Voltage at Battery(1)	.82	.88	.66	.70	.66
Voltage at Track, Battery End (2)..	.815	.54	.425	.60	.52
Current Flow to Track, Normal (3)	.230	.118	.098	.160	.480
Current Flow to Track Shunted (4)..	1.04	.38	.32	1.08	2.2
Voltage at Relay(5)	.78	.53	.42	.49	.43
Current Flow Through Relay (6)	.190	.100	.087	.144	.108
Resistance of Relay—					
Neutral	5.	5.	5.	4.	4.
Polarized—b	5.	5.	5.	4.	4.
Relay Pick-up.....	.071	.071	.071	.075	.074
Relay Shunt.....	.035	.035	.035	.036	.034

Circuit A is within a yard and is shunted a considerable part of each day.

Circuit B has a polarized relay and requires a greater current flow to effect rapid pick-up on reversal.

Circuit C is a circuit with a relatively high normal current flow.

TO THE MAINTAINER.

BY D. M. C.

The continued introduction and use of new materials, methods and appliances in the art of railway signaling, and the high standard of efficiency required by this department, emphasize the necessity of increased knowledge, both general and technical, on the part of the maintenance forces.

While it is true that experience is essential to success in signal maintenance, as in other lines of railroad work, it is also becoming more evident that the experimental knowledge thus acquired is more valuable if supplemented by adequate instruction in mechanical and electrical science. Understanding the principles involved, the maintainer can look forward to securing perfect results with more confidence, is more self-reliant and resourceful when conditions which require his inventive faculties arise, and is more satisfied with himself and his work.

Signalmen familiar with the early types of apparatus and signal installations realize that the field of the maintainer is widening and that a more general knowledge is required of him, both of the details of manufacture and the application of new methods in maintenance. Many improvements have been made in materials and in the development of plans for their arrangement and use, and the extension of signal control of train movements has been made practicable, in a large measure, by efficient devices and new applications of electrical and mechanical principles.

Changes have been made in manufacture along the lines of more rugged and durable construction, and, where it has been demanded, in the use of much more expensive materials. This has really proved more economical in the securing of better operative results and the reduction to a minimum of inspection and repair work.

To maintain this higher standard requires skilled men. More scientific methods demand better trained operatives. In other words, the successful signal maintainer to-day must, more than ever before, be well versed in the subjects relating to his work.

There are certain qualifications that seem to be possessed by natural endowment, rather than acquired through educational training and these qualities are found to be necessary to success in signal maintenance. Through lack of such essentials men may fail, though well prepared in technical training. To sum up in a general way these natural characteristics they include: faithful and untiring study of the details of equipment and the causes of failures; a knack of inspecting in such a way that troubles may be removed or avoided *before* an actual failure occurs; the instinctive faculty of being on the ground when needed and of doing at the proper time what is required to keep the signals working or to restore them to working order in the shortest possible time.

While it thus appears that a kind of intuition or natural aptitude is required, this is assisted by, and results from, the closest concentration of the mind upon the idea of perfect maintenance, and a determination to succeed regardless of personal hardship, precedent, or other deterrent influences.

I have known men possessing such qualities, though lacking even the rudiments of technical training, to get excellent results in the maintenance of signals and interlocking, and it is indeed unfortunate if they, having that which education does not give, should be deprived of the additional advantages which it alone can confer.

Lack of mental training along proper lines is not only a barrier to promotion but a handicap in any position held. Even comparatively successful work cannot be satisfactory without a knowledge of the principles governing it, and often difficult situations arise that such a knowledge would quickly overcome.

The extension of the use of telephones, alternating current and varied applications of electric power in railroad service will make it more and more difficult for the man without mental and technical training to hold his own in the maintenance field. On the other hand, the man with established record, experience and practical knowledge, who has acquired by proper courses of study not only special information but the ability to apply the same to the problems met with, and thus independently to solve them, is the one to satisfactorily fill the demand for the highest efficiency in the maintenance of signal equipment and to occupy positions of greater trust and responsibilities.

It is probably true that no one is working to his full capacity, and where there is an earnest desire to equip one's self for better service and promotion the way can be found. I would say particularly to those engaged in signal maintenance who are handicapped by lack of education, and are thus losing the pleasure of work intelligently done, that they could not do better for their own welfare and that of those depending upon them, than to begin at once upon a course of study leading up to a knowledge of the principles of electricity and mechanics. Even if it should be necessary to begin with the simplest branches of language or mathematics, a fixed purpose and the employment of all spare hours will soon prepare the way for more advanced studies. As knowledge increases mental power will be added and the work to be done will be more quickly and easily accomplished.

PENNSYLVANIA SIGNALS IN THE GREAT STORM.

The experiences of the Pennsylvania Railroad in restoring traffic after the snowstorm of March 1 are worthy of notice. The following concerns the behavior of the block and interlocking signals.

The storm destroyed most of the aerial wire lines between New York and Bristol, Pa., 68 miles; but the signals operated successfully except at a few points where aerial wires were used.

Between Jersey City and Newark, nine miles, and over the line from Manhattan Transfer to the tunnels leading to the Pennsylvania station, Thirty-fourth street, New York, the 2,200 volt aerial signal feeders were broken and crossed in several places. This put all automatic signals and the track circuits and lights at interlockings out of order. The most important signal lights at the interlockings in this territory, were connected to storage batteries and, as the switches and low-speed signals were operated from storage batteries, trains were kept moving through the interlockings at reduced speed. The electric trains between Newark and Jersey City (Hudson & Manhattan connection) were kept in operation throughout the blizzard.

West of Newark, eight signals were held at stop near Rahway on account of having the "Bezer foreign current protection system," which requires the use of line wires. At Monmouth Junction eight signals and at Trenton four signals were at stop on account of having alternating current track circuits, which require the use of line wires. At Morrisville wires which had fallen across the tracks became crossed with high voltage wires in the city, and set fire to a track transformer, burning the relay box at the signal bridge, putting four signals to stop. Vigilance on the part of the repairman, in removing the wires, saved the interlocking station, but not until several instruments in the tower had become so hot that they were smoking.