three-phase wire. Let W represent the weight of each three-phase wire, then the total weight of the three wires will be 3 W. The weight of each single-phase wire will be 2 W and the weight of the two single-phase wires will be 4 W. This shows that the three-phase line will require 75 per cent of the copper that will be required for the single-phase line. This copper saving is worth considering on long lines where station lighting and other loads increase the line current, but with a short line where the signal load only is carried, calculations often indicate a wire that is too small for mechanical strength.

The three-phase system gives better voltage regulation and permits the use of polyphase motors, which are more economical and have better starting characteristics than the single-phase induction motors. Repulsion or series single-phase motors may be used on the single-phase lines for operating the signals, but these motors require more attention than the polyphase motors and are not as dependable.

Three-phase transmission with single-phase current at signal locations may be obtained by rotation of phases between signal locations; that is, by taking the load for one location from one phase, for the next location, from the second phase, etc. Where track circuits with double-element relays are used, it is necessary to feed the local element of the relay and the track transformer for each track circuit from the same phase; therefore, if three-phase transmission, with single-phase operation, is to be used in territory of this sort, the line should be divided into three sections, feeding one section from each phase. Care should be taken to arrange the sections so that the load will be as nearly balanced as possible.

The above has reference principally to color-light signal installations. Where a.-c. semaphore signals are installed, using induction motors, it would be desirable to have a three-phase system, on account of the better starting characteristics of a three-phase induction motor.

Favors Single-Phase Circuits Wherever Power and Communication Wires Are Carried on Same Pole Line

By W. F. Follett

Assistant Signal Engineer, New York, New Haven & Hartford, New Haven, Conn.

IN considering the comparative merit of a three-phase and a single-phase, 440 or 550-volt signal power supply line, it is assumed that the location of the supply line is to be on the signal cross arm beneath communication circuits, in which case the National Safety Code limits the amount of power to 1,600 watts per circuit. The best authorities upon this subject, interpret the term "circuit" as used in the Code, to mean all three wires of a three-phase system. This being the case, if a three-phase circuit is used, the total amount of energy transmitted must not exceed 1,600 watts for the three phases.

In practically all instances, it is more economical to use single-phase. We are, therefore, limited to the same amount of power whether we use two wires or three wires and will be until another revision of the Code is made. Such a revision, I believe, could be made to the great advantage of the railroads without undue hazard to communication circuits.

If the signal supply circuit is to be located on a pole line by itself, or under other power wires (not communication wires), undoubtedly, the three-phase system would have considerable merit, as there would be no legal limit to the load and transmission could be extended beyond the limits of single-phase.

In reference to the advantages, both from a voltage standpoint and an economic standpoint: With a fixed value for the voltage between lines, transmission distance, power transmitted and power lost and assuming unity power factor, the copper efficiency of the two systems is a follows:

	Single-phase	Three-phase
Relative current per wire	100	57.7
Total relative conductor weight	100	75.0

Color-Light, Train-Order Signals Are Effective

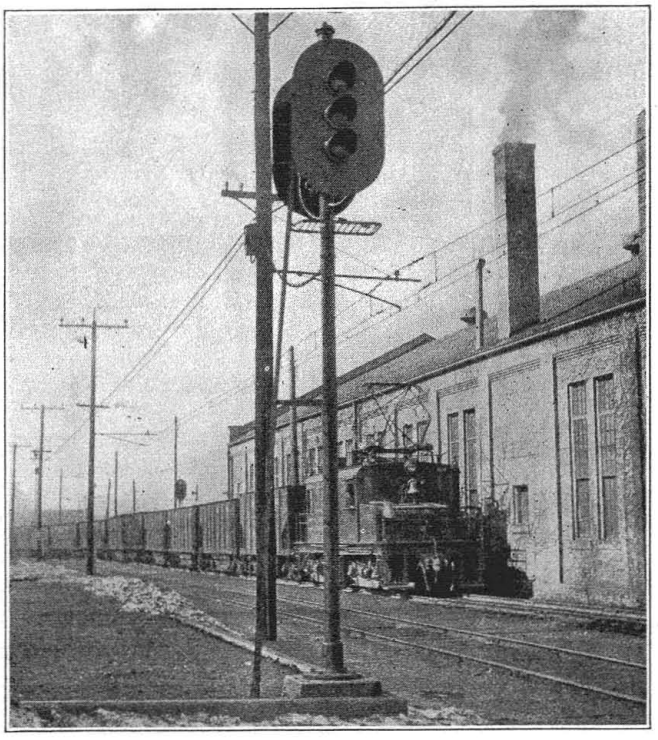
"Do you use color-light signals for train order purposes? If so, how is the signal controlled and what check is made to determine whether the proper indication is being displayed?"

South Shore Adopts Color-Light Train-Order Signal as Standard

By B. L. Smith

Signal Supervisor, Chicago, South Shore & South Bend, Michigan City, Ind.

THE South Shore is using a color-light train-order signal, the details of which were worked out by the supervisor in charge of signal work. Two Union Type-M light signal heads are mounted on a 20-ft. pole opposite each other. The color-light train-order signal is distinguished from an automatic signal by a lunar white marker light. The signal lights are controlled by two switches in the dispatcher's office at Michigan City. The switch for eastbound trains is mounted on the east side of the call board and the one for the westbound trains on the west side. These switches are of the tumbler type in which the handle moves up and down. When



Typical color-light train-order signal on the South Shore

in the up or clear position, a green plaque is visible in the lower part of the switch. In the red, or down position, this plaque is red, the green disappearing. In addition to this, a red and green light is mounted above the call board. These lights are wired in series with the lights in the signal and give the dispatcher immediate information as to the indication of the train-order signal. Also, should a lamp burn out in the signal, this fact would be evident immediately in the dispatcher's office.

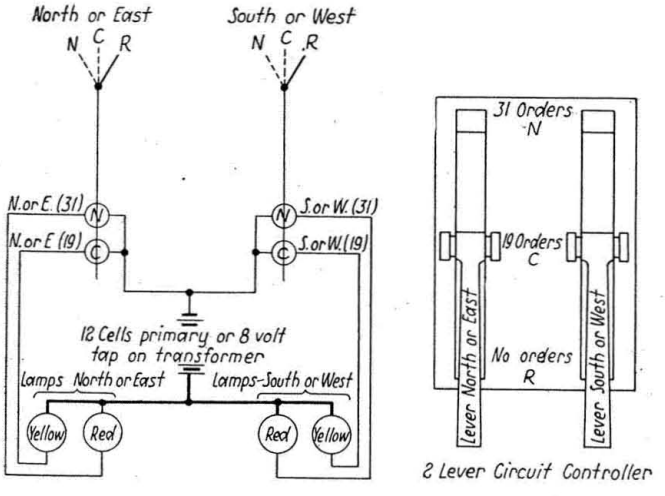
A track diagram furnished by the Railroad Supply Company is mounted above the call board. This covers automatic territory extending two blocks in either direction and gives the dispatcher advance information as to the approach of trains. This arrangement has proved satisfactory due to the frequency of trains at this point. This color-light train-order signal has been in service for a year and has proved superior to the old mechanical type of semaphore signal. The color-light type has been adopted as standard and has been placed in operation at three other points on the road.

Color-Light Train Order Signals Are Used at Interlocking Plants on the A. C. L.

By C. J. KELLOWAY
Superintendent of Signals, Atlantic Coast Line, Wilmington, N. C.

THE Atlantic Coast Line uses color-light signals for train order purposes at interlocking plants, under the following rule:

"221 (d) At interlocking stations a red light or a yellow light displayed from the office, in view of the approaching train, in addition to the interlocking home signal at stop, will indicate that orders are held for the approaching train. The red light will indicate that trains are to be *stopped* for train orders;



Control circuit for color-light train order signal

the yellow light will indicate that trains are to receive "19" orders *without* stopping.

"Enginemen finding light signal displayed at the office and home signals indicating "stop" will acknowledge signal displayed by two short blasts of the whistle. The operator then, if other conditions permit, will clear home signal authorizing the train to pull up to the office for orders. Trains will not leave when such signals are displayed without clearance card."

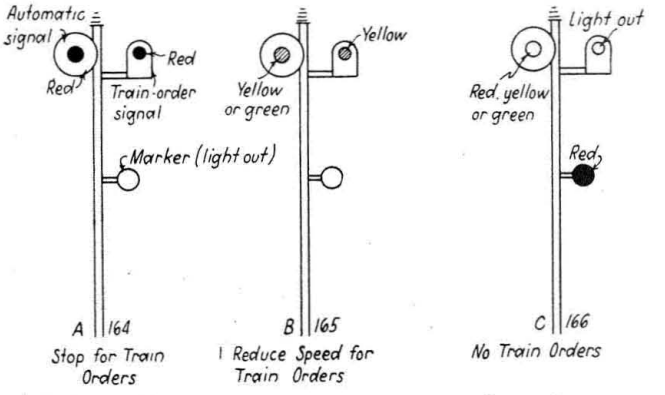
A specially designed small lever-type circuit controller controls the signals. Its lever positions correspond to those of an interlocking machine lever, and enameled plates, reading "31 ORDERS," "19 ORDERS" and "NO ORDERS," are fastened opposite the corresponding positions of the lever. The circuits are in accordance with the drawing.

It has not been considered necessary to supply a check to determine whether the proper indication is being displayed, as the trains are controlled by indications of the interlocking signals, the train order signal being secondary. It is intended, however, to supply a "light out" indication, but we have not decided whether to use an indicator or an auxiliary light.

Color-Light Train-Order Signals on N. Y. C. Are Mounted on Automatic Signal Masts

By B. J. SCHWENDT
Assistant Signal Engineer, New York Central, Lines West, Cleveland, Ohio

WE have in use what might be called color-light train-order signals. Two separate applications are involved, one for color-light automatic signal territory, and the other for interlocking territory. The chart shows the application in automatic signal territory. Normally, our automatic color-light signals have the red marker light diagonally arranged with the main light. At stations where train orders are to be handled,



Color-light train-order signal in automatic territory

the train-order light (shown in the upper right-hand corner) is applied to an adjacent automatic signal mast. Circuiting is so arranged that whenever the train-order light is displayed, the marker light is extinguished, thus there are always two lights displayed under normal conditions.

The application to an interlocking plant is explained by the following rule:

"Where train-order signals are not provided at an interlocking plant, a yellow flag by day and a yellow light by night displayed, to an approaching train, in addition to the stop indication of the fixed signal, indicates there are train orders and will be acknowledged by two short sounds of the whistle. If after acknowledging signal by two short sounds of the whistle, stop signal is not changed to proceed, it will indicate there are '31' orders and conductor must promptly report at signal station. If stop signal is changed to proceed it will indicate that '19' orders are to be delivered and train may advance to signal station but must not leave until orders have been received."

In order to take care of conditions of poor visibility due either to weather or local conditions, the use of a color-light signal (yellow) fits in nicely with the following code rule:

"Day signals must be displayed from sunrise to sun-