First Position Light Signal Installation*

Discussion of Conditions on P. R. R. Electrified Line Prompting This Important Development

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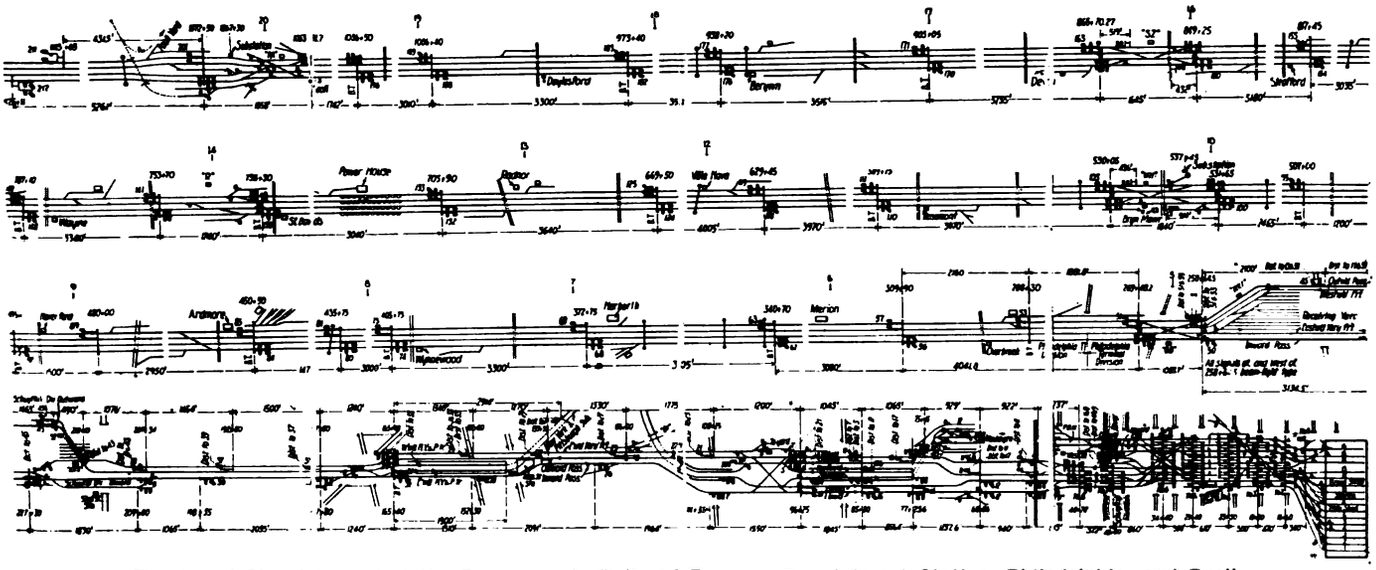
Five or six years ago the congestion of trains became so serious at the Broad Street (Philadelphia) terminal of the Pennsylvania that it was evident to the operating officers that some relief would have to be found at an early date. A committee of operating officers was appointed, who worked arduously for several years, looking into every phase of the situation and examining a number of other terminals. Enlargement of the station would have meant extensive changes, running over a long period of time, and, as more immediate relief was necessary, various schemes of electrification were considered. Finally the committee recommended, in the early part of 1913, that one of the principal suburban routes be electrified, together with about one-half of the terminal tracks. This will provide the most relief at a fairly moderate expenditure, doing away with a large number of light-engine movements and providing more standing room at the platforms, to say nothing of moderating the smoke nuisance to a large degree. It is estimated that the relief will be equal to a reduction of the number of trains of about 8 per cent, which will perhaps take care of the normal expected increase of traffic for the next three or four years. As the most important suburban service is that on the main line between Philadelphia and Paoli, 20 miles out, this section was selected for the initial installation, to be followed up by others if the expected relief is attained.



Track and Signal Layout of the Pennsylvania Railroad Between Broad Street Station, Philadelphia, and Paoli.

Much thought was given to the selection of a proper electrical system. The company has had extensive experience with third-rail operation at the New York terminal and on the line between Philadelphia and Atlantic City, but after carefully analyzing all of the systems available and comparing estimates of costs, the overhead-contact, high-voltage system was chosen, particularly as it seemed to be better adapted to expansion from suburban to trunk line electrification over long distances, if such action should become desirable in the future. During the summer and fall of 1913 a trial installation of the overhead structure was erected for about a mile east and west of Wayne station, 15 miles from Philadelphia. Two principal schemes were tried. Both used round steel poles planted about 8 ft. from the near rail on each side of the tracks. In one scheme the poles were connected at the top by a steel beam of H construction, about 10 in. deep. In the other an ordinary messenger wire connected the poles, making it absolutely necessary to guy them.

The first scheme was looked upon very favorably, and appeared somewhat better, in that no guy rods were required, as these cannot be used in some locations, where the right-of-way is limited. However, it was seen that the succession of beams would present a very serious obstruction to the view of the signals unless the latter were suspended below the level of the beams. As a last resource it might have been possible to do this on a tangent, but as the road between Philadelphia and Paoli is largely a succession of curves on which the catenary messenger wire is directly over the center of the inter-track space, such an arrangement would not answer at all. As a consequence the guyed poles and wired cross-construction was finally adopted. Where the right-of-way is not wide enough to permit guy rods being placed, self-sustaining posts of lattice construction are used.

POWER SYSTEM.

Single-phase power is purchased from the Philadelphia Electric Company, at 13,000 volts, 25 cycles, and transmitted through submarine cables under the Schuylkill river to the first substation. The voltage is raised here to 44,000 for transmission about 1½ miles to the main substation at Thirty-second street, near the West Philadelphia station. Here the voltage is lowered to 11,000 volts, which is used on the contact wires. From this station also two 44,000-volt lines are carried on the extensions of the catenary supports, one on each side of the tracks as a rule, to the substations at Bryn Mawr, 9 miles, and Paoli, 19 miles away. Taps are taken from both of these main lines into the substations, where the voltage is reduced to 11,000 and fed through the necessary oil circuit breakers to the contact wires. Air-break sectionalizing switches and electrolytic

*This is the first of two articles describing the signal work carried out in connection with the electrification of the Pennsylvania suburban line between Broad street station, Philadelphia, and Paoli. The second article, which will appear in an early issue, will describe in detail the interesting features of the power line, control circuits and automatic and interlocking track circuits.

lightning arresters are erected on the roof of each substation.

The West Philadelphia substation is the only one where an attendant is regularly on duty, and this is largely on account of the motor generators necessary to supply 60-cycle current for the signal system. At the other stations remote control boards are located in the nearest signal cabin and all the switches are operated from this board by the regular signalmen at the request of the power director. At Overbrook, 4 miles from West Philadelphia, there is a set of section break switches, located on a signal bridge near an interlocking cabin, which are also remotely controlled and operated by the signalman. In case it should become necessary to open one of the air break sectionalizing switches on the roof of the substations, the signal repairman located nearest is instructed to do this by means of a specially constructed wooden pole while wearing rubber gloves. The signal repairman would also be called upon to operate the oil circuit breakers in case anything happened to the remote control arrangement. A large car repair shop is located at Paoli, and in this is a motor-generator set for supplying 60-cycle current to the signal line in emergencies when trouble occurs between West Philadelphia and Paoli, or when the West Philadelphia generator set fails. The starting of the emergency set at Paoli would devolve either upon one of the men employed in the shop or upon the signal repairmen located close by.

In order to induce the propulsion current to use the rails rather than the ground for the return circuit, the booster transformer method is being applied, which vitally affects the operation of the signaling track circuit. This method has been tried before only on the Norfolk & Western. (Described in the July *Signal Engineer*.) At points 1 or 1½ miles apart, the contact wire on each of the four tracks is broken and taken through a transformer in series. The secondary of this transformer, the ratio of which is practically one to one, is connected across the neutral points of the impedance bonds in each track. A difference of potential is produced across these secondary terminals dependent on the voltage drop in the primary, and this is directly dependent on the propulsion load. There may be as much as 100 volts across the insulated joints. These points of high potential cause a sucking or drawing effect, which has the result of keeping most of the return current at least in the neighborhood or actually on the rails. After trial trains had been run, it was found that these points of high potential also had a very disturbing effect on the track relays, which will be described later.

The entire power system is under the supervision of an assistant electrical engineer, who has under him the transmission foreman, power director, gang leaders, linemen, etc. The direct charge, however, devolves upon the power director, who is always on duty at the West Philadelphia substation. To him are reported all troubles either from the contact, transmission or signal lines and it is his duty to straighten these out. Very elaborate telephone facilities are provided, and it is possible to reach him very quickly. Explicit rules and regulations concerning correct and safe methods to be followed when working on high-tension lines have been worked out and a copy has been provided for the use of everyone likely to be called on for such duty.

SIGNAL SYSTEM.

There was in service on the section to be electrified a very complete signal system—both automatic and interlocking. From "K" Cabin, two miles from Philadelphia, to Paoli, 18 miles, automatic signals of the electro-pneumatic type had been installed in 1901 and 1902. This was one of the earliest if not, indeed, the first installation of any size in the United States to be operated entirely by storage batteries and to be controlled by the so-called wireless or polarized system. From Overbrook to Paoli, about 15 miles, the signals were located on steel bracket posts to the side of the tracks. These were still in very fair condition, but it was found that they would be in line with the posts supporting the catenary construction and transmission lines, and therefore the view would be considerably obstructed. Furthermore, it was found necessary to erect anchor bridges at intervals of 3,000 to 4,000 ft. to stiffen the catenary construction, and as these distances would about fit the signal scheme, a combined anchor and signal bridge spanning the four tracks at regular signaling distances was agreed upon, and the old automatic signal system abandoned. In this section, between Overbrook and Paoli, there were five interlockings of about standard four-track size. At Bryn Mawr, the machine was entirely electro-pneumatic, and this was replaced by a type

Erecting New Signal Bridge Around the Old One in Busy Terminal.

"F" U. S. & S. electric machine. At the other plants the switches were operated mechanically and no changes were made. All of the existing signal bridges, however, were replaced by others of the heavier anchor type.

The section between Overbrook and Philadelphia constitutes the Terminal division, and the four-track system expands into a yard and the main passenger tracks. The entire operation of both switches and signals is electro-pneumatic, and no general change was made in these. Many of the existing signals had to be relocated, and all of the old signal bridges were replaced by those of the heavier anchor design, These heavy bridges were built close to the old ones and

The Old and New Types of Signal Bridge on the Electrified Section.

the signals were transferred one at a time. At one location, however, where the existing signals were located directly over a diamond crossing, the new bridge had to be built around the old one. As this location was in one of the busiest sections of the terminal, the job was an extremely difficult one. The new bridge was built with as little bracing as possible, entirely enclosing the old one. The signals were then moved, the old bridge taken to pieces and the bracing of the new bridge completed, with few detentions to trains.

Between Overbrook and Paoli, where the signal system had to be entirely reconstructed, the location of the signals was

given very careful consideration. In general the grade is ascending all the way from Philadelphia to Paoli. Rising from the Valley of the Delaware a few feet above sea level and proceeding west, there is a steep gradient as far as Bryn Mawr, which is about 500 ft. higher. Continuing westward the grade rises, short stretches being level or even somewhat down grade, but generally up until Paoli is reached. It was therefore decided to use the two-block indication on the westward tracks on the heavy upgrade as far as Bryn Mawr, and for the rest of the distance to Paoli on these tracks, the three-block indication. On the eastward tracks three-block indication is used throughout.

The three-block indication has been used with much success on the Pennsylvania's main-line divisions for several years. It affords maximum use of the trackage, particularly where there is a heavy mixed high-speed passenger and comparatively slow freight traffic. It allows the use of rather short blocks, permitting freight trains to follow one another closely without stopping and gives maximum protection to passenger trains, there being at all times ample braking distance between a stop signal and its caution indication. In other words, in a two-block system, a train has one block and in a three-block system two blocks to stop in, the braking distance in each case being practically the same.

In order to get maximum signaling efficiency, the braking distance for various speeds, the gradient and curvature of road were all given consideration, and an elaborate and carefully planned table was made by the motive power department, according to which the signals were finally located. Attention also had to be given to the spacing of the catenary supports. These are on an average 300 ft. apart, and as it was deemed advisable to stick closely to this distance and as the signal bridges are, as already explained, a part of the catenary supports, they had to be located to suit. As can be readily imagined, there was at times some difficulty in finding locations which would suit both the signal and construction departments and many plans were made and remade before both were satisfied. The distance between signals varies from 2,500 to 4,000 ft. At one place, near Ardmore, it is contemplated in the future to install a new interlocking, and the automatic signals are somewhat irregularly spaced with this idea in view.

The three-block system requires the use of two arms and the two-block indication one arm and a marker light. However, as the latter was to be used only on two tracks for about five miles, it was decided for the sake of uniformity to use two arms on all of the signals, the second arm on the two-block indication taking the place of the marker light and being, of course, fixed.

DEVELOPMENT OF POSITION LIGHT SIGNAL.

During this period of the development of the system, it had been proposed to use a. c. motor-driven signals. Several hundred miles of four-track system on the P. R. R. has been equipped with this type of signal, some of them being in service for more than four years. They are now giving excellent service, but at the time of their installation and for a considerable period afterward their performance was far from satisfactory. There are inherent defects in every motor-driven signal, if it is to have any efficiency at all, which act against its use; therefore, after various experiences with the a. c. motor signal, the Pennsylvania's signal department looked for something better.

Light signals are, of course, not new. They have been used for many years past on trolley roads, both for day and night indication. An ordinary incandescent lamp was placed in a box behind a lens, or even an ordinary piece of glass, and was visible for 100 ft. or so, forming a fairly efficient short-range signal at little expense. For a long time no headway was made in development for long range, and this made its use very limited for steam railroad work, it being confined to tunnel signaling until the New York terminal work of the P. R. R. was undertaken. It was considered desirable to continue the light signal scheme in the tubes to the interlocking located in the opening directly to the west of the station, and for this purpose a light signal was designed which has a range of about 500 ft. in daylight, with an expenditure of about 80 watts per signal. During the last two or three years much progress has been made by the different signal companies in securing long range through the use of more efficient lenses and principally by the use of concentrated filament tungsten lamps, which have been highly developed by the lamp companies largely through the automobile industry.

By the latter part of 1913 the range of the light signal had been increased to 2,500 ft. in bright daylight, and it had become a commercial possibility. It should be borne in mind, however, that in all of this development work the units were large, the lenses being 8 or 10 in. in diameter, and that automobile lamps of not less than 20 watts were used. Furthermore, unless the signals were very low, the close indication was a failure and even at this writing little improvement has been made in this direction with this type of signal. Again all of the daylight signals so far developed were of the color variety, which was objectionable from the P. R. R. standpoint. While green, yellow and red are used for the clear, caution and stop indications in the New York terminal district, they have never been generally adopted for other portions of the line, principally on account of the difficulty in obtaining three absolutely distinctive colors.

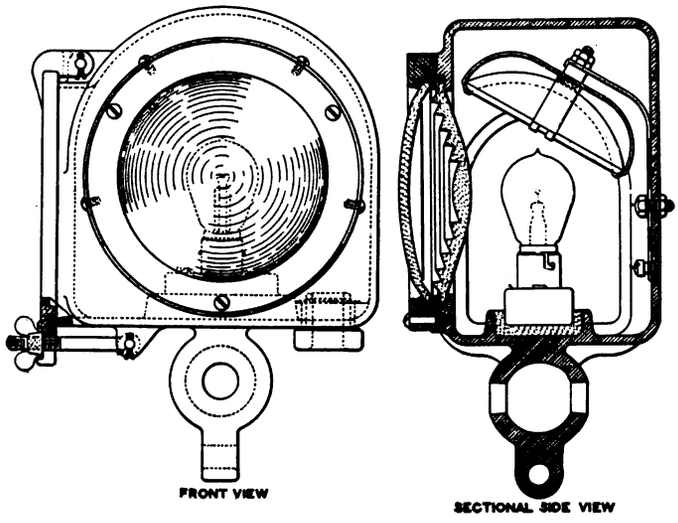
Early in 1914 Dr. Churchill of the Corning Glass Company, while working on some of the electric headlight troubles of the western railroads, discovered that it was possible to secure very long range from a small light source located in the exact focal point of a small wide angle lens, and in talking the matter over with A. H. Rudd, signal engineer of the Pennsylvania, it was seen to be altogether practicable to combine these small separate units into rows of lights which would have the effect of the present semaphore arm and would do away with the color scheme altogether. Thus was evolved the position-light signal, which has now been covered by various patent applications. It was, of course, a long way from the conception of the idea to the perfection of the design, and it was not until the summer of 1914 that the signal was considered satisfactory enough to adopt. The principal experiments were conducted at Wayne and later at Paoli. A great many combinations of lamps, lenses, cover glasses and backgrounds were tried. The signal was inspected and viewed from every angle by the various officers of the company on numerous occasions. Every opportunity was given for comparison with the semaphore and the color light signal, a sample of which had also been installed, and finally, in the summer of 1914, the electrification committee voted practically unanimously in favor of its adoption, which action was later approved by the president.

Each unit of the position-light signal consists of a container or box painted dead black inside, holding a 12-volt, 6-watt horizontal helical filament tungsten lamp in the exact focus of a toric inverted lens of 2¼-in. focus, 5⅜ in. diameter, in front of which is a special convex cover glass of the same diameter. Over the lamp is located a 4-in. spherical mirror at such an angle that no light from the lens can be reflected outward. This mirror gives the extreme close indication, and is for no other purpose, having no effect on the range. The whole unit is so designed that practically no light from the front can be reflected back again, which might cause an unlighted unit to appear lighted.

The lamp is spherical, and the stem holding the filament is unusually short to cut down reflection, and tipless to prevent loss of light from shadow. The filament is in the form of a helix ¼ in. long and ⅛ in. in diameter. In order to get it in the exact focus of the lens it is necessary to rebase the lamps after they are received from the makers. A slip ring is soldered over the base in a machine with telescope sights. The single contact bayonet receptacle is secured in its proper place in the bottom of the unit by means of a jig in the lens opening. In other words, the filament of the

lamp, the receptacle and the lens are all located in relation one to the other, so that when a lamp burns out, a single replacement is all that is necessary—no adjustment of any kind being made after the signal is once properly located and sighted. Repeated efforts were made to get the manufacturers to locate the filament uniformly in each lamp, but they could not do it; hence the necessity for rebasing.

On some of the curves it has been found desirable to use a special lens with more side spread than the regular one, and for this purpose a toric spreadlite lens has been perfected.



Lamp and Bracket of the Position Light Signal Unit.

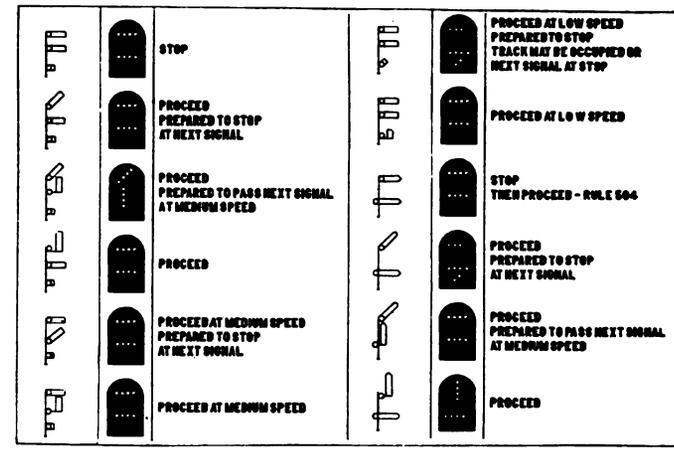
It looks like the regular lens, but the steps have been distorted so that more light is thrown to the sides as well as to the ground while the top portion is undisturbed. While this arrangement, of course, cuts down the range to some extent, it is no disadvantage as a curve allows of only a short range at best.

The cover glass is of a peculiar shape, being so designed that any light striking it from the front on any portion except the apex will be reflected backward. At the apex a spot about 1 in. in diameter is frosted to diffuse the reflection from this portion. Originally a rather flat cover glass was used, from which heavy reflections were obtained in the early and late hours of the day, when the sun was low and directly in front. For a few minutes in the day several of the signals appeared to have all of the indications lighted, depending on the location of the track in reference to the points of the compass. While this was not particularly serious, it constituted a stop signal and was the cause of several delays. The new cover glass does away with that altogether. The tint of the glass is a light yellow known commercially as No-Glare. This is for several reasons: the color is distinctive, being different from other lights the enginemen might see; it is a contrast to the ordinary blue of daylight, and it is easier on the eyes of enginemen than a white light would be. While the range at present is easily 4,500 ft. in bright daylight, it could be increased somewhat for some special cases if necessary, by the use of a plain white cover glass with no more expenditure of energy, although it might not be so satisfactory in some other respects.

Attached to the unit over the cover glass and partly encircling it is a sheet-iron hood, 11 in. long, which affords protection from the sun, and a very considerable protection from snow and sleet. Four of these complete units constitute an indication equivalent to a semaphore arm, except in the case of the low-speed signal, where two units are considered sufficient and are only displayed when necessary, which means that ordinarily only two rows of lights are shown at interlocking as well as automatic signals. In the former case the rows are located directly under one another, while in the latter the lower row in the stop position is staggered 18 in. to the left. The units are mounted on a framework of pipe, each unit being fastened to the pipe by means of a ball-and-socket joint, which allows it to be sighted properly in relation to the track governed. To the back of the framework is attached a background of sheet iron. For best results, particularly where long range is required, this background is made amply large, so that no light from the back will strike through and around the units and dilute, as it were, the light from the lenses. At two interlockings intermediate signals between the home and advance signals, for run-around purposes, and which need be only short range, are placed on ordinary bracket posts and the backgrounds are only narrow strips of iron about 12 in. wide behind each row of lights. These answer fairly well, but can be improved by filling in between the rows, and this has actually been done in one instance for trial and the remainder will be fixed in the near future.

It was found necessary in the early development of the signal to reduce the voltage considerably at night. Burning at the daylight voltage the glare was very marked at night, being hard on the enginemen's eyes, and furthermore the straight-line effect of the rows of lights became lost at a distance from the signal, the circular effect making it somewhat hard to read the correct indication. It was thought also that the transition from the daylight to the night voltage was too sudden, particularly during the summer months, when the twilight persisted for an hour or more. Consequently a third voltage was decided upon, making the standards 11 volts in daylight, 6 volts in twilight and 4 volts at night. After the signals were in service about three months it was found that two voltages would suffice and at the present time 11 and 6 volts are being used with entire satisfaction. The change in voltage is made at the proper time by the signalmen at the different interlockings, who control the signals from each interlocking to a point about half way to the next. No particular schedule is adhered to. When it appears dark or light enough, as the case may be, the men get together on the telephone and agree to make the change. In case of fog at night or perhaps heavy snow, the signalmen have instructions to turn on the daylight voltage.

These signals have now been in service since February, 1915, and three or four polls of the enginemen running under them have been taken. Many of these men had seen the experimental signals and being conservative as enginemen



Corresponding Aspects of Semaphore and Position Light Signals with Their Indications.

often are, they had made up their minds in advance that they were no good. However, they were all required to attend a school of instruction and by the aid of working models were carefully drilled in the aspects of the new signals, and it became apparent to most of them at once that the rows of lights took the place of the semaphores and that there was really nothing new to learn. When the change was actually made and the semaphores abandoned, the men read the new signals just as if they had always done so, and not the slightest hitch occurred. When the first poll was taken, about two weeks after the signals were in service, nearly one-third

of the enginemen professed to believe that the semaphore was the better signal. This number decreased on the second poll, and in one taken several weeks ago, practically all of the men were decidedly in favor of the light signal. The average engineman knows a good thing when he sees it, and he can appreciate the difference between a a semaphore signal oftentimes slowly and painfully struggling to assume an aspect for an approaching train and the position light signal which instantly changes its aspect. The writer has many times ridden on engines and heard the crew hesitate to call the aspect of a semaphore signal until it had been in sight for a time, and it is almost uncanny now to hear the aspects called promptly immediately the signal comes in view. The aspect of the position light signal is so generous and the line effect so pronounced that it impresses itself on the mind at once. One look is enough.

DWARF SIGNAL.

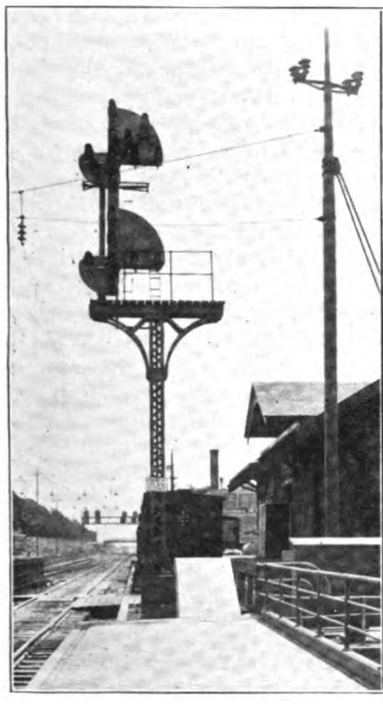
The dwarf signal was not developed until the design of the high signal had been decided upon, although at present a number of them are in service. The problems encountered in designing this signal were in some cases harder to solve than in the high signal. It is obviously impossible to use a hood of more than a few inches in length, as the engineman looks down upon the signal and must see the indication when he is very close. For this reason much trouble was experienced from the reflection of the sun from the unprotected cover glass and also from the interior portion, lens, lamp, etc. To kill the surface reflection from the cover glass it was necessary to resort to fine acid etching and to get rid of the internal reflections a diffusing screen of fine mesh woven material, such as chiffon, was placed between the lens and cover glass. This has a tendency to break up the beam of light entering and leaving the lens, so diffusing the reflections as to make them unobjectionable. The chiffon also has a further use in darkening the unlighted cover glass so that it becomes almost a part of the background, and the contrast between the unlighted and lighted lenses is very marked. Of course the use of chiffon and the frosting of the outer side of the cover glass made it impossible to use the same candlepower lamp as is used in the high signals, it being found that at least 12 cp. was required to give the necessary illumination in daylight.

Twelve-volt lamps are used as in the high signals and the same voltage, that is, 11 in daylight and 6 at night, the signals all being on the same voltage control circuit. The dwarf signals are quite small, being about 17 in. square outside, and are set on the foundation so that the front is tilted back a little, which directs the beam up and shortens the range. The lenses and cover glasses are 4 in. in diameter and are 8 in., center to center. Two lights constitute an indication and a complete three-position signal has four lenses. The lamps are rebased exactly as in the high signals, and the receptacles are accurately placed in reference to the lenses. Lamp renewals are made by simply removing the burnt-out lamp and placing a new one in its stead, no adjustment of any kind being made. The mirror is the same as in the high signal, being placed, of course, below the lamp, so as to give a close indication.

INTERLOCKINGS.

On account of the change from semaphore to position-light signals, the five interlockings between Overbrook and Paoli had to be considerably revised. While the operation of the switches, except at Bryn Mawr, was left mechanical, the plants had to be practically rewired. New relay housings and wireways of fireproof construction, mainly angle iron and asbestos lumber, were built in all of them. The local circuits are all d. c., as much of the apparatus already in service could be utilized. The old chloride storage batteries previously charged from a 500-volt d. c. line were abandoned, and Edison storage batteries substituted. These are the A-4 style in two sets of ten each and are charged from mercury arc rectifiers of 20 amperes capacity. The transformers are all located outside the cabins in iron cases. Practically all of the apparatus is in the first floor, there being nothing except the approach lights and slow releases in the signalmen's compartment. Where it was necessary to rebuild the outside trunking, it was placed on concrete foundations. As the air supply is discontinued, the air whistles had to be abandoned and Klaxon horns have been tried with only fair success. There are so many automobiles constantly passing some of the cabins that it is hard to distinguish between their horns and those on the cabins. Neither can they be heard as far as the air whistles, so that the matter of a noise-producing device is somewhat open.

At Bryn Mawr the electro-pneumatic machine has been replaced by an all-electric, type "F," U. S. & S. machine. It



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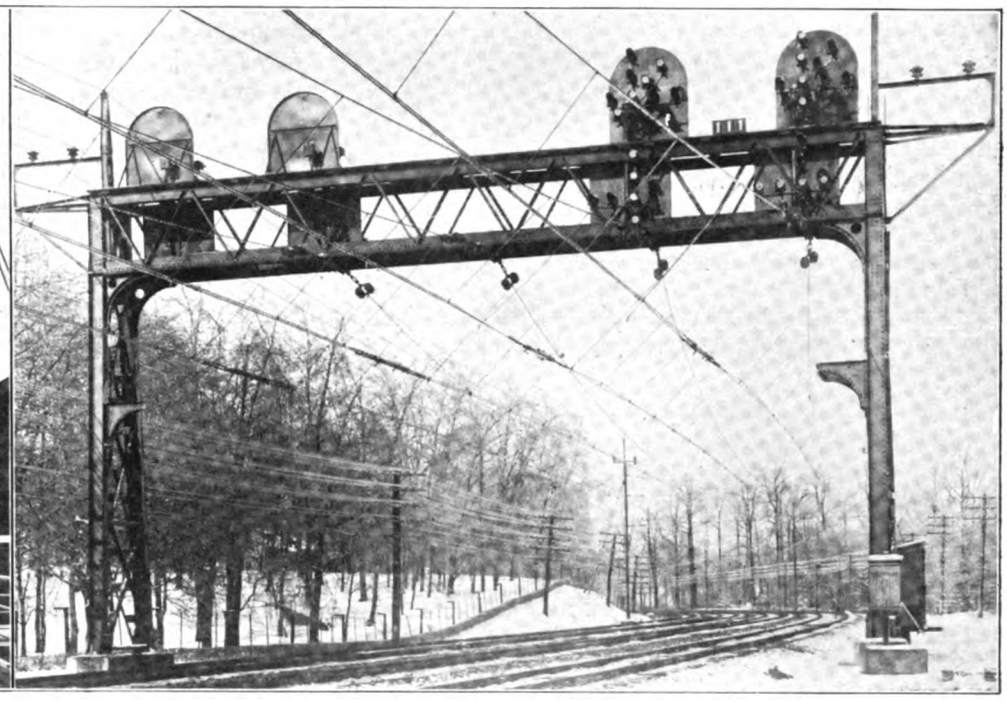

Typical Bridge and Position Light Signals, Indicating Three Blocks Clear on Outside Track and Two Blocks Clear on Inside Track.

is operated by direct current supplied by two sets of Edison storage battery, charged by two mercury arc rectifiers of 40 amperes capacity, one of which is held in reserve. Power is taken from a 10-kv.a. transformer at 220 volts. The switch movements are of the de-energized type and the indications are given by a. c. current.

Between Philadelphia and Overbrook the work on the interlockings consisted largely of track circuit changes and the relocation of all of the signal bridges, which, while involving an enormous amount of actual work, did not introduce any new or novel features. All of the d. c. electro-pneumatic, upper-quadrant semaphores were retained, and all of the old material was used as far as possible. Mercury arc rectifiers were installed at Fifty-second street and "GV" cabins, but at all of the other plants the old motor generator sets are still used.

On February 14 the first section of the new work was placed in service between Overbrook and Bryn Mawr; on the following Sunday it was extended to Devon, and on the next Sunday to Paoli. Immediately after each section was placed in service the old bracket posts were removed and shortly after the underground telephone and telegraph lines were put to work and the old pole lines removed, making it possible to finish stringing the high-tension transmission lines.

As there was no serious interference of the old signal work with the propulsion construction on the section between Philadelphia and Overbrook, this work was not particularly hurried, and has only just been completed and is not all in service. Troubles have developed in the catenary construction which have slowed down this work, and it is not yet completed, particularly at the Broad Street station end. Regular electric service has, therefore, not yet been inaugurated, although trial trains are run between Overbrook and Paoli nearly every day.

RESULTS.

The signal work has now been in service on this section nearly five months and there has been practically no trouble except that due to unbalancing of the track circuits already explained. The power supply obtained from an outside source has been fairly satisfactory. We are arranging to change over to our own power in a few days. The position-light signals have proved entirely satisfactory, with the exception that the first lamps were not very good and burnt out after a rather short life. This has now been remedied. Not a single difficulty has been experienced with the voltage-change arrangement. The use of two voltages instead of three will lessen the cost of installation. A wattmeter reading of the consumption of current, taken with the signals equipped with a less efficient lamp than those first used, but which gives much longer life, gave an average result of three watts per lamp per hour. These signals will also be used between Chestnut Hill and North Philadelphia. Where these signals are in service, about all that the maintainer has to do is to replace burnt-out lamps and wipe off the cover glass, and it is hoped some saving can be made in the number of maintainers.

A very efficient telephone system helps to make the installation a success. At every signal bridge the phone connection can be made with either the Bryn Mawr or the West Philadelphia exchange. All of the telephones may be connected together, so that conversation may be carried on between a number of men; or the nearest interlocking or block station may be called exclusively. Practically any point can be reached through the exchanges.

CAB SIGNALS IN ENGLAND.—Among the English railway companies which are known to have commenced experimenting with locomotive cab signals are the Lancashire & Yorkshire, the Great Central and the South-Eastern & Chatham. The Great Western and North Eastern have them in regular use, and the Midland has been trying two systems for some time.

DEMONSTRATION OF GOLLOS TRAIN CONTROL SYSTEM

The operation of the Gollos automatic train control was demonstrated on the Chicago, Burlington & Quincy, between Sugar Grove, Ill., and Big Rock, on August 3 and 4. A special train carrying officers of the company and a number of representatives of the signal and operating departments of central and western roads left Aurora, Ill., at 12:30 p. m. each day, returning about 4:30 p. m. The installation over which the demonstration run was made is 6 mi. long and includes 8 ramp locations for westbound movements and 10 ramp locations for eastbound movements.

The system is of the intermittent contact rail type, with the engine apparatus inoperative while running between points of indication. When the engine shoe makes contact with an energized contact rail, the engine apparatus is still held inoperative. When a train is standing, the apparatus is in such a condition that the train can proceed only at a predetermined reduced speed. When the engineman opens the throttle, a whistle in the cab is automatically started, which continues to sound until the engine shoe engages a clear contact rail. This rail being fully energized supplies the current which actuates the control in the cab to permit the train to proceed at full speed, and also stops the whistle. The contact with this shoe is recorded by an automatic apparatus, and the contact also causes the lighting of a signal lamp in the cab. The passage of this rail is acknowledged by the engineman by pressing a button which puts out the lamp and records the fact on the automatic recorder. This is the usual procedure in passing a clear contact rail.

When the contact shoe engages a partially energized contact rail, indicating caution, the engine apparatus is again set for reduced speed and the whistle blows continuously. If, while passing through a block at caution speed, the train in the advance block has moved on or other obstruction has been removed so that the next contact rail is in the clear condition, the cab system will be automatically returned to normal full-speed condition, but if the danger condition continues, the contact rail is de-energized and the train will be automatically stopped when the contact shoe strikes the de-energized rail. This stop is also recorded and a chime of two whistles is sounded to warn the engineman of the stop application. If the engineman desires to proceed, he unlocks and opens a cabinet box which encloses the instrument and resets the automatic apparatus to caution or slow speed condition. The opening and closing of this cabinet and also the resetting of the instrument are recorded automatically. He may now proceed at controlled reduced speed until he strikes a clear ramp.

If the engineman has observed a danger signal and stops his train before the shoe comes in contact with the de-energized rail, he may pass to the energized rail by holding down continuously a separate button. The pressing of this button is also recorded and if he should attempt to pass a rail by pressing this button before the train has stopped, a stop application would result.

The functions of the system include: automatic speed control and automatic train stop; visible signal to indicate entrance to block section, audible signal sounded continuously in caution block; audible signal sounded continuously in danger territory as distinguished from the audible caution signal; and an automatic record of the time block is entered, the time of acceptance of signals by the engineman, automatic application of brakes due to engineman passing signal at danger, opening of cabinet to release train brakes, release of train brakes after automatic application, closing and automatic locking of cabinet to again secure integrity of the apparatus and non-interference, and permissible emergency passing of a signal at danger.

The system, which is controlled by the Gollos Railway Signal Company of America, Chicago, was turned over to the Interstate Commerce Commission for tests on July 26.