by the disk, for any difference in speed between nut and screw will cause the nut to move along the screw until the diameter of the cone is reached which fulfils the above conditions for equality in speed. In fig. 11 the edge of the disk serves as the pointer an<l the scale gives the percentage of slack, or (*N*—*n)∕n.* The wire being paid out without slack measures the actual distance and speed over the ground, and the engineer in charge is relieved of all anxiety in estimating the depth from the scattered soundings of the pre­liminary survey, or in calculating the retarding strain required to produce the specified slack, since the brakesman merely has to follow the indications of the instrument and regulate the strain so as to keep the pointer at the figure required—an easy task, seeing that the ratio of speed of wire and cable is not affected by the motion of the ship, whatever be the state of the sea, whereas the strain will in heavy weather be varying 50 per cent. or more on each side of the mean value. Further, the preliminary survey over the proposed route, necessary for deciding the length and types of cable required, can afford merely an approximation to the depth in which the cable actually lies, since accidents of wind and weather, or lack of observations for determining the position, cause deviations, often of considerable importance, from the proposed route. From the continuous records of slack and strain combined with the weight of the cable it is a simple matter to calculate and plot the depths along the whole route of the cable as actually laid. Fig. 12, compiled from the actual records obtained during the laying of the Canso-Fayal section of the Commercial Cable Company's system, shows by the full line the actual strain recorded which secured the even distribution of 8 per cent. of slack, and by the dotted line the strain that would have been applied if the soundings taken during the preliminary survey had been the only source available, although the conditions of sea and weather favoured close adherence to the proposed route. The ordinates of the curve give the strain in cwts., and the abscissae the distance in miles measured from the Canso end; as the strain is proportional to the depth, 18 cwts. corresponding to 1000 fathoms, the black line represents to an exaggerated scale the contour of the sea bed.

Owing to the experience gained with many thousands of miles of cable in all depths and under varying conditions of weather and climate, the risk, and consequently the cost, of laying has been greatly reduced. But the cost of effecting a repair still remains a very uncertain quantity, success being de­pendent on quiet conditions of sea and weather. The *modus operandi* is briefly as follows: The position of the fracture is determined by electrical tests from both ends, with more or less accuracy, depending on the nature of the fracture, but with a probable error not exceeding a few miles. The steamer on reach­ing the given position lowers one, or perhaps two, mark buoys, mooring them by mushroom anchor, chain and rope. Using these buoys to guide the direction of tow, a grapnel, a species of five­pronged anchor, attached to a strong compound rope formed of strands of steel and manila, is lowered to the bottom and dragged at a slow speed, as it were ploughing a furrow in the sea bottom, in a line at right angles to the cable route, until the behaviour of the dynamometer shows that the cable is hooked. The ship is then stopped, and the cable gradually hove up towards the surface; but in deep water, unless it has been caught near a loose end, the cable will break on the grapnel before it reaches the surface, as the catenary strain on the bight will be greater than it will stand. Another buoy is put down marking this position, fixing at the same time the actual line of the cable. Grappling will be recommenced so as to hook the cable near enough to the end to allow of its being hove to the surface. When this has been done an electrical test is applied, and if the original fracture is between ship and shore the heaving in of cable will continue until the end comes on board. Another buoy is then lowered to mark this spot, and the cable on the other side of the fracture grappled for, brought to the surface, and, if communication is found perfect with the shore, buoyed with sufficient chain and rope attached to allow of the cable itself reaching the bottom. The ship now returns to the position of original attack, and by similar operations brings on board the end which secures communication with the other shore. The gap be­tween the two ends has now to be closed by splicing on new cable and paying out until the buoyed end is reached, which is then hove up and brought on board. After the "final splice,” as it is termed, between these ends has been made, the bight, made fast to a slip rope, is lowered overboard, the slip rope cut, and the cable allowed to sink by its own weight to its resting-place on the sea bed. The repair being thus completed, the various mark buoys are picked up, and the ship returns to her usual station.

The grappling of the cable and raising it to the surface from a depth, of 2000 fathoms seldom occupy less than twenty-four hours, and since any extra strain due to the pitching of the vessel must be avoided, it is clear that the state of the sea and weather is the predominating factor in the time necessary for effecting the long series of operations which, in the most favourable circumstances, are required for a repair. In addition, the intervention of very heavy weather may mar all the work already accomplished, and require the whole series of operations to be undertaken de *novo.* As to cost, one transatlantic cable repair cost £75,000; the repair of the Aden-Bombay cable, broken in a depth of 1900 fathoms, was effected with the expenditure of 176 miles of new cable, and after a lapse of 251 days, 103 being spent in actual work, which for the remainder of the time was interrupted by the monsoon; a repair of the Lisbon-Porthcurnow cable, broken in the Bay of Biscay in 2700 fathoms, eleven years after the cable was laid, took 215 days, with an expenditure of 300 miles of cable. All inter­ruptions are not so costly, for in shallower waters, with favourable conditions of weather, a repair may be only a matter of a few hours, and it is in such waters that the majority of breaks occur, but still a large reserve fund must be laid aside for this purpose. As an ordinary instance, it has been stated that the cost of repairing the Direct United States cable up to 1900 from its submergence in 1874 averaged £8000 per annum. Nearly all the cable companies possess their own steamers, of sufficient dimensions and specially equipped for making ordinary repairs; but for exceptional cases, where a considerable quantity of new cable may have to be inserted, it may be necessary to charter the services of one of the larger vessels owned by a cable-manufacturing company, at a certain sum per day, which may well reach £200 to £300. This fleet of cable ships now numbers over forty, ranging in size from vessels of 300 tons to 10,000 tons carrying capacity.

The life of a cable is usually considered to continue until it is no longer capable of being lifted for repair, but in some cases the duration and frequency of interruptions as affecting public convenience, with the loss of revenue and cost of repairs, must together decide the question of either making very extensive renewals or even abandoning the whole cable. The possibility of repair is affected by so many circumstances due to the environment of the cable, that not even an approximate term of years has yet been authoritatively fixed. It is a well-ascertained fact that the insulator, gutta-percha, is, when kept under water, practically imperishable, so that it is only the original strength of the sheathing wires and the deterioration allowable in them that have to be considered. Cables have frequently been picked up showing after many years of submergence no appreciable deteriora­tion in this respect, while in other cases ends have been picked up which in the course of twelve years had been corroded to needle points, the result probably of metalliferous deposits in the locality. It is scarcely possible from the preliminary survey, with soundings several miles apart, to obtain more than a general idea as to the average depth along the route, while the nature of the constituents of the sea bed can only be revealed by a few small specimens brought up at isolated spots, though fortunately the globigerine ooze which covers the bottom at all the greater ocean depths forms an ideal bed for the cable. The experience gained in the earlier days of ocean telegraphy, from the failure and abandonment of nearly 50 per cent. of the deep-sea cables within the first twelve years, placed the probable life of a cable as low as fifteen years, but the weeding out of unserviceable types of construction, and the general improvement in materials, have by degrees extended that first estimate, until now the limit may be safely placed at not less than forty vears. In depths beyond the reach of wave motion, and apart from suspension across a submarine gully, which will sooner or later result in a rupture of the cable, the most frequent cause of interruption is seismic or other shifting of the ocean bed, while in shallower waters and near the shore the dragging of anchors or