Eliminating the Written Train Order*

A System for Operating Trains on Single Track Lines by Signal Indications Exclusively

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ALMOST from the inception of vehicles that run upon rails the problem of getting trains past each other on single track has been an absorbing one. From the first, contrary to popular belief, this problem has been one of avoiding delays rather than one of safety. This is exemplified by the experience in the early days of railroading with the "time-card" system of operation as well as with the first crude forms of the train-staff. Both of these systems afforded perfect protection against collisions (subject of course to the inevitable weakness of the human element involved), but were utterly incapable of preventing serious delays whenever there was the least departure from normal conditions. A delay to one train literally disorganized the whole service. Figuratively speaking, the operation structure was in unstable equilibrium, and ready to fall to the ground under the influence of the least irregularity.

With the invention of the telegraph, however, came the possibility of providing almost perfect flexibility to the time card through train-orders that took precedence over it. Scheduled meeting points could be changed at the will of a single man in control of train movements, and changes in plans due to extraordinary conditions could be made with comparative ease. As compared with the primitive operating methods that had gone before it, the train-order system was a wonderful improvement and as it was eminently satisfactory for the infrequent and slow-moving steam-railroad trains of that early period its use soon became practically universal.

Human Element a Factor in Train Order System

For single-track operation this has been the case for nearly half a century, during which time operation by train-order has been refined, elaborated and surrounded by a comprehensive but somewhat complicated code of operating rules. These precautions were made necessary by the fact that operation by time-card brought in the weak link of human fallibility only in one case—that of the engine driver. With the train-order system, however, especially in the later days of long freight trains, there were no less than four of these weak links in the chain, namely, the dispatcher who conceived the order, the operator who received it, the conductor who accepted it, and the engineman who carried out its provisions. Here, then, was a case where the problem of operation was attacked along lines of facility of train movement, safety being cared for by elaboration of details and not by the basic change which was made in the system of operation.

Of course the checks against failure of the weak links in the system, which could be (and were) introduced, satisfied all reasonable demands for safe operation, but with the increased speeds and more frequent service of the later days of railroading other weaknesses developed in the train-order system. As single-tracks became fairly well crowded with traffic, great difficulty was experienced in moving trains of inferior class over the road within reasonable time limits. The holding of trains at sidings for periods of one hour or more was by no means unusual, and extra freight trains not infrequently spent 30 hours in running over a 150-mile division. For such conditions double-tracking was a manifest relief and many roads accepted it without question notwithstanding the enormous expense involved.

Naturally, double-tracking simplified the operation of trains, but with the continued growth of traffic the same problem of inflexibility of operation, which had arisen years before with single-track operation became acute. It was easy enough to operate a double-track line with slow trains that made frequent stops, but, where recognition was given to the necessity for utilizing both track and equipment up to their full capacities, such limiting factors as the long headways between sections of high-speed trains, the need for clearance time for inferior trains, the risk involved in advancing a passing point when the overtaking train was delayed, and the like, could not be permitted. The result was the introduction of signals.

In a way, of course, the question of safe operation has been back of every installation of signals that has been made. Yet it is safe to say that not one per cent of the signals existing on double track today would ever have been installed if the railroads had not faced the dual demands of the traffic department for increased service and of the operating department for economy obtained by utilizing the equipment to its utmost capacity. Here, then, is the record of still another great forward step in the art of train operation which was based primarily upon the demands of rapid movement. It differed from the step made when train orders replaced the simple time-card in that it aimed toward the elimination of the human element with the characteristic but inexplicable lapses from normal action, and thus it provided a great improvement in safety, but the step was brought about, essentially, because of the need to accelerate traffic. On double-track roads the cycle is now very nearly complete. A vast mileage is equipped with signals and the train-order has been relegated to a distinctly inferior position, serving as little more than a means for communication with the "trouble-man." It has been absolutely divorced from the checks, complications and formalities of the original system.

Signals on Single Track Promote Use of "19" Train Order

An exactly similar cycle is now beginning upon single-track roads. In single-track operation the design of signal systems is by no means so simple as it is on double-track lines, and this, no doubt, has retarded the development of signals in this field. During the last few years, however, a very remarkable advance in

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the art of single-track signaling has taken place and this has not reached the stage that the simpler double-track signaling was in a decade ago. Experience has demonstrated the reliability of signal indications, just as experience on double-track effected the practical elimination of the old "normal-danger" signal, and the custom of setting the signal in advance of the entrance to the block so that the change in indication could be seen from an entering train. At the same time the cost of double-tracking has greatly increased and there is a strong incentive for devising means to increase the capacity of existing single-track lines.

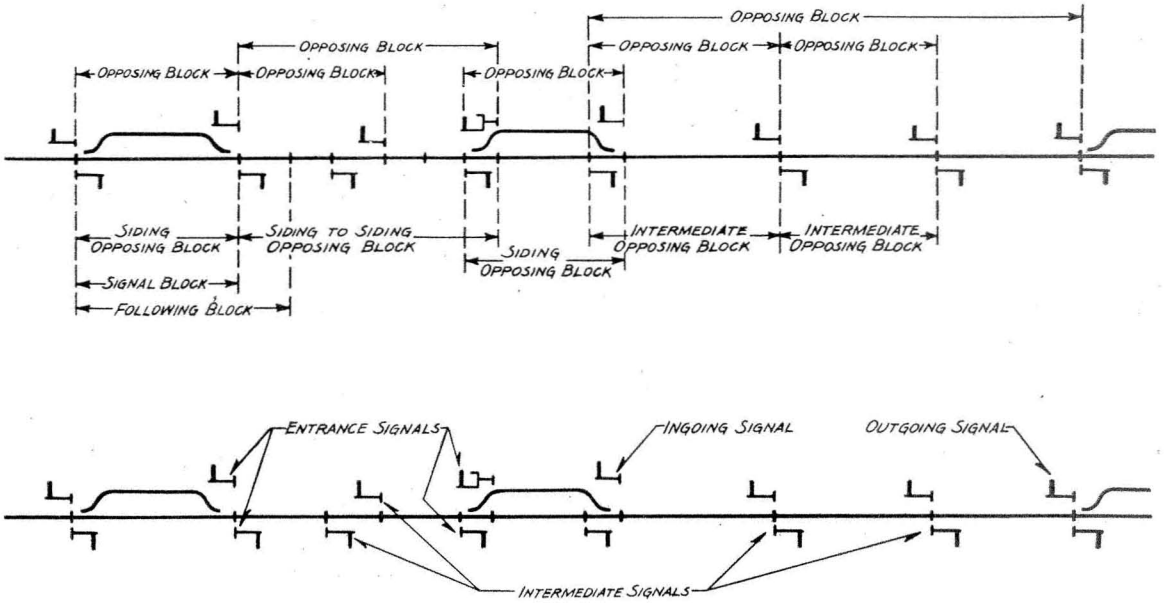
This tendency has already begun to take concrete form. On signaled lines the relatively new "19" order, which was devised to permit trains to proceed without waiting to comply with all the precautions incident to the issuance of the standard "31" order, has come into extended use. Here again is seen the results of the demand for reducing delays. Under the old train-order system no train affected by a change in plans could leave the passing track until it was definitely known that all other trains affected had been advised of the change. The "31" order was not made "complete" by the dispatcher until he knew that all the trains had been stopped. But with the "19" order in vogue, a train could proceed as soon as the station operator received the new order even though the opposing trains for miles in advance did not know about the change.

To the railroad man of the old school this was a most radical innovation. But to those familiar with the history of signaling, the new method was anything but startling. It was only a step half-way toward a practice that had been well established for a long time on signaled, double-track lines—namely, the acceptance of signal indications at their face value.

Necessarily, in the case of the "19" order, every train proceeds by signal indication only until such a time as all of the trains affected have actually received and read the new instructions. Should these fail of delivery to any train whose rights have been restricted, only the signal system stands in the way of confusion and delay. Yet under these conditions the "19" order has thrived. It has affected appreciable savings in time and the resultant economies have made the steam roads look eagerly toward the next forward step in single-track train operation which is, obviously, the elimination of the time lost in stopping for orders and in waiting for meets with delayed trains.

Train Orders Eliminated by Signals

Whether or not the present operating methods that produce these conditions represent the highest possible development in the art of single-track operation is a question that can only be answered in the negative. The record of everything that has gone before points clearly to the elimination of that which has produced delays as soon as the demand for better schedules has become sufficiently acute and the means for supplying the demand have been at hand. At the present time there is no doubt about the necessity for getting more mileage from railroad equipment and one certain way to obtain it is to cut out unnecessary delays upon the road. The means for this accomplishment is available in the form of the modern single-track signal system. Apparently the only doubtful matter is the definition of the conditions under which it pays to introduce operation by signal indication only.



Track and Signaling Plan for Signaling System To Control Train Movements by Signal Indication

Manifestly, if traffic is very light the amount of time lost through the train-order system is small. As speeds increase, the danger of collisions demands that double-checks be provided against the failure of an increasing percentage of the parts of the protective apparatus, a perfectly feasible though somewhat costly proceeding. In consequence, it is hard indeed to believe that the signal will not take precedence over the train-order in the near future, at least on the busiest single track roads.

The foregoing, written in 1915 by an associate editor of a railway publication, shows a noteworthy perception of conditions becoming better recognized as we appreciate the possibilities of railway signaling. At the present time, the signal is too largely considered only in the light of a safeguard—an incident to operation rather than an essential, but with further investigations into the savings effected, the signal will also become known as a traffic accelerator.

There has undoubtedly been some hesitation to accept signals as sufficiently safe in operation but considering the remarkable performance records of many roads and the fact that train operation in subways is absolutely dependent upon their guidance because of

the very restricted view ahead, modern signal apparatus, properly applied, installed and maintained, will prove to give all desired safety.

Train operation by signal indication between interlocking or block stations having operators at signal locations being well established, the important future development would appear to be remote manual control and the following will outline the basis for a single track railroad.

General Features of the Auto-Manual System

The Auto-Manual Traffic Control System is a scheme of block signaling for single-track operation in which blocks affecting opposing train movements extend, (a) from passing siding to passing siding, and (b) between the ends of each passing siding, the signals at the entrances thereto being controlled manually by signal operators and automatically by continuous track circuits. A signal operator will control a certain number of blocks and cause the display of signals for all trains to proceed without written or verbal orders. This, of course, does not apply to work trains and others requiring special instructions. Signal operators will co-operate to provide for the proper movement of trains passing from one signal operator's section to the next section and all signal operators will be governed by instructions of a train dispatcher or other authority.

If justified by the number of stops which may be eliminated the switches at the ends of passing sidings and other selected locations will be controlled and operated by the same signal operator to expedite the movement into and out of sidings. Other switches may be provided with electric locks controlled by the nearest signal operator, who will give orders for entrance to the main line.

Additional signals intermediate to the entrance signals will be provided as required by traffic conditions for securing a shorter headway for following trains. The signal operator will control the signals and switches through the medium of an interlocking machine or its equivalent. A telephone system, local to each signal operator's section, will provide communication between the ends of passing sidings, all other switches and selected locations and the signal operator's cabin, communication being otherwise provided between the signal operator and train dispatcher. Visual and possibly audible indicators will advise the signal operator of the approach and location of trains he will control.

Definitions Covering Auto-Manual Scheme

The following definitions covering blocks, signals, etc., are included because not heretofore clearly defined:

1. **Opposing Block.** A length of track of defined limit in single track operation territory, use of which is confined to trains of one direction at any one time, opposing trains being blocked, and controlled by a signal or signals at each entrance.
2. **Siding to Siding Opposing Block.** An opposing block between adjacent passing sidings.
3. **Siding Opposing Block.** An opposing block on the main track between the ends of a passing siding.
4. **Intermediate Opposing Block.** An opposing block intermediate to and shorter than the distance between adjacent passing sidings.
5. **Following Block.** A length of track of defined limit extending from a signal to the limit of the 45° (or its equivalent) control of the signal as affected by a train after passing the signal in a proceed position
6. **Signal Block.** A length of track of defined limit extending from a signal to the next signal in advance for the same direction of traffic.
7. **Entrance Signal.** A signal at the entrance to a siding to siding opposing block or to a siding opposing block.
8. **Outgoing Signal.** A signal at the end of a passing siding for governing train movements entering the siding to siding opposing block. (See definition 2 above.)
9. **Ingoing Signal.** A signal at the end of a passing siding for governing train movements entering the siding opposing block. (See definition 3 above.)
10. **Intermediate Signal.** A signal located between entrance signals.
11. **Approach Signal.** (Distant Signal.) A signal which when in the 45° or 90° position, or its equivalent, is a repeater of the signal in advance.

Requisites for Auto-Manual Traffic Control System

1. The territory to be controlled or signaled to be divided into sections, each controlled by a signal operator, of such length or embracing such blocks or units as will permit proper train operation within the capacity of the signal operator.
2. Siding to siding opposing blocks, due consideration being given to (a) the points where a train must be stopped when an opposing movement is to be made, (b) the use or non-use of sidings for meeting trains and (c) shifting operations.
3. Siding opposing blocks with limits at passing siding end switches.
4. Standard signal indications and aspects.
5. Continuous track circuits.
6. Power operated signals.
7. Entrance signals so controlled that signal operator may place in stop position at any time.
8. A normal stop signal at the entrance to each siding to siding opposing block and to each siding opposing block.
9. Entrance signals so located as to govern movements over switches operated mechanically or electrically by the signal operator, also over switches which it is reasonable to assume will be so operated in the future.
10. Approach (distant) signals.
11. Take siding signals.
12. Interlocking to prevent simultaneous display of opposing proceed entrance signals, this secured by an interlocking machine or its equivalent in each signal operator's cabin.
13. Means for establishing and maintaining a direction of traffic with a time element to prevent sudden reversal of direction.
14. Entrance signals automatically placed to the stop position by the passing of a governed train and retained in that position until restrictions are removed and the signal operator operates certain apparatus to again clear the signal.
15. A telephone system, local to each section, connecting all switches or groups of switches and selected locations to signal operator's cabin and telephone or telegraph connection between signal operators and train dispatcher.
16. Indicators located in signal operator's cabin to show presence of trains in: (a) each signal block in approach to a main line interlocked signal; (b) each track section embracing a remote controlled switch.
17. Approach locking in connection with each interlocking signal having an approach signal.
18. Non-control by signal operator of switches used principally for shifting operations in which the switches are continuously set for the siding during such operations.

Adjuncts to Auto-Manual Traffic Control System

1. Block signals intermediate to the entrance signals to secure following blocks as required for traffic and proper headway for following trains.
2. Remote control operation by the signal operator of the switches and correlated signals at passing siding ends.
3. Remote control operation of switches other than passing siding ends, such as junctions or ends of extended passing sidings, with control by the signal operator of the section in which the switches are located and signals for proper control of train movements over same.
4. Electric locks for switches not remote controlled if used as entrance to the main line following a situation in which the switch is set for the main line.
5. Indicators located in signal operator's cabin to show presence of trains in sections of tracks not covered by indicators mentioned in Clause 16 of "Requisites for Auto-Manual Traffic Control System."

The foregoing is subject to changes to meet the many local physical and operating conditions peculiar to each property and installation. It is suggested the Signal section A. R. A. consider and formulate requisites and adjuncts of installation and possibly requisites of circuits for this important work.