(Continued from page 436)

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-

(Continued on page 440)

(Continued from page 438)

tive system offers the most practical and reliable solution to the problem.

Two Methods

By A. A. CURRY
Systems Engineering Department
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IT is my opinion that each installation calls for special engineering consideration. However, one method that has been suggested, and which may have some merit, is the system using a fixed-station antenna located at each end of the tunnel. The two antennas are connected through the tunnel by means of an open-type transmission line, which will pick up or radiate enough energy from the mobile antenna to carry out through the respective fixed-station antenna and, from there, radiate by space to the other end of the train.

Another method which probably has more merit than the one first described is the one employing two repeater stations. A repeater station would be located at each end of the tunnel, and the two repeaters would be interconnected by means of a telephone pair running through the tunnel. Signals on one side of the tunnel would automatically be repeated at the other side.

Up to the present time, however, most railroads have felt that the limited amount of money they have had to spend for radio equipment could best be spent to extend the radio-equipped mobile units. It is felt that as the roads become more fully saturated with radio equipment, the problem of 100-per cent radio coverage, even through tunnels, may become more pressing, with the result that more engineering work may be devoted to improved or simpler methods of accomplishment.

TELEPHONE SWITCHBOARD JACKS

"As applying to telephone switchboards, what is meant by the terms 'double cut-off' and 'single cut-off' jacks, and what are the differences between and the functions of each of these two type jacks?"

A Manufacturer Explains

By N. H. SAUNDERS
Engineering Manager
Kellogg Switchboard & Supply Company
Chicago

A "cut-off" jack is a telephone-type jack, arranged so the line is normally connected through contact springs to an auxiliary circuit, which is disconnected from the line when the plug is inserted into the jack. A "single cut-off" jack has provisions for opening one line conductor from its auxiliary circuit upon insertion of the plug. A "double cut-off" jack has provisions for opening two line conductors from the auxiliary circuit upon insertion of the plug.

Single cut-off jacks have been used (1) to open one lead to the line signal coil of a magneto telephone line, and (2) on test panels. Double cut-off jacks have been used (1) to open both leads to the line signal coil of a magneto telephone line, (2) to disconnect the line relay from a common-battery telephone line, (3) to disconnect subsequent jacks from a line when the jacks are wired in series, and (4) in test panels.

Double cut-off jacks used in telephone switchboards are designed with a pair of line conductor springs, each of which is normally in contact with another local spring. These contacts are opened when the plug is inserted in the jack, breaking contact between the line springs and the local conductor springs. This may be used to provide normal contact to a local line signal coil, or to carry the line conductors through to another jack in a series circuit, so that when a plug is inserted into the first line jack the line conductors will be disconnected from the signal or subsequent jack. Single cut-off jacks have only one line conductor spring in contact with a local spring, so that when a plug is inserted, only one conductor contact is opened. Such jacks are usually used to open one conductor to a line signal coil, while the double cut-off jack would open both conductors.

Both single and double cut-off jacks are frequently used in test panels with the series circuit application, which allows each line conductor to be opened or split, with one end available for electrical testing while the other end is disconnected. It is common practice to use a double cut-off jack with both line conductor springs and both local cut-off springs connected in multiple, to serve a single line conductor and derive the benefit of better electrical contact in the series circuit, and better contact with the plug conductor.

If you have a question, answer, or Kink, please write the editor.

COMMUNICATION CIRCUIT LOADING

"With reference to phantom groups in communication circuits, is it possible to load the phantom without loading the side circuits, vice versa, and should one side circuit be loaded without loading the other?"

More Important to Load Side Circuits

By J. A. PARKINSON
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Atchison, Topeka & Santa Fe
Chicago

IT is possible to load a phantom circuit without loading the corresponding side circuits, and the side circuits may be loaded without loading the corresponding phantom circuit. It is usually more important to load the side circuits than it is to load the phantom and, in normal installations, it will be found that either the side circuits only or the side circuits and the phantom are loaded, but never the phantom only. It would be impractical to load one side circuit of a phantom group without loading the other side circuit, because it is necessary to keep the two sides of the phantom group balanced in order to minimize cross-talk and noise in the circuits.

No

By J. B. HITT
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THE Louisville & Nashville does not use loading but, to the best of

(Continued on page 448)