

the voltage present at the track can readily be determined. For instance, if the fixed artificial resistance is 1.08 ohms and the shunt reading 700 mil-amperes, the voltage should be .65 volt.

In the office these curves can be used to advantage in checking up the reports from the maintainers, because with

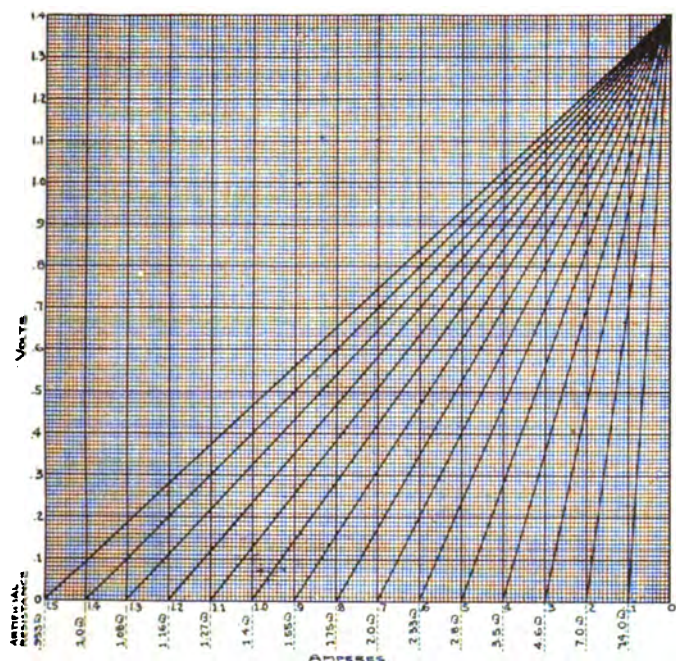


Fig. 1. Shunt Values for Two BSCO Cells Connected in Series.

a certain artificial resistance and a certain style battery, the voltage and amperage values should be of corresponding proportions. Fig. 2 shows the same style battery having two cells connected in multiple. Similar curves can be

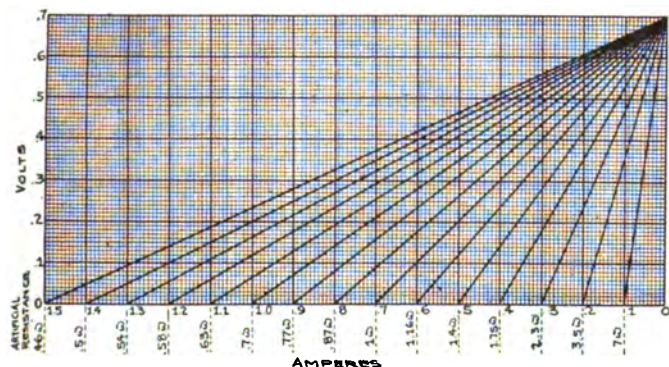


Fig. 2. Shunt Values for Two BSCO Cells Connected in Multiple.

computed for any style of battery and should prove valuable for track circuit work both in the field and office. The curves will also show the capabilities of the various styles of batteries with different inserted resistances for track circuit work.

CLEARING TROUBLE ON UNDERGROUND POWER LINES BY "ONE OF THEM"

The signals, lights and track circuits on the Philadelphia division of the Pennsylvania, between Marysville, Pa., and Atglen, are supplied by a 33,000-volt alternating-current power line, which is laid in 2¾-in. trunking filled with petroleum asphaltum pitch, approximately 2 ft. underground. The signals on this 67-mi. section are the Union Switch & Signal Company's style T-2, upper right-hand quadrant, with a. c. induction motors operating at 110 volts, 60 cycles, single-phase. The line between Marysville and Royalton, about 19

mi., is normally fed by the Harrisburg power plant; from Royalton to Conestoga, 25 mi., by the Dillerville plant, and from Conestoga to Atglen, about 22 mi., by the Atglen plant.

As the first and most important factor in the maintenance of one section of this power line with which the writer is familiar, an emergency supply car is kept at Harrisburg and an emergency power plant is provided at Royalton. The car is equipped with all material and tools necessary for clearing power-line and signal trouble, consisting of junction boxes, power-line wire, pitch, trunking and capping, alternating and direct current motors, polyphase relays, etc. In one end of the car is an office for the signal foreman and a workshop for making minor repairs to signal apparatus is also included. The emergency plant consists of a 12½-kw. gasoline engine generating set, which is fully capable of taking the load off the plant located on either side of it. This emergency plant generates normally at 220 volts, 60 cycles, single-phase, which is stepped up to 33,000 volts for power-line transmission.

Upon receiving notice of power-line trouble, the assistant supervisor of signals immediately takes charge and directs the operation of locating it. The emergency plant is started in order to be ready to take the load if necessary, and to assist in making tests, as it is considered bad policy to throw the line in trouble in with an adjoining section, as it is likely to put that section in trouble also.

A rough test is first made by opening an oil switch about the middle of the 25-mile section, and if this takes the load off the plant, it is known that the line between that point and the plant is all right. The line that is in trouble is then thrown on the emergency plant and the trouble is localized by opening and closing oil switches at signal locations until the fault is passed, which immediately shows up on ammeters or ground detectors in the powerhouse. When it is localized between two signal locations, which are about one mile apart, the signals at each end are sectionalized by jumping the polyphase relays, giving a caution indication by hand, as these relays will not work under this condition since they are then receiving energy from different machines that are not in synchronism.

The exact point of trouble was formerly located by digging down on the power line at intervals of 5 or 6 ft. to see if any heat or odor of burning pitch could be detected. This odor is always present to a greater or less degree. This method has been abandoned, however, and a better one adopted in which a spear-shaped iron, with a small cup in the heel of the spear, is used. This is pushed down through the earth toward the power line, and on being withdrawn, brings up a small quantity of earth in the cup. If it is near a burnout, the earth will have an odor of burnt pitch and rubber insulation, which, when once smelled is always recognized. This method of locating trouble was developed by the assistant supervisor of signals on this division, E. G. Bauman. After a recent burnout, the men were distributed along the power line, trying to locate the trouble. Mr. Bauman, who was working with the men, pushed a stout pointed stick through the earth toward the power line and when he withdrew the stick, he detected the familiar odor of burnt pitch. He had the men dig at that point and it was found that he had pushed the stick down on the exact point of the trouble. This led to the adoption of the spear or harpoon, which is about 3 ft. long, made of ½-in. iron, with a wooden handle similar to an auger, the handle being carefully insulated.

As soon as possible after the trouble is located, the emergency car is ordered out and is taken on the first train that can carry it. In the meantime, the line is dug up and a section of about 30 ft. is prepared, so that no time is lost when the car arrives. Upon its arrival the necessary tools and materials are unloaded on trucks or carried to the place of action, a fire is immediately started under the pitch tank, as the pitch melts very slowly, the junction boxes are placed in position and a new section of wire is run to them, all con-

nections being made in a junction box or sectionalizing case. After the connections are made, melted pitch is run in the trunking and junction boxes are filled almost to the connection.

TESTING ON THE NORTHERN PACIFIC

The Northern Pacific has recently prepared three new forms for the use of maintainers and inspectors in reporting tests on relays, signals and track circuits. In addition

to the ordinary daily inspection of the maintainer and the closer inspection of the division inspectors, the latter take special readings if any trouble occurs, and fill in the information called for on forms 1647 and 1650. Form 1645 is only used by the general signal inspector in testing out relays. Two men are employed at this work continuously, and under present conditions they are able to get over the line once in three years, making a thorough inspection, not only of relays, but also of all track sections, motors, batteries, etc. Any correction that is to be made in the apparatus is attended to while the general inspector is present.

It has been found necessary to make a careful inspection of all relays about once in three or four years as high resistance has set in on the carbon contact and silver-plated

N. P. RY RELAY INSPECTION REPORT.	
On <u>Division Between</u> and <u>Inspector</u> Date <u>19</u>	
Type of Relay.	Make.
	Number.
	Frame Neutral or Polarized.
	Resistance of Coils.
Adjustments as Found.	Pickup.
	Drop Away.
	Front Contact Opening.
	Working Air Gap.
Kind of Contacts and Resistance.	Contact No. 1.
	Contact No. 2.
	Contact No. 3.
	Contact No. 4.
	Contact No. 5.
	Contact No. 6.
Other Data.	Date Installed.
	Location Installed.
	Contacts in Service.
	Spare Contacts.
Service.	

Form 1645 for Relay Report.

N. P. RY REPORT ON ELECTRIC SIGNAL OPERATION	
On <u>Division Between</u> and <u>Tested by</u> Date <u>19</u>	
Signal	Number
Type	
Battery	Number of cells.
Type	
Date of last renewal.	
Time	To clear from 0°-90°.
Going to block.	
Hold clear of battery.	
V ₁	Normal discharge of battery.
A ₁	0°-90° operating at battery.
V ₂	0°-90° operating at motor.
V ₃	0°-90° operating current.
A ₂	Approx. length of wire in motor circuit.
V ₄	Drop across relay contact #3.
V ₅	Drop across relay contact #4.
V ₆	Drop across 45°-90° relay contact.
V ₇	Drop across 0°-45° motor contacts.
V ₈	Drop across 45°-90° motor contacts.
<p>Note: Readings V₁, V₂, A₁ & T₁, to be taken during one 0°-90° operation of signal. Reading lowest V₁, V₂ and highest A₁. If V₁ minus (V₂ plus the estimated voltage drop in motor circuit) is greater than .5 volts, readings V₄ to V₈ must be taken.</p>	

Form 1647 for Electric Signal Report.

N. P. RY REPORT ON TRACK CIRCUITS.	
ON <u>Division Between</u> & <u>Tested By</u> DATE <u>19</u>	
Number of Section	
Kind of battery: Dry-Cell, General-Graded, Stone	
Condition of circuit: Wet-Dry-Frozen	
Approximate Length of circuit	
Resistance of unit.	
Type of battery	
Number of cells	
Date of last renewal	
V ₁	Volts at battery terminals
V ₂	Volts across track at battery
A ₁	Normal discharge
A ₂	Discharge train in block
A ₃	Current thru relay
V ₃	Volts at relay terminals
V ₄	Volts at front relay points
V ₅	Volts at neutral relay points
Relay pickup	
Relay drop	
Track resistance	
<p>Note: Readings V₁ & V₂ need not be taken unless the drop between V₁ & V₂ is considered excessive.</p>	

Form 1650 for Track Circuit Report.

contact, and would at times destroy the silver plating and prevent the contact from arcing. It was also found that the drop-away, the pick-up and the air-gap would change, and in some cases relays were found that were really dangerous to leave in after a few years of operation. This is particularly true of relays that were installed years ago when the art of manufacturing them was not as well developed as it is to-day.

In order to know exactly what condition the old apparatus is in, the general inspector filling out these blanks puts in the first column the condition in which he found the apparatus and whether or not it needed correction and readjustment. In the second column he records the condition in which he left the apparatus. As all tests are made with very fine instruments, it is a frequent occurrence to find many things wrong which could not be discovered ordinarily, which, of course, are corrected before the general inspector leaves. By this method it has been found possible to get better and greater use out of the same batteries, as all undue resistance in the circuits is thereby removed.