tower to change the direction of traffic on any or all of the tracks between Grove St. and Bergen.

The track relays and track battery feed at each point are interchanged when the lever controlling the direction of traffic is reversed. By doing this, the polarized system may be used without any line wires for controlling the distant signals. The lever for the change in the direction of traffic cannot be thrown if there is a train between the outbound signals at Grove St. and the inbound signals at Bergen. This not only prevents the reversal of traffic while a train is using a track, but also prevents the possibility (which would otherwise be present) of throwing signals to danger in face of traffic.

The advantage of the control used for the block signals is apparent, as it allows the maximum number of train movements in the direction of traffic established, it being possible to have a train in each of the five blocks on any of the four tracks between the interlockings when the traffic is set up for running between Grove St. and Bergen, and a train in each of the four blocks when the traffic is set up for running between Bergen and Grove St., while in previous installations of this nature it has been customary to make one block of the system when reversed traffic was established.

It is the practice, with the system above described, to use the three southerly tracks for inbound traffic during the rush hours in the morning when a great many trains are entering the station and few, if any, are leaving; while, in the evening, the three northerly tracks are used for trains in the opposite direction.

Between Grove St. and Bergen Interlockings, aerial cable is used which is suspended from a stranded messenger wire, the messenger being clamped to iron pipe poles about 12 ft. high and set in concrete foundations. Where it is necessary to carry this cable through the short tunnels and street bridges, which are all of concrete, lead-covered cable has been installed in clay ducts provided for that purpose and connected to the aerial cables in terminal boxes at each end of each duct.

This entire installation was carried out by the Union Switch & Signal Co. under the direction and supervision of W. H. Willis, signal engineer of the Erie.

AN INTERESTING CASE OF TROUBLE

BY S. L. B.

While maintaining a certain district some time ago a case of trouble showed up which by voltmeter test proved to be a short in a track section. In making tests at a switch located in the circuit I discovered that on stepping upon the back switch rod, the needle of the voltmeter responded with a jump, so I took the insulated rod apart, thinking, of course, that the trouble was there. I could not find anything wrong with the insulation of the rod, however, but to my surprise the circuit was clear while this rod was out of the track. I then thought it must certainly be in the other rod, so I put the back rod in place again and took out the front rod. My experience with this rod was the same as that with the other.

My next move was to pry the switch point away from the stock rail, and this caused a deflection of the voltmeter needle also. Next I discovered that by disconnecting the switch-box rod the trouble was cleared. Upon further investigation I found that the short-circuit was through the switch box and connecting rod as follows: A large nail had been driven, by construction men, through the trunking covering the track wires leading to the switch box, cutting the insulation of the wire leading from the far rail and making contact with it. The end of the nail was up against one of the lag screws which secured the switch box to the head block, and the short-circuit was established. The current passed through the far rail, through the wire to the nail, thence through the nail to the lag screw, and to the switch box and switch-box rod to the near rail.

SIGNALING PRACTICE ON STEAM RAILWAYS*

BY L. R. CLAUSEN.†

Probably every man who is interested in railway signaling has, at some time, realized the comparative scarcity of recorded information relative to "Signal Practice," or the use of signals as related to the operation of trains. Much of a technical character relating to the construction and mechanical or electrical operation of signaling devices has been published by the Railway Signal Association, the railway periodicals and the signal manufacturers, but very little of the why and wherefore of the use of signals.

In 1895 the Railway Signal Association was founded, as The Railway Signal Club, by six signal engineers in Chicago for the study of railway signaling problems, and in 1899, the American Railway Engineering and Maintenance of Way Association was established for similar study of all problems of railway maintenance. The Railway Signal Association, as a body, and the signal committee of the latter association devoted the first two years of their existence to the details of construction and maintenance. During this period, a feeling was gradually developing among signal engineers, and others interested, that something should be done in the way of investigating and adopting fundamental principles involved in signal practice. Considerable variation existed in the practices of the different railways, each being largely determined by the opinion of the individual signal engineer. With very few exceptions, the engineers were not sufficiently well informed to have confidence in their opinion and many changes in methods occurred. The free exchange of ideas at the meetings of the two associations referred to, had the effect of creating new doubts and changes. The need of some fundamental principles or standards was fully recognized and a search was started in the year 1905.

About the same time it became evident that there might be conflict in the work of the Maintenance of Way Association Committee No. 10 and that of the Railway Signal Association. To guard against this unfortunate possibility, the executive committee of the Signal Association, through the president, appointed a standing committee on signal practice, composed of all members of that association who were also members of the Maintenance of Way Committee No. 10. This had the effect of making the membership of both committees nearly identical and paved the way for the harmonious action desired.

EARLY PRACTICE.

Very soon after the establishment of regular traffic on American roads, the need for some kind of fixed signal for the control of trains became apparent. This brought into use various forms of targets or signs. Some of these were used in connection with breaks or obstructions in main track, such as switches, railroad crossings, junctions, drawbridges, etc. Others were used for stopping trains at stations for various reasons, such as the delivery of train orders or spacing trains under a block system. The indications of these signals or targets (that is to say their meaning to the engine and trainmen), first used were danger or stop,—caution,—and safety or clear. The corresponding lights used at night were red, green and white. In later years the indications have been changed to stop, caution and proceed. The conception of these indications as used was as follows:

STOP—As mandatory.

CAUTION—You may proceed unless otherwise restricted, but always with caution.

PROCEED—You need not stop, or you may proceed unless otherwise restricted.

The semaphore, on account of its distinctive appearance, was early adopted for use at stations. This is true of points where interlockings were not in use, as well as where interlockings were in use.

*Read before the Canadian Railway Club, Montreal, Quebec, on Tuesday, March 7, 1911.

†Division superintendent, Chicago, Milwaukee & St. Paul Railway.

EARLY INTERLOCKING PRACTICE.

At interlockings, where more than one route was available, it became common practice to provide an arm and light for each route. The top arm controlled movements to the extreme right-hand route. The other arms, from top to bottom, in order, controlled movements to consecutive routes in order from right to left. It is obvious that, under this practice, the arm for main-movements might be in any position on the mast from the top to the bottom. Accidents growing out of this practice, due to lights being out at night and the large number of mast lights, showed the necessity of having one definite position for the main line arm. It was, therefore, located at the top of the mast in all cases. This was route signaling, purely and simply.

The increase in the number of routes available at many stations or plants made the number of arms excessive and introduced more or less confusion and doubt in the minds of employes. Because of this fact and the mechanical difficulties encountered in attempting to provide an arm for each route, the maximum number of arms was reduced to two, the upper of which was used for main-line movements. The second arm was used for all other routes, but numbered indicators operating in conjunction therewith, were provided to show the route cleared or set up. This was still route signaling.

The mechanical difficulties in operating the indicators referred to, where a considerable number of routes led from one track, combined with the apparent lack of attention paid the indicators by train employes, led to the experiment of discontinuing their use. The result of this experiment was to show that train movements were made apparently as freely without indicators as with them. As a further natural result, their use was abandoned. This development marks the abandonment of route signaling.

This step left but two arms on the signal used for interlockings, regardless of the number of routes. The combination of the upper arm inclined and the second arm horizontal became, with corresponding lights at night, a proceed signal.

The combination of the upper arm horizontal and the second arm inclined, with corresponding lights at night, became a caution signal, to all intents and purposes as it was used for any diverging route. "You may proceed with caution" was the only interpretation the engineman could reasonably place on this combination, as he was compelled to run with caution, expecting to take any diverging route. The steps in the development of this caution signal used for diverging routes at interlocking plants are easy to see and comprehend. The reason why it was felt necessary to develop a new aspect or signal for caution, instead of using the one already at hand and used extensively for other purposes, is not so readily discernible.

The first advocate I can find of the use of one caution signal for all purposes requiring caution is Frank Rhea, then inspector of signals on the Pennsylvania Lines West. Mr. Rhea, in 1899, read a paper before the Railway Signal Association or Club at Boston, in which he recommended the use of three-position signaling and showed the extreme simplicity following the use of the intermediate or caution position for all diverging routes at interlockings. So far as I can find, no action was taken as a result of this paper. This brings us to the year 1903.

EARLY BLOCK AND OTHER SIGNALS.

While these changes in practice at interlockings were in progress, corresponding changes were taking place elsewhere. At non-interlocking stations, the simple one-arm semaphore, or the single disc or target, were modified in great variety according to the specific use to which the signal was assigned. Arms were painted various colors, were striped in different designs; the ends were rounded, squared, pointed or notched, half-round or V-shaped, as dictated by personal opinion, to designate such use and differentiate and define

(a) A signal used to stop trains for orders,
as a *Train Order Signal*

(b) A signal used for manual blocking,
as a *Block Signal*

(c) A signal used for automatic blocking,
as an *Automatic Block Signal*

(d) A signal used to regulate approach to obscurely located switches
as a *Switch Signal*

etc., etc., etc.

As a general rule, however, the red, green and white lights only were used for night indications and no distinctions were made at night. Under these conditions, it is obvious that any information or meaning that a train employe could get from a signal at night, other than stop or caution or proceed, must come from the employe's memory and from his knowledge of location. In other words, under the practice outlined, no distinction was made at night when, because of darkness, such distinction was most necessary.

It is my understanding that signals were originally used to control train movement merely by the indications stop, caution and proceed, or their equivalent. If such is the case, it is interesting to note the wide variations in practice that have developed in attempting to give additional information by fixed signals.

FURTHER STEPS IN DEVELOPMENT OF SIGNAL PRACTICE.

In May, 1903, H. M. Sperry read before the Signal Association a paper on "Block Signaling for Fast Trains," in which he asked consideration of the use of the distant signal, the overlap and the automatic stop.

At the November meeting of the Association in Detroit, C. H. Morrison presented a paper entitled "How Best to Automatically Block-Signal Single-Track Roads." At this meeting, a committee, of which C. C. Anthony was chairman, presented a report showing the relative merits of three different methods of automatically blocking double track lines, viz.: "The Overlap Method," "The Separate Home and Distant Signal Method" and "The Three-position Signal Method."

In November, 1903, the managers of the Pennsylvania Lines East and West appointed a committee, composed of their respective signal engineers, to harmonize the differences in practices existing on those lines. The result was a compromise and proved to be unsatisfactory.

A committee composed of the signal engineers of the several New York Central lines was appointed by the vice-president in October, 1904, to investigate and unify signal practices. This committee is still working, but up to date the work has been principally with details of construction.

In May, 1905, the managers of the Pennsylvania Lines East and West selected a second committee to formulate an ideal system of signals. This committee reported in August, 1905. I am advised that the report was not adopted.

The discussion of a paper on the design of the semaphore spectacle casting, presented by W. H. Elliott, of the New York Central, at the May, 1905, meeting of the Railway Signal Association in New York, brought out the diversity in the angular travel of the signal arm or blade used by the various roads. A committee was appointed to canvass the situation and report on the preferred angular travel. At the same time the committee was instructed to secure a vote for and against the use of the arm in the upper quadrant instead of the lower. This committee reported at Niagara Falls in October, 1905, 27 votes in favor of the 90-degree upward movement and 16 opposed.

WORK OF THE SIGNAL AND M. OF W. ASSOCIATIONS.

To these brief references to the period previous to 1906, I will try to add a short history of the work of the Signal and Maintenance of Way Associations since that time.

At the March meeting of the Maintenance of Way Association in 1906, the signal committee included in their report:

6 conclusions relative to manual block working;
1 conclusion relative to automatic block working;
10 diagrams showing recommended arrangement of signals;

also, a vote on angularity of travel of manual block signal arms; and a vote on the use of upper versus lower quadrant.

In June, 1906, Committee No. 1 on "Signal Practice" was appointed by the Railway Signal Association to discover, if possible, the fundamental principles underlying the art of signaling and apply them in building up a proposed uniform system. This system, when completed, was to be recommended to the Signal Association for approval. The investigation was to be carried along comprehensive lines and include all angles and phases of the subject. To this end, all members were invited to present anything and everything that might have a bearing on the subject.

The first report of this committee was presented at the annual meeting, 1906, at Washington, D. C., and outlined a proposed uniform system of signaling.

Twenty-four indications were shown classified as follows:

8 indications—restricting rights
5 indications—conferring rights
11 indications—conveying information.

Twelve principles were enunciated, including:

(a) the use of two lights on all high signals;
(b) red lights in vertical line indicate "Stop";
(c) red lights in diagonal line indicate "Stop and Proceed";
(d) red lights in horizontal line indicate information;

Thirty-three aspects were shown; the automatic block signal having a pointed arm and interlocking signals, two full size and one short arm. The purple light was indicated as the proper light for dwarf signals in the stop position.

A note was added to the effect that "'*Caution*' indicates the function of distant signal."

The January, 1907, New York meeting and the March, 1907, Chicago meeting of the Railway Signal Association discussed the October, 1906, report.

The March, 1907, report of the Maintenance of Way Association committee—

First—Indicates approval of upper right-hand quadrant;

Second—Recommends a list of 23 indications for a uniform signal scheme, classified as follows:

8 indications—restricting rights
5 indications—conferring rights
10 indications—conveying information.

Third—Recommends three principles or requisites for adoption as follows:

for all signals restricting rights
(a) red—Stop.
yellow—Caution (function of distant signal)
green—Proceed;
(b) day indication shall be given in the upper right hand quadrant;
(c) horizontal arm—Stop
45 degree upward—Caution
90 degree or vertical—Proceed;

Fourth—Nine more principles submitted as a progress report.

Fifth—As a part of the progress report, 33 aspects, which the committee says is not all.

At the annual meeting of the Signal Association, October, 1907, at Milwaukee, the Signal Practice Committee submitted a report which included:

First—19 indications, classified as follows:

4 stop indications
5 clear indications
7 caution indications
3 supplementary indications

Second—A diagram of typical aspects, four in number.

Third—A revised list of requisites of installation based on the A. R. A. code, but enunciating new principles.

Approval of report was asked by the committee and given by the association.

In March, 1908, the October, 1907, report just referred to was presented to the Maintenance of Way Association at Chicago. The committee asked approval by the association and the adoption of two resolutions to the effect, "that the list of indications and the requisites of installation are sufficient and adequate, and should be recommended to the American Railway Association." The resolutions were adopted.

A report similar to the 1907 report, though much modified, was submitted at the annual meeting of the Signal Association in October, 1908, at Washington. A new list of indications with a different arrangement was presented. They were classified as

14 primary indications;
7 secondary indications;

23 primary aspects were shown, but the aspects for the secondary indication were not completed.

This report was submitted and accepted as a progress report.

The October report to the Railway Signal Association was presented to the Maintenance of Way Association in Chicago, March, 1909. An additional list of aspects, 23 in number, was presented by T. S. Stevens of the Santa Fe. This report was also submitted and accepted as a report of progress.

About November, 1908, a division occurred in the two committees referred to, which was first made known publicly at the March, 1909, meeting of the Railway Signal Association. A small minority, as a result of the study given the subject, felt justified in requesting that the number of indications be materially reduced and a very much simpler scheme presented for approval.

In October, 1909, a report similar to the 1908 report, but again very much modified, was presented at the annual meeting of the Railway Signal Association. The report included:

1. 16 primary indications:
   4 secondary indications, or a total of 20.
2. 3 diagrams of primary aspects, 16, 21 and 23 in number.
3. 1 diagram of secondary aspects, 16 in number.
4. Recommendation for the lunar white light (so called).
5. Resolution asking approval of report by the Railway Signal Association and transmitting for approval of the A. R. A.
6. A minority report dissenting.

This report of 1909 failed of adoption on letter ballot.

In March, 1910, the same report was presented to the Maintenance of Way Association, as was also a minority report. On account of the fundamental differences existing between the majority and the minority sections of the committee, the whole report was referred back, and the committee requested to lay the matter before the proper committee of the American Railway Association for decision. This was done in June, 1910, and the Transportation Committee still has these differences under consideration. When a decision has been received as to the proper indications to use in a uniform system of signals, the Railway Signal Association and the Maintenance of Way committees will undoubtedly proceed with the work of providing aspects that will be satisfactory from an operating standpoint. and can be successfully constructed mechanically.

When the fact is considered that the two committees referred to include some of the best signal engineers in the United States, men who have spent a large share of their lives at their work, and are recognized authorities on the subject, the foregoing recital will, I believe, be sufficient to indicate that it is not an easy matter for a man to decide what is proper and best in the matter of signal practice.

PRESENT DIFFERENCES OF OPINION.

As a member of the minority referred to, I desire to take this opportunity to explain some of the differences of opinion that resulted in a minority report. I also wish to state the minority's position clearly and remove any wrong impression you may perhaps have gained from the paper read before this Club by a prominent member of the majority some time in November. I refer to Mr. Rudd of the Pennsylvania Lines East, who is justly celebrated as a signal engineer, and whom I claim as a warm personal friend.

AS TO THE NUMBER OF INDICATIONS AND ASPECTS.

The majority recommends a system of signaling which includes 14 primary indications and four secondary. It requires a large number of aspects or pictures to represent them, nearly 60 in all. We, the minority, take the position that there is no demand for such an elaborate scheme and that it is impracticable, unnecessary, and confusing to the runner and other train employes. We believe that, regardless of the large number of aspects used to represent the indications, train employes will classify certain of them as meaning *stop,* certain of them as meaning *caution,* and the remainder as indicating *proceed.* The engineer frequently is compelled to read signals under very adverse weather conditions and, if he is to run safely, he should never be in doubt as to the meaning of a signal. A signal should mean something perfectly definite to him, which he cannot mistake, under any conditions of wind and weather. The engineman has no time to hesitate or deliberate over the meaning of a signal when he is running at high speed.

The aspect and its meaning must be so simple and so distinct that it immediately produces an impression on the mind of the runner, without the necessity for any intervening thought or mental process. If this impression should be followed by an involuntary action to comply with the signal without mental process, we have a still more desirable condition and one that makes for safety and immunity from accident. To obtain these results, the number of indications and aspects must be limited to a very small number, we believe less than half a dozen, and signals must be acted upon as a train meets them, and not at some point in advance, as the majority recommend.

AS TO THE USE OF THREE STOP INDICATIONS.

Because of the fact that the majority has provided several different proceed aspects, it is necessary for them to use three stop aspects. That is to say, if several different arrangements of signal arms are used to indicate proceed, it results in several different stop aspects when those arms are restored to their normal position. These aspects are called

1. Stop until authorized to proceed
2. Stop and proceed
3. Stop and investigate

The minority is unable to see why it is necessary to show on the face of a signal why a train must stop, or what it may or must do after it has stopped, before the stop is made. The all important and the only necessary information is that the train must stop. Why telegraph ahead by a specially shaped signal what the stop is being made for? One kind of signal will stop all trains just as effectively as three or more kinds.

AS TO USE OF THREE ARMS ON INTERLOCKING SIGNALS.

The majority has assumed that there are three permissible speeds at interlocking plants, viz.: normal, limited, and low. Each speed is provided with a signal arm, the normal-speed arm being at the top of the mast and each arm arranged for operation in three positions. This arrangement makes it possible to give a considerable variety of information. The limited-speed indication is designed to make possible a speed of 30 to 50 miles per hour through long crossovers.

The minority feels that the method now largely used of providing a two-arm signal, giving a proceed indication by means of the upper arm for the normal speed or through route, and a caution indication by means of the second arm for all diverging routes, is entirely sufficient for practical purposes. We favor, however, the use of the same proceed and caution aspects as are used elsewhere, which make it unnecessary to use more than one arm on signals used at interlockings. It seems unnecessary to say more than "Proceed" when the normal or through route is set up, and if so, why not use the same proceed aspect as is used elsewhere for proceed? In the same way we now give with the second arm, what is, in effect, a caution indication when a diverging route is set up, why not then use the caution aspect we already have available and dispense with the use of the second arm? We believe that the indications stop, caution and proceed, given by the three positions of a one-arm signal, are entirely practical, sufficient and adequate to safely control the movement of trains at interlocking, as they will elsewhere. The simplicity of the arrangement is apparent.

THE INTERPRETATION OF THE CAUTION INDICATION.

The majority has provided no caution aspect per se, but has attempted to provide separate indications and aspects for each of the conditions arising on a railroad that require caution. The 45-degree position of the arm has been limited to repeating signals in advance. In the various discussions of these matters, the majority has held that the word "caution" described the "function of a distant signal." Also it has been held that the 45-degree position of the arm should "imply and assure clear track to the next signal." The same aspect, modified by the addition of a distinctive mark for both day and night, is recommended for the permissive manual block signal. The distinction is made because the first indicates

"Proceed with caution to a known point."

and the second,

"Proceed with caution to an unknown point."

Also for the further reason, the members of the majority state, that trains shall be allowed to pass the distant signal at any speed provided they can be stopped at the next signal. They state further that serious delays to traffic would follow if engineers were compelled to observe the distant or caution signal at the signal. The indication is worded "Proceed—Prepare to stop at the next signal," which leaves it optional with the engineer when he shall cease regarding the first part of the indication and begin to regard the second part.

The minority regards this interpretation of the distant or caution signal as erroneous, dangerous and productive of laxity in the observance of signals as well as accidents. A number of serious and fatal accidents in the past few years, wherein the engineman failed to properly observe the caution signal, but fully intended to stop at the next signal, testify most conclusively to the correctness of our position in this matter.

We hold that:

1. It is impractical to provide a separate signal for each of the conditions on a railroad requiring cautious running and to maintain the fine-haired distinctions necessary to their interpretation.
2. It is unnecessary, and in fact dangerous, to tell the engineman by fixed signal how he shall control his train at some point in advance.
3. Advance information so given is misleading and unreliable, as it is subject to change without notice and, therefore, the engineman can not safely use it. If he does so use it, it is done at the expense of safety.
4. The conditions of modern railway operation do not require trains to be run at full speed past caution signals, and that any time gained by this practice, is gained at the expense of safety.
5. Each signal should indicate *stop* or *caution* or *proceed* and have no relation to signals in advance or in the rear.
6. That each signal should be observed in turn as the train comes to it and not at some point in advance at the option of the engineman.
7. That with signals properly located, it is time a train should be run with caution if it has reached a point so close to preceding trains or stop signals in advance that a caution signal is received.
8. That no proceed or caution indication should "imply or assure clear track to a point in advance." That railway signaling devices and our methods of communication have not reached the perfection that will admit of this being done. We cannot know positively if the track is clear and further, it may not stay clear. We are under a moral obligation not to give such misleading information.
9. That the giving of information by signal indications about conditions in advance, whether it be regarding the next

signal or the next station or any other object or condition, is wrong practice, productive of laxity and a fruitful source of danger and accident.

10. That it will be difficult, if not impossible, to maintain discipline and proper observance of the great variety of caution indications proposed by the majority because of the fine distinctions involved.

AS TO LOW SPEED INDICATIONS.

In the majority's recommended scheme appear
indications 13—Proceed at low speed,
14—Proceed at low speed, Prepare to stop.

We feel that a simple caution indication, combined with ordinary judgment on the part of employes, will avoid the use of these indications and the separate aspects used to represent them. Why use two? If the engineer is running at low speed, he is already prepared to stop.

AS TO NUMBER OF RED LIGHTS DISPLAYED.

One of the principal objections made by operating officials and train employes to signal practice at interlockings in the past, has been with regard to the number of red lights displayed. Also, objection has been made because it is necessary for enginemen to disregard and run by one or more red lights on a mast when passing a signal having more than one arm. A glance is sufficient to show that the number of red lights would be very largely increased under the plan recommended by the majority. This is principally due to the use of the red marker light on nearly all signals. We feel that it is against the principles of good operation to provide so many red night signals, and especially those that are not used. We feel that all red lights that are not absolutely necessary should be eliminated.

HARMONY WITH STANDARD CODE.

Attention is called to the fact that the standard code of the American Railway Association shows at present but four inditions. The majority feels that the code is incomplete and should be amplified by the addition of 10 more primary and several more secondary indications. We are of the opinion that the code contains all the indications that are necessary and needful.

PRESENT STATUS OF SIGNALING.

At the present time—speaking in general terms—the signaling of America is represented by a small mileage rather intensely signaled and a very large mileage with a very few signals. One, at least, of the causes contributing to this condition is the fact that much of the signaling already installed has been so elaborate that the expense has been prohibitive for thinner traffic lines. Further than this, the "elaboration of interlockings at many of our crossings, junctions and terminals has been carried to a foolish limit of unnecessary and impracticable attempts to tie up every human action, leaving nothing to discipline and good sense of employes. Also, great expense has been unnecessarily incurred to overcome human frailty by installing more complicated lockings and appurtenances than are demanded by the conditions."

It has been our custom to spend large sums of money on appliances for checking the work of the individual employe, but, on the other hand, very little or none on the man himself. Each new accident has called for additional checks and devices when the true remedy for the condition lay with education, discipline or, perhaps, some similar action. We are in all the United States, prone to make new laws or legislation for every condition or abuse, when old laws, properly enforced, will take care of the situation. It is the same in the operation of railways.

It should always be borne in mind that it is impossible to prevent all accidents by means of new checks or devices, as these appliances are all subject to failures and do fail in the same ratio as other signal devices. Further, all of these checks tend to laxity on the part of employes, which is, in itself, a source of accident. New circumstances always arise, whatever checks and appliances are installed. Everything cannot be done by machinery and apparatus; something must be left to human intelligence.

Because of certain accidents, we have heard much recently with regard to automatic stops. I do not, personally, recall any that could not have been prevented by the proper instruction of employes and good discipline. From the often-quoted records of the English railways in handling passengers, I judge that travel on English railways is reasonably safe and that the record is fairly satisfactory. Let us not forget that this record is made without the use of automatic stops or other checks and under conditions that are substantially worse than exist in America, on account of the prevalence of fogs.

TRUE FUNCTION OF A SIGNAL.

The true function of a fixed signal is to control train movement. It is not the function of a fixed signal to show in its aspect or appearance the specific purpose for which it is being used. I know of no better definition than the one in the Standard Code, which reads as follows:

> "A fixed signal covers such signals as slow boards, stop boards, yard limits, switch, train order, block, interlocking, semaphore, disc, ball or other means of indicating stop, caution or proceed."

The function of a stop signal is to stop trains, not to indicate by its appearance why the stop must be made. The same is true of a caution signal.

The signal engineer, with his intimate knowledge of the mechanical and electrical construction and inter-connection of signaling devices, sees circumstances and opportunities under which slightly increased speed may be maintained. To obtain this result, an elaborate scheme of indications and aspects has been recommended which involves refinements designed to give shades of meaning that are unnecessary, confusing, and bound to be very expensive to install and maintain. We believe that any benefits to be derived are imaginary rather than real; that any increase in speed will be at the expense of safety.

The complicated scheme advanced introduces fine differentiations of caution and speed indications which require prompt reading as they are met, and remembrances for execution when some point in advance is reached. We believe that there are too many localities and sets of conditions to permit of representing each of them by fixed signals. The signal engineer has assumed a burden in attempting to do this, which is not justified by the experience of operation of trains.

Generally speaking, the simplest scheme of signals and the smallest number of indications and aspects that will do the work is the best one to use. We believe that the indications *Stop, Caution* and *Proceed,* with corresponding three aspects, will do the work and take care of practically every operating condition, if due investigation is made. We believe further that the present diversity of practice, which has finally resulted in the recommendation of the elaborate scheme presented to the Signal and Maintenance of Way Associations, is due to the adoption and use of new forms of indications and aspects without full investigation of the signaling principles involved or the possibilities of the simple scheme *Stop, Caution* and *Proceed.*

It should not be overlooked that the relative chance of error on the part of train employes under any two signal schemes, is probably represented by the ratio of the respective squares of the number of aspects.

In conclusion, and in further support of our views favoring the utmost practicable simplicity in railway signaling, I desire to read extracts from three letters; the first from an operating official, the second from a railway vice-president and the third from a railway-president.

FIRST LETTER.

"The very elaborate signaling recommended by some is founded upon the idea that engine runners, on account of their mental incapacity, must be instructed by the language of signals the precise manner which their trains shall be handled under every circumstance, overlooking the fact that it required greater in-

telligence and greater use of the mental machinery to interpret and carry the numerous shades of meaning into which the 'Proceed' and 'Proceed with Caution' indications are elaborated. It should not be forgotten that, however much these indications may be multiplied, and however correctly their language may be instantaneously read by the runner, we must still rely for safety upon his exercise of the sense of judgment which the meanings of the various signals on his road intended to convey to him.

The fact is, our engine runners are capable, as a rule; they understand the road and the conditions perfectly. They have numerous and important duties that are engrossing while on the road, therefore, it seems to me our signal layouts should be so simple as to require the smallest possible use of the runner's mental machinery.

SECOND LETTER.

"I agree thoroughly with the views expressed. Signal engineers are introducing too many complications that are unnecessary. The first interlocking plant installed in the West is still in operation, in the goose-neck at Kansas City, probably as busy a place as most roads have. It is simple, the first cost was comparatively small and the maintenance is not heavy.

In negotiations with the ——— R. R. for an interlocking plant at ——— recently, the first estimate was about $5,000.00, but this, since the ——— R. R. have gotten a new signal engineer, has been increased to more than $11,000.00.

The matter of derails has always been considered one of the essentials. My impression is that the time is coming when, instead of putting these traps into high speed tracks, the railroads will eliminate them, excepting in rare cases where some extraordinary protective measures are essential.

Having had an experience covering a period of 15 years on the same railroad, with two interlocking plants located at junctions within 6 miles of each other, one with derails and the other without, I was impresed with the fact that not a single derailment or accident occurred at the plant without derails, while there were a dozen or more at the other, none of which saved a collision, as the derailments invariably occurred when the plant was not protecting other train movements.

Another interesting fact is that the Union Station at St. Louis, which has one of the largest interlocking plants in the country, has not a single derail in it, and no serious accident or loss of life has occurred during the 16 years it has been in operation.

THIRD LETTER.

"I returned to my office this morning after quite a trip on the road, and find your letter of November 3rd awaiting me. I have read it with a great deal of interest, and I think it expresses excellently well a danger that is always before us whenever we are dabbling with a scientific subject.

I have been very strongly of the idea for a long time that there is nothing so important in railway operation as simplicity. Delicate shades of meaning are, as you say, beneficial only in theory. When a man is running a train at a speed of 60 miles an hour, perhaps on a down grade, a 'Stop' signal may mean a very different thing to him from what it means to a man going perhaps ten miles an hour on a level or on an up grade, pulling a heavy train. In other words, the signal may say the same thing in both cases, but what it will mean in practice to the man who receives it is a very different thing. Then why confuse the situation by all sorts of absurd refinements?

A distant signal is put in advance of a home signal at an interlocking tower to repeat the position of the home signal and, therefore, give advance warning to the engineer; but what will be the shade of meaning which this distant signal will give if in practice the towerman does not pull the distant signal off when he pulls the home signal down? Suppose—as I have seen in actual practice—that this distant signal remains up all the time. Will not its position be disregarded and might it not as well, or some better, be removed altogether? Here we have a case where it isn't the shade of meaning of the signal that concerns us, but it is the proper manipulation of the signal, as controlled by discipline, which cuts the figure.

So, if you are asking my opinion, you can count me with the minority of the signal committee who are standing for simplicity, even if the minority of that committee represents only one man."

HOW A BATTERYMAN BECAME A MAINTAINER

BY J. O'BRIEN.*

The ordinary batteryman after doing his daily work generally has some time left, which, though he might use it profitably in self-improvement, he seldom turns to good advantage. If his section is running smoothly and no battery failures occur, he is usually satisfied; and if, on the other hand, his batteries are not in good condition and cause occasional trouble with the signal circuits, he may make little or no effort to overcome the trouble, and is quite likely to jog along at the same gait as though he had a section to be proud of. But occasionally there will be found a man who is taking advantage of every opportunity to learn the circuits which are operated by the batteries he maintains.

It happened on a certain railway, that such a man was placed on a battery section, and, although he had no knowledge of the work to begin with, he gained considerable signal experience through persistent effort and diligence in his position as batteryman. During his first week on his battery section he performed his duties so thoroughly that the signal maintainer began to take an interest in him. For two months he worked persistently in getting his batteries in shape and in continually going over his section. After his batteries were in perfect condition, when he had any spare time he would go with the maintainer and make notes of failures, and their causes and remedies, and the maintainer would draw rough sketches of the circuits and explain the failures in detail. At night when he went home he would study these sketches and copy them into a small book which he always carried in his pocket for future reference. When going on a train from station to station, or while waiting for a train, he lost no time, but made it a practice to take out his little book and "look things up," as he termed it.

He worked on in this manner from day to day, grasping all the knowledge he could possibly get, and not forgetting in each case to make a sketch from which to study.

One day the maintainer was called to cover trouble, and it happened that he had two failures, at different points at the same time. Knowing that he could only cover one of them himself, he sent his batteryman to the other. The batteryman, on his way to the tower which was in trouble, began studying his sketches, and when he arrived the towerman informed him that the electric lock would not release, and that he could not reverse the home signal lever to clear the signal, thus causing the trains to come to a stop.

The first place he looked for the trouble was at the track circuit relay. This relay was picked up, and there was no trouble there. He then looked for loose connections and defective or dirty relay contacts, but to no purpose. Meanwhile the number of detentions was increasing, and the "Twentieth Century" was due within five minutes. He had no instrument with which to test out the circuits, and yet he wasn't going to stop that train, if he could help it. One glance at his sketch book, and then to some contacts he had forgotten—the contacts in a circuit controller. He tried the contact springs to make sure of good connections, and then after careful scrutiny his efforts were rewarded when he located a broken wire at the binding post. The "Twentieth Century" was coming then, so no time was lost in making a new connection. This released his signal lever, and to his delight the "Twentieth Century" went through on clear signals. The batteryman had "made good."

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