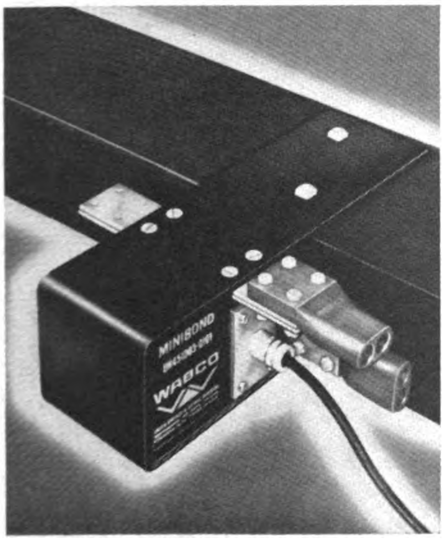
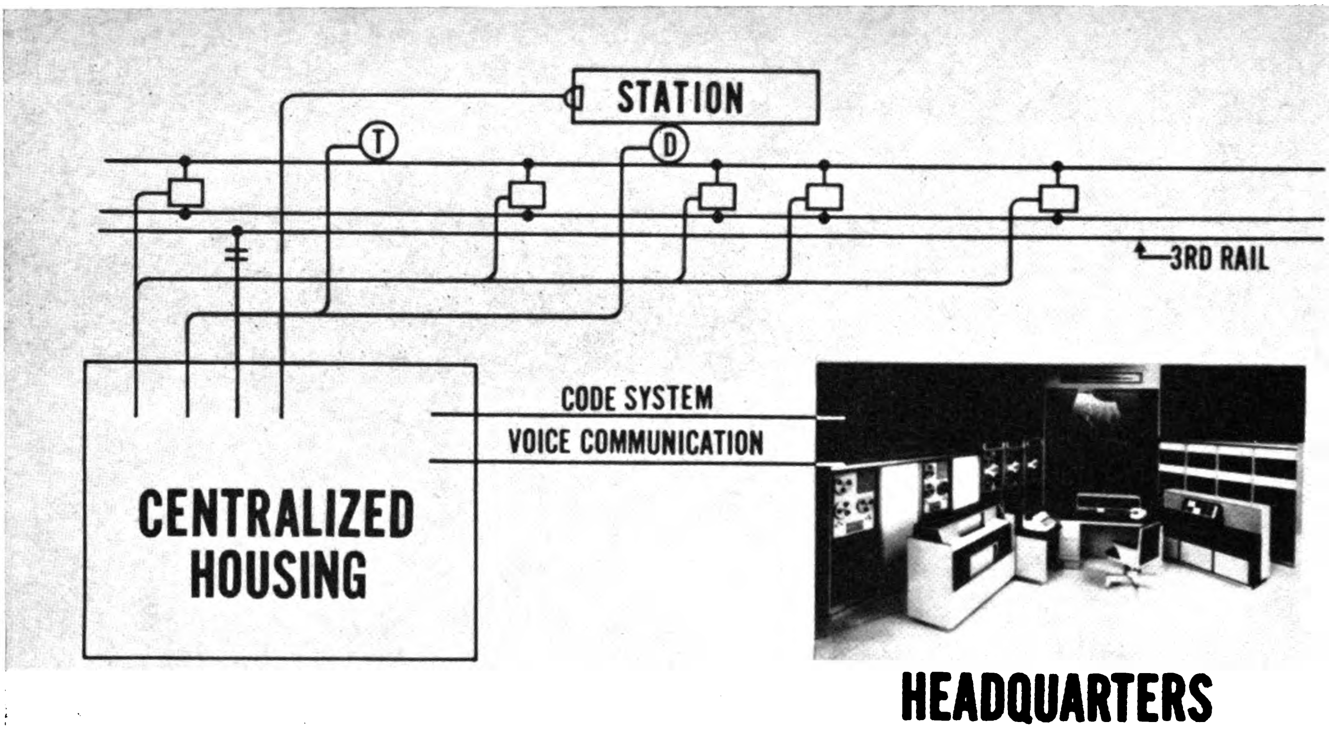

New miniature impedance bond could be mounted between the rails in an existing subway.




# AFO circuits can be used in subways

The use of audio frequency track circuits can materially reduce installation and maintenance costs of the signal and control systems used in rapid transit networks. Such AFO track circuits will be used for the Expo Express (without wayside signals) serving the 1967 Montreal World Exposition. Similar equipment will be put forward by Union Switch & Signal division of WABCO for the test track of the San Francisco Bay Area Rapid Transit District at Concord, Calif.

In a talk to a recent meeting of the American Transit Association, Crawford E. Staples, consulting engineer, US&S, described new de-



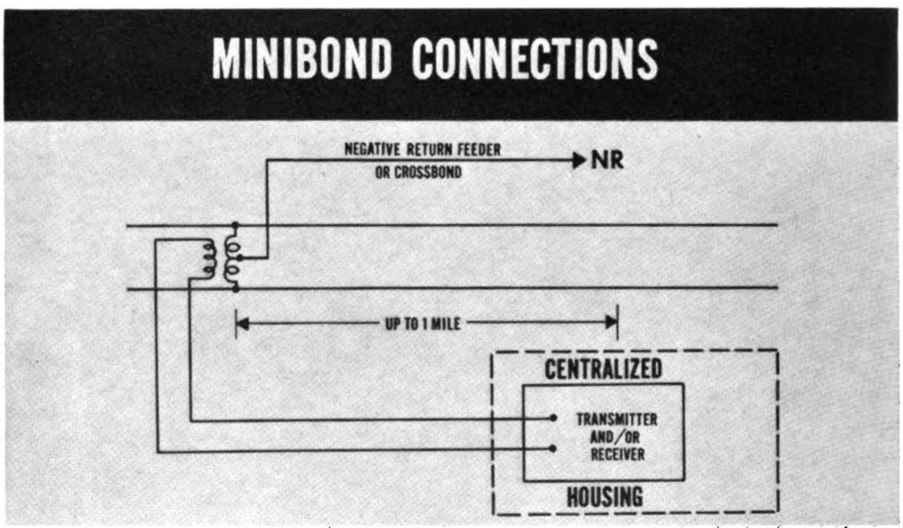

Communications network using high-speed coding system can tie wayside equipment to a headquarters computer.

velopments in AFO circuits for transit signaling.

A new audio frequency track circuit, cab signaling, and speed control system eliminates, between stations or interlockings, all of those items which require the most maintenance or the most difficult installation—insulated rail joints, wayside signals, trip stops, and instrument cases. This system permits centralized housing of control equipment at stations or interlockings, convenient to maintain and applicable to centralized traffic control.

The heart of the new system is the Minibond, a small impedance bond designed for use with audio frequency track circuits. Though weighing only 60 lb, and one-tenth the size of a standard bond, it is capable of carrying 2,000 amp per rail continuously. It may be mounted on the center or end of a crosstie, or may be inverted to mount on concrete. It is encapsulated and watertight.

A single Minibond and its connections are all that is required at each intermediate control location. The center-tap on the track winding is used for cross-bonding or connected to the structure, making use of all rails for propulsion return. A pair of wires to the nearest centralized housing handles all controls. Centralized housings may be over two miles apart. This arrangement minimizes maintenance and fosters use of track maintenance equipment.




Miniature impedance bond would be at intermediate control locations.

The audio frequency track circuit consists of the rails between two Minibonds, a transmitter connected to one Minibond, and a receiver energizing a track relay connected to the other Minibond. Because of the relatively high impedance of the rails to audio frequencies of 2 to 6 kc, no insulated rail joints are required to limit the track circuit. The track circuit will not be shunted when a train is more than a few feet outside of the Minibond locations.

Where ballast is well maintained, audio frequency track circuits may be over 2,000 ft in length, and still provide broken rail detection, adequate shunting, and protection from interference.

One transmitter location may feed two track circuits, one in each direction, at the same audio frequency. Otherwise, different audio frequencies must be used in adjoining track circuits and on parallel tracks to prevent mutual interference. There is a small overlap area at each Minibond, where a train will shunt adjoining circuits.

The same principle is used for cab signaling. However, since the cab signal must operate in any track circuit, the same audio carrier frequency, about 1 kc, is superimposed on the rails throughout the system, and is coded or modulated at various rates to provide various commands, when required and permitted. Two cab signal audio frequency carriers may be coded alternately or independently to increase the number of commands.

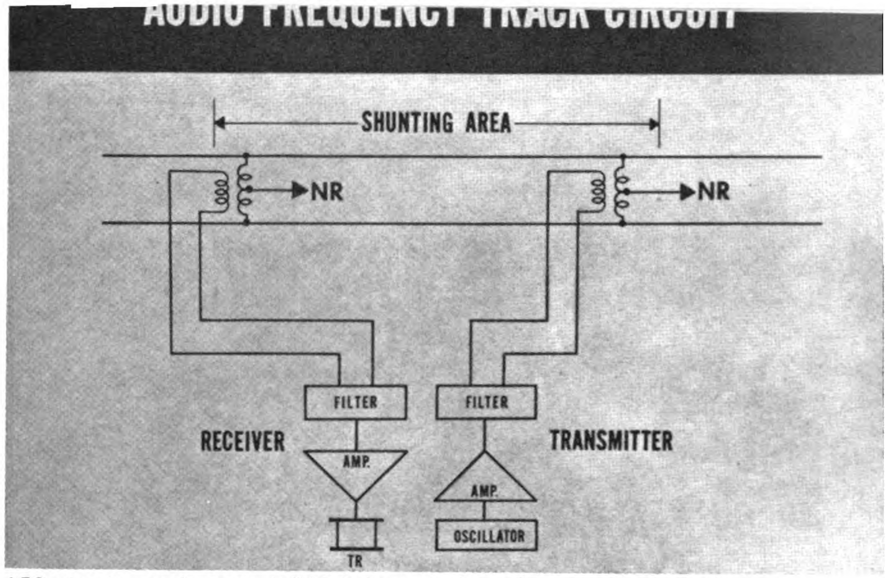
When a train occupies a track circuit, the cab signal coded carrier is applied to the Minibond at the exit end if traffic conditions permit. The resultant current flowing through the axles of the train induces a voltage in the train carried receivers mounted over the rails ahead of the front axle.

The received signal is filtered, amplified, and decoded by equipment on the train to obtain suitable outputs, which may be used to provide cab signaling. The same outputs, in conjunction with speed-sensing devices provides speed control.

This is a major step to automatic train operation. A train-carried station stop profile, in conjunction with wayside triggers, and a velocity control programer, provides for automatic station stops. Other controls provide for station stop time, selective door opening and closing, train reversal, etc.

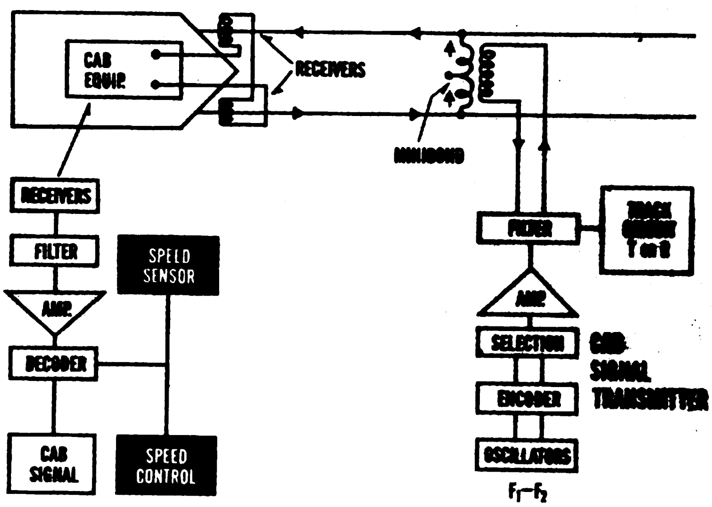
The entire system can be tied together by communication networks, employing high speed code systems, between the centralized housings and headquarters, where computers can be used to control the system. Voice communication can be selectively superimposed to provide public announcements or private two-way communication between train attendants and dispatchers.

Some of the major advantages of the basic audio frequency track circuit and speed control system are: (1) Reduction in installation and maintenance costs, (2) Improvement in propulsion negative return, (3) Reduction of trackside equipment, (4) Applicability to welded rail, (5) Reduction of noise, (6) Simplification of track maintenance, (7) Centralized housing, (8) Expandibility to centralized system control; and (9) Expandibility to automatic train operation. **RS&C**

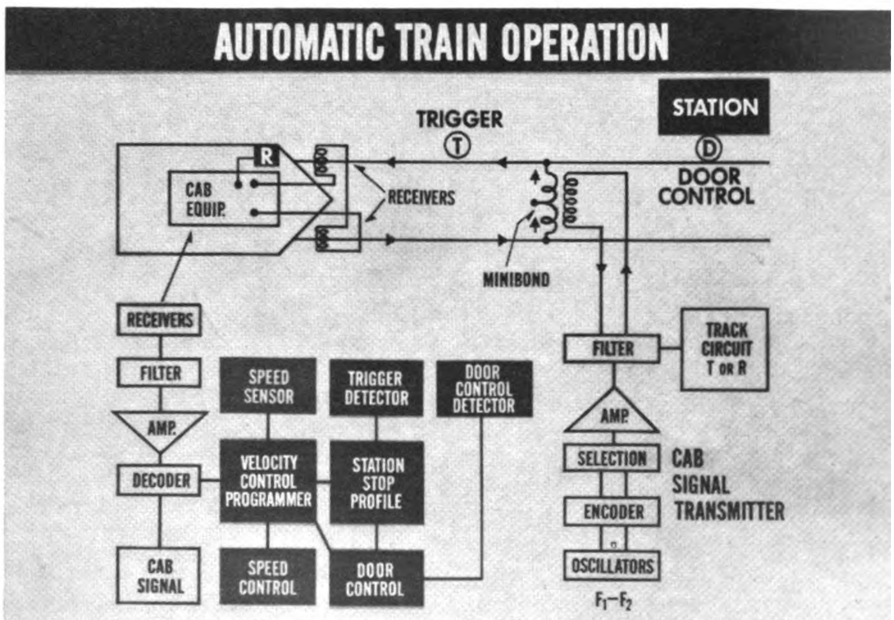


AFO circuit may be over 2,000 ft long, and needs no insulated joints.

## CAB SIGNALING WITH SPEED CONTROL



Audio carrier frequency of about 1 kc is superimposed on the rails.



Cab signaling with speed control is a basic component of ATO.