MODERN FIXED AND INTERLOCKING RAIL= ROAD SIGNALS.

R AILROAD signalling is the art of conveying information as to the occupancy or condition of the track ahead to an engineman or conductor in charge of a train so that he may move his train safely and expeditiously. It is obviously necessary for the train crew to have this information whenever more than one train is operated over the line at the same time. The means of conveying it are numerous, and include the time card, dispatcher's orders, precedence of one class of train over another, hand or lamp signals, and fixed signals.

A discussion of fixed signals, and the interlocking and other devices connected therewith is contained in a paper on railroad signalling read by H. J. Pfeifer, engineer maintenance of way, Terminal Railroad Association of St. Louis, before the Engineers' Club of St. Louis. From it the following notes are taken.

The end sought by all railroads, signal engineers, and the manufacturers of signal appliances is "Safety First." To be successful, however, in these times of dense traffic at high speeds, increased expense and low rates, a signal installation must have other qualities in addition, among which are facility, reliability, and economy.

In the early stages, attempts to secure safety and facility were more or less compromises between the two with sacrifices on the part of each. The advance of the art, however, has been so rapid of late years that less and less sacrifice is necessary. To secure safety and facility the signal mechanism must be reliable in operation; *i.e.*, subject to the minimum of failure.

True economy is not confined to the cost of installation, or even of maintenance and operation, but takes into account the entire conduct of the railroad and that system is the best in each case, which results in the safe movement of the traffic at the least gross expense, and in the shortest time, even though the signalling system is elaborate and costly in itself.

Fixed signals may be divided into two general classes, block and interlocking. The first are for the purpose of maintaining a proper space interval between trains on a given stretch of track, and the second for controlling the movement of trains at crossings, junctions and terminal points.

Block Signals.—Probably the simplest form of block signal is the train order board or simple manual block at a station which is under the control of an operator or agent. Information as to the condition of the line is transmitted to him by telegraph, and in recent years by the telephone. Ordinarily this board gives three indications, "Stop," "Proceed cautiously" because of train in block moving in same direction, (this order is usually given to freight trains only) and "Proceed," block is clear. The manipulation of the signal is entirely in the control of the operator, there being no connection between adjoining stations, except for the transmission of information. You will note that in the use of this system, collision or accident may result, through the unchecked action of at least three men or agencies : First, the operator at the station in advance, having overlooked the train in the block, may give false information; second, the operator may make a mistake and give a clear signal with a train in the block ahead, and third, the engineman may fail to obey a stop signal.

The danger of this lack of control over the operators resulted in the development of the controlled manual block. In this system the signal is locked in the stop position and cannot be cleared until released by the operator at the station in advance. After the passage of the train the signal automatically returns to the stop position. This system increases safety because a clear signal cannot be given, except by the concurrent action of two operators. There is nothing about it, however, reducing the danger resulting from the failure of the engineman to obey a stop signal.

An additional safeguard on single track lines is the electric train staff. In this system there are interlocked receptacles at each station containing staffs for delivery to the engineman. Not more than one staff can be taken out at one time, which is an assurance that there can be only one train in the block, as no train is permitted to enter unless the engineman has a staff. The staff is placed in a frame, adjacent to the track, similar to a mail catcher, out of which the engineman can take it if moving at a reasonably low rate of speed. As the train passes the advance block the staff is thrown off by the engineman and placed in its receptacle by the operator, after which it is again possible to withdraw a staff at either one end or the other. In addition to the main staff, provision is made for permissive staffs, which can be issued to following trains, and grant the right to enter the block under control and with the advice that block is already occupied. This gives great additional safety, because the key for unlocking the system is on the train itself and cannot be used until the train has cleared at either end. In this system also there is no mechanical device to check the engineman in case he fails to obey the signal.

The St. Louis tunnel, as an example, is operated on on an absolute controlled block, with a modified staff system added for eastbound freight trains only. On account of the smoke and darkness it is essential that not more than one train is on each track at one time.

The system consists of an interlocking machine at the west end of the tunnel, known as "X" office, and another at the east end known as "MS" office. They are a little more than a mile apart.

The two machines are connected by a system of electric locking which compels the co-operation of the operators at both ends before signals can be given which will permit a train to enter the tunnel. These signals, by means of track circuits, are automatically returned to the stop position behind the train accepting the proceed signal and entering the tunnel. The track circuit is in two sections of about 240 feet, one at each end of the tunnel. The signal automatically restored to the stop position and the signal governing in the opposite direction cannot again be cleared until the train has passed out of the tunnel. As an additional precaution there must be a red light on the rear end of each train. The operator at the outlet station must see this light and then record on his train sheet the hour and minute during which the train passed his station. There is a heavy grade eastward through the tunnel and it is possible that an eastbound freight train may break in two, and leave cars standing between the track circuits, without being noticed by either the engineman or the operator. As the forward part of the train would release the track circuit control, it is within the bounds of possibility for the operator to make a mistake, say, that he saw the red light on the rear end of the train, when he actually did not, and release the tunnel entrance signal at the west end for another train. The disastrous possibilities of the resulting collision with the cars in the tunnel led to the adoption, a few years ago, of the following device: