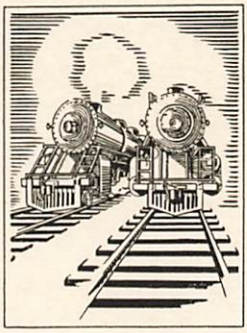

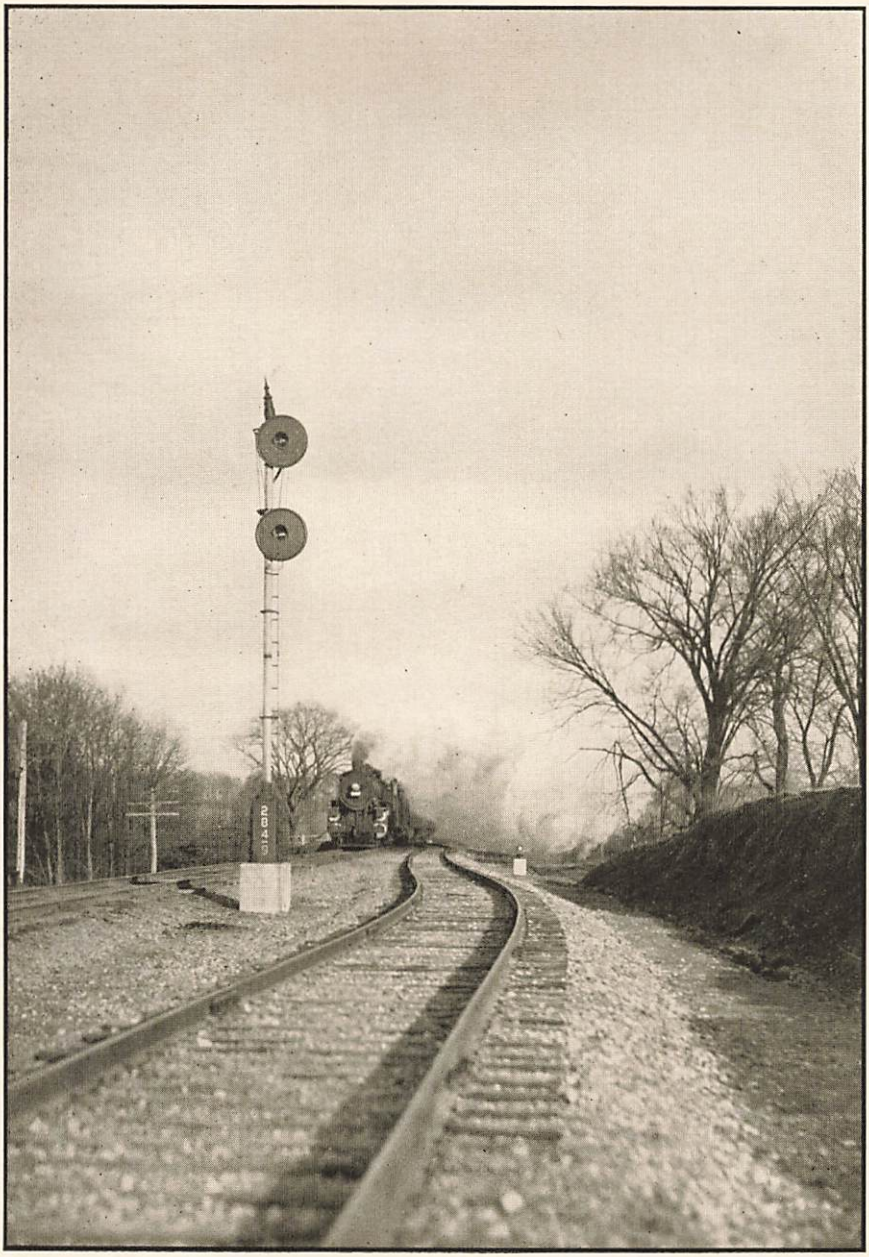

CENTRALIZED TRAFFIC CONTROL

Bulletin No. 148

UNION SWITCH & SIGNAL CO.
SWISSVALE, PA.

Preface

WHEN the first telegraphic train order was sent by Superintendent Charles Minot of the Erie on September 22, 1851, a new era in railroad operation was inaugurated. For prior to that date the time card was the sole reliance of the railroad man for getting trains over the road.

The telegraphic train order greatly reduced the former delays to trains which were required to wait one hour for opposing trains, then proceed under flag until they met. In spite of the great advantages resulting from the written train order, it has its limitations as well. And it has been only through the development of modern signaling systems that many of its shortcomings have been mitigated.

Through the development of the "Union" Centralized Traffic Control System the written train order now may be discarded, for orders can be delivered to the train *by signal indication* at the point where action must be taken.

The "Union" C. T. C. System, as described in the following pages, is flexible enough to meet the numerous operating problems arising on the railroads. Its application enables railroads to operate entire divisions by signal indication from a centralized point or to correct certain troublesome operating conditions on short sections of track with a minimum of materials and labor. This bulletin describes how the railroads are using the "Union" C. T. C. System for making further substantial reductions in operating costs.

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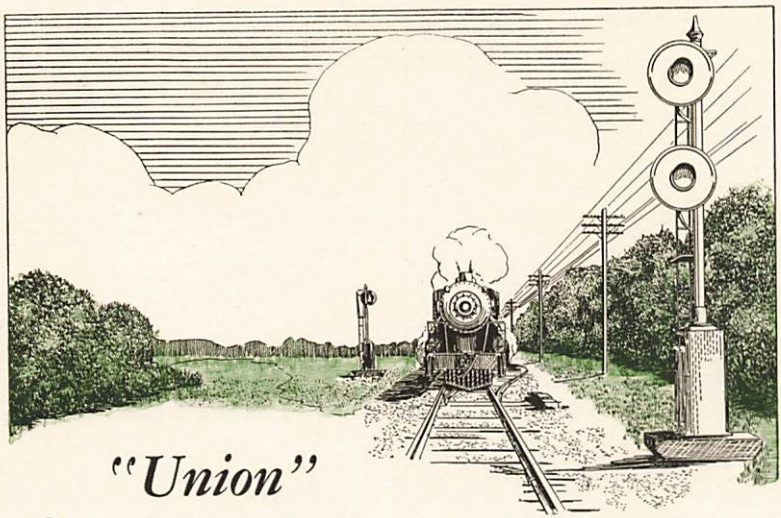


"Union" CENTRALIZED TRAFFIC CONTROL

RAILROADS ARE LIMITED in the charges they may make for their services. Stockholders and managements are looking to the operating officers for a lower cost per traffic unit so that they may earn a satisfactory return upon the money invested in the system. The operating officers are charged, not only with the task of keeping operating expenses at a minimum, but also with the utilization of physical property to its fullest extent. It is important that the fixed as well as the direct charges applicable to each ton-mile or passenger-mile be kept within reasonable bounds.

The revenue of a railroad is dependent directly upon the production of ton-miles; its expenses are largely dependent upon the train miles and train hours required in that production. Tonnage offered the carrier for transportation fluctuates with business conditions and is, therefore, ordinarily beyond

the control of the railroad. Operating expenses are, however, subject to control of the management to a great degree and remarkable strides have been made by American railroads in the improvement of operating efficiency and the reduction of expenses during the past decade.

Modern signaling has contributed a great deal to this program of efficient transportation and is capable of doing much more. Operating officers have found that, in addition to providing for more expeditious handling of trains with greater safety, signal installations have increased the capacity of the line to the extent of deferring the need for major additions to trackage. Such additions may be postponed for sufficiently long periods that the initial cost of the signaling has been saved several times over out of the conserved capital cost of the more expensive trackage improvement.

The "Union" Centralized Traffic Control System, which is among the latest developments in railway signaling, provides a means for the more efficient handling of trains and the more economical utilization of existing trackage. It is in accord with the trend to more efficient transportation by greater utilization of existing operating units and facilities. In addition to cutting the direct costs of operating trains by reducing their time on the road, the system, where it defers the addition of trackage, cuts the indirect or fixed charges of producing transportation.

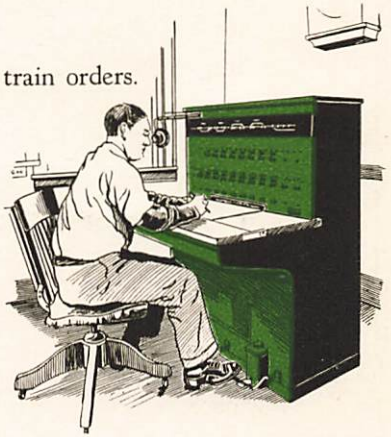
This system goes a step beyond any previous development in the railway signaling field in that it combines all the functions of control over traffic into one centralized unit, permitting train operation by signal indication without the use of written train orders. Protection, direction and the actual manipulation of switches and signals for the passing of trains are brought about by this system. It is adaptable to any existing signal installation and can be applied in combination with

any type of automatic signaling, train control, cab signaling or power interlocking installation. It may also be applied in connection with manual block signaling to handle special situations.

"Union" Centralized Traffic Control may be applied to double and multiple track lines as well as to single track lines. The centralized control features may be employed for the economical control of an interlocking or of a single outlying switch. The system may be applied to a short section with a particular operating problem or to a full division where the entire operation can be handled by signal indication. Consideration of this modern method of signaling will often reveal its economical application to operating situations of all kinds where more intensive use of tracks is required.

Advantages of the "Union" Centralized Traffic Control System

1. Increases
   - (a) Net earnings.
   - (b) Productive use of equipment.
   - (c) Safety of train operation.
   - (d) Track capacity.
   - (e) Switch point protection.
   - (f) Car miles per car day.
   - (g) G. T. M. per train hour.
2. Reduces
   - (a) Train delay.
   - (b) Number of train stops.
   - (c) Number of operators required.
   - (d) Danger of misunderstanding of train orders.
   - (e) Number of train orders.
   - (f) Possibility of collisions.
   - (g) Fuel consumption.
   - (h) Train miles.



3. **Provides**
   (a) Prompt and correct automatic "OS"es.
   (b) Greater protection to work and extra trains.
   (c) Approach and section locking at each power-operated switch.
   (d) A model board which shows the operator the train movements over the entire controlled section.
   (e) The operator with instant information relative to trains holding to schedule or losing time.
   (f) The advantages of either-direction signaling.
   (g) Additional "OS"ing points.

4. **Facilitates**
   (a) Switching movements.
   (b) Meets on close schedule.
   (c) Handling of additional traffic.
   (d) Stopping trains in case of emergency.

5. **Saves**
   (a) Running time by transmitting orders by signal indications.
   (b) Stops or reduction in speed for delivery of train orders.
   (c) Necessity for additional trackage.
   (d) Locomotive hours.

6. **Is Universal in Application.** May control all signals and switches or a portion of them in a given territory, or simply the signals. Can be used on one or more tracks to speed up operation under a variety of conditions.

7. **Centralizes** control of train movements in charge of one instead of a group of operators.

8. **Transmits Orders Instantly** and directly by signal indication without requiring co-operation of second party.

9. **Provides Safety** by making it impossible for opposing trains to get clear signal for the same block.

10. **Costs Less** than any alternative capital improvement providing equivalent increase in capacity.

11. **Saves Most** train time per dollar of investment.

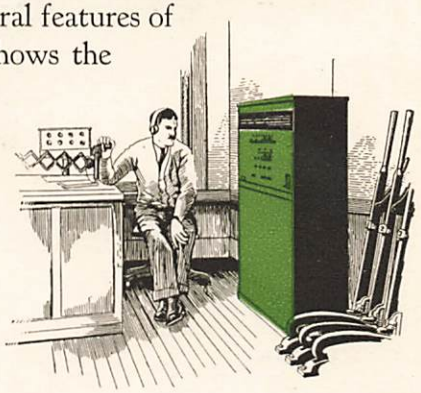
Extent of Application

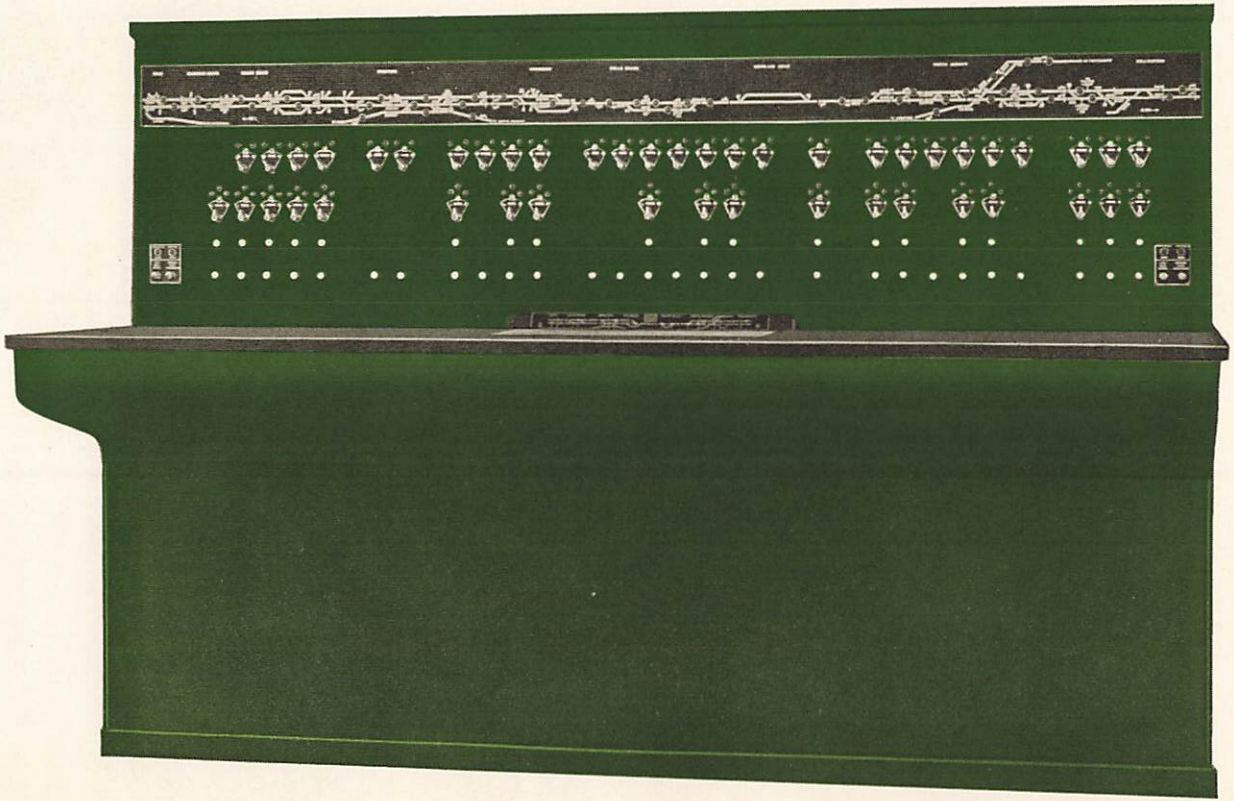
THAT THE "UNION" C. T. C. SYSTEM, because of its flexibility and adaptability to all operating conditions, has met with the favor of the railroads is evidenced by the number of installations now in service or under contract. The first extensive application of this system was only made on the Pere Marquette in 1928. Those installations in service, including the remote control applications, range in length from approximately 1 track mile to 100 or more track miles, and include from 1 to 55 controlled switches.

The remote control installations utilize the C. T. C. principle, in that but two or three line wires are required, thus dispensing with expensive pole-line construction. The installations permit additional controlled switches and signals to be placed in service at any time in the future without the necessity of stringing other line wires for their control.

The "Union" C. T. C. System is not only adapted to single track operation, but is proving its worth also in connection with multiple track operation where it is desired to run trains on either track in either direction by signal indication. An example of this type of installation is that under construction between Dover and Rigby on the Boston and Maine for the control of 35 miles of single track and 34 miles of double track for "either direction" operation.

Elsewhere in this bulletin are shown actual applications of this system for solving operating problems together with a brief description covering the general features of each installation. A table also shows the installations in service or under contract with certain information pertaining to each installation.





The control machine may be located at any convenient place on the division.

Component Parts of the System

THE "UNION" C. T. C. SYSTEM combines the safety features of modern automatic signaling, either-direction signaling and power interlocking. Each end of each passing siding is, in fact, a small interlocking plant, remotely controlled from a designated point on the division. The signals between passing sidings operate automatically on the well-known A. P. B. principle whereby the block for opposing trains extends from passing siding to passing siding while permissive moves in the same traffic direction may be made.

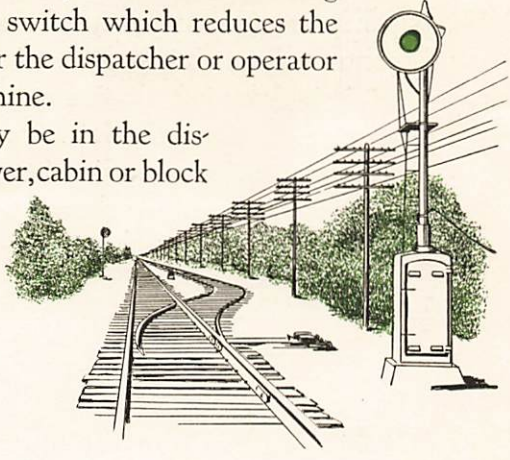
CENTRALIZED TRAFFIC CONTROL

The units making up the C. T. C. System are the control machine, the automatic train-graph, the controlled wayside signals, power-operated switch machines, and other signal apparatus.

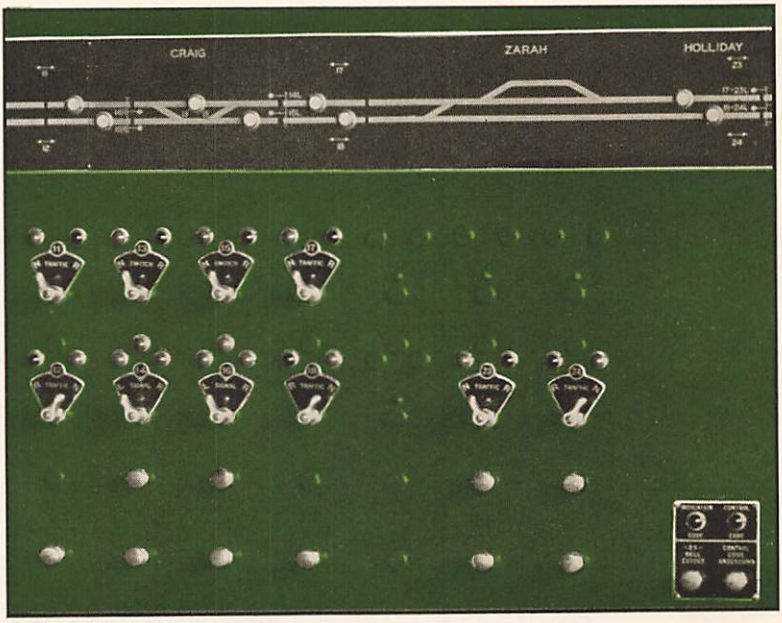
The power-operated wayside signals may be of any standard type in use on American railroads or the indications may be carried directly into the cab of the locomotive by use of the "Union" Continuously Controlled Cab Signal System.

The power-operated switch machines more often used are of the dual-control type which permit hand operation, as occasion requires. Switch machines may be electric (d. c. or a. c.) or electro-pneumatic, dual control being available for each type. Thus local freights may do station switching by manual operation of the switch which reduces the amount of work necessary for the dispatcher or operator in handling the control machine.

The control machine may be in the dispatcher's office or at some tower, cabin or block office on the division and it may be handled by the



dispatcher, an operator, leverman or designated employee working under instructions from the dispatcher. As the control machine provides for the housing of all code-sending



On the control machine is a miniature track layout of the district.

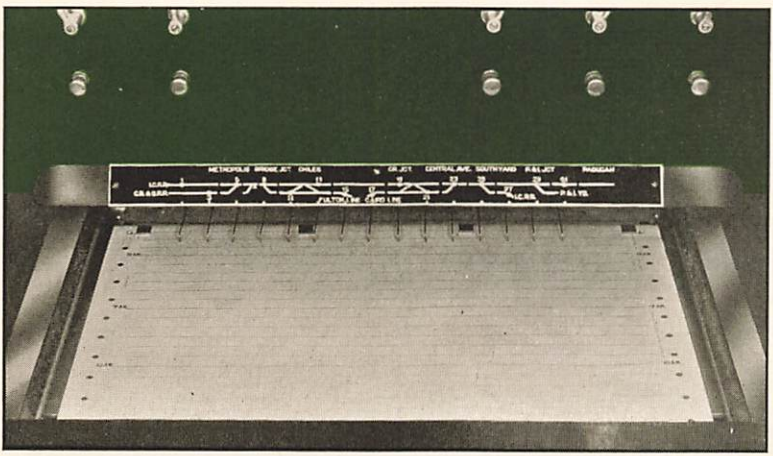
and receiving equipment at the control point, the space required is determined only by the size of the machine.

On the control machine before the operator, is a miniature track layout of the district. Colored lights indicate the occupancy or non-occupancy of the track circuit in which each controlled switch is located. Additional track circuits as may be desired for information may be indicated, thus making it possible to show the locations of trains between stations. Indication lights to advise the operator if the functions have responded properly to the movement of the levers are located directly above the levers on the control panel. These indica-

tion lights show at all times the locked position of the switches and whether the signals at the ends of passing sidings are in the clear or stop position.

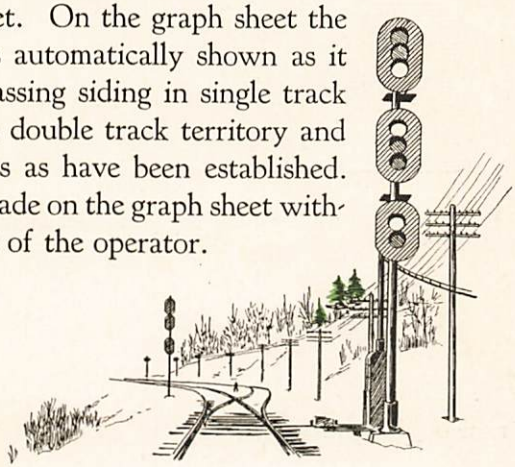
The Automatic Train-Graph

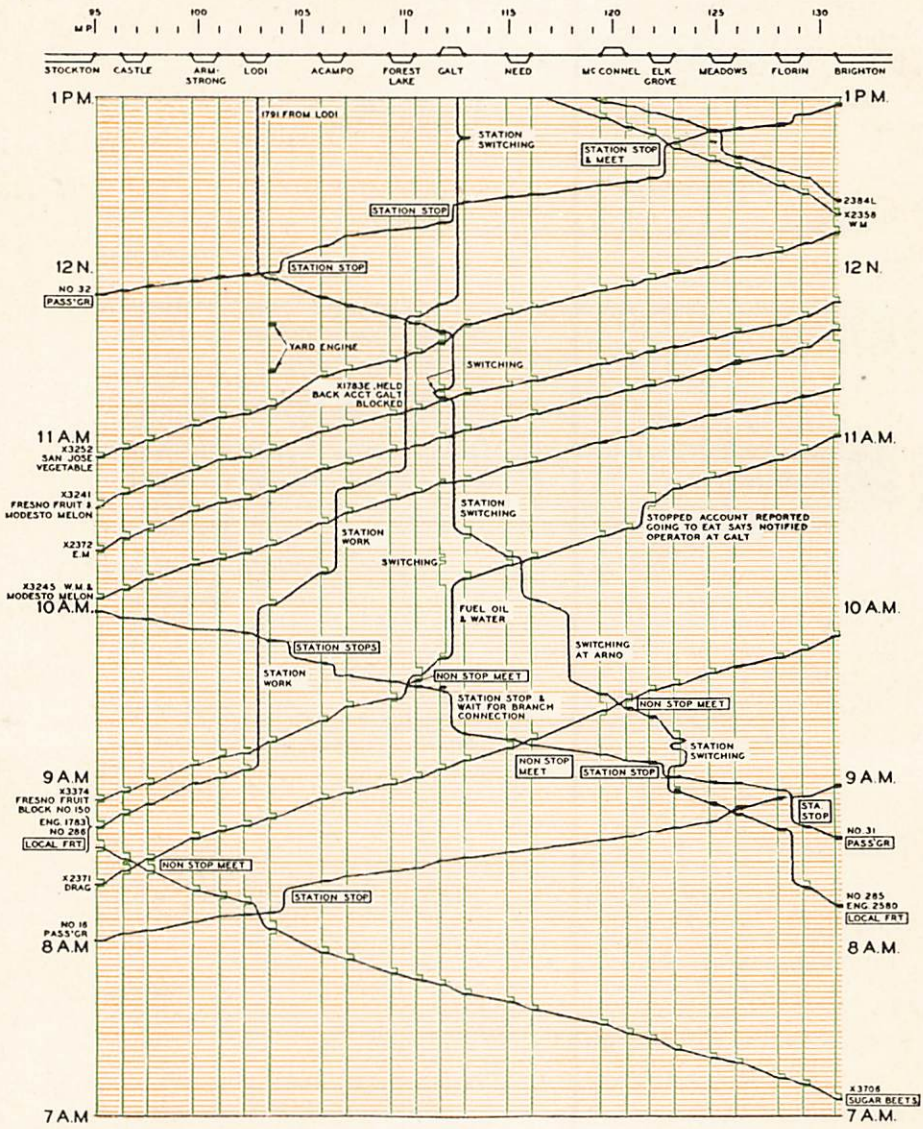
One of the important units entering into this system is the automatic train-graph which is part of the control machine,



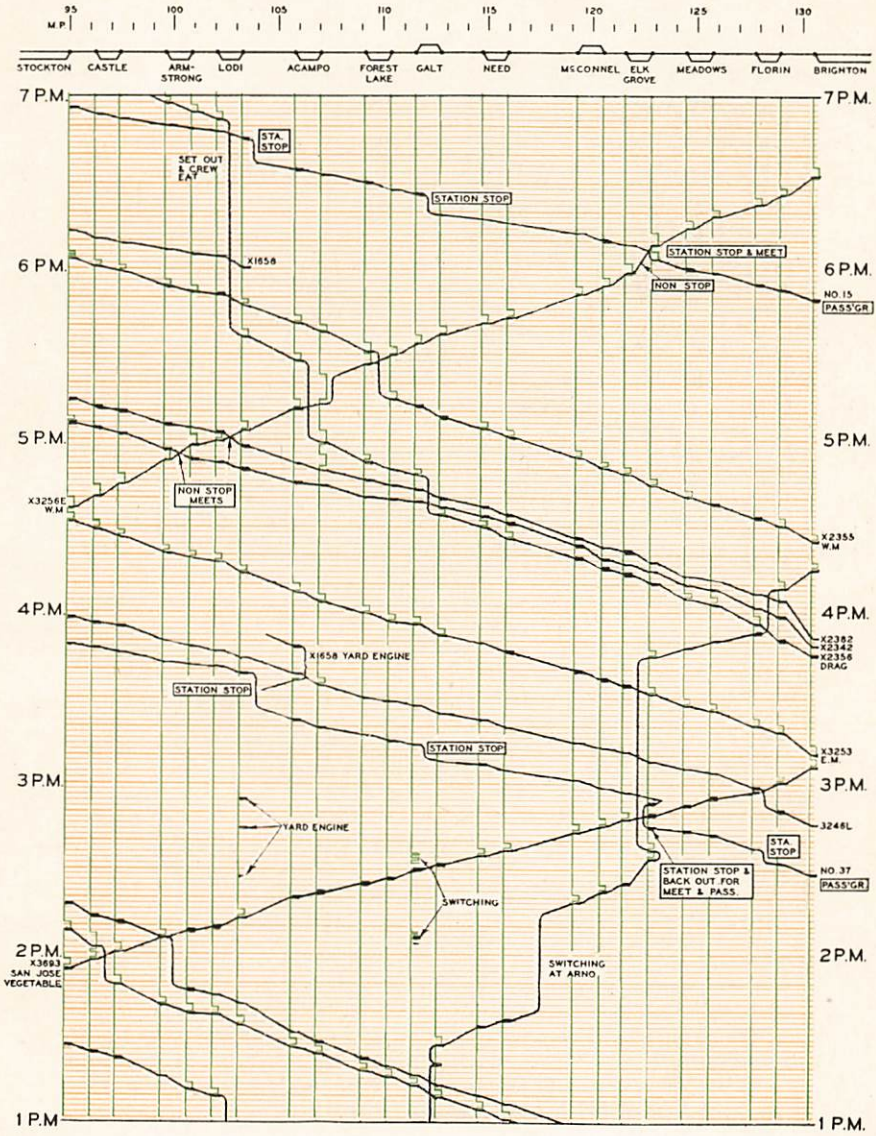
Movement of each train is automatically shown on the graph sheet.

particularly on the longer and more important installations. The automatic train-graph is so located on the machine that the graph sheet is visible under a glass cover on the desk which is part of the cabinet. On the graph sheet the movement of each train is automatically shown as it passes each end of each passing siding in single track area and each crossover in double track territory and such other "OS"ing points as have been established. This permanent record is made on the graph sheet without any action on the part of the operator.

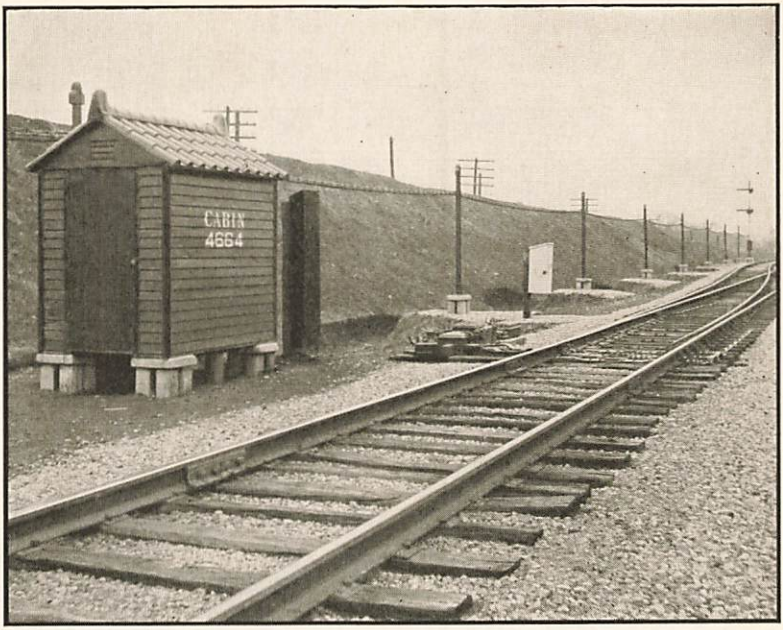




Reproduction of an actual train graph for a typical 12-hour



period on the Southern Pacific Stockton to Brighton installation.



The field equipment at end of passing siding is called a "station."

To secure this information under the train-order method of operation, it is necessary to have an operator at each station or block office to telegraph or telephone the time of the train's arrival and departure and for the dispatcher to record this on the train sheet. At stations and other points where no operators are on duty, or when the offices are closed part time, the information is not available and this frequently results in considerable delays to trains, particularly at night. Thus the automatic "OS" gives the dispatcher the equivalent of an operator at each end of each passing siding and at every other point where an "OS" is desired; this without the work required in receiving these reports and the expense of maintaining additional operators over the territory.

As the "OS"es are graphically recorded on the train-graph

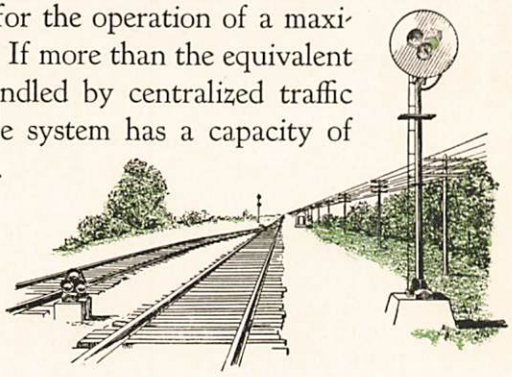
sheet, the passage of trains over the territory is not only brought to the attention of the operator, but a permanent record is produced which may be attached to the daily train sheet. This record is made even though the operator momentarily may be otherwise engaged and it is only necessary for him to glance at the graph sheet which shows the location of all trains.

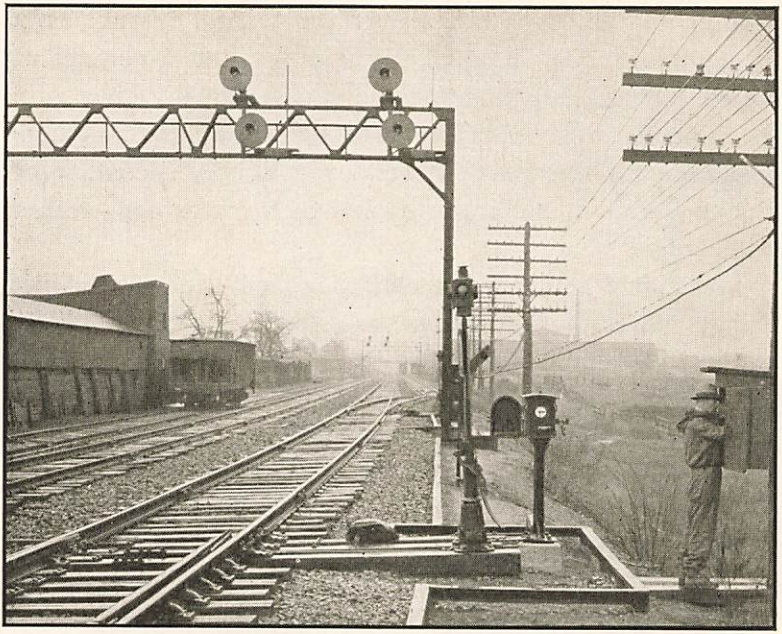
The train-graph, together with the other indications, makes the system one which gives the dispatcher or operator an audible, visual and permanent record indication of the location and movement of trains. The visual indication is given by the lights on the control panel; the audible indication by a single stroke bell which may be used at the will of the man in charge of the control machine to call his attention to a particular train's arrival at a certain point.

The Code System is Rapid and Flexible

The control of wayside equipment throughout the territory is obtained by means of a coded relay scheme which is very rapid in operation. These codes are sent out from the control machine by pushing the starting button after the switch and signal levers have been moved to the desired position.

Through the employment of the code system, up to 35 stations can be controlled and indicated over 2 line wires; over 3 wires, as many as 81 stations can be so controlled. The term "station," as used herewith, represents the field equipment at one end of a passing siding; therefore, for one passing siding there are two field stations. Consequently, the two-wire code system provides for the operation of a maximum of 17 passing sidings. If more than the equivalent of 17 sidings are to be handled by centralized traffic control, the three-wire code system has a capacity of more than 40 passing sidings.





Main line switches, not power-operated, are sometimes electrically locked.

By using the "Union" two or three-wire code system it is possible to locate the control machine at one end of the controlled territory, near the center, or miles away. It is thus apparent that the code system is very flexible.

The code equipment for a controlled switch location will operate all functions normally operated by one switch lever, including both ends of a crossover or a switch and derail.

It is not always advisable or necessary, from an operating standpoint, to equip all main line switches for power operation. When main line switches in the controlled territory are not power-operated at locations where trains may clear the main line, they are sometimes electrically locked. In this way, control is maintained over the use of the switch by the operator of the C. T. C. machine.

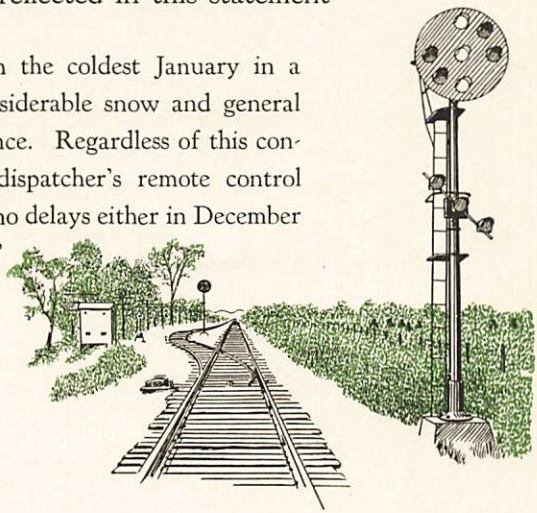
Reliability of Operation

THE QUESTION is frequently asked as to the effects of snow, sleet and other adverse weather conditions upon the operation of the power-operated switches and signals at isolated locations many miles from the point of control.

During snow or sleet storms or at times when rain freezes as it falls, the dispatcher or operator will manipulate his switch levers frequently enough to prevent the switch points freezing up or becoming clogged with snow. In the event of a switch being obstructed by snow, sleet or ice the dispatcher can, by stopping the train, instruct the train crew to enter siding and to sweep out the switch if necessary, after which it may be power-operated. Through the use of the dual-control power-operated switch machine it is a simple matter for the train crew to hand-operate the switch, as it is easily moved by means of the lever for hand operation. The weather conditions mentioned would not interfere with the operation of the signals, the only possibility of delay being in the obstruction of the switch. It might sometimes be desirable to have extra attention given to cleaning out certain switches by track maintenance forces.

An evidence of the excellent performance of power-operated switch machines is reflected in this statement of a railroad officer:

"We have just passed through the coldest January in a number of years, along with considerable snow and general bad weather for proper maintenance. Regardless of this condition the performance of the dispatcher's remote control equipment was perfect. We had no delays either in December or January due to the equipment."

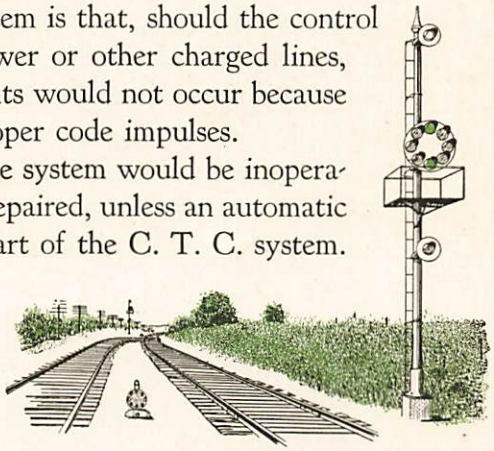


To hand-operate switch, trainman calls operator for authority. When granted, operator places tag on switch lever. Trainman then throws selector lever setting opposing signals red and hand-operates the switch as required.

Adverse weather conditions do not interfere with proper operation.

Another question which frequently arises is, "What happens should a cross occur between the two or three wires used throughout the territory for the control of the equipment?" A cross on the control wires would make inoperative the stations located beyond the cross, but the operator would have control and could operate the stations from his machine up to the station nearest the cross. An additional safety feature of the "Union" C. T. C. System is that, should the control lines become crossed with power or other charged lines, false signal or switch movements would not occur because they respond only to their proper code impulses.

Should a line wire break, the system would be inoperative until after the break was repaired, unless an automatic feature was incorporated as part of the C. T. C. system.



C. T. C. Helps Solve Superintendent's Problems

ONE OF THE PROBLEMS confronting the superintendent is to get trains over the division in the shortest time without undue and unnecessary delay. He is striving constantly to lower his division operating costs because, in so doing, he is providing better service for his patrons, the shippers, and he is also helping to lower the operating ratio for the railroad.

Many costly delays arise through the use of the written train-order system because of the time consumed in calling operators, repeating, checking and completing orders. Their delivery to trains necessarily slows down or stops the trains to obtain information for them to proceed. Before these orders may be issued, it is necessary that meets be arranged considerably in advance of the time the meets are actually made and conditions may change whereby the superior train may fail to make its schedule, thus necessitating a complete realignment of orders or costly delay to the other train.

Delays to trains are more frequent in territory where telegraph offices are far apart and additional delays occur through errors and tardiness in the "OS"ing of trains. When many trains are on the road, the dispatcher has no idle moments because, when he is not sending orders and checking their repetition, he is busy recording "OS" reports on train sheet.

The dispatcher is expected to keep passenger trains running on time; to keep freights out of the way of passenger trains; and to give certain manifest, symbol or "red ball" trains virtually the same treatment as is accorded passenger trains. Conditions, such as the 16-hour law, the livestock confine-

ment law, and many other requirements of state and national regulatory bodies must engage his attention.

Train dispatching has developed from the time, after the telegraph was invented, when conductors on trains would arrange their own meets, until the time when train orders were handled from division points—the orders being sent by the superintendent or his chief clerk, acting in his absence, to the time when train dispatchers were appointed to issue all orders for the operation of trains. As traffic continued to increase and it was necessary to promote greater economies, more and heavier burdens were placed upon the dispatcher until, to meet these conditions and simplify the work, the "Union" C. T. C. System was developed.

CENTRALIZED TRAFFIC CONTROL

Centralized Traffic Control eliminates much of the "red tape" from train dispatching and makes it possible for the dispatcher to confine his attentions to the actual arrangement of meeting or passing points. Automatic "OS" reports, as produced by the "Union" C. T. C. System, are always accurate and are not subject to the time interval in their reception.

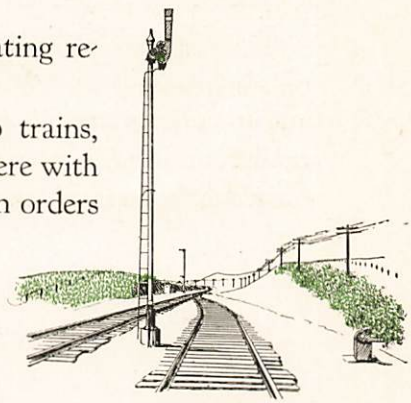
Eliminating Delays at Yards

Substantial delays to trains getting out of the yards are due to train-order requirements and could be eliminated by the movement of trains by signal indication. Delay at yards may generally be classified under two heads:

1. Those incident to yard operation and the classification and making-up of trains.

2. Those incident to road operating requirements.

Yard delays due to making up trains, inspection, etc., are bound to interfere with dispatching trains by means of train orders



which must be placed for trains in advance of the action required of them. The "Union" C. T. C. System makes it possible to move opposing trains without dependence upon the estimates of yard forces which cannot, by the very nature of yard operation, always be accurate.

Under a system of operation using "Union" C. T. C., the dispatcher could always operate his district without delay, with respect to those trains within the territory and ready to enter it, rather than being hampered by consideration of trains called out of a terminal which may or may not be ready. The flexibility of Centralized Traffic Control makes it possible to keep the *maximum number of trains in motion at all times* and permits the dispatcher to transmit orders by signal indication *at the time they are to be executed* rather than in anticipation of a series of events which are problematical.

With the "Union" C. T. C. System to aid the dispatcher he is able to take immediate action, in the event of unforeseen contingencies, to keep traffic in motion and to secure the maximum utilization of his trackage with minimum delay and the least confusion.

The capacity of the line is dependent not only upon the line itself but also upon the yards through which the traffic must pass. The capacity of existing yard facilities and sidings along the line should be such as to permit a greater use of "fleet dispatching" and reduce the number of meets to a minimum. The use of a "Union" C. T. C. System, with adequate sidings, affords a means of regulating the flow of traffic by providing points where less important trains can be held and more important ones run around them. Thus one unit in a transportation machine may work to the benefit of another, and to the more efficient handling of traffic through a series of transportation facilities.

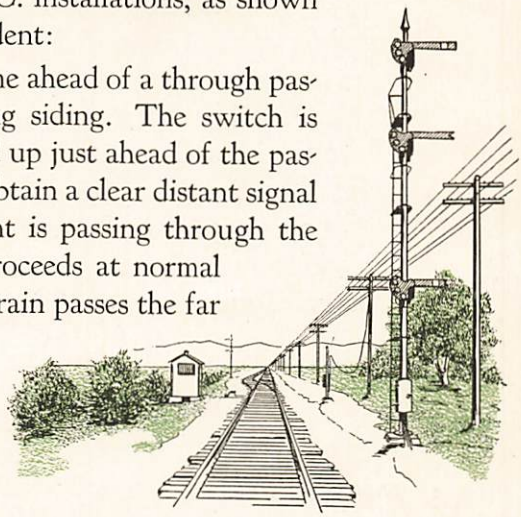
Expediting Traffic

TRAFFIC IS EXPEDITED by the "Union" C. T. C. System because all trains are moved by signal indication, regardless of time-table superiority. No delays occur awaiting the transmission and delivery of train orders at stations along the line. The movement of through trains is expedited by the elimination of train orders and local trains can spend a larger portion of their time in productive work.

The dispatcher is not concerned with trains which are to leave terminals until they are actually ready to depart. Under normal train-order operation, where there are only a few operators on the territory, the effect of trains in yards has to be considered if the dispatcher does not desire to slow up opposing moves.

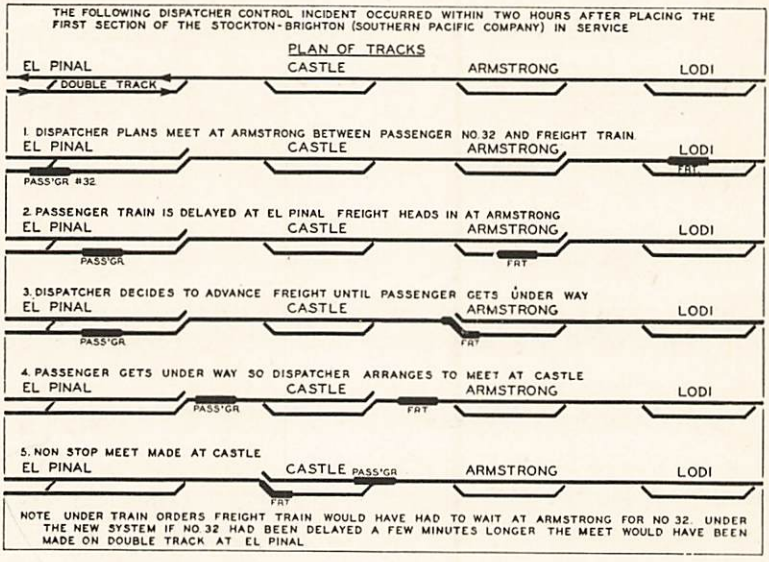
An advantage which the "Union" C. T. C. System provides for double track operation is that trains may be run around each other with ease when it is desired to put a following train into a terminal ahead of a preceding train of less importance. These orders can be given and the switches operated without relying upon any other means of communication than the switch and signal levers on the control machine. The ease with which this can be done is frequently evidenced on existing C. T. C. installations, as shown by the following typical incident:

A freight train on short time ahead of a through passenger train, enters a passing siding. The switch is placed normal, signals cleared up just ahead of the passenger train in time for it to obtain a clear distant signal indication. While the freight is passing through the siding the passenger train proceeds at normal speed. After the passenger train passes the far



end of the siding, the switch is reversed for the freight to continue on its way. Neither train has been stopped.

A very striking feature of how a "line-up" may be shifted to prevent delays to trains is illustrated in the accompanying diagram. Just two hours after four stations on the Southern



Ability to change "line-up" instantly prevents train delays.

Pacific, Stockton to Brighton installation were placed in service, passenger train No. 32, having left El Pinal, was unavoidably delayed near the end of double track. In the meantime, a freight was at Lodi and the dispatcher planned to make the meet at Armstrong when the report reached him of the delay of No. 32. The dispatcher immediately lined up the exit end of the passing siding, permitting the freight to continue on its way. The dispatcher then put the freight in on Castle siding, both trains passing each other without either having to stop. This illustration is just one of the many advantages of the "Union" system for expediting traffic.

Economic Advantages

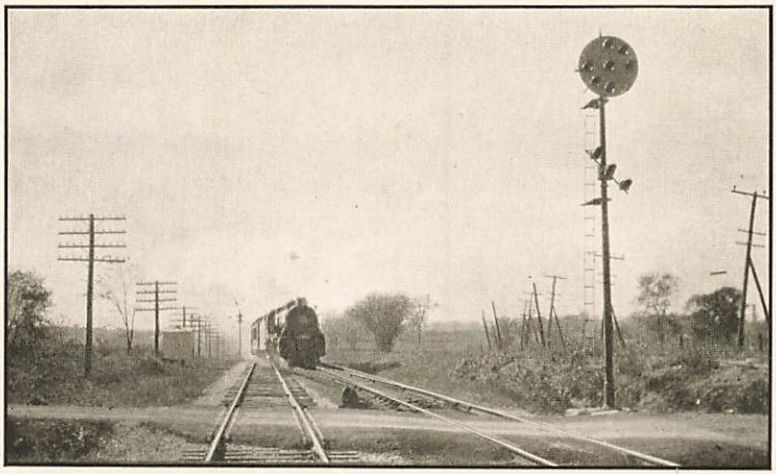
ECONOMIC ADVANTAGES resulting from the installation of the "Union" C. T. C. System are many. These advantages result from the fact that the methods of operation employed have been tested by time and have met with the approval of the most conservative railroad officers. The advantages may be classified under two general heads:

1. The conservation of capital by providing increased capacity of existing facilities at a much lower cost than by any other improvement.

2. The reduction of operating expenses by providing for greater efficiency in the movement of trains; by reducing the number of train hours and by the elimination of train stops to take sidings or receive train orders.

Among operating expenses, the savings will be greatest in the individual items which go to make up the direct cost of running trains, such as overtime wages, fuel, the wages of telegraph operators and the expense of maintaining the telegraph and block stations; but there will also be a great many other operating accounts in which savings will be brought about by greater operating efficiency.

The saving in equipment costs as reflected by reduction of per diem charges and the release of equipment for a new tour of productivity is important although, in absolute amount, ordinarily it does not compare with the wage and fuel savings. The speeding up of traffic makes it possible to move the tonnage of the division with fewer locomotives and brings about a saving in locomotive costs, because the released power ordinarily can be used at other points on the



Train stops for throwing switches are eliminated.

railroad. The purchase of new cars also can be deferred because of the increased availability of existing locomotives for service. On some installations it has been found possible to increase train loads because of the fact that trains can be run into sidings without stopping.

Among the specific economic advantages of the "Union" C. T. C. System may be mentioned:

1. Delays Are Reduced.

Under the C. T. C. System the dispatcher can operate from minute to minute instead of from hour to hour because no time is required to change the line-up when it becomes necessary to do so. Under the train-order method of operation, the dispatcher must base his estimates of meets upon future train performance. This makes it necessary for him to take into account the train movements to be made an hour or more after the issuance of an order. Should these superior trains fail to meet the expected performance, the inferior trains frequently will be tied up because the train-order system

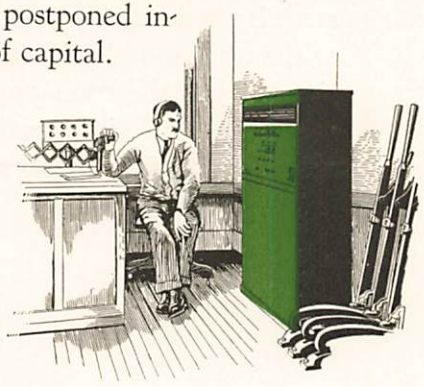
requires so much time in the transmission of orders that it is not always possible to afford relief to them by new orders.

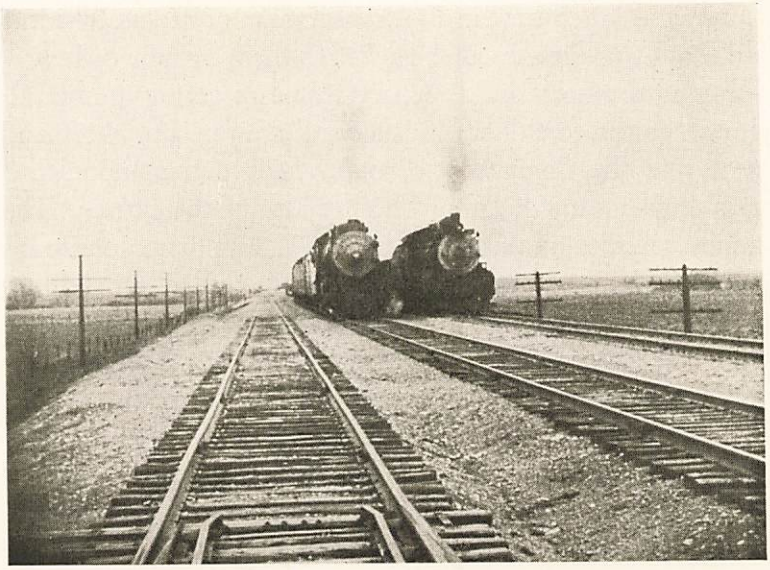
Railroad officers in all departments are giving greater attention to the cost of train delay and are realizing more and more that the elimination of unproductive train hours and train stops means dollars in the treasury of the carrier. The money value of a saved train hour will vary with conditions on each road, but in a number of cases has ranged from $15.00 to $20.00. Where competitive conditions are severe a train hour saved may be worth much more. Where a road is near its margin of capacity, the saving of a number of train hours each day will be of even greater importance.

Slow-downs and stops are eliminated and trains are kept moving when they are directed by signal indication instead of by train orders. Train stops for throwing switches are also eliminated because the power-operated switches keep the trains moving. The train stop saved has a wide range of values depending on the length and tonnage of the typical train involved and the characteristics of profile on the road. This value for a typical freight train stop may range from $1.00 to $3.00 or more.

2. Track Capacity Is Increased.

Train operation over a division is much smoother when trains can be kept moving. Trains are kept moving by the "Union" C. T. C. System because delays are reduced and track capacity is increased. Because the track capacity is increased on single track lines, double tracking, which is often prohibitive in cost, is frequently postponed indefinitely with a resultant saving of capital. By the application of this system for either-direction operation on multiple tracks, the track capacity





"Union" C. T. C. provides either-direction operation on multiple tracks.

is increased materially or to such an extent that the construction of additional main tracks often can be postponed.

3. Increase in Safety.

The facilities provided by the "Union" C. T. C. System greatly reduce operating hazards. The operating facilities include dispatcher or operator control of the signals in use at points where it is necessary to direct train movements such as at passing sidings, switches, ends of double track, crossovers, junctions, etc. The same man also has control of the power-operated switches in the territory. The train movement is automatically made visible for the operator by means of the track model with its colored indications, and, in addition, he has the train-graph which automatically gives the necessary "OS" information for each train. Because this system reduces train delays and trains are kept moving, safety

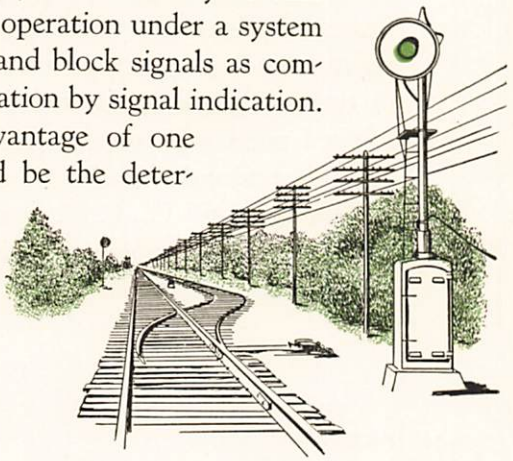
is increased. It has well been said that "a standing train is a liability."

4. **Freight Train Operating Costs Are Reduced.**

Whenever the operating costs are unduly high on a portion of railroad, even though no serious consideration of additional tracks is involved, it will pay to investigate the running of trains by signal indication and operating siding switches by the "Union" C. T. C. System. The savings in direct operating costs alone will ordinarily make the installation financially desirable. By reducing freight train delays through the elimination of unnecessary stops, the average speed of trains between terminals is increased without increasing the speed while in motion. This increase in average speed decreases train hours, crew overtime and fuel and also increases track capacity.

A decrease in the train hours increases the efficiency of a transportation system because less labor and fewer cars and locomotives will be required to produce a given output of ton-miles. Through the increased track capacity afforded, the need for additional main track may be postponed indefinitely as is shown by records of many C. T. C. installations at present in service; thus heavy expenditures for additional main tracks are postponed, effecting large savings in operating, maintenance and interest charges.

In order to determine what particular system of operation is best adapted to a road's use, it is necessary to take into account the cost of train operation under a system of time-table, written orders and block signals as compared to the cost of train operation by signal indication. Therefore, the economic advantage of one system over the other should be the determining factor as to the system to be used and the cost



Modern signaling makes possible large improvement in freight service.

of the installation must be balanced against the estimated saving.

Modern signaling has been largely instrumental in bringing about large improvement in freight service. The shipping public has quickly noted this improved operating condition and accordingly has taken advantage of it to reduce the amount of stock formerly maintained for their restrictive businesses. Still better and more dependable freight service will result from further reductions in avoidable train delays. This, in turn, will react upon the shipping public in building increased good will toward that railroad which supplies the class of service desired.

The "Union" C. T. C. System is not only applicable to single track lines where the elimination of the written train

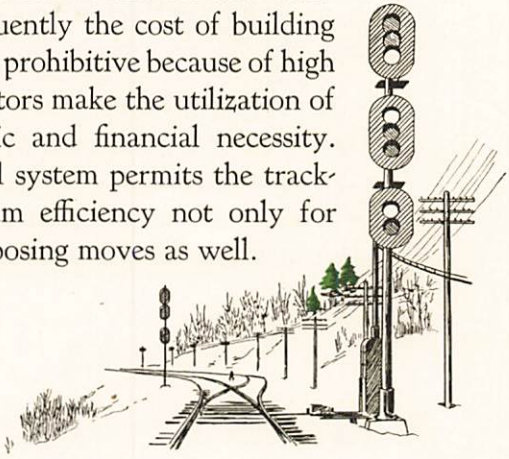
order is a great factor in the promotion of operating efficiency, but is applicable as well to double or multiple track layouts where greater capacity of line can be secured by operating trains against the normal current of traffic by signal indication. The advantages of the system, particularly as it is applicable to double track situations in the immediate vicinity of terminals, has attracted some consideration. Some of the reasons for installing C. T. C. on double track lines are:

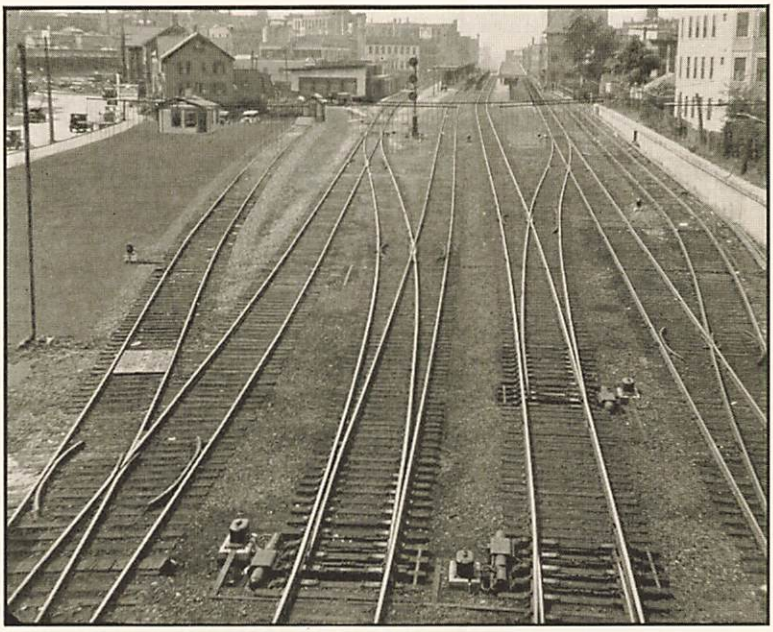
1. Directional Peak Traffic—Double Track.

Because of the fleeting of trains from terminal territory after business hours, there is a heavy volume of traffic in one direction during a portion of the day which can be expeditiously handled on existing tracks, provided they are made available for safe train operation. The cost of providing the new signaling and necessary crossover facilities is nominal compared to the cost of building additional tracks and other facilities. This method of operation permits the handling of freight trains at a time when the passenger movement in the same direction is heavy and the movement on the opposite track light.

2. Heavy Traffic in Terminal Zones.

The growth of industries and suburban passenger business in some localities has greatly increased the number of trains required for the movement of passengers and freight. The existing trackage cannot handle this increase without serious delays and frequently the cost of building additional trackage is almost prohibitive because of high property values. These factors make the utilization of existing tracks an economic and financial necessity. An extremely flexible signal system permits the trackage to be used at maximum efficiency not only for following moves but for opposing moves as well.





Heavy traffic in terminal zones requires flexible and safe operation.

3. Keeps Tonnage Freight Moving.

With the advent of longer and heavier freight trains with heavier power, it becomes all the more essential to keep these trains in motion whenever possible. Lighter freight trains and even passenger trains can be routed around the slow tonnage train on other tracks which are not in use for the normal direction of traffic, in that particular territory. Such procedure enables tonnage freight to make increased mileage per day and results in economy of train operation.

4. Widens the "Bottle Neck."

The existing trackage may not be sufficient to handle the increased business available from certain yards or terminals on the normal traffic lines. The present trackage can be made available for the safe movement of this new business

in a much shorter period of time without as large a capital expenditure as would be required to build new track facilities.

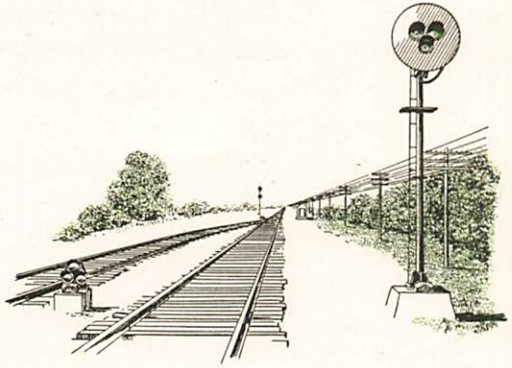
5. Emergency Detours.

During emergency conditions, such as wrecks, etc., the ability to use one or more tracks at will, by simply giving the proper signal indications, is an important factor in reducing traffic delays.

6. Speed Factor in Competition.

Competition among the railroads has resulted in improved passenger and freight service which has overtaxed the older track facilities with train order operation and made it necessary to utilize the existing trackage to its capacity in the most economical manner. Modern signaling plays a big part not only in reducing operating costs but in expediting fast competitive traffic.

Economic studies of the performance of C. T. C. installations on various railroads show estimated annual returns upon the investment, above interest and maintenance charges, which in some cases exceed 50 per cent, with traffic varying from 15 to 46 trains a day. The time saved per freight train on some installations is averaging about one minute per mile of signaled territory.

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