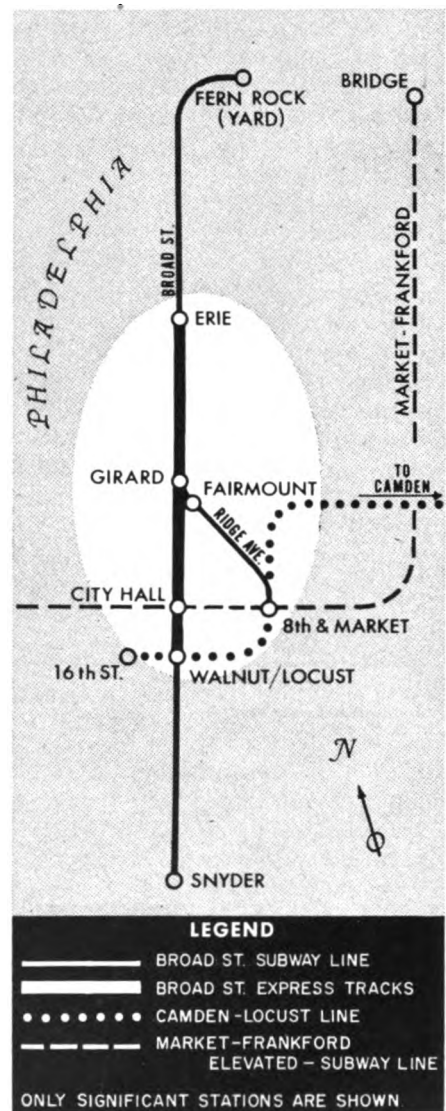


A southward train, about to identify itself at Hunting Park, will select a route at Erie either to the express track or local track.

The Broad St. subway was built by the city in 1925 with provision for four tracks north of Walnut-Locust. The Delaware River Port Authority built the line from 8th and Market to downtown Camden, N.J. Express tracks have been installed from Walnut-Locust to Erie and a train identification system employed to route the trains. The Philadelphia Transportation Co., a private company, operates the system.



# Subway Trains Route Themselves

• Because of the congestion developing in the central portion of the Broad Street subway line, the City of Philadelphia decided to smooth out the passenger load by the operation of express trains. When the subway was built, a four-track right-of-way was provided from Walnut-Locust to the yards at Fern Rock. The present \$5 million improvement involved the laying of 5.21 additional miles of express track with

the associated signaling system. An important adjunct to the signal system was the extensive train identification system, called "Identra," for the automatic routing of trains.

The Identra system consists of a demountable, train carried, inert tuned coil and wayside coils and equipment. The train coil, carried on the upper right front of the train, includes a rotary switch and a capacitor box. The

rotary switch permits the choice of nine different frequencies, by changing the capacitance in the tuned circuit. The nine frequency Identra system was designed especially for the Philadelphia Broad Street subway installation. Previous Identra installations had fewer identities. All trains in passenger service on the Broad Street subway system, including the Ridge Avenue and Camden lines, carry a coil.

The wayside equipment consists of an instrument case and a pair of coils. The coils are positioned one on top of the other, each in a vertical plane parallel to the rails, opposite and 17 in. from the train-carried coil. One of these coils is connected to the input, the other to the output of a two-stage resistance coupled amplifier. The two coils must be carefully positioned to reduce the mutual magnetic coupling to zero, thereby preventing oscillation in the amplifier.

When the train-carried coil enters the magnetic field of the wayside coils, the mutual coupling causes the amplifier to oscillate. The frequency of this oscillation is determined by the resonant frequency of the coil and capacitor in the train-carried unit. This oscillation signal from the amplifier is then

applied to the frequency selective networks, which are essentially band-pass filters, each sensitive to a different channel or band of frequencies. The network that coincides with the frequency of the input signal from the amplifier accepts this signal, then rectifies it and applies the resultant dc to the coil of a style KP relay, causing it to pick up and operate an external control circuit. The networks tuned to other channels reject the input signal and hence the corresponding control relays do not operate.

**Need Three Wayside Units**

At each location where it is desired to identify a train, three sets of wayside equipment are provided: a first identification point, a second identification

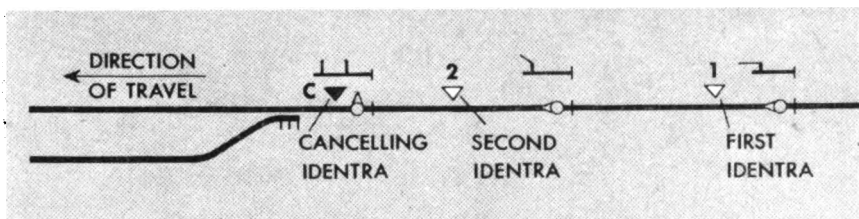
point, and a canceling point. The first identification point is located sufficiently in advance of the controlled location that switches have time to operate and signals to clear to the least restrictive indication possible.

A second identification point is located shortly before the home signal. Although there are two stop signals behind each train, the motorman on a second train may "key-by" the rear-most stop signal by operating a small lever on the signal. When trains have close headways, a second train may pass the first identification point before the first train passes the canceling point, and hence the second train would not register a route in the Identra equipment. This closely following second train will then select its route at the second identification point. This method is preferable to storing identifications from the first location for more than one train, as it eliminates the possibility of a storing system fault misrouting trains.

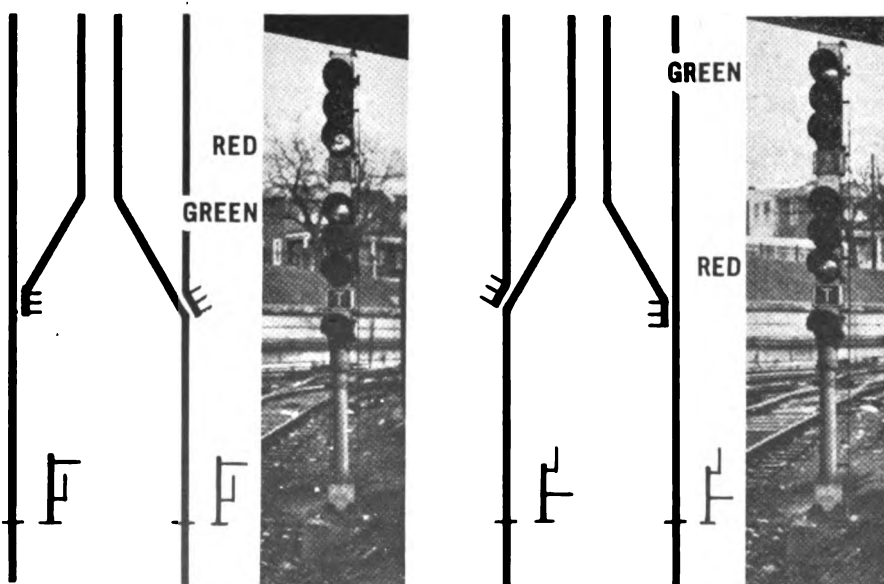
The canceling location is just past the home signal. It is a wide bandpass unit and accepts any coil tuning to clear the Identra equipment for the next train selection.

**Trainman Can Change Route**

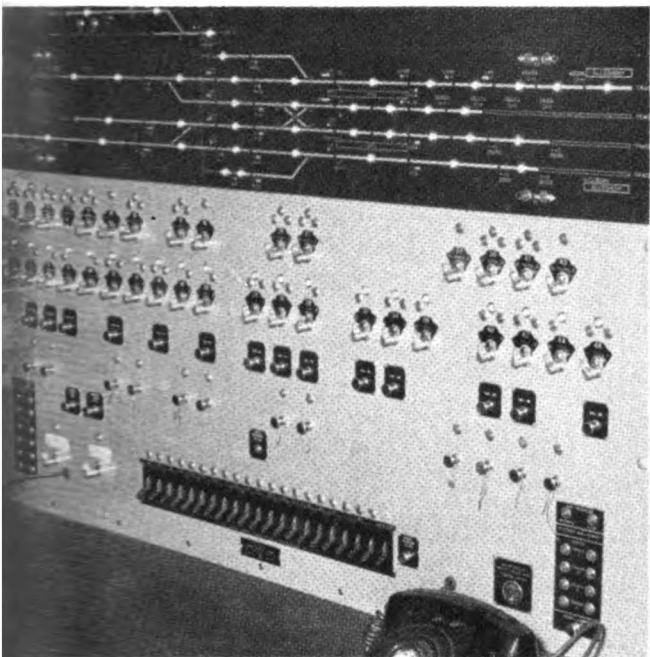
In the event an incorrect route is established due to an incorrect setting of the selector switch or to a failure of the Identra equipment, the motorman can change the routing at each turnout by depressing a pushbutton for the desired route. A pushbutton and a white light for each route (switch normal, switch reversed) is mounted 11 ft in advance of the home signal governing moves over that switch. The motorman will depress the button corresponding to the desired route and the associated white lamp will light to indicate that the request for the change of route has been established. The signal, which had been cleared for the incorrect route, will go to stop. After the time locking is released, about one minute, the switches will throw and the signal will clear for the new route. The white lamp at the pushbutton is extinguished automatically by the passage of the train into the next track circuit. It is also required that the motorman notify the dispatcher whenever it is necessary to change the route, so that corrective



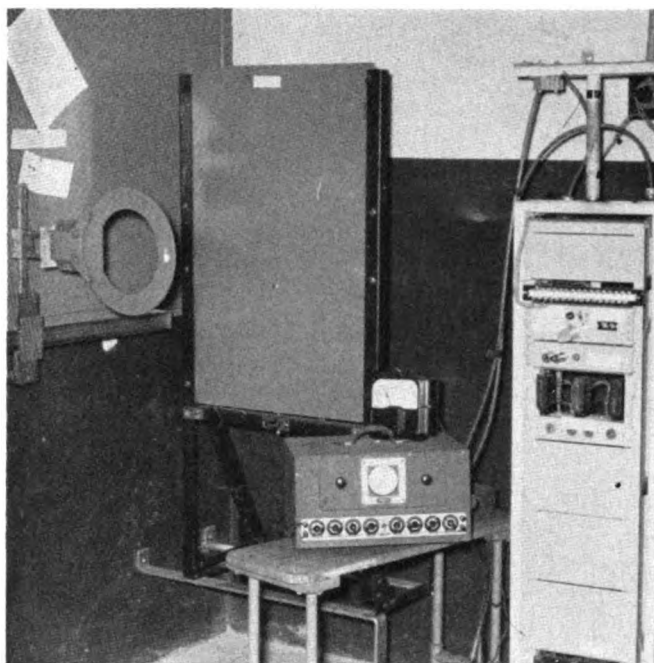
Three sets of Identra equipment are provided at each routing location.



Route signaling is used: at interlockings the top arm indicates the condition of the right hand route, the lower arm the condition of the left hand route. The "T" indicates "Tower controlled" and the bottom unit is a call-on signal. A yellow, instead of green, is displayed if the next signal is at stop. The yellow aspect indicates "approach next signal prepared to stop", and carries no speed restriction. Timed signals are used to enforce speed restrictions.



The control machine at Erie tower is normally unattended. Beneath the switch and signal levers are a row of spring return call-on pushbuttons. Beneath these are the sealed emergency release pushbuttons. A signal maintainer's key operated emergency circuit controller is at the lower right. Contact rail power is indicated by the lights in both lower corners. The two levers left of the telephone keys hold trains on the local turn-back tracks.



A complete set of Identra equipment in the signal shop provided testing facilities. The train coil is mounted on a bracket which slides on a steel bar so that the train coil may be moved towards or away from the wayside coil. The maximum distance at which the relay in the frequency selective circuit will pick up provides a "figure of sensitivity". The selective frequency of the wayside unit may be changed by changing plug-in filter units.

action may be undertaken.

Table 1 lists the selector positions on the train carried coil, the resonant frequency, and the route it selects. In only one case is it necessary for the selector to be changed enroute: The motorman of a train originating at 8th and Market and going to the shops at Fern Rock must change the selector from "E" to "A" at the Girard station, or any station before Erie. The "E" position routes him onto the local track north of Fairmount heading for the turnback at Erie; the "A" position routes him to the through local track at Erie. Otherwise, once the selector is positioned at the beginning of a tour of duty, it need only be changed if the terminals of his run change. The motorman carries the coil from one end of the train to the other at each terminal.

### Emergency Interlocking is Unattended

The Erie Avenue interlocking is the busiest on the system. This point is the north end of the express tracks and both express and local trains may turn back here. The local turn-back tracks are located on an upper level. The all-

relay interlocking has a miniature free lever control machine which can control all switch and signal functions in the interlocking. While the machine is not large by railroad standards, it has been determined that with trains on two-minute headways on four tracks, one man alone would have to be extremely alert to operate the machine manually.

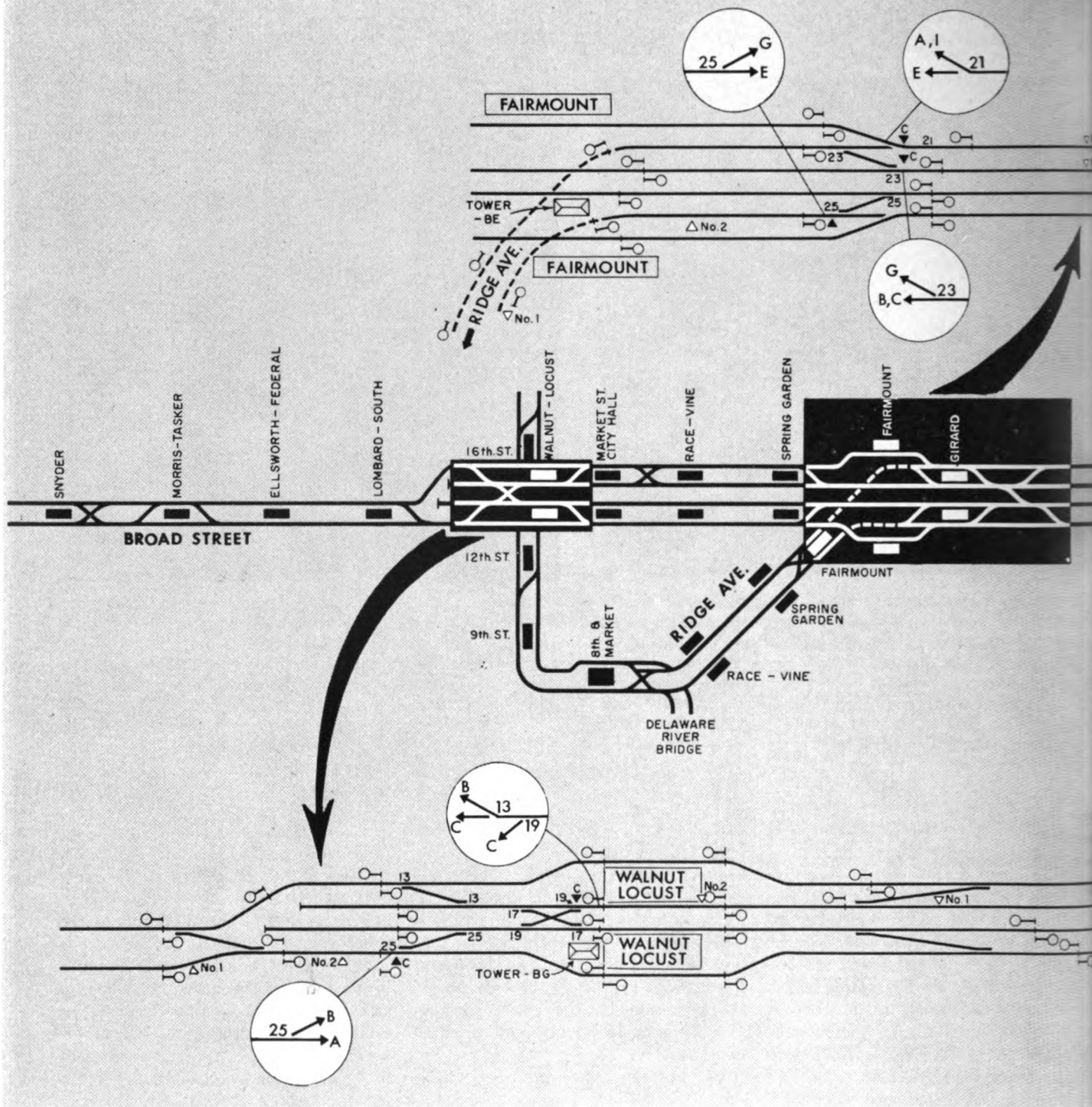
The interlocking circuits are so designed that either automatic or manual operation may be selected by operating a master lever. When the interlocking is in automatic operation, it operates with an unattended tower. Routes are then established by the Identra train identification system and track occupancy. To place the interlocking in automatic operation, all emergency releases must be in their normal position, all traffic must be established in the normal direction, and certain signals must be cleared. Then the master lever may be operated to the automatic position. The master lever may be operated from automatic to manual control at any time, except that certain types of circuit failure will prevent the actual transfer of control. A key operated circuit controller is

provided on the machine to allow transfer to manual control in the event of a stored route selection or circuit failure. It may be operated only by the signal maintainer.

Sealed emergency time release pushbuttons are provided for the release of switch and traffic locking circuits. The switch release pushbuttons are of the spring return type and enable an operator to move a switch with the detector track circuit deenergized. The traffic release pushbuttons are of the stick type and allow the traffic lever to reverse traffic direction when there is a track circuit failure.

### Turn-back Tracks are Automatic

Once a local train has been routed to the turn-back tracks on the upper level, the operation of switches and signals on these tracks is entirely automatic, as it is at all turn-back locations on the system. These circuits operate on a first-in first-out basis. During rush hours a man is stationed here to supervise schedules. Two levers on the Erie control machine allow the supervisor to put each local turn-back track out of service independently so that he



## TRAINS ROUTE THEMSELVES continued

may hold one train while another goes ahead.

The timing of the departure of local trains from the upper level, and of through trains on the lower level is controlled by two automatic dispatcher units in the tower. These operate from encoded 35-mm film and cause a blue departure signal to light. Two 20-pen recorders are also provided in the tower to record train movements.

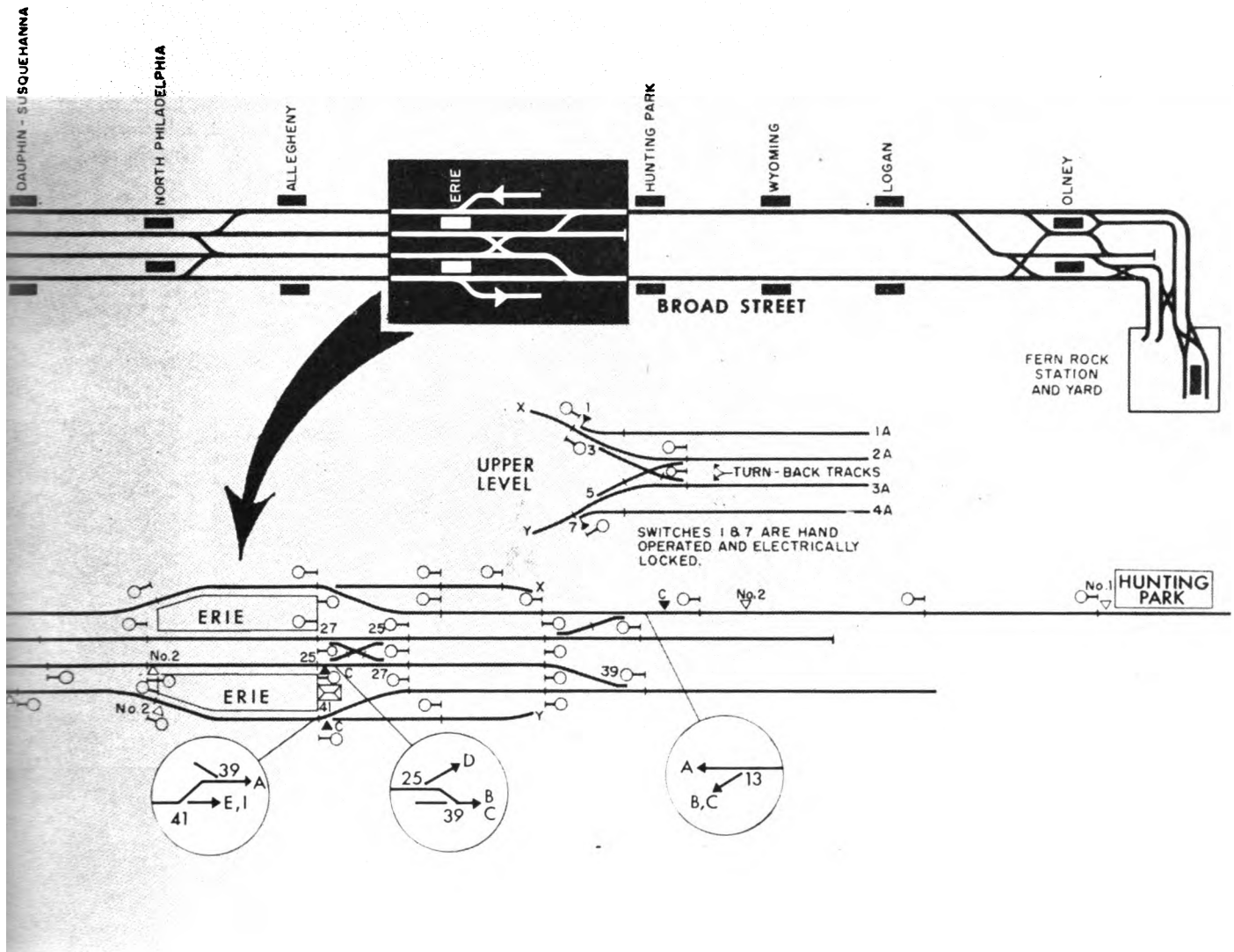
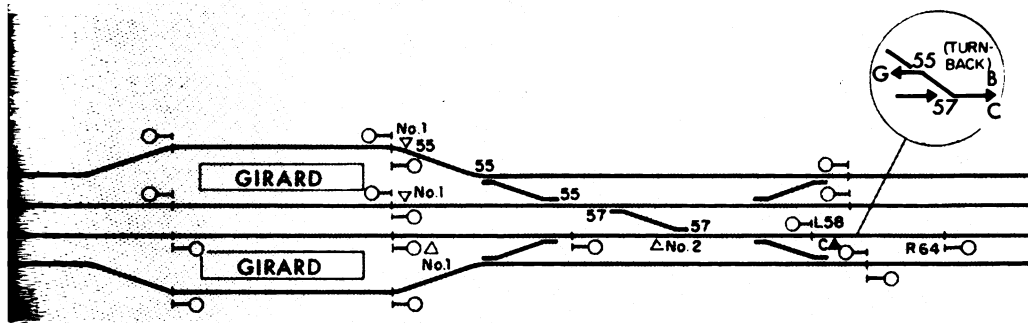
Time requirements made it necessary to put the system into service upon completion of construction, with little test operation. As might be ex-

pected in a system as new and complex as this one, some bugs developed. One of these was the operation of the train identification cancel unit on the express track by the passage of a train on the local track. This problem was solved by installing a shield of sheet metal on the supporting columns between the express and local tracks. Similar considerations required the decision to have the motorman carry the coil from one end of the train to the other at the terminals. If coils had been used at both ends of a train, the coil on the rear end of a local train

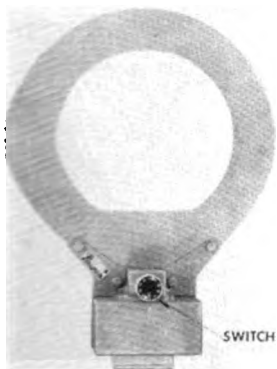
would be almost the same distance from the wayside identification coils on the express track as the express train coil. All the difficulties were soon eliminated and the system is now operating smoothly.

The system was installed under the jurisdiction of J. W. Boorse, superintendent of power, Philadelphia Transportation Co., and H. V. Varani, director of architecture and engineering, City of Philadelphia. All signal and Identra equipment was supplied by Union Switch & Signal—Division of Westinghouse Air Brake Co.





IDENTRA ROUTING SELECTIONS FOR BROAD STREET SUBWAY



A train coil switch allows the choice of nine frequencies and off.

SWITCH POSITION	RESONANT FREQUENCY	TYPE OF SERVICE	TERMINALS OF ROUTE
A	85 KC	LOCAL	FERN ROCK -- SNYDER
B	92 KC	EXPRESS	FERN ROCK -- SNYDER
C	100 KC	EXPRESS	FERN ROCK -- WALNUT-LOCUST
D*	108 KC	EXPRESS	ERIE -- WALNUT-LOCUST
E	117 KC	LOCAL	ERIE -- EIGHTH AND MARKET
F*	126 KC	EXPRESS	ERIE -- EIGHTH AND MARKET
G	136 KC	LOCAL	GIRARD -- EIGHTH AND MARKET
H*	146 KC	EXPRESS	FERN ROCK -- EIGHTH AND MARKET
I	156 KC	LOCAL	ERIE -- SNYDER

\*NOT YET IN USE