L M Ericsson's Manual Block System

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L M Ericssons Signalaktiebolag has designed a manual block system (Swedish patent no. 148660), which is both simple and reliable in operation and employs to a large extent the same components as a normal relay interlocking plant. The manual block system is suitable mainly for single track lines where traffic has not yet attained such volume as to justify introduction of an automatic block signaling system and, possibly, C.T.C.

This article describes first the historical development of manual block systems, then the goals set for the design of L M Ericsson's manual block system and, finally, in more detail, the circuitry and operation of the system.

Ever since the first railways were constructed, a simple means of avoiding train collisions has been an active problem. Many engineers and traffic experts have wrestled with it, and many ingenious solutions have seen daylight.

In the good old days, when there were only a few trains on a line, when everyone had plenty of time, and train speeds were extremely low (an American railway at one time used a horseback rider in front of their trains to make sure the line was free), the risk of collision was insignificant. If two trains happened to meet on the line, they could easily stop and, after the usual argument between the engineers and passengers of the respective trains, a friendly agreement was reached as to which train should back to its starting station.

If there were some guarantee that trains would run exactly on schedule, there would still be no risk of collision. The timetable would simply be arranged so that trains run at time intervals. But since we cannot always rely on train schedules, the engineers must be given additional orders—train orders—and there must be some means of checking that there is not more than one train on one section of line at the same time (a line section consisting of a whole or part of a station-to-station section). The train orders must be issued ultimately by the station staff. On some railways the check that a line section was occupied by only one train at a time was effected by hoisting a colored ball—the color varying with the position of the train—on a high pole at a section boundary. The ball could be seen through a telescope by a man who climbed a pole at the next section boundary. This system of control was later superseded by telegraphic or telephonic communication. A manual block of this kind, however, may lead to errors which can cause train collisions.

Other solutions to the problem of line safety, however, which virtually eliminate all risk, have been found in different countries at different times. To start with, a pilot, with special arm band which authorized him to dispatch trains on his section, was allotted to every station-to-station section. The pilot had to follow every "last" train moving in one direction, so that he could then dispatch trains in the opposite direction from the other end

Fig. 1 X 2047

Keyset for manual block system with key *M* for operation of home and starting signals, and key *C* for operation of the block system. The indication lamps give information of permission requested, permission received, train on line etc.

of the line. The arrangement involved considerable work and expense, and there was the risk that the pilot was at the wrong end of the section when the train arrived. A less expensive arrangement was to replace the pilot by a train staff, which accompanied all trains on their passage between the two stations to which the staff was allocated. This system, however, was even less flexible than that with the pilot, since the trains had to run alternately in the two directions. The train staff was later replaced by a key with which to open a box at the stations concerned. At the station where the key happened to be, a ticket could be taken out of the box which gave the train crew the same authority to proceed to the next station as the staff itself. This made the train staff system as flexible as the pilot system.

With line wires between stations an electric tablet system could be introduced. This consisted of a number of tablets placed in a container at each station; the containers were electrically connected so that the removal of a tablet from either station prevented the taking of another tablet. Thus if a train at station *A*, on a section *AB*, had taken a tablet, no new tablet was obtainable at station *A* or *B* until either the train had returned its tablet at station *A* or, after arrival at station *B*, had replaced it in the box there.

Electrical train staff and tablet systems are still being used on many railways and should be satisfactory from the safety standpoint. The exchange of staffs or tablets at the stations, however, is a troublesome and tedious business. It was natural, therefore, that other means of manual block system should be constructed. Several such systems have been in use for a very long time. They consist of "block instruments" at the stations connected by an inter-station electric circuit. Two stations can inform one another of the departure and arrival of trains by signaling on the block instruments. If the block instrument is suitably connected with the station's starting signals, it is possible to prevent a signal from being set to proceed if there is a train on the line.

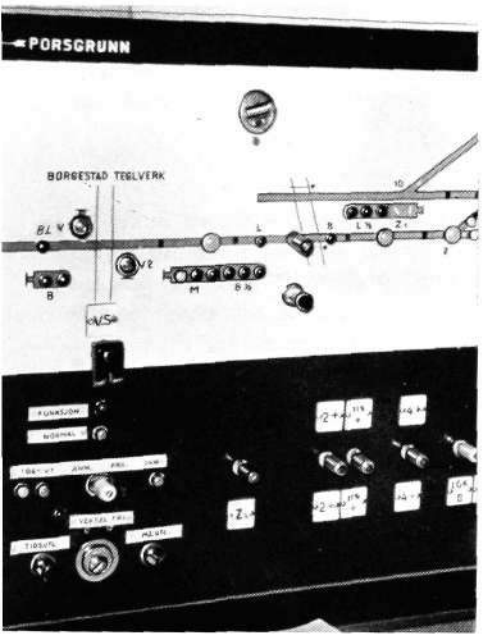

Fig. 2 X 2046

When the manual block system is used on a line with relay interlocking plants, the control and indication equipment of the block system can be placed on the relay interlocking control panels, as for example in the system in Norway shown in the figure. The control buttons and indicating lamps of the block system are seen at the bottom left.

Requirements in a manual block system

When L M Ericsson was preparing to design equipment for manual block systems, it was decided that the following requirements must be fulfilled.

1. The equipment should be simple and reliable in operation and should, as far as possible, comprise the same components as a normal relay interlocking plant. The block equipment should provide full traffic safety. The system should not require any track circuits on the line.

2. The system should operate on two line wires without grounding connection.

3. All equipment should operate on direct current, and its power requirement should be low enough to be supplied by primary cells.

4. The restrictiveness of the block system should not be lessened by short or open circuit faults.

5. It should be possible to set the station for unattended movement of trains, and the block system should be usable between the nearest attended stations under these conditions. Indication of line occupation should be given to the normal extent at the unattended station or stations.

6. It should be possible to factory-wire the relay equipment on suitably designed racks.

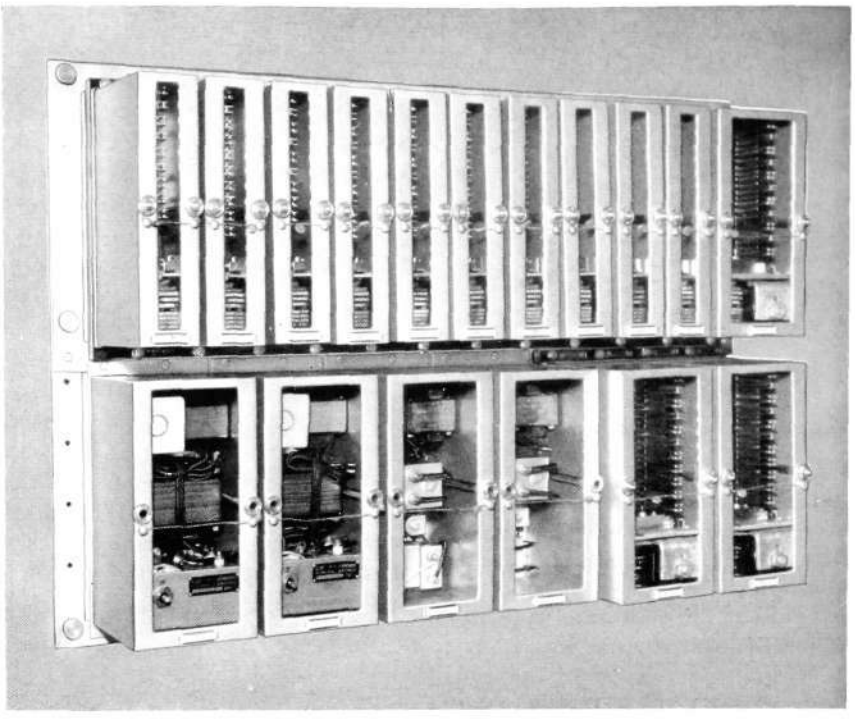

Fig. 3 X 6920

The relays, transmitters and receivers of the manual block system are erected on factory-wired racks

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L M Ericsson's solution to the above requirements is described briefly below.

Equipment

The equipment for the manual block system, apart from the two line wires, contains key-sets, signal relays, transmitters, receivers and station track circuits and station signals.

The block system key-set for the stations is designed as shown in fig. 1. If the manual block system is installed on several adjacent station-to-station sections, there must be two key-sets at every station. If a station has an electric interlocking machine, the control and indication equipment of the block should be placed on the control panel of the machine, for example as shown in fig. 2. In both cases the control and indication equipment is so placed and electrically connected that the indications are easily understandable and the controls readily effected.

The mounting and wiring of relays, transmitters, and receivers is shown in fig. 3. If a station has an electric interlocking plant, it is preferable to place the equipment in the interlocking relay rack.

Fig. 4 shows the circuits of a sender and a receiver. The transmitter contains a polarized relay, operating on 24 V, which generates alternating current in the transformer. The secondary side of the transformer is connected to the line via a series-resonant circuit matched to the frequency of the transmitter.

The receiver is connected to the line via a series-resonant and a parallel-resonant circuit. In the latter circuit is a transformer with rectifier bridge and direct current relay on its secondary side. Transmitters and receivers are made

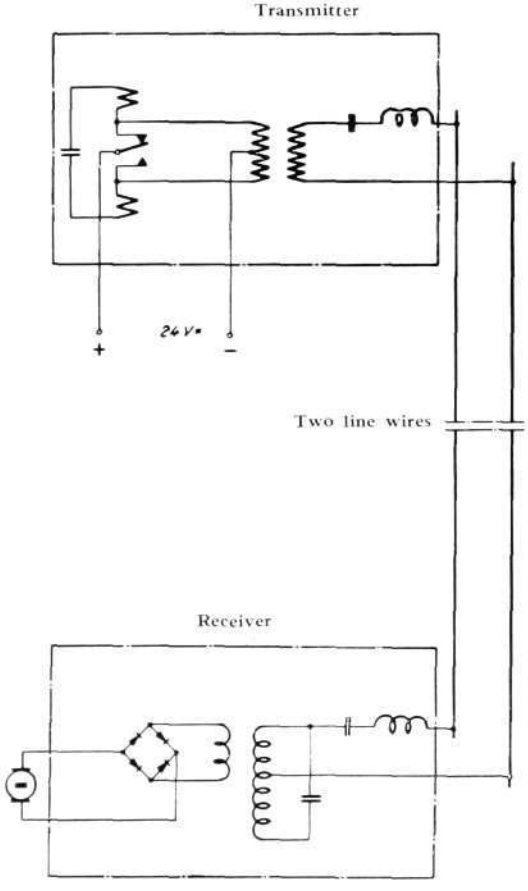

Fig. 4 X 6916

Simplified diagram of transmitter and receiver designed for 24, 38 and 60 c/s

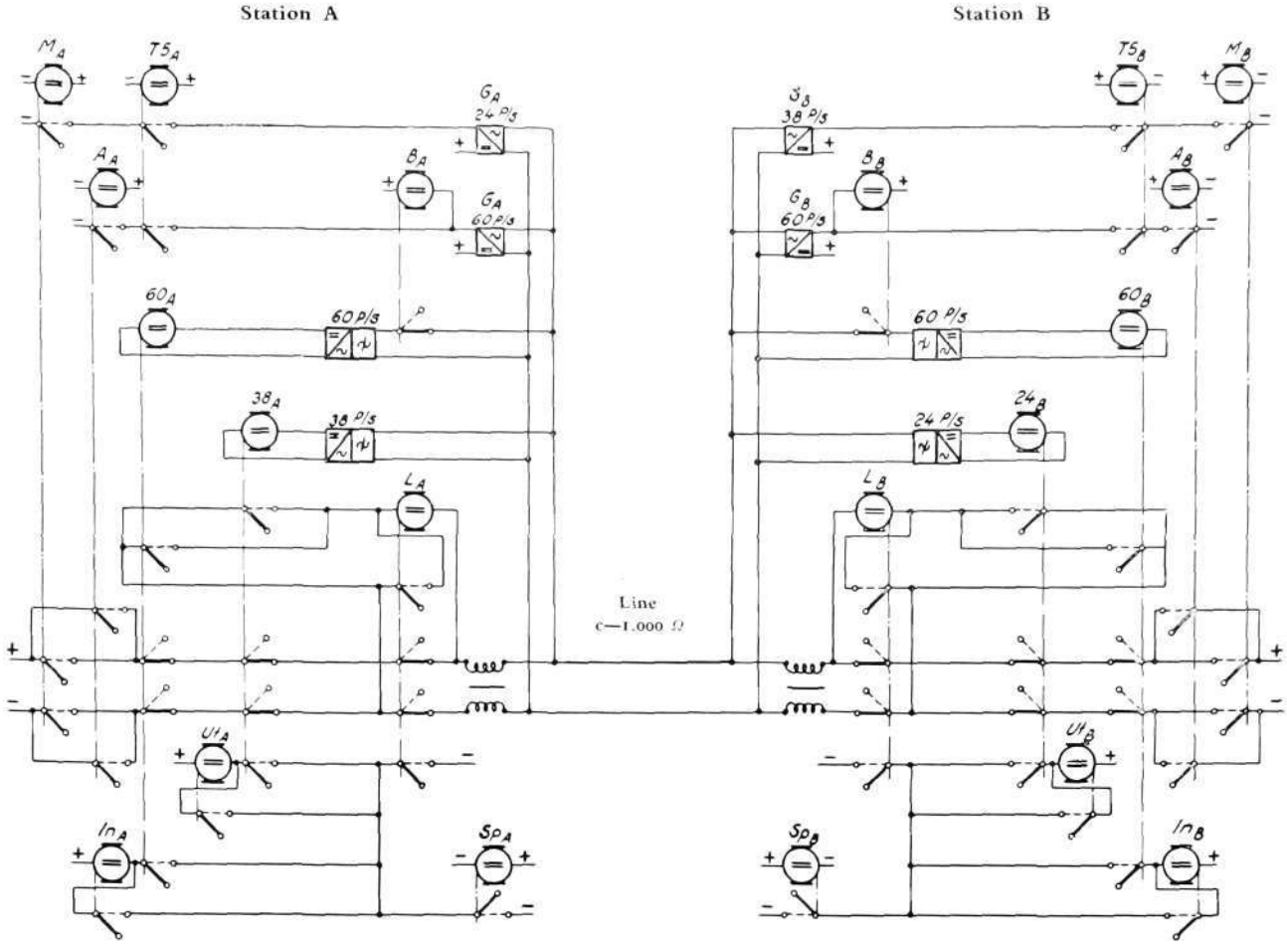

Fig. 5 X 7678

Greatly simplified diagram of the manual block system

for three different frequencies, 24, 38 and 60 c/s. The relays are L M Ericsson's plug-in JRK-type.

Short track circuits and home and starting signals are arranged at each end of the stations.

System schematic and operation

The transmission of information on the line wires is effected by a short duration A.C. of 24, 38 or 60 c/s and continuous D.C., possibly of different polarities. D.C. and A.C. of one frequency are used for clearing the line, and two A.C. frequencies for release.

Fig. 5 shows the schematic principle of the block system.

When station *A* (left), by operating a block key, requests station *B* (right) for permission to dispatch a train on the line, relay A_A and (for roughly 5 secs.) relay $T5_A$ operate. Relay B_A, which operates, disconnects the 60-cycle receiver of station *A*. D.C. and 60 c/s A.C. is transmitted on the line. At station *B* relay 60_B operates as long as station *A* transmits 60 c/s. Relay L_B operates and sticks. Relay In_B likewise operates and sticks. A call lamp lights on the control panel at station *B*. In this position station *A* can, if desired, recall its request by returning the block key to normal, whereupon all relays at stations *A* and *B* restore.

Station *B* grants permission to station *A* by operating its block key. Relay M_B and (for roughly 5 secs.) relay $T5_B$ operate. A.C. 38 c/s is transmitted on the line, and relay 38_A at station *A* operates. The D.C. from *A*

is cut off, and D.C. is connected instead to the line from station *B*. Relay L_A operates. Relay Ut_A also operates. A permission lamp lights on the control panel at station *A*. In this position station *B* can, if desired, recall its granted permission by restoring the block key to normal. It can, however, release the block only by cooperation from *A*. This is because, when station *B* operated its block key, the lock relay Sp_B also released and relay In_B was energized through a contact on Sp_B. The lock relay cannot re-operate unless *A* transmits 60 c/s and 24 c/s simultaneously. Station *A* can also recall a permission received by direct transmission of 24 and 60 c/s.

The train dispatcher at station *B* can refuse to grant permission by setting his block key to the request position. A.C. 60 c/s is then transmitted to the line and the D.C. from station *A* is cut off.

When station *A* sets its starting signal to proceed in the direction of station *B*, relay Sp_A releases and the *H*-relay of the starting signal is energized through a contact on relay L_A. Relay Ut_A is energized through a contact on Sp_A. In this position station *A* can restore the signal to stop, but the block will not be released until after a certain interval, and only on condition that the train to which the signal applies has not moved on to the line during the interval. Station *B* can also set the starting signal at station *A* to stop. This is done by cutting off the direct current from the line, whereupon relay L_A and the *H*-relay of the starting signal release. Station *B* thus has no possibility of releasing the block, but this must be done in the normal way, which will be described below.

If any of the block keys is restored to normal when there is a train on the line, the block system is not affected except that a buzzer sounds at the station at which the block key was operated.

When the train dispatcher at station *B* has checked that the entire train has entered the station, he restores the block key to normal. A.C. 60 and 38 c/s are transmitted on the line. At station *A* the lock relay Sp_A operates, after which 60 and 24 c/s frequencies are transmitted on the line, causing the operation of lock relay Sp_B at station *B*.

The schematic in fig. 5 is greatly simplified and does not show, for example, what happens when a station is connected for unattended train movement.

The block system can be wired so that a station can grant advance permission to its neighboring station.

The indication lamps on the panel provide information of permission requested, permission received, permission refused, train on line etc.

For some time the majority of railways seem to have been in agreement that safety arrangements on single track lines are necessary, even when train speeds are fairly moderate. When such arrangements are introduced nowadays, it is often desirable at the same time to improve the efficiency of traffic controls by converting block signaling to automatic operation and adopting C.T.C. Before doing so, however, it must be decided whether installation of automatic blocking and possibly C.T.C. offers greater advantages—considering volume of traffic, size of station staffs required for purposes other than operation of the signaling system, capital costs, etc.—than the introduction of merely a manual block system. There are at present, and will undoubtedly continue to be in the future, many railways with moderate traffic, where a station staff is required at all times and the price of capital is fairly high. The introduction of a manual block system, which offers much greater security to traffic than purely telegraphic or telephonic communication may then prove to be the rational solution, even though it does not permit reduction in station staff otherwise than by putting stations on unattended train movement.

L M Ericsson has already installed its block system in Sweden, Norway and Spain.