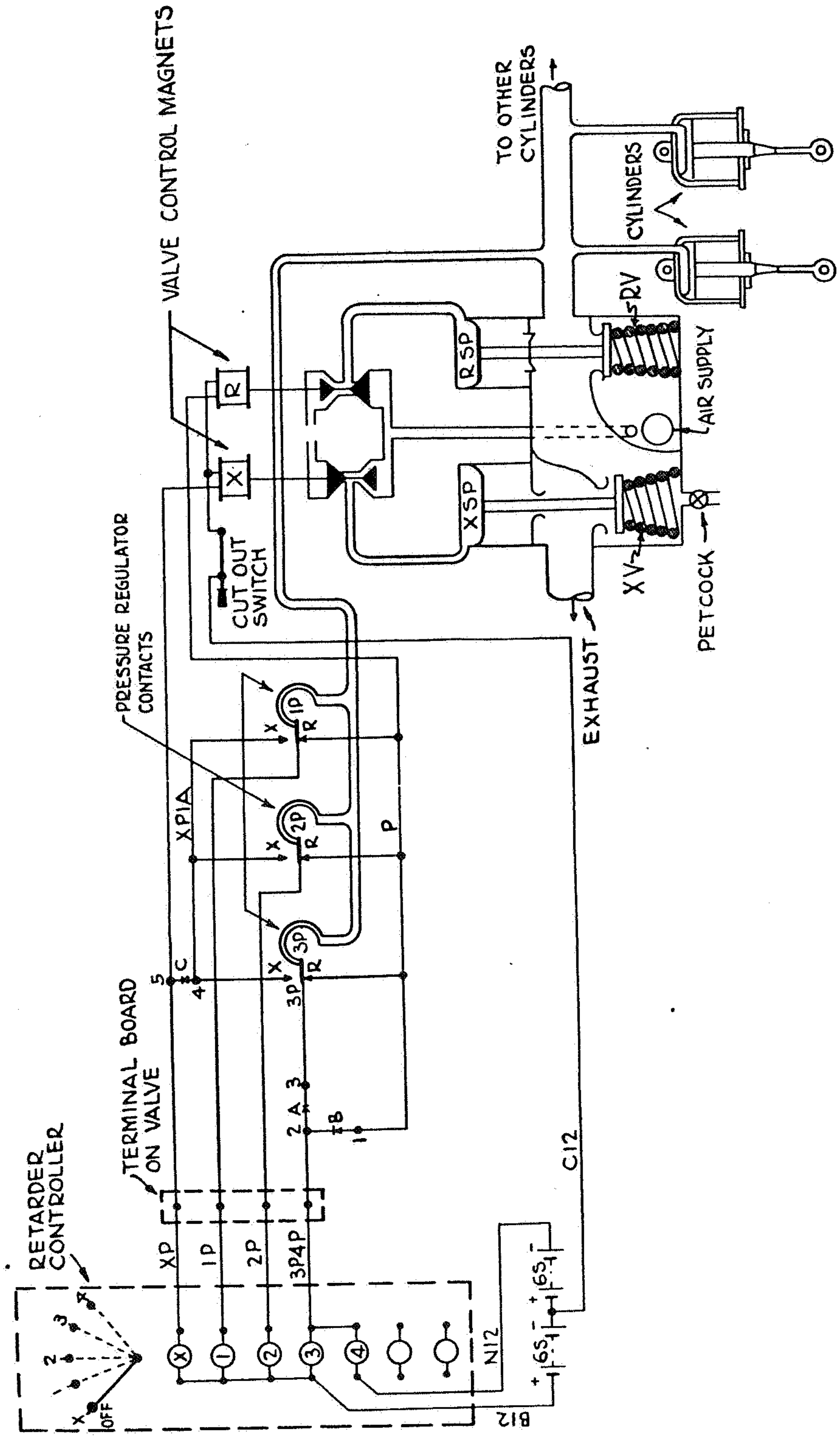


Fig. 28.
Control Circuits for Model 31 Electro-Pneumatic Retarder.

the rail support bearings. (Fig. 27.) The lower lever which carries the inside brake beams, moves to its open position through the combined effect of gravity and the lower lever return spring, and comes to rest when the piston is pushed all the way back in the cylinder. The upper stop spring and centering spring arrangement are designed so that, with the retarder in either its closed or open position, the levers and cylinder, and their associated brake beams and shoes, can swing as a unit about the lever fulcrum pin an amount equivalent to at least one-half inch travel of the brake shoes either side of their positions shown. With the retarder in the closed position, this permits the brake shoes to adjust themselves to the various spacing of car wheels on axles, and with the retarder in the open position permits the brake shoes to adjust themselves to the passage of locomotives having unusually wide driving wheels.

The control circuit, as well as a diagrammatic view of the control valve and pressure regulator, is shown in Fig. 28. The operation of the pressure regulator is similar to that described for the Model 28 retarder. In the fourth step of retardation, air at full pressure is used.

Switch Layouts

In retarder yards the necessity for a very compact layout has led to the occasional use of lap switches. Figure 29 shows a plan of the switch layout for a lap switch.

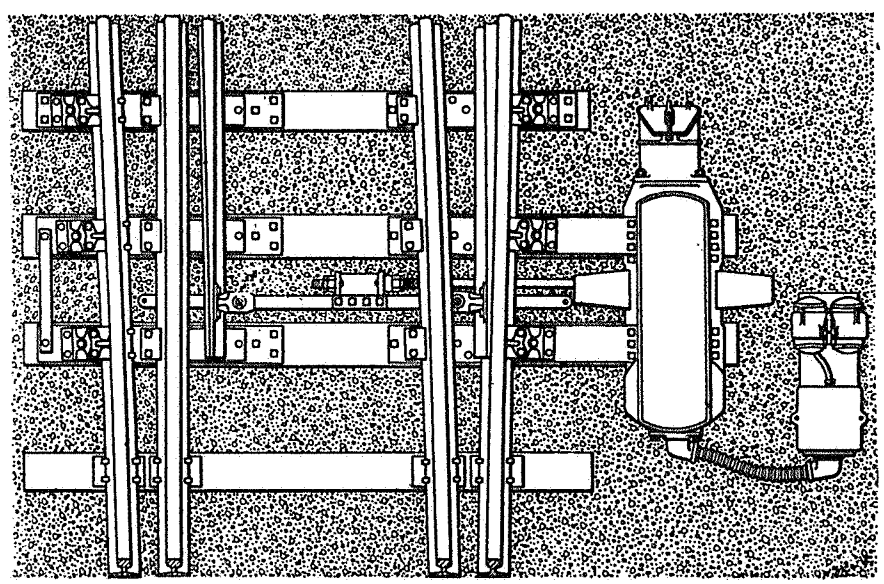
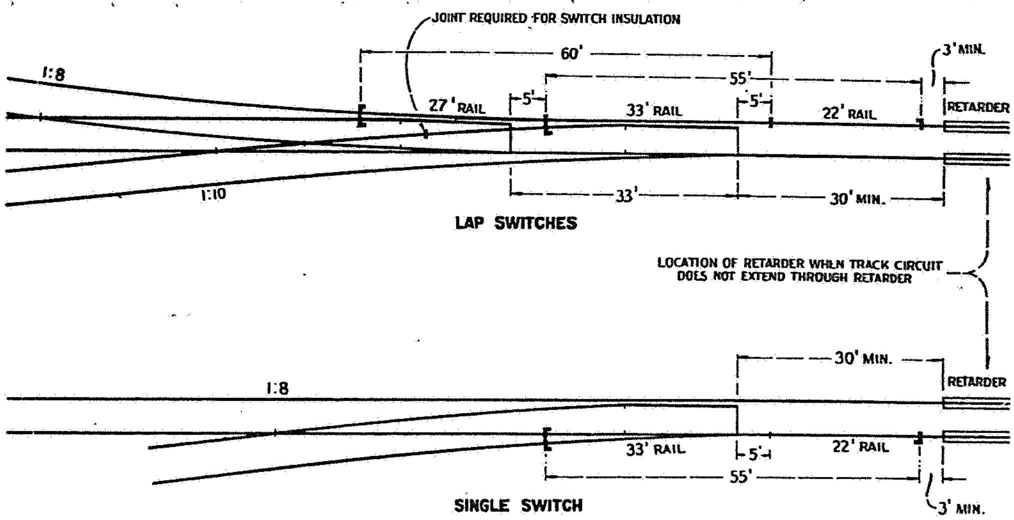


Fig. 29.
Lap Switch Layout.

Figure 30 shows the location for insulated joints for track circuits at single and lap switch layouts. It will be noted that in a lap switch layout, three separate track circuits are employed, the first and second circuit protecting the first switch and the second and third circuit protecting the last switch.



NOTE: WHERE MILL TYPE GONDOLAS ARE NOT OPERATED, LENGTH OF TRACK CIRCUIT MAY BE 50 FEET. LENGTH OF TRACK CIRCUIT IN-REAR OF SWITCH POINT IS SHOWN FOR SPEED OF 15 M.P.H. WHICH IS MAXIMUM SPEED ENCOUNTERED IN OPERATION OF RETARDER YARDS, AND IS BASED ON THE FOLLOWING FORMULA:

SWITCH MACHINE OPERATION	0.85 SEC.
TRACK CIRCUIT SHUNT	0.10 "
25 % FACTOR SAFETY	0.24 "
APPROACH LOCKING REQUIRED	1.19 " = 27 FT. AT 15 M.P.H.

WHERE THESE FACTORS VARY FROM THE ABOVE, APPROACH LOCKING DISTANCE SHOULD BE VARIED ACCORDINGLY. INSULATED JOINTS MAY BE PLACED IN OPPOSITE RAIL IF DESIRED.

Fig. 30.
Location of Insulated Joints for Track Circuits for Switches in Hump Yards with Retarders.

It will be noted that the track circuits as specified are at least 55 feet in over-all length and have a length ahead of the points which is sufficient to permit the complete operation of the switch machine within the time required for a car to move this distance.

General principles.

The switch is quick in movement, requiring not more than 1½ seconds to operate.

Switch machine does not need to be reversible in midstroke since the time available is not sufficient to permit making such an operation.

Switch may or may not be protected by track circuits, depending upon the type of layout and local conditions.

Indication at the control machine is of advantage but not necessary.

It is possible to trail through the switch points without damage to the points or the switch machine.

A target or light is provided at each power-operated switch to indicate the position of the points.

Power Switch Machines

Model 6 switch machine—Electric operation.

The Model 6 switch machine is mounted on tie plates on the end of two ties similar to switches in electric interlocking. Figure 31 shows the machine with covers removed. The motor and train of gears are similar to those de-

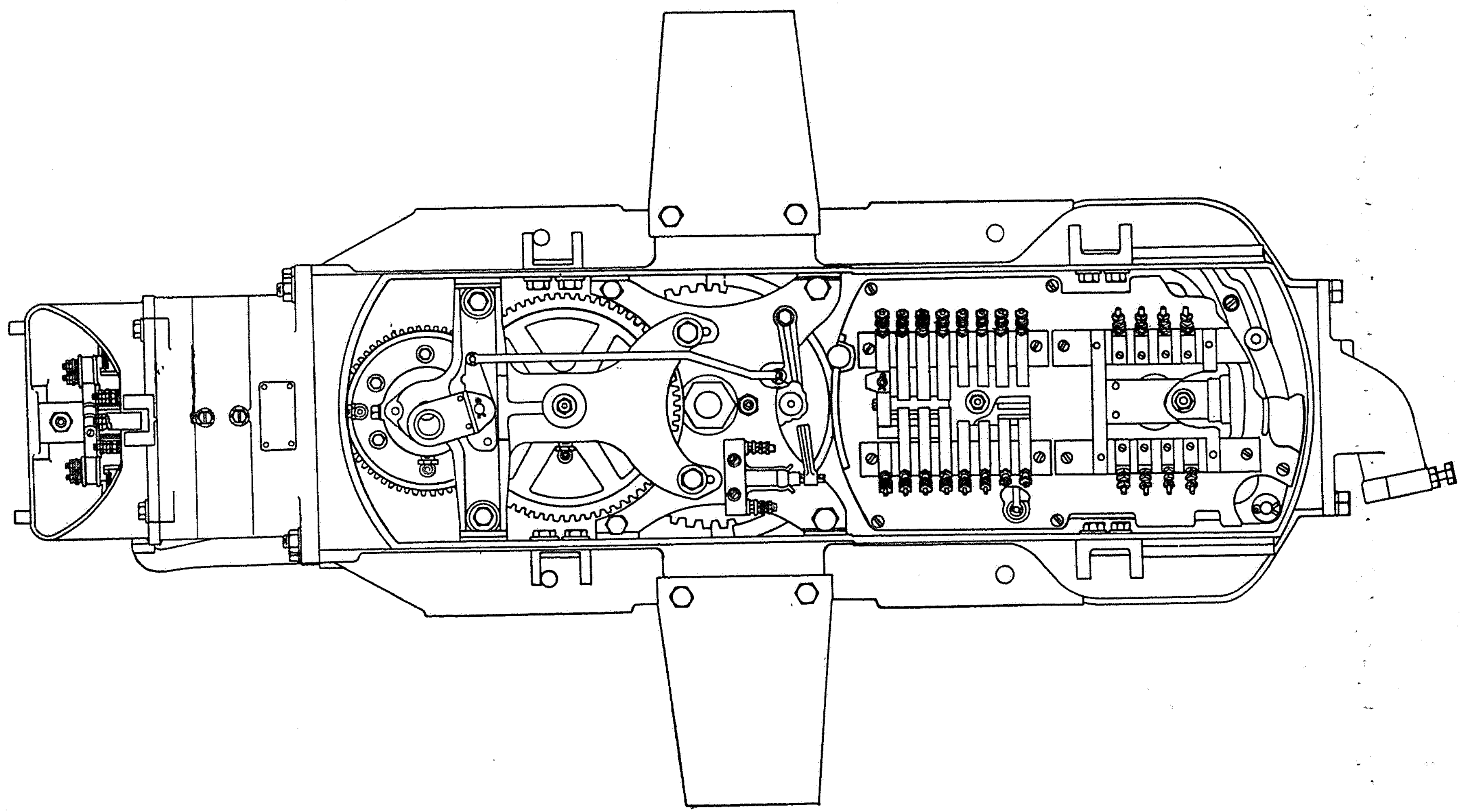


Fig. 31.
Diagram of Model 6 Switch Machine.

scribed in Chapter XIX—Electric Interlocking. The connection to the throw rod, however, differs because of the trailable feature. Two levers, one fitted with a roller and called the "lever" and the other fitted with a cam and called the "cam" are pivoted from the bottom of the case and provide a medium for driving the throw rod. They are connected together and normally move as a unit because the roller is held by spring pressure into a detent in the center of the cam. A roller on the other end of the lever bears against a cam in the main driving gear which causes the unit to pivot and the throw rod is connected to the other end of the cam by means of a roller and fork arrangement which causes the throw rod to move.

For normal operation the two levers move as a unit, but if the switch is trailed through, only the cam is moved and since the roller which rests in the detent of the cam is moved out of the detent, the cam is allowed to pivot with respect to the lever. Sufficient stroke is provided either way from the detent so that regardless of the position of the switch a full movement of the points can be obtained by trailing through without the necessity of moving the lever connected to the main gear.

After a switch has been trailed through, as previously described, it is necessary to move the control lever to the opposite position so that it will agree with the switch points at which time the roller will drop back in the detent and again connect the lever and cam together. From then on the machine operates as formerly.

This trailable feature also serves to make the switch machine reversible even though the points may be blocked since there is sufficient power to force the roller out of the detent in the cam thus accomplishing the same result as when a switch is trailed through. Hence it is impossible to stall the motor by obstructing the points and, therefore, fuses are never blown unless short circuits are developed.

A further use is made of the trailable feature in that the cam is used for point detection. On the cam is mounted a second cam which operates the point detector. Adjustments as close as ¼ inch between the point and stock rail are indicated. Contacts, also controlled from this indication cam, are used for selecting indications.

The pole changer is mechanically operated from cams attached on the edge of the driving gear. This necessitates, therefore, that the stroke be completed once it has started since otherwise the circuit could be opened and the points left on center. Transformers for indication lights are frequently mounted in the switch machine. When track circuits are used an auxiliary case is mounted on the end of the machine for housing the track transformers, resistances and occasionally a rectifier.

Figure 32 shows track and control circuits for Model 6 switch machine including the control lever, lever lock and indication lights. The circuits for the switch operation are similar to that used in electric interlocking with the exception that the reversible pole changer coils are omitted.

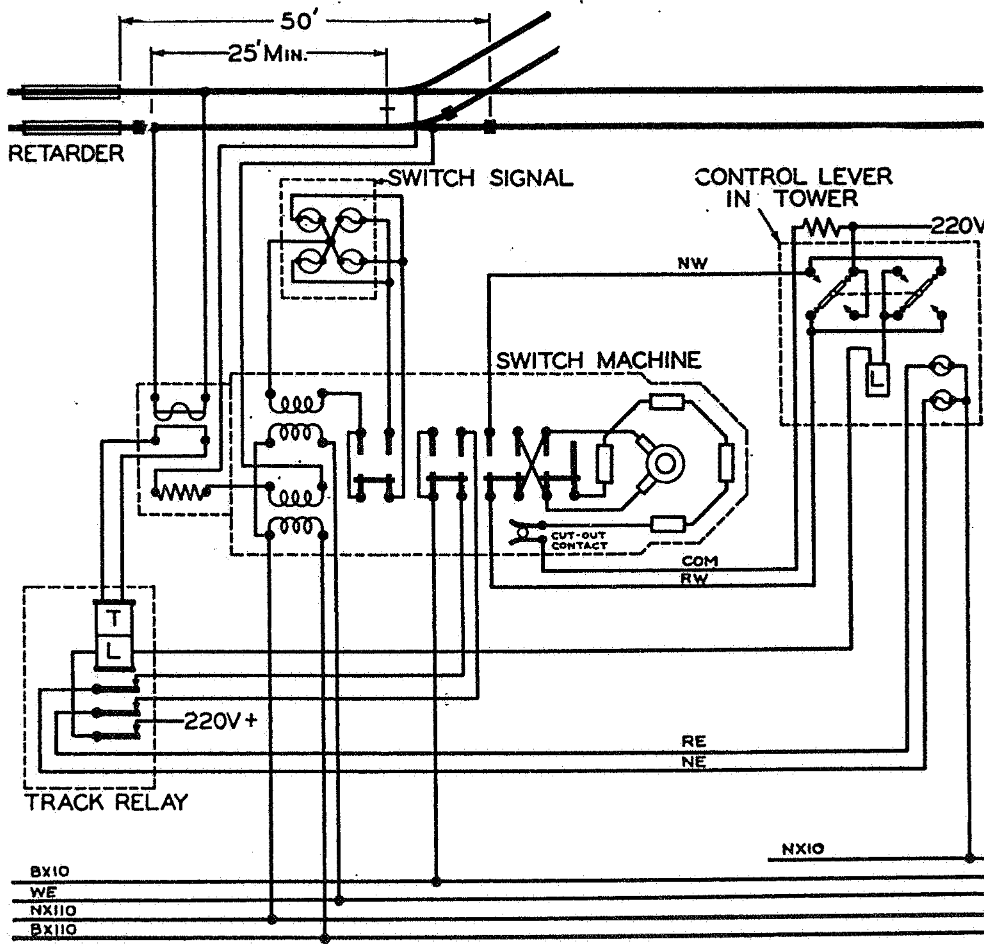


Fig. 32.
Track and Control Circuits for Model 6 Switch Machine.

Where track circuits are used, they are usually operated from an alternating current source and a rectifier to operate a direct current relay. The relay has an independent coil which is connected in the operating circuit of the switch machine, which provides, first, that in order to energize the relay the track circuit must be unoccupied, and, second, that once it has been energized and the switch machine operation is started, the track circuit can be shunted and still maintain closed contacts in the relay until the switch machine operation is completed. This insures that once the switch has started to move, it will continue until the operation is completed. Therefore, in laying out the track circuit enough distance ahead of the points is provided so that, at average normal speeds, the car will not reach the points before the switch movement is completed. The shunting time of the track circuit is also a factor in the distance required ahead of the points. With the a.c.-d.c. track circuit the track relay is shunted in from 0.05 to 0.08 second.

The lock on the control lever is in series with the operating circuit and is energized immediately the control lever is operated, thus locking the lever in that position until the movement of the switch machine is completed. This prevents another movement of the control lever which if made prior to the completion of the switch machine operation might open the operating circuit and leave the switch points on center.

Other types of track circuits are in use but the general principles employed are similar to that already described.

Direct-acting switch movement—Electro-pneumatic operation.

The direct-acting switch movement, Fig. 33, consists essentially of an air cylinder, the piston rod of which is connected directly to the throw rod of the switch, and two electromagnets, one of which controls the normal position of the switch, the other the reverse position. It is very similar to the switch valve and cylinder described in Chapter XVIII—Electro-Pneumatic Interlocking, except that the lock magnet and the locking device of valve D is not used. As no lock rod, lock magnet or motion plate is used with this switch movement, the switch may be trailed through at any time, the air in the cylinder merely acting as a cushion. When track circuits are used, the control circuit is arranged so that, as the switch is trailed, the operation of the switch circuit controller causes air to be so admitted to the cylinder as to hold the switch in its trailed position until the track circuit again becomes clear, when the switch will return to its original position and again be in agreement with the control lever. Thus, if an engine, with or without cars, trails partly through the switch and then reverses its direction, there is no splitting of the switch.

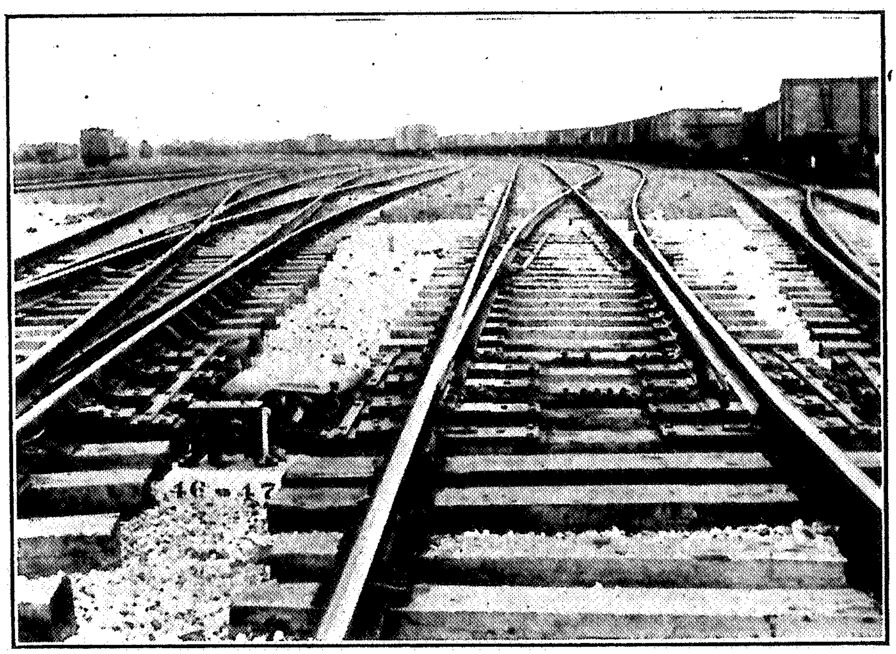


Fig. 33.
Direct-Acting Switch Movement—Electro-Pneumatic Operation.

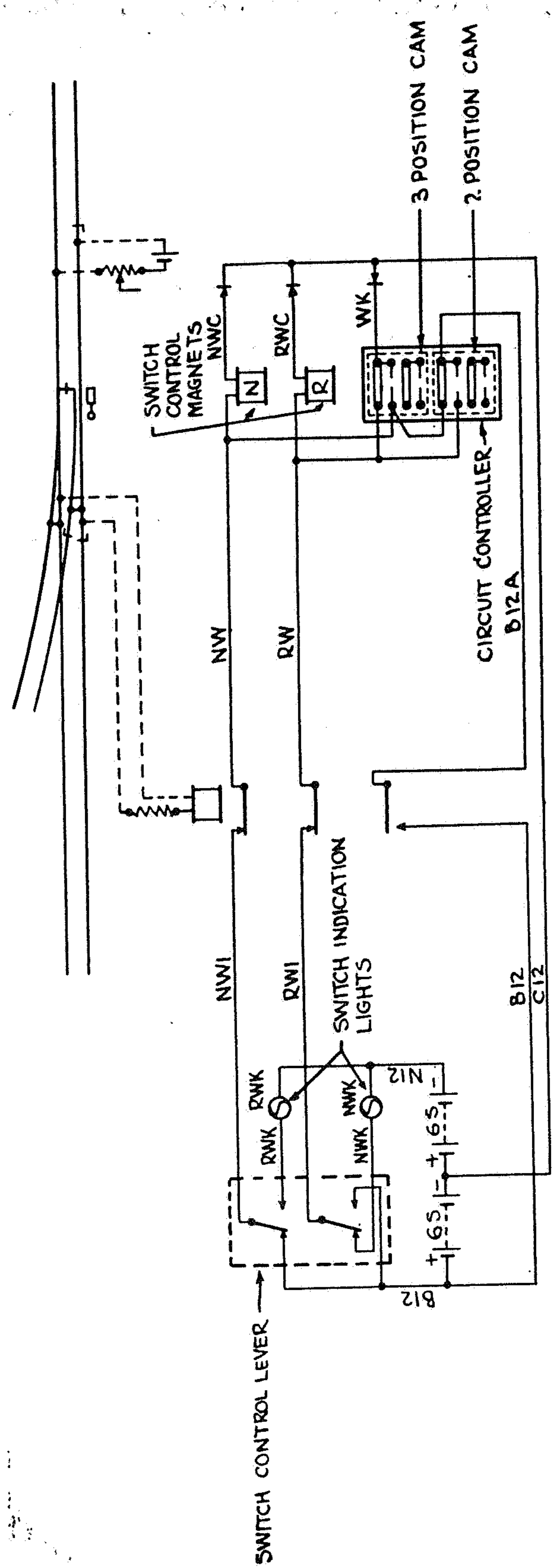


Fig. 34.
Track and Control Circuits for Direct-Acting Switch Movement—Electro-Pneumatic Operation.

Figure 34 shows track and control circuits for a direct-acting switch movement. When the track circuit is occupied thereby shunting the track relay, energy is maintained by a holding circuit (wire B12A) on the normal or reverse magnet, as the case may be, depending on which magnet was energized at the time the relay was shunted. Due to the speed of the direct-acting switch movement as well as the speed of the shunt of this circuit a distance of 22 feet ahead of the switch point for the beginning of the circuit is ample for any ordinary yard speed.

Skate Layout

Skates are used in some classification yards as an emergency measure to stop cars.

General principles.

The device is quick in movement and does not take more than one second from the time the control lever is moved before the skate is placed on the rail.

Skate machines are reversible in midstroke so that if the skate is thrown against a wheel it may be returned to its original position.

The connection between the skate and the support is such that the skate can be taken away by the car wheel without shock to the mechanism.

The skate, after being taken by a wheel, is carried back and placed on the skate clip by hand. Usually the yard crew, when taking the car off the skate, bring back the skate and the maintainer places it on the skate clip.

Skates are located on each classification track about two or three hundred feet beyond the switch at retarder end of yard.

Power Skate Machines

Electric operation.

The electric skate machine, Fig. 35, consists of a train of gears driven by a reversible motor, the shaft of the driving gear being extended through the housing and equipped with a crank to which a link is connected for the purpose of moving the skate clip. The skate is attached to the clip by means of a wedge arrangement and ball and detent. The wedge is parallel to the track and the skate slides off easily when the car wheel takes it away. A ball, backed up by a spring in the skate, is pressed into a detent in the wedge which holds the skate from vibrating off the wedge when it is not placed on the rail. A magnetic shoe type brake, connected in series with the motor, is used for stopping and holding the skate in the open or closed position. Contacts, operated by cams, are used as a controller to open or close circuits at the proper time.

The circuit for controlling the movement is shown in Fig. 36. The control lever has two positions and in one position energizes one of the field coils for one direction of rotation and in the other position energizes the other field for the opposite direction of rotation. The controller contacts are in series with the control wires and cut off power at the proper point to stop the mechanism without over-run.

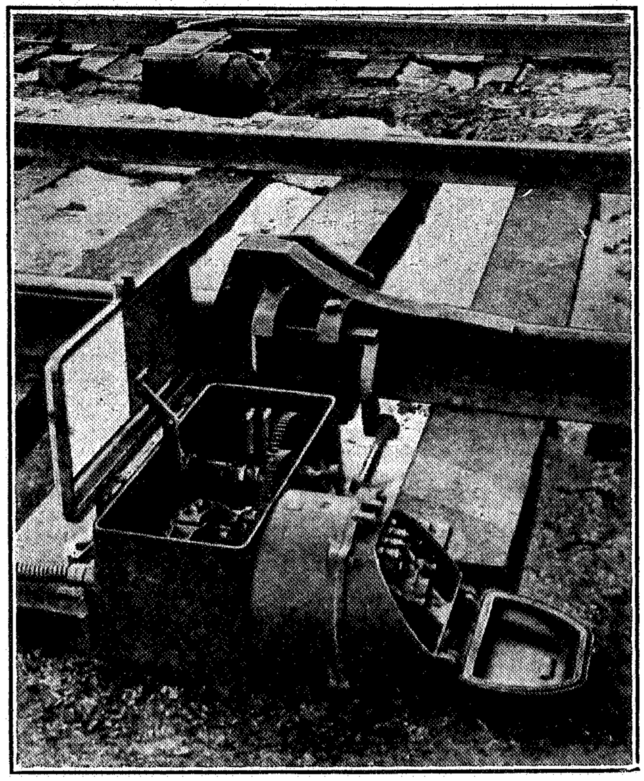


Fig. 35.
Power Skate Machine—Electric Operation.

Electro-pneumatic operation.

The electro-pneumatic skate machine, Fig. 37, is a simple arrangement of levers by which the movement of a piston in a small cylinder places the skate on the rail when the piston moves out, and removes the skate from the rail when the piston returns. The admission and release of air for this cylinder is controlled by one magnet, which, when energized, admits air to the cylinder, forcing its piston out and thus placing the skate on the rail. When this magnet is de-energized, air in the cylinder is exhausted to atmosphere and springs force the piston back, removing the skate.

The control circuit of two wires is controlled by the operation of a toggle switch in the control machine.

Control Machines

Control machines are located in towers at strategical points in the yard. From these points of vantage, operators can see the entire switching area and judge quite accurately the speed at which cars are traveling. These towers are located so that the operators can see approximately the amount of space left on each track and release cars into these tracks at speeds which will carry them either to couple or very nearly so. The floor of the tower

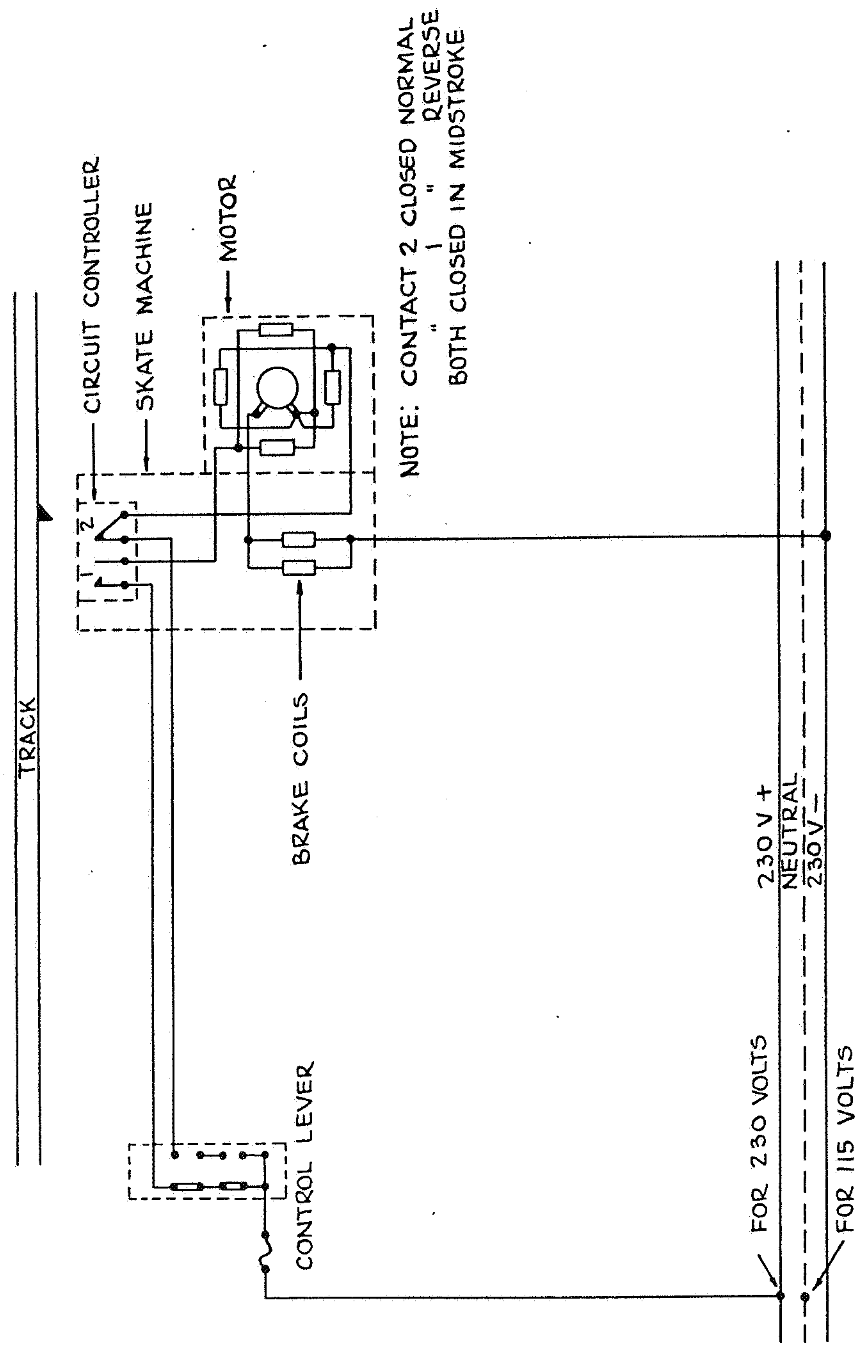


Fig. 36.
Control Circuit for Electrically-Operated Skate Machine.

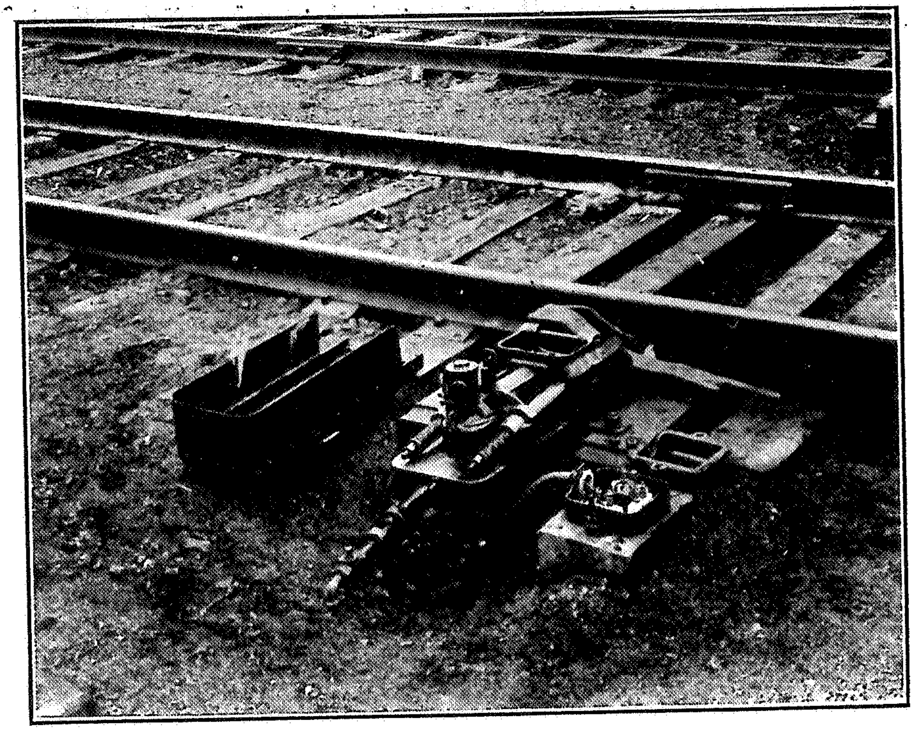


Fig. 37.
Power Skate Machine—Electro-Pneumatic Operation.

is usually from 15 to 20 feet above the top of rail. Towers are equipped with windows set in very narrow frames so that there is a minimum of obstruction to the view of the operator.

Usually three towers are used, one located at the junction switch and the other two further down in the yard, one on one side and one on the other. The operator in the tower at the junction switch controls the retarders on the hump lead and usually on the sub-leads. The operators in the other two towers control the retarders in advance of the groups of classification tracks and the switches in these groups.

In practically all cases the switches immediately in the rear of the retarders have their controls in the same tower in which the retarder controls are located, since it is better for an operator to adjust car spacing for the switches he controls.

General principles.

The arrangement of levers in the machine is compact so that a large number of functions can be controlled by one operator.

The numbering and arrangement of the levers is such that they may be readily located.

The indications from the various units are provided whenever necessary. In most cases, indications showing the position of the switch and the occupancy of the track circuit are provided.

The control machine is of a design so that an operator may be seated and still have a clear view of the entire yard or at least that section of the yard under his control.

The control machine is designed so that all levers are accessible for maintenance purposes without interfering with the operation of the plant.

The control machines are built with a sloping top and with a projection in the front under which there is room for the operator's knees. The top of the machine is divided into sections or panels. The levers are attached to the panel which is hinged at the top, thus making the levers easily accessible for maintenance purposes. Usually the switch levers are arranged in groups similar to the order in which cars pass through the switches in the yard. Where there is a junction or lead switch the lever is either equipped with a red handle or set slightly apart from the other switch levers to distinguish it from the others. Insofar as possible the retarder levers are located just above the switch levers controlling switches immediately following the retarders.

The numbering of switch levers agrees as far as practicable with the tracks to which the switch leads. In one method of numbering, for example, if a switch, when reversed, leads to track 1, the lever is No. 1. In another method each switch bears two numbers, the numbers being the extremes of the track numbers to which the switch leads. For example, if the last switch led to track 1 when reversed and to track 2 when normal, the lever number would be No. 1-2. Retarder levers are usually numbered the same as the switch which is immediately in the rear. Skate levers take the number of the track on which the skate is located. The switch levers are at the bottom of the panel, the retarder levers next above and the skate levers usually at the top, as shown in Fig. 38.

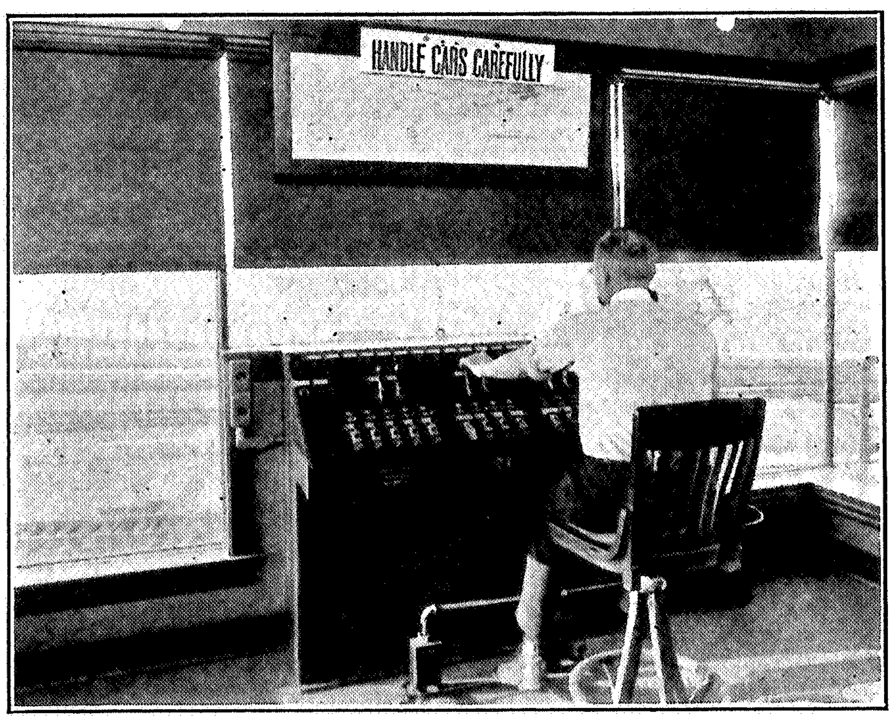


Fig. 38.
Electric Control Machine.

Electric system.

Control machines are shown in Figs. 38, 39 and 40. All levers have a forward and backward movement, the forward or normal position being away from the operator. The panels, into which the top is divided, are two levers in width. The accessibility for maintenance is shown in Fig. 39.

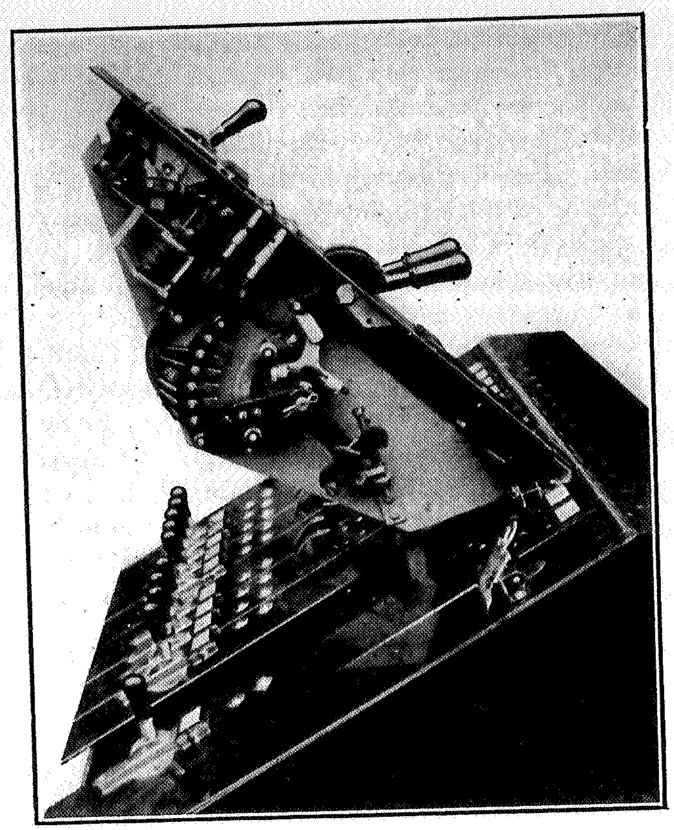


Fig. 39.
Electric Control Machine with Panel Raised.

The retarder lever has five positions, one in the forward position for the open position and the others for the four steps of retardation. The lever is held in the various positions by means of a roller, backed up by spring pressure, dropping into notches (see Fig. 39) and there is a click as the roller drops into the notch, thus making it possible for the operator to move the lever to a definite position by listening for the click instead of watching the lever. Sometimes it is necessary to look at the lever to find out the position in which it is located and a plate on the front is scribed with numbers which match with the top of the panel to mark these various positions.

The switch lever has two positions, forward for normal and backward for reverse. Indication lights are located directly above the switch lever with the normal light above the reverse light. At all times, except when the switch machine is in transit, or when the trailable feature has been operated by a car or because of an obstruction in the points, the indication lights agree with the position of the lever.

The switch lever is a large toggle switch designed so that it is impossible to leave it on center. The drive between the lever and the yoke is positive so that when the lever is moved the yoke and contacts move also.

The lock is attached to the bottom of the lever and consists of a magnet and armature operating a plunger which when the lock is energized obstructs the movement of the yoke and prevents the opening of the contacts until the movement of the switch machine is completed.

The skate lever is a smaller toggle switch and is not equipped with additional features. The toggle is actuated by spring pressure only. No indication is provided since in most cases the operator can see the skate when it moves.

The control machine, Fig. 40, in the tower at the junction switch, is equipped with a switch for turning the switch lights on or off or for dimming them at night, a push button for resetting the main circuit breaker in the power house and another to sound a siren to call the maintainer. Indication lights are provided to show when either alternating current or direct current power is off. Hump signal indications are repeated in this tower and a switch is provided so that the operator can set the hump signal at "stop," regardless of the desires of the humpmaster, if cars are being cut off too fast or if there is an accident which might require the stopping of the hump operation.

Fig. 40.
Electric Control Machine in Junction Switch Tower.

Electro-pneumatic system.

Control machines are shown in Figs. 41 and 42. The retarder and switch levers have a horizontal movement, the open position of the retarder and the normal position of the switch being to the left. The skate lever has a forward and backward movement, the normal or off position being away from the operator.

The control machine illustrated in Fig. 41 has a slightly different lever arrangement than that usually provided in that the skate levers are grouped in much the same way as the tracks.

The retarder lever has five positions, open to the left and successively four positions toward the right for the four steps of retardation. The number plate (see Fig. 42) fastened to the control panel bears corresponding numbers, to which the lever points. The operator, however, soon gets to know the feel of the position of the lever and seldom has to look to see in what position the lever is. The retarder lever is held in the various positions by a spring-backed ball dropping into notches on a quadrant actuated by the lever handle, making each position positive.

The switch lever has two positions, normal to the left and reverse to the right. Indication lights are so located, Fig. 42, that the lever in the normal position points to the normal indication light and in the reverse position to the reverse indication light. Indication lights are not displayed when the track circuit is occupied thus giving the operator information as to the location of the car. There is no lock on the lever itself, the switch control circuit providing circuit locking if the track circuit is occupied. The switch lever is provided with a toggle designed so that the lever must move to one position or the other.

The skate lever is also a toggle, and has two positions, on and off.

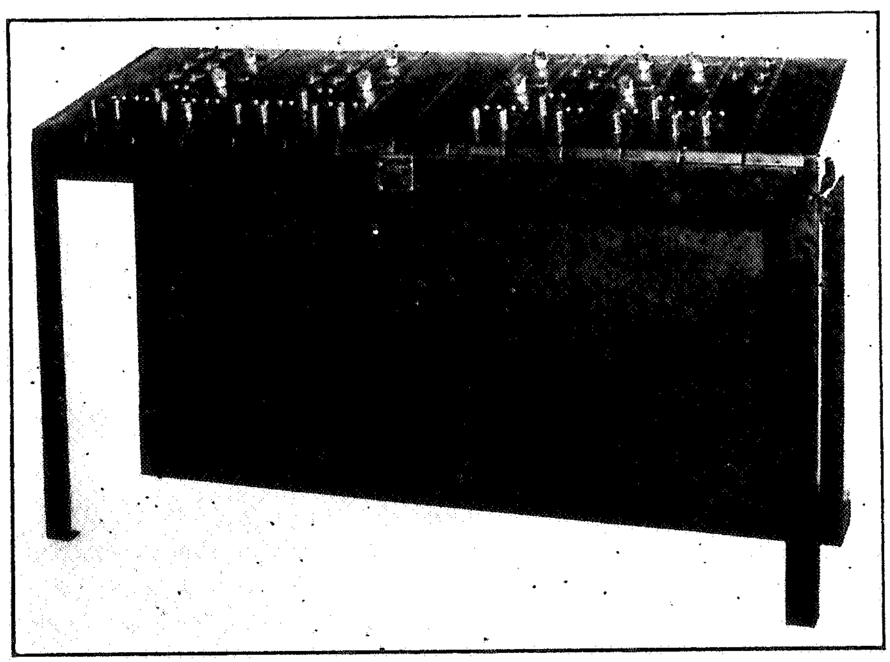


Fig. 41.
Electro-Pneumatic Control Machine.

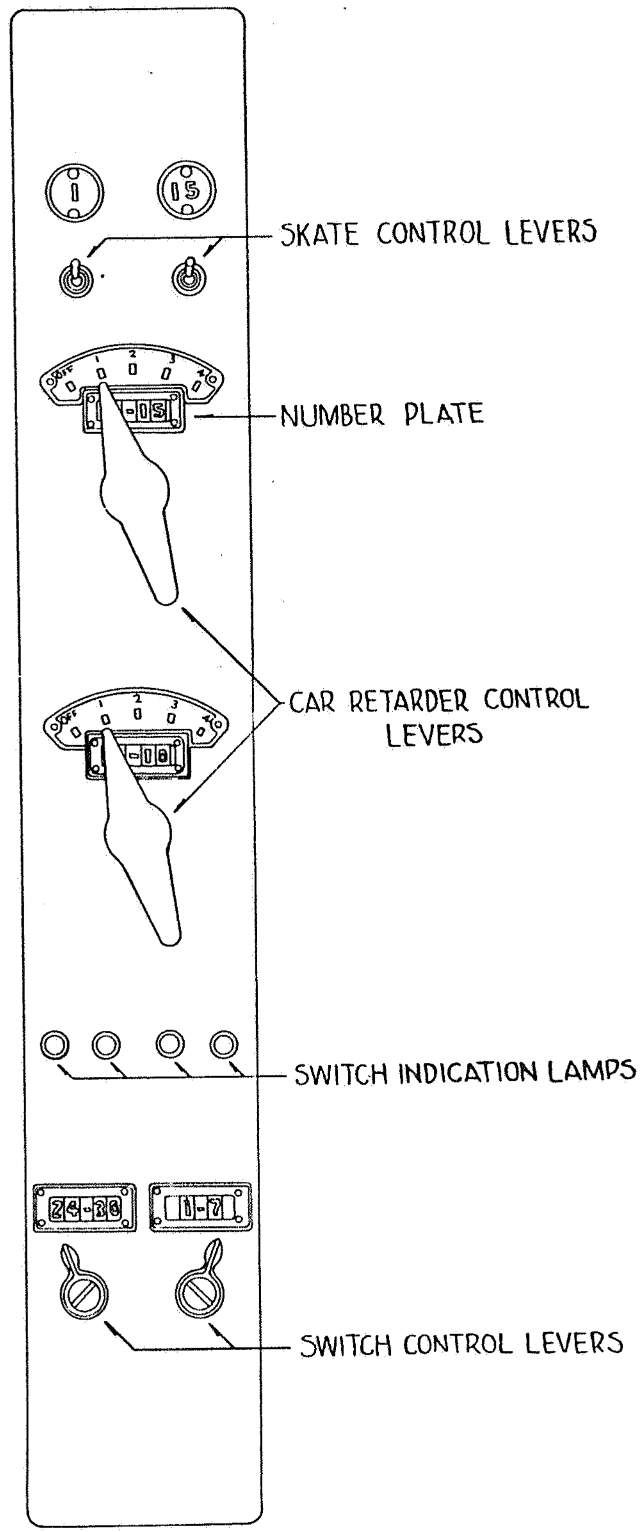


Fig. 42.
Electro-Pneumatic Control Machine Panel

The control machine in the first tower is often equipped with auxiliary apparatus, such as a lever controlling the switch lights, a siren to call the maintainer, and often indication lights repeating the indications of the hump signal and with a master controller by which the operator can set the hump signals at "stop," in case of accident or other necessity, regardless of the position of the hump signal controller. (See Fig. 51.)

Power Plant

The type and equipment of the power plant depends upon the type of retarder, size of the yard, etc. Usually a commercial source of power is brought into the yard and converted as required, depending upon the apparatus and its characteristics of operation. Occasionally power is generated by the railroad company and even then some conversion is provided.

General principles.

The power plant is large enough in capacity to operate the retarder system under maximum demand of traffic.

Reserve power is provided so that if the commercial source fails the plant can be operated for a period of time.

Electric system.

A typical layout of a power plant for the electric system is shown in Fig. 43.

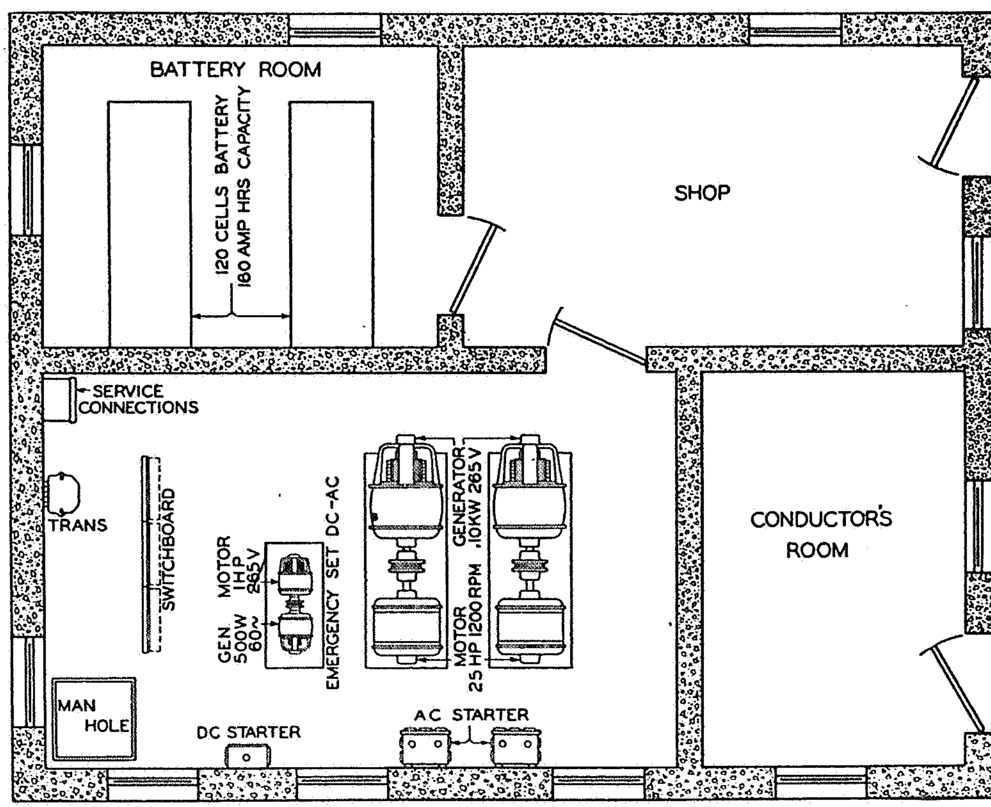


Fig. 43.
Power Plant Layout for Electric System.

Retarders, switches and skates are operated by direct current. The track circuits, signal system and all indication lights are operated by alternating current. The communicating system and especially the teletype system may be either alternating current or direct current.

Usually a commercial source of alternating current is supplied to the yard and then converted into direct current or transformed to the proper voltages of alternating current at the power plant. A number of different methods are employed, two of which are described.

In some plants an overcompounded motor-generator normally supplying 250 volts with a peak voltage of 265 is used to operate the retarders. This generator is capable of delivering from 400 to 500 amperes without the voltage dropping below 230 volts. Usually duplicate motor-generators are installed so that the operation can be alternated from one to the other, leaving at least one of them free for maintenance purposes. Such a plant is shown in Fig. 44.

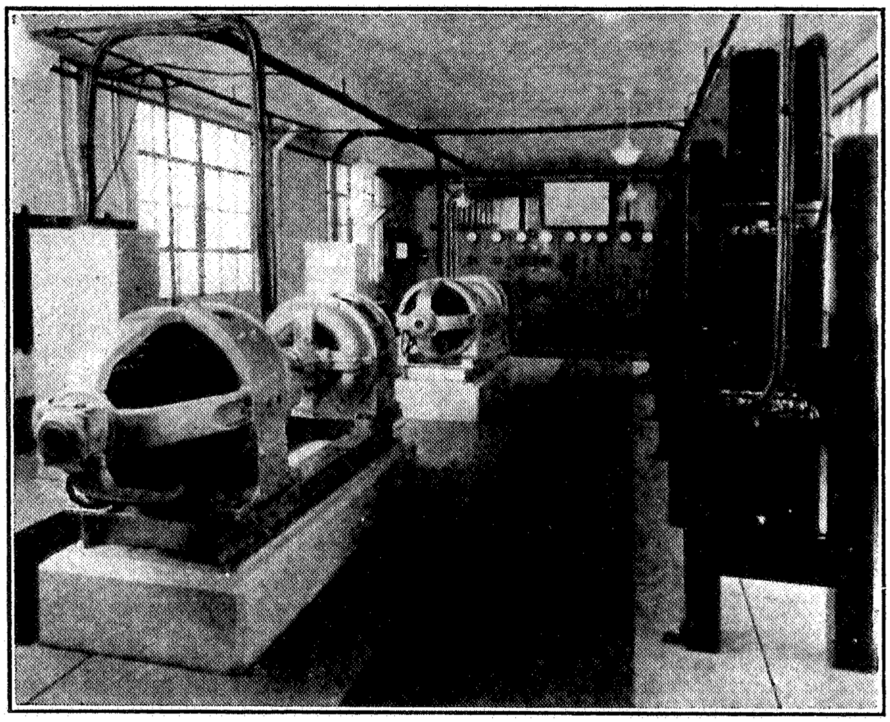


Fig. 44.
Power Plant Overcompounded Motor-Generator Installation.

A storage battery, varying from 160 to 300 ampere hours in capacity, is used for a reserve and sometimes this battery is divided, one-half being used for operating switches, skate and retarder controls, while the other half is being charged. When the main source of alternating current fails, this battery is automatically cut in on the feeders of the plant, and operation is continued without interruption. The battery is charged either by a motor-generator or a mercury arc rectifier.

In other plants, such as shown in Fig. 45, a diverter pole motor-generator is used for operating the retarders and for floating the storage battery. The generator is designed so that, for example, 100 amperes can be taken directly from the generator for operation and if more than 100 amperes are required the current in excess of that amount is taken from the battery.

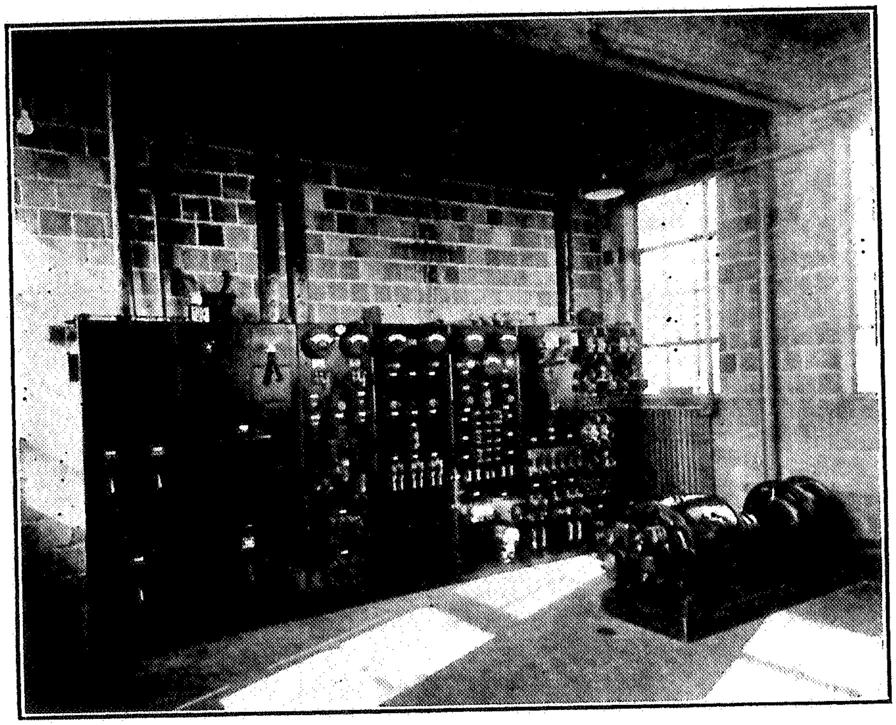


Fig. 45.
Power Plant Diverter Pole Motor-Generator.

In some cases an induction motor is used to drive the generator but in others a synchronous motor is used so as to secure the benefits to be derived in correcting the power factor of the entire system, which may include shop and engine house.

When the main source of power fails, the battery, being permanently connected, automatically feeds the retarder system and also the diverter pole generator which then operates as a motor. If the power plant is equipped with a synchronous motor the act of operating the diverter pole generator as a motor drives the synchronous motor which then becomes an alternating current generator. Automatic controls cut off all alternating current units from the main source of alternating current and cut them onto the synchronous motor, acting as a generator. It will be noted that in this way both alternating and direct current are supplied for the operation of the retarder system whether the units require alternating or direct current and that this is done without any interruption in the service.

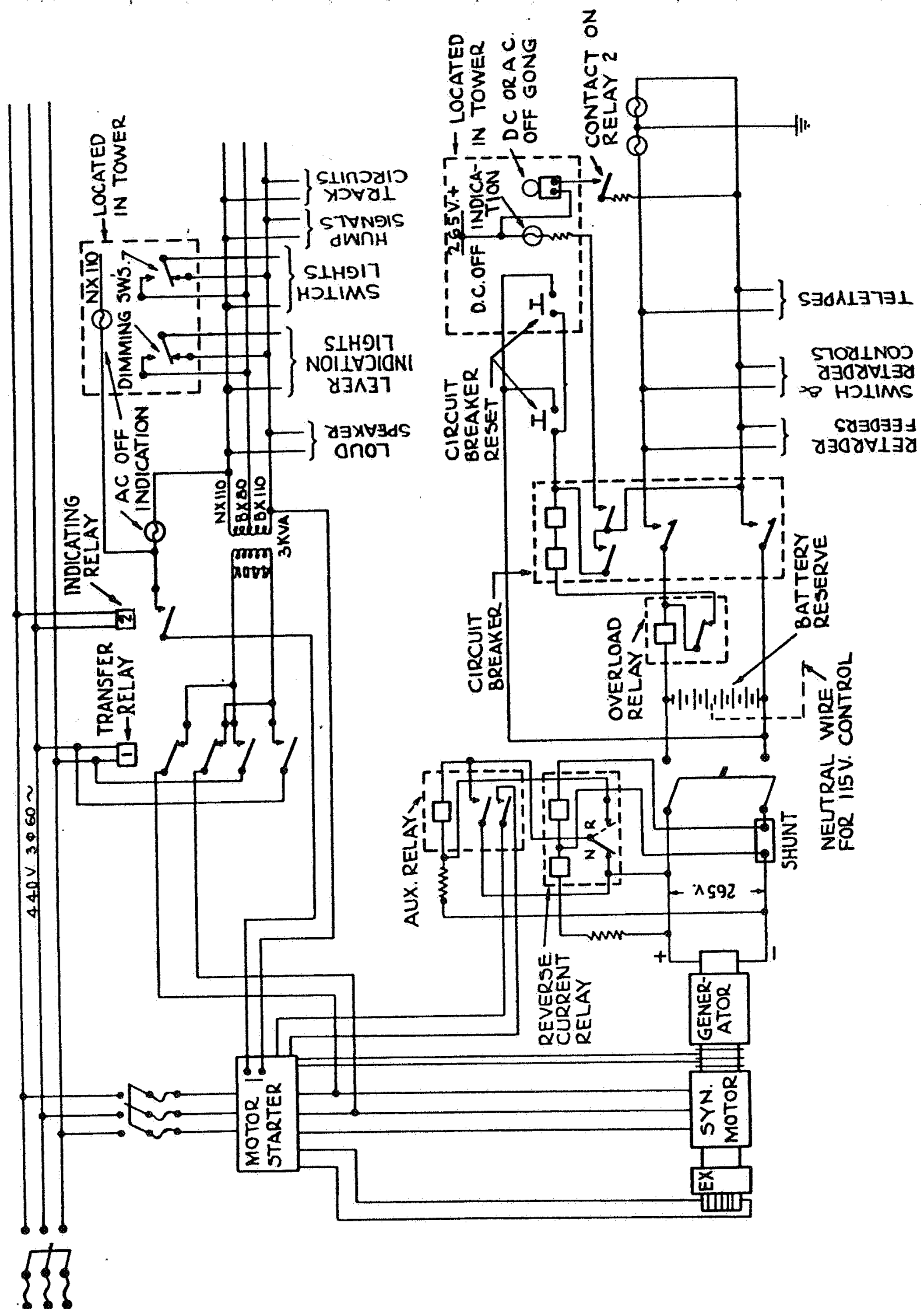


Fig. 46.
Wiring Diagram of Power Plant Using Diverter Pole Type Motor-Generator.

The switchboard is equipped with the various controls necessary for starting and stopping generators, measuring current and power, measuring grounds, selecting feeder circuits, etc.

The main feeders to the retarder circuits are controlled by an overload circuit breaker on which interlocked contacts are used for indicating whether or not it is closed. This indication is taken to one of the towers so that if the direct current power is interrupted the operator can reset the circuit breaker immediately without calling a maintainer.

The main source of alternating current is controlled automatically so that if the alternating current source fails the line will be cut off the plant. An indication of this is given in the tower.

Circuit plan, Fig. 46, shows typical wiring for a power plant using the diverter pole type motor-generator.

Direct current at 265 volts from the generator flows through overload relay coil, through main circuit breaker contacts and then out to the several yard units. The reverse-current relay contact is in normal position N, as shown, and the auxiliary relay is energized through the normal contact of reverse-current relay.

Alternating current from the 440-volt line energizes relay 1 and through its front contacts feeds the primary of the 3 kv-a. transformer which supplies alternating current at 80 and 110 volts to the yard units.

In the event of an overload, the overload relay contact opens de-energizing the main circuit breaker coils, the breaker trips out and opens the main 265-volt direct current circuit. The circuit breaker can be reset by means of a push button at the power station or in the nearest tower.

When an alternating current power failure occurs, direct current at 265 volts from the storage battery serves the plant. The generator inverts and operates as a motor, from the storage battery. The reverse-current relay reverses, its contacts assuming the R position, thereby shunting the coil of the auxiliary relay. The opening of its front contact trips the motor starter thereby opening contacts which prevent the synchronous motor (now operating as an alternator supplying alternating current 440 volts) from feeding back to the 440-volt line. Alternating current from the alternator is now supplied through the back contacts of relay 1 (which was de-energized when alternating current failure occurred) to the primary of the 3 kv-a. transformer and from the transformer to the various yard units.

Electro-pneumatic system.

The power requirements for the electro-pneumatic car retarder system consist of a supply of 12-volt direct current energy and a supply of compressed air at approximately 100 pounds pressure. A supply of alternating current for charging batteries and sometimes for compressor operation is also required.

The 12-volt direct current energy is usually supplied by storage battery, charged by copper-oxide rectifiers (see Fig. 47).

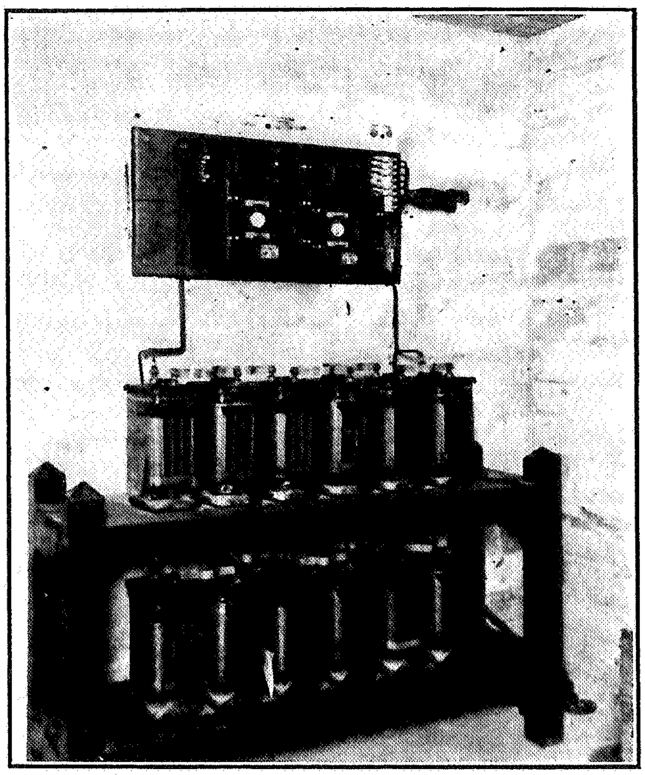


Fig. 47.
Storage Battery with Charging Rectifiers.

Many hump yards are located near car or locomotive shops, which use a considerable amount of compressed air and are already provided with compressor plants. In a majority of the electro-pneumatic retarder installations the compressed air is supplied from such a central plant. Sometimes it is advisable to install additional storage tanks and atmospheric aftercoolers near the retarders where the line from the central compressor plant ties into the retarder system. Such an installation is shown in Fig. 48. Where a central compressor plant is not available other means must be provided. Usually a small power house is built housing two compressors, a water aftercooler, and the storage batteries and rectifiers. A switchboard is seldom used. Each compressor has capacity to take care of the maximum conditions, one is held in reserve. Such compressors are usually motor-driven and are automatic in their operation. Figure 49 illustrates such compressors.

Just outside the power house an installation of storage tanks and aftercoolers is provided, Fig. 48, similar to that sometimes provided when the air is obtained from a central point.

The provision of the alternating current power supply varies with local conditions, commercial power available, existing facilities, etc., so that no definite general practice has developed.

In emergency, the storage battery provides sufficient reserve for supplying the direct current. For emergency compressed air, there is usually a con-

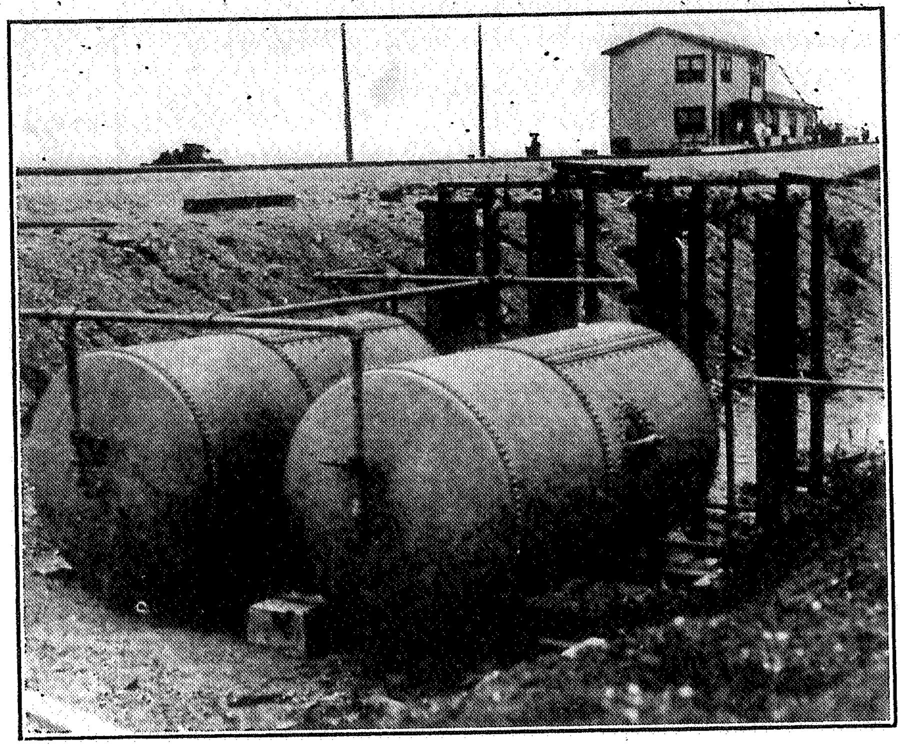


Fig. 48.
Storage Tanks and Atmospheric After-Coolers.

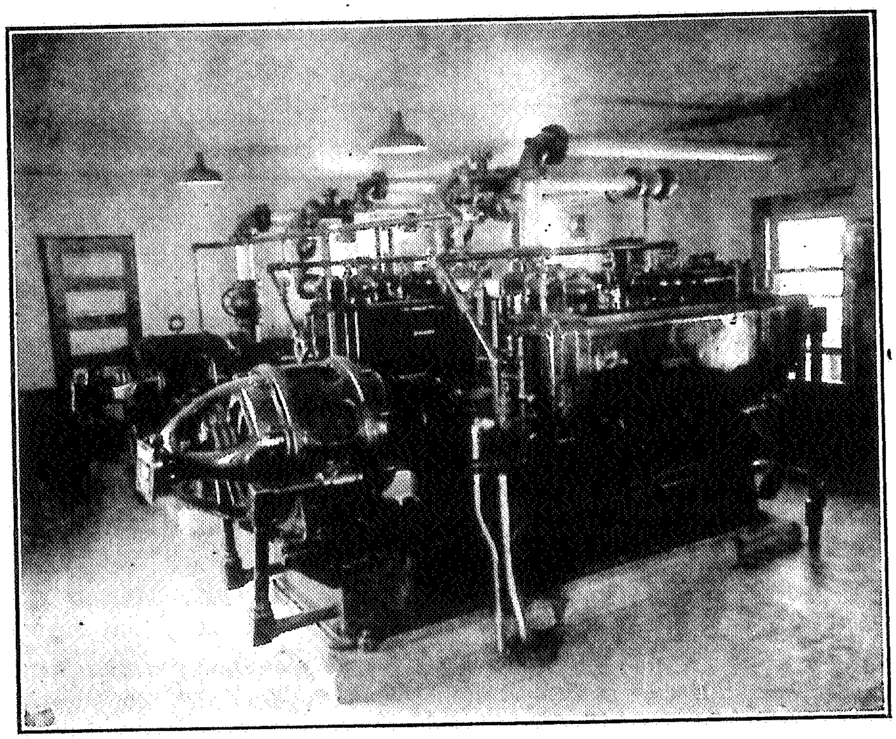


Fig. 49.
Motor-Driven Air Compressors.

venient connection made into the air piping system in such a way that a locomotive air pump can supply the compressed air for the system.

Signal System

Signals are required to control the movement of trains to and from the hump and to indicate the speed at which trains are to be pushed over the hump and to protect movements in the switching area.

The hump signal located at the hump governs movements from any track of the receiving yard. Instructions are given to the hump engine crews, if there are more than one, as to which is to come first.

Repeater signals, when used, are located at frequent intervals so that in foggy weather the enginemen are able to determine the indication of the hump signal at all times.

The aspects and indications recommended by the Signal Section, Association of American Railroads, are as follows:

Aspect	Indication
Red	Stop
Green	Proceed at normal hump speed
Yellow over yellow	Proceed at medium hump speed
Yellow	Proceed at slow hump speed
Flashing red	Back up

In some of the installations described in this chapter, the aspects and indications used are as follows:

Aspect	Indication
Green	Hump fast or bring train to hump
Yellow	Hump slow
Red	Stop
Yellow over red	Back up

Note.—Some installations use a double red for a back up signal so that in case of a lamp failure a more restrictive signal will be displayed.

A trimmer signal is necessary for controlling the movement of engines through the switching area. Switch targets or lights are used to indicate the position of each switch. An engine on a classification track is not allowed to move into the switching area until the switches are in proper position even though the trimmer signal may be displayed for movements through the switching area.

The aspects and indications recommended by the Signal Section, A.A.R., are as follows:

Aspect	Indication
Red	Stop
Yellow	Trim

In some of the installations described in this chapter, the aspects and indications used are as follows:

Aspect	Indication
Yellow	Permits moves through the switching area being governed by switch targets or lights
Red	Stay in the clear

The controller, for operating the signals, is mounted at the hump and near the track so that if desired the switchman can reach the lever as he walks alongside the train.

Different types of signaling systems are used: for example, light signal, semaphore, and cab signal.

When the semaphore or light signal is used, one is located at the hump as shown in Fig. 50 and several others are located along the hump lead and sometimes at a point halfway down the receiving yard so as to provide an indication for the engineman under all conditions. In some yards masts are located about 800 feet apart and the signal indicates in both directions so as to give a minimum range of vision of 400 feet. This was found of advantage in a heavy fog.

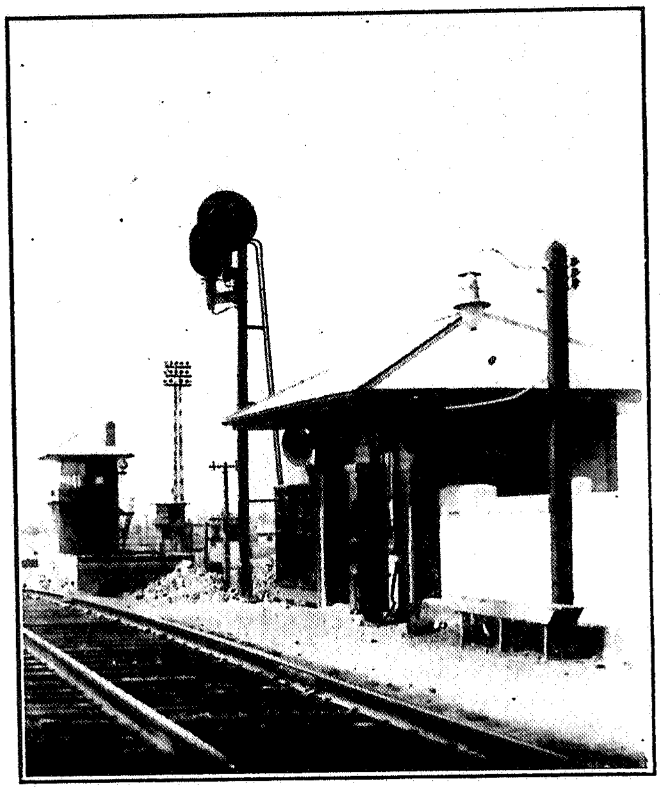


Fig. 50.
Hump Signal with Controller.

When the cab signal is used the repeater signals are not installed but usually the hump signal is employed for the movement of road engines which frequently pass over the hump after leaving their trains in the receiving yard and for yard engines not used regularly in humping service.

The continuous inductive system, developed for automatic train control, is used for cab signals and the indications are provided by code frequencies transmitted through the rails or through wires attached to the rails and back over a line wire. Circuits for individual receiving tracks are selected by

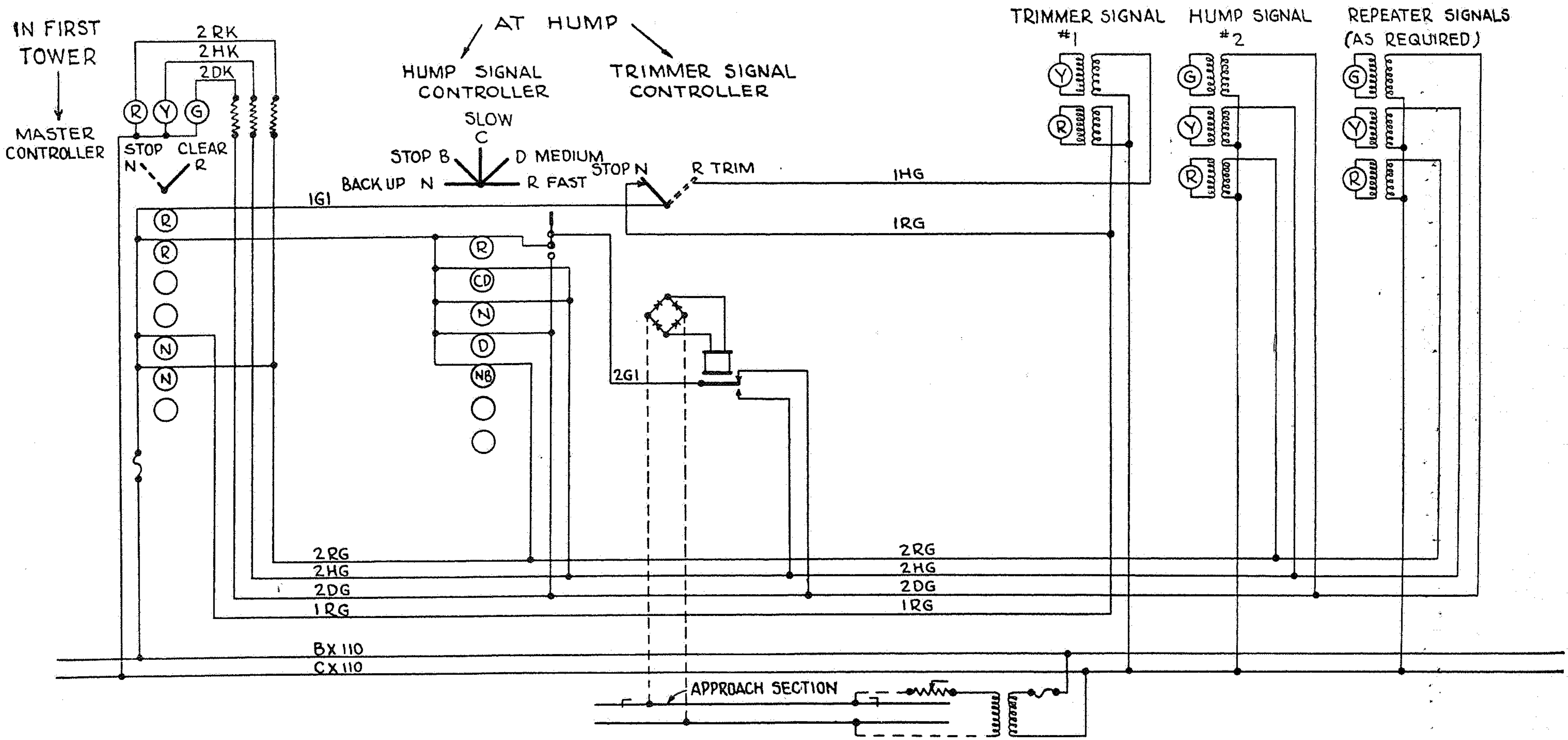


Fig. 51.
Retarder System Signal Control Circuits.

switch circuit controllers operated by the switch points at the hump end of the yard. With such an arrangement the priority of trains moving out of the receiving yard can be set up whereas with fixed signals the enginemen must be instructed prior to their leaving the hump.

In some yards a track circuit is located in the track approaching the hump and is used in interlocking the hump signal with the trimmer signal in such a way that both signals may be cleared if the track circuit is not occupied. This permits the trimmer engine to work in the switching area at the same time a train is being brought to the hump and provides for the display of a stop indication in the hump signal as soon as the first car of the train arrives at the hump. The track circuit extends far enough ahead of the hump to give the engineman time to observe the change in indication and stop his train. In a number of yards this track circuit does not affect the interlocking of the hump and trimmer signals and is used for a different purpose than just described. In these cases, the green is used in bringing the train to the hump, but as the first car shunts the track circuit the aspect changes to yellow, or the normal humping speed (see Fig. 51). This is of particular advantage if the lead to the hump is rather long.

A special type of controller is used to control the hump signal. It is usually located close to the track and near the humpmaster's office as shown in Figs. 50 and 52. In the controllers shown in Figs. 52 and 53 five positions are used: hump fast, hump medium, hump slow, stop and back up. In many cases the hump medium indication is not used.

In the controller shown in Fig. 53 a modified table interlocker is used for selecting the circuits, no trimmer signal being used. When one is used the

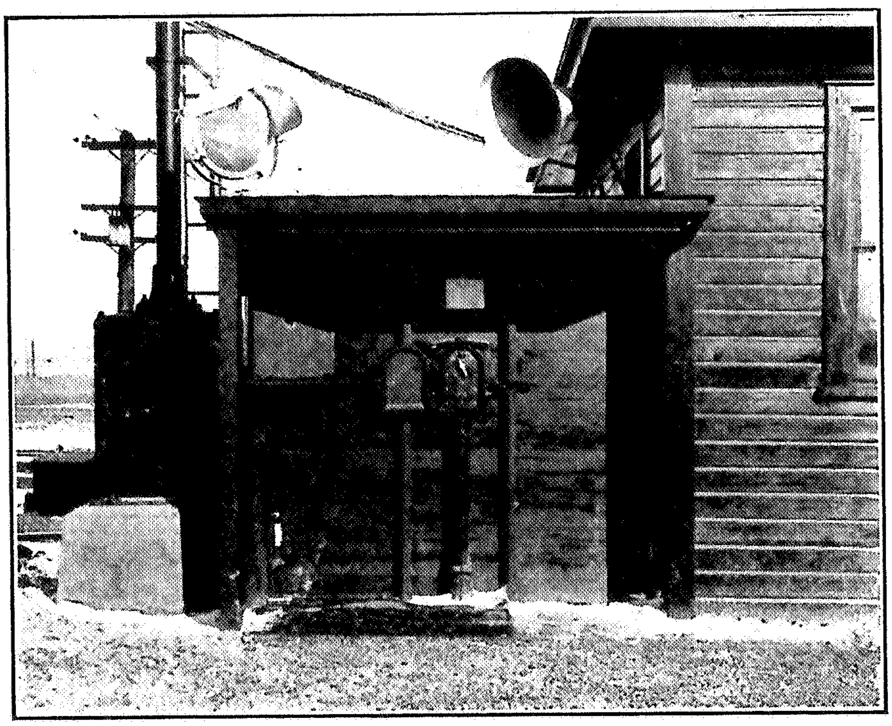


Fig. 52.
Hump Signal Controller.

lever for its control is located in the same housing. Indication lights shown at the top, under the hood, repeat the indications displayed on the hump signal and the trimmer signal when it is used. Relays for the control of the signals are located in the lower half of the housing.

In the controller shown in Fig. 52, selection of the circuits is made by the rotation of a roller equipped with suitable circuit controllers and connected directly to the operating lever of the controller. The small lever in the lower part of the controller is the trimmer signal control and has two positions, stop and trim. In this controller the trimmer signal lever and the hump signal lever are mechanically interlocked so that the trimmer signal lever cannot be in the "trim" position unless the hump signal lever is in either the stop or back up position. In a number of installations this interlocking has been accomplished by the circuit arrangement instead of mechanically. The circuit used with the controller, shown in Fig. 52, is illustrated in Fig. 51. With this circuit no relays are used except in connection with the approach track circuit.

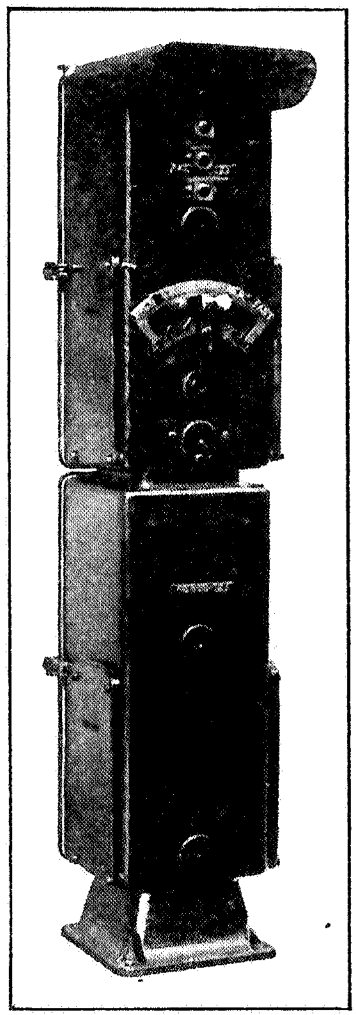


Fig. 53.
Hump Signal Controller.

Communicating System

Means of communication is important, it being necessary to transmit car lists to the humpmaster and operators so they will know the tracks to which cars are to be switched. Verbal communication is necessary in case changes have to be made in the lists due to errors in tabulation or due to changing the assignments of classification.

Teletype.

The teletype system consists of a master or sending machine usually located in the yardmaster's office. This machine not only sends the information to the various locations around the yard but also prints a copy at the yard-master's office. Receiving machines are located at the hump and in each of the control towers. The machines are mounted on a steel frame under-structure and provided with a soundproof housing as shown at the left in Fig. 40.

Pneumatic tubes.

The pneumatic tube system consists of tubes extending from one point to another, machines being used on each end to introduce air behind a carrier, thus driving it through the tube. Messages are transmitted by means of this apparatus.

Tubes connect the yard office with the receiving and departure yards for transmitting waybills, and occasionally with the hump office and each of the towers for transmitting hump lists to operators. When tubes are used for the purpose last named the teletype system is not used.

Telephones.

Telephones are located in the yard office, the towers and other points where required. In addition, loud speaker systems are sometimes used. The receiver horn for such an installation is illustrated in Fig. 50, and the transmitter is shown in Fig. 40.

Piping

Main and branch piping and connections are installed in the same general manner as is covered in Chapter XVIII—Electro-Pneumatic Interlocking.

Wiring

The usual wiring practice followed in interlocking is followed in retarder systems.

Flood Lighting

Flood lighting is very important for retarder operation since it is necessary that the operator see the cars and their location with respect to switches so as to control the speed of the cars and throw the switches at the proper time. A typical layout of flood lighting is shown in Fig. 54.

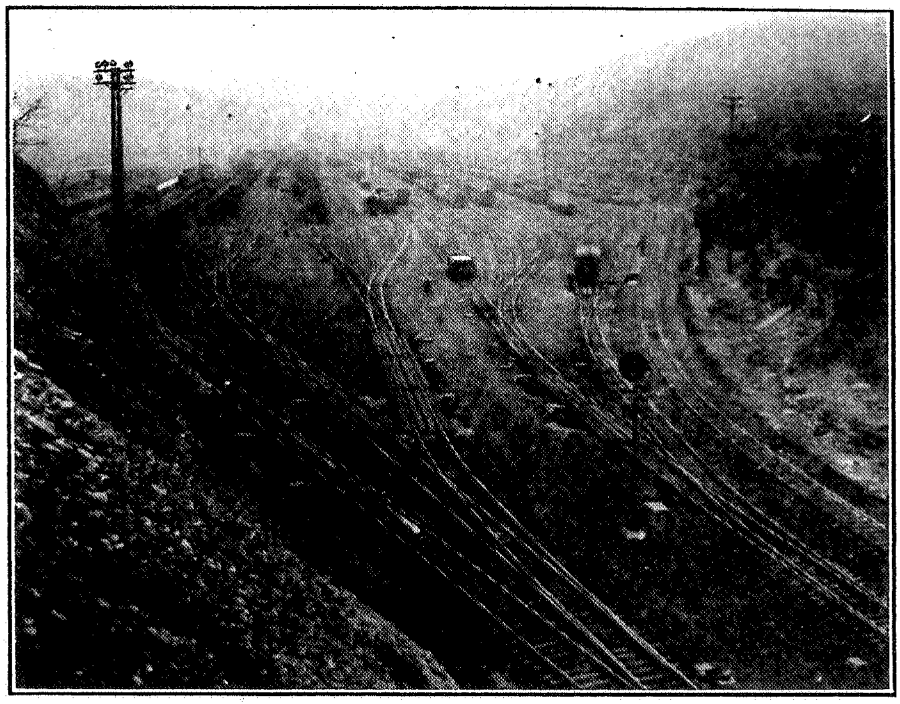


Fig. 54.
Flood Light Layout.

Hot Oil Plant

In severe winter weather some difficulty was experienced with the free running of empty cars into clear. Hot oil, introduced in the journal boxes as a car moves over the hump, tends to reduce the rolling resistance and thereby provides for better operation.

An oil tank with arrangements for heating is installed approximately 100 feet ahead of the crest of the hump. The oil is taken through underground pipes, one pipe to each side of the track and a hose, fitted with a nozzle, is connected at this point. Air pressure is applied to the tank of oil which provides a pressure at the nozzle.

The journal box covers are lifted by the inspectors in the receiving yard and as the cars move up to the hump a man on each side of the track introduces a small amount of oil directly on the journal and then closes the journal box. (See Fig. 55.)

Another method of reducing journal resistance in cold weather is by moving the cars back and forth, thereby warming the journals sufficiently to provide good lubrication.

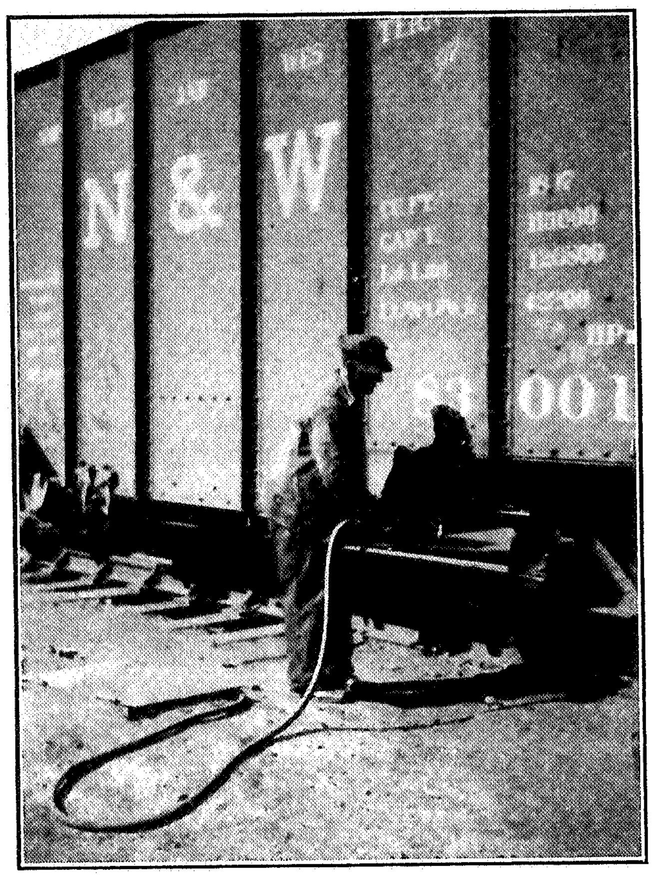


Fig. 55.
Hot Oil Injector.

American Railway Signaling Principles and Practices

QUESTIONS ON

CHAPTER XXI

Hump Yard Systems

QUESTIONS ON CHAPTER XXI

HUMP YARD SYSTEMS

General.

1. In the early days of railroading, how were freight cars classified?
2. As traffic increased, what was done to handle freight cars?
3. What was the next step taken to do a large part of the work formerly done by the switch-engine?
4. What was then instituted for effecting economies, and what is the improvement known as?

Power-Operated Switch Systems

5. Where was the first installation of power-operated switches in a hump yard made?
6. What roads later had hump yards equipped with power-operated switches?
7. Since the invention of the car retarder, how have a few hump yards been equipped?
8. What does the usual operation of hump yards, equipped with power-operated switches, involve?
9. How is the operator able to follow the movement of the different cars?

Electro-pneumatic.

10. To what machine does the push button machine, illustrated in Fig. 1, compare?
11. What is the upper and the lower row of buttons termed?
12. What effect does pressing in a button have on a corresponding button, and how is it accomplished?
13. How are the indicators above the buttons controlled?
14. If the track circuit is unoccupied what is indicated?
15. If the track circuit is occupied, what position does the indicator take?
16. With the indicator in mid-position, what takes place?
17. How do the switch cylinders and valves compare to those used in the electro-pneumatic interlocking installations?
18. How are push buttons connected and operated, and what is accomplished?

Electric.

19. Of what does the lever machine for controlling switches consist?
20. Which is the normal and which the reverse position of the lever?
21. What do the indication lights show?
22. Why is a relay built into each lever, and how is it connected?
23. What, while occupied, are used to prevent the operation of switches?
24. What machines are used for operating switches?
25. How does the Model 6 switch machine compare with that illustrated in Fig. 31?

Car Retarder Systems

26. How was the classification of cars handled prior to the use of car retarders and in many freight yards at present?

27. Why is the cost of classifying cars without car retarders expensive?

28. What causes the greatest loss of time?

29. What is the advantage of the car retarder system with respect to men and engines?

30. What devices does the system include?

Historical.

31. When and by whom was the first system of retarder invented, and where was it installed and tested?

32. What were the results of the first test?

33. By whom were the first patents taken out?

34. What type retarders have been developed since the original one?

35. What are the prevailing types used in America?

36. What type is used in Great Britain and on the Continent most extensively, and why is it advisable?

Track layout and gradients.

37. Why is it important that the track layout and gradients be designed and the retarders be located properly?

38. What minimum track change was made when retarders were first installed?

39. As the art developed, what changes seemed advisable with respect to track and retarders?

40. When reconstructing the Mechanicville Yard at Mechanicville, N. Y., on the Boston & Maine R. R., Fig. 6, how were the tracks arranged and where were retarders used?

41. How does the present design of yard compare to the one at Mechanicville?

42. What is the average gradient from the crest of the hump?

43. What consideration is given the spacing of retarders?

44. What consideration is usually given the gradient in the classification track?

45. What is considered the ideal arrangement of track layout, gradients and retarders, and why?

46. Why were track circuits not used in the earlier installations?

47. Why was it decided later that track circuits would not slow up operation?

48. How has the use of track circuits resulted in economy?

Car Retarders

General principles.

49. How is retardation secured?

50. How is the pressure cushioned?

51. In what proportion is retardation obtained?

52. Why is means provided for varying retardation?

53. What is considered important in the retarders used in Great Britain and on the Continent, and why is it necessary?

54. How does the ratio of retardation to the weight of cars in America compare with that in Great Britain and on the Continent, and what is the reason?

55. Why may a derailment occur if too much pressure is applied against the wheels?

56. What is generally used so that a maximum average pressure can be secured without having pressures per wheel in excess of that at which wheels will lift?

57. What other feature makes equalized shoe pressure advantageous?

58. How do the forces throughout the retarder compensate for uneven surfacing?

59. Why is adjustment provided?

60. Why must the construction be made strong?

61. What provision is made in the design with respect to ties?

Types of retarders.

62. How many general types of retarders have been developed and installed in America?

63. What are the types, and what is used for the control and operation of each?

64. How many steps of retardation does each provide, and how are they used?

Electric retarder, Type A.

65. When and where was the machine, shown in Fig. 9, first installed?

66. When and where was this type later installed?

67. Describe the foundation used for the Type A retarder.

68. To what is the mechanism attached, and how is it supported?

69. Where are the shoes fastened, and what prevents their lifting?

70. What is the length of the shoe beams, and how are they arranged so that there is a flexing of the assembly to compensate for variation in the thickness and the spacing of wheels?

71. How is the pressure between the shoe and the wheel provided?

72. How is the spring kept in line?

73. How is the adjustment for the initial spring pressure provided, and how is the position of the shoe obtained?

74. How are the girders kept in line?

75. How many pairs of girders are there, and how are they assembled and connected?

76. What movement does the T-crank provide to each pair of girders, and how is each pair connected?

77. How does any movement of the crank provide equal movement as between the inside and outside shoes to and from the rails?

78. How is a connection provided to the mechanism throw rod, and what causes the latter to be moved out and in from the mechanism?

79. How is the gear driven?

80. Explain the operation of the magnetic brake on the motor.

81. When and how is power cut off the motor, and when is the brake applied?

82. How is the pressure necessary for retardation provided?

83. What provides for a variation in the pressure against the wheel and, therefore, a variation in the degree of retardation?

84. How may the retarder be used to secure more or less retardation, and what is the usual practice?

85. How may retarders be assembled to secure one long operating surface, how may mechanisms be used, and how are they operated to secure various degrees of retardation on each of the units independent of the other units?

86. Why is an adjustment provided on the throw rod?

87. Why is it necessary to adjust the position of the shoes for alignment?

88. In what varying length is this retarder used, and when in some cases is it used on one rail only?

Electro-pneumatic retarder, Markham type.

89. When and where was the electro-pneumatic retarder first installed?

90. When air is admitted in back of the piston in the cylinder, how does the cylinder and its piston move, and to what position does this bring the brake shoes?

91. As the car wheel enters the retarder, what takes up the initial shock and compensates for the variation in the wheel thickness and spacing on the axle, and how is the retardation effected?

92. How are the four degrees of retardation obtained?

93. How is the retarder opened?

94. How many positions of the brake shoes are there?

95. How is the entire structure mounted?

Electro-pneumatic retarder, Boston type.

96. In the reconstruction of the Mystic Junction Yards at Boston, Mass., what necessitated the design of a sturdier and more powerful retarder than the Markham type?

97. When and where was the Boston type, shown in Fig. 12, installed?

98. How does the Boston type retarder compare to the Markham type?

99. How are the outer ends and the inner ends of the springs attached?

100. By what are the brake beams moved, and where is it located?

101. What closes the retarder, and what is the action on the piston and rod?

102. What then moves the driving bar, and how does the movement compare to the direction of traffic, and what then is the result with each brake beam?

Electric retarder, Type B.

103. When and where were the first Type B retarders installed?

104. How were the tracks and retarders arranged at Mechanicville Yard?

105. What necessitated the designing of a retarder which had about twice the capacity for retardation of the Type A retarder for the Mechanicville Yard?

106. Of what does the foundation of the Type B retarder consist?

107. How do the opposing forces in the Type B and Type A retarders compare?

108. How is the tie spacing maintained?

109. How are the chairs which support and guide the shoe beams fastened?

110. How are the rails supported and held in place?

111. Where are the crossbars located, and how are they supported?

112. How are the fixed levers and the floating levers supported?

113. Where is the spring suspended, and how does it contact with the levers?

114. Where do the upper ends of the levers contact with the shoe beam?

115. How does the point of contact minimize the pressures between the shoe beam and chair?

116. How are the crossbars connected?

117. How is the operating bar supported and connected?

118. How is the toggle crank driven, and how is its drive moved back and forth?

119. What does Fig. 14 illustrate?

120. What positions do the full lines and the dotted lines show?

121. Explain the action that causes the toggle crank, lever and operating bar to move away from the mechanism?

122. What takes up all play during the operation, and how is it accomplished?

123. What effect does this pressure have on the floating lever and the crossbar?

124. What is the lever ratio for both the fixed and floating levers?

125. What causes a one-inch movement of the upper end of the fixed lever?

126. How does the movement of the upper end of the fixed lever effect the shoe beam?

127. How do the operations of parts mentioned compare, and what effect does a movement of the crossbar have on the shoe beams?

128. What parts does the brake, attached to the motor, hold in a fixed position?

129. What is the effect upon the large spring as the wheel moves in between the shoes?

130. Why are the pressures resulting on either side of the wheel equal?

131. How is a variation in retardation secured by the Type B retarder? Give an example.

132. What is the spacing between the shoes, to obtain minimum retardation?

133. Explain how maximum and minimum retardation is secured with a spacing of 5 inches between the shoes.

134. What relation is there between Figs. 15 and 14, and what do they cover?

135. What does the hand in Fig. 15 represent?

136. With a wheel between shoes E and B, how is the pressure from spring C transmitted?

137. What will any additional pull on the crossbar tend to do?

138. What will be the effect between the shoes and the wheel, and spring pressure, by decreasing the pull on the crossbar?

139. What is the shape of the shoes, and how are they attached to the shoe beam?

140. What is the height of the outside shoes and the inside shoes above the top of rail?

141. Of what material are the outside shoes made, and why are they specially treated?

142. Of what material are the inside shoes made, and why is it not necessary to be of the same material as the outside shoes?

143. What does the extra height of the shoe above the rail provide?

144. How does the combination of high inside and low outside shoes assist in preventing derailments?

145. As the face of the shoes wears off, why is it necessary to move them in toward the rail?

146. How is the adjustment made, and for how many shoes is this sufficient?

147. How is the excessive wear in bearings taken up?

148. Where are additional adjustment facilities provided, and how is the adjustment accomplished?

149. For what do all the adjustment facilities taken together compensate?

150. How are the shoe beams opened to the removable position?

151. After what parts are removed are all parts in the retarder easily reached for maintenance purposes?

152. What greasing system is used throughout for all pin type bearings, and what is done with most pins to transmit the grease?

153. What lubricant is used for all sliding surfaces?

154. How is the toggle crank supported, and where is its pivot with respect to the operating bar?

155. What is it that gives enough additional mechanical advantage to permit the use of the same mechanism used on the Type A retarder, and what changes are made to secure the proper shoe spacing for the various degrees of retardation?

156. Of what does the mechanism shown in Fig. 16 consist?

157. What does the horizontal shaft carry, and how do the bearings it runs in compare to the other shafts?

158. How are the lower bearings and the gear teeth lubricated, and what system is used to lubricate the upper bearings?

159. How is the mechanism controller, reference 13, Fig. 16, driven, and of what does the controller consist?

160. With what do the cams contact?

161. What type motor is assembled in the main housing, and how is it connected to the mechanism?

162. Of what type is the brake, and how is it attached?

163. How many wires are used from the retarder lever to the mechanism controller of the retarder mechanism, and to what are they connected?

164. What are the two control wires used for, to what are they connected, and to where do they extend?

165. When the control lever is moved to any one of the five positions, how and where does current flow?

166. If contactor F is energized, what is the result, and why is this true?

167. Describe how current flows in operating.

168. For opening the retarder, what contactor is energized, how does current flow, and in what direction does the motor operate?

169. As the mechanism is moved, describe the cam action in the mechanism controller, the contactor action, its effect on the motor, and method of accomplishing dynamic braking.

170. Does the mechanism always move to a position corresponding to that of the control lever, and why?

171. What protective devices are used, and why?

172. How is the time relay normally energized, and how is it de-energized?

173. How is the timing obtained, and what is the time?

Electro-pneumatic retarder, Model 28.

174. Why was the Model 28 retarder, Fig. 19, designed?

175. Where were complete installations made?

176. Into what parts may the Model 28 retarder be said to be divided?

177. How does the brake cylinder, used in operating the Model 28 retarder, form a closed system of forces?

178. How many pistons has this cylinder, and as what are they known?

179. How is the piston rod of the brake cylinder connected to the floating toggle lever?

180. What does the floating toggle drive, and how is it accomplished?

181. What maintains the floating toggle lever in such a position that when the retarder is either being opened or closed, the brake shoe beams take the proper position with relation to the rail?

182. In what position does Fig. 20 show the linkage?

183. With the control lever in either the first, second or third position, how does the toggle lever move?

184. How does this angle of the control lever affect the piston?

185. How then in these three positions do the principles of the earlier designs of electro-pneumatic retarders compare?

186. With the control lever in the fourth position, how does the toggle lever form with the outer driving links?

187. Although the toggle lever does not come into a dead center position, what will be the effect upon the piston during retardation?

188. How is retardation obtained in the fourth position, and for what is the air used?

189. If a locomotive, with its comparatively wide driving wheels, should move through a closed retarder, what would be the result?

190. Referring to Fig. 23, what tends to keep the brake shoes always in proper relation to the rails as it opposes movement of lever E?

191. What is the initial compression adjusted into the centering spring sufficient to overcome?

192. When a car enters the retarder, what is the reaction of the two inside sets of brake shoe beams as compared to that of the two outside beams?

193. How does this construction affect the brake shoe beams, and how does it maintain the center line of trucks over the center line of the track?

194. Why does this condition of balance hold?

195. When too great a retardation pressure is applied to light cars, what may be the result?

196. In such a case, what will be the effect on the wheels?

197. What insures that the wheels will always drop back on the rail?

198. What do turnbuckles in the toggle connecting rods provide?

199. How many adjustments are provided for shoes?

200. If it is necessary to adjust any particular shoes independent of the others or to compensate for wear in the driving linkage, how can this be done?

201. Referring to Fig. 23, at what angles do we find the arms of the outer and inner driving cranks constructed?

202. With crank set at the angles mentioned, what linkage advantage is maintained?

203. How are the cranks mounted?

204. How does the radius rod brake beam assembly compare to that used in the Boston type retarder?

205. Of what is the radius rod assembly composed?

206. What practically covers and protects the radius rod assembly from damage?

207. What closes the space between the top flange of the brake beam and the top plate of the trunnion bearing plate assembly?

208. How is space provided for tie tamping?

209. Of what is the trunnion bearing plate assembly, supporting the brake beams and driving bars and the trunnion ends of the radius rod assemblies, composed?

210. Where are the plates located, and how are they tied together?

211. How is a higher grip (3 inches above top of rail) provided, and what is the advantage?

212. Why do the usual clearance limitations exist?

213. Why are the brake beams, at each end of the retarder, flared out?

214. To what is the entire structure securely fastened, and how do they act?

215. How is the desired control of the retarder obtained, and where connected and mounted?

216. Of what does the control valve assembly consist?

217. Of what does the control valve consist?

218. How does the construction of the control valves compare to those described in Chapter XVIII—Electro-Pneumatic Interlocking under the heading "Switch valves"?

219. With what type retarders is the three-step pressure regulator, Fig. 24, used?

220. Of what does the three-step pressure regulator consist?

221. Why is the pipe connected to the operating portion of the brake cylinder to the right of the main piston?

222. What is the characteristic of the Bourdon tubes?

223. What is the purpose of a contact finger on the end of tube?

224. How does the single-step pressure regulator, Fig. 24, compare with the three-step regulator, and where is it connected?

225. How does the circuit controller compare to those used on electro-pneumatic interlocking machines, and how is it actuated?

226. What is the purpose of the rectifier, Fig. 24?

227. What does Fig. 25 illustrate?

228. What magnets are shown de-energized and what magnets are shown energized?

229. In what position of the magnets is air admitted to the rod side of the main piston?

230. In what positions of magnets is air at full pressure admitted to the rod side of the auxiliary piston?

231. Where is the auxiliary piston held with magnets in these positions, and what is the effect on the main piston?

232. What is the action of the air and the effect with the magnets in the fourth position?

233. In the fourth position, why is air at full pressure applied?

234. Between this point and the end of the stroke, how is the air governed?

235. In the third position, where is air at full pressure admitted?

236. In moving from fourth to third position, where is air at full pressure applied, and what is the result on both pistons?

237. In what position of the main piston, and by what action, is air admitted at full pressure to the rod side of the main piston?

238. In moving from open to the first and second positions, what is the effect on the pressure regulator and the action of the air?

239. In opening the retarder, what is the effect on the air?

240. What controls valve A when opening the retarder and thus regulates the pressure used?

241. When the retarder has almost reached its full opened position, what magnet remains energized and what ones de-energized?

242. With magnet N energized and magnets A and N de-energized, what is the effect on the air and how is the retarder moved to its full opened position?

243. Assuming that the retarder is open, as in Fig. 25, all magnets except magnet X de-energized and the air vented, illustrate the principle of the circuit.

244. What starts the retarder toward the closed position?

245. Explain the action of piston, circuit magnet and air that causes the auxiliary piston to move to the inner end of its travel.

246. At what position of the piston and by what action is air at full pressure cut off and shunt removed from contact 2P on the pressure regulator?

247. Under what power and until what value of pressure does the piston continue to move?

248. At what pressure and for what purpose is contact 2P on the pressure regulator set?

249. What would cause the pressure to rise above 40 pounds and how would the excess air be vented?

250. How do other circuits compare?

251. With what type grease fittings is the Model 28 retarder equipped, and in what lengths are they manufactured?

Electro-pneumatic retarder, Model 31.

252. Why was the Model 31 retarder, shown in Fig. 26, designed?

253. Have any new yards been equipped with new retarders since the Model 31 was designed?

254. Where is a six-section single-rail retarder, and where is a ten-section double-rail retarder in service?

255. Upon what principle is the Model 31 retarder built, and what is the length of each section?

256. Describe the units and spacing of same in a double-rail retarder on each side of the track.

257. How is the air to each cylinder unit supplied?

258. How does the retarder move to its open position?

259. Are springs required to obtain retardation or take up initial shock?

260. To what extent is there a tendency of empty cars to be raised, and what provision is made to prevent derailment of cars which might be raised?

261. Of what do the cylinder units, shown in Fig. 27, consist, how are they connected, and how do they operate?

262. How is the fulcrum pin supported?

263. What else do the bearings support, and where are they fastened?

264. How are the levers centered with relation to the rail?

265. When air is admitted to the cylinder, what is the action on brake shoes and beams?

266. When and how does the upper lever, which carries the outside brake beams, move to its open position, and how does it come to rest?

267. What causes the lower lever, which carries the inside brake beams, to move to its open position and come to rest?

268. By what arrangement, with the retarder in either its closed or open position, will the levers and cylinder, and their associated brake beams and shoes, swing and to what extent?

269. In what position of the retarder are the brake shoes permitted to adjust themselves to the various spacing of car wheels on axles and in what position of the retarder are the brake shoes permitted to adjust themselves to the passage of locomotives having unusually wide driving wheels?

270. How does the operation of the pressure regulator, shown in Fig. 28, compare to that described for the Model 28 retarder?

Switch Layouts

271. In retarder yards what has led to the occasional use of lap switches?

272. For what circuits are the location of insulated joints shown in Fig. 30?

273. How many separate track circuits are employed in a lap switch layout, which circuits protect the first switch and which the last switch?

274. What is the length of track circuits, as specified, and what is the length ahead of the points sufficient to permit?

General principles.

275. What time is required for the switch to operate?

276. Why does the switch machine not need to be reversible in midstroke?

277. Are track circuits necessary?

278. Is indication at the control machine necessary?

279. What is the effect upon switch points or switch machine, if switch is trailed through?

280. What provision is made to indicate the position of the points?

Power Switch Machines

Model 6 switch machine—Electric operation.

281. How is the Model 6 switch machine mounted, and how does the mounting compare to switches in electric interlocking?

282. How does the motor and train of gears compare to those described in Chapter XIX—Electric Interlocking.

283. How does the connection to the throw rod compare to that shown in Chapter XIX?

284. What provision is made for driving the throw rod?

285. How are they connected, and why do they move?

286. What causes the unit to pivot, and how is the throw rod connected which causes it to move?

287. For normal operation how do the two levers move, and what only moves if the switch is trailed through, and what allows the cam to pivot with respect to the lever?

288. Regardless of the position of the switch, how can full movement of the points be obtained without the necessity of moving the lever connected to the main gear?

289. After a switch has been trailed through, what action must be taken to make the switch operate as formerly?

290. What makes the switch machine reversible even though the points may be blocked?

291. Can the motor be stalled by obstructing the points, and when would fuses blow?

292. What further use is made of the trailable feature?

293. What operates the point detector?

294. How close are adjustments between point and stock rail indicated?

295. What other method is used for selecting indications?

296. How is the pole changer operated?

297. What necessitates that the stroke be completed once it has started?

298. Where are transformers for indication lights frequently mounted?

299. What addition is made to machine when track circuits are used?

300. How do the circuits, shown in Fig. 32, for Model 6 switch machine, compare to those used in electric interlocking?

301. Where track circuits are used, how are they usually operated?

302. How is the independent coil of the relay connected, and what does it provide and insure with respect to switch?

303. What provision is made so that at average normal speeds the car will not reach the points before the switch movement is completed?

304. What is another factor in the distance of track circuits required ahead of points?

305. With the a.c.-d.c. track circuit, what is the shunting time of the track relay?

306. What locks the lever in that position until the movement of the switch machine is completed?

307. What other movement is prevented by the lock, and what would be the result if made?

308. When other types of track circuits are employed, how do their general principles compare to that already described?

Direct-acting switch movement—Electro-pneumatic operation.

309. Of what does the direct-acting switch movement, shown in Fig. 33, consist?

310. How does the switch machine compare to the switch valve and cylinder described in Chapter XVIII—Electro-Pneumatic Interlocking?

311. Why may the switch be trailed through at any time without damage?

312. When track circuits are used, how is it arranged to hold switch in its trailed position until the track circuit again becomes clear, and to what position will the switch then move?

313. What will be the effect upon switch if an engine, with or without cars, trails partly through the switch and then reverses its direction?

314. What circuits are shown in Fig. 34?

315. When the track circuit is occupied, thereby shunting the track relay, how is energy maintained on the magnet?

316. Why is a distance of 22 feet ahead of the switch point for the beginning of the circuit ample for any ordinary yard speed?

Skate Layout

317. Why are skates used in some classification yards?

General principles.

318. What is the maximum time, from the time the control lever is moved, before the skate is placed on the rail?

319. Why are skate machines reversible in midstroke?

320. What makes it possible to take the skate away by the car wheel without shock to the mechanism?

321. How is the skate, after being taken away by a wheel, replaced on skate clip?

322. Who usually brings the skate back, and who replaces it on the skate clip?

323. Where are skates usually located on classification tracks compared to the switch?

Power Skate Machines

Electric operation.

324. Of what does the electric skate machine, shown in Fig. 35, consist?

325. How is the skate attached to the clip?

326. How is the wedge arranged so the skate slides off easily?

327. What prevents the skate from vibrating off the wedge when it is not placed on the rail?

328. What is used for holding the skate in the open or closed position?

329. What is used to open or close circuits at the proper time?

330. What circuit is shown in Fig. 36?

331. How many positions has the control lever, and what is the effect on the field coils with lever in each position?

332. How is the mechanism stopped without over-run?

Electro-pneumatic operation.

333. Describe the electro-pneumatic skate machine shown in Fig. 37.

334. How is the admission and release of air for this cylinder controlled, and by what action is the skate placed on the rail?

335. How is the skate removed from the rail?

336. Describe the control circuit.

Control Machines

337. Where are control machines located, and what is the advantage?

338. Describe the general design of tower.

339. How many towers are usually used, and where are they located?

340. What retarders does the operator in the tower at the junction switch usually control?

341. What do the operators in the other two towers usually control?

342. Why, in practically all cases, do the switches immediately in the rear of the retarders have their controls in the same tower in which the retarder controls are located?

General principles.

343. Why is the arrangement of levers in the machine compact?

344. What consideration is given the numbering and arrangement of the levers?

345. When are indications from the various units provided?

346. What indications are provided in most cases?

347. What consideration was given the operator in the design of the machine?

348. In the design of the control machine, what consideration was given the levers for maintenance purposes?

349. Give a brief description of the machine.

350. How are the levers attached?

351. In what order are switch levers usually arranged?

352. Where there is a junction or lead switch, how is it arranged so the lever can be distinguished from the others?

353. Insofar as possible, where are the retarder levers located?

354. What consideration is given the numbering of switch levers, and what are some of the methods?

355. With what do retarder lever numbers usually conform?

356. With what do the skate lever numbers conform?

357. How are the switch levers and the retarder levers usually located in the panel?

Electric system.

358. What machines are shown in Figs. 38, 39 and 40?

359. What movement have all levers and what is the normal position?

360. What is the lever width of panels into which the top is divided?

361. What is shown in Fig. 39?

362. How many positions has the retarder lever, which is the open position, and for what are the other positions?

363. How is the lever held in the various positions, and what assists the operator to move the lever to a definite position instead of watching the lever?

364. What is it necessary to do sometimes to determine the position of the lever, and how are the various positions marked?

365. How many positions has the switch lever, and which is the normal and which the reverse position?

366. Where are indication lights located, and how distinguished?

367. When do the indication lights agree with the position of the lever?

368. Describe the switch lever, and for what feature it was particularly designed.

369. Why is the drive between the lever and the yoke positive?

370. Where is the lock attached, of what does it consist, and what is its function?

371. Describe the skate lever.

372. How is the toggle actuated?

373. Why is no indication provided for the skate lever?

374. In which tower is the control machine, Fig. 40, located, and with what controls is it equipped?

375. What means is provided to show when either alternating current or direct current is off?

376. What indications are repeated in this tower, what control has the operator over the hump signal, and for what purpose?

Electro-pneumatic system.

377. What movement has the retarder and switch levers, and in what direction is the open position of the retarder and the normal position of the switch?

378. What movement has the skate lever, and in what position is the lever, when the skate is in the normal or off position?

379. How does the control machine, illustrated in Fig. 41, compare with that usually provided?

380. How many positions has the retarder lever, what is the open position, and what positions are the four steps of retardation?

381. With what does the number plate, shown in Fig. 42, fastened to the control panel, bear corresponding numbers?

382. How does the operator soon get to know the position of the lever without looking?

383. How is the retarder lever held in the various positions, and what makes each position positive?

384. How many positions has the switch lever, and what are they?

385. How are the indication lights, shown in Fig. 42, located with respect to the position of the lever pointing to the lights?

386. How do the indication lights give the operator information as to location of a car?

387. How is circuit locking provided, if the track circuit is occupied?

388. Why must the switch lever move to one position or the other?

389. How many positions has the skate lever, and what are they?

390. With what auxiliary apparatus is the control machine in the first tower often equipped?

Power Plant

391. Upon what does the type and equipment of the power plant depend?

392. What arrangement is usually made for power?

393. How is power furnished occasionally?

General principles.

394. What consideration is given size of plants in capacity?

395. Why is reserve power provided?

Electric system.

396. By what kind of current are retarders, switches and skates operated?

397. By what kind of current are track circuits, signal system, and all indication lights operated?

398. What kind of current may be used for the communicating system and especially the teletype system?

399. How are the different currents usually obtained?

400. What type and size of motor-generator is used in some plants to operate the retarders?

401. What current is this generator capable of delivering without the voltage dropping below 230 volts?

402. Why are duplicate motor-generators usually installed?

403. What figure shows such a plant?

404. What capacity battery is used for reserve, and how and why is it sometimes divided?

405. How is operation continued without interruption when the main source of alternating current fails?

406. How is the reserve battery charged?

407. What is used for operating the retarders and for floating the storage battery in other plants?

408. For how many amperes is the generator designed, and if more current is required how is it furnished?

409. What type motor is used in some cases to drive the generator, and why is a synchronous motor used at other times?

410. When the main source of power fails what does the battery feed?

411. If the power plant is equipped with a synchronous motor, what act causes the motor to become a generator?

412. What is the function of automatic controls?

413. Are both alternating and direct current supplied for the operation of the retarder system whether the units require alternating or direct current without interruption in the service?

414. With what is the switchboard equipped?

415. How are the main feeders to the retarder circuits controlled?

416. Why are interlocked contacts used on the circuit breaker?

417. Why is this indication taken to one of the towers?

418. How is the main source of alternating current controlled, and for what purpose?

419. Where is an indication of the line being cut off given?

420. What does circuit plan, Fig. 46, show?

421. At what voltage does direct current flow from the generator, and through what units does it flow?

422. In what position is the reverse-current relay contact, and how is the auxiliary relay energized?

423. How is alternating current at 80 and 110 volts supplied to the yard units?

424. In the event of an overload, what opens the main 265-volt direct current circuit?

425. How can the circuit breaker be reset?

426. When an alternating current power failure occurs, what current, at what voltage, and from what source is the plant served?

427. What is the reaction upon the generator when the storage battery is used?

428. How is the coil of the auxiliary relay shunted?

429. What prevents the synchronous motor (now operating as an alternator supplying alternating current 440 volts) from feeding back to the 440-volt line?

430. How is alternating current from the alternator now supplied to the various yard units?

Electro-pneumatic system.

431. Of what do the power requirements for the electro-pneumatic car retarder system consist?

432. Why is a supply of alternating current required?

433. How is the 12-volt direct current energy usually supplied?

434. In a majority of electro-pneumatic retarder installations, from what point is compressed air generally supplied and why?

435. What is it sometimes advisable to install in addition to the regular air supply?

436. Where a central compressor plant is not available, what equipment is necessary?

437. Is it the general practice to use switchboards?

438. What consideration is given the capacity of compressors, and how are they arranged for service?

439. How are such compressors usually driven, and how is their operation controlled?

440. How do the storage tanks and after-coolers, shown in Fig. 48, compare with those sometimes provided when the air is obtained from a central point?

441. Why has no definite general practice been developed for alternating current power supply?

442. What emergency provision is made for supplying direct current and compressed air?

Signal System

443. Why are signals required?

444. What movements does the hump signal, located at the hump, govern?

445. Where there are more than one hump engine, how is the information given as to which is to come first?

446. What consideration is given the location of repeater signals, when used?

447. What aspects are recommended by the Signal Section, Association of American Railroads, and what indications do they convey?

448. What aspects are used in some of the installations described in this chapter, and what indications do they display?

449. Why is a double red aspect used for a back up signal in some installations?

450. Why is a trimmer signal necessary?

451. What are used to indicate the position of each switch?

452. What governs the movement of an engine on a classification track through the switching area in addition to the trimmer signal?

453. What aspects are recommended by the Signal Section, A. A. R., and what indications do they convey?

454. What aspects are used in some of the installations described in this chapter, and what indications do they display?

455. Why is the controller, for operating the signals, mounted at the hump and near the track?

456. What are some of the types of signaling systems used?

457. When the semaphore or light signals are used where are they located, and why?

458. How are masts located and indications arranged to give a minimum range of 400 feet, and why is this an advantage?

459. Are repeater signals used when cab signals are used?

460. What system is used for cab signals, and how are the indications provided?

461. How are the circuits for individual receiving tracks selected and operated?

462. What is the advantage of cab signals over fixed signals?

463. Why is a track circuit, located in the track approaching the hump, used in some yards?

464. How does the track circuit effect the work of the trimmer engine and the movement of a train being brought to the hump, and when does the train being brought to the hump cause a stop indication to be displayed in the hump signal?

465. What determines the length of the track circuit ahead of the hump?

466. Does this track circuit effect the interlocking of the hump and trimmer signals in all cases?

467. In these cases, what is green used for, and when does the aspect change to yellow, or the normal humping speed, and why is this of particular advantage?

468. What is used to control the hump signal and where is it located?

469. In the controllers shown in Figs. 52 and 53, how many positions are used, and what information do the indications convey?

470. What indication is not used in many cases?

471. In the controller shown in Fig. 53, what is used for selecting the circuits, and is the trimmer signal used?

472. When a trimmer signal is used, what is used for the control and where is it located?

473. How and where are the indications displayed on the hump and the trimmer signals indicated?

474. What is used for the control of the signals and where are the controls located?

475. In the controller shown in Fig. 52, how is the selection of circuits made, and where is the control located?

476. What does the small lever in the lower part of the controller control, and what are its positions?

477. In this controller why are the trimmer signal lever and the hump signal lever mechanically interlocked?

478. In a number of installations how has the interlocking of signals been accomplished instead of mechanically?

479. In what figure is shown the circuit used with the controller, Fig. 52?

480. With this circuit, when are relays used?

Communicating System

481. Why is means of communication important?

482. Why is verbal communication necessary?

Teletype.

483. Of what does the teletype system consist, and where is it usually located?

484. Where does this machine send information, and what does it provide at the yardmaster's office?

485. Where are receiving machines located?

486. How are the machines mounted and housed?

Pneumatic tubes.

487. Of what does the pneumatic tube system consist, and what is its function?

488. Why do the tubes connect the yard office with the receiving and departure yards, and why occasionally the hump office and each of the towers?

489. When tubes are used, is the teletype system also used?

Telephones.

490. Where are telephones located?

491. In addition to telephones, what systems are sometimes used?

Piping

492. How does the installation of main and branch piping and connections compare to those covered in Chapter XVIII—Electro-Pneumatic Interlocking?

Wiring

493. What usual wiring practice is followed in the retarder system?

Flood Lighting

494. Why is flood lighting very important, and in what figure is a typical layout shown?

Hot Oil Plant

495. What brought about the use of hot oil, where is the oil applied, and at what location of car?

496. Where is the oil tank and arrangements for heating installed?

497. What arrangement is used to make the oil convenient for use?

498. How is pressure at the nozzle provided?

499. By whom is the oil applied, and what is the procedure?

500. What other method is used to provide a reduction in journal resistance?