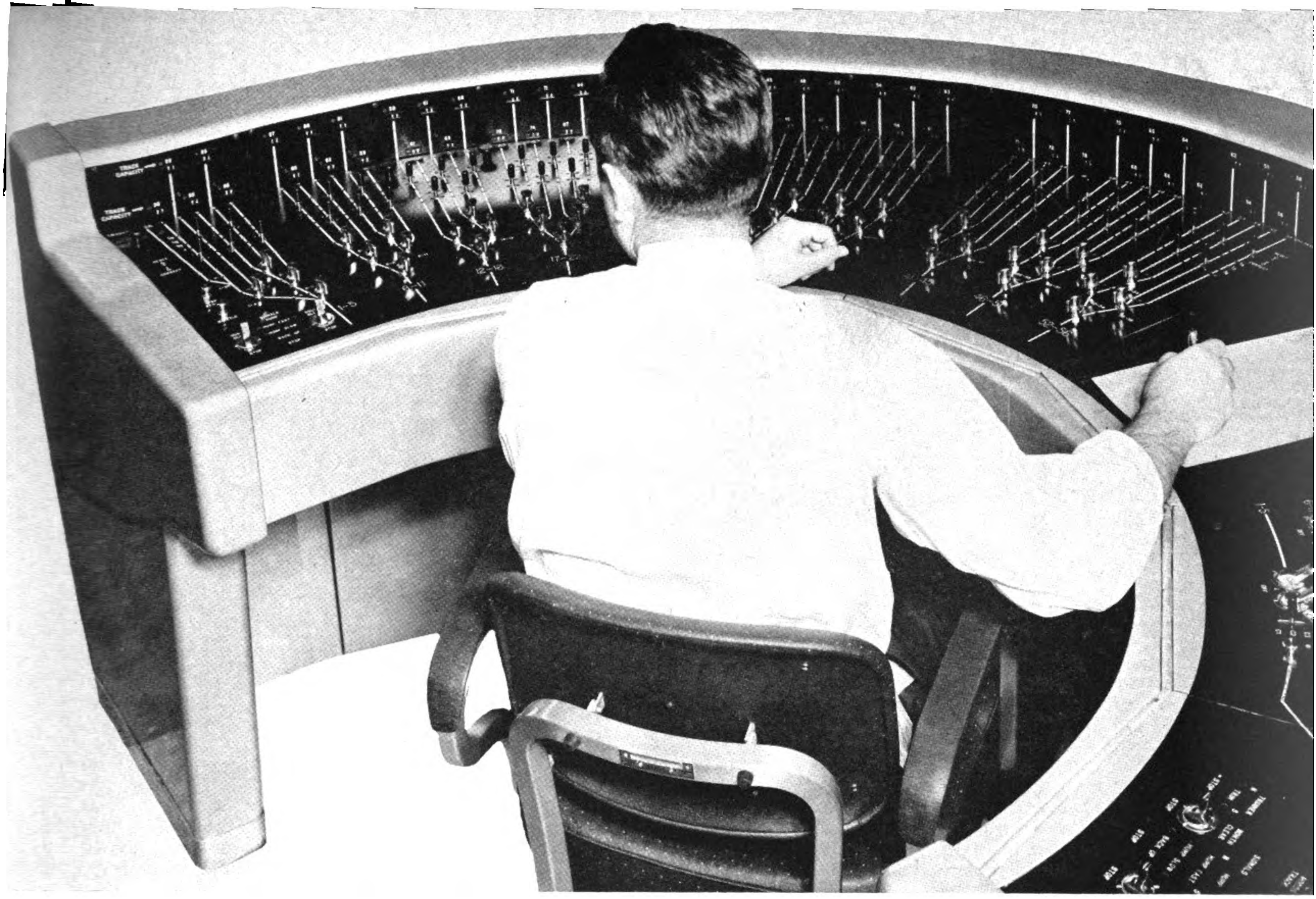


This project includes first of the new semi-circular control panel machines, a unique feature being the numerical indicators, on the back board, which show the number of car lengths of empty track on each classification track

Automation Yard Control

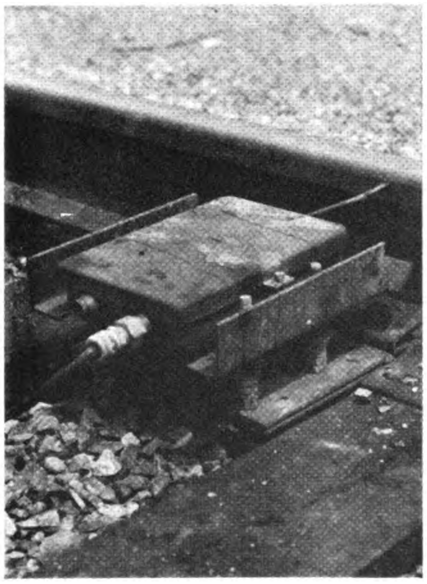
... on the Pennsylvania

Track-fullness is included with five other factors in automatic control of group retarders. Higher frequency for radar gives more accurate measurement of speed. Analog computer solves problem quickly because it is working all the time—New multiple-vent electro pneumatic valves regulate cylinder pressure in small frequent steps so that cars are released at exact speed, + or − 0.1 mph. New semi-circular control machine for monitor-operator, includes track-fullness indicator for each yard track

THE PENNSYLVANIA recently put in service the first 45 tracks of a new 53-track westward classification yard at Conway, Pa., which is in the Pittsburgh area. Conway also includes a 54-track eastward yard which was completed in 1955 and is of the semi-automatic push-button type.

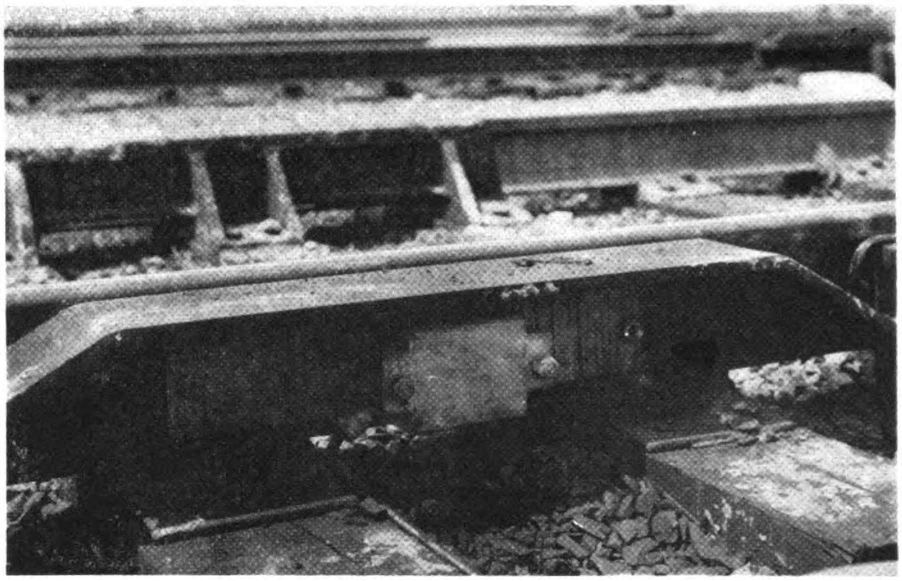
Conway was selected as the location for this modern freight classification yard because of its location near Pittsburgh, which makes it the ideal location where trains from western points could be classified and reassembled, and all trains from eastern points could be dispatched without seriously affecting the mileage of causing any appreciable backhaul. Conway is also a logical point trafficwise for this new facility because through it flow manufactured products from Chicago, automobile traffic from Michigan points, heavy ore shipments from Cleveland and Ashtabula, coal from the Tri-State area for delivery to lake ports, and agricultural products from the West, as well as the steel and steel products originating in the Pittsburgh and Beaver Valley areas.

The former yard at Conway, which had approximately one third the capacity of the present facility, had eastward and westward rider operated humps. Although adequate for handling the business flowing through this terminal at that time, the former yards were entirely inadequate for handling the additional trains which will be



How Many Cars on Track?

Treadle on turnout to each class track counts cars as they enter determining ahead of time, length unoccupied track



How Much Does Car Weigh?

As each car goes over the crest this inert device, known as a weigh rail, classifies weight of the car as "light," "medium" or "heavy"; used direct in control of the master retarder and pre-control of the group retarders

routed to this new yard when it is fully completed. With a considerable increase in number of classifications, the yard is providing relief to other existing yards and making considerable reduction in overall movement time for many cars. Conway now creates relay trains at other yards that previously had to reclassify the cars.

Two Hump Tracks

One of the unusual features of the new westward classification yard is the use of two one-directional switching leads on the hump. This was done for several reasons. Under normal conditions, switching is carried out from the south lead, and the hump conductor's office, containing an automatic switch-control panel, is adjacent to this lead. As a train is being classified from one lead, a second train can be moved up on second lead ready to be classified immediately when first train is completed. The second lead also permits trimming moves to be made on one half of the yard while a train is being humped on the other half or simultaneous trimming moves on each side of yard. Also, road engines can move on one lead to the house without delay while the switching is being carried out on the other lead.

A 90-ft scale, with both electronic and mechanical scales, is installed on north side only; therefore, if a car to be weighed appears on a consist, that train is classified over the north lead at the hump. Cars to be weighed are cut off singly and weighed without slowing down hump operations.

Important news concerning this new westbound yard is that it is the first to include, in complete manufactured form, the special equipment for automatic control of retarders, as well as switches, made by Union Switch & Signal Division of Westinghouse Air Brake Company. Called the Velac automatic classification yard control system, it has been under development for the past three years. An extended test, using laboratory models of apparatus, has been in development service on the lead and 8 tracks for about 9 months in a yard on the Union Railroad in Pittsburgh.

Weight Is First Factor

A weighing device, attached to a 7-ft section of specially constructed rail, is located directly in approach to the master retarder. This device classifies each as as being "heavy," "medium" or "light." The master retarder is controlled automatically, according to the weight classification "H," "M" or "L." Under normal weather conditions, light cars are released at 12 mph, and other cars at 10.8 mph. If weather conditions are adverse for good rolling, the towerman can throw a special lever to the "Fast" position, which raises the release speed to 13.6 mph for light cars, and to 12 mph for other cars. If the weather is hot, the track is wet or there is a strong wind from the east to help the cars along, the special lever is thrown to the "S" position which reduces the release speed to 10 mph for light cars, and 8.8 mph for other cars. This FNS lever is normally sealed, and can be changed only by joint action of the towerman and signal maintainer.

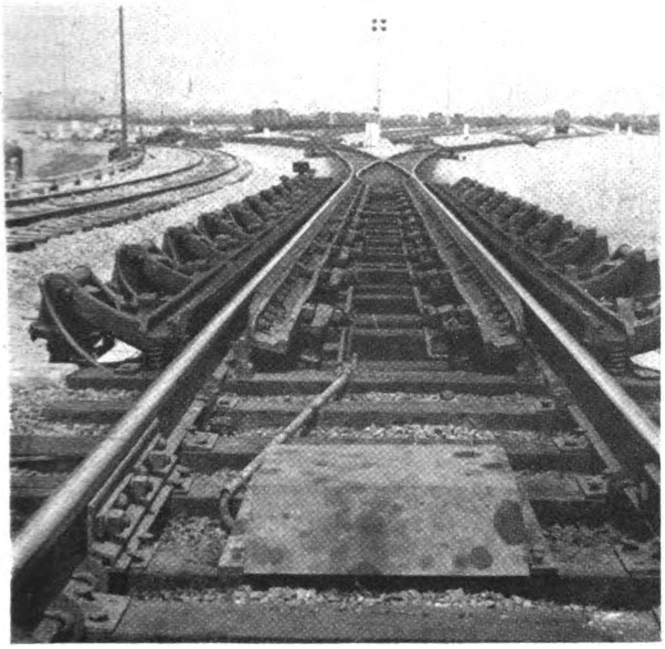
The intermediate retarders, likewise, are controlled automatically, based on car weight and position of the FNS special lever, the release speeds being the same as for the master retarder.

How Rollability Is Measured

Five factors enter into the automatic control of the group retarders, the objective being to release each car at the proper speed so that it will pass through the switches and curves, leading to its classification track, and then roll along that track at the proper speed so that it will couple with the car then standing there, at a speed of 4 mph or less, so that no damage will be done to cars or lading.

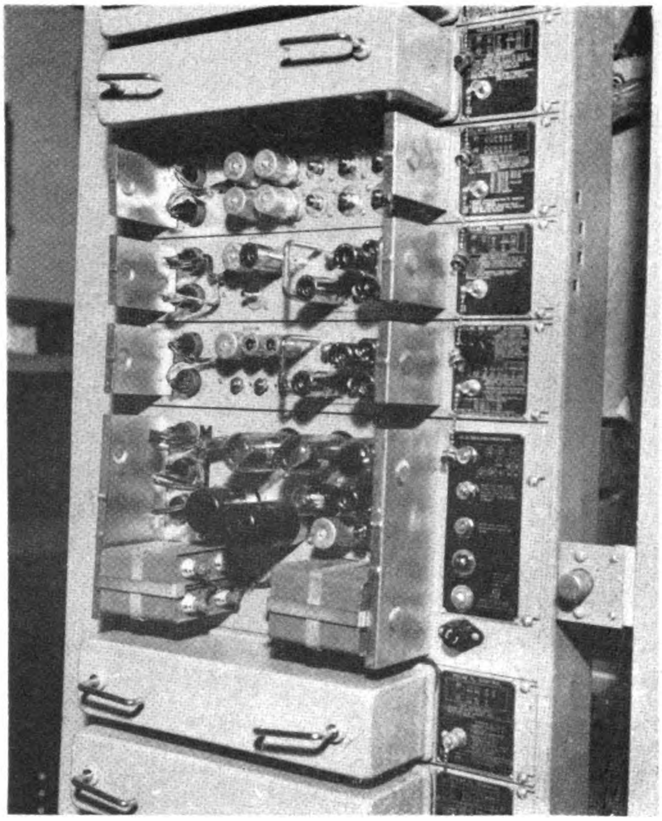
As previously stated, the weight of each car is classified as light, medium or heavy, by the weigh rail on the incline down the hump. Even with cars of the same weight, one may be a "hard roller" and the other an "easy roller," with all degrees of variation between these limits. Furthermore, a car has different rolling characteristics on curves, compared with tangent.

The rollability of cars on tangent



How Fast Is It Going?

A radar antenna mounted under the special cover in center of the track in approach to this retarder measures speed of each car constantly when within range of this antenna



To Calculate Release Speed

The factors are each represented by a d.c. voltage which are stored until fed to electronic computer which instantly calculates speed in m.p.h. at which car is to be released

track is determined by measuring the acceleration on an accurately maintained 3 per cent descending constant grade, located in approach to the master retarder. If a car rolled with absolutely no friction its acceleration would be according to Newton's law of gravity for a falling body, 32.2 ft per second, reduced by the angle factor of the 3 per cent grade. From this value, subtract the rate of acceleration as measured for each car, which gives a resultant figure that can be used to represent the rollability of that car.

The rollability of each car on curves is determined by measuring the acceleration on the curves of the turnouts between the intermediate retarder and the group retarder.

Number Of Cars In Cut

The length of each cut is determined automatically as cars pass over four track circuits in approach to each group retarder. These track circuits measure the approximate cut length depending upon the combination of these track circuits which may be occupied simultaneously.

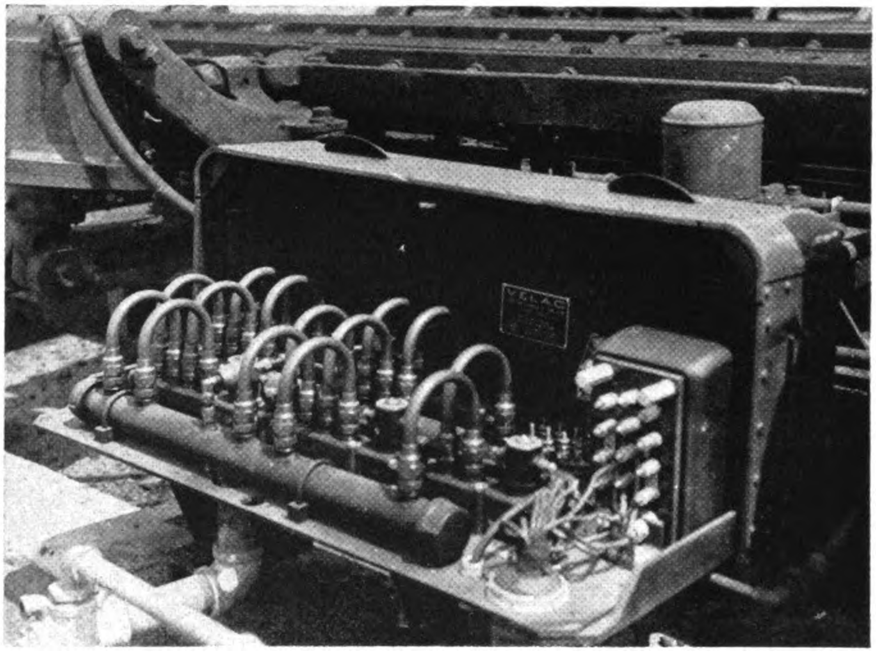
Each group retarder serves five or six tracks. The curves and grades on each of these routes are different. In a series of tests a number of cars were routed to each of the classification tracks, and rolling resistance measurements were made of each car rolling between the intermediate retarder and group retarder, and again between the group retarder and point of tangency. The correlation of these two measurements produce the relationship between the curved rolling resistance measured and the individual route resistance to each classification track. These values are stored, and when needed, are brought out in accordance with the routing set up by the automatic switching system.

Critical Part Of Route

In yards on other roads where automatically controlled projects were completed prior to late 1956, one objective was to provide a non-accelerating grade on the classification tracks, so that if a good rolling car enters the tangent on its classification track at approximately 4 mph, it proceeds without increasing its speed, until it couples with the first car then standing on that track. Thus the objective of the design was that, regardless of the distance from the clearance point to the first standing car, the speed of impact of a good rolling car will be within range to prevent damage to car or lading. However this is not true when poorer rolling cars are being classified. These cars require higher release speeds depending on the distance they must roll.

The new westward Conway yard includes "track fullness" devices, so that the distance which a car is to go from clearance point to first car then standing on a track, is a factor included in the automatic controls. As each car passes a point ahead of its group retarder, the wheel flanges actuate a mechanical track unit, furnished by Transcontrol Corp. When this device is actuated by the four wheels on one side af a car, a counting device for that track, is advanced one step to count the car which has thus entered the track. This information enters into the control system to subtract one car length from the value of unoccupied car length for that track.

In this yard, the descending grade on the classification tracks is



To Get Smooth Control of Retarders

This new multiple sort automatic pneumatic valve arrangement releases the air in the retarder cylinders in numerous small increments so that the speed of the car is controlled to that called for, within 1/10 m.p.h.

0.15 per cent. If a car is to be routed to a 60-car classification track that is empty, it has about 2,700 ft to go on tangent track. If the car was measured as a "medium roller" with a rollability factor of 6 lb. per ton the fact that it is to go 2,700 ft on the classification track may increase the leaving speed from the group retarder say to 13 mph, as compared to 10.4 mph if the track was half full and the incoming car had to go only 1,350 ft. If the track already had 55 cars on it, an incoming car would have only 225 ft to go, and therefore the release speed would be reduced to 7.6 mph.

How Result Is Determined

Thus a value has been determined for each of factors; rollability on tangent, rollability on curves; length of cut; characteristics of route to each classification track; and length of empty track to first standing car. Each of these values of each car or each cut of cars is represented by a separate d.c. voltage. As a car is immediately approaching its group retarder, these d.c. voltages are fed to an analog electronic computer, which quickly calculates the speed at which the car is to be released from that retarder, and then the system controls the retarder accordingly, as will be discussed later.

A new feature claimed for the Union Velac system is that the computer calculates the answer more quickly with inherent accuracy due to stability. This result is obtained by having the computer in operation all the time, solving a sample problem. Thus the computer is "hot" and therefore can solve any new incoming problems instantaneously. Furthermore by keeping the computer in service constantly, it is thereby self checking to give a warning if it is not in operating condition. This eliminates yard delays that could be caused by "dead" computers.

New Pneumatic Control

In previous electro-pneumatic retarder projects, the air pressure in the cylinders could be controlled to four pressures such as 25 lb, 50 lb, 75 lb and 100 lb, thus resulting in four degrees of pressure of the retarder shoes on the car wheels, with corresponding retarding effect on the car speed.

New electro-pneumatic valves were developed by US&S recently, and production units installed for the first time in this westbound Conway yard. With these new valve arrangements in service, the pressure of the air in the retarder cylinders is decreased gradually, in very small increments, at rapidly succeeding intervals, governed according to the gradual decrease in the speed of the car. Thus the pressure and speed are so nicely coordinated, that the car is released at a speed that is exactly called for, within + or −0.1 mph. This is the vital factor in obtaining correct coupling speeds.

Pre-Control of Group Retarder

Weight of a car, "heavy," "medium." or "light," as set up by the weigh rail, previously explained, enters into the pre-control of the group retarder through which this car is to be routed. For example, for an empty car of light-weight construction, such as an empty flat car, the control is automatic setting the retarder for less retardation when the car enters, so that the car will not be retarded excessively, stopped inadvertently, or pinched out of the retarder. On the other hand, for a car that is "heavy," the group retarder is precontrolled to make more retardation effective as the car enters.

Higher Frequency For Radar

In this yard, radar is used to determine the speed of cars when they are in the retarders and when they are proceeding on the sections where rollability is being measured. Each set of radar equipment is in a flat housing, about 3 in. deep, placed on the track ties between the rails. The cover on this case is made of sheet plastic which does not interfere with the radar operation. This radar equipment sends out high frequency waves toward each car, and these waves are reflected back from the car to the RF unit in the same radar case. The difference in timing produces a Doppler effect which is used to measure the speed of the car at any instant, rather than over any given distance.

Radar has been used in this manner in previous yards, the new feature of the Union Velac system, as installed at Conway, is that the frequency used in the radar is higher than used previously in yards. This new frequency is in the range of 10,525 megacycles, as compared with about 2,500 megacycles in previous yards. An advantage of the higher frequency is more accurate measurement of speeds in the low range, 4 to 20 mph.

With the 10,525 megacycle radar frequency in use, the resulting variations, caused by the Doppler effect range from about 2 cycles per second for 0.06 mph, to 633 cycle per second for 20 mph, or 39 cycle per second for 1 mph. The difference is 31.39 cycles per second, per mile, per hour. These resultant frequencies in the range up to about 600 cps are transmitted in cable to electronic equipment in the instrument room in the tower.

New Semi-Circular Machine

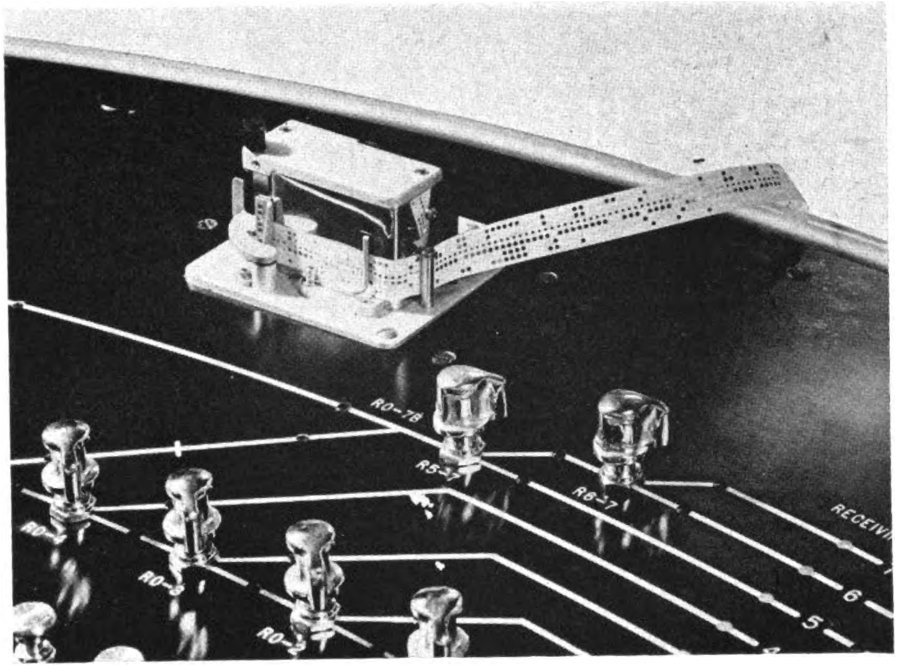
In this yard, one tower and one man, known as a monitor-operator is required. His primary duty is to watch cars to see that they are routed to their proper tracks, and that they keep going to couple properly at speeds that are not too high. When trimming is underway, this monitor operator controls the switches and retarders manually. A new feature of this westbound Conway yard is that it includes the first of the new semi-circular control panel machines, shaped as shown in one of the pictures herewith. An important advantage is that all the controls are within arm's reach of a man sitting at the panel.

The portion of the control panel at the right, as shown in the picture, includes a track plan with levers for manual control of switches and retarders in the area from the crest down through the master, intermediate and group retarders. The area of the panel to the left of the operator includes a track plan and levers for switches beyond the group retarders. All of these manual control levers for switches and retarders are for use primarily during trimmer operations or in emergencies.

Also the section of panel to the left includes numeral indicators to show the number of car lengths of track not yet occupied on each classification track, these indicators being controlled automatically by the wheel counters which were explained previously. When cars are pulled out of the departure end of the classification track, the monitor-operator uses a toggle key switch for that track to reset the indicator according to the unoccupied portion of that classification track. This action by the operator also resets that portion of the automatic control which has to do with the length of track that is unoccupied on the corresponding classification tracks as was explained previously.

Programmed Automatic Switching

Originally planned, but not as yet in use at Conway westbound yard, is the new tape-fed transmitter which indicates the automatic controls for the power switches down the hump and to the classification tracks. For the present, these automatic controls are set up by means of a set of buttons in a panel in a small cabin at the crest. This board is operated by a yard conductor. The push button switching panel, complete with tape reader, is shown in the illustration.



Programmed Switching

Switch list is punched in tape, same as printing telegraph. As cars go over hump, tape feeds through telegraph printing transceiver which initiates controls for automatic switching system to control power switches

The use of punched paper tape to initiate controls for automatic switching was developed and first installed on the Norfalk & Western at Portsmouth, Ohio, in 1955, as explained in detail in an article in *Railway Signaling & Communications* for September 1955. This method, with further improvements, is incorporated in the US&S Velac system of automatic yard controls, and is being installed in yards under construction on the Burlington at Chicago, the Louisville & Nashville at Birmingham, the NC&StL at Atlanta, C&O at Russell, Ky.

The system works in the following manner. The switching list for a string of cars is received in the control tower and printed with a conventional tape printer. As the switching list, which includes various information about each car, including the track to which it is to be routed, is being received, the track destination information is automatically and simultaneously punched on a tape by a reperforator, attached to the tape printer. The reperforator can be arranged to cut in when the printer comes to the track number, and to perforate this information only.

The tape is fed into a tape reader which "reads" the punched holes, and then feeds this destination information to the decoding unit. The decoding unit translates this code into numbers which are fed into the Union automatic switching system which sets up the required route automatically.

This programmed switching system automatically keeps five storages in the initial storage units at all times, including a numerical display of storages of both hump conductor and retarder operator's positions. The system "stays in step" with cars as they go over the hump because it is so arranged that when one cut goes over the hump, another storage is introduced automatically.

A set of push-buttons, one for each track, is provided for the operator's use in case of emergencies or to change the destination of cars from that given in the programmed list in case bad-order cars are discovered as the cars approach the hump. In these instances the operator presses a "cancel" button to cancel the original destination of the cut when it enters the automatic switching system. This operation also stops the tape system, allowing the operator to manually add the track destination desired.