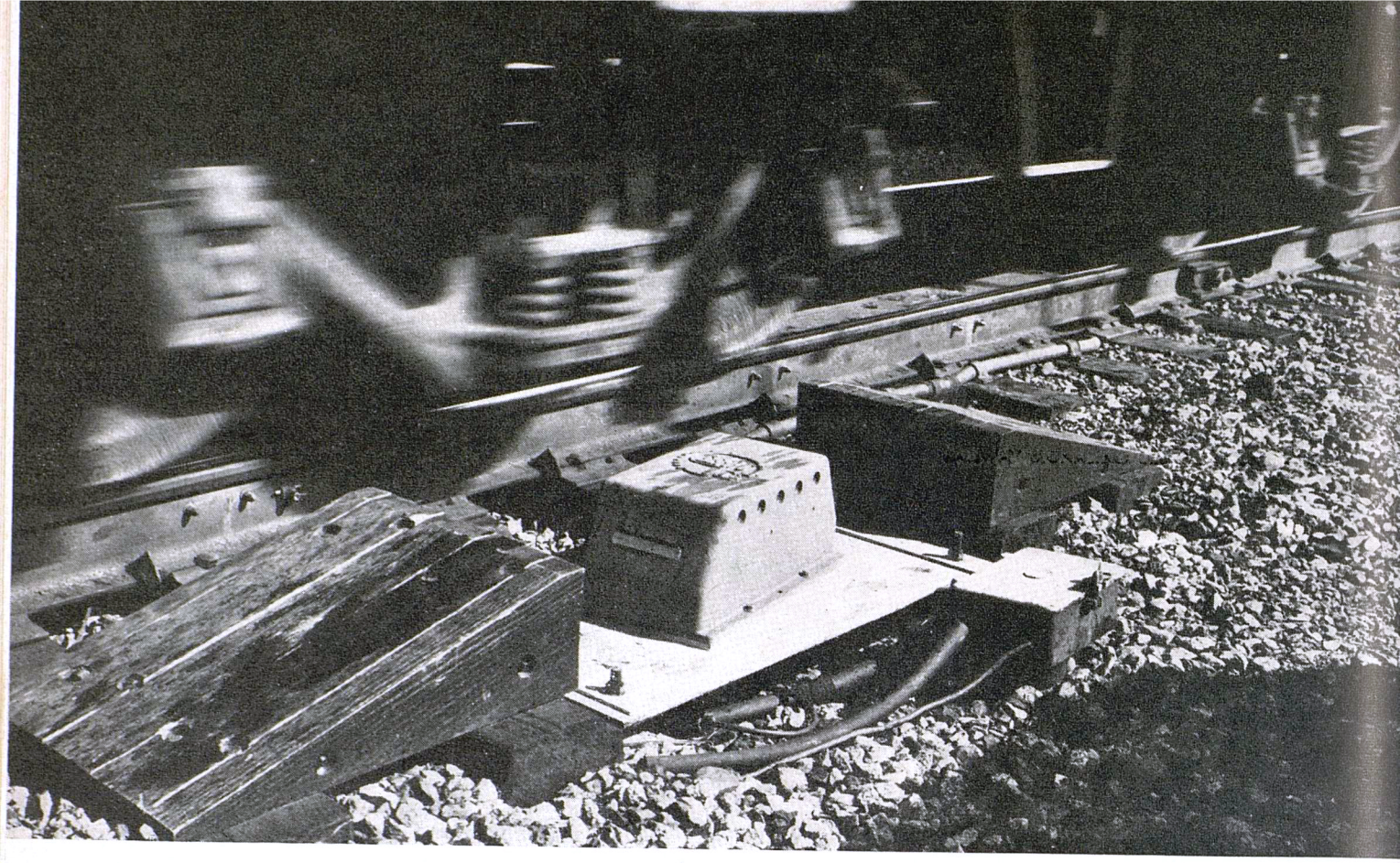


HOTBOX DETECTORS TALK

By J. R. DePriest, Superintendent Communications and Signals, Seaboard Air Line

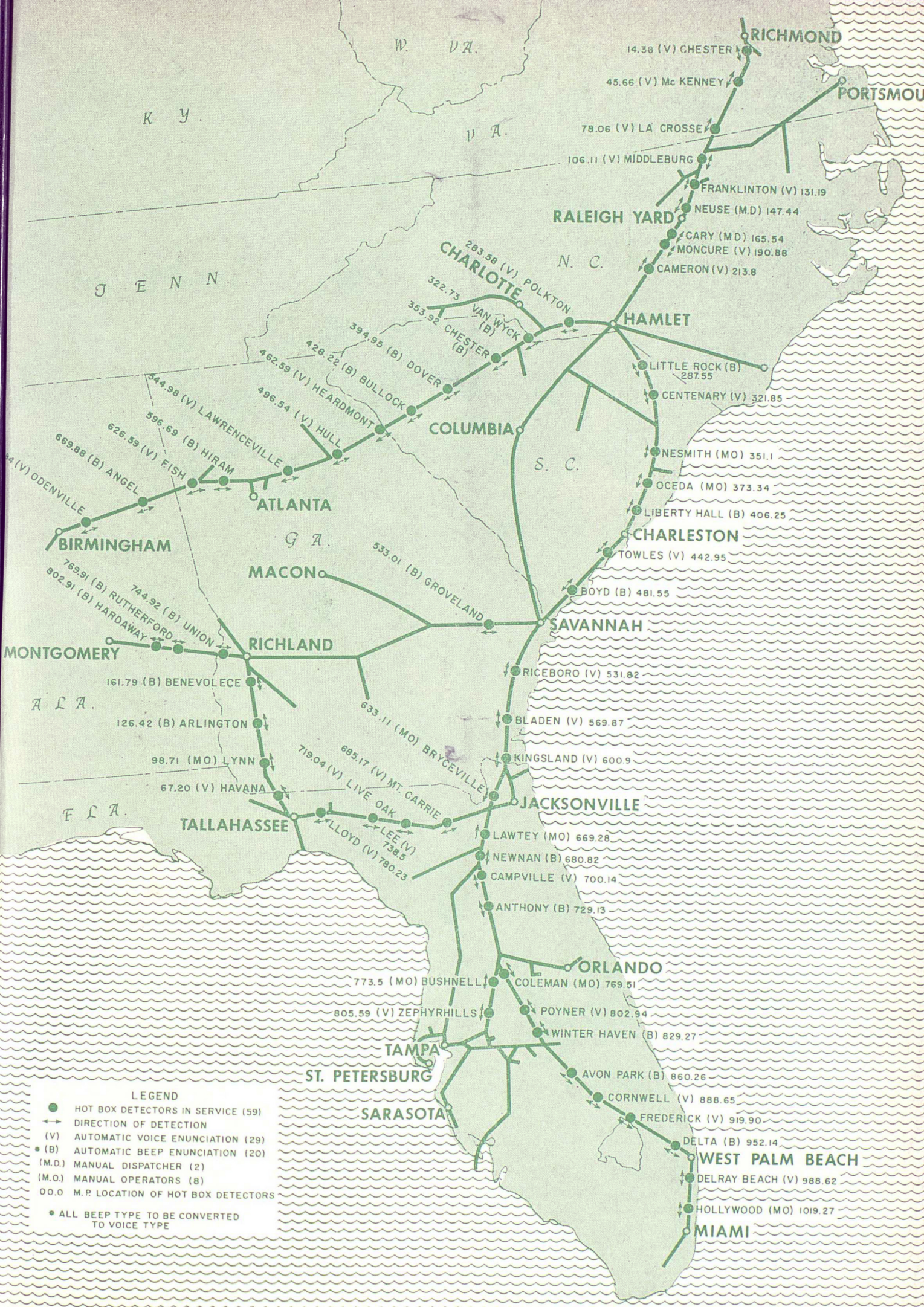
When the Seaboard Air Line first considered the installation of hotbox detectors, it was evident that there would be relatively few places where the basic manually operated systems could be utilized to advantage. There are few locations at strategic points along the principal routes where employees are on duty around the clock. Therefore, an automatic form of detector seemed to be desirable for inspection at points other than at entrance to yards. It was decided that the most practical arrangement, from an operating standpoint, would be to extend the information to the train by radio. In this way it would not be necessary for the engine crew to stop at a precise point and read a chart or indicator once a hot journal was detected. If the job could be accomplished automatically and on a local basis, it would furnish the information directly to the train crew at the earliest possible moment and reduce communication and human errors and human delays which might affect safety. It would also eliminate transmission lines, associated carriers, additional housing, etc.

An analysis of the problem indicated that information needed by the train crew was as follows: (1.) An alerting signal. (2.) An indication that the detector was operative and electric power available and connected. (3.) The number of hotboxes detected. (4.) The location, with respect to the specific side of the train, for each hotbox detected. This can be designated as either "Left Side" or "Right Side". This information is variable for a hotbox occurring on a fixed side of the track and this is determined by train direction when only one set of equipment is used for inspection of trains moving in either direction. (5.) The location, with respect to the position within the train, of each hotbox detected. This can be designated by axle number as counted from either the front or rear of the train. (6.) Instantaneous notice of the detection of the first hot journal, irrespective of its location in the train. This information allows the engineman to initiate the proper brake application at the earliest practicable moment.

Other information needed when radio or telephone are used to extend such information to the crew or train dispatcher is as follows: (1.) Name of railroad owning radio transmitter. (2.) The geographical location of the hotbox detector and radio transmitter. (3.) An oral statement so advising if no hotboxes are detected. This should be extended after the rear of the train has passed the detector. (4.) A visual indication to the crews on trains as to whether the detector is operative, and whether or not a hot journal has been detected. This is necessary in event the radio is inoperative.

The elements needed for the talking hotbox detector to meet these and other requisites are as follows: (A.) Infrared detector system. (B.) Train direction detector. (C.) Alarm computer. (D.) Oral message composer. (E.) Radio transmitter. (F.) Dispatching line amplifier. (G.) Red and white light indicators. (H.) Monitor amplifier.

The basic Servo infrared detector system as manufactured by Servo Corp. of America will normally provide two analog electrical outputs that


W. VA.
KY.
VA.
TENN
N. C.
S. C.
GA.
ALA.
FLA.
RICHMOND
14.38 (V) CHESTER
45.66 (V) Mc KENNEY
PORTSMOU
78.06 (V) LA CROSSE
106.11 (V) MIDDLEBURG
FRANKLINTON (V) 131.19
RALEIGH YARD
NEUSE (M.D) 147.44
CARY (MD) 165.54
MONCURE (V) 190.88
CAMERON (V) 213.8
283.58 (V) POLKTON
CHARLOTTE
322.73
353.92 VAN WYCK (B)
CHESTER (B)
394.95 (B) DOVER
428.22 (B) BULLOCK
462.59 (V) HEARDMONT
496.54 (V) HULL
596.69 (B) HIRAM
626.59 (V) FISH
669.88 (B) ANGEL
(V) ODENVILLE
344.98 (V) LAWRENCEVILLE
HAMLET
LITTLE ROCK (B) 287.55
CENTENARY (V) 321.85
COLUMBIA
NESMITH (MO) 351.1
OCEDA (MO) 373.34
LIBERTY HALL (B) 406.25
CHARLESTON
TOWLES (V) 442.95
BOYD (B) 481.55
ATLANTA
BIRMINGHAM
MACON
533.01 (B) GROVELAND
769.91 (B) RUTHERFORD
802.91 (B) HARDAWAY
744.92 (B) UNION
SAVANNAH
MONTGOMERY
RICHLAND
RICEBORO (V) 531.82
161.79 (B) BENEVOLECE
126.42 (B) ARLINGTON
633.11 (MO) BRYCEVILLE
BLADEN (V) 569.87
98.71 (MO) LYNN
719.04 (V) LIVE OAK
685.17 (V) MT. CARRIE
KINGSLAND (V) 600.9
67.20 (V) HAVANA
JACKSONVILLE
TALLAHASSEE
LLOYD (V) 780.23
LEE (V) 738.5
LAWTEY (MO) 669.28
NEWNAN (B) 680.82
CAMPVILLE (V) 700.14
ANTHONY (B) 729.13
ORLANDO
773.5 (MO) BUSHNELL
COLEMAN (MO) 769.51
805.59 (V) ZEPHYRHILLS
POYNER (V) 802.94
WINTER HAVEN (B) 829.27
TAMPA
ST. PETERSBURG
AVON PARK (B) 860.26
CORNWELL (V) 888.65
SARASOTA
FREDERICK (V) 919.90
DELTA (B) 952.14
WEST PALM BEACH
DELRAY BEACH (V) 988.62
HOLLYWOOD (MO) 1019.27
MIAMI
LEGEND
HOT BOX DETECTORS IN SERVICE (59)
DIRECTION OF DETECTION
(V) AUTOMATIC VOICE ENUNCIATION (29)
(B) AUTOMATIC BEEP ENUNCIATION (20)
(M.D.) MANUAL DISPATCHER (2)
(M.O.) MANUAL OPERATORS (8)
000 M.P. LOCATION OF HOT BOX DETECTORS
* ALL BEEP TYPE TO BE CONVERTED TO VOICE TYPE

vary proportionately as to amount of infrared radiation emitted from each journal of an axle.

The train direction detector consists of a normally energized relay controlled by transistor logic circuits and one additional track transducer. The relay remains energized for southward trains and is deenergized for northward trains. The extra transducer is located south of the two basic transducers. Northward trains will pass the extra transducer first and thus will deenergize the directional relay. This relay interchanges the basic transducer cables in such a manner as to allow one basic set of detector equipment to operate for trains in either direction. The relay is also connected with the message composer to change "East side" to either "Right side" for northward trains or "Left side" for southward trains. "West side" is converted to either left or right side in a similar manner.

The output voltages derived from infrared radiation of opposite ends of each axle are compared by the alarm computer. When the electrical signal proportional to the infrared energy radiated from one end of an axle exceeds the electrical signal proportional to the infrared energy from the opposite end of that axle by a predetermined amount, a relay operates indicating that the journal associated with the larger signal is hot. There are two relays in the alarm computer which operate in this manner, one for hot journals located on the east side of the train and one for hot journals located on the west side of the train. The basic equipment includes components which generate a voltage or pulse each time a wheel passes the hotbox detector scanner. Information from the operation of the relays in the alarm computer and from the wheel passing the scanner is fed into the oral message composer.

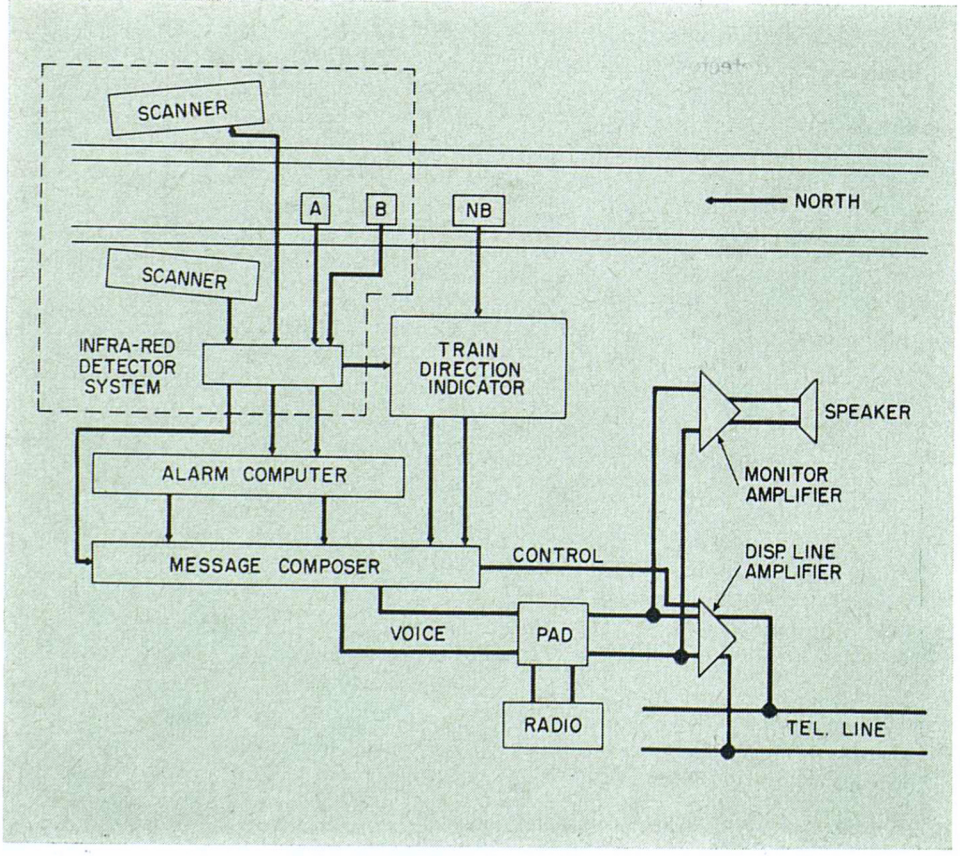
The oral message composer, as designed on the SAL, is capable of storing information and translating this into voice for each of four hotboxes. The device may be readily expanded to provide for additional hotboxes if desired. It consists of storage facilities to remember (1) the name of the railroad involved; (2) the location of the detector; (3) train direction; (4) the order in which hotboxes occur (up to four); (5) the specific side of the train for each hotbox; (6) the number of axles counted from the hot journal to the rear of train for each hotbox (this latter information is obtained from four counters each capable of counting to a total number of 999 journals); and (7) that no hotboxes were detected. All of the information is stored and retained for use until the equipment is reset to normal. The resetting of the equipment occurs about three minutes after the rear of the train passes the detector if a hotbox has been detected. If no hotbox is detected, the resetting occurs immediately after one statement of five words is made. This statement includes the location and advice that there were no hotboxes detected.

The oral message created by this device is fed into the modulator of the radio transmitter and into the dispatching line amplifier simultaneously. However, the dispatcher hears the alerting information only once. He does, however, hear all reports transmitted concerning hotboxes until he operates a selector to terminate such message. This information is broadcast to the train by radio and transmitted to the dispatcher over the dispatching telephone line.

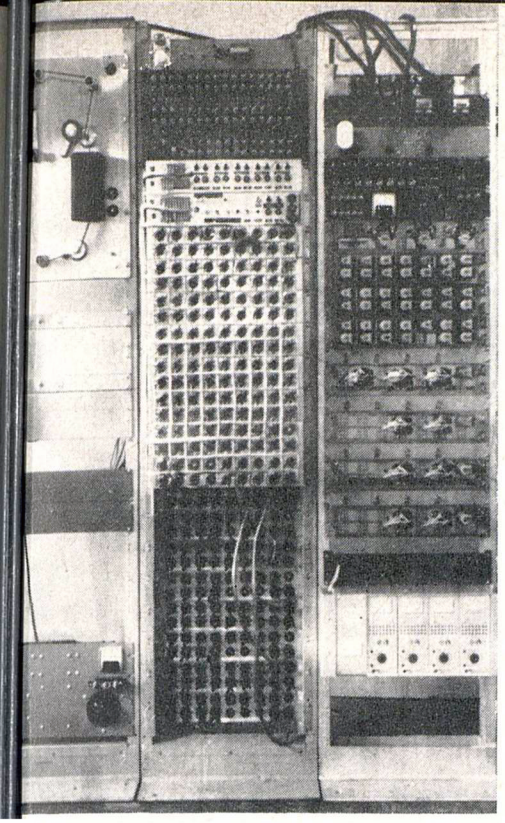
The white light indicator operates when the engine first passes the detector and will remain lighted until a hotbox is detected or, if no hotbox is detected, until the equipment is reset after the train has passed. The white light is extinguished and a red light is illuminated when a hotbox is detected. Simultaneously, an uninterrupted 1,000-cycle per second tone is immediately broadcast by radio in order to notify the crew at once of a hotbox. The white and red light indicators provide the necessary basic information to the crew when their train has a hotbox, even though the radio is inoperative or if the train is not equipped with radio. These indicator lights are mounted on the track side of each house containing the alarm computer, oral message composer, radio transmitter, etc., at the hotbox detector location.

The monitor amplifier is provided for use by maintenance personnel to check the output of the message being broadcast and for routine equipment maintenance.

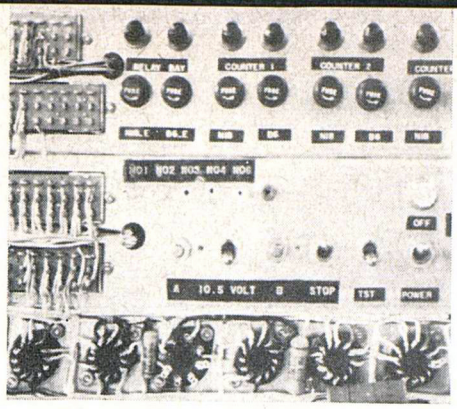
The apparatus, as presently used on the Seaboard, operates as follows: When a northward train approaches the detector, which is assumed to be located at Hull, Ga., it passes over an auxiliary transducer that in turn drops a directional relay. This conditions the basic infrared equipment to operate for a northward train. When the next transducer of the basic equipment is reached, a voice tape recorder, which is an integral part of the message composer, begins operation. A few seconds thereafter, the following is heard over the dispatcher's loudspeaker, all radios within range of the transmitter and the monitor amplifier: "Seaboard Railroad Hull, Ga.". These words require approximately six sec. After about 15 or 20 sec, the message is repeated again if the train is of sufficient length to be still passing the detector and no hotboxes have been detected. After the rear of the train passes the detector, if no hotbox has been detected, these



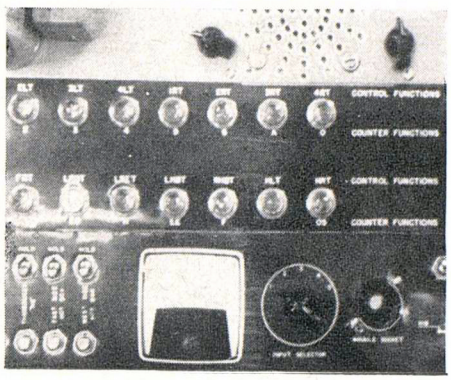
Block diagram of talking hotbox detector.



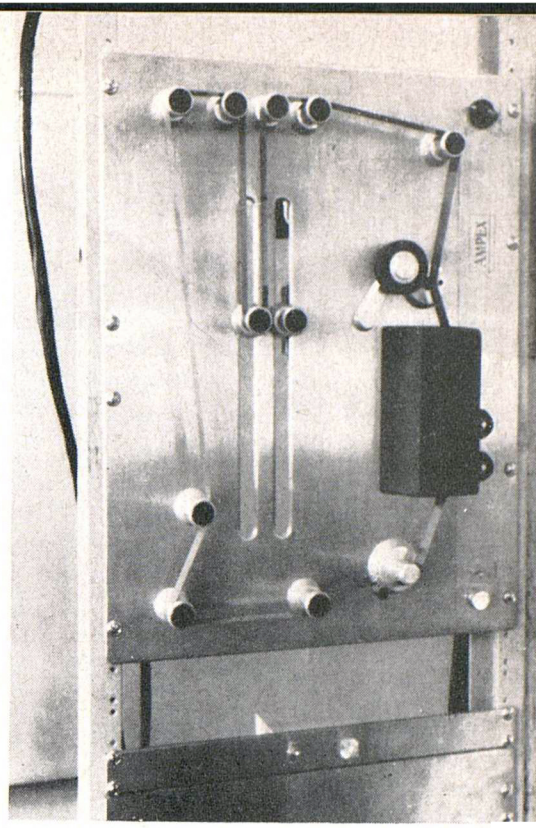
Oral message composer



Fuses, switches, etc.



Test and indicator panel



Tape recorder transport

words will be broadcast: "Hull, Ga., No Hotbox". After one broadcast of this statement, the equipment is restored to normal.

As an example, assume a northward train containing one hotbox approaches the same detector. The operation is similar until the car with the first hot journal passes the detector, then the message "Seaboard Railroad Hull, Ga." is immediately interrupted and a 1,000-cycle tone is heard. This tone will continue until the rear of the train has passed the detector. Shortly thereafter, the following words will be heard: "Seaboard Railroad Hull, Ga., First Hotbox Left Side Two Nine Five". After a time interval of a few seconds, the same message will be repeated, provided only one hotbox has been detected. Of course, the hotbox would be found on the left side, or fireman side of the train, 295 axles from the rear axle of the train. If there are two hotboxes, the words heard would be as follows: "Seaboard Railroad Hull, Ga., First Hotbox Left Side Two Nine Five". Then silence would ensue for a few seconds and the words heard would be as follows: "Seaboard Railroad Hull, Ga., Second Hotbox Left Side One Three Eight". Then silence would again ensue for a few seconds and the words "Seaboard Railroad Hull, Ga., First Hotbox Left Side Two Nine Five" would be heard. The messages would continue alternating for a period of three minutes, at which time the transmission would cease and the equipment would restore to normal condition.

If there were three hotboxes, information concerning each of the three hotboxes would be repeated sequentially at equal intervals and continue for three minutes. If there were four hotboxes, information for each of the four hotboxes would be repeated sequentially at equal intervals and would continue for three minutes. It should be pointed out that the dispatcher will hear the words "Seaboard Railroad Hull, Ga." only one time if no hotbox is detected. If a hotbox is detected, the dispatcher will then again hear the message with the hotbox information and such message will continue until the detector is restored to normal condition or until the dispatcher uses his selector to terminate the verbal message on his phone circuit.

Tape Recorder Used

A patent application has been made for the device and, therefore, it will not be possible for me to divulge the details as to how the message composer works at this time. However, I can state that the reproduce section of a 14-channel tape recorder operating at a speed of 3¾″ per sec., equipped with a loop of tape 1″ in width and approximately 7 ft in length, is used, in conjunction with relays, transistors, stepping switches and four telegraph carrier receivers. The line and monitor amplifiers are transistorized. Transistors are also used for logic circuits. It was determined that at mainline train speeds, it was necessary to use solid state switching circuits for selection for storage and for the unit decade section of each counter, since conventional relays available were too slow. It was also found that the substitution of solid state logic circuits for relays in counting, selection and storage did not afford any economy, but was required account of the operating speeds encountered.

Seaboard has 59 hotbox detectors in operation. Ten of this total are of the manual type, 20 of the automatic "Beep" type, and 29 of the "Talking" type. The automatic "Beep" type are being converted to the "Talking" type at a rate of two per month and when the present program is complete 49 of the "Talking" type will be in service.

The results obtained from the use of this device have generated much praise and enthusiasm from the operating personnel. As to the economic results, a study revealed a reduction in the cost of accidents due to journal failures, broken journals, and broken axles in 1961 as compared with 1960 amounted to $2,828 per detector-month. A similar comparison for the first six months of 1962 and 1961 revealed a reduction of $2,971 per detector-month. These costs include damage to equipment, track and lading and cost of clearance. It does not include the cost of detouring, cost of delays and loss of business and customer good will.

Editor's Note: John W. Smith, SAL, president, speaking before the New York Society of Security Analysts, Oct. 19, 1962, said: " In 1960, we began the installation of hotbox detectors, which program was completed early this year at a cost of approximately $2 million. These installations have done much to improve train operations and expedite the movement of traffic. They have more than justified their cost." RSC