Progress of Railroad Signaling in America*

A Detailed History of Apparatus aud Methods Used from the Days of the Smoke Blanket to Present Efficient Systems

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THE earliest type of signaling is traceable to the Indian. Tradition teaches us that many so-called codes were gotten up by the red man. You will recall that they built bonfires and by the application of man-power to blankets the smoke and light waves were coded. The blankets were spread over the fires and raised and lowered to produce the "indication."

The first purpose for which the semaphore was used was, without doubt, that of conveying messages or information, and there were regularly established lines of communication in sections of Europe where information was sent and received by this means previous to the discovery of electrical methods of signaling from place to place. The semaphores, usually of a "T" shape, were of large size and were erected on the tops of hills, as the sky made an ideal background, and this location also furnished the best view in both directions along the line of communication. By the adoption of codes covering the various angles of the horizontal with the vertical member of the signal, or successive positions or combinations of the same, fairly good speed was obtained in clear weather.

The United States Weather Bureau employed a system of semaphores in the early stages of transmission of "weather indications." Its semaphores were mounted on tripods located on mountain tops. Heliographing, i. e., signaling by flashing rays of light from one point to another, was also satisfactorily used for signaling purposes. It is still in use. There is no doubt but that we borrowed the semaphore arm for signaling purposes from the semaphore. It is but a slight exaggeration of the principle of heliographing to bring to mind the flashing railway signaling system of Sweden, which is so well transferred to this country by the application of gas or electricity. You appreciate the wonderful results achieved in this direction.

The relative location of the semaphore arm to its mast seems to have popularized the use of lower quadrant signals. You know that many reasons are stated for its continuance. Yet, with all this desire to avoid a change-over to some other application of semaphores, we are quite convinced in this country that upper quadrant signaling is the preferred type and it is the one now most commonly used. Many arguments have been advanced that we need to dispense with semaphore mechanisms and we are passing through a campaign to take away the very valuable semaphore arm, whether lower or upper quadrant. We, therefore, reach the highest development when we apply the so-called daylight color signal and the position light signal to railroad service. Their popularity is growing, and we are on the threshold of a new era. Light signals will, no doubt, in time replace signals with movable parts. The maintenance will be simplified and there will be much opportunity to reduce the infrequent improper indication.

Not long ago we instituted the train-order on our railways. (The Erie was the first to use it.) We then took a step into space, or time signaling. This was effected by the use of flags at train-order points, and finally by many types of box, or lamp indications. Train-order semaphore signals next appeared. They were worked first in the two-position lower quadrant and gradually the three-position lower quadrant came into use. We also have them operating in four to six positions. The most popular type now used is the three-position upper quadrant signal. Manual blocking followed the time system, and this was followed by controlled manual installations.

Treadles or track instruments came into use for the control of signals. In 1872, or thereabouts, Robinson and Pope conceived the wonderful solution for signal control with which you are now dealing—the track circuit. It is at this point that most of the signal people now meet on common ground. Practically all that has been said is along the line of "block signaling."

You should not fail to study the development of the interlocking systems. From the time the United Railroads of New Jersey introduced at Trenton, N. J., the first interlocking layout in 1870 (a Saxby and Farmer machine, brought over from England) we have made great strides in placing interlockings upon the railroads of this country, and these are without comparison anywhere in the world.

Long Time Burners

Scientific research caused us to seek light and the long time burner was introduced. The original long time burner was mounted on a switch lamp fount. It was developed at Scranton, Pa., and the service tests were made on switch lamps. A chimney was used and the service rendered from a light distribution standpoint was excellent, the scheme immediately becoming popular. It is true that incrustation of wicks was the cause for some retardation in the development and it was necessary to produce better wicks and oil. The burner has been subjected to modifications, but the original idea has not been destroyed, and we now use the burners in signal lamps of every description. They burn without attention from 3 to 22 days, as the founts are constructed to provide ample oil supply for the requirements of the service. Two transcontinental railroads now use a type of lamp which has a capacity of one gallon of oil. Oil is now available which gives the desired result.

Control of Devices

We need to analyze the earlier methods of controlling devices.

1. Rosseau Track Control. This design provided an assembled contact device placed underneath the running rail of the track, and so mounted as to cause the contacts to make an electric circuit whenever the track was occupied and break contact when unoccupied.

2. The Union Switch & Signal Company's early type of track instrument was constructed in such a manner that by the use of a long arm, properly supported, it made possible the opening and closing of contacts. The housing for the contacts was located on a pedestal. The arm for opening the contacts was so designed as to permit the end nearest the running rail to be slipped over the base of the rail. The arm was, as in the Rosseau device, operated by depression of the rail.

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3. The Hall track instrument is similar in design to the Union type, except that the arm or treadle is placed in such a manner as to be depressed when flanges of wheels pass over it. The arm is raised slightly above the level of the rail.

These devices have been used for many years to give control for crossing alarms, approach annunciators for crossing and interlocking stations and also for station annunciators. These and many similar devices, operated by the passage of trains, were gotten out by the early inventors in order to provide a suitable control for automatic block signals. Their popularity for automatic block signaling was, however, short lived, due to the early use of various methods of track circuiting. They had inherent faults, as a part of a system, because of the difficulty in providing a satisfactory means of preventing following movements to get into the same section of "protected" track occupied by a preceding train.

When direct current track circuits were developed there was great difficulty in getting relays which would do the work required. The small amount of knowledge available for design, etc., made progress very slow. All appreciate that even today there are many mysterious details which cause heartaches and sore feet in an effort to locate the particular lug on some poorly insulated circuit. There is a long list of designs of these relays. Most of the earlier types have been placed in the discard, but a few of them remain. Quite a number of signal men have knowledge of the U. S. & S. Co.'s original enclosed type 4-ohm relay. This relay was assembled on an iron base. It was supplied with one or two points. These relays were tested in the shop—then permanently sealed against moisture or meddling. Then again there are many who will remember the Hall slate or porcelain base open type 4-ohm wall type sliding contact relay. Not so many of the present day employees will recall the famous Buchanan 4-ohm track relay. It was similar in design to a telegraph relay, except there was a provision through back contacts for the arresting of lightning. You will recall that this relay had its own lightning protection, but that very often the insulations broke down and one was forced to chase grounds.

In connection with track instrument control for signals, it may be of interest to refer to the Hall bell circuit, or stick relay. This relay was made of two sets of magnets so controlled through track instruments or tripping devices as to provide an interlocking of control. It is still used quite extensively in single track crossing bell work. A quick description of a limited collection of types of relays is available when we study the new style (enclosed) Hall wall type d.c.; the galvanometer a.c.; universal type d.c.; radial circuit controlled a.c. polyphase, and vane type relays. It would require too much time to detail all of the types of track relays, either d.c. or a.c. I have, however, selected a type of relay working on a.c. which is a very satisfactory type. This design is in use on the Hudson-Manhattan railroad (Hudson Tubes), New York-New Jersey. The track element is so employed as to permit the operation of the numerous contacts pneumatically.

A rather old piece of apparatus is the small rubber base enclosed relay which was in use on the original hydro-pneumatic interlocking on the Kansas City Terminal, Kansas City, Mo. It was built up of small and compact magnets and very small binding posts. It was so assembled as to provide contact and armature mounting on the same assembly as that containing the magnet. The whole arrangement was screwed into a rubber base. Wonderful service was afforded the railroad by the use of this type. We would not be able now to get anyone to use such a device because of our higher technical knowledge and more rigid requirements in the line of pick-up and drop-away.

Various Types of Signal Mechanisms

The early types of mechanisms had a decided leaning toward clock driven designs. For example, the Rosseau enclosed disk signal was designed by an expert French-Canadian clockmaker named Rosseau. While we pass, he also sold many ingenious and perfectly functioning crossing bells. His automatic signal was so designed as to turn a disk clockwise, the disk being controlled through an electro-magnet. The drive was through a counterweight, on the principle of a Grandfather's clock.

The highest type of clockwork signal is the Union Switch & Signal Company's design. It is commonly known as the Pennsylvania signal. In this style we find the first effort at operating a disk exposed to the elements. Like the Rosseau, it is controlled through an electro-magnet, and rotated by use of a counterweight. Quite a number of these signals are still in use.

The exposed Pennsylvania design of disk signal developed some well-known objections, and next we find two prominent designs of the enclosed disk signal—one gotten out by the U. S. & S. Co. and the other by the H. S. & S. Co. The Hall wire automatic block signal system (track instrument or treadle controlled) was installed on the Boston & Eastern railroad (now B. & M.) in 1871. This is one of the earliest systems of block signaling. It was at least the most extensive.

The first direct current low voltage semaphore signal was invented by and placed on the market by Lattig. The first location chosen was on the Central Railroad of New Jersey, just east of Phillipsburg, N. J. You will recall the reproduction of a photograph of this signal on the R. S. A. pin. The motor was used to wind a cable on a drum. The cable operated a balance lever, this lever in turn operating the signal arm.

Lattig was awarded a bronze medal by the Franklin Institute of Philadelphia for priority of invention. But a very few weeks' difference in time is recorded in the patent office between Lattig's invention and that of John D. Taylor. Taylor invented the well-known No. 2 motor, now controlled by the General Railway Signal Company.

The first installation of electro-pneumatic automatic block signals was made on the Fitchburg railroad. They were track circuit controlled. In this application the semaphore arm was direct-connected to the valve by the use of a yoke.

The style "B"—U. S. & S. Co.'s d.c. mechanism—is built for one or two-arm operation. It employs a motor which drives an endless chain. The chain is so arranged as to raise the arms carrying the control devices, the arms being connected to rods employed to operate the semaphore arms.

The style "W" Hall d.c. mechanism also employed a chain driven device. The operation of this mechanism differed from the "B" type because the slot or clutch, when engaged, was raised through the medium of toes engaging the loops of the chain, the motor driving the chain in but one direction. When the clutch electro-magnet was de-energized, the arm would restore all of the mechanism to the stop position by gravity.

The type "D" Hall mechanism was a departure from this practice in so much that there is an entire absence of chains. This type is also operated by a low voltage d.c. motor.

The Hall electro-gas mechanism is a step in the direction of using a power supply which can be handled in portable tanks. This was indeed a departure from the field of development. Through valves, controlling the pressure received from the storage tanks, gas was passed to cylinders, by which the semaphore arms were raised. The control of the valves is through the medium of an electro-magnet.

On electric lines we find numerous types of signal mechanisms operated by electricity. For example, there is in use a solenoid mechanism operated from the 660 volt d.c. propulsion circuit (third rail). Then again we have the a.c. mechanism known as the G. R. S. No. 6, which is one of the early types of the 25-cycle motor-operated signal.

The earliest type of electric mechanism for operating three-position signals was the Gray design. It was used very extensively on the Pennsylvania, Lines West. Several very ingenious clutch and electric controls were put to use in this design.

The Hermann three-position, lower quadrant semaphore, d.c. low voltage mechanism was a marvel of strength. The assembly was indeed unique. A motor, through a gear controlled electrically, performed the various functions.

The field of semaphore arm control would not be complete without a brief reference to the "slot." Quite a few designs are available. There is one type known for its simplicity—namely, the Hall. This slot is provided with an electro-magnet, the armature is in the shape of a long arm. The connection between the balance lever and the semaphore arm is maintained or broken due to the presence or absence of current. This type of control is termed "semi-automatic."

The record would also be incomplete without a reference to cover the two and three position early types of electro-pneumatic mechanisms. The two-position type is the older design and has fulfilled its mission in the signal field most admirably. The three-position design, first in use at the Washington, D. C., terminal, has also performed wonderful work. In this latter plant the mechanisms are located at the base of the pole, and each one operates two arms.

Systems of Signaling Employed

The foregoing details form a part of the world's greatest development in signaling. We will now review a few of the systems of signaling employed on some of the railway lines.

On the Ninth avenue elevated, New York City, in 1888 an apparatus which was simple and strong in construction was in use. It was very efficient in operation. This system was known as the Black Automatic Block Signal System. It consisted of a lever placed just outside of the rail, which was depressed by the tread of the wheel passing over it. A rocking shaft was connected with the ground connection by means of a rod having on one end of it a strong spiral spring, the object of which was to prevent severe shocks to the various parts. A standard form of mechanical semaphore signal was used to display the indication.

The train spacing was accomplished through the application of detector bars. Thirty-two continuous blocks were used very successfully for many years. A limited number of applications were made on the Staten Island Rapid Transit, Kings County elevated and the Brooklyn Bridge.

Robert Black, the inventor, now dead, was the roadmaster of the Ninth avenue elevated line. He was prominently connected with all early signaling schemes in and around New York City. He was in the employ of the Dressel Railway Lamp Works in later years.

A rather unique scheme of signals was worked out by an unidentified individual for use at a junction of the New York, New Haven & Hartford with the Central Vermont at Willimantic, Conn. The junction is a double-track with a single-track line. The mast signal, as the device is termed, is built up as follows: The mast is securely braced to take care of wind pressure, and for supporting the arms, lights and platforms. The latter is required to get to the various operating mechanisms and to set up the required indications. Two arms—one long and the other somewhat shorter, and offset slightly to the right of the top or prevoiusly referred to arm—are suitably mounted on the mast in order to permit their operation from the zero-horizon, or stop position, to those required for the several routes. To the end of each arm is attached a square signal lamp. At the top of the mast, permanently mounted to suitable fastening, is a fifth square lantern. In a vertical plane with the latter lantern, located directly between the two arms, is placed the sixth lantern. It is of the cylindrical type.

The indications, as displayed, are very distinctive. They are given by a combination of the position of arms and the two fixed lanterns. The rules governing the use of this signal are as follows:

327. Mast signal, Willimantic, Conn., on New York, New Haven and Hartford R. R., junction with Central Vermont. Clear for "Third district" trains New Haven R. R. in both directions. "Third district" being the given branch operating at that point. It controls trains in both directions on this division. The indication given is for the stopping of all "First district" trains operating over this division of the New Haven and Central Vermont trains, as well. Indication given is two red lights on lower arm, two green lights on upper arm.—1913.

328. Mast signal, Willimantic, Conn., on New York, New Haven and Hartford R. R., junction with Central Vermont. Clear route for Central Vermont trains in either direction. Indication for stopping of New York, New Haven and Hartford trains, which means either "First" or "Third district," which is the branch operating at this point. Indication given, two green and two red lights.—1913.

329. Mast signal, Willimantic, Conn., on New York, New Haven and Hartford R. R., junction with Central Vermont. Route indicated is clear for the "First district" New Haven trains only, covering them in either direction, and stops all Central Vermont and "Third district" New Haven trains. Indication given by two green lights on upper arm.—1913.

Enclosed disk signals for automatic signaling soon became popular and on many of the lines varying applications were made. During the World's Fair, held in Chicago, the enormous passenger traffic on the Illinois Central was handled by this type of signal, through the medium of the track instrument. Following systems were in use in connection with track circuits:

On the Morris & Essex branch of the Lackawanna the signal disk was used. On this line, the line circuits were carried in wooden trunking mounted on stakes located between the two main tracks. On the Delaware & Hudson the single disk was in use, generally; a few rare cases of two disks, located in the same case or banjo, were installed for the purpose of indicating diverging routes or caution indications. On the Lehigh Valley the single disk assembled in two banjos on each signal mast, one above the other, giving "home" and "distant" indications, was the first type of automatic block signaling. On the same road, for the purpose of indicating routes at a non-interlocked junction, three banjos were placed vertically on the same mast.

To get away from the difficulties of reflection on the glass covers of banjos, etc., a type of semaphore signal operated similarly to a disk mechanism, known as the Sargent motor semaphore automatic block signal, was in use for quite some time on the Staten Island Rapid Transit division of the Baltimore & Ohio.

The New York Central's traffic in the Park avenue tunnel, New York City, during steam operation, was also thus controlled for a period of time succeeding the introduction of the Coleman Lock and Block System.

A bridge was used in order to more clearly define the trackage of the Philadelphia & Reading and Baltimore & Ohio railroads at the entrance to the subway in Philadelphia. On this bridge the Reading Company placed home and distant disk signals vertically on a mast for its train protection, while the Baltimore & Ohio used its standard one-arm three-position lower quadrant semaphore gas operated mechanism for the information of its trains.

On the Lehigh Valley an early type of indication at an interlocking point consisted of a two-doll bracket post. To the one mast was attached two home interlocked (non-slotted) semaphore route signals, and underneath, arranged vertically, two enclosed disk signals—the latter gave the home and distant indications for the automatic block signal system. On the other mast, for a second track (siding to main), was a single-armed semaphore signal. The Lackawanna has in use, in conjunction with the overlap, many one-arm two-position lower quadrant Union type "B" motor-operated automatic block signals. On some parts of the Baltimore & Ohio lower quadrant home and distant three-position automatic signals, operated by electro-gas mechanisms, are in use.

On the Central Railroad of New Jersey, on what is known as the Royal Blue Line, many home and distant electro-pneumatic automatic block signals, normally clear, have given most excellent service. The 660 volt d.c. solenoid type of semaphore signal, previously referred to, is in very successful use on the Interborough on the several elevated lines. On the Baltimore & Ohio, in order to avoid misinterpreting the signal arm indications when in the stop position with the arms on the numerous telegraph poles, the automatic semaphore block signals were placed on very high masts. On the St. Louis & San Francisco one-arm three-position upper right hand quadrant model "S" U. S. & S. Co. signals give entire satisfaction. On the 600 volt d.c. third rail system of the New York Central one-arm three-position upper right hand quadrant 2-A G. R. S. Co. 25-cycle, 150-volt a.c. signals are in use. On the Toronto, Hamilton & Buffalo there is in use the Absolute Permissive Block system of the G. R. S. Co. design.

Numerous methods have been employed to give the maximum information at difficult junction points in various parts of the country. For example, on a four-track line to a two-track four-track junction, over each track the signal assembly consists of the following:

Top arm—Home.
Second arm—Distant.
Third arm—Home.
Fourth arm—Distant.
Fifth arm—Home.

Analyzed, they indicate top and second arms, straight track, main line; third and fourth arms, diverging track, main line; fifth arm, to yard, or inferior routes.

At another junction, single to double track, top arm diagonal; second arm vertical—main to second main, over No. 15 crossover, next automatic signal at proceed. Bottom arm, inferior routes. On the top arm at diagonal, or vertical, main to first main.

On the Chesapeake & Ohio the lower quadrant interlocking semaphore signals are supplemented by the installation of upper quadrant three-position automatic block signals, making a unique combination of indications. The old and new methods of crossing the Gulf in order to provide railway communication with Galveston by the Santa Fe recalls the wonderful system of signaling in that part of the country. The $2,000,000 permanent causeway is equipped with an electro-pneumatic signal system. The Long Island's six-track system is admirably protected by three-position upper quadrant signals located on bridges. The signals are controlled by a.c. track circuits. The road is equipped with d. c. propulsion. Signal mechanisms are of the 2-A, G. R. S. Co. a.c. type. On the New Haven the combination signal bridge high tension pole line construction is used. The early types of signals are of the home and distant (arm-center suspended) type hung from the bottom cord of the bridge in the inter-track space. The mechanisms are of the 2-A, G. R. S. Co. held clear a.c. type, controlled by a.c. track circuits. On the Central of New Jersey, in d.c. track circuit territory, an important two-track junction equipped with Union slots, was formerly used. The home and distant (or top arms) were used for the superior or main line route, and the bottom (full size) arm for the other main line route. On the South Australian railways at Adelaide we find semaphore arms of the three-position upper left hand quadrant type and the line is equipped for single track movements.

One-arm, three-position, upper right hand quadrant, d.c., G. R. S. Model 2, signals were installed quite some time ago on the Northern Pacific double track.

The Southern also have a number of these d.c. mechanisms on their double track line. In addition thereto they have a very large mileage of G. R. S. model 2 a.c. signals operating on a.c. track circuits.

We need pause a moment in this review to take a peep at the electric train staff. This device has been in successful operation with and without track circuit control on railroads for many years. Its application has been most prominent on single-track lines. The late Tom Patenall was the expert in this development.

Development of Light Signals

About 1900 there was a great deal of talk and some development work along the line of producing so-called daylight signals. Many efforts were made to get satisfactory color indications for this purpose. The records are not very complete, and it is, therefore, difficult to trace the history unless it be primarily through the lens and roundel development. Even such a record is more or less obscure. Some new signals of this type for ranges not to exceed 500 to 700 ft. were used with some degree of success. The major portion of the development, therefore, centered around the requirements for satisfactory indications to eliminate moving parts in so far as possible. The most prominent example probably is the development for the Interborough Rapid Transit subway in New York. The early development there was what we might call a light signal, but produced by the use of moving parts, controlled and operated electro-pneumatically.

Day and night indications that could be read from 1,200 to 1,500 ft. in the bright sunlight were supplied on some interurban or trolley lines, and the only way that the indication could be satisfactorily provided was by the use of hoods. So much depended on the type of electric light, source of power and the distribution from the lenses that progress has been very slow in this direction. We find early types of so-called color-light indications in the tunnels leading to the Pennsylvania station on the Hudson & Manhattan, and on the New York Central approaching the Grand Central terminal.

The daylight signals on the many electric railways certify to their usefulness for short range medium speed use. The early types of light signals in many tunnels were, generally speaking, a lens provided with an electric light or lights being controlled through the contacts of the track relays. The light signals in the Hudson and Manhattan tubes and the Pennsylvania terminal division are examples of earlier and very satisfactory developments.

When the work of signaling the electrified territory of the Pennsylvania (Philadelphia to Paoli) was undertaken, a scheme of signal indication was evolved by Dr. Wm. Churchill of the Corning Glass Works and A. H. Rudd, signal engineer, Pennsylvania R. R., now known as "The Position Light Signal."

Color light signals, in the opinion of the inventors, were not satisfactory for the particular work in hand, so that they finally patented about 1915 what is known as the uncolored electric light position light signal for both day and night use. This position light signal has been in use on a portion of the four-track main line of the Pennsylvania. The experimental or original signal carried five lights in a row—at first two rows of four lights each were used with the bottom row normally horizontal so that if the top lights were extinguished the bottom ones would indicate "stop." Eight lights were, therefore, displayed at all times. The large background was no detriment when used for bridge signals, but because of the surface exposed to wind pressure, ground masts had to be 7 in. or 8 in. in diameter.

The latest improvement is a simplified and symmetrical frame and background, and with this arrangement a row (or rows) of not more than three lights in a row now serves to give any and all indications. It may be of interest to record that indications of the aspects are in accordance with the standard code.

A background is provided for the lower row, vertical only, this being a restricted speed signal (restricted speed is one-half of 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 the wind pressure area eliminates the necessity for the large masts, previously referred to. Signals can be installed on existing masts, and they need less clearance than a semaphore. Experience shows that these signals, lighted six hours a day, cost no more to operate and maintain than semaphores.

Interlocking Developments

A few interlocking machine records are available. They are unique when compared with our present day requirements. On the Michigan Central we note the presence of a wheel type of interlocking machine, more properly known as Capsan type. It was placed in service in 1878 on the Michigan air line at Jackson, Mich.

What appears from the records to be the earliest effort at developing an interlocking machine was when Toucy and Buchanan developed their machine and installed a very large unit at Spuyten Duyvil, N. Y., on the New York Central. No records at this time are available to detail that installation. A machine of the same type was installed about 1906 on the same railroad at Batavia, N. Y.

The first real electro-mechanical interlocking machine, known as the Post type, was placed in service on the Pennsylvania in 1909.

The pneumatic interlocking machine with its wonderfully developed switch and lock and signal movements is fast passing into history. Only a limited number of units of this type remain in service.

Many peculiar "stunts" were required in the upkeep and arrangement of the signaling devices operated by this type of interlocking during the reconstruction of the Grand Central Terminal, New York City, no doubt the most remarkable being the operation of the famous fly-switch. Engines were cut off and the trains permitted under their momentum to be placed on the station tracks. Can you conceive such operation being successful? From 1872, when this switch was operated by hand, until abandoned in 1907, there is recorded but one period of non-operation for a period of 48 hours. This was due to track changes.

Highway Crossing Protection

Crossing gates, or alarms, are also interesting details in connection with the subject of signals. The Long Island has in use a type of highway crossing signal built up of a G. R. S. crossing alarm, and a gate, or arm, controlled by a model 2-A, d. c. signal mechanism.

On the Baltimore & Ohio, in a certain town in Ohio, there is an unusual crossing sign in the form of a semaphore, controlled and operated by a single wire from a distant tower.

The latest designs of crossing protection are covered by the developments gotten out by C. H. Morrison and A. H. Rudd of the New Haven and Pennsylvania, respectively. The Morrison type is in use on the New Haven at Titicut, Mass., and New Britain, Conn.

The Morrison highway crossing signals are made distinctive, as the mast carrying the signal is painted between the ground and the face of the signal in black and white diagonal stripes, similar to the painting that has been standardized for highway crossing gates. When this signal is flashing a red light it indicates approach of a train and travelers on highway should stop before passing the signal and wait until the train has passed the crossing. If the signal continues to flash after the train passes over the crossing, it indicates the approach of another train either on the same track or one adjoining. This highway crossing signal has been approved for installation by the Public Service Commissions of Massachusetts and New York, and the Public Utilities Commissions of Rhode Island and Connecticut."

The Rudd type is in use on the Pennsylvania at a number of road and street crossings in Pennsylvania, New Jersey, Ohio and Virginia. One of these highway crossing signals is in use in Haddonfield, N. J. It is a new design of light signal to warn travelers on the highway of the approach of trains, the lights (electric) showing red both day and night whenever a train is approaching. The light is controlled in the usual way by track circuit. By placing the Rudd highway signal on this post the general appearance and usefulnes of the highway crossing indications become very apparent.

Methods of Making Semaphore Arms Distinctive

I desire to record a few of the efforts on the part of inventors to "assist" in reading the indications given by semaphore arms.

1. Professor Koyl of Swarthmore College in 1888 invented the arm which bears his name. His plan was to reflect light from an oil lamp to the face of the arm. He had a parabolic mirror in the arm with corrugations on it. The indication was good up to about seven hundred feet. The signal lamp was so arranged as to move with the arm and thus provide the illumination as required. The rays were so bunched, as one might term it, that you could get an image of the lamp at a reasonably close range, it having the appearance of a ball of light.

2. In 1893 Lottig arranged a row of gas jets or electric lamps, on the face of the signal arm. When gas was used it was rather difficult to give the service that was desired due to variation in pressure. The electric lamps which were controlled by a commutator gave excellent results. They were arranged in rows of red and white, so that the white lights would be displayed for the proceed indication and the red for the stop indication.

3. In 1888 the Union Switch & Signal Company brought out the Spicer & Schrender illuminated semaphore. This design could be used as a purely position signal, or in combination with colored lenses as a combined position and color signal. It is described by a certain writer as being "a beautifully distinctive signal, and cannot be confounded with any other lights."

As a direct result of the subjects detailed in this paper we are privileged to enjoy the operation of many large and busy terminals with safety, reliability and economy. In closing we may recall Major Ames' historic song, "Every Little Signal Has a Meaning All Its Own."