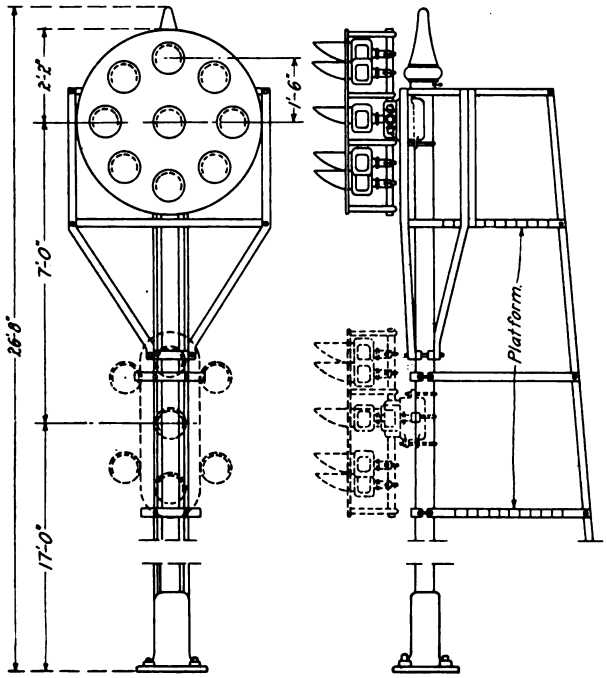
The Development of Position-Light Signals

The Latest Design Reduces the Cost of Operation and Maintenance and Promotes Simplicity and Safety

By A. H. RUDD,
Chief Signal Engineer, Pennsylvania System, Philadelphia, Pa.

THE development of the position-light signal on the Pennsylvania Railroad during the past seven years presents an interesting study in simplification and elimination, although it was less complicated in its original form than most signals. It was originally designed for the specific purpose of signaling a portion of the four-track main line, electrified for local passenger service while retaining the steam trains for freight and through passenger service. It was originally planned to support the trolley wires on H beams at right angles to the tracks and three or four hundred feet apart, and the trial position-light signal was selected, instead of the semaphore or colored light, on account of its visibility over and under the obstructions, and because the use of suspended signals was most undesirable on account of the 11,000 volts at the trolley. The idea of the H beam was later rejected and cross members are composed of steel cables.



Construction of the New Type Light Signal

Articles describing the signals have appeared, from time to time, in the *Railway Signal Engineer* as follows: Page 156, May, 1918; page 253, August, 1918, and page 234, June, 1920.

The experimental signals carried five lights in a row —those first installed had two rows of four lights each; the bottom row normally horizontal, so that, if the top lights were extinguished, the bottom row would indicate stop. Eight lights were, therefore, displayed at all times.

The "Light-Out-Relay" was later developed, operating in connection with the lights of the top row, so that, if these were extinguished, the bottom row could not light up to display caution or clear. This arrangement made it safe to display only the top row of four lights normally, lighting the lower row only when it was needed, and thus incidentally reducing the number of aspects. Still later it was decided that, as the bottom row 45 deg. was a slow speed signal, four lights were unnecessary and only three were, therefore, displayed. This signal has been the standard for position-light signals for three or four years.

Although single signals have been furnished to two or three roads in the United States, England and Australia for experimental use, the Pennsylvania is the only one which has so far installed them for actual service, with the exception of the Lehigh Valley, which has two, the principal objection to them apparently being the large background, the supposed excessive first cost, and the general conservatism where signaling is involved. The large background was no detriment on bridge signals, but on account of the surface exposed to wind pressure required special seven and eight inch ground masts.

Recently the number of lights on these signals was reduced to three in a row all over the system, and the result has been so satisfactory that, instead of the eight lights originally displayed, three in a row has been adopted as standard for high signals; the dwarf signal, with two lights, remaining substantially on the general lines originally laid down, although a considerable amount of development work has been done on it also.

As the enginemen have christened the dwarfs "Cats Eyes" and "Owl Eyes," and the upper-quadrant semaphore the "Dr. Munyon," it is presumed that the high position-light signals will shortly be known as the 'Tit, Tat Toe—Three in a Row."

The New Design

The drawing shows the new design and the aspects which may be displayed. The indications of the aspects are in accordance with the Standard Code as follows:

1—Stop.
2—Stop, then proceed. (Rule 509, Standard Code.)
3—Proceed at slow speed prepared to stop.
4—Proceed with caution prepared to stop short of train or obstruction.
5—Proceed at slow speed prepared to stop short of train or obstruction.
6—Proceed at restricted speed.
7—Approach next signal prepared to stop.
8—Approach next signal at restricted speed.
9—Proceed.
11—Approach home signal with caution.

No. 4 is the manual permissive block signal.

No. 5 is to be used as the grade signal which may be accepted by tonnage freight trains without stopping, while other trains stop before proceeding.

No. 11 is the distant switch signal. It will be noted it is similar to No. 4, which, under the rules, may not be accepted by a passenger train without stopping. The addition of the bottom light permits passenger trains to accept it.

If, at some future time, the stop requirement in Rule 509 should be eliminated, aspects Nos. 3 and 5 would be eliminated, and No. 2 substituted for aspect No. 5.

Dwarf signals may be four-position:

(a) Horizontal for indication No. 1.
(b) 45 deg. upper right hand quadrant for indication No. 3.
(c) 45 deg. lower right hand quadrant for indication No. 5
(d) Vertical for indication No. 10, proceed at slow speed.

Aspect (b) being displayed in terminals, with track clear but next signal at stop.

Aspect (c) with track occupied, and,

Aspect (d) with track clear and next signal clear.

(a) and (b) and rarely (c) being used out on the road.

It will be noted that a background is provided for the lower row vertical only, this being a restricted speed signal (restricted speed is one-half the authorized speed) but not for the diagonal rows or the single light, as these are slow speed signals and long range is unnecessary. The reduced size of the background and wind pressure area eliminates the necessity for the special masts, and R. S. A. standard masts will be used throughout.

Installation Extended

The signals can be installed on existing masts, and in places where ordinary semaphores cannot be used because of scant clearances.

The immediate and universal popularity of these signals among the enginemen and trainmen, signal forces and operating officers led to a desire for their extended use, but, on account of the large current consumption as compared with the motor and the apparent necessity of reducing the voltage at night, it was felt that, while ideal for use in connection with a. c. track circuits, which in turn required a power line and central source of supply, they were not available for use with primary battery. However, after the production of the "light-out" relay, it was evident that only one row need be displayed, and the battery consumption would be cut in half. It was also demonstrated that, with only four lights, the voltage reduction was unnecessary, and it was figured that, if the signal was lighted only two hours a day, it would compete in maintenance and operating costs with the motor signal.

Two signals were installed in December, 1915, at Woodhill tunnel to protect a gauntlet and were lighted up by an approach circuit about 2000 ft. long. The lights burned about an hour and a half a day. The cost of maintenance and operation was less than one-half that of motors used under similar conditions.

Recent figures prove that the redesigned signal with three lights can be installed as a distant switch signal, including the approach lighting circuit, at about the same cost as the motor, and that it may be lighted *six* hours a day for the same cost as the motor. An installation of distant interlocking signals where the approach locking circuit is utilized for lighting up, of course, costs less than the motor, and, as few if any circuits approaching a distant signal are occupied anywhere near six hours a day, the saving in maintenance and operation is evident.

A large number of distant block, switch and interlocking signals of this type are in use, and as the old signals in d. c. automatic territory required replacement the substitution of the light for the motor signals had been decided on, but there yet remained the doubt as to the utility of the light signal for interlocking or manual block home signals with approach circuits frequently occupied for considerable lengths of time. This problem has now been successfully solved by the development of the "trickler" and "farm lighting outfit;" tricklers for use where commercial power is available and farm lighting outfits at other points.

Of course, with the various methods of construction in vogue, cost of installation varies on different roads, and it is useless to attempt to give basic figures. For comparative purposes, however, it may be stated that electro-mechanical machines and power signals can be installed at approximately the same cost as mechanical machines with power-operated distant signals, and that (presupposing no commercial power is available) single track grade crossings can be most efficiently and economically protected by position-light signals with primary batteries approach lighted while double track grade crossings, single track junctions with double tracks, and larger installations up to the size requiring power interlockings can well be protected by position-light signals with small storage batteries floated across the smallest capacity farm lighting outfits or duplicate outfits, one of which may or may not be constantly running. The saving in operating and maintenance of the signals themselves, other features of the plant being equal, will vary from a small amount in the smaller plants up to 50 per cent at the larger ones as compared with motors.

It has been stated that these signals, lighted six hours a day, cost no more to operate and maintain than semaphores. Assuming the cost of current from primary batteries at $5 per k.w.h.—the signals could be lighted 24 hours and still compete if their power could be obtained for $1.25 per k.w.h. It is claimed that it can be furnished by farm lighting outfits for 5 cents—even if it cost 10 cents, the saving would be $1.15 per k.w.h.

The lamps used in the high signals are 12-volt, 6 watt, burned under voltage, so that the total energy required for the three lights is 15 watts, and for the three lights and marker (aspect No. 2) 15 watts when the signal is at caution or clear and 20 watts when at stop. The dwarf signal requires two 12 watt lamps burned under voltage, with an actual watt consumption of 16 for the two lights.

Given then, even the same cost for installation as for semaphores, but less cost of operation and maintenance in all cases, it seems to us that the logical procedure is to install these signals everywhere instead of motors as an economic proposition.

On January 1, 1921, there were in service on the Pennsylvania system 925 high signals and 1,038 dwarfs of the position-light type.

Advantages of the Position-Light Signal

The advantages of any light signal, displaying the same aspects day and night and without moving parts and their incidental failures, are so obvious and have been so frequently set forth that comparison with the semaphore in this respect appears unnecessary.

Many signal engineers, however, favor colored-light signals and some a combination of color and position. The semaphore governs by position by day and color at night—sometimes by both or either at dusk or dawn, or by position if the lights are out, so there is some argument for the color-position signal, but, if the position is accurately defined, why the color?

Illuminated arms have been advocated and sought after for years. Semaphore arms do not show red when horizontal and yellow when diagonal and green when vertical; such change is not necessary, and the constant consumption of current for the sole purpose of forcing light through an opaque glass constitutes an economic waste and, therefore, is not good engineering.

A color-blind man can read a position-light signal accurately. The lights penetrate fogs better than colored lights. Two lights must fail before the signal ceases to be displayed effectively. Four positions *without combination* are available and used, as against three positions of the semaphore and three colors which may be seen distinctively at a distance, and this additional position gives the greatest flexibility.

If two lights are extinguished on the bottom row, either diagonal or vertical, with the top row horizontal, the aspect "Stop and Proceed" is displayed; if all lights are

extinguished on these rows, the indication is "Stop." In general, the more lights extinguished, the more restrictive the indication. False clear and caution aspects, or, as some prefer to call them, improperly displayed proceed indications, due to the signals themselves, are eliminated.

While some roads will purchase motor signals for years to come, and others will install color-light signals at slightly lower first cost, the day of experimentation is practically over, and, while no one can tell what further development may be made, it would appear that those roads which are figuring on using the safest and best signal, and which are willing and able to expend a little additional sum on installation in order to effect a large interest saving on the investment, through continuing low cost of maintenance, will adopt the position-light signal as a money saver, at least until something better is produced; just as they will install a.c. track circuits for automatic signal control; electro-mechanical machines with switch and lock movements instead of facing-point locks; low-voltage mechanisms for outlying switch operation; controlled manual with automatics for following movements on multiple tracks; eventually eliminate the stop at automatic signals, and finally apply a continuously controlled speed control except in congested districts and terminals.

REPORT ON COLLISION AT ABERMULE

THE Minister of Transport of Great Britain has issued a report, made by Col. J. W. Pringle, inspecting officer, on a disastrous butting collision of passenger trains on the Cambrian Railways, at Abermule, Wales, on January 26, 1921, in which 11 passengers were killed and 36 persons, mostly passengers, were injured, three of these subsequently succumbing to their injuries. Abermule is about ten miles southwest of Welshpool and about four miles north of Newtown; it is the junction of a branch to Kerry. The line is operated under the electric train-tablet system with Tyer's No. 6 instrument, which system has been in use 30 years; and the collision, one mile south of Abermule, was due to negligence in allowing the southbound train to enter the block section at Abermule with the tablet which had just been surrendered by that train (for the section north of Abermule). The trains met at about 25 or 30 miles an hour, and the engineman and fireman at fault were killed.

The inspector says that the engineman and fireman of the southbound train, Jones and Evans, should bear half the responsibility for the collision, holding, also, that if the engineman had been keeping a good lookout, he could have applied the brakes so as to mitigate the effects of the collision. Both men evidently had accepted the tablet in a pouch without reading it. E. P. Rogers, a station porter, 17 years old, accepted the northbound train from the station to the south without authority from the stationmaster or the signalman, and immediately after this he started for the south end of the yard to set the switch for the two trains to meet at Abermule. F. W. Thompson, ticket clerk, 15 years old, took the tablet from the southbound train as it came in, this also without authority, and instead of putting the tablet into the instrument he met the acting stationmaster, Lewis, in the waiting room and handed the tablet, in its holder, to him, asking him to change it. Thompson then went across the tracks to take up the tickets from incoming passengers from the north. Lewis assumed that Thompson had already changed the tablet and that he was receiving one for the section south of Abermule, and he gave it to the fireman, the engineman being engaged in oiling.

Rogers, at the south end of the loop, was surprised to find that he could not set the switch for the northbound train (the switch being controlled by a bolt lock from the signal cabin), but he saw the stationmaster give a hand signal for the southbound train to proceed, and he assumed that the meeting place of the trains had been changed.

Several other irregularities are noted in the report and responsibility is placed on the acting stationmaster, Lewis, signalman Jones (60 years old) and the porter and the clerk. The regular stationmaster, Parry, was on vacation; he is held responsible for the growth of these irregular practices and in less degree the inspectors who failed to detect them. Lewis, with Jones, is held responsible equally with the engineman and fireman. All of the rules which were violated are simple and well understood and of long standing and, indeed, violations are so infrequent that the collision is characterized as unique in the annals of British railways. "Such indiscipline and slipshod methods would have been incredible prior to this collision."

Having set forth the facts the inspector feels so strongly that the rules will be observed in the future that he finds no justification for recommending additional precautions, except the following: at meeting points where the tablet instruments cannot be placed in the signal cabin there should be electric interlocking between the tablet instrument and the starting signal; in special circumstances such interlocking should be provided even where instruments are in the signal cabin. The switches at Abermule should be worked from the cabin, and the governmental committee which is now engaged in standardization of rolling stock should consider the question of equipping new passenger cars with buffers designed to prevent overriding of one car by another in case of collision.

The engineman and fireman of the northbound train, men of long experience, could not recall cases of enginemen or firemen who did not habitually read tablets handed to them. We find no mention of the age, character or experience of the engineman and fireman who were killed.

OPERATING DEMONSTRATION OF REGAN TRAIN CONTROL SYSTEM

A DEMONSTRATION of the Regan automatic train control system, as installed on the main line of the Chicago, Rock Island & Pacific between Blue Island, Ill., and Joliet, was made on June 3 for J. H. Thomas, head of the Railroad Men's Union, Great Britain, Member of Parliament, and Privy Councillor to the King. A special train consisting of an engine, combination coach and two official cars left the La Salle Street Station at 1:05 p. m. Between Blue Island, Ill., and Midlothian signal 171 was set to give a caution indication to demonstrate the effects of automatic speed control in bringing the train down to a predetermined speed, while signal 181 was set in the stop position in order to demonstrate the action of the apparatus under such circumstances. At Midlothian a stop was made in order that those in the party could examine the engine apparatus.

J. H. Thomas, who was formerly a locomotive engineman, ran the engine between Midlothian and New Lenox. During this time a speed of 75 miles an hour was registered on the speed recorder and a caution indication was received at signal 323, west of Mokena, Ill., which brought the train down to a speed of 25 mi. an hour, the train later being stopped by signal 339, which was in the stop position. On the return trip demonstrations were made on different signals at varying rates of speed, the apparatus functioning perfectly in each case.