Light Signals to Supplant the Semaphore

The Day of Motor Mechanisms Is Slowly Passing As Elimination of Movable Parts Decreases Failures and Maintenance

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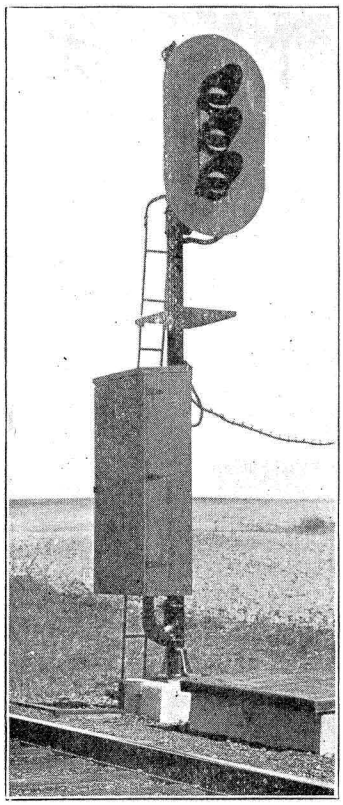

A Color-Light Signal in the Open Country as Used on a Trunk Line

POSITION - LIGHT signals are in service in various parts of the world. One has been tried out at San Francisco, two are on trial in India, one in Australia and one in England. Color-light and uncolored light signals have been used on trolley lines for a great many years. A lamp in a box with a lens in front of it has been used effectively and satisfactorily, but not for trains running 70 and 80 miles an hour.

The color-light signal has been in existence for a good many years. I believe the first that was really developed for far-distant seeing was on the Pennsylvania. When the tubes in New York were built we had to have color-light signals in the tunnel and they were also used for the station areas which were exposed to sunlight although not to the direct horizontal rays. At these locations the sun is shut off by the cuts in the tunnel so that probably the lowest point it reaches is 35 or 40 deg., and no problems exist in connection with the direct sun rays at such points beyond the taking care of any reflections that might be caused by the sun. The light signal was developed so that it could be seen 1,000 or 1,500 ft. Dr. Churchill of the Corning Glass Works gave a lecture on color-light signals at New York about six or seven years ago, and after that talk he suggested the consideration of a position-light signal and this type of signal is the result of that talk.

The semaphore is a pretty good signal for the day and it is supplemented by colored lights at night. Twice a day the system of signaling changes from a position signal to a colored signal and in the early morning and at dusk the signal is vary hard to see. Those who have ridden on engines know that it gets so dark it is hard to see the arm and at the same time it isn't dark enough to get a good light indication from the ordinary signal lamp.

In 1888 Professor Coyle of Swarthmore invented an illuminated arm. He had a parabolic mirror in the arm with corrugations on it. The indication was good up to 700 or 800 ft. He had a lamp attached to the signal mast that moved with the arm and it was illuminated day and night. Beyond 700 or 800 ft. the rays bunched and an image of the lamp appeared. Then, the old National Signal Company had a scheme of hanging bulbs with a commutator so that two or three red lights were lit when the arm was horizontal and three or four white ones when the arm was down. This, however, was unsatisfactory, the bulbs having a very short life.

Various schemes existed but no real results were obtained until the color-light arrangement was developed, which produced a long range signal. This could be seen at first probably 1,500 ft. in the daytime. The red lens cuts about thirty per cent off the transmission of the rays, the green not quite so much, but it has reduced the utility of the lights back of the colored lenses anyway from 35 to 40 per cent. In other words, it is necessary to supply more energy back of them.

In 1913 the range of color-light signals was increased to 2,500 ft. in broad daylight and it has become a commercial possibility. It should be borne in mind, however, that in this development work the units were large, the lenses being 8 or 10 inches in diameter and lamps of not less than 20 watts were used, usually 30 to 40 watts being employed. Furthermore, unless the signals were very low the close-up indication was a failure, and even at this time little improvement has been made in this direction on the color-light signal. If the signals were on a bridge they were very hard to see when within a few hundred feet, as the lights faded out. That is largely true of color-light signals today, the close-up indication is poor.

I believe the day of the semaphore is slowly passing. We hear that the day of the steam locomotive is also passing. It is going slowly, but it is going. The motor signal is going to fade away in the same manner. It will be some time, though, because there are a great many motor signals. The signal of the future is going to be the color-light or the position-light signal without moving parts.

With the lack of skilled labor in our business, the present financial situation and the present condition of the railroads, we have to do two things. In the first place, we have to keep going on with what we have. The chances of getting money for improvements for the next year or two are rather poor. In the second place, if we get the money, we have to spend it to the best advantage, and that best advantage as I see it is to put in apparatus which can be maintained and operated at a less cost than some other apparatus which may be cheaper in the beginning, but which carries with it a constant maintenance charge. It isn't good economy to install something costing twice as much to maintain when something else that costs perhaps a little more can be maintained for half. If a showing of 10, 15 or 20 per cent saving or interest earned on the capital in saving and maintenance can be shown, one is justified in putting in the more expensive proposition. If a saving of 15 or 20 per cent can be shown and the equipment doesn't cost any more and is better, one is certainly warranted in putting in such an installation. That is the first proposition.

The second proposition is to build for the future. Electrification is coming. It may be a great many years before all the roads are electrified, but the trolley has shown us the way in which to operate our roads with

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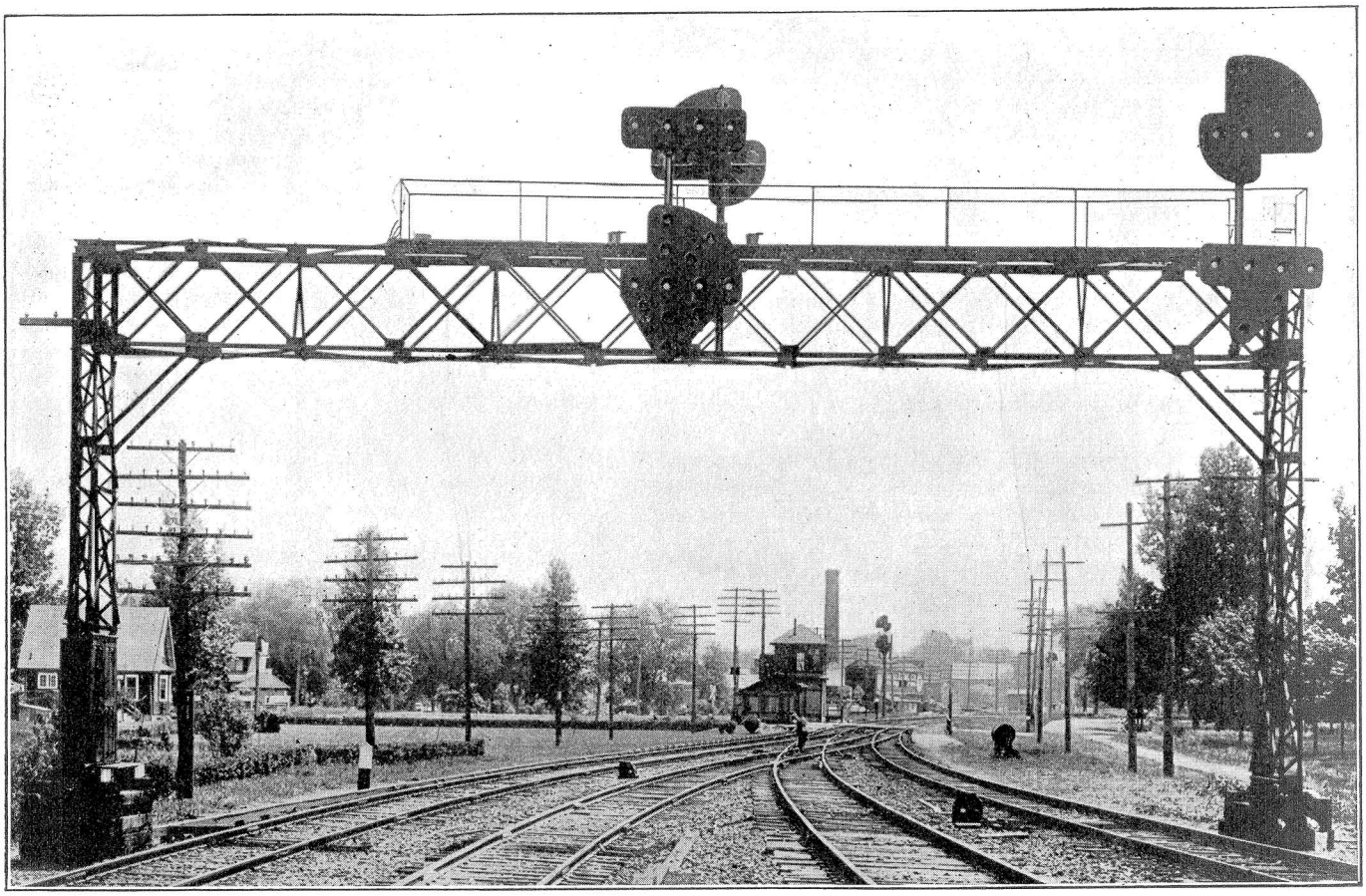


Position-Light Signals in Use on the Pennsylvania at An Interlocking Plant

economy. What is good engineering? To put in d.c. track circuits, electrify, throw them out and then install a.c., or to use the a.c. track circuits in the first place? If a.c. track circuits can be operated cheaper than d.c., there is only one answer—a.c. track circuits. With the a.c. track circuits all false clear signals due to foreign current are eliminated. An a.c. track circuit will give more trouble if the track is dirty than d.c., but the troubles are on the safe side, and false clear signals will not occur with bad, dirty a.c. track circuits. The only moving part in connection with the light signals is the relay. If the wrong king of trouble occurs on the relays false signals will occur no matter what system of signaling is in use, but foreign current trouble will have been eliminated.

The Pennsylvania has had position-light signals in service five years. We have had no false clear failures due to the signal itself during this time. Recently we have had one case of trouble caused by the light shining on the Susquehanna river reflecting up from the river and giving a phantom light. That will be taken care of by cutting down the short range and building up a shield. An electric headlight will not give a phantom light on these signals.

Mr. Dohoney of the Public Service Commission of Pennsylvania wrote: "The attention of the Commission is directed to the advisability of bringing before the steam railroad companies the matter of bettering the automatic signal system now generally installed on various lines operating in this state.

"The signal indications at night are conveyed by the color of light, and, although this system may be maintained properly, it has frequently happened that the engineman by reason of fogs or other conditions has failed to observe the warning. Rear-end collisions are the result. Under circumstances of this kind too many passengers and employees have been killed or injured during the past five years, and until the practicability of a system of train control can be established the most advanced method of signaling ought to be provided.

"There is now in limited operation a system known as position-light signals under the principle of which the engineman is not required to determine the color of signal lights. Colors are not involved in the indication. The latter are represented by the position of the lights and under favorable conditions they are more readily observed than are the indications in which the colors figure. It is the judgment of those familiar with signals that the substitution of the position for the color system would contribute largely to the prevention of accidents of the rear-end character."

Dr. Churchill in his investigation of the electric headlight and of lighthouse lights for the government made one discovery. The government was using kerosene lamps in the lighthouses because the light from the electric lamps did not penetrate the fog. He found that the reason the electric light would not penetrate fog was because of the blue rays which were reflected back by the particles of moisture. That led the Corning Glass Works to produce "no glare" glass for automobiles and by tinting the cover glass, the rays penetrate the fog where the ordinary white electric light will not. The electric light and the tinted glass is used in position-light signals. The light penetrates better than the kerosene light and the enginemen do not have to feel their way because the indications can be picked up far enough away so that if the indication of the signal back is obeyed the engineman can get by. There is no chance of seeing a wrong light and in a heavy fog when one cannot see the light the angle of the beam is indicated

through the fog. The signal indication lights up like a searchlight. Therefore it is more vivid and gives a better signal for the engineman. It is a cheaper signal to operate and maintain, requires less care and therefore it is more economical of power and labor. It is a labor-saving device.

The Pennsylvania is using the position-light signal for distant switch signals at places where the track is not occupied more than two hours a day. These are lighted up as the train approaches. If the track circuit is occupied more than two hours a day one cannot compete with the motor signal, and if one tried to light one of these signals as one would operate a semaphore, with the lights burning 24 hours a day, on a primary battery it would cost six or seven hundred dollars a year per signal.

The a.c. signals cost, according to our figures, about $25 a year more to maintain than position-light signals. A position-light signal on a bridge costs less than a motor. The position-light signal on the ground costs a little more. It is up to those who want to, to determine how much more they can afford to pay for a ground position-light signal where they can save $25 a year. That is according to the present labor figure. As the cost of labor goes up the saving will be greater.

I made a comparison with a.c. motors and d.c. position-lights at a tunnel and the a.c. motors were $150 and the d.c. were $75. Those figures don't hold today because of a number of changes. I think the d.c. will cost more than the a.c. because of the increased cost of labor. I haven't any reliable figures on d.c. motors. Those who have d.c. motors know what their own figures are or can get them, probably, and can compare them with the a.c. position-light signals at about $92 per year, and, of course, that depends upon the number of trains.

Don't think there is anything in putting these in where you have d.c. motor signals at present with the polarized track circuit. One cannot put that relay close to the signal on the battery end and light these up satisfactorily. One cannot use the same circuits anyway that are used for normal danger automatics. As I said, it means running the lighting-up wire back to the home signal in the rear.

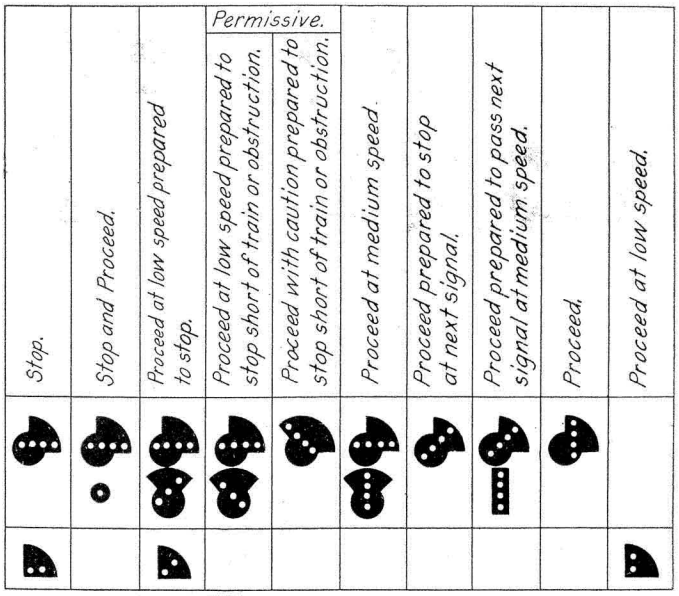
It is our intention to build a pole line where we have telegraph lines on both sides of the track, consolidating the pole line on one side and leaving the line on the other for the signal power line. In going through cities underground, the overhead power line a.c. and position-light signals can be put in at a not much greater cost than d.c. signals and enough can be saved to make it worth while, especially if by this construction a wreck or two is prevented.

In summing up, five years' experience has shown that safety has been promoted by eliminating colors; by providing sufficient lights so that if one or two are extinguished the indication may still be given; and by doing away with all moving parts except the control relays, so that the chance of false clear or mis-read signals is reduced to a minimum. Records of actual performance show that the number of failures of all kinds have been greatly reduced, insuring greater accuracy and less delays to train movement.

Where semaphores are used the indication is given by position in daylight, by color at night and by both in morning and evening. That is, the system of indication changes twice daily. Color-light signals uniformly give the indication by color only; position-light signals by position only; thus with these two latter classes of signals the system is uniform.

The position-light and the color-light are the ideal systems and they are going to replace the others. But as a comparison between the two, the position-light is ahead of the color-light, first for serviceability, and second for economy. The lamps used are practically 5 watt; 10 watt at the most, or 25 watts for the whole row. That is, from one of these 40-watt lamps you can light and operate two signals, while the color-light signal takes a 30, 40 or 50-watt lamp and then another one is really needed should the first go out, whereas with the position-light signal a couple can go out and still the signal indication is retained. Then, there is the flexibility. Any aspect can be displayed. That is what is done on the West Jersey. We have a number of signals that are automatics there, so arranged that they may be used as stop signals. If an operator wants to deliver an order he throws a switch and no train is allowed to go by. Those offices are closed at night. In order to take care of the particular situation without having the train stop and call up, the special instructions on that division are that if the signal is at stop the engineman must see whether the office is closed. If it is closed he regards that as an automatic to proceed.

With the position-light signal one horizontal row is



Position-Light Signal Indications

stop, one with a light below is stop, then proceed. The aspects are reduced to nine and three speed signals can be obtained with these aspects.

As a general broad proposition the disc signal is displayed or withdrawn. Thus any one signal can give but two indications. The color-light signal may be made to display as many indications as there are colors available. Three indications are all that have been attempted so far. You might get four. The semaphore is limited to three, horizontal, diagonal and vertical, because it cannot go through the stop position.

Where power from a central plant is available, as where alternating track circuits are installed, these signals have every advantage. They are particularly available for distant switch and block signals on single and double track branches.

It may be stated that under ordinary conditions, where power is available, the position-light signals can be maintained and operated with half the current required for color-light signals and with about an equal maintenance cost; that they cost about 15 per cent less than the motor signals, and where primary battery is used, with the track not occupied more than an hour a day, they cost from 20 to 25 per cent less than the motor signal under

the normally clear system in use on the majority of roads.

The signals may be installed at any point where clearances now permit the installation of semaphores. They can be installed where a clearance is not permitted by the leaving off of one or two of the lights or these lights may be mounted on a shaft. The lights can be closed in, using only three lights if desired.

The automatic stop for the future, I believe, will be of the induction type. I do not think it will be any contacting device, as such a device infringes on the clearance of the rolling stock or of the roadbed or structures. The energy is going to be picked up from the track by wireless or by some induction arrangement, and if a.c. track circuits are in, a very workable device is at hand for that purpose. So one looks further into the future and builds for the automatic stop.

We use a permissive signal on the Pennsylvania, and it may be called upper left-hand or lower right-hand quadrant, but it is a distinctive signal.

Discussion

W. H. Arkenburgh (Canadian National Carbon Company): I appreciate the fact that Mr. Rudd has shown that there is still need for primary batteries. When he started out to tell what the light signal was going to do for the signaling art it appeared there would be very little use for batteries. I am not qualified to speak on light signals themselves, but it seems to be an interesting subject.

Mr. Rudd: I stated we were going to use a.c. track circuits where we used automatic signals. Now there are many places where distant switch signals are installed that there is very little foreign current and the track circuits are short. On a branch where the speed is limited to 40 miles an hour if you want to put your signal, probably 2,000 ft. away you haven't any power, there is a place for the use of d.c. track circuits, a primary battery to light your signal and an approach lighting circuit of 1,000 or 2,000 ft., depending on your railroad. If a signal cannot be seen more than 1,000 ft. because of curvature and cuts, it is useless to put in an approach circuit of more than 1,200 ft. Now the battery consumption, as far as the battery is concerned, is only while the train is passing over the 1,200 ft. of approach circuit. When the train passes, the light goes out. This is a good field for primary battery. There is a big field for storage battery with the new development that has just come out of utilizing storage battery as a storage for a.c. current by transformation.

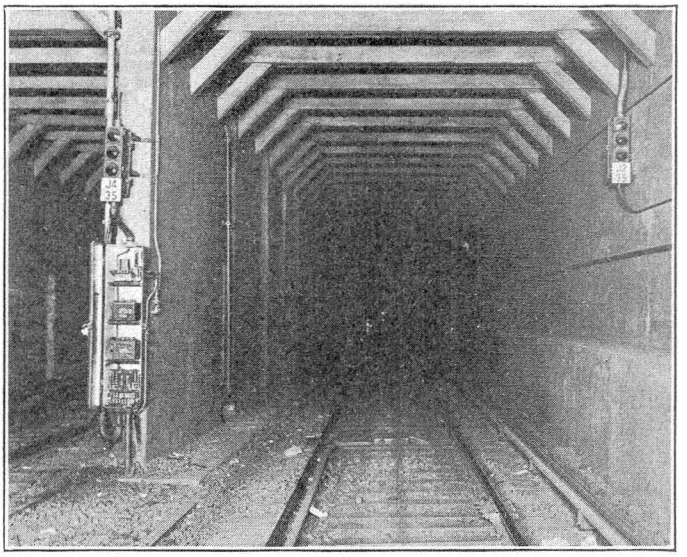
For interlocking, where power is not available, an electro-mechanical machine with backup dwarfs and motor home signals makes a good layout. That is what the Pennsylvania intends to install.

J. M. Waldron (Interborough Rapid Transit): It might be interesting to tell of some of the early troubles in the development of the light signal. About 1903 we became interested in the work and tried to do away with the moving parts of signals to cheapen the construction. Unfortunately the signal manufacturers, at that time, had an idea that they could not recommend relays which would at all times make and break 55 or 60 volts with the necessary amperage for the signals. So we were compelled, practically, to develop a light signal with moving colors in front of a stationary light. But immediately we started to experiment with the stationary light signal or the color-light signal. This type of signal was a decided success and we have discarded all the moving parts and are using these exclusively.

With the position-light signal we were limited in space and so could only go to the position in one direction, which did not give us much service. The position-light will give indications to suit the conditions, as Mr. Rudd explained, and he has covered all of the position indications which they need on their road and, I imagine, on every road in the country. But in addition to this, the color-light has been developed to give indications which are satisfactory and somewhat cheaper than the position indications.

I have been very much pleased with the success and development of the color-light signal and the results, particularly on our road, have been highly satisfactory. The motormen are all pleased with them. Bright sunshiny days do not interfere with their usefulness, they can be picked out at sufficient distance in advance and there is never any mistake made, as there is good, substantial bright light with sufficient color to make it plain, so that every motorman can pick up the indication without mistake. I am of the opinion that the color-light will enter permanently in the future development work.

R. C. Johnson (Brooklyn Rapid Transit): I have been very much interested in Mr. Rudd's explanation of

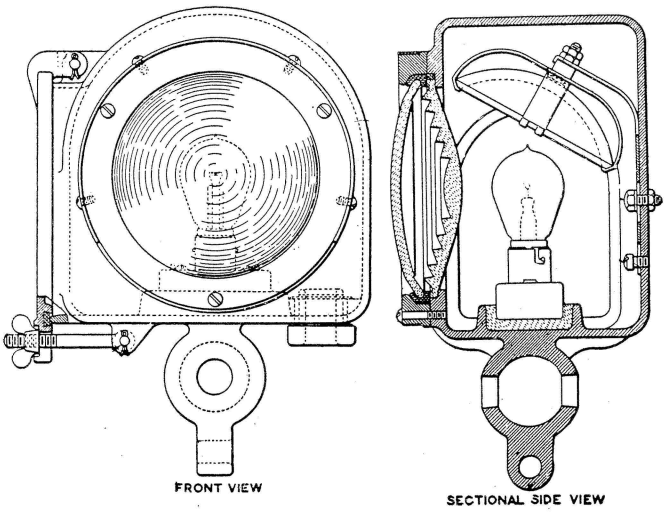


Color-Light Signals in the Subways, New York

the advantages of the position-light signal. I must agree with Mr. Rudd in all his remarks as to the advantages of the light signal as compared with the motor semaphore signal. On a road such as the B. R. T. a position-light signal is impossible. We have no clearance to put them in, either on our elevated or in the subways. We are limited in some places to about a foot clearance between the side of the car and the same side of the subway. We started in with color-light signals in 1913; since that time we have installed several thousand, and I have yet to hear any remarks from the operating department as to any disadvantage of the color-light signal as compared with the semaphore signals with which the road was previously equipped. We still have some of the semaphore signals, but I know the operating department prefers the color-light to the semaphore. We have some fogs in Brooklyn; we also have bright sunlight. The color-light signals have shown up under both conditions as well as the semaphore signal.

Mr. Rudd: I think Mr. Johnson and Mr. Waldron have proved an alibi. They have a signal without moving parts, they have a condition where they are limited for space. They haven't as much fog as we have along the Susquehanna. They haven't the smoke from engines that is liable to change the colors. They have an ideal condition for color-light signals. My only guess is that

the day of the semaphore is passing. A great number of roads will use color-light signals. They are good. You cannot see them as far as you can a position-light. You cannot get as clear an indication under adverse weather conditions. But in a tunnel, such as exists in the East river and North river tubes, the color-light is the thing to use. We cannot put position-lights in the tubes. We wouldn't want to change the color-lights we have. Each type has its usefulness, but each has the advantage of having no movable parts to get out of order, adjust and oil. I think there is a field for both. I believe, for roads in the country where speed is made and few stops occur, you want something you can absolutely see, and the position-light is a better signal for this purpose, Now the Interborough and the Brooklyn Rapid Transit have some express trains that run a long distance without stopping, but not so long as 100 miles or 150 miles. There is not the danger of a man overlooking signals in the congested districts. I don't think you need automatic stops; I think you need them less in a terminal and approaching a terminal than out on the road. The speed in a terminal on the steam road is usually slow; the men are on the alert.



Lamp and Bracket of the Position Light Signal Unit

The place where the signal is needed for the man to see and pick up is when he runs from 75 to 100 miles on a hot summer night and is likely to drowse off and miss one. That is where you need a signal that will attract attention, as well as during the twilight period. In the tunnels it is dark all the while, and there is no time when the signals are indistinct. There is a field for the a.c. and the d.c. signaling and the good engineer is the man who uses the two to the best advantage.

Mr. Waldron: Evidently Mr. Rudd had the wrong understanding of our discussion on the color-light signal. I did not have in mind the use of it in tunnels. We all know that where it is dark or practically dark the color-lights will shop up to the best advantage. I had in mind the use of it on elevated roads such as we have in New York and where we have the glare of the street lights, the sharp reflection from the windows of the houses along the street and under the worst conditions possible. We have the glaring sunlight. That is where you have the real traffic and the real car mileage. On the Ninth Avenue line in New York there is a brilliant row of lights. Color-light signals are used and they can be seen any day of the year, in sunshine or at any time. Position-light signals are out of the question; we couldn't use them. The color-light signals have given us the greatest amount of success. I believe they are the best to use and they are far cheaper than the position-light. But I want to give Mr. Rudd all the credit in the world for developing a position-light system that is satisfactory to his road and that will be satisfactory to many others.

G. H. Dryden (B. & O.): What voltage lamp is recommended for the position-light signal? Another question I want to ask regarding the control of the interlocking signal is whether it is customary to check-lock the position of the relay used for controlling the signal?

Mr. Rudd: I will answer that last question first. No, you mean back indication on it?

Mr. Dryden: Yes. On the machine lever.

Mr. Rudd: Yes.

The lamp is a 5-candle power, 12-volt lamp.

At first we had the sun glare very bad. The Corning Glass Works designed many lenses before the right one was finally obtained, and still trouble occurred. We started out with a cover glass that was slightly rounded and finally used the conical glass lens which killed the glare. This lens is frosted at the tip and that took care of the surface reflection. After apparently having eliminated the sun glare we found that it still existed, so the mirror in the receptacle was moved and set at an angle, still the glare existed. We finally painted the lower steps of the lens black and this eliminated the glare. The steps of the lens are supposed to be at right angles to its axis, but as a matter of fact they have to be a little bit off, and that small difference from the horizontal was enough to give a reflection which came up to the mirror and down and gave a spot of light for close indication. After painting the steps, moving the mirror up and putting the lamp back we had a reflection again. We then provided a lamp with the filament above the center curvature of the lamp bulb. This eliminated the reflection unless light should shine up from below and strike the lens. It is a bifocal toric lens and the bottom steps are flatter than the top ones.

SIGNAL DIVISION ANNUAL MEETING

THE sixth session of the Signal division, A. R. A., will be held at the Thousand Island House, Alexandria Bay, N. Y., on Wednesday, Thursday and Friday, July 14, 15 and 16. Meetings will be held as follows: Morning session, 9:30 a. m. to 12:30 p. m; afternoon sessions, 2:00 to 5:00 p. m. The reports of committees will be mailed to members of the division about June 25.

The following rates will be in effect at the Thousand Island House: American plan, room and bath, $7.00 per day; room without bath, $6.00 per day. Requests for hotel reservations should be made at an early date direct with the secretary of the Signal division, who will assign the rooms on June 15th in the order received. The secretary will also arrange for sleeping car reservations on trains of the New York Central, either from New York or Chicago, provided members make their wants known to him by July 1.

The round trip fare from New York City to Redwood, N. Y., the nearest railroad station, is $19.80; from Chicago by rail to Toronto and then by steamer is $48.76. Tickets can be purchased Chicago to Alexandria Bay, N. Y., and return via New York Central Railroad and use bus service from Redwood to Alexandria Bay, the fare for which is 50 cents per capita in each direction.

At the end of the annual meeting there is a possibility that some may desire to go down the St. Lawrence river to Montreal, Quebec, and from there on to the beautiful Saguenay river, which is a most picturesque trip. The details will be available to those desiring such information between June 1 and July 15, by addressing the secretary of the Signal division.