Principles and Practices

CHAPTER XV

Block Signal Systems

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No attempt will be made in this chapter to indicate in chronological order the sequence of events leading to the adoption of operating trains under block systems, as this is covered in Chapter I—History and Development of Railway Signaling. Suffice it to say that a block system is a means of maintaining a fixed minimum interval of space between two trains traveling in the same direction on the same track and to prevent two trains approaching in opposite directions from colliding on the same track. Prior to the adoption of the block system, a predetermined interval of time was the means used to avoid collisions. The time interval is still in use to a limited extent on roads or parts of roads where trains usually follow one another only at long intervals.

Types of block signal systems.

There are two general types of block signal systems used on American railroads. They are designated as "manual block signal system" and "automatic block signal system."

Included in this chapter is a method of governing opposing and following movement of trains by block signals, which is designated as "traffic control system."

Definitions.

The Standard Code of the Association of American Railroads defines the following terms as used in block signal systems:

Block.

A length of track of defined limits, the use of which by trains and engines is governed by block signals, cab signals, or both.

Block Signal.

A fixed signal at the entrance of a block to govern trains and engines entering and using that block.

Fixed Signal.

A signal of fixed location indicating a condition affecting the movement of a train or engine.

Cab Signal.

A signal located in engineman's compartment or cab, indicating a condition affecting the movement of a train or engine and used in conjunction with interlocking signals and in conjunction with or in lieu of block signals.

Home Signal.

A fixed signal at the entrance of a route or block to govern trains or engines entering and using that route or block.

Approach Signal.

A fixed signal used in connection with one or more signals to govern the approach thereto.

Manual Block Signal System.

A block or a series of consecutive blocks, governed by block signals operated manually, upon information by telegraph, telephone or other means of communication.

Block Station.

A place at which manual block signals are displayed.

Manual Block Signal System†

Rules.

In order that the student may have a better conception of operating trains under a block signal system, the rules for manual block signal system as contained in the Standard Code are quoted, and are as follows:

305. Block signals govern the use of the blocks, but, unless otherwise provided, do not supersede the superiority of trains; nor dispense with the use or the observance of other signals whenever and wherever they may be required.

306. When a block station is open at an irregular hour, trains must be notified when possible by train order.

307. A train having entered a block on other than a proceed indication, must not accept a Proceed indication at any intermediate block station which was closed when such train entered the block, without receiving Clearance Form A.

(To be printed on white paper 5" x 6¾")

A

EAST AND WEST RAILROAD COMPANY

CLEARANCE FORM A

A

.....19.....

To C & E. .....at .....

I have .... orders for your train.

(If no train orders, operator must write "No" in space provided above)

Orders: No..... No..... No..... No..... No.....
No..... No..... No..... No..... No.....
No..... No..... No..... No..... No.....

* When this form is used as authority for a train to pass Manual Block Signal in Stop position, condition of block will be shown below.

Block: .....

Time OK..... M. ..... Dispr.

..... Opr.

Manifold copies will be made for each Conductor, Engineman and Operator, the latter retaining a copy.

* To be used only in connection with Rule 308.

308. When Clearance Form is used information will be shown as to condition of block "clear" or "occupied." If block is occupied train will proceed prepared to stop short of train or obstruction, but not exceeding 15 miles per hour.

† Manual Block Signal System rules will be used only on the territory specified on the time-table or in special instructions.

311. Signals must be kept in the position displaying the most restrictive indication, except when displayed for an immediate movement.

312. Appliances must be operated carefully and only by those charged with that duty. If any irregularity affecting their operation is detected the signals must be displayed to give their most restrictive indication until repairs are made.

313. Operators must observe, as far as practicable, whether the indications of the signals correspond with the positions of the levers.

314. Operators must not make nor permit any unauthorized repairs, alterations or additions to the apparatus.

Any defects in the appliances must be promptly reported to the ..... .

315. A block record must be kept at each block station. (See Fig. 2)

317. On single track, to admit a train to a block, operator must examine block record and if block in advance is clear of opposing trains and preceding passenger trains, request operator at block station in advance to "Block for No. ..... ." If it is proper for the train to be admitted, the operator in advance will reply "OK, blocking for No. ..... ." Operator requesting block will then display the proper signal indication. Operators must promptly enter on block record the time block is given or received.

A passenger train must not be admitted to an occupied block, nor any train admitted to a block occupied by an opposing train or a passenger train, except under flag protection.

A train other than a passenger train may be permitted to follow a train other than a passenger train into a block under Permissive indication, train order or Clearance Form A.

317. (Optional) On single track, to admit a train to a block, operator must examine block record and if block in advance is clear of opposing trains and preceding passenger trains, request operator at block station in advance to "Block for No. ..... ." If it is proper for the train to be admitted, the operator in advance will reply "OK, blocking for No. ..... ." Operator requesting block will then display proper signal indication. Operators must promptly enter on block record the time block is given or received.

A train must not be admitted to a block which is occupied by an opposing train or by a passenger train except as provided in Rule 333 or by train order. A train may be permitted to follow a train other than a passenger train into a block under Permissive indication or Clearance Form A.

Note to Rule 317 (Optional).—Railroads that do not require blocking opposing trains should omit this rule.

318. On two or more tracks, to admit a train to a block, the operator must examine the block record and display proper signal indication.

A passenger train must not be admitted to an occupied block, nor any train admitted to a block occupied by an opposing train or a passenger train, except under flag protection.

A train other than a passenger train may be permitted to follow a train other than a passenger train into a block under Permissive indication, train order or Clearance Form A.

missive indication or Clearance Form A.

Note to Rule 318 (Optional).—Railroads that do not use Rule 317 (Optional) should omit "On two or more tracks."

319. When a train enters a block, the operator must give train number and time to the next block station in advance. When two or more tracks are used in the same direction, operators must also specify the track. When the rear of the train has passed ..... feet beyond the Block Signal, he must give the record of the train to the next block station in the rear.

This information must be entered on the block records.

320. Unless otherwise provided, operators must not ask for the block until they have received a report of the train from the next block station in the rear.

321. Operators must, as far as practicable, observe all passing trains and note whether they are complete and in order. Should a train without markers pass a block station, the operator must notify the operator at the next block station in each direction, and must not report that train clear of the block, nor clear the signal for the block in the rear, until he has ascertained that the train is complete.

322. Should a train pass a block station with any indication of conditions endangering the train, or a train on another track, the operator must immediately notify the operator at the next block station in advance, and each must display Stop indications to all trains that may be affected, and must not permit any train to proceed until it is known that its track is not obstructed.

325. An operator informed of any obstruction in a block must immediately notify the operator at the other end of the block, and each must display Stop indications to all trains that may be affected until it is known that the track is unobstructed.

326. When a train or engine clears the main track, the operator must know it is clear of the block before giving block for another movement or displaying a clear indication for that block.

The operator must obtain control of the block before permitting a train or engine to re-enter the block.

327. To permit a train or engine to enter a block or foul the main track, or to cross from one main track to another, the operator must examine the block record and if all the blocks affected are clear of approaching trains he must provide or arrange for block protection before permission is given, and until movement is complete and block clear, trains will not be admitted to the block except as prescribed by Rule 289 or Clearance Form A.

All crossover movements must be entered on the block record.

328. When coupled trains are separated, as prescribed by Rule 364, the operator must regard each portion as an independent train.

329. When necessary to stop a train for which other than a Stop indication has been displayed and accepted, the operator must give hand signals in addition to displaying the Stop indication.

333. When, from any cause, an operator is unable to communicate with the next block station in advance, he must stop all trains approaching in that

hand signals are necessary they must be given from such a place and in such a way that there can be no misunderstanding on the part of enginemen or trainmen as to the signals, or as to the train or engine for which they are intended.

335. Block signals for a track apply only to trains moving with the current of traffic on that track. Operators will use ..... for blocking trains moving against the current of traffic.

336. Operators are responsible for the care of the block station, lamps, and supplies, and, unless otherwise provided, of the signal apparatus.

337. Lights in block stations must be so placed that they cannot be seen from approaching trains.

339. If a Stop indication is disregarded, the fact must be reported to the next block station in advance and then to ..... .

340. To open a block station, the operator must notify the next block station in each direction and record the trains that are in the extended block.

When trains, which were in the extended block when the block station was opened and which had passed his block station before it was opened, clear the block in advance he must repeat the record to the block station in the rear.

341. A block station must not be closed except upon authority of .....
..... .

342. Unless otherwise provided, a block station must not be closed until the block in each direction is clear of all trains.

To close a block station, the operator must notify the next block station in each direction and when he receives the acknowledgment enter it on the block record, with the time it is received from each block station.

The block signals must then be secured in the clear position, all lights extinguished, and the block wires and, when necessary, circuits arranged to work through the closed block station.

343. When a block station is open at an irregular hour, operators must use hand signals, in addition to block signals, to give the required indications until all trains have passed which have not been notified by train order that the block station is open.

344. Operators must not permit unauthorized persons to enter the block station.

Engine and train crews.

361. Block signals for a track apply only to trains moving with the current of traffic on that track.

..... will be used for blocking trains moving against the current of traffic.

362. Trains must not pass a Stop indication without receiving Clearance Form A.

363. Trains must not proceed on hand signals as against block signals.

364. Unless otherwise directed, when two or more trains have been coupled and so move past any block station, they must be separated only at a block station and the operator notified.

Fig. 1 .

Arrangement of Manual Block Stations, Two Tracks.

A train or engine having passed beyond the limits of a block must not back into that block without permission of the operator.

370. When there is an obstruction between block stations, notice must be given to the nearest operator.

371. When a train is stopped by a home or block signal the conductor or engineman must, when practicable, immediately ascertain the cause.

372. Conductors must report to ..... any unusual detention at block stations.

373. A block station must not be considered as closed, except as provided for by time-table or ..... .

Description.

As the name implies, the manual block signal system is a method of spacing trains in which the signals are operated manually, without electrical or mechanical check, subject only to rules. Manual block is flexible since the facilities provided can be increased or decreased as traffic warrants by shortening or lengthening the blocks. The protection afforded is against head-on and rear-end collisions.

Signal aspects and indications.

Signal aspects and indications are explained in Chapter II—Symbols, Aspects and Indications.

Two or More Tracks

Figure 1 illustrates a two track section with block stations spaced approximately 5 miles apart. There is an operator on duty at each block station shown, with necessary means of communication between block stations, also between these stations and the train dispatcher located at some distant point. The means of communication are generally telephones, telegraph is gradually being displaced.

At each block station there are generally two manually operated block signals. Approach signals to govern the approach of trains to these block signals may be provided.

When a train passes block station A the operator reports this fact to block station B. The operator at B, on receiving this information, makes entry on his block sheet and then, according to Rule 318, displays the proper signal aspect. When train enters block at block station B the operator at B, according to Rule 319, communicates with operator at block station C giving him the time train passed B. When rear of the train has passed the block signal a specified distance, he must give record of the train to block station A. This information must also be entered on the block sheet. The block sheet at block station B would then show time that train passed block stations A, B and C. Should it be necessary for the train to be held at block station B for any reason, this fact would also be recorded by an arriving and departing time for that train being shown with a short explanation as to the cause. If train is not held at the block station only one time is shown, which is entered in the D or "departed" column. Part of a typical block sheet record for block station B is shown in Fig. 2.

THE A AND B RAILROAD XYZ DIVISION

STATION RECORD OF TRAIN MOVEMENTS AT "B" Block STATION April 6 194.

Signalman or Operator	Went on Duty	Went off Duty	Leverman	Went on Duty	Went off Duty	Weather	Temp.	Time
P S. Duer	12:01AM	7:00AM		M	M	Light Fog	42	5AM
R H Brown	7:00AM	3:00PM		M	M	Cloudy	55	11AM
E S. Smith	3:00PM	11:00PM		M	M	Clear	60	5PM
P S Duer	11:00PM	12:01AM		M	M	Clear	52	11PM

INSTRUCTION

1. This record shall be made a office, or place from which the ti ture, or passing of trains is re or telephone.
2. Each operator, signalman, enter the time he goes on and provided for that purpose.

TRANSFER RECORD

	AT 7:00 AM	AT 3:00 PM	AT 11:00 P
19 Train Orders Undelivered For Trains	None	None	None
MESSAGES " " " "	"	"	"
OVERDUE TRAINS	"	"	"
NOTED AND UNDERSTOOD—SIGNED	R H. B.	E. S. S.	P. S. D

East WARD

ENG.	Time Block Given	A Time Departed	A Trk.	Time Block Received	B Time Arrived	B Trk.	B Time Departed	B Trk.	Time Block Cleared	REMARKS
8281		1:45		1:46			2:14		2:50	At C-Clear
3715		5:20		6:01			6:20		6:45	At C-Clear
4371		7:34		7:55			8:02		8:30	At C-Clear
3862		8:10		8:32	8:30		8:34		8:51	At C-Stop-Clear

West WARD

TRAIN	ENG.	Time Block Given	C Time Departed	C Trk.	Time Block Received	B Time Arrived	B Trk.	B Time Departed	B Trk.	Time Block Cleared
912	3672		3:49		3:55			4:30		4:59
PB2	1570		4:40		5:02	5:30		5:35		6:02
TCX	4926		6:10		—	6:25		—		—
502	4472		6:40		6:45			7:00		7:20

Fig. 2.
Typical Block Sheet.

and locked, the conductor reports this fact to the operator at C who then displays a clear block signal aspect for the passenger train which passes the freight train. After the passenger train passes D, the operator gives permission to the freight train to move from the siding and proceed toward D. By referring to Rule 318 it will be seen that a train must not be admitted to a block which is occupied by a passenger train. If one freight train is passing another freight train, the slower train can follow from the siding as soon as the first freight train has passed and permission is received from the operator.

Various arrangements are in effect relative to method to be followed should means of communication fail between an outlying point and the operator. One method prescribes that if, from any cause, conductor or engineman is unable to communicate with the operator either by the usual means of communication or the use of commercial lines and should no cause for detaining the train be known it may proceed through block on its rights or time-table authority, preceded by a flagman to the next point of communication and report to the superintendent.

Single Track

Figure 3 illustrates a section of railroad where trains are operated in both directions on the same track. It is usually necessary to have more sidings in single-track territory than in territory with two or more tracks. The frequency of sidings is determined by the density of traffic. Assume two trains of the same class traveling toward each other from block stations A and D: the train traveling from A to D is superior by direction to the train traveling from D to A, so that it will be necessary for the latter train to clear on a siding before the superior train is due to leave the block station at that siding.

The operator at block station A has obtained the block from block station B in accordance with Rule 317 and a clear block aspect is displayed for movement from A to B. Shortly after the superior train passes block station A, the inferior train in opposite direction approaches block station D. The operator at D obtains the block from the operator at C so that the inferior train passes block station D with a clear block aspect. As the superior train approaches block station B chis operator has obtained the block from block station C and this train is given a clear block signal aspect at B. The inferior train approaches block station C, but the operator must keep both block signals in the stop position as a train is approaching from each direction. The inferior train approaching from D stops before reaching the switch at entrance to siding. A member of the train crew sets the switch for movement to the siding and train then enters siding. When the rear of train is clear of the fouling point, the main track switch is restored to the normal position and the conductor reports that his train is clear of the main track and that the switch is closed and locked. Operators at block stations D and C make proper record on their block sheets and operator at C then requests block from operator at D for superior train approaching from block station B. After this permission is obtained operator at C clears the block signal allowing superior train to proceed toward block station D without a stop at C. On arriving at the other end of siding, the conductor of the inferior train calls block station C for permission to proceed on the main track to block station B. As the superior train has passed block

Fig. 3.
Arrangement of Manual Block Stations, Single Track.

block from operator at A, so that he can display proper signal aspect for the inferior train as it approaches his block station.

In the case of passenger trains only one train is permitted between block stations; no other train is permitted to occupy that block. A number of railroads permit freight trains to follow each other in the same direction in the same block; this is termed "permissive blocking." On some railroads only one train is permitted in the same block at the same time and this is known as "absolute blocking."

Various arrangements of sidings are in effect on different railroads. In some cases one end of the siding is at the block station, in other cases it may be midway between block stations, while still in other cases there may be two or more sidings between block stations. Where there is no operator at siding and signals are not provided, the first train entering the block must report into clear before the opposing train is admitted to the block.

In some cases what are known as lap sidings are used, one of which is shown at block station B, Fig. 3. With this arrangement it can be seen that parallel movements can be made and that meets can be arranged without either train stopping. Where traffic warrants, the siding switches may be interlocked, or provided with a spring switch.

*Automatic Block Signal System**

Rules.

Automatic block signal system rules, as contained in the Standard Code, are quoted, and are as follows:

505. Block signals, cab signals, or both, govern the use of the blocks, but, unless otherwise provided, do not supersede the superiority of trains; nor dispense with the use or the observance of other signals whenever and wherever they may be required.

Engine and train crews.

508. Unless otherwise provided, block signals for a track apply only to trains or engines moving with the current of traffic on that track.

509. When a train is stopped by a Stop indication it must stay until authorized to proceed, and will then proceed at restricted speed, or in case of failure of means of communication it may proceed when preceded by a flagman to the next signal displaying a Proceed indication.

510. When a train is stopped by a block signal which is evidently out of order, unless otherwise provided, the fact must be reported to ..... .

511. Both switches of a crossover must be open before a train or engine starts to make a crossover movement, and the movement must be completed before either switch is restored to normal position.

512. Where switch indicators are used, the indications displayed do not relieve enginemen and trainmen from protecting their train as required by the rules.

* Automatic Block Signal System rules will be used only on the territory specified on the time-table or in special instructions.

ment. This will not relieve employees from the duty of promptly and properly protecting the movement.

513 (a). When a train or engine has passed a signal permitting it to proceed and is delayed in the block, it must proceed at restricted speed to the next signal.

513 (b). Unless otherwise protected, entrance to a main track through a spring switch must be made under the provisions of Rule 513, operating the switch by hand.

514. A train or engine entering a block between signals must be protected as required by the rules and must proceed at restricted speed to the next signal in advance.

515. A train or engine having passed beyond the limits of a block must not back into that block except under protection as prescribed by Rule 99 or ..... .

516. Should cab signal and fixed signal indications conflict, the more restrictive indication will govern.

517. Cab signal indications do not supersede fixed signal indications, except when cab signal changes to a more restrictive or a more favorable indication after passing a fixed signal.

518. If after passing a fixed signal, the cab signal indication changes from restricted speed to a more favorable indication, speed must not be increased until train has run its length.

Rules governing the movement of trains in the same direction and opposing and following movement of trains by block signals are also quoted from the Standard Code:

Rules Governing the Movement of Trains in the Same Direction by Block Signals

251. On portions of the railroad, and on designated tracks so specified on the time-table, trains will run with reference to other trains in the same direction by block signals whose indications will supersede the superiority of trains.

253. The ..... must be advised in advance, of any known condition that will delay the train or prevent it from making usual speed.

254. Except as affected by Rule 251 all Block Signal Rules and Operating Rules remain in force.

Rules Governing Opposing and Following Movement of Trains by Block Signals

Note.—Railroads operating under these rules must provide proper signals to control the approach and movement of trains.

261. On portions of the railroad, and on designated tracks so specified on the time-table, trains will be governed by block signals whose indications will supersede the superiority of trains for both opposing and following movements on the same track.

Description.

In the description and explanation of the operation of automatic block signal systems given in this chapter it is to be understood that the circuits, special symbols and wire nomenclature are not necessarily specifications. They represent, however, typical circuits that are used on railroads with certain modifications to meet the requirements or standards of the individual road. The descriptions are given with the thought that they will enable the student to more readily understand circuits of a similar nature, the details of which may be somewhat different depending upon the practice of the individual railroad.

The automatic block signal system is arranged for a track signaled in one or both directions. Generally the track signaled in one direction is in effect where two or more main tracks are in service while a track signaled in both directions is in effect where only one main track is in service. In congested traffic areas, however, where more than a single track is in service, one or more of the tracks may be signaled for train operation in both directions. The various schemes will be described in detail later.

Direct current or alternating current is used for operating automatic block signal systems. Direct current is generally obtained from primary or secondary batteries for the operation of the track circuits and signals. The signals usually operate on first voltage range (30 volts or less), while approximately 1 volt is applied to the track circuits. Alternating current is generally obtained from a transmission line; the necessary power houses, substations and allied equipment are distributed throughout the signal territory. Transformers are connected to the transmission line at signal, or cut-section locations to step the voltage down to that required for the operation of signals and track circuits. In some installations commercial power is obtained at specified locations. Direct current track circuits are explained in Chapter VII—Non-Coded Direct Current Track Circuits; alternating current track circuits in Chapter XI—Non-Coded Alternating Current Track Circuits; coded track circuits in Chapter XXV—Coded Track Circuits; semaphore signals in Chapter XII—Semaphore Signals; and light signals in Chapter XIII—Light Signals and Light Signal Lamps.

Two or More Track Signaling

In two or more track signaling, with traffic in one direction only on each track the signals should theoretically be spaced a uniform distance apart on level tangent track. In practice, however, it is impractical to obtain this desirable arrangement, as various conditions on the railroad will tend to vary more or less the spacing between signals. The exact location of the signal is always selected with care, consideration being given to such factors as the approach view of the signal, presence of turnouts, crossovers or sidings, curves, grades, fills, bridges, tunnels, etc.

Signaling on two or more track railroads is generally of the two-block indication type, although considerable three-block indication signaling has been installed on roads of heavy traffic density or where necessary to provide proper stopping distance. There are also some installations of four-block indication.

Fig. 4.
Aspects Displayed in Two-Block Indication System, Two Tracks.

Two-block signaling is so named for the reason that a Clear aspect indicates that at least two blocks in advance of such signal are unoccupied. A fixed signal displaying an Approach aspect indicates that only the block immediately in advance of the signal is unoccupied and that a train must be prepared to stop at the next signal. The Stop and Proceed aspect indicates the block in advance of the signal is occupied and that the train must stop and then proceed at restricted speed. Two-block indication signals are spaced stopping distance apart as a minimum, but this spacing is frequently increased where traffic is light.

Figure 4 illustrates the aspects displayed by the different signals when a block is occupied in a system of two-block signaling on a section of two-track territory, the signals being normally clear.

Figure 5 (folded sheet in back of chapter) illustrates circuits used on one track of a two-block indication color light signal installation employing direct current neutral track circuits and polar line relay.

Signal control circuits.

The aspect displayed by each signal is controlled by the polar line control relay HDR and slow drop-away repeater relay HPR. The control of signal 11 is as follows: positive battery B through coils of relay 21AER, wire 11H3 through front contact of track relay 21TR, wire 11HD2 through front contact of repeating relay 21HPR, wire 11HD1 through front contact of track relay 11TR, wire 11HD through coils of relay 11HDR, wire N11HD through front contact of track relay 11TR, wire N11HD1 through front contact of repeating relay 21HPR, to negative battery C. This circuit will cause polar relay 11HDR to be energized so that the left polar contact controlling the clear position of signal 11 will be closed. When a train enters the block controlled by signal 11, relay 11HDR will be de-energized as this relay is controlled through the front contacts of track relay 11TR, which will cause signal 11 to display its most restrictive aspect. It will also be noted that while track relay 11TR is de-energized a shunt is provided through its back contacts to further insure that polar relay 11HDR remains de-energized as long as track circuit 11T is occupied.

When the rear end of train has passed out of the block protected by signal 11, track relay 11TR will be energized and polar relay 11HDR will also be energized, but its polar contacts will be closed in the opposite or right position from that shown in Fig. 5. The control circuit for polar relay 11HDR is then as follows: positive battery B through coils of relay 21AER, wire 11H3 to front contact of track relay 21TR, but as this relay is de-energized the circuit will take wire 11HD2A through back contact of relay 21HPR as this relay will also be de-energized, wire N11HD1 through front contact of track relay 11TR, wire

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* "In advance of a signal" is a term used in defining the territory beyond a signal as seen from an approaching train.

"In approach of a signal (in rear of a signal)" is a term used in defining the territory to which a signal indication is conveyed.

Signal lighting circuits.

The circuit for the lights of the three aspects displayed by signal 11 is as follows: positive battery B through back contact of relay 11AER as this relay will be de-energized when train passes signal in rear of signal 11, wire 11DG2 through front contact of relay 11HPR, wire 11DG1, through left polar contact of relay 11HDR, wire 11DG to lamp in signal which will display the green or Clear aspect. If polar contact of relay 11HDR is closed in opposite position the circuit will then be from wire 11DG1 through right polar contact of relay 11HDR, wire 11HG to lamp in signal which will display the yellow or Approach aspect. If relay 11HPR is de-energized the circuit will then be from wire 11DG2 through back contact of relay 11HPR, wire 11RG to lamp in signal which will display the red or Stop and Proceed aspect. The return circuit from each signal lamp is wire C to negative battery.

It will be noted that signal 11 is approach lighted; that is, the signal is normally dark, but when a train enters the block in the rear of signal 11, the track relay at that signal will be de-energized which will cause relay 11AER to be de-energized, similar to the de-energization of relay 21AER, completing the light circuit through its back contact to light the proper lamp in signal 11 depending on position of contacts in relays 11HPR and 11HDR. The HPR relay is slow drop-away so that when pole changing of relay HDR occurs there will be no momentary change of aspects during that operation.

Some railroads desire that the signal in rear of train should remain lighted as long as the block is occupied. In this case there would be a slight change in the wiring as indicated in Note 1 of Fig. 5.

As previously stated, there are various modifications of the control circuits for the automatic block signals, such as using retained neutral polar line relays, or biased relays instead of the ordinary polar relays shown in Fig. 5. By a careful study of Fig. 5, any modification should be readily understood.

Frequently, due to traffic conditions, the automatic block signal spacing is such that it is necessary to have more than one track circuit between the signals. Figure 6* illustrates an installation using relayed cut-section and neutral line relay. It will be noted the two track sections are designated as A11T and B11T. Track section A11T is controlled through track relay B11T as follows: from positive track battery on wire A11TB to variable resistance, wire A11TB1 through front contact of track relay B11TR, wire A11TB2 to positive rail of track circuit A11T, from negative rail of track circuit A11T, wire A11TN to negative track battery. It will be noted that when track relay B11TR is de-energized a shunt on track circuit A11T is provided from wire A11TB2, through back contact of track relay B11TR to wire A11TN. This further insures that track relay A11TR will remain de-energized as long as track relay B11TR is de-energized. If more than one relayed cut-section is required, the additional ones would be arranged in a similar manner to that just described. The control circuits for the other relays and light circuits are quite similar to those described in Fig. 5 and should be easily traced out. In this circuit it will be noted that it provides advance and approach lighting of signals.

* Folded sheet in back of chapter.

through front contact of relay 11TR to coil of signal 11, through front contact of relay 11TR, wire N11HDG through front contact of relay 21HDGPR, wire C to negative battery. With this circuit signal 11 will be energized and the movable element will be in position to display the green or Clear aspect. This aspect will be displayed with signal 21 displaying a green or yellow aspect which will keep relay 21HDGPR energized as follows: positive battery through contact G of signal 21, through coils of relay 21HDGPR, wire C to negative battery. If yellow aspect is displayed, circuit would then be positive battery to contact RY, to contact Y which would be closed, through coils of relay 21HDGPR, wire C to negative battery. Should signal 21 be displaying a red aspect, relay 21HDGPR would be de-energized. This in turn would reverse the flow of current through signal 11 as follows: positive battery through back contact of relay 21HDGPR, wire N11HDG, through front contact of relay 11TR, through coil of signal 11, through front contact of relay 11TR, wire 11HDG, through back contact of relay 21HDGPR, wire C to negative battery. This reversal of current through signal 11 would move the yellow roundel in signal mechanism in front of the lamp so that a yellow or Approach aspect would be displayed. Should track relay 11TR be de-energized, signal 11 would be de-energized and the movable element would place the red roundel in front of the lamp by gravity and a red or Stop and Proceed aspect would be displayed. The circuit controlling the lamp in signal 11 is positive battery B through back contact of relay 11AER, wire 11E to filament of lamp and wire C to negative battery. The circuit in Fig. 7 indicates that signal 11 is normally dark and lights up when head end of train passes signal in rear of signal 11. Should advance lighting of signal not be required the wire (A) shown dotted would be added in accordance with Note 1 in Fig. 7.

Alternating current track and control circuits.

There are a number of installations where alternating current track circuits are used and Fig. 8* illustrates the circuits used in a two-block indication color light signal installation on a two-track electric road using alternating current propulsion. This installation employs two-element two-position centrifugal track relays; two-element three-position, and single-element two-position line relays. The 110-volt busses at all locations are energized and so connected from the same source that they will be of the same instantaneous polarity.

The local element of all two-element relays is connected direct to BX110 and CX110 busses.

The line element of the signal control relay (HDR) is only energized when the track circuit in advance of the signal is unoccupied. The instantaneous polarity of the line element and the local element are the same when the signal control repeating relay (HPR) at the signal in advance is energized and opposite when relay (HPR) at the signal in advance is de-energized. The circuit for the line element of relay 58HDR is as follows: from the secondary of a transformer, the primary of which is connected directly to the BX110 and CX110

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control relay (HDR) is energized and the slow drop away feature causes the front contacts of the relay (HPR) to remain closed thereby preventing the red lamp lighting while relay (HDR) changes from one energized position to the other. The control circuit for relay 60HPR is as follows: wire BX110, through contact of relay 60HDR closed in either of its energized positions, wire 60HP, through coil of relay 60HPR, wire NX110 to CX110 bus.

The filament of each lamp is connected directly to the secondary of a transformer located in the signal unit. The primaries of these transformers are connected, through relay contacts, to the BX110 and CX110 busses. When relay (HPR) is de-energized the transformer at the red lamp will be energized. When a train approaches a signal at which relay (HPR) is energized, either the transformer at the yellow lamp or at the green lamp will be energized depending upon the position of relay (HDR). In order to have the marker lamp burning whenever any other lamp is burning, the transformer at the marker lamp is energized whenever relay (HPR) is de-energized or when a train is approaching the signal.

The circuit for the red lamp on signal 56 is as follows: BX110, through back contact of relay 56HPR, or through back contact of relay 58TR, wire 56DG2 through back contact of relay 56HPR, wire 56RG to the transformer at the red lamp, to CX110. The circuit for the yellow and green lamps on signal 56 is as follows: BX110, through back contact of relay 58TR, wire 56DG2, through front contact of relay 56HPR, wire 56DG1, either through a normal polar contact on relay 56HDR, wire 56DG, to the transformer at the green lamp, to CX110, or through a reverse polar contact on relay 56HDR, wire 56HG to the transformer at the yellow lamp, to CX110. The circuit for the marker lamp at signal 56 is as follows: BX110 through a back contact of relay 58TR or through a back contact of relay 56HPR, wire 56MG to the transformer at the marker lamp, to CX110.

Fuses are used at different locations in the circuits to protect the apparatus and are shown in Fig. 8.

Three-block indication signaling.

Three-block indication signaling is employed where it is desired to increase track capacity; that is, to permit closer spacing of trains moving under proceed signals than would be possible with two-block indication signaling. It will be recalled that with two-block indication signaling the signals are located stopping distance apart, as a minimum, to permit a train to stop at a Stop and Proceed signal when moving at authorized speed at the Approach signal.

As an illustration, in three-block indication signaling each fixed signal usually displays Proceed, Advance Approach or Approach Medium, Approach, and Stop and Proceed aspects, depending upon block conditions. Generally the fixed signal has two operating units, one three-position unit above a two or three-position unit. The three-block indication system is so named for the reason that a Proceed aspect cannot be displayed until at least three blocks in advance of signal are unoccupied. The Advance Approach or Approach Medium aspect cannot be displayed until at least two blocks in advance of

the second train will be closer to the Stop or Stop and Proceed signal behind the first train by a distance equal to half the stopping distance resulting in greater track capacity. This also results in less train delay after stopping at a Stop and Proceed signal, on account of the shorter distance the train is required to operate at restricted speed.

Where the signal spacing is shorter than the distance required to reduce from maximum to medium speed, the Advance Approach indication Rule 282, "Proceed preparing to stop at second signal," is used instead of the Approach Medium indication Rule 282. For high maximum authorized speeds, this distance is usually from 75 to 80 per cent of the stopping distance.

Figure 9* illustrates the control circuits for signals in a three-block indication system using local control by track and retained neutral polarized line relays, the signals being of the searchlight type.

Signal control circuits.

The proceed or clear control circuit for signal 22 is as follows: from positive battery B through front contact of track relay 12TR, through contact G of signal 12A, through coils of relay 12AER, through front contact of relay 12DGPR, wire 22D through front contact of relay 22TR, through coils of relay 22DR, wire N22D through front contact of relay 12DGPR, through front contact of relay 12TR, wire C to negative battery. This will cause signal 22A to be energized in the position to display the green or Proceed aspect of signal 22 as follows: positive battery B through front contact of relay 22TR, through normal polar and front contacts of relay 22DR, through coils of signal 22A, through front and normal polar contacts of relay 22DR, through front contact of relay 22TR, wire C to negative battery. Should signal 12 be displaying an Approach aspect, signal 22 would display an Approach Medium aspect as follows: positive battery B through front contact of relay 12TR, through contact Y of signal 12A, through coils of relay 12AER, through back contact of relay 12DGPR as this relay would be de-energized on account of signal 12 displaying an Approach aspect, wire N22D through coils of relay 22DR, through front contact of relay 22TR, wire 22D through back contact of relay 12DGPR, through front contact of relay 12TR, wire C to negative battery. This circuit would cause the normal polar contacts of relay 22DR to open and to close the reverse polar contacts which in turn would reverse the flow of current through coils of signal 22A as well as energize signal 22B. The circuit to display the Approach Medium aspect of signal 22 would then be as follows: positive battery B through front contact of relay 22TR, through reverse polar and front contacts of relay 22DR, through coils of 22A, through front and reverse polar contacts of relay 22DR, through front contact of relay 22TR, wire C to negative battery. This would cause signal 22A to be energized in the position to display the yellow light and at the same time would energize signal 22B so as to display the green light on bottom unit of signal 22 as follows: positive battery B through front contact of relay 22TR, through contacts Y and RY on signal 22A, through front and reverse polar contacts of

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Should signal 12 be displaying a Stop and Proceed aspect, signal 22 would then display an Approach aspect as follows: relay 12TR would be de-energized therefore relay 22DR would also be de-energized, so the circuit for the yellow or Approach aspect of signal 22 would be positive battery B through front contact of relay 22TR, through back contact of relay 22DR, through coils of signal 22A, through back contact of relay 22DR, through front contact of relay 22TR, wire C to negative battery. This would cause current to flow through coils of signal 22A in the direction to cause the yellow or Approach aspect to be displayed.

A train in the block in advance of signal 22 would de-energize relay 22TR so that signal 22 could not be energized and the red or Stop and Proceed aspect would be displayed. The purpose of the retained neutral feature in relay 22DR is to keep the front contacts closed while the polar contacts are moving from one position to the other.

Two-block indication signaling with one-block overlap.

This system is shown in Fig. 10, in which the fixed signals operate in three positions and display Proceed, Approach, and Stop and Proceed aspects. The Stop and Proceed aspect displayed by each signal, however, is controlled through two blocks instead of one. Systems of this type are generally used on subway and elevated railway lines where trains are operated at high speed at frequent intervals. An automatic train stop device is also generally used in such a signal system.

Figure 11* illustrates the circuits used with a normal clear color light signal installation on a subway line where trains are operated by direct current, the signal system employing alternating current track circuits and direct current neutral control circuits.

The track circuits are single rail alternating current using two-element relays, one rail acting as a common rail for the return of the direct current propulsion and for the alternating current track circuit.

With a train occupying the block protected by signal 2 it will be noted that signals 2 and 4 are displaying Stop and Proceed aspects, signal 6 an Approach aspect, and signal 8 a Proceed aspect. In this system the signals are spaced braking distance apart for the maximum speed so that a train is always protected by the automatic train stop at the Stop and Proceed signal one block in the rear from a following train, should it pass a signal indicating Stop and Proceed.

Local element circuits.

The local elements of all track relays are energized continuously, BX55 and CX55 being connected directly to the coil terminals.

Automatic train stop control circuits.

An automatic train stop assumes the non-tripping position when two track circuits in advance are unoccupied. When a train enters the first of these track

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Fig. 10.
Aspects Displayed in a Two-Block Indication System, Two-Track, with One-Block Overlap.

C16; or, positive battery B16 through back contact of track relay 6TR, through the coil of 6V to negative battery C16.

The stop may be cleared to pass the Stop and Proceed indication at signal 4 by the train entering track circuit 4T. This is accomplished by placing the insulated joint not less than 10 feet 6 inches nor more than 11 feet 6 inches in the approach to the location of the stop and the signal. This arrangement will automatically clear the stop ahead of the train provided the move is made slowly enough to allow the stop to assume the non-tripping position.

Signal control relay circuits.

The signal control relay (HSR) which controls the approach indication circuit of a signal is energized following the passage of each train through a contact of the train stop in the tripping position at that signal and a front contact of its associated track relay and of the next track relay in advance with both circuits unoccupied. It is then held energized over its own front contact as the stop moves to the non-tripping position. This is the so-called "cycle check," checking that the stop has gone to the tripping position back of a train.

The signal control relay (DR) which controls the proceed indication is energized over the HSR relay in advance energized and the stop in advance in the non-tripping position. This guards against a proceed indication with the next stop in advance in the tripping position.

The circuits for the signal control relays at signal 8 are as follows: positive battery B16 through front contacts of track relays 6TR and 8TR, through a contact of stop 8V in the tripping position (over a front contact of 8HSR after it has picked up and the stop cleared), through the coils of 8HSR to negative battery C16. Positive battery B16 through a front contact of 6HSR, a contact of stop 6V in the non-tripping position, through the coils of 8DR to negative battery C16.

Signal lighting circuits.

When signal control relay HSR is de-energized, or when the train stop is in the tripping position, the red light will be burning. When relay HSR is energized and relay DR is de-energized, the yellow light will be burning. When both signal control relays HSR and DR are energized, the green light will be burning.

The signal at red, or Stop, any time the stop is in the tripping position checks against a clear signal if the stop fails to go to the non-tripping position for any reason.

The lighting circuits for signal 4 are as follows: BX55 through a back contact of relay 4HSR (or contact of stop 4V in tripping position), through filament of the lamp in the red signal to CX55; or, BX55 through a front contact of 4HSR, a contact of stop 4V in the non-tripping position, a back contact of relay 4DR, to filament of the lamp in the yellow signal to CX55; or, BX55 through a front contact of relay 4HSR, a contact of stop 4V in the non-tripping position, a front contact of relay 4DR, to filament of the lamp in the green signal to CX55.

explained in detail in Chapter XXV—Coded Track Circuits. Figure 12* illustrates an installation using coded track circuits with direct code for control of the signals and reverse code for approach lighting or other approach controls. There is also a cut-section between signals. The codes generally used for the track circuits are 75 per minute to cause the Approach aspect to be displayed, 120 for the Approach Medium where used, and 180 for the Proceed aspect. No code would cause the Stop and Proceed aspect to be displayed.

The circuits as shown in Fig. 12 cause signal 22 to display a Proceed aspect as follows: signal 12 is displaying a Proceed aspect so the 180 code control relay, CT, at this signal would be operating by receiving positive battery B through front contact of relay 12HR, through coils of relay CT-180, wire C to negative battery. This would cause relay 12CTPR to operate at 180 code by receiving positive battery B through contact of CT-180, through front contacts of relays 12HR and 12HDGPR, through coils of relay 12CTPR, wire C to negative battery. Current to track circuit B22T is from positive side of track battery through front contact of relay 12CTPR to positive rail, then from negative rail to negative side of track battery. This would place 180 code in track circuit B22T and cause relay B22TR at the cut-section to operate on this code by receiving energy from positive rail through back contact of relay B22TPAR, through coils of relay B22TR to negative rail. With relay B22TR operating at 180 code, track circuit A22T would receive 180 code from positive side of track battery through front contact of relay B22TR to positive rail and from negative rail to negative side of track battery. Relay A22TR would respond to the 180 code in track circuit A22T by receiving current from positive rail, through back contact of relay A22TPAR, through coils of relay A22TR to negative rail. A22TR would be operating at 180 code and this would supply current to the decoding transformer 22DT from positive battery B through front contact of relay A22TR to tap on primary winding of 22DT, then from center tap to negative battery C. When A22TR was de-energized, the circuit would then be from positive battery B, through back contact of A22TR, to lower tap on primary winding of 22DT, then from center tap to negative battery C. This circuit would energize the primary coil of 22 decoding transformer by a pulsating direct current which would produce an inductive effect on the secondary coil of 22DT. Relay 22HR would then be energized from the center tap of secondary coil of 22DT, through coils of relay 22HR, with relay A22TR energized through front contact of A22TR to lower half of secondary coil of 22DT and with A22TR de-energized, through back contact to upper half of secondary coil of 22DT. With relay 22HR energized relay 22DR would then be energized by the circuit from upper binding post of primary coil of 22DT, through decoding unit 180 DU, through front contact of relay 22HR to bottom binding post of primary coil of 22DR. The operation of decoding units is covered in Chapter XXV—Coded Track Circuits.

The Proceed aspect on signal 22 would be displayed by positive battery B, through front contacts of relays 22HR and 22DR to coils of signal 22, through front contacts of relays 22DR and 22HR, to negative battery C. This would

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delivered to the track circuit and relay 22DR would not be energized, but relay 22HR would be. The control for signal 22 would then be: positive battery B, through front contact of relay 22HR, through back contact of relay 22DR to coils of signal 22, through back contact of relay 22DR and front contact of relay 22HR to negative battery C. With the flow of current reversed in 22 this would cause the yellow roundels to be moved in front of the electric lamp so that an Approach aspect would be displayed to an approaching train. It will also be noted a shunt circuit is provided to insure that no Approach or Proceed aspect can be displayed with relay 22HR de-energized.

Any remaining circuits in Fig. 12 should readily be traced out in accordance with the explanations given in the preceding description.

There are various other arrangements of circuits and apparatus in service on the individual railroads but the principle of application is much the same as described in Fig. 12 and the student should experience little difficulty in tracing the various circuits.

Single-Track Systems

On single track, train movements are in both directions and signals are arranged to permit following movements as well as opposing movements. For opposing movements the signal control circuits must be so arranged as to prevent the display of signal aspects that would permit opposing trains to enter the same block at the same time. There are three general schemes in effect for the control of signals on single track. The first is known as overlap, the second as absolute permissive, and the third as traffic locking. The latter scheme permits movements of trains by signal indication without regard to class, direction or right. Under this scheme, Standard Code Rules 261, 263 and 264 are in effect. The first two schemes require that superiority of trains must be observed.

On track signaled for movements in both directions, a train shall cause one or more opposing signals immediately ahead of it to display an aspect requiring a stop. On such track, signals shall be so arranged and controlled that if opposing trains can simultaneously pass signals displaying Proceed aspects, and the next signal in advance of each such signal then displays an aspect requiring a stop, the distance between opposing signals requiring a stop shall be not less than the aggregate of the stopping distances for movements in each direction. Where such opposing signals are spaced stopping distance apart for movements in one direction only, signals arranged to display restrictive aspects shall be provided in approach to at least one of the signals. Where such opposing signals are spaced less than stopping distance apart for movements in one direction, signals arranged to display restrictive aspects shall be provided in approach to both such signals.

Overlap system.

The overlap system provides for the control of signals extending into the territory which another signal or signals govern.

Figure 13 illustrates the controls for an overlap system in which the leaving signals at the sidings are located at the clearance point. In some cases these

Fig. 13.
Diagram Showing Track Limits for Signal Controls of Single-Track Overlap System.

cause signal 10 to display an Approach aspect. The eastward train passing signal 12 would cause signal 9 to display a Stop aspect which would in turn cause signal 7 to display Approach, but signal 7 would not display Stop until the eastward train reached a point some distance in advance of signal 12 so that the westward train would receive no advance warning that signal 7 was at Stop. Therefore, the distance between signals 7 and 8 must be not less than the aggregate of the stopping distances for movements of trains in each direction.

Detailed circuits for the overlap system are not described as they are quite similar to those used in absolute permissive block system which are described later and which is now superseding the overlap system.

Absolute permissive block system.

In the absolute permissive block system, the block is from siding to siding for opposing movements and the signals governing entrance to this block indicate Stop when the block is occupied by an opposing train. For following movements the section between sidings is divided into two or more blocks and train movements into these blocks, except the first one, are governed by intermediate signals usually displaying Stop; then Proceed as their most restrictive indication.

Figure 14 illustrates the controls for an absolute permissive block system. In this system of signaling the block for opposing train movements is from siding to siding with the head block signals located just ahead of the switch. These signals are the "absolute" or Stop signals. For following train movements the section between sidings is divided into three blocks and train movements into these blocks, except the first one in each direction, are governed by intermediate signals, the most restrictive indication of which is Stop and Proceed.

It will be recalled that in describing the overlap scheme shown in Fig. 13, should two trains move toward each other from sidings A and B and pass signals 5 and 12 simultaneously, with each signal indicating Proceed, it would not cause all opposing signals to assume their most restrictive aspect. Under the absolute permissive scheme all intermediate signals would display their most restrictive aspect so that signals 7 and 10 would display Stop and Proceed to the approaching trains, thereby providing ample aggregate stopping distance.

Figure 15* illustrates the control circuits for a section of track between sidings A and B and an opposing train would be held at the siding by a Stop signal. Following train movements in the same direction will, of course, receive a signal depending on the location of the train it is following. In the absolute permissive scheme of signaling it is to be understood that trains must also observe class, direction and right, similar to that in the overlap scheme.

The circuits as shown in Fig. 15 indicate that with no train approaching in either direction all signals are indicating Proceed. Assume now a westward train is approaching signal 1. Signal 2 will be displaying Stop and Proceed due to the approaching train occupying the block controlled by signal 2. With

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CONTROLS FOR OPPOSING MOVEMENTS SHOWN WITH SOLID LINES.
CONTROLS FOR FOLLOWING MOVEMENTS SHOWN WITH BROKEN LINES.

Fig. 14.
Diagram Showing Track Limits for Signal Control of Absolute Permissive Automatic Block Signal System.

ing signal 32 to display Stop, which would provide an absolute stop for any approaching eastward train.

The circuit arrangement in this installation uses polarized HD relays and neutral slow release HP relays with three-wire HD control between signals. The control circuit of signal 22 is as follows: with everything normal positive battery BS is taken over a front contact of relay 12HPR, back contact of stick relay 11SR, front contact of track relay 11TR, wire 22HD, front contact of track relay 22TR, through coils of relay 22HDR, front contact of relay 22TR, wire N11-22HD, front contacts of relays 11TR and 12HPR, to negative battery CS. With current flowing through the coils of relay 22HDR in this direction it will cause the left-hand polar contacts of this relay to close completing a circuit from positive battery B, front contact of relay 22HPR, left polar contact of relay 22HDR, wire 22DG to lamp in green or Proceed aspect unit, wire EN, through back contact of relay 21HPR, wire C to negative battery. An eastward train approaching signal 22 would have signal control relay 21HPR de-energized, which permits approach lighting of signal 22 as soon as the train occupies the track controlled by signal 21.

When train passes signal 22 it will de-energize track relay 22TR which will de-energize signal control relay 22HDR, which will in turn extinguish the green light and light the red unit by receiving positive battery B, through back contact of relay 22HPR, wire 22RG to red unit, wire EN through back contact of relay 21HPR or 22HPR, wire C to negative battery. With relay 22HPR de-energized it will continue to keep the red unit displaying Stop and Proceed as long as this block is occupied.

As train is passing signal 12, stick relay 12SR will be energized by receiving positive battery BN through back contacts of relays 11SR and 11TR, front contact of relay 12HDR, through coils of relay 12SR, wire CN to negative battery. The stick circuit will keep relay 12S energized through back contacts of relays 11SR and 11TR, through front contact of relay 12SR, then through the coils of this relay to negative battery CN. When rear end of train passes signal 12, relay 12SR will still remain energized by the circuit tapping off between relays 11SR and 11TR, through back contact of relay 12HDR, through front contact of relay 12SR, through coils of this relay to negative battery CN. Under this condition signal 22 will then display an Approach aspect to an approaching train by its controlling relay 22HDR being energized from positive battery BS through front contact of relay 12SR, back contact of relay 12HPR, front contact of relay 11TR, wire N11-22HD, front contact of relay 22TR, through coils of relay 22HDR, front contact of relay 22TR, wire 22HD, front contact of relay 11TR, back contacts of relays 11SR and 12HPR to negative battery CS. With current flowing through the coils of relay 22HDR in this direction it will cause the right-hand polar contacts of this relay to be closed thereby completing the circuit to display the Approach aspect by receiving positive battery B through front contact of relay 22HPR, right-hand polar contact of relay 22HDR, wire 22HG to yellow or approach unit, wire EN through back contact of relay 21HPR to negative battery C. When rear of train passes signal 2, relay 12HDR will be energized, relay 12SR de-energized

There are other arrangements [illegible] missive schemes, but the principles are much the same as illustrated in Fig. 15.

Traffic control system.

A traffic control system is a block signal system under which train movements are authorized by block signals whose indications supersede the superiority of trains for both opposing and following movements on the same track.

In a traffic control system, Standard Code Rules 261, 263 and 264, which govern opposing and following movement of trains by block signals on the same track are in effect. Traffic locking must be provided as a part of a traffic control system, to prevent the manipulation of levers or other devices for changing the direction of traffic on a section of track while that section is occupied or while a signal displays an aspect for a movement to proceed into that section.

Where Rule 261 is in effect, providing that trains be governed by block signals whose indications supersede the superiority of trains, certain requirements in addition to those required for automatic block signals must be met, as follows:

1. Signals governing movement at higher than restricted speed shall be controlled by continuous track circuits. Also, in addition, at controlled point they shall be controlled by control operator, and, at manually operated interlocking, manually in cooperation with control operator.

2. Signals at a controlled point shall be so interconnected that aspects to proceed cannot be displayed simultaneously for conflicting movements.

3. Signals at adjacent controlled points shall be so interconnected that aspects to proceed cannot be displayed simultaneously for conflicting movements.

4. On track signaled for movements in both directions, occupancy of the track between opposing signals at adjacent controlled points shall prevent changing the direction of traffic from that which obtained at the time the track became occupied.

5. Occupancy of track circuits at controlled points shall be automatically indicated at the control station.

6. Approach or time locking shall be provided for all controlled signals and for all electric locks on hand-operated switches.

7. Each hand-operated switch installed in main track where train movements are made at speeds exceeding 20 miles per hour shall be electrically locked in normal position. Electric lock may be unlocked either automatically or by the control operator, but only after control circuits of signals governing movements over the switch in each direction have been opened.

In the territory listed on Time-Table Special Instructions, where Rule 261 is in effect, the signals at the interlockings or block stations are operated manually, controlled by track circuits and other electrical and mechanical agencies subject to the rules in effect.

Where operators are located at adjacent block stations they must communicate with each other to obtain use of the block and, in addition, must cooperate with each other so that by means of operating a lever or device in one block station it releases a lever or device in the other block station permitting this

displayed at adjacent or controlled block stations.

Traffic conditions determine whether manual block or automatic block signal system rules shall be in effect for following trains.

On lines of light traffic, where it is considered desirable to operate under Rule 261, intermediate automatic signals may be omitted and manual block signal rules may be applied for following movements, so that operation would be similar to manual block except that trains would operate by signal indication which would supersede time-table superiority and dispense with train orders.

On lines of denser traffic, automatic block signal system rules would be placed in effect and intermediate automatic block signals for both directions would be installed. Under this arrangement, trains would continue to operate by signal indication which would supersede time-table superiority and dispense with the use of train orders, but trains moving in the same direction would be governed by the intermediate signals similar to that explained in the early part of this chapter.

There are many different types of circuits and devices used in traffic locking so that it would not be practical to enumerate them in this chapter, but Fig. 16* illustrates typical traffic circuits between two attended offices. The principle of operation is similar with other types of circuits, but the main purpose is to insure that all opposing signals are locked out before clearing a signal governing movements to the track in question. In certain cases all signals are controlled from the same block station so the traffic locking is confined to the one machine.

Figure 16 shows a two-wire traffic control arrangement. The circuits are drawn to show the traffic direction established for an eastward movement. When traffic is established for a westward movement, both traffic levers are in the reverse position. Lights are provided to show block occupancy and direction of established traffic. A bell is provided to indicate that the adjacent office desires to change the established traffic. Blocking rectifiers are shown in the control of the FR relays to prevent discharge of one battery into the other in case of unequal potential.

To reverse the traffic direction, the east office pushes traffic button 1PB which energizes relay 1PBR. This reverses the energy in relay 27NFR and de-energizes relay 27FKR which receives its energy from a normal polar contact on relay 27NFR. When relay 27FKR is de-energized and energized by operating 1PB, the bell will ring and the block light flash at the west office. The west office then reverses traffic lever 27 which de-energizes relay 27NFSR placing the traffic batteries in opposition and releasing relay 1NFR. When relay 1NFR is de-energized relay 1FKR is de-energized. The bell at the east office then rings and the block light is extinguished. The east office then reverses traffic lever 1 which energizes relays 1RFSR and 1RFR. Relay 1FKR is energized through contacts on relays 1RFSR and 1RFR. This lights block light and removes energy from the bell. Relay 1RFPR is now energized through contacts on relays 1RFR and 1RFSR. With relay 1RFPR energized

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movement, the operation of the traffic lever at the adjacent office will not affect the signal indication displayed. The circuit arrangements for relays 1WFSR and 27EFSR can provide for following movements into an occupied block under the individual railroad's rules, operating practices and signal indications.

Intermediate signals are frequently provided between the controlling stations to permit following movements under automatic block signal system rules, but these signal controls are not shown as they are similar to those in previous figures of this chapter with whatever modifications may be necessary.

FIG. 11

CIRCUITS FOR TWO-BLOCK INDICATION, NORMAL CLEAR, COLOR LIGHT SIGNALS, TWO TRACKS, ONE BLOCK OVERLAP WITH ALTERNATING CURRENT TRACK CIRCUITS AND DIRECT CURRENT NEUTRAL LINE CIRCUITS.

FIG. 9

CIRCUITS FOR FOUR ASPECT SEARCHLIGHT
AUTOMATIC BLOCK SIGNALS.

FIG. 8

CIRCUITS FOR TWO-BLOCK INDICATION, NORMAL CLEAR COLOR LIGHT SIGNALS, TWO TRACKS, WITH ALTERNATING CURRENT TRACK AND CONTROL CIRCUITS.

NOTE 1:
WHERE ADVANCE LIGHTING IS NOT
USE CONNECTION (A) AND SLOW RE

FIG. 7

CIRCUITS FOR THREE ASPECT SEARCHLIGHT
AUTOMATIC BLOCK SIGNALS.

NOTE 1:
WHERE ADVANCE LIGHTING IS DESIRED REMOVE CONNECTION "XY" AND APPLY POSITIVE ENERGY AS SHOWN BY DOTTED LINE AT "Y."

FIG. 5

CIRCUITS FOR THREE ASPECT COLOR LIGHT AUTOMATIC BLOCK SIGNALS.

FIG. 6

CIRCUIT USING RELAYED CUT SECTION AND NEUTRAL LINE RELAY.

NOTE 1:
THIS CIRCUIT PROVIDES ADVANCE LIGHTING AND APPROACH LIGHTING OF SIGNALS.

FIG. 16

RELAY TYPE TRAFFIC CIRCUITS

BETWEEN ATTENDED OFFICES