

The carriage *l* is mounted on wheels *U U'*, in order that the watch may be slowly advanced into the helix *V* to its smaller end, and again slowly withdrawn. It should be withdrawn to a distance of several feet from the helix.

The helix, as shown in section, is given this form in order that the electro-magnetic effect of the current on the watch may be gradually increased and diminished as the watch is advanced into the helix and withdrawn. When the watch has reached the smaller end of the helix there are more lines of magnetism passing through it for the reason that there are more coils of wire around and about it, and the coils are also nearer to it. Thus the polarity of each steel part of the watch is successively changed with a gradually diminishing force as the watch is slowly withdrawn, until every piece of steel in it is brought back to its normal condition. Such is my theory, and I hope my machine will be successful. In the meantime I will be glad to receive any suggestions.

ELECTRICAL SECTION.

Stated Meeting, November 25, 1896.

MR. CLAYTON W. PIKE, President, in the chair.

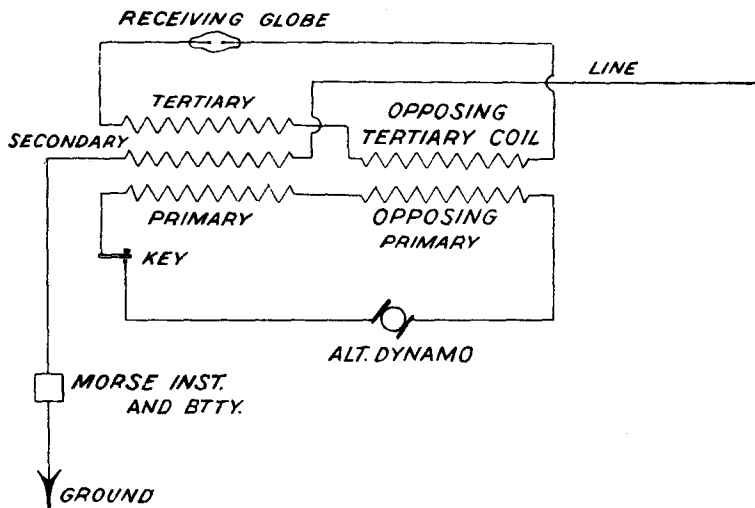
AUXILIARY TELEGRAPHY.

By DR. I. KITSEE, Member of the Institute.

Telegraphy in the last score of years has made such rapid progress that it is hardly possible to increase the capacity of a line wire, or to facilitate the ease with which messages are transmitted or received.

We have quadruplex and multiplex systems. We can send a number of messages in opposite directions; but we cannot, if the terminals of a line are used for transmitting or receiving one kind of messages, transmit messages from and to intervening stations of such line without interfering with the telegraphic communications of the terminal offices.

And the lack of a system permitting communication between intervening stations, at one and the same time, when the line is being used by the terminal offices, is generally a great source of inconvenience, but specially so on such lines running along railways, where the general business of the telegraph company must give preference to the business of the railway company. On such lines it very often happens that the main offices have to suspend business altogether for a considerable length of time in the midst of the busiest part of the day because the intervening railway stations have to exchange messages about some more or less impor-



tant point pertaining to the railroad service, and the device as presented to-night to your kind inspection is designed to overcome this difficulty.

We have here represented two telegraphic stations equipped with the Morse system, the sounders, and also with the Auxiliary system, both stations joined together through wire-resistance of 2,500 ohms, equal to about the resistance of the ocean cable. The diagram shown herewith will illustrate the instruments used, as well as the electrical connections of same, and the gentleman assisting me will, as the evening progresses, send and receive messages over this

line with the aid of the auxiliary device, as well as the Morse, and the ease with which such messages are simultaneously transmitted will, no doubt, be apparent to you.

The first requisite of such device to be worked from intervening stations at one and the same time, when the line is used by terminal stations, is that there shall not be inserted in the line large resistance or batteries, or other generators of electricity which may come in conflict with the batteries of the terminal stations.

The second requisite is that the current transmitted from the main stations shall not actuate the receiving or sending instruments of intervening stations, and *vice versa*.

The third requisite is that the current used from intervening stations shall not be of too high a potential, so as not to injure the insulation with which common lines are provided.

It must also be understood that no additional connections shall be introduced between line and ground.

It is believed that the "Auxiliary Telegraph System" about to be described answers all of these requirements. Also, it has the great advantage that it is in itself a duplex, allowing the sending of messages in opposite directions simultaneously.

Generally considered, the equipment of the Auxiliary system consists of :

(1) A sending device, consisting of a small alternating dynamo, or, if such be not at hand, of a mechanical alternator, in connection with some batteries in the circuit, in which is placed a sending key and the primary of a convertor.

The secondary of this convertor is connected in series with the line, and the tertiary of this convertor is locally connected with the vacuum globe, which acts as a receiver.

The primary, as well as the secondary of the convertor, should be a low-resistance one. The tertiary coil should be wound in such manner as to increase the E.M.F. to an extent necessary for producing the glow in a vacuum globe.

Each of the stations, the sending as well as the receiving station, is also provided with a second primary, connected in series with the first primary. This second primary is

placed into a coil equal in its inducing capacity to the tertiary first spoken of. The terminals of this coil, which I call the second or opposing tertiary, are connected in opposition to the first coil with the receiving vacuum globe.

This second series of coils is necessary for the duplexing of the system.

Following is a short description of the mode of sending messages according to this—the Auxiliary system:

At the sending station, the operator connects his first primary coil through his sending key with the source of electricity. With the aid of this key he sends through his primary coil currents of electricity. These impulses, which are alternating, induce impulses in the secondary, corresponding in time to the time of the flow of impulses in the primary. It will be understood that the operator, in opening and closing the key once, does not send a single impulse only through the primary, but a series of impulses, the flow time of which corresponds with the closing time of the key, a dot with its short closing time sending impulses through the primary for a shorter period than a dash with its longer closing time. As far, therefore, as the operator is concerned, he has to manipulate the key as if the current-flow were a constant and not an alternating one.

These alternating impulses in the primary induce alternating impulses in the secondary. These impulses travel over the line, wire or cable, and through the secondary inserted in the line at the receiving station. We, therefore, have, as a result of the sending of a message travelling over the line rapidly alternating impulses of such short duration that the other, *i. e.*, Morse or similar sending or receiving instruments, depending, as they do, on the movement of the armature of an electro-magnetic device, cannot respond and remain practically unaffected by the flow of these impulses. As around each of the secondary coils, sending as well as receiving station, the tertiary coil is wound, it follows that the alternating impulses, travelling through the secondaries, will induce alternating impulses in the tertiaries, and as the coils are wound to the necessary high potential, the generated tertiary impulses

will, if the terminals of the coils are connected to a vacuum tube or device similar in its action, produce in said tube or similar device a glow, corresponding in time to the time of the electric impulses generated through induction—shorter glow-time for dot and longer glow-time for dash.

The office and function of the second primary coil has, so far, not been taken into consideration, and if this system is used only as a simplex one, then the addition of this coil is not necessary; but as set forth above, the object is to con-triplex or duplex the auxiliary of telegraphy, and the prime conditions to be fulfilled in practically carrying out of the method of simultaneous transmission in opposite directions are:

(1) That the receiving instrument at the home station shall remain entirely unaffected by the movements of the transmitting key at that station, while at the same time it shall remain free to respond to the currents transmitted by the key at the distant station.

(2) If this induced system shall be used in conjunction with the usual receiving and sending instruments, which are liable to be opened just at the time of transmission with induced currents, that the same currents shall always be provided with an uninterrupted passage to the ground, at the home station as well as at the distant station.

To fulfil the first condition, is the office and function of the second primary coil. This coil is so wound or connected to the source of current that the alternating impulses flowing through it are capable of inducing in the second tertiary coil impulses of opposite direction from the impulses induced through the action of the secondary coil in the first tertiary.

The necessary adjustment of the inducing influence of one coil on opposing coil can be accomplished:

(1) Through the operation of a rheostat, through the action of which more or less resistance can be thrown into the circuit of the second primary; or,

(2) The second primary can be partially withdrawn from the inner space of the second tertiary.

Supposing now, the adjustment being perfected, the

operator at one station is transmitting a message to the second station.

In depressing his key he sends a multitude of impulses through the primary, inducing thereby a multitude of impulses in the secondary, which multitude of impulses will induce tertiary impulses in the tertiary coil, and will flow over the line into the secondary of the second station, inducing impulses in the tertiary of the receiving station.

Ordinarily, the receiving instruments of both stations, the receiving as well as sending, would answer; but as the depression of the key at the sending station also sends, simultaneously with the sending of the impulses through its first primary, impulses starting at the same time and at the same frequency through its second primary, and as the inducing effect of such impulses is opposite from the induced impulses flowing through its first primary, it follows that both the influence of the first and second primaries on its tertiary are neutralized, and that therefore the receiving instrument at the sending station will not respond.

The proviso of an uninterrupted passage for the induced current is fulfilled by shunting the key and instrument of the Morse, or similar devices, through a condenser.

As stated in the introductory remarks, the alternating current flowing over the line is of such low potential that it would not affect or injure the insulation of a submarine cable, and it is believed that it can be used with impunity on cables as well as land lines.

In conclusion, it can be said that the tests of the chief electrician of one of our foremost telephone companies have established the fact that the leakage and induction from a line traversed by the currents of the auxiliary are not greater than the leakage and induction from a wire traversed by a telephonic current, and that, therefore, the application of this system to existing submarine cables is believed to be a practical one.

[NOTE.—During and after the reading of the paper, Mr. W. B. Eldridge operated the system by sending and receiving messages on both the Morse and Auxiliary at one and the same time over a single line-wire.—ED.]