Signal Training Bulletin

COMMITTEE G: Education & Training
Communication & Signal Division, AAR

D-2 AC Track Circuit-General

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Definition: An alternating current electrical circuit in which the rails of the track form a part.

Symbol: None.

Description: Refer to Figure 1. An alternating current (ac) track circuit is designed to be operated by ac — a current that constantly changes amplitude and periodically changes polarity (dependent on its frequency, e.g. 25Hz, 50Hz, 60Hz, 100Hz, etc.). The arrangement of an ac track circuit is similar to that of a dc track circuit. The limits of a particular ac track circuit are established by the use of insulated joints. Intermediate rails are connected together by splice bars and bond wires. Considering end-fed circuits, ac is fed to the rails at one end of the circuit by the secondary of a transformer; a resistor or an inductive reactor (coil) is connected in series with the transformer secondary at the feed end to limit the flow of current when the track is shunted and to set the operating voltage available from the transformer secondary to the track circuit, in a manner similar to battery-end resistance in a dc track circuit. The track relay, designed to function only when ac is applied to it, is attached to the rails at the other end of the track circuit; a variable resistance or reactance may or may not be placed in series with the ac track relay for fine track circuit adjustment. The function of the basic ac track relay is to monitor the track circuit and control secondary circuits in the same manner dc track circuit relays control secondary circuits.

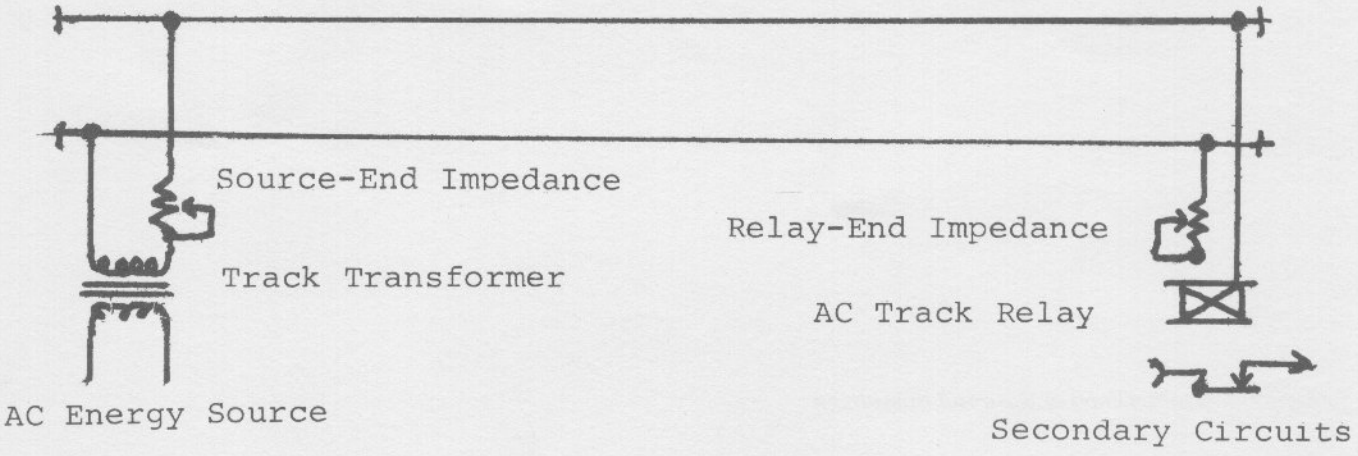

Figure 1: Diagram of ac track circuit.

Purpose and Function: The main function of an ac track circuit is to detect train occupancy and report any occupancy to the signal system via the secondary circuits controlled by the track relay. The ac track circuit is designed around the closed-loop, normally energized, fail-safe principle and therefore detects most malfunctions such as broken rail, broken bonds, broken track connectors, poor ballast conditions, etc., that are severe enough to cause the ac track relay to de-energize, which reports these conditions, via the secondary circuits, to the signal system.

Alternating current track circuits also provide protection against stray dc due to the fact that ac track relays are

operated on the induction principle which makes them practically immune to stray direct currents. This is a very significant feature on railroads that are electrified that use one of the rails as a return path for the propulsion energy. Direct current track circuit relays in electrified territory are vulnerable to not de-energizing during occupancy when one of the rails is employed as a return path for the propulsion current.

General Information: There are many types of ac track circuits, appliances, etc., depending on the situation involved. It is the purpose of this signal training bulletin to familiarize the reader with the basic ac track circuit, its operation, characteristics and appliances. Other signal training bulletins will be developed concerning specific kinds of ac track circuits and appliances.

A partial list of the various types of ac track circuits follows:

1—AC track circuits on non-electrified railroads.
2—AC track circuits on dc electrified railroads.
3—AC track circuits on ac electrified railroads.
4—Single rail ac track circuits.
5—Double rail ac track circuits.
6—Non-coded ac track circuits.
7—Coded ac track circuits.
8—Polarized ac track circuits.
9—Frequency selective ac track circuits.
10—AC track circuits through a rectifier to control dc track relays.
11—Audio frequency track circuits.

A partial list of the various apparatus and appliances employes in ac track circuits follows:

1—Single element ac track relay.
2—Double element ac track relay.
3—Rotor-type ac relay.
4—Vane-type ac relay.
5—Frequency selective ac relay.
6—Centrifugal frequency ac relay.
7—Static frequency ac relay.
8—Two-position ac track relay.
9—Three-position ac track relay.
10—Step-down track transformer.
11—Impedance bonds.
12—Shielding impedance coil.

Detailed Operation: Refer to Figure 1. Alternating current energy of the appropriate frequency (usually 60 Hz) is applied to the rails via the secondary of the track transformer and series limiting resistance or reactance. This ac energy is then conducted to the ac relay and relay-end resistance or reactance to operate the ac track relay. The track relay, via the secondary circuits it controls, reports this normal situation to the signal system and cause the signals that govern entry over this section of track to display green aspects.

Some of the energy leaving the secondary of the track transformer does not get to the ac track relay due to ballast leakage current which is inversely proportional to the ballast leakage impedance.

When the first set of wheels of a train occupies this track circuit, the relatively low (with respect to the track relay coils) impedance of these wheels shunts the ac away from the track relay control coils to below holding current. The ac track relay then de-energizes causing the signals that govern train movement over this track circuit to display red aspects.

If a malfunction exists that is severe enough to reduce the energy to the ac track relay to that value below holding current, the relay de-energizes and the signals governing train movement over this track circuit display red aspects.

NOTE: This bulletin is for general information only. For specific applications consult the rules, standards and instructions published by your railroad.