Appendix 3.

Early fault location tests on Submarine Telegraph Cables.

Soon after the first successful telegraph cable was laid from Dover to Calais in 1851 it became clear that a means of locating faults on submarine cables was needed. On land it had already been found that if a record of the resistance of a newly constructed line was taken, then under fault conditions, the change in resistance to that fault would help locate ~~the fault~~ it. In a similar manner, the resistance R of a newly laid cable was taken and recorded for future use. Fig.1. shows such a cable laid from A to B, with the conductor earthed at B and measurements taken from the other end of the cable at A.

Fault conditions could be either a broken cable with the ends of the conductor exposed to the sea (Fig.2), or a damaged cable with the insulating gutta percha broken and the conductor exposed to the sea but still intact (Fig.3).

Let the resistance to the fault from A be x

the fault resistance be z

and the resistance from the fault ~~from the fault~~ to the other shore end be y.

In fig.2 station A would measure the resistance to the fault as x+z. From the original resistance measurement the resistance was found to be R for the length L nautical miles, of the cable. So that the distance to the fault was R nautical miles.

$$\frac{R}{x + z}$$

It was assumed that z was very small, but was soon found to be more complex than at first thought. With the broken end of the cable in the sea a simple battery was formed, made up of the copper (conductor), the iron (armouring), and the electrolyte (sea wa

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APP.3.

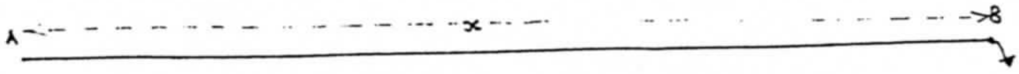


FIG. 1.

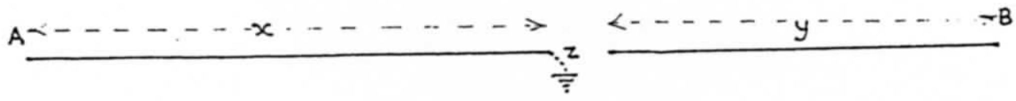


FIG. 2.

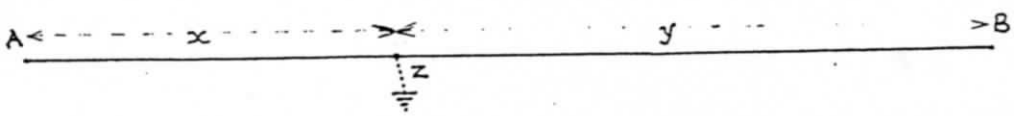


FIG. 3.

THREE POSSIBLE CABLE CONDITIONS DESCRIBED IN APPENDIX. 9.

). From this simple battery it was possible to measure the electri current flow at the shore testing station. At the broken end in th sea the conductor soon became coated with substances of varyin conductivity causing an increase in the fault resistance z to such a extent that it could not be ignored.

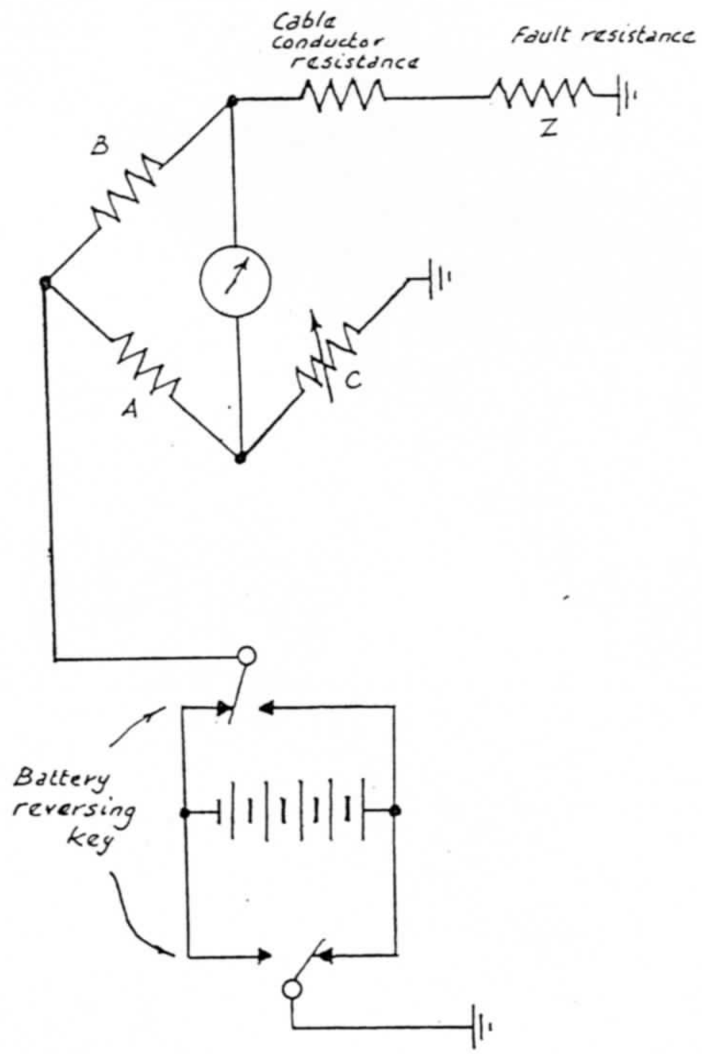
Mr. Lumsden, the Electrician to the Electric an International Telegraph Company (and after 1870, the Submarin Superintendent to the Post Office) devised a method of overcomin this problem. It was called " Lumsden's Polar Test", and the apparatu is shown in fig 4. An electric current opposing the flow from that the fault was applied, this cleared the deposit of salts and the fau resistance droped to a low point when the cable conductor was clea after this the resistance increased again due to the formation hydrogen bubbles over the conductor.

From fig 5 it can be seen that if resistance A equal that B, then by varying C the change in the fault resistance will be fou by trying to keep the galvanomter on the zero point. When the lowe possible value of resistance C has been obtained then that will equal to the conductor resistance to the fault position.

This Test was replaced in later years by more complex test Other factors had to be taken into account, such as the temperature the sea at the time the cable was aid and again at the time of t fault, they were taken at the same depth as the cable lay. Any ear currents flowing at the time of testing also had to be allowed for.

When a battery was first connected to the cable conductor the current flowed at a high rate for a short time then slowly reduces. In effect the cable appears as a large capacitance which has to be fully charged before a steady current will flow to the distant end. This surge of current will damage the testing galvanometer and ~~they~~ it ~~were~~ was only switched into circuit when the current was low enough to be used safely. For a perfect cable, the resistence of that cable multiplied by its absolute capacity in Farads (C x R or C.R) will give the approximate time in seconds to allow for charging. So for a broken cable the resistance to the fault had first to be found approximately and the [illegible] capacity to the fault estimated then the CR calculated to allow for the charging up the cable to the fault. After this the sensitivty of the testing galvanometer could be increased by reducing its shunt resistence to give a more accurate test.

In the present day and age it is not always realised that over a hundred years ago the cable company Electricians had to find their own solutions to faults and devise their own tests to account for factors not met with or understood before. Indeed we owe a great deal to these dedicated men who advanced the knowledge of basic electricity when testing the telegraph circuits.



LUMSDEN'S POLAR TEST

FIG. 5

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