New Haven Installs Five-Aspect Signaling Controlled By Coded Track Circuits

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Fourth and fifth aspect required where distances are short between interlockings in dense traffic territory—New system obviates line control wires as an aid in conservation of critical war materials

THE New York, New Haven & Hartford has completed an initial section of an extended territory on which color-light signals are to replace three-aspect semaphores, the new system of aspects including as many as four and five aspects where required, and the outstanding feature is that all aspects are controlled by coded track circuits, thus demonstrating the adaptability of this system of control to the exacting requirements of modern multiple-aspect signaling. Furthermore, the use of coded track circuits obviates the use of line control wires, thereby conserving critical metals as an aid in the war program.

Each of the new automatic signals have two searchlight signal units. Interlocking signals are assembled with two vertical lights while the automatic signals are assembled with staggered lights and, in addition, are equipped with a number plate. The vertical distance between light centers is 4 ft. 6 in. The aspects and indications, which are all in accordance with the A.A.R. Standard Code, are shown in the accompanying table.

In brief here, to be explained in detail later, the Approach aspect is controlled by codes in the track circuit at the rate of 75 per minute, the Approach-Medium by 120-code, and the Clear by 180-code, while the Advance-Approach is controlled by the recently developed 75-modulated code. The most restrictive aspect, Stop-and-Proceed, is controlled by the absence of code, or steady energy, which might be occasioned by foreign current, will likewise result in the display of the Stop-and-Proceed aspect. Lock-out circuits provide protection if the insulation in insulated joints should fail.

Reasons for New Signaling Including Additional Aspects

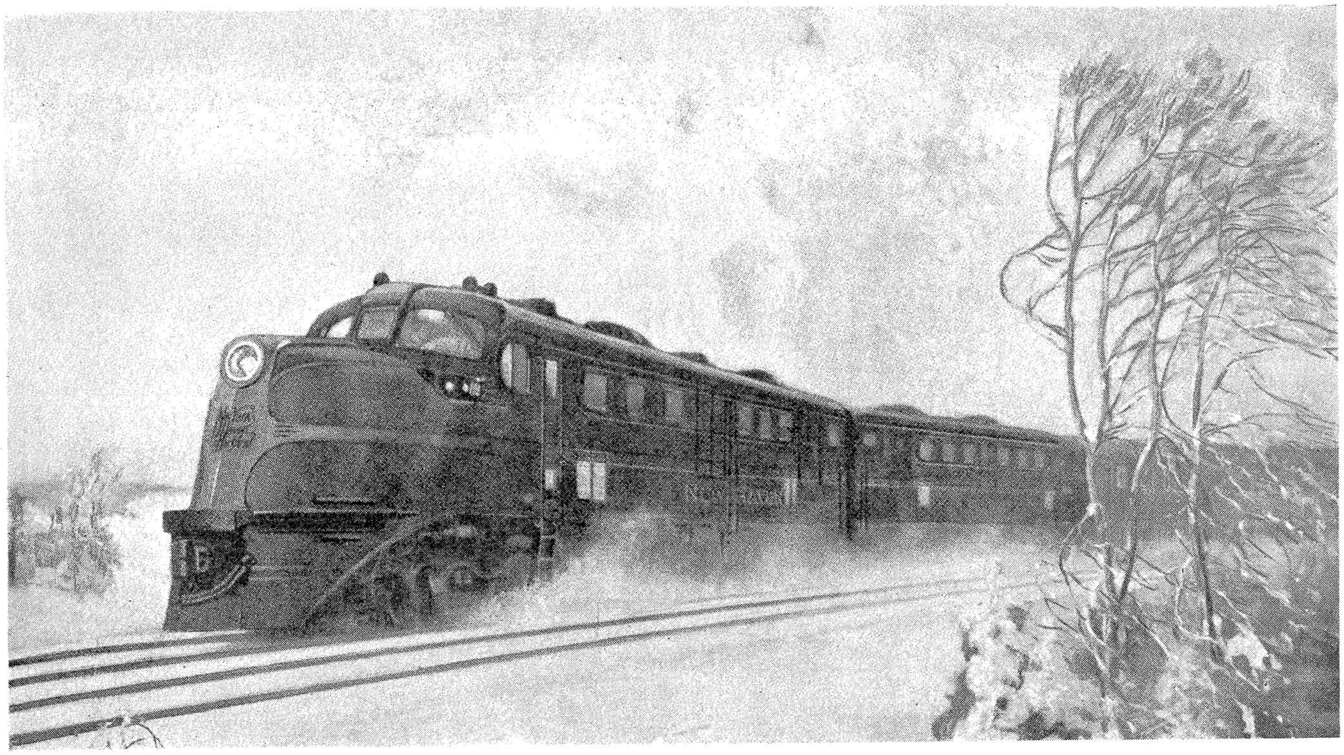
The semaphore automatic block signaling was installed in this territory in 1917, at which time smaller trains at lower maximum speed were operated. At present, the maximum permissible speed for passenger trains is 70 m.p.h. and for freight trains, 50 m.p.h. The traffic has increased, especially during 1942, to the extent that this territory is now handling an average of 50 suburban passenger trains, 125 through passenger trains and about 37 freight trains daily.

In this territory there are four main tracks, each of which is signaled for single-direction train operation. The semaphore signals were located on signal bridges and were spaced an average of 3,000-ft. blocks, including the interlocking home signals, while the new signals have an average of 4,000-ft. blocks, but due to location of interlockings and physical conditions there are some blocks only 2,690 ft. long. The semaphore signal system used single-arm signals for the automatic and double-arm signals for interlocking home and approach signals. The approach signals were controlled to give four aspects when required for approach to interlocking home signals. The automatic signals were arranged for three aspects.

A number of studies were made to revise the existing signals to meet the requirements for present traffic. It was found that to provide for the slower speed of the suburban trains, comparatively short blocks were required, while the high-speed passenger and heavy freight trains required longer blocks for proper breaking distances and train spacing. To meet this requirement, plus the short blocks due to physical conditions at

Aspects and Indications of Automatic Signals

NAME	ASPECT	INDICATION
Stop and Proceed Signal	Red-over-red	Stop, then proceed
Approach Signal	Yellow-over-red	Proceed preparing to stop at next signal. Train exceeding medium speed must reduce to that speed.
Advance-Approach Signal	Yellow-over-yellow	Proceed preparing to stop at second signal on the same or diverging route.
Approach-Medium Signal	Yellow-over-green	Proceed approaching next signal at medium speed.
Clear Signal	Green-over-red	Proceed



New York, New Haven & Hartford passenger train en route between New York and Boston

interlockings, and to provide suitable indications for the approach to interlockings, it was found necessary to use four-aspect as well as five-aspect signaling. The use of these additional aspects has been found to meet all the anticipated requirements, and further to result in a train spacing which allows the various classes of traffic to reduce speed or accelerate in a gradual manner, and thus avoid all abrupt changes in speed, and further to allow the various classes of traffic to proceed at a uniform speed as required by their schedule.

How Multiple-Aspects Aid Train Operation

The three conventional aspects, Stop, Approach, and Clear, in reality constitute a one-speed system. As long as only Clear aspects are encountered, a train is operated at maximum permissible speed, but when an Approach aspect is encountered, the engineman, according to rule, has no alternative other than to apply the brakes preparatory to stopping within the shortest distance consistent with a service application of the brakes and smooth handling of the train. On the other hand, the addition of the fourth and fifth aspects provide a "cushion" which absorbs the differences in time-distances so that "second" trains pass through the sections where the speeds must be reduced over drawbridges and through interlockings, without the necessity for stops or unnecessary reductions in speed, thereby keeping them moving at the highest speed consistent with safety until the train ahead has accelerated to clear the block or route, so that the second train can again accelerate. On account of the numerous train movements, especially during certain periods of the day, the circumstances explained above occur numerous times each day at various locations, and, therefore, the new signaling including the fourth and fifth aspects is an important aid in minimizing delays, increasing track capacity and in general expediting the flow of important traffic occasioned by the war.

The Approach-Medium

The diagram, Fig. 1, shows the home signal at an interlocking and the two automatic signals in approach. The crossover is a No. 20 good for diverging train movements at medium speed, 30 m.p.h. If the crossover is reversed and home signal No. 1 displays a Medium-Clear aspect for this line up, then signal No. 2 would display the Approach-Medium aspect, so that an engineman can thereby bring his train up to and through the crossover at the speed for which it was designed. If the Approach-Medium aspect were not provided, the ordinary Approach aspect would, in the case cited above, have to be used on signal No. 2, which means that, at signal No. 2, the engineman would, according to rule, apply the brakes prepared to stop at signal No. 1. Thus the use of the Approach-Medium aspect effects a saving in train time as well as obviating unnecessary braking and perhaps rough handling. An important point is that the Approach-Medium is an extra aspect used on the first signal in approach to a home interlocking signal.

The arrangement shown in Fig. 1, however, is not adequate if local conditions are such that the length of the block between signals No. 1 and No. 2 is not sufficient for the speed of a train to be reduced from maximum to minimum speed. In such instances, as shown in Fig. 2, rather than display a Clear aspect on signal No. 13, the Approach-Medium aspect, yellow-over-green, is displayed and again repeated for signal No. 12.

For through moves on a main track and strictly as an automatic block proposition, there is also need of another aspect in addition to the conventional three aspects of Stop, Approach and Clear. Referring to Fig. 3, block B is not long enough for full train stopping distance, and, therefore, signaling must be provided to allow two blocks, the total length of which is more than train stopping distances. When a train is occupying block C, signal No. 21 displays the Stop-and-Proceed aspect; signal No. 22 displays the Approach aspect; and signal No. 23 displays the Approach-Medium aspect. This aspect of yellow-over-green indicates that an engineman is to control the speed of his train so as to pass signal No. 22 at medium speed which will allow for a stop at signal No. 21. In most instances block B is long enough for stopping at signal No. 21 when passing signal No. 22 at medium speed but if this distance is too short, then signal No. 23 would display Advance-Approach (yellow-over-yellow) aspect. Where the total of two blocks is less than stopping distance as indicated in Fig. 4, the Approach-Medium aspect is

The standard codes of 75, 120 and 180 cycles per minute are assigned to control the Approach, the Approach-Medium and the Clear aspects, respectively. The Advance-Approach aspect is controlled by the recently developed and named 75M code. This is fundamentally a 75 code, except that it has the "on" time of every third cycle lengthened so that there is a short "off" and long "on" cycle occurring every 2.4 seconds. The short "off," long "on" component of the 75M code is de-

5, which will be referred to in explaining the circuits, is one of a number of typical plans which were used in developing the circuits for this installation. Briefly, the procedure in developing the complete plans was as follows: The railroad company furnished plans showing all special circuit requirements other than those covered by the several typicals showing the various features of the signal controls in connection with the coded track circuits. The plans for shop wiring, which were prepared for each

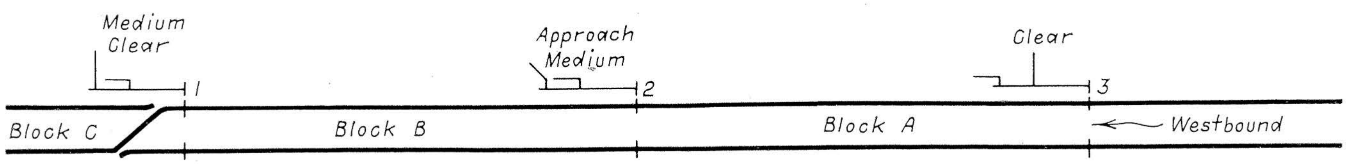


FIG. 1 Arrangement where block B is long enough for a train to reduce from maximum to medium speed

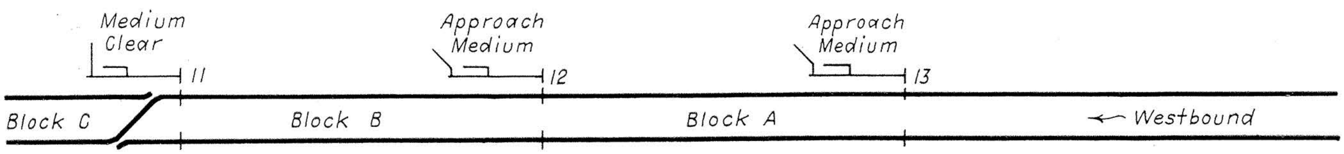


FIG. 2 Arrangement where block B is not long enough for a train to reduce from maximum to medium speed

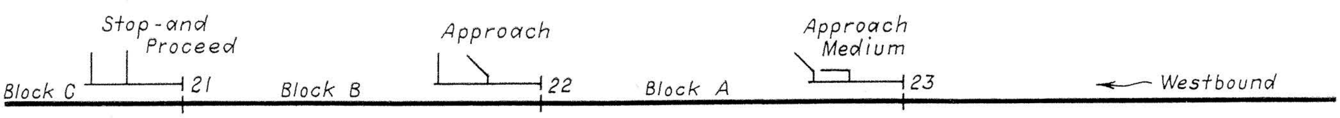


FIG. 3 Arrangement where block A plus block B is more than train stopping distance

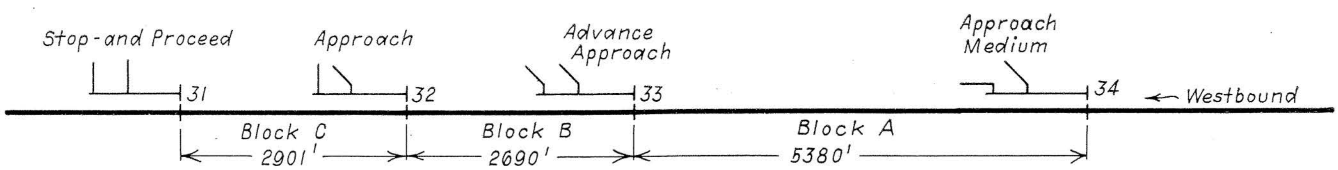


FIG. 4 Arrangement where block C plus block B totals less than train stopping distance

shown for signal No. 34, Advance-Approach for signal No. 33 and Approach for signal No. 32, the total of which provides for a gradual reduction in speed and a normal stop at signal No. 31.

New Track Circuit Controls

In the previous semaphore signaling, a-c. centrifugal frequency relays were used on the track circuits, and Model-15 a-c. vane relays were used for line circuits. In the new signaling system, there are no signal line control circuits, all the various aspects being controlled by coded track circuits, which are fed alternating current at 100 cycles so that there is no chance for inductive interference from parallel high-tension lines.

coded to produce the Advance-Approach aspect. It may be noted that the short "off," long "on" period of the code occurs 25 times per minute, and when considered alone, this component amounts to a 25-cycle code.

The new 75M code was adopted rather than some other code due to the fact that it would permit using the existing standard 75, 120 and 180 codes exactly as heretofore, and, further, if desirable, the 75M code may be used for operating the 75 code cab signal, if cab signaling is installed on this territory at a later time. This arrangement works satisfactorily and illustrates the adaptability of coded track circuits to a wide range of conditions.

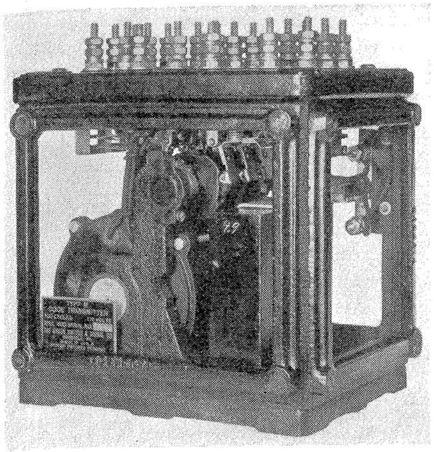
The circuit drawing shown in Fig.

relay house location, referred to these various typical circuits rather than showing the complete circuit detail for the location.

Control of Approach Aspect

Several articles have appeared in *Railway Signaling* concerning fundamental coded track circuits, and their associated equipment. Therefore, in explaining circuits in this article, only circuits peculiar to this installation will be described. The diagram, Fig. 5, shows the circuits for the control of a five-aspect signal.

In describing the functioning of the circuits to cause signal 6 to display an approach aspect it will be assumed that the track circuit in advance of signal 4L, not shown, is

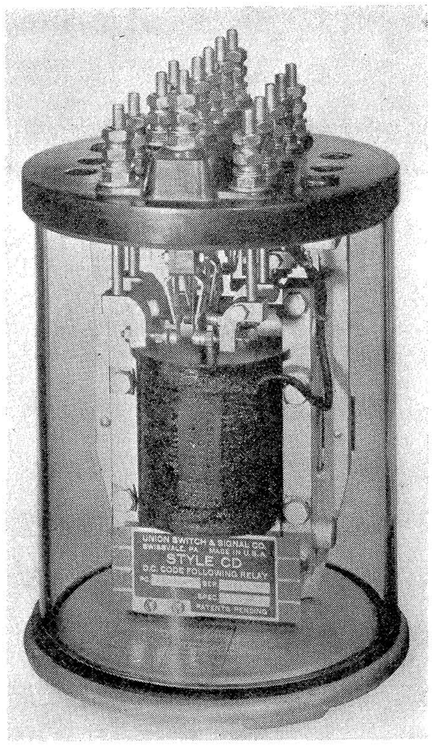


A code transmitter

occupied by a train which has just moved out of the track circuit in advance of signal 6. Under this condition, 75 code is fed to the track circuit in advance of signal 6 and is followed by the code-following track relay at signal 6. Positive energy is fed through the decoding transformer DT in the usual manner to cause the energization of lock-out relay LOR. The design of this relay, the purpose of which will be described later, is such that it will become fully energized on the second impulse of the coded energy. The stick circuit which is then established over a front contact of the lock-out relay, a back contact of the aHSC relay, and a front contact of the code-following track relay T, is an integral part of the lock-out circuit and will also be described later.

Relay BSA will energize over a front contact of relay LOR at the first "off" interval of the code following the energization of the LOR relay. A snub circuit, including a 200-ohm resistor, is used in conjunction with relay BSA to retain this relay energized during the "on" interval of the code. With energization of relay BSA, relay aHSC will also become energized, near the expiration of the third code impulse, by a circuit that includes a front contact of the code-following relay. A stick circuit is established through a front contact of the aHSC relay to retain it energized as long as relay BSA is energized. The slow-release characteristics of the aHSC relay are such that it will remain picked up during any transitory de-energization periods of the BSA relay. Relays aDSC and bDSC are not energized because they are electrically tuned to pick up only on 180 and 120 code respectively.

When the aHSC relay is energized, a circuit is completed over a front contact of that relay to energize the "a" arm of signal 6. This circuit also includes, from positive d-c., a back contact of relay aDSR and a back contact of relay aDSC, to the A+ terminal of the searchlight signal operating unit. The circuit returns to negative over the back contacts of relays aDSC and aDSR, and a front contact of relay aHSC. Thus, with the circuit just described, the "a" arm of the signal will energize to its yellow position. The "b" arm can assume only a red aspect because the relays bDSC and bDSR are de-



A d-c. code-following track relay

energized. Therefore, the signal will display a yellow-over-red, Approach aspect.

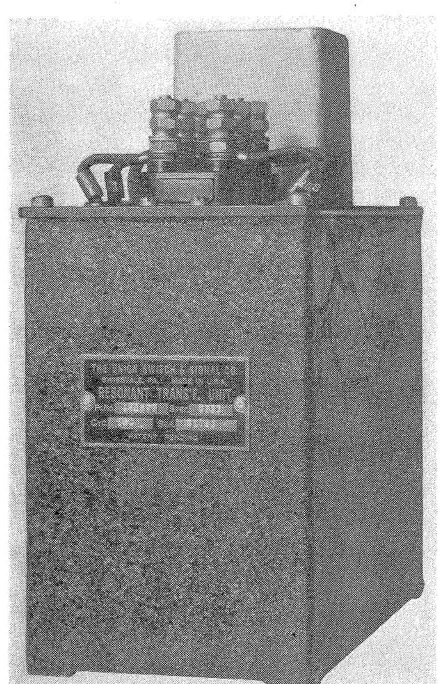
Control of Advance-Approach Aspect

At a five-aspect signal, the coding and decoding equipment is the same as at a four-aspect signal, with the additional equipment required for coding and decoding the 75M code for control of the Advance-Approach aspect. A 75M code transmitter BCT at the exit end of the block supplies 75M code for control of the Advance-Approach aspect, and a standard code transmitter ACT supplies the 120 and 180 codes for the Approach-Medium and the Clear aspects. This coding equipment is at the signal in advance of signal 6.

The additional decoding apparatus consists of a second code-following relay TRA with an associated decoding unit bHDU and a decoding relay bHSC, with circuit selection to allow for full operation of the additional apparatus effective only when 75M code is received. As the transformer circuit and the selection circuit are broken through the same contact of the code-following track relay, a blocking rectifier "RN" is used in the selection circuit to segregate it from the transformer circuit.

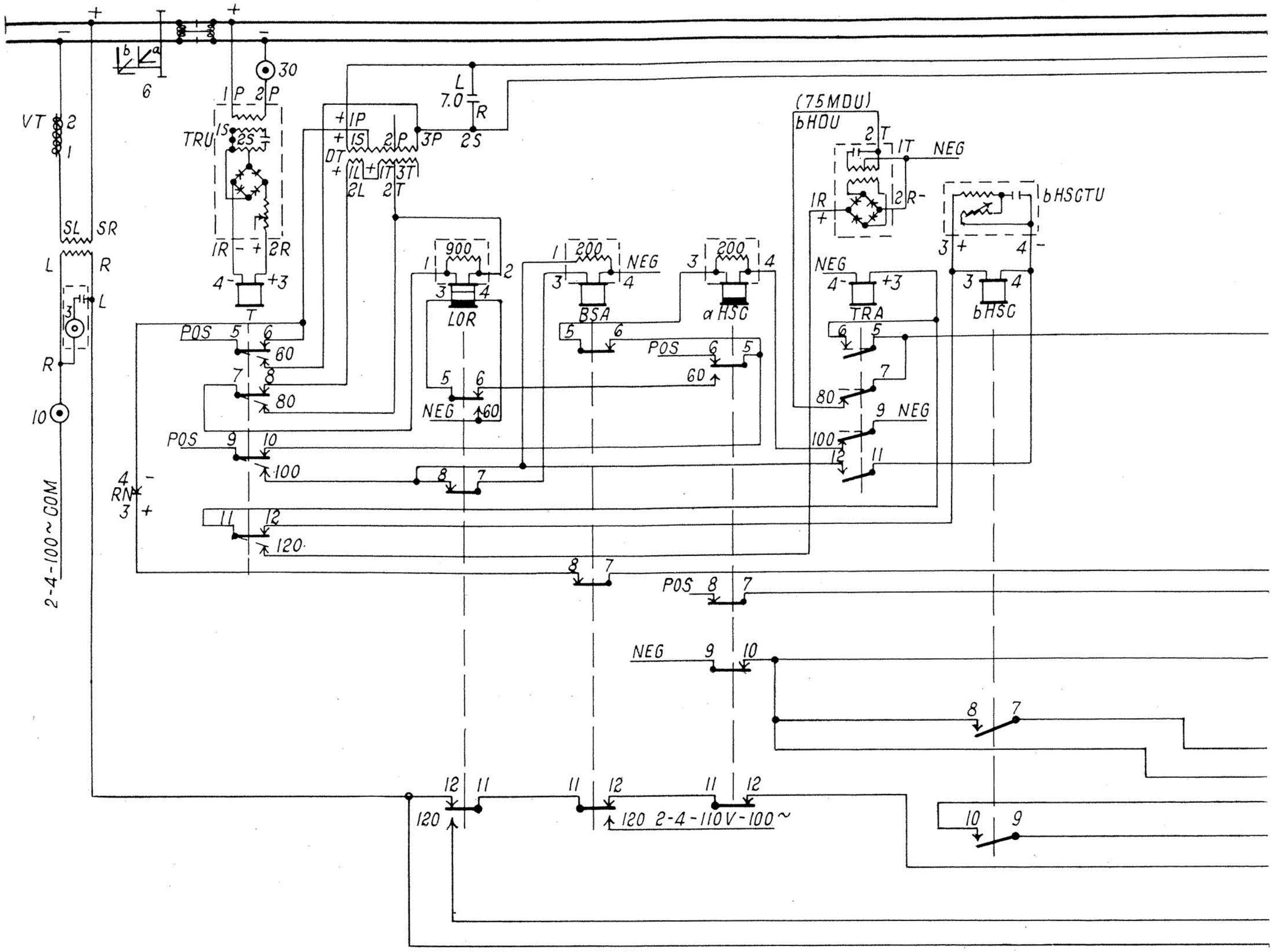
In describing the control for an Advanced-Approach indication, first it will be considered that signal 4L, not shown, is at Stop. In this case 75 code would be fed to signal 6 to cause it to display an approach indication. Since the track relay T at signal 6 will be operating on the 75 code, relays LOR, BSA and aHSC will be energized in the usual manner. As signal 6a will be displaying a yellow aspect, its repeater relay aHSR will be energized to feed 120 code to signal 8, not shown, for display of an Approach-Medium aspect, and 180 code will be sent to signal 10, not shown, for display of a Clear aspect.

As soon as 75 code is received, signal 6 will display an Approach aspect in the usual manner. The TRA relay and its decoding unit are so designed and proportioned that the TRA relay will energize and become de-energized during each "off" period of the code. The energization of its complimentary relay bHSC, however, because of the circuit struc-



A resonant transformer unit

ture, will not be affected unless the short "off" period of the 75M code is received. The TRA relay is energized by each "off" period of the code by the following circuit: When the track relay has its front contacts



closed during each "on" period of the code, positive d-c. energy is fed over a front contact of that relay, through blocking rectifier RN, over a front contact of relay BSA, over a back contact of relay aDSC, over a back contact of relay bDSC, over a back contact of relay TRA, to one side of the primary winding 2T of the 75M decoding unit bHDU, through a portion of that winding to terminal 1T and thence to negative battery.

It will be noted from the above that during the "on" period of the 75 code, energy flows through the primary winding of the bHDU decoding unit. Current does not flow from the d-c. output, however, during the "on" period of the code because the circuit is open at the back contacts of the track relay. When the track relay is de-energized, d-c. energy flows from the positive 1R terminal of the decoding unit bHDU, over a back contact of the track relay to positive terminal 3 of relay TRA and through that relay to the negative terminal 2R of decoding unit bHDU. The design of the decoding unit is such that, when used in conjunction with the TRA relay, the d-c. energy will flow for a sufficient length of time to energize the TRA relay for a period of from .183 second to .210 second. The TRA relay returns to its de-energized position during the "off" period of the 75 code before the code-following track relay is again energized. Negative energy is supplied to relay aHSC through a back contact of relay TRA to provide a check of the coding action of relay TRA, and to make certain that relay bHSC will energize only on the 75M code.

When signal 4L displays an Approach indication relay 4LaHSR will become energized, and 75M code will be fed through code selection circuits to the track circuit ahead of signal 6. The energization pulse for relay bHSC comes after the first short "off," long "on" component of the 75M code. When the TRA relay is energized during the "off" period, a stick circuit functions to retain the TRA relay in its energized position until the code-following track relay is again energized by the "on" period of the code. This includes the energizing circuit of the 75M decoding unit bHDU and a front contact of the TRA relay. When the code-following track relay and the TRA relay are simultaneously energized, an energization pulse of .66 second duration is produced to pick up relay bHSC. The pick up time of relay bHSC is greater than the length of the first energization pulse, but the relay continues to receive energy through the action of its associated timing unit bHSCTU. Enough energy is received to retain the contacts of relay bHSC closed during each "off" period of the code.

The energization circuit of relay bHSC is as follows: Positive d-c. energy over a front contact of the code-following track relay, through the blocking rectifier RN, over a front contact of relay BSA over a back contact of relay aDSC over a back contact of relay bDSC and over a front contact of relay TRA, and from there to a front contact of code-following track relay T. The circuit continues to terminal 3 of relay bHSC and to positive terminal 3 of the timing unit bHSCTU in parallel to terminals 4 of relay bHSC and 4 of the timing unit. From there the circuit continues over a second front contact of relay TRA to a front contact of relay LOR, and to terminal

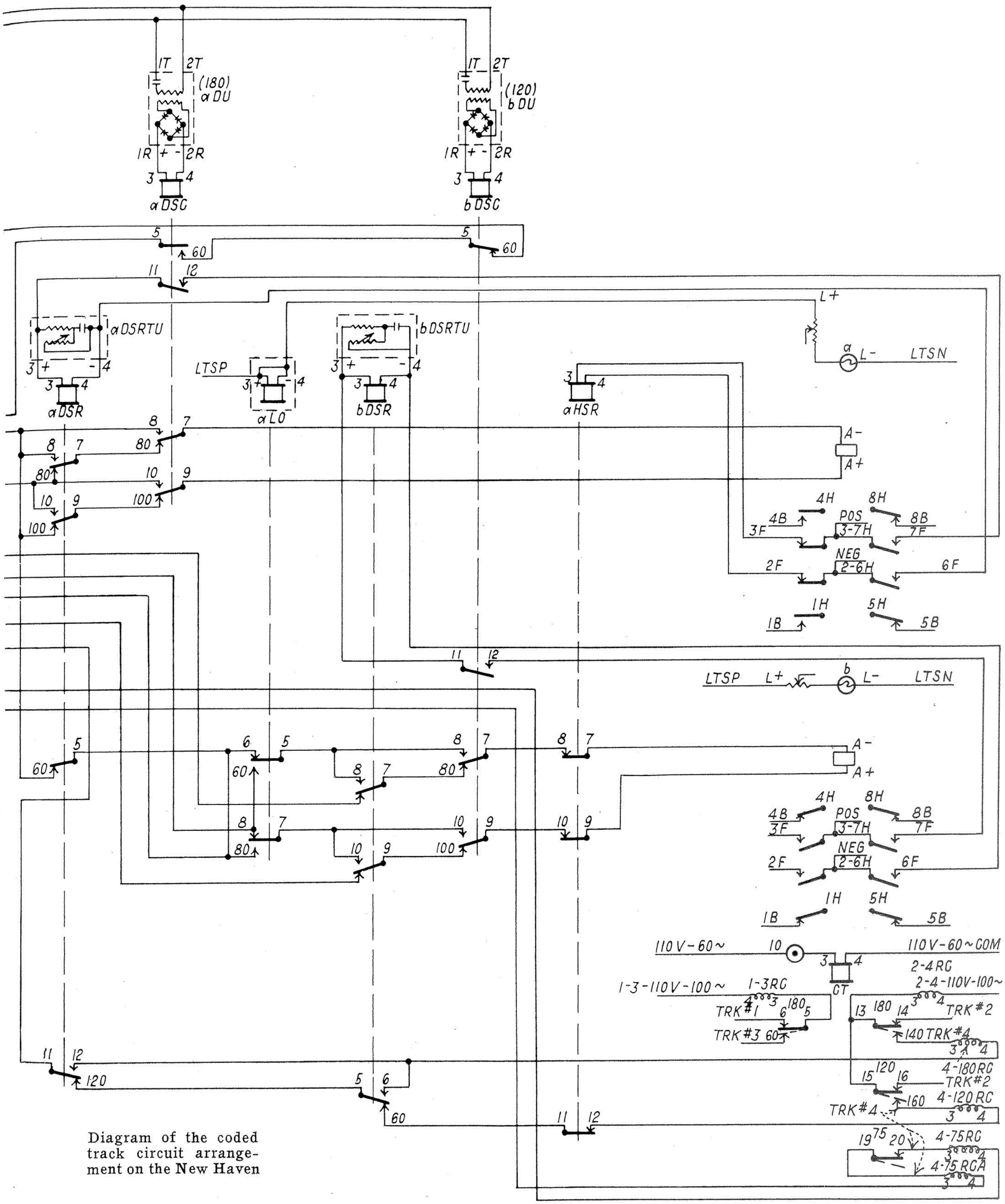


Diagram of the coded track circuit arrangement on the New Haven

3 of relay BSA, and from terminal 4 of relay BSA to negative battery. Relays bHSC and BSA are placed in series during the energized period of the code-following track relay, in order to retain relay BSA energized during the long "on" of the code.

With relay bHSC energized, the following circuit is completed to cause the energization of the "b" unit: Positive d-c. energy is fed through a front contact of relay aHSC to a back contact of relay aDSR, a front contact of relay bHSC, back contact of relay bDSR, back contact of bDSC and over a front contact of relay aHSR to the positive A terminal of the signal operating unit. From the negative A terminal, the circuit continues over a front contact of relay aHSR, a back contact of relay bDSC, back contact of relay bDSR, front contact of relay bHSC and a front contact of relay aHSC to negative battery.

Control of Approach-Medium Aspect

If 120 code is fed to signal 6 with the result that the code-following track relay is following that code, relay bHSC no longer receives an energization pulse and commences to release. However, its slow-release characteristics combined with the associated timing unit bHSCTU retain its contacts closed for a sufficient period of time to permit the energization of relay bDSC on 120 code. The circuit to energize the "b" arm is from positive energy over a front contact of relay aHSC, over a back contact of relay aDSR, over a front contact of relay aLO, and over front contacts of relays bDSC and aHSR to the A negative terminal of the "b" searchlight operating unit. The return circuit is from the A positive terminal of the operating unit through second contacts of the same relays to the negative source of energy. The control circuit to allow the "b" arm to display a green aspect is thereby closed, permitting signal 6 to display an Approach-Medium.

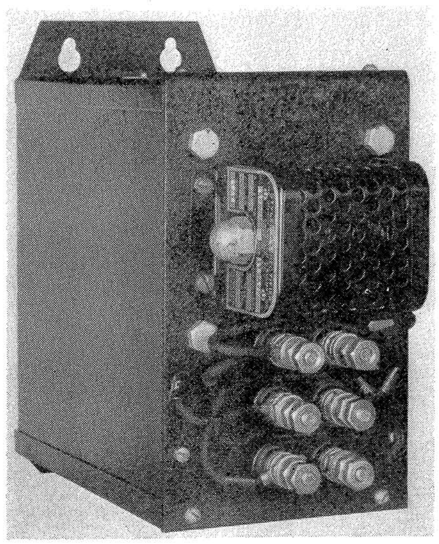
Control of Clear Aspect

Code of 180 interruptions per minute is received at signal 6 when the signal repeater relay bDSR of signal 4L in advance is energized when that signal displays an Approach-Medium aspect. The receipt of 180 code causes the energization of relay aDSC and the de-energization of relay bDSC. When relay aDSC becomes energized the circuit for the control of the "a" arm of that relay is pole-changed through the aDSC relay. Thus the aspect of the "a" arm is changed from yellow to green, and relay aHSR becomes de-energized due to the fact that its circuit is opened at contacts 2F and 3F on the searchlight signal unit. The signal-repeater relay aDSR becomes energized by a circuit which is completed over front contacts 6F and 7F on the "a" unit, when the "a" arm is displaying a green aspect. The control circuit for the "b" arm is opened by the de-energization of relay aHSR and the energization of the signal-repeater relay aDSR. Consequently, the "b" arm will display a red aspect, the "a" arm a green aspect, and signal 6 will then be displaying a Clear aspect.

The application of 180 code to the track circuit in the rear of signal 6 is not interrupted during the interval that signal 6 is changing from Approach-Medium to Clear. This is because relay bDSR, due to its slow release characteristics remains energized until after relay aDSR is energized. Furthermore, because of the slow-release characteristics of relay bDSR, the yellow-over-green aspect is retained in the course of the transition period that relay bDSC is de-energized until relay aHSR is de-energized.

Non-Cascading Lock-Out Circuits

An interesting phase of the signaling is the use of non-cascading lock out circuits to protect against defective insulated joints. In elec-



Approach-restricting decoding unit

trified terirtory, the impedance bond operates as an auto transformer in such a maner that false energy would flow over the insulated joints, even with only one joint broken down. If such false energy is coded, the code-following track relay of the signal system would be affected. The purpose of the lock out circuit is to prevent such conditions.

If a train is in the track circuit in advance of a signal where a defective insulated joint is present, the lock out circuits will operate in the following manner: With the train in this position, 75 code would be fed to the track circuit to the rear of the signal, which would feed over the defective insulated joint by the auto transformer action of the impedance bond and reach the transformer resonant unit TRU to energize the code-following track relay. The lock out relay LOR energizes at the second interval of the 75 code, and, with the relay in this position, steady energy is fed to the track circuit in the rear, over a front contact of the LOR relay and a back contact of relay BSA. The code-following track relay is then held steadily energized, and likewise the LOR relay is retained in the energized position by the stick circuit that is established. Thus with these relays continuously energized and relays BSA, aHSC, aDSC and bDSC continuously de-energized, a lock out condition is in effect which will cause a Stop aspect to persist as long as the leakage is present at the joint.

Should a defective insulated joint be present between two unoccupied track sections, a so-called "scrambled" 180 code would occur. The track relay of one track circuit would receive false energy from the transformer of the adjacent track circuit as well as the proper energy from the normal source. The false energy would partially or wholly fill in the "off" interval of the normal code, resulting in an abnormally long "on" code. Under this condition relay BSA will release because it is designed to remain energized only with code intervals of proper length. Steady energy will then be received at the track relay, from the transformer on the adjacent track section to the rear, over the defective insulated joint. The track relay will remain steadily energized until relay LOR releases. Relay aHSC is so timed that it will release shortly after relay LOR releases. Relays BSA, LOR and aHSC will then become de-energized.

With relays BSA, LOR and aHSC de-energized, the false energy fed to the track relay will be the 75 code. At the second closure of the front contacts of the code-following track relay, the LOR relay will pick up and remain energized by the stick circuit previously described, and the "lock out" will be in effect.

Under "lock out" conditions the track relay of the circuit to the rear of the defective joint location is fed steady energy. Relay LOR will not become energized, however, at the first "on" interval of the code, so it will be de-energized when the track relay is continuously energized by steady energy. The signal to the rear will display a Stop aspect with its LOR relay de-energized, but under these conditions, energy of 75 code will be connected to the track circuit in the rear of the second signal so that there will be no further cascading of the steady energy. This is known as the non-cascading feature of the "lock out" circuit.

Power Supply

Power for operation of the circuits is obtained from duplicate 11,000-volt, 62.1-cycle, single-phase transmission lines which extend along both sides of the track. Each transmisison line is equipped with a step-down transformer for providing 110-volt power to the signal circuits. An automatic power-transfer device automatically transfers the load from the secondary of the normal line transformer to the emergency transformer in the event of a power failure, or in case it is necessary to de-energize one pair of high tension mains to allow work on any of the high tension wires.

The energy for decoding power, for the control of the searchlight signals and other d-c. relay circuits is obtained from constant-potential rectifiers which are connected to the 110-volt, 62.1-cycle bus. Style R3Q-408 rectifiers, rated at 3 amp. and 14-volts are used at double signal locations, and R3Q-416 rectifiers rated at 5 amp. and 14 volts are used at four-track automatic block signal locations.

Small motor-generator sets, furnished by the General Electric Company and rated at 110-volt, 60-cycle to 115-volt, 100-cycle, are provided at the exit or transformer end of each track circuit. The motors of these sets, when running at synchronous speeds and supplied 62.1 cycle energy, will produce an output of 103.5 cycles per second at the generators.

Each of these sets is normally used to feed two track circuits. At a four-track location there would be two sets in use. Small switches are used in the generator circuits so that in case it is necessary to replace one of the machines, all four of the track circuits may be connected to one machine for a time long enough to permit of the change without interrupting the track circuit supply.

The 4-cam Style-M motor-driven code transmitters, which have 180-120-75 and 75 code cams with their associated front and back contacts, are used to code the track energy of four-track circuits to control four-aspect signals. Where the modified 75M code is required to control the advance-approach aspect of five-aspect signals, an additional three-cam transmitter, for coding 75M and 75 codes is provided.

By using coded track circuits for control of the signals without line wires, the New Haven has eliminated the sources of trouble common to line circuits on steam railroads as well as electrified railroads. In addition, protection has been afforded against inductive interference from the two paralleling high tension lines, which are used for propulsion current.

The engineering work was carried out by the signal engineer's office of the New Haven, while the field construction work was performed by the regular divisional forces. The apparatus, including factory-wired steel houses and relay cases, was furnished by the Union Switch & Signal Company.

Accident on the Big Four

On September 16, a head-on collision occurred between a freight train and a passenger train at Ashmore, Ill., on the Cleveland, Cincinnati, Chicago & St. Louis. The following information concerning this accident was abstracted from a report of the investigation by the Bureau of Safety, Interstate Commerce Commission.

In this territory the main line is single track, a passing track 4,943 ft. long being located on the north side of the main line at Ashmore. The east switch of this passing track is equipped with a dual-control power switch machine, which is controlled by a control machine in the station at Ashmore.

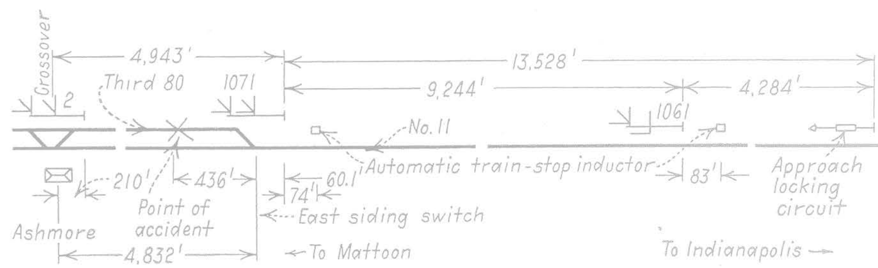
Eastbound freight train Third 80, consisting of 49 loaded cars and caboose, entered the passing track at 2:29 p.m., and stopped with the front end of the locomotive 436 ft. west of the east switch. Westbound passenger train No. 11 passed signal 1061, located 9,244 ft. from the switch, at 60 m.p.h., as indicated by the tape of the speed recorder on the locomotive, and while moving at a speed of 55 m.p.h., this train entered the east siding switch and collided with the front end of train Third 80.

The signal maintainer was at the remote-control switch when the operator informed him of trouble in the switch-indicating circuit, and he immediately started to look for the cause. After 2:37 p.m., the maintainer and his helper went to the depot at Ashmore and were engaged in checking the circuits for about 10 min. During this time the maintainer observed that lever 1 could not be latched in either the normal or the reverse position and, because of this condition and the fact that the relays were de-energized, he felt certain that signal 1071 displayed red-over-red.

Shortly after 3 p.m. the maintainer and his helper returned to the east siding-switch and conducted tests to ascertain the cause of the trouble. When the maintainer arrived at the switch involved, he observed that the selector lever on the switch mechanism was in position for power operation. About 3:07 p.m. the maintainer instructed his helper to call the operator at Ashmore by telephone and to tell him to move lever 1 to center position, and then to move it to normal-indicating position. The helper, who had had but little experience and did not fully understand signal terminology, said he instructed the operator to place lever 1 in neutral position. The operator was not certain what was meant by neutral position, but after some delay he placed the lever in center position. A conductor who was in the station said he saw the operator move this lever about a minute and a half before the accident occurred.

Shortly before No. 11 approached, the remote-control switch moved to position for entry to the siding. The front brakeman of Third 80, the maintainer's helper and the maintainer noted this operation, but none of them was able definitely to deter-

(Continued on page 44)



Track and signal plan of territory where the accident occurred