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THE BLOCK SIGNAL SYSTEM.

HENRY MAXON BRIGHTMAN.

CLASS OF 1900.

THE BLOCK SIGNAL SYSTEM.

Railroads, according to history, have apparently made the land area of the world smaller. Formerly it took a man with iron nerve and constitution three or four months to go from New York to San Francisco, feeling that perhaps he would never return to his native town, but now he can make the same journey and return in eight days time.

In 1801, at the beginning of Jefferson's administration, men thought that the Alleghanies would be the limit to civilization on the west; but with the introduction of the first successful locomotive, run over the Baltimore and Ohio Railroad in 1830, and the subsequent development of railroad transportation service, this idea completely vanished. Central and Western United States have not only been populated, but have become a source of vast wealth and revenue to the country. Thus while we note at the present time the value of the railroad service, and the fact that railway lines are threading the country in every direction, it should be remembered that safety, rapidity, and convenience in transportation of people and merchandise depend almost entirely on one controlling factor, the block signal service.

The average person in travelling by rail, seldom considers the responsibility imposed on hundreds of operatives required to conduct an express train from one of our large cities to another. Over 90% of the railway companies in Great Britain and a large percentage of those in America, have men stationed at intervals of from two to ten miles equipped with suitable appartus to provide for the safety of the thousands of passengers who are transported daily. With such an arrangement only, is it possible to run trains at high speed through towns and cities, over mountains and prairies, through cuts and tunnels, over bridges and around curves with absolute safety.

Block signalling in this country, though heretofore somewhat limited, is rapidly becoming important owing to the constant increase of business. In the time of the stage coach, signalling was unnecessary, for the few passengers could board or leave the coach anywhere they wished along the route. The advent of the railroad has changed all this, for it is, as it were, autocratic. The stage coach moves along the crowded street with safety, stopping in an instant if necessary or turning aside to allow a carriage to pass. But with the railway train it is different; moving as it does in a direct route, at a high speed with comparatively little friction, it is wholly unprepared for an emergency and must decrease its speed by degrees, thus requiring a previous warning in order to avert danger. For this reason a system of signalling is necessary.

The earliest form was the flag signal. This was a piece of cloth fastened to the end of a pole and waved to give the needed information to the engineer. White was used for "all clear"; red, "danger"; green, "caution"; and green and white, "stop for passengers". The latter is used to-day.

A little later came the barrel or ball signal. This was a barrel or ball fastened to a rope and raised to the top of a pole to inform the engineer whether the road was clear. The colors generally adopted were the same as in the case of the flag signal. The line that used this with the greatest success was the Newcastle and Frenchtown railroad, in Pennsylvania, in 1832. The information was conveyed in the following manner. When a train started from Newcastle, the man in charge raised a white ball to the top of the pole. The man at the next station seeing the ball through a telescope, raised his half-way, showing that a train was appraoching. As soon as the train had passed, the ball was raised to the top of the pole. Just as soon as the train moved into the next section, the ball was lowered and the route was open to that point for another train, and thus the information was conveyed throughout the whole route. Should an accident happen, the nearest signal raised a black ball to the top of the pole and the man in the rear seeing it, did likewise and all others repeated this signal back to Newcastle, whence a relief train was sent. This system was liable to error because of the inattention of the operator.

Different systems are applicable to different roads. Take for instance a branch road twelve miles long and having at the most but eight trains passing over it daily. One engine could handle all the trains and one flagman at each crossing only is necessary to look out for the safety of the public and give the advance signal to the engineer. On a long and heavily crowded road, such as the New York Central and Hudson River;-Delaware, Lackawanna and Western, and the New York, New Haven and Hartford, the above-mentioned systems would be dangerous and altogether unsatisfactory. Men are not only liable to mistakes, but may go to sleep and on awakening, having forgotten which train previously passed and being confused, grasp the wrong flag and thus give the wrong signal. This system though now classed as a very imperfect one, was used in its best form in 1851 by the New York Central road.

Within the past few years has come the semaphone type of signal, which is used almost exclusively on all the more prominent roads of to-day. This system involves a division of the railroad into what is known as blocks. These blocks are sections of tracks, over which the movement of trains is controlled by fixed signals. This semaphone is a board about four or five feet long and eight inches broad at thewider end. It is bolted at one end to the top of a high pole and operated by means of wires to the two required positions; viz. horizontal, meaning danger, and diagonally at about 45°, clear. In the evening a light is placed behind colored glasses fastened in one end of the blade to designate the position of the signal. On the well-regulated roads there are three of these signals for each block on each track and they are controlled by one man in what is known as the tower, which is located in the best position to command a view of the road. It has been found best to place the signals near the station so that a train may stop for passengers or freight without the least danger of a collision. The signal for an approaching train, called the "distant", having a forked end and painted yellow, is placed from two to three thousand feet from the home signal, (a red blade with square end) which is located about three hundred feet from the station. The third signal, or "starter," is the same as the "home" and is about two thousand feet distant on the other side of the station. The distant signal may be called a cautionary one, but the home and starter are positive, either "danger" or "all clear", and woe to the engineer who runs his engine by a negative home or starter signal. He may, however, run by the distant but at a reduced speed, so as to be prepared to stop, if when he arrives at the home signal that also be at danger. This system is the cheapest and consequently in vogue on many roads; but is not positively safe, since an operator may forget to throw the right signal or is unable to remember just which lever he ought to throw, thereby causing a train to pass over a misplaced switch with consequent derailment.

Thus the question of an interlocking system arose. This arrangement requires the operator to throw the signal of approach to the position of danger before a switch can be unlocked and opened. Then if the engineer heeds the signal, there is no trouble. This locking of the signals is all done by an arrangement of locking bars, which in general are long flat steel rods sliding in a groove with V shaped notches into which locking dogs fit, and from which they can be removed only when the block is protected for all approaching trains. For example, if a train is in B's block, A cannot throw his signals to clear and allow another train to pass into B's block, until the first train has moved on into C's. B may now unlock A in response to an electric signal connecting the two towers, giving A. the privilege of permitting the second train to pass into B's block. Thus it is seen that a set of signals would be operative between every two trains. Should one of the signals for any reason be out of order and uncontrollable by the operator, it will always drop to the position of danger and every approaching train must stop and wait for a card from the signaler in order to advance.

By this system it would seem almost impossible for any two trains to come into collision. But as railroad corporations wish to save money, they do not always bond wire their tracks other than between the distant and starter signals. So that it is possible for a train which is between the starter signal of one tower and the distant of the next to be practicably uncontrollable by the signals at either of the towers. It sometimes happens, also, that the towerman, and the flagman that accompanies every train, place too much confidence in each other with disastrous results. The towerman for some reason becomes inattentive because he feels that the flagman will protect the train if it stops between blocks; and the flagman on the other hand doesn't always see the necessity of running back with the flag a mile or two, because he expects the towerman to attend to his business. So if the two ideas happen to coincide the train is left in a very unfortunate position. By bond wiring a track throughout its length, however, it is utterly impossible for the operator at one tower to allow the train to pass him if there be any part of a train whatever on the track ahead, even so much as a caraxle, or if anything has occured to displace any part of the track; such as a broken rail, a washout, or any open switch between his starter signal and the distant of the next tower. This very important safety device depends for its action upon the simple fact that an electric conductor such as a car axle, a broken rail, or a misplaced switch would interfere with the circuit of his interlocking machine and render him powerless to unlock and throw his signal to a position of safety.

There is no system whatever that can compel an engineer to heed signals except an automatic safety device attached to the locomotive which shuts off the steam and applies the brake whenever the engine passes a danger signal. This arrangement is not yet perfected and is consequently of little practical importance.

Another system which has recently developed is the electro-pneumatic. One can gain an idea from the name that electricity and compressed air play an important part in its operation. A special mechanism must be placed at each switch and signal. Some of the largest roads are installing it at the most complex crossing and terminals on their route and it is now being operated with great success at the Southern Terminal Station. It does away with the large signal levers in the tower, and connecting pipes and wires on the outside. One man can handle twice as many switches and signals as in any of the other systems. In the tower will be found a long bench with a number of small crank-like levers on the front of it, and on the top a frame with the miniature tracks of the yard or such portions of the same as the tower is intended to control. These miniature tracks are connected with the special mechanism at the switches and outside and move in unison with them, thus enabling the operator constantly to see the result of his work. The small levers for controlling, are electric switches for directing and reversing an electric current. This current is used in connection with an electro-magnet to open valves for the admission of compressed air which actuates a piston, for controlling the switch or signal, as may be desired.

The compressed air used in moving these machines is furnished by an air compressor in a station located near the place of operation. This is a very expensive system because of the necessary piping, wiring and air-compressing machinery, but is particularly valuable in the yards of the largest stations, where the switching of hundreds of trains and engines daily, is constantly going on.

Another district system, the automatic, of which there are many forms has undergone a great many improvements as the science of electricity advanced, so that now the electro-automatic is acknowledged to be the best form. One form, the clock-work signal, was liable to give the wrong indication if the tripper was accidently touched or the mechanism out of order. There are several types of the electro-automatic, but one to which railroad officials give the most attention is the semaphone, and this has come nearest to a practical signal in the hands of J. W. Lattig, Superintendent of Telegraphy for the Lehigh Valley road. The signal is the usual semaphone type, and instead of its being pulled to its position by wires from a central station, it is operated by a small electric motor, attached to a platform near the top of a pole, and is operated with eight to twelve primary cells. The circuit is made through the rails by bond wiring, and a train passing over them. The signal stands normally at danger; and when a train approaches, the circuit is completed and the motor pulls the signal to safety. Should a train be in the next block, however, the signal would remain at danger until it had passed into the following, and then the signal would drop and allow the train to proceed. An engineer must be careful not to run his train by the signal; if he does and a train is in the block, the signal will remain at danger on account of the wheels of his engine holding the signal locked. Then the only thing to do is to run his train back of the signal, and allow it to fall. A great deal of discussion has taken place as to whether the signals should be close together on curves, and a long distance apart on straight road. It was finally decided best to place them all at equal distances so as to have the trains equally spaced.

With the automatic signals, the weather has to be taken into consideration. Should snow or ice clog it, since it is counterbalanced to go to danger, it would remain in that position until reported and fixed. The motor is substantially boxed so that the machinery is protected from the weather. It has been installed on the Central New Jersey Railroad for several years and from last reports it was working satisfactorily. About the only drawback to the electro-automatic signal is, if it should happen to get out of order and give the wrong signal several times in succession, engineers would lose faith in such signals and disregard a negative one when a little late, thinking that perhaps it was out of order. Or should the engineer come to a negative signal and true to his duty stop and wait for it to come to safety when it was out of order, such a delay, if the train were a fast mail, might be a serious matter.

The torpedo system which is in practicable operation on the elevated railroads in our great cities, is worth mentioning as a final one in this series. The trains are spaced here as in all absolute systems; ie., having a set of signals operative between every two trains. As a train passes, an automatic arrangement places a torpedo on the track; and should another train enter the section before the first had left it, the second train would explode the torpedo and give a signal of danger to the engineer. As a train leaves a section, this automatic arrangement withdraws the torpedo and allows the second train to enter the section. This system is a very successful one, but for various reasons it is only adapted to this particular class of work.

This brief discussion of the various modern systems of railroad signalling may serve to emphasize to the travelling public the fact, that though accidents occasionally take place, trains are handled in a very safe way.

Obviously it is to the interest of railroad corporations to improve their signal systems in order to protect themselves against the loss of their own property. So among all questions pertaining to railroading, that of controlling the movements of trains is of maximum importance.

A practical study of the intricate mechanism for controlling the train service at the Boston Southern Station, and through the courtesy of Superintendent Clark of the New York, New Haven, and Hartford Railroad, of models used in general signal work, as well as the inspection and photographing of signal apparatus on different railroads, together with a study of authentic articles have furnished the material for this paper.

Henry M. Brightman.
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