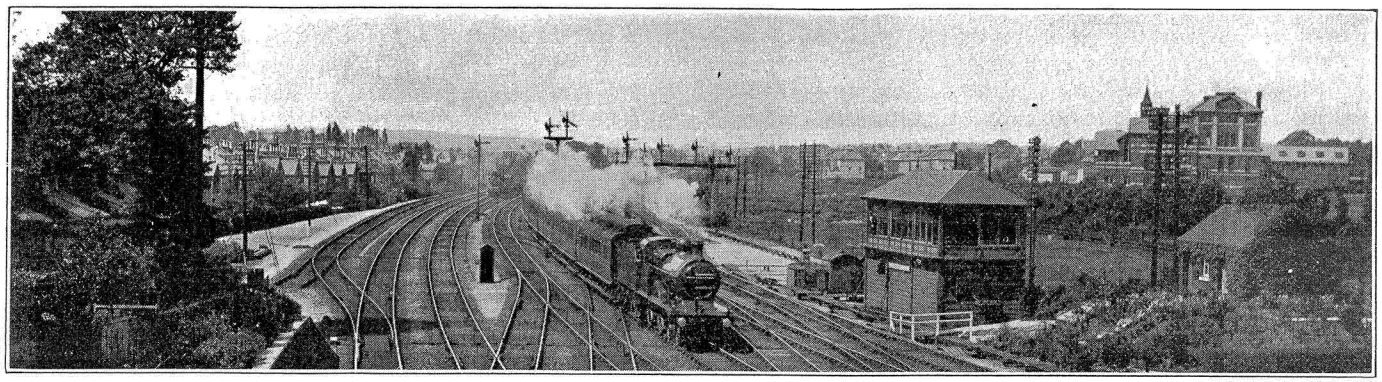

View of Midland Railway, 5 Miles from St. Pancras

Train Control Approved by the British

Ministry of Transport Committee Recommends Contact Type; Disproves Continuous Control and Speed Control

THE practicability of train control devices "has been proved beyond dispute by extended trial and actual operation covering long periods" and they can no longer be regarded as in the experimental stage, according to the Automatic Train Control Committee appointed by the Ministry of Transport of Great Britain. In its report, which was submitted on April 20, 1922, the committee recommended the gradual adoption of the intermittent contact type of train control as best adapted to prevent a large proportion of train accidents directly occasioned by failure of enginemen to obey signals, which it found amounts to about one-third of the total number. While the committee considered continuous control to possess merit it was thought to have too many disadvantages to warrant its recommendation. Speed control also was not considered essential, because an analysis of the accident records for past 10 years indicated that only 3 out of 193, or 1.6 per cent, of the accidents could have been prevented by speed control. The intermittent induction type likewise was not considered suitable for British railways because it would require complex electrical arrangements and a considerable addition to the skilled maintenance class. Any system of train stop or train control must be used to supplement the present highly developed and efficient signal systems and be reasonable in first cost and annual charges for maintenance and renewals. The committee recommended that multiple track lines only (except in exceptional cases, single track) be equipped. This mileage was estimated to be 24,000 track miles. Approximately 23,000 locomotives should be equipped, while track devices would be required for 24,000 distant signals and 38,000 stop signals. The total estimated first cost was £4,660,000 ($20,550,600), with a total annual charge for maintenance and renewals of £407,000 ($1,894,870, based on a rate of exchange of $4.41).

Of 193 accidents analyzed for a 10-year period ending September 30, 1921, the committee said that 71, or 36.8 per cent, could have been prevented by train control and that on the basis of the number of accidents reported by the railways, but not investigated by the government, train control "would have a preventive effect, not obtainable by any other means, upon a yearly total of more than 100 cases." The committee did not recommend the use of speed control, saying that "the difficulties arising * * * and the need for insuring that the capacity of roads is not injuriously affected by imposing unnecessarily low speed restriction upon express traffic, would, in the opinion of the committee, render such devices unsuitable to British conditions." In discussing the continuous type of control, while the committee felt that such a system would cover practically every risk which such devices are designed to safeguard, other conditions would not make the expenditure justifiable upon surface lines in Great Britain. Therefore, the committee recommended the use of the intermittent contact type, which supplements rather than replaces existing signaling and block telegraph systems.

The use of train control was considered only for multiple track lines handling passenger and mixed traffic because of the security afforded on single track lines "by single line token working, with interlocking of signals and relative tokens, and to the small number of accidents upon single lines. The committee is of the opinion that a case for the adoption of automatic train control upon single lines so worked and protected has not been established, although there may be a few special cases where control may eventually be found desirable. It considers also that lines used purely for freight or mineral traffic do not as a general rule call for the adoption of automatic train control."

The committee was instructed to enumerate the possible functions of train control as it relates to railway conditions in the United Kingdom; prescribe requisites which the devices should meet; examine those under trial; recommend others which are or may become available during the period of investigation, and form conclusions on its adoption with regard to its advantages and the cost involved.

Three of the earliest general conclusions unanimously arrived at by the committee were: (1) That existing traffic facilities and line capacity must not be injuriously affected by the general introduction of automatic train control; (2) that any acceptable method of control must be such as can be fully developed in conjunction with the highly developed block working and signaling systems on the British railways, and (3) that the introduction or extension of any system of control could not be recommended unless a standard, in respect to track and locomotive apparatus, be first decided upon, which would

enable the desired effects to be produced upon all locomotives, whether working on home or foreign lines.

Calling attention to the high degree of security attained on British railways in the past, the committee points out that in recent years the growth of traffic has made it necessary to shorten block sections in order to increase track capacity without incurring the cost of constructing new interlockings or additional lines. This has resulted in the adoption of track circuits, electric interlocking and other safety devices "to supplement the powers of observation and memory of signalmen." Continuing, the committee says that "No general action, however, has been taken to provide appliances for obtaining additional security against mistakes by enginemen, although they must have been affected, possibly to an equal extent with signalmen, by growth of traffic and altered conditions of working. The functions of automatic train control * * *are broadly to assist enginemen in the proper observance of signals and regulations, and to safeguard liability to train accidents which may arise from failure in this respect." In the opinion of the committee, train control can no longer be regarded as being in the experimental stage. "The question is rather whether its adoption is expedient in the interests of safety, and financially possible."

Applicability to British Railways

In discussing the applicability of train control and its adoption on British railways, the committee considered it from the standpoint of (1) the conditions, whether technical, climatic or physical, which govern the conduct of railway traffic and which may render special treatment necessary; (2) the degree of safety existing, and the extent to which additional security is desirable and can be obtained; (3) the methods of control which appear most suitable for the purpose and (4) the cost of installation. In this connection the committee obtained the views of responsible officers and a number of locomotive inspectors and enginemen of standing and experience; it analyzed accident statistics furnished in government returns and by certain railway companies; systems of train control in operation on the Great Western, the North Eastern, and the Great Central were inspected and studied in detail and the experimental installations on the London & North Western, the Great Eastern and the London, Brighton & South Coast were also inspected. Estimates were obtained from railroad companies and inventors, which were based on present day prices, but without allowance for quantity production.

Relation of Block Signaling to Train Control

The committee, commenting on certain outstanding features in the working conditions, equipment and methods of block signaling upon British railways, called attention to those peculiar to Great Britain and which needed special consideration. All are factors which have to be allowed for satisfactorily in considering the expediency of automatic train control. They are as follows:

"(a) The dissimilarity in brake power of trains. Three classes of trains have to be provided for, viz., passenger and express goods, which are fitted throughout with continuous power brakes; freight trains, which have only the locomotive fitted with the power brake; and mixed trains in which a certain proportion of unfitted freight cars may be attached to fitted passenger cars, and partially fitted freight trains with which the proportion of fitted cars is variable.

"(b) The speed maxima likely to be attained on level road by various classes of trains may differ as widely as 20 and 80 miles an hour.

"(c) The standard block interval or overlap (440 yd.) has been fixed without any regard to speed or gradient. On level or falling gradient, therefore, if the brake, owing to inattention, etc., on the part of the engineman, is not applied until a stop signal at danger is actually reached, the speed of the train may be such that it will not be brought to a standstill, even though full brake is exercised, until a train has passed beyond the clearing point and entered the danger zone.

"(d) The liability to bad atmospheric conditions, such as fog, falling snow, etc., and the consequent difficulties that enginemen have in observing signals, have necessitated the use of a manual fog signal, supplementary to wayside signaling, without which congestion, amounting even to complete stopping of traffic, would inevitable result.

"(e) The high frequency and complex character of traffic in many railway areas.

"(f) The number of lines either jointly owned or used by different railway companies.

"(g) Existing variations in structural and load gages will present difficulties in adopting a uniform system of automatic train control unless these are foreseen and provided against. This point also calls for special consideration in connection with the electrification of railways."

Devices to Prevent Mistakes by Enginemen

Continuing an abstract of the report, the committee says that all devices designed to prevent accidents primarily due to mistakes of enginemen obtain their effect either indirectly or indirectly as follows:

"(a) Indirectly: By automatically providing either on the train or on the track, distinctive visual and audible indications, supplementary to those given by the wayside signal. Reliance for necessary action to avoid danger is, with these inventions, still placed upon enginemen, and appliances of the kind are often described as cab or fog signaling devices.

"(b) Directly: 1. By the automatic application of the power brake. In this case it can be arranged that enginemen either have the power to release the brake at any time after it has been applied, or do not have the power of doing so until the train has come to rest. Appliances of this nature are indifferently termed 'train stops' or 'train control' devices.

"2. By automatic speed control. In this case the brake is applied at any desired point if the speed exceeds a prescribed rate, and cannot be released until either the train has come to rest or the speed has been reduced to a predetermined limit. All these effects can be produced either singly or in combination."

Continuous Train Control

The committee next divided the devices into two general types: "Continuous" and "localized" or "intermittent." With respect to the continuous type of control the committee says:

"(a) A continuous type of control aims at entire and constant protection of the train at all stages of its journey against every risk of collision, either with other trains or, in some cases, with earth slides; and, as a general rule, against risk of derailment due to rail breakage, lack of continuity of track, washouts, etc. Devices of this kind are essentially electrical, and usually, though not invariably, of the non-contact type so far as the control mechanism is concerned. They are dependent on complete track circuiting or its equivalent. The outstanding advantage of a control of this type is that it can be made to cover practically every risk which automatic train control can be expected to safeguard.

"There are, however, the following arguments against the adoption of this form of control upon British railways:

"1. The first cost of engine and track equipment is higher than that required for localized control.

"2. The cost and difficulty of supplying electrical energy to all railways in the country in such a form as to be suitable for a standard system of control, is likely to be prohibitive, and would delay installation almost indefinitely.

"3. Although it can be arranged to exercise control at signal locations, its function, broadly speaking, is to provide a substitute for, rather than addition to, existing systems of signaling and block workings, which have already been installed at considerable cost, and have reached a high stage of development.

"4. Maintenance would be costly and necessitate the use of a large number of skilled workmen.

"5. The principle of action in apparatus of this class is that electrical energy must be constantly supplied to the train during the whole of its journey. If this energy is cut

off, the train is then unable to proceed. Its energy may be cut off for two reasons: (a) Because it is unsafe for the train to proceed owing to some obstruction, etc., on the line ahead; or (b) in consequence of failure in the source of supply, or break down of the control apparatus.

"No form of automatic train control can be considered wholly immune from risk of failure such as described in (b). The continuous control systems which have been examined require the use of comparatively delicate locomotive apparatus. Such apparatus is more likely to be affected by the vibration and shock of ordinary working conditions than the more robust apparatus used in localized systems. Although failures from this cause would doubtless be on the side of safey, they would cause traffic delay. With regard to the breakdown of the main electrical supply, such a contingency would be serious in a continuous control system handling a frequent service of trains, as all traffic would come to a standstill in the area concerned. Failures from either of the above causes would necessitate arrangement to enable release from the control to be effective. The difficulty and risk of accident attached to such a provision will be apparent, particularly when the main electrical supply fails."

Localized or Intermittent Control

"In the light of the foregoing disadvantages, the committee is of the opinion that expenditure to the extent necessary for continuous control would not be justifiable upon surface lines in Great Britain. On the other hand, in the case of an entirely new railway system, or on railways upon which appliances are less complete, or where accidents of the class preventable only by continuous control are comparatively common, this type of control might be worthy of consideration. The attention of the committee has therefore been directed to localized control, which supplements rather than replaces existing signaling and block telegraph systems. Localized control can be either of the non-contact or contact type.

"The non-contact type is essentially electrical, and although it has the advantages consequent upon the avoidance of any physical contact between track and locomotive apparatus, it necessitates the use of somewhat complex electrical arrangements, entails a considerable addition to the skilled maintenance staff, and is likely to be more expensive, both in first cost and upkeep, than the contact type. There is also a difficulty in arranging for the production of more than two distinctive effects.

"The contact type is the best known and most developed. Despite the inherent disadvantage, in regard to shock effects, which is common to all forms of contact control, apparatus of this nature has proved reliable after many years of operation under working conditions, and capable of withstanding satisfactorily the effects of high speed traffic. Three indications can readily be provided, viz., 'clear,' 'warning,' and 'danger,' and alternative methods for obtaining brake release can be arranged. Devices of this type do not necessarily require either primary or secondary batteries on the locomotive. In conjunction with local track circuiting, this type of control can be used with automatic and three-position signaling. Moreover, as track circuiting is extended, the control exercised by any localized device, although not strictly continuous in character, will confer nearly all the benefits obtainable from the continuous system.

"To safeguard shock effects in the case of contact devices at wayside signal locations, locomotive and track elements used to obtain control of tracks at distant signals should be more robust than those at stop signals. Trains are authorized to pass, and do pass, distant signals at high speed, whether they indicate 'clear' or 'warning.' It follows, especially if separate indications for warning and clear are required, that contact between locomotive and track elements will be of high frequency. On the other hand, the occasions upon which trains pass stop signals at danger are comparatively rare, and it is not considered necessary for the stop signal apparatus to provide more than one effect, i. e., 'danger.' In special cases a 'clear' indication can, if required, be provided at stop signals by other means, e. g., hand signaling. While, therefore, means for detecting the integrity and correct position of the track mechanism for affording control at stop signals will be required, to insure that contact is made when enginemen pass them at danger, it is not a matter of primary importance if damage to the apparatus should result from contact between locomotive and track elements at such signals."

Speed Control

"The employment of speed control and time element relay devices, in conjunction with other indirect or direct methods already mentioned, has been very fully considered by the committee, especially in relation to the outstanding features which characterize British railways. It is argued with some cogency that an appliance either of one character or the other is necessary, because the clearing point, which defines the length of overlap in advance of home signals, etc., is often too close to insure, in all conditions of gradient, speed, and brake equipment, that a train will be stopped by a full application of the power brake when the danger point is reached.

"With some well-known speed control devices, the conditional character of release, would, in certain conditions, impose restrictions in the rate of speed unacceptable to British practices and unnecessary for safety. There is not only the dissimilar extent of power brake equipment upon trains to be remembered, but also the variation in speed maxima, in combination with gradient effect. It is common practice for the same engine to be used for hauling fully fitted passenger and unfitted freight trains. Consequently, an engine working a passenger train on one trip might require a speed control set to act at 40 miles an hour, and on another trip hauling a freight train, the device would have to be adjusted for a different speed, of, say, 20 miles an hour.

"Again, a time element relay arranged to apply the continuous brake to a passenger train which approaches a home signal at danger at a higher speed than, say, 55 miles an hour, would not furnish a safeguard to an unfitted freight time approaching the same signal at a very much lower and yet dangerous speed. Moreover, with time element relay appliances there is always in existence an element of danger. A train may be traveling at a comparatively slow rate of speed when the first point of contact on the track is made and afterwards accelerate, so that, although the time occupied in traversing the measured length of track is not less than that for which the apparatus is set, its speed at the moment it passes the second point of contact is considerably higher than that calculated to be safe in the event of the signal in advance being at danger.

"The difficulties arising from such conditions, and the need for insuring that the capacity of roads is not injuriously affected by imposing unnecessarily low speed restrictions upon express traffic, would, in the opinion of the committee, render such devices unsuitable to British conditions. Moreover, it will be seen that out of 193 accidents which have been fully analyzed, in only three (or 1.6 per cent) of the whole number could it be said that a speed control device would alone have proved remedial. Such cases of accidents can, in the opinion of the committee, be adequately safeguarded, if not entirely prevented, by installing a train control device either of a

permanent or temporary character, which would provide an audible indication, as well as a brake application, to remind enginemen of the existence of a speed restriction over any curve, crossing, etc., in advance.

"The question of the utility of any form of automatic train control as a means for preventing buffer stop collision has been carefully examined. It has generally been recognized, and the analysis of accidents reported upon during the past 10 years confirms the view, that the majority of buffer stop collisions take place at low speeds, seldom exceeding 5 or 6 miles an hour. Collisions at higher speeds are of rare occurrence, and are almost entirely due to brake or pump failures, or to lack of continuity of the power brake upon a train. For accidents of this description no remedy could be found in any form of automatic train control * * *."

Analysis of Accidents

"An analysis of accidents reported upon during the 10 years ending September 30, 1921, furnishes information with regard to the preventable character of typical accidents upon British railways. It will be seen that the 193 cases analyzed have been divided as follows:

"A. Accidents of various types (including buffer stop collisions), for which automatic train stop or train control is not likely to afford any remedy—73. Percentage, 37.8.

"B. Train accidents due mainly to signalmen's errors, which are preventable by such well-known appliances as track circuit, electrical control of signals, etc.—49. Percentage, 25.4.

"C. Train accidents mainly caused by failure of enginemen, which some form of train stop or train control with automatic application can alone prevent or beneficially affect —71. Percentage, 36.8.

"The 71 cases of accidents under C have been allocated under three heads:

"1. Derailments due to speed upon sharp curves, etc., for which speed control would be the best remedy, 3. Percentage of these cases, 4.22; percentage of all cases, 1.6.

"2. Miscellaneous cases such as collisions with platelayers' trolleys or other vehicles standing in the section between block posts, and derailments due to switches being out of position, or to rail breakages. For these classes of accident either a form of continuous control is necessary or localized control combined with continuous track circuiting and signal interlocking. Number, 12. Percentage of these cases, 17.0; percentage of all cases, 6.2.

"3. Train accidents directly due to failure of enginemen to observe or obey signal indications. This type of accident is preventable either by localized or continuous control. Number, 56; percentage of these cases, 78.87; percentage of all cases, 29.0."

The committee considers that on a very conservative estimate, automatic train control would have a preventive or beneficial effect, to the same percentage as is shown in the foregoing tabular statement, upon a total number of accidents at least 10 times as great as those actually inquired into.

Relative Value of Train Control at Distant and Stop Signals

"The evidence of both railway officers and men was generally in favor of some form of automatic train control, as a preventive measure against accidents of the class under consideration. But with regard to the relative value of train control at distant and stop signals, there are two distinct schools of thought. One, perhaps the older, school considers that the provision of control at distant signals is indispensable for safety; and that control at stop signals is of quite minor importance. This view is held very strongly by some of its advocates, so much so that it is thought that, if observation by enginemen of distant signals can be secured, security will result in many cases of accidents. The other school regards control at stop signals as of first importance, and control at distant signals as of secondary value. The main points in the evidence may be briefly summarized as follows:

"(a) In respect of stop signals—the weight of evidence was in favor of control by means of a full brake application when danger was indicated, but against any audible indication.

"(b) In respect of distant signals—a partial brake application combined with an audible indication was favored by the majority for the warning position.

"(c) There was unanimity against the utility of visual cab signals, with which the general opinion of the committee concurs.

"The committee is in no doubt respecting the relatively higher value of control at stop than at distant signals. Further information obtained from the critical analysis of accidents confirms this view. In the 56 cases in which it is considered that beneficial results might have been expected from a system of automatic localized train control, it is shown:

"1. That control at distant signals would in the circumstances have been necessary as a preventive measure in 7 instances.

"2. That control at either a distant or stop signal would have proved effective in 18 instances.

"3. That control at a stop signal, either home, starting or advance, would have been necessary in 31 instances.

"The above figures prove conclusively that control at the selected stop signals is an essential feature of automatic train control. * * * The committee finally agreed that in general, and especially in areas liable to bad atmospheric conditions, sufficient provision for safety against preventable train accident due to failures of enginemen cannot, in the existing conditions, be made without recourse to train control at distant signals also.

"There are three alternative methods of train control at distant signals:

"1. The first and simplest, which provides 'location' of effect, is to provide a track appliance fixed in character which shall be of one and the same effect on locomotives whenever the distant signal is approached, irrespective of its position. Advocates of this method were particularly unanimous that a brake application and audible signal should be combined for the desired effect.

"2. The second method is to provide an appliance which shall give these warning effects, whenever distant signals are passed in the 'warning' position, no effect being produced when the signal is in the clear position. If method necessitates, if the track appliance is fixed in character, the employment of electrical energy for the purpose of differentiating between the warning and clear positions of the distant signal. It is consequently more costly, both as regards track and locomotive apparatus, than the 'location' system. * * *

"3. The third method, advocated by a large majority of the witnesses examined, provides train control in the direction of two separate effects for the warning and clear positions, respectively. The clear effect to be an audible signal distinctive from that given for the warning effect, but with no brake applicatioun. The increase in cost of this over the second method (presuming the track apparatus is fixed in character) is small, and affects the locomotive apparatus only. * * * *"

Fog Signaling and Train Control

"Train control at distant signals should be considered in relation to manual fog signaling. The questions that arise are: Will control prove an acceptable substitute for fog signaling; and if so, what effects must train control produce to prove acceptable? On the first point, though some of the witnesses expressed doubt, the answer was in the affirmative by a large majority of both officers and men. On the second point, it is clear, at all events in areas subject to fog that train control must produce effect on all occasions when the train passes distant signals, otherwise, one of their functions, i. e., to give geographical information to enginemen of their whereabouts, will only be performed when these signals are passed in the warning position. With this minimum requirement, both the first and last methods comply, but the second does not.

"There was considerable diversity of opinion whether it is essential, in order adequately to meet all fog signaling

requirements, that separate effects must be produced by train control to differentiate between the clear and warning positions of distant signals. It appears to the committee to be more a traffic than a safety question. In some areas, no doubt, existing traffic facilities would be reduced unless an indication were provided.

"As a general rule, the committee considers that train control at distant signals, in order adequately to meet fog signaling requirements, should provide distinctive effects for both clear and warning positions. Over large and well defined districts, however, where there is no liability of fog, the 'location' method, whereby the warning indication only is given on approaching all equipped distant signals, whatever their position, may prove sufficient. * * *

Outside of the financial effects which the committee states would not be so great as might be expected, it continues, saying, "there are certain beneficial effects which it may be anticipated will result from the use of control wherever possible, in place of manual fog signaling. These are:

"(1) Manual fog signaling is not free from special danger to the personnel employed. A number of fatalities occur yearly to men employed in visiting fog posts, and injuries result to fog men from the explosion of detonators. The elimination of this class of accident proportionately to the degree of substitution of control may be anticipated.

"2. Owing to the sudden appearance of fog it is not always possible for fog men to be at their post when their services are essential. Enginemen in such condition have an anxious time. Sometimes they receive no geographical indication of their whereabouts and are in complete uncertainty whether they have passed a signal, and have missed seeing the fogman's green light, or whether the absence of an explosion or green light is to be explained by the fact that the fogman has not arrived at his post. Control producing both an unmistakable clear and warning effect would do away with this sense of insecurity and undoubtedly improve safety conditions.

"3. Failures of detonators to explode, and of enginemen, especially in the case of double-headed trains, to hear the sound of detonations as well as mistakes made by fog-signalmen themselves, are not unknown under the manual system of fog signaling. A betterment in all these respects may undoubtedly be expected from the introduction of control.

"4. Some additional facilities to traffic working may be counted upon."

Train Control Considered Essential

"As the result of this general investigation of the subject matter, the committee has found that there is a *prima facie* case for automatic train control upon British railways, as the only means for obtaining greater security against the class of train accident which in general results from failure on the part of enginemen.

"They consider that the method of automatic train control most likely to suit existing conditions upon British railways, should supplement rather than replace existing block telegraph and signaling systems, and comprise:

"(a) Automatic train stop, located at or near selected stop signals, which shall, in the event of a train passing such signals when they indicate, or should indicate, danger, bring the train to a standstill.

"(b) Automatic warning control unworked distant signals, also at worked, distant signals whenever these are passed in the warning position, and at such other places where danger from too high a speed may be anticipated. An addition to the above, which the committee regards as the minimum necessary to obtain adequate security against train accidents, it is held that the selected system of control should be capable of producing a distinctive audible effect for the clear position of worked distant signals, in order to meet conditions of fog signaling.

Requisites for Installation

"In compiling these requisites, due weight has been given to safety requirements as well as to the following considerations:

"(a) Standardization of equipment to obtain uniformity of effect upon all railways.

"(b) Future development, in the direction, for example, of three-position and automatic signaling, and extended electrification.

"(c) Lowest cost compatible with due regard to safety conditions.

"1. The control apparatus should be constructed to work in conjunction with any system of fixed signaling, mechanical, power worked, or automatic.

"2. To be so constructed in respect of both track and train elements, as to insure the undermentioned effects being produced upon locomotives* when running either upon home or foreign lines in Great Britain.

"3. The control to be capable of producing three alternative effects, namely (a) danger, (b) warning, (c) clear, as follows:

"(a) The 'danger' effect to be produced at a two or three-position stop signal when this indicates or should indicate danger, and to consist of a full application of the power brake. In the case, however, of purely automatic signals, the danger effect is required to be produced only when the signal correctly indicates danger. The brake application to be capable of release by the engineman, only by an action entirely distinctive in character from that required for the release of the warning brake application.

"(b) The warning effect to be produced at a two-position distant signal or at a three-position signal, whenever these indicate or should indicate caution, and to consist of an unmistakable brake application and audible warning. The brake application in this case to be capable of immediate release by the engineman. The action for brake release in respect of both danger and warning effects must necessarily reset the locomotive apparatus in the normal receptive position.

"(c) The 'clear' effect to be produced at a two-position distant signal or at a three-position signal, when these correctly give the clear indication, and to consist of an audible signal distinct from that required for the warning effect. The control of this locomotive apparatus to be in the hands of the engineman, so that he can render it operative or inoperative at will.

"The clear effect shall be produced only when this condition is indicated both by the signal concerned and by the position in the frame of the corresponding signal lever; and in the case of automatic or semi-automatic signaling also by the condition of the corresponding track controls. In all other circumstances, either the danger or the warning effect, as the case may be, shall be produced.

"4. To be so constructed that the correct position of all track and train elements of the device shall be assured under all conditions of speed, atmosphere, weather, wear, oscillation and loading: and that the device shall operate under all conditions which permit of traffic movements.

"5. The track apparatus in the event of failure of any of the actuating mechanism, electrical energy, or connections, and in the event of other electrical faults, to assume the danger or warning condition, as the case may be, and give the corresponding indication. The integrity and correct position of all moving parts of the track apparatus, which are designed to come in contact with the locomotive apparatus, must be continuously indicated to the signalman, or detected in the case of automatic signaling. Failure of any portion of the locomotive control apparatus, which prejudicially affects the brake control in connection with the danger and warning effects, to give an unmistakable application of the power brake.

"6. To be capable of operation upon locomotives fitted with air, vacuum, steam or other power brakes, or any combination thereof.

"7. The locomotive apparatus to be such as not to interfere with or impair the efficiency of the normal working of the power brake.

"8. The apparatus to be such that it will be operative when the locomotive is running in forward or backward gear, without involving any action additional to that normally necessary for reversing the direction of travel of the locomotive.

"9. The apparatus to be inoperative automatically in respect of the danger effect when a train passes a signal not applicable to the direction of its movement.

"10. To be of simple standardized construction with easily interchangeable parts so that maintenance, inspection and tests to insure efficiency of all the parts shall be easily carried out. Any part of the apparatus which is liable or designed to be destroyed by shock of impact must be capable of rapid replacement.

"11. To be so constructed and installed as not to constitute a source of danger to railwaymen or passengers.

* The word "locomotive" wherever used in these requisites includes the leading control vehicle of multiple unit trains, whether steam or electric.

"12. Where there are a number of signals at any point applicable in the same direction to one road, the track apparatus for that road must be capable of operation in conjunction with any one of the signals in question."

Recommendations Regarding Requisites

The committee has the following recommendations and remarks to make in connection with the requisites:

"(a) Localized (intermittent) control is recommended as more suitable for prevailing conditions on British railways than continuous control. The contact type is selected in preference to the non-contact type. The necessity in this country for a speed control or time element device has not been established.

"Locomotive and track apparatus for train control at distant signal locations must be of a robust and durable character; the track apparatus of the fixed element type. The use of electrical energy for obtaining a distinctive clear effect is acceptable. Locomotive apparatus should preferably not require the carriage of batteries, particularly those of a secondary character.

"For stop signals, the train stop apparatus, both track and locomotive, should be of a simpler and less expensive character, the track element preferably of the mechanical movable trip type. In the case of the locomotive apparatus a mechanism of the frangible character would not be objectionable. Overhead train stop or train control devices are not regarded as suitable. The possible development of power working signals should not be lost sight of in the selection of train stop and train control devices.

"(b) In the opinion of the committee the most suitable position for the track element of train control at distant signals is the center of the four-foot way. The possible effect of the selection of this position upon any scheme for electrification has to be borne in mind.

"(c) Requisite No. 3—Change of effect: In connection with the release of this effect of control the committee records its preference that the arrangement should be such as will permit of the engineman actuating the release without having to leave the foot plate of the engine for the purpose, unless the additional expense thereby incurred is considerable.

(d) To meet the possibility of failure of locomotive apparatus for train control or train stop appliances, the cut out or other device for the purpose should differ essentially from that in use for obtaining the normal stop signal control release, and will require to be protected from unauthorized use.

"(e) For emergency, e. g., pilot working upon track equipped with control apparatus for one direction of travel only, it will be necessary for railway companies to issue instructions regarding the precautions to be taken for cutting out the locomotive control or stop apparatus as required.

"(f) The requisites do not deal specifically with difficulties which may arise from the adoption of automatic train control in connection with helper engines, double-headed trains, or two trains coupled together. As regards helper engines, it is held that track control apparatus will not be required at signal locations on short and continuous lengths of severe rising gradient where helper engines are normally employed at the rear of all trains. This may perhaps render the retention of manual or fog signaling at distant signals located on such grades necessary.

"In localities where, over longer section of track, with variations in direction and inclination of gradient, automatic train control will no doubt require to be installed, there is a possibility of signalmen returning a track control device from clear to normal before a banking engine in rear of a train, or the second engine of two trains coupled together, has passed it. The committee suggests a last-vehicle or track circuit device would meet the case. In the case of dobule-headed trains, the committee sees no reason why both enginemen should not be called upon to release their brakes in the event of a train control distant signal warning effect. In the case of stop signals, the likelihood of the signal being returned to danger before the second engine has passed is inconsiderable.

"(g) The effect of the extended adoption of electric traction upon the use of the electrified ramp for distant signal control will require consideration, and special precautions may be necessary to safeguard a false clear effect being given as the result of the ramp becoming energized from an extraneous source. The possibility of alternating current proving necessary eventually for the purpose of energizing the ramp, will be for consideration in the design of the engine apparatus."

Cost of Installation

In estimating the cost of installation the committee has taken the figure of 24,000 track miles as representing the maximum mileage for passenger lines to which automatic train control would in any circumstances require to be applied. Regarding the number of signals and locomotives it estimates as follows:

Distant signals—Equipped with dual application, 18,000; equipped with warning indication only, 6,000.

Stop signals—Equipped with trip device for "danger" effect, 38,000.

Locomotives—23,000.

The estimated first cost is: 18,000 distant signals at $308.70 each, $5,556,000; 6,000 distant signals at $110.25 each, $661,500; total for distant signals, $6,218,000.

The annual charge for maintenance and renewals at 7½ per cent of first cost is estimated at $466,357. The first cost of fitting 38,000 stop signals is given as $4,189,500; annual charge for maintenance and renewals, 7½ per cent, $314,212.

The first cost of fitting 23,000 locomotives at $441.00 would be $10,143,000, and the annual charge for maintenance and renewals (10 per cent of first cost) would be $1,014.300.

The total cost of the full scheme would appear to be:

Distant signals, $6,218,100.

Stop signals, $4,189,500.

Locomotives, $10,143,000.

Total first cost, $20,550,600. Total annual charge for maintenance and renewals, $1,894,870. (The above figures are based on an exchange rate of $4.41.)

Railway:	Track Mileage of Common Lines	No. of Signal Boxes	No. of Distant Signals	Number of Stop Signal	No. of Locomotives
Caledonian†	1,707	666	1,677	3,425	1,075
Glasgow & South Western†	760	286	575	1,492	527
Great Central	1,282	510	1,299	2,540*a	1,351
Great Eastern	1,942	650	1,740	4,990	1,203
Great Northern	1,553	603	1,403	2,757	1,359
Great Northern of Scotland†	415	127	198	483	122
Great Western	4,855	1,646	4,846*b	8,597	3,127
Highland†	566	154	240	620	160
Lancashire & Yorkshire	1,248	752	2,247	3,183	1,663
London, Brighton & South Coast	886	349	1,102	2,484	612
London & North Western	3,848	1,254	4,166	7,272	2,903
London & South Western	1,983	531	1,230	2,658	878
Midland	2,720	1,203	2,992	5,284	3,023
North British†	1,757	641	1,581	3,829	1,132
North Eastern	2,856	1,191	3,088	6,330	1,946
South Eastern of Chatham	1,293	453	1,084	2,286	725
GRAND TOTALS	29,671	11,016 1 per 2.69 track mile	29,468 1 per 1.01 track mile	58,230 5.28 per signal box	21,806

N. B.—The above statistics are computed in the following manner:
(1) Track mileage represents the mileage of all up and down lines, used wholly or partially for passenger traffic, added together, and includes single lines, but not cross-over roads, junctions, crossings, etc.

(2) Distant Signals—A distant signal post carrying splitting signals all applicable to one line of way is counted as a single unit; but where one or more signal arms on the same post apply to two or three lines of way, the number counted equals the number of lines of way. Similarly with stop signals.
(3) Number of Locomotives—Engines used solely for shunting purposes are included if such engines are required to travel light on passenger roads from shed to shunting yards.

*a Includes 1,005 home signals, 430 intermediate signals, 1,105 starting signals.
*b 1,569 of these are permanently fixed at "danger."
† Roads in Scotland.

A Resume of the Committee's Conclusions

The conclusions of the committee are summarized as follows:

1. The committee is of opinion, after careful examination and analysis of statistics during the past 10 years, that automatic train control presents the only reliable method of preventing a large proportion of train accidents directly occasioned by failures of enginemen to obey signals, which amount to about one-third of the total.

2. It considers, therefore, that a case for the installation of control upon British railways has been made out, and recommends its gradual adoption, in accordance with the list of requisites given.

3. It considers that the system likely to prove most suitable to prevailing conditions will be of the contact type, designed to operate in conjunction with existing methods of signaling.

4. It regards it as essential that the system of control should be uniform in character, and that all working parts should be of standard design in order to facilitate replacements and to ensure interchangeability.

5. It is of opinion that a complete system of automatic train control should include a train-stop device at selected stop signals, and train control generally at distant signals. It is satisfied from its investigations, however, that control at stop signals is of first importance, as a mean for providing additional security.

6. If, therefore, owing to financial considerations the complete scheme cannot at present be entertained, the committee considers that the preliminary step should be the introduction of control at selected stop signals.

7. It recommends the immediate formation by the railway companies of a committee of experts to determine and standardize track and locomotive apparatus, having regard to differences in structural and loading gages, and the position of conductor rails on electrified railways.

Labor Board Decides That I.B. of E.W. Has No Jurisdiction of Signal Men

THE United States Railway Labor Board on July 6, issued decision No. 1091, which in effect established a rule that those maintaining automatic signals and electric interlockers, should handle their grievances, etc., according to the regulations applicable to signalmen rather than by those governing the electrical workers. This particular case has to do with a maintainer of an electric interlocking who presented his grievance through the International Brotherhood of Electrical Workers and the Labor Board decided that such cases should justly be under the agreement of the Brotherhood of Railroad Signalmen of America. The decision is given practically in full as follows:

Railway Employes' Department, A. F. of L.
(Federated Shop Crafts),
vs.
New York Central Railroad Company

Question—Classification and assignment of J. W. Hickey, employed at Calumet river (Chicago) drawbridge. The following questions are involved in this dispute:

(a) Is 50 per cent or more of Mr. Hickey's time consumed in the performance of work such as is designated in rules 140 and 141 of the shopmen's national agreement?

(b) Has the general chairman of the International Brotherhood of Electrical Workers authority to handle a grievance for Mr. Hickey?

(c) Is Mr. Hickey entitled to the first trick at 71st street interlocking plant?

Statement—This dispute was filed in *ex-parte* form by representatives of the Federated Shop Crafts on December 6, 1920, a copy of which was forwarded to the management in the usual manner. On March 23, 1921, the carrier replied, stating, in effect, that a jurisdictional question was involved affecting the International Brotherhood of Electrical Workers and the Brotherhood Railway Signalmen of America, and attached for the information of the Labor Board a statement prepared by the general chairman of the signalmen's organization wherein he takes the position that Mr. Hickey is properly classified and paid as a signalman.

On April 28, 1921, an oral hearing was conducted in connection with this dispute, at which time representatives of the electrical workers and signalmen were in attendance. At the request of representative of the electrical workers, the case was postponed. On May 4, 1921, a joint communication was addressed to representatives of the carrier, representative of the I. B. of E. W. and representative of the B. R. S. of A., stating that in the opinion of the Labor Board the question involved was one that should be handled in conference between representatives of the respective parties to whom this communication was addressed, in an effort to arrive at the facts and accordingly agree upon a national agreement that properly covers the employee in question.

On February 10, 1922, a communication was addressed to the Labor Board by a representative of the Railway Employes' Department, A. F. of L., in behalf of the electrical workers, wherein a statement was made that, acting in conformity with the Labor Board's suggestion, a conference was held for the purpose of endeavoring to adjust the dispute, but without satisfactory results. In this communication the representative of the Railway Employees' Department objected to the action of the Labor Board in making the B. R. S. of A. a party to this dispute, for the reason, as claimed by him, that Mr. Hickey is a member of the I. B. of E. W., and was performing 50 per cent or more of his time on work specified in rules 140 and 141 of the shopmen's national agreement and of Addendum No. 6 to Decision No. 222.

An oral hearing was conducted in connection with the resubmission of this case and the three parties were duly notified and represented. The positions of the respective parties have been summarized as follows:

1. The representative of the I. B. of E. W. (Railway Employees' Department, A. F. of L.) takes the position that Mr. Hickey is employed by the New York Central at Calumet river interlocking plant as signal maintainer, being assigned to this job since October 22, 1918; that Mr. Hickey is working the second trick at Calumet river and since being there has refused three first-trick jobs that were open and given to younger men in seniority than he; that on March 22, 1920, the first trick at 71st street was vacant and Mr. Hickey made application for this job, but that he was ignored and the job given to an employee with less than one year's seniority rights; that the 71st street plant is the same kind of plant as Calumet river plant, and that the work assigned to Mr. Hickey is as follows:

"Inspecting, repairing and maintaining the electric wiring of General Railway Signal Company electric interlocking machine (model No. 2) operated with 120 volts and 64 levers; that in connection with the machine are 64 circuit controllers, 35 indicator selectors, 64 polarized