Overlay Circuit Reduces Joints

At two highway crossings (so far) on the Denver & Rio Grande Western, an audio frequency series overlay track circuit (OTC) is being used for the "island" (over highway) track circuit. Only one set of insulated joints on one side of the highway is required (to separate the two DC approach circuits) instead of a set of joints on both sides of the road. The frequency of the voltage fed to the rails is about 10 kilocycles.

The type of overlay circuit employed is that developed by GRS for switch lock release. This equipment operates by the action of the train wheels completing the circuit rather than shunting it. Since the track circuits in approach to the highway are standard DC track circuits, safety of operation is maintained.

Fail Safe Operation

As will be seen from the circuits, the failure of the OLTR to pick up with a train on the circuit would result in operation of flashers and bell so long as any part of the train occupied either approach, as the crossing stick relay, 95XSR, would have no pickup circuit. Should the OLTR remain energized improperly, the 95XR would remain de-energized and the flashers would continue to operate.

The rail connections for the OTC are made at the highway side of the insulated joints. It is felt that better operation is obtained by using separate track connections for the OLT, rather than to use the B75T track connections which go to the same rails. This is in line with the manufacturer's recommendations. Effective operating range at the local battery voltage of 10 volts DC is approximately 45 ft for relay pickup (track occupied) and 145 ft for relay drop-away. The insulated joints prevent the 10-kc voltage from being transmitted down the rails away from the crossing.

OTC Equipment

The OTC equipment consists of three units: the Tuner, the Transceiver, and the Relay. The tuner is a series arrangement of a variable inductor and a capacitor, and is used to tune out the reactance of the track leads, which would otherwise seriously impede the flow of the 10-kc energy. The tuner can accommodate leads up to 150 ft in length. The capacitor in the tuner also serves to keep the DC track circuit energy out of the other OTC equipment. Keeping the tuner separate from the transceiver allows the transceivers to be interchangeable without the need to retune the transceiver for each location.

The transceiver is a combination of transmitter and receiver. The transmitter section is an oscillator which develops the 10-kc voltage. The receiver section is inert, thus relay operating energy must be received from the transmitter via the rails. This eliminates the possibility that self-oscillation might cause the relay to become improperly energized. The relay is a standard signal relay, with a resistance of 6 ohms to match the output impedance of the receiver.

In the circuits printed here, only those circuits involved in the highway crossing protection are shown. Various signal circuits also break through the track relays, including the OLTR. The HD wires are broken through the back contacts of the OLTR relay to provide a check that it is operating properly. Maximum train speed on the D&RGW is 70 mph. The approach circuits are of sufficient length to provide a minimum of 20 seconds warning at this speed.

Circuit Operation

Assume the approach of an eastbound train through track circuit C75T: When the leading wheels shunt track circuit B75T, the track relay B75TR will drop. This will open the circuit to 95XR relay, and that relay will also drop. With the 95XR down, a circuit is completed to the bell, the flasher relay 95FFR, and signal lamps.

Because of the impedance that the track circuit offers to energy at a frequency of 10 kc, its strength diminishes rapidly as we move away from the rail connections. At a distance greater than 45 ft from the rail connections, the voltage is insufficient to permit the relay to pick up.

As the train approaches the crossing the leading wheels will reach a point where the audio frequency voltage will be sufficiently high to allow the relay OLTR to pick up. With OLTR up, the circuit to the crossing stick relay 95XSR is completed and that relay will pick up. The picking up of OLTR insures that the 95XR relay remains down with the crossing occupied, and the picking up of the 95XSR provides a path around the contacts of approach relays B75TR and A75TR in the XR circuit.

Next, the leading wheels of the train will shunt track circuit A75T, and track relay A75TR will drop. The XR and the XSR are not affected by this action. However, as the rear wheels of the train proceed eastward past the insulated joint, the OLTR will drop away and the B75TR will pick up. When the OLTR drops out, the direct circuit to 95XSR is opened, but this is a slow release relay, and it will remain up until B75TR closes its front contacts. The stick circuit is established from positive battery XBI through A75TR down, through B75TR up, through a front contact of the 95XSR itself to the relay coils. With both the OLTR down and the 95XSR up, a circuit is completed to the 95XR, and that relay will pick up and flasher operation will cease. When the rear wheels of the train leave track circuit A75T, the A75TR will pick up, and the stick relay 95XSR will drop out, thus releasing the approach cut-out for the next train.

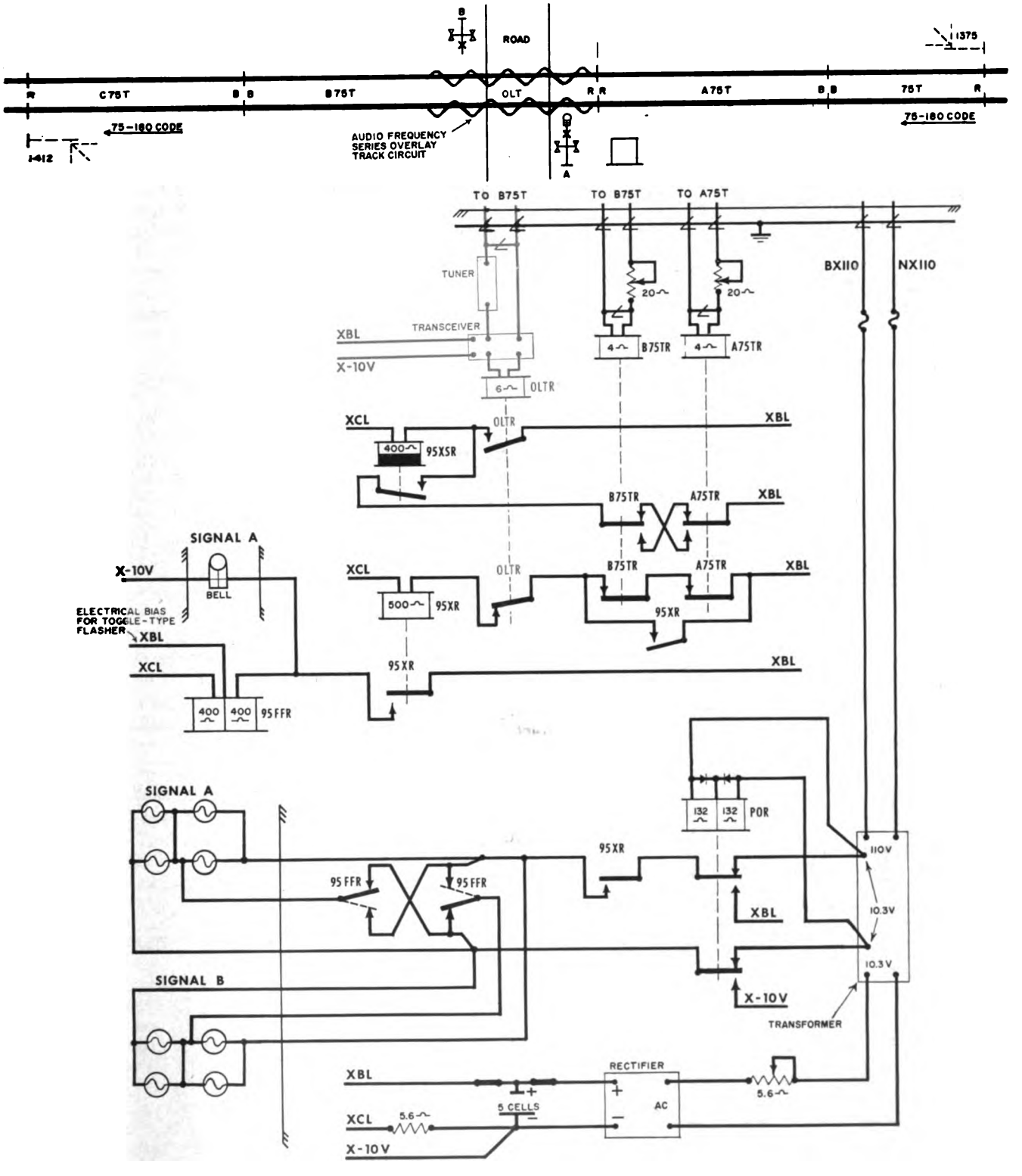
Operation of the circuits is similar for a westward train: the OLTR picks up and the B75TR drops as the first wheels of the train pass to the west of the insulated joints, and the OLTR will drop out before the B75TR picks up as the rear of the train recedes westward from the crossing. The OLTR will remain up until the rear wheels of the train have reached a point approximately 145 ft west of the crossing. (The difference between the pick-up distance of 45 ft and the drop-away distance of 145 ft of the OLTR is accounted for by the fact that, as with all relays, a greater voltage is required to *pick* the relay up than to *hold* it up.)

Quick Shunting Track Circuits

The A75T and B75T track circuits are high voltage, quick shunting circuits. They are fed with one cell of lead-acid storage battery. With the battery at 2.15 volts, a shunt composed of two #10 wires in multiple (wire resistance approximately 0.0025 ohms) is connected across the rails at the battery end of the circuit, and the battery limiting resistor is adjusted to provide two amperes shunt current on track circuits over 500 ft in length. The 20-ohm resistor in series with the track relay is then adjusted to provide the proper relay current.

The circuits were designed and installed under the jurisdiction of B. W. Molis, now Assistant Chief Engineer of the D&RGW. The signal equipment was supplied by the General Railway Signal Co. and the operating battery by Exide. ●

DENVER & RIO GRANDE WESTERN
HIGHWAY CROSSING PROTECTION WITH OVERLAY TRACK CIRCUIT



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