• *What's the* ANSWER? •

D.C. TRACK CIRCUIT TROUBLE

"What is the best and quickest way, especially at night, to find a partial short on a d.c. track circuit, such as that caused by a fouling bond touching a rail anchor and shorting the circuit just enough to prevent a two-ohm relay from picking and holding up, but which results in no appreciable difference in volts at any point in the circuit when checking with a voltmeter?"

With Ammeter

By P. W. GAGE
Signal Inspector
Chicago, Burlington & Quincy
Lincoln, Neb.

I WOULD suggest the following method of locating a partial short in a d.c. track circuit:

First, cut out all series resistance at the battery end of the circuit. Then, place an ammeter in series with the relay, using the scale which will position the needle in about the center of the dial. Observe the needle closely while the meter is resting on a solid surface and while someone pounds each bootleg riser, insulated joint, insulated gage plate, spread rod and gage rod. If the needle fluctuates slightly when the hammer strikes, it is quite certain that the partial short is in that insulation.

Meter and Exploring Coil

By D. GUIGUE
Leading Signal Maintainer
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FIRST, find out if the trouble is in the nature of a short or an open circuit, that is, whether electric power leaks, or it is prevented from getting to the relay by too much resistance in its path. To find this out, it is only necessary to take a voltage reading across the limiting resistance. For example if, when using a two-volt battery, the voltmeter reads one, when its leads are connected to each side of the resistance, it shows that there is a large flow of current to the track. The power, then, must be finding some other path or leaking out before reaching the relays.

Possibly, the rails are not sufficiently insulated from one another. Of course, the leak could be through the balast, but assuming that there are good ballast conditions, the most likely place for the trouble would be around a switch or turnout that is, where cotter pins or other pieces of metal are most likely to bridge insulation. The quickest and easiest way to locate trouble of this kind is usually by means of an exploring coil. If that is not available, however, one must resort to very close inspection with the eyes.

Wherever there is insulation, it should be thoroughly examined. Hammering at the same time that a reading is being taken on the track will usually reveal if there is trouble at the point hammered. Cotter pins sometimes touch where they are not supposed to. Grindings, scales and other rail abrasion may cause trouble at insulated joints, especially those in turnouts. Fouling wires or bonds may come in contact with rails they are supposed to be clear of.

STOPPING DISTANCE ON GRADES

"When dealing with the problem of locating signals in relation to the braking distance of trains, what is the general method of calculating the plus or minus allowance for the stopping distance on grades?"

Lot of Variable Factors For Freight Trains

By R. E. TAYLOR
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New York, New Haven & Hartford
New Haven, Conn.

THE braking distance for a freight train is dependent upon a number of variable factors, which are difficult to reliably evaluate. Some of these are: speed of the train; weight of the train; number of cars; condition of the brake system; ratio of braking efficiency; condition of the rails; grade; and alignment. If a value can be established for a given train for stopping on a level tangent track, compensation for grades and speed can be quite accurately computed.

To Be Answered In a Later Issue

(1) In a teleprinter tape relay office, what practice is used to assure transmisson of multiple-addressed messages to each address?

(2) Where shelter is not otherwise available, do you prefer to use boxes or booths to house telephones in the field, such as at the ends of passing tracks, at signals, in interlockings and elsewhere? Why? Please explain the advantages of your particular practice.

(3) When installing submarine-type communication or signal cables across rivers or other bodies of water, what practices and procedures have you found to be most effective in preventing the cable from being damaged due to dragging or snagging on the bottom?

(4) When pulling signal, telephone or telegraph line wires under power circuits which cross overhead, what precautions should be observed by the men doing this work from the standpoint of safety?

(5) What use is being made of lunar white by itself, or in combination with red, green or yellow, to provide additional or distinctive signal aspects?

(6) What is the safest, most reliable and satisfactory method of connecting tap wires from the rail to underground cable—inside or outside of the bootleg pedestals, and should these connections be made mechanically or soldered? Why?

If you have a question you would like to have answered, or, if you would like to answer any of the above questions, your comments will be welcomed. Address: "What's the Answer?" Department, Railway Signaling and Communications, 79 West Monroe Street, Chicago 3, Ill.

100-car train	4,000 tons	40 m.p.h.	4,050 ft.
100-car train	4,000 tons	45 m.p.h.	5,200 ft.
100-car train	4,000 tons	50 m.p.h.	6,500 ft.

Values used by New York, New Haven & Hartford

It is well known that, in the actual makeup of several 100-car trains, there will be so many variations in the condition and efficiency of the brake system that actual stopping tests will show materially different results. There is also a difference of opinion as to the effect the number of cars has on total stopping distance, due to the time required to get full braking effect on the rear cars, and what the retardation may be progressively as the application is being made.

We are using the values shown in the accompanying table, which were determined by calculation, and then adjusted for results in actual tests. For trains of more than 4,000 tons, these values are increased one per cent for each additional 100 tons. In using these values, we assume that the brake application will be made at the location of the approach signal, and whatever margin is obtained by preview of the signal is an additional factor of safety. The use of Diesel locomotives has made it possible to increase the number of cars and tonnage on many lines, and it is necessary to continually recheck signal spacing to keep up with the changes.

25 Per Cent Figure

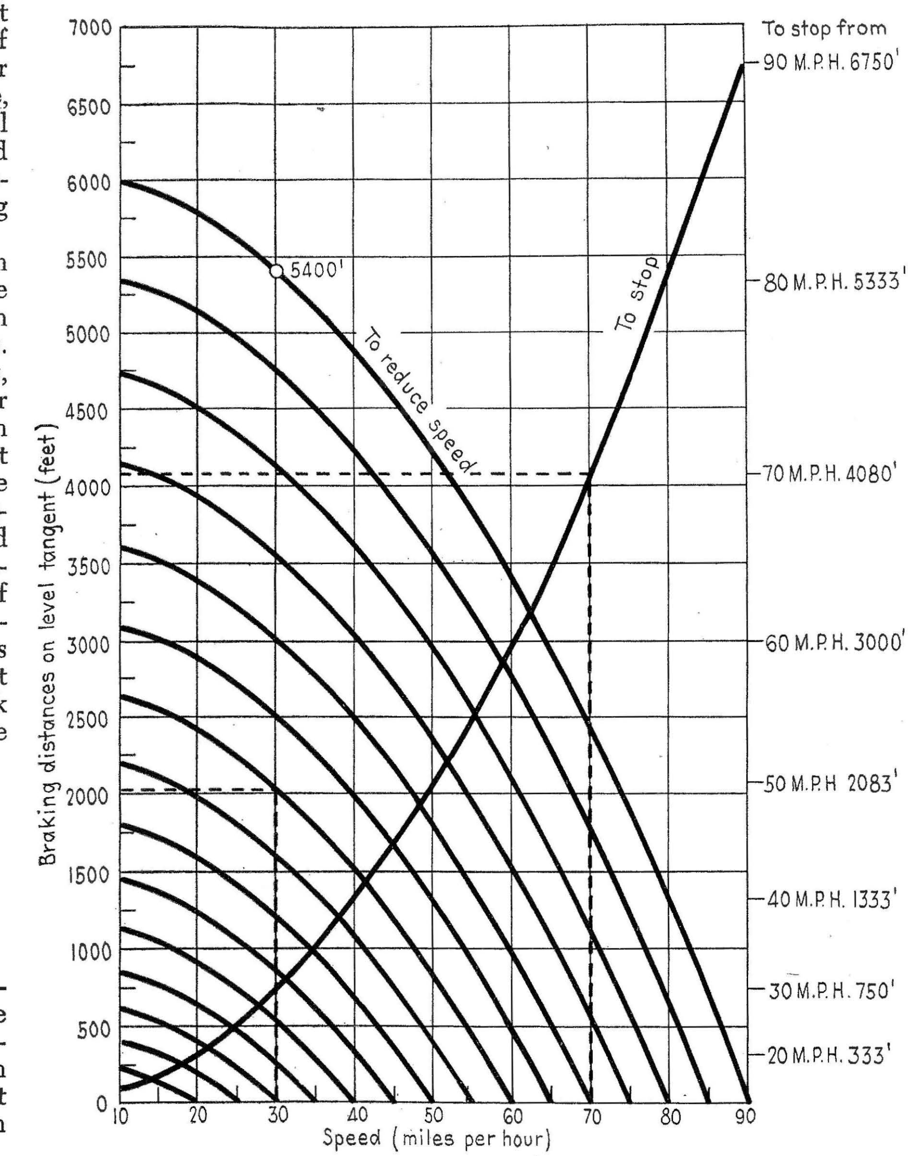
By L. S. WERTHMULLER
Signal Engineer
Missouri Pacific, St. Louis, Mo.

WHEN taking grades into consideration, in the location of wayside signals with reference to the braking distance of trains, it has been our policy to require 25 per cent additional braking distance for each per cent of grade.

By W. G. SALMONSON
Philadelphia, Pa.

AFTER an extended series of trials, under actual running conditions, with many passenger trains of all classes and various conditions of brake equipment, a braking-distance chart was developed for passenger trains.

The curves on the graph show the allowable braking distances for passenger trains on the basis of full service application on level tangent for the location of signals, the single curve representing the distances required to stop from any particular speed, and the 15 curves at the left the required distances to reduce



Curves showing allowable braking distances for passenger trains

from any speed to a lower speed. For example, to stop from 70 m.p.h. requires 4,080 ft., and to reduce speed from 60 m.p.h. to 30 m.p.h. 2,025 ft., these distances being determined by following the dotted lines on the curves. The distances determined from the curves are modified for grades from 0.1 to 3.0 per cent by multiplying the length of the service stop on level by the factors shown in the accompanying table, which is also part of the chart formulated by us. Factors for any grade greater than 3.0 per cent are obtained from the formula $\frac{400}{4 \pm \text{grade}}$ = Factor (per cent of service stop on level tangent). On a 4.0 per cent descending grade, the gravity exactly balances the average service-brake effect, and the train continues to move at the same speed. Distances determined from the curves on the graph are further modified by the presence of curves in track alinement. A 1.0-deg. curve is equivalent to an adverse grade of .05 per cent; 2.0 deg. of 0.1 per cent; so that a 10-deg. curve is equivalent to a 0.5 per cent adverse grade. The distances determined from the braking-distance curves and modified for grades and alinement are used to determine the minimum distance between signals.

On the accompanying graph, it will be noted that the distance, 5,400 ft., required to reduce from

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90 m.p.h. to 30 m.p.h., plus the distance required to stop from 30 m.p.h., does not equal a continuous stop from 90 m.p.h., which is 6,750 ft. This is due to the fact that, after the brakes are applied for a short time, the braking effort between the wheel and the brake shoe decreases, but, if the brakes are applied while running say at 30 m.p.h., the maximum braking effort applies, and the train will stop in a shorter distance.

While the graph and table herewith provide the proper distances required, a short method for calculating the various changes of grade between signals, to obtain the equivalent level-tangent distance, is that the distance varies 2.5 ft. for each 0.1 per cent grade for each 100 ft. of track. If ascending grade is involved, this distance is added to the actual distance; if descending, the distance is substracted from the actual distance. The presence of curves modify the grade as noted previously, so the effects thereof are added to or substracted from the grade, depending upon whether the grade is ascending or descending.

Per Cent Grade	Ascending	Descending	Per Cent Grade	Ascending	Descending
0.1	0.9756	1.0256	1.6	0.7143	1.6667
0.2	0.9524	1.0527	1.7	0.7018	1.7391
0.3	0.9302	1.0811	1.8	0.6896	1.8182
0.4	0.9091	1.1111	1.9	0.6780	1.9048
0.5	0.8889	1.1429	2.0	0.6667	2.0000
0.6	0.8696	1.1764	2.1	0.6557	2.1053
0.7	0.8511	1.2122	2.2	0.6451	2.2222
0.8	0.8333	1.2500	2.3	0.6349	2.3530
0.9	0.8163	1.2903	2.4	0.6250	2.5000
1.0	0.8000	1.3333	2.5	0.6154	2.6667
1.1	0.7843	1.3793	2.6	0.6061	2.8571
1.2	0.7692	1.4286	2.7	0.5970	3.0770
1.3	0.7547	1.4815	2.8	0.5882	3.3333
1.4	0.7407	1.5385	2.9	0.5797	3.6364
1.5	0.7273	1.6000	3.0	0.5714	4.0000

Table of factors for grades from 0.1 to 3.0 per cent

CONTINUITY OF TRAIN COMMUNICATION

"What can be done to insure continuity of end-to-end and train-to-wayside radio and/or inductive communication when trains are passing through tunnels which have, heretofore, been considered as 'blind spots'?"

Wire Through Tunnel

By E. W. BREISCH
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THE inductive train communication system is essentially a relatively high-frequency carrier-current system, making use of the line wire/or wires adjacent to the railroad tracks as the conductor for the modulated-carrier current. Frequencies ranging from 80 kc. to 196 kc. are now in commercial use on a number of railroads. It is usual practice to equip locomotives and cabooses with two-way vehicle apparatus, and to install similar wayside equipment at intervals up to 50 or 75 mi. in selected towers along the right of way.

In the operation of the system, i.e., during transmitting periods, signal energy is originated in these line wires by inductive coupling with the transmitting loop on the vehicles and/or by direct electrical connection at the wayside towers. As the signal current travels along the line wires, in both directions from the point of inception, it produces an alternating magnetic field, which is intercepted by specially-designated receiving coils, also mounted on the vehicles and again, by induction, supplies the extremely small minimum voltage for which the receivers are designed, to the input stage of each receiver.

Since the intensity of the magnetic field produced by the transmitting loop current is greatest within the vicinity of the loop structure, it is apparent that high values of signal energy may be induced in the line wires if they are close to the vehicle. Also, the magnetic field set up by the induced modulated-carrier current in the line is at a maximum value immediately adjacent to the line wires.

Ordinarily, the line wires along the railroad vary in distance from the tracks, therefore, the inductive system has been designed for adequate operation with line-wire separation up to 150 ft. In tunnels, however, the line wire is either suspended from the roof or mounted on the side wall, in either case, just about as close as it is possible or practical to approach the locomotive or caboose. Where open lines suitable for connection into the communication system do not transverse the tunnel, a single-conductor of No. 6 copper wire or the equivalent in Copperweld wire may be installed on brackets, with glass insulators, throughout the tunnel and connected to the telephone line through capacitors at each end of the tunnel. Other than the installation of the line wire with its simple mechanical problems, there is no special treatment required to maintain communications through any tunnel, regardless of the over-all length of it.

It is readily apparent, under these conditions, that maximum signal strength may be induced in the line wire from the nearby transmitting loop, also that a large incoming signal is available at the receiver.

As a result, instead of the tunnels representing so-called "blind spots", i.e., points of no reception, with the inductive communication system, they are actually locations where transmission and reception are as good as, and may be appreciably better than, on the outside where there is a greater distance to the line wires. Also, with the inductive system, there are no "blind spots" along the railroad at any location, i.e., through tunnels, through steel bridges with high-latticed superstructures, between tall buildings, or at any other point on the railroad within the range of the equipment, provided a carrier wire is within a reasonable distance to the train. This is one of the outstanding advantages of the inductive system of train communication. Where the complete system is properly engineered and installed, there is inherently 100 per cent continuity of service along the entire right of way, under all weather conditions, from train to wayside, from train to train, and from end to end with tunnels and bridges usually improving the performance rather than "blacking out". For applications where "solid communication" is required to include relatively long distances, through congested, restricted and/or shielded areas, the induc-

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