fishing trawls has been mostly responsible. Since by international agreement the wilful damage of a cable has been constituted a criminal offence, and the cable companies have avoided crossing the fishing banks, or have adopted the wise policy of refunding the value of anchors lost on their cables, the number of such fractures has greatly diminished.

*Instruments for Land Telegraphy.—*At small country towns or villages, where the message traffic is light, the Wheatstone “A B C ” instrument is used. In this apparatus electric currents are generated by turning a handle (placed in front of the instrument), which is geared, in the instru­ments of the most recent pattern, to a Siemens shuttle armature placed between the two arms of a powerful horse­shoe permanent magnet. When one of *a* series of keys (each corresponding to a letter) arranged round a pointer is depressed, the motion of the pointer, which is geared to the shuttle arma­ture, is arrested on coming opposite that particular key, and the transmission of the currents to line is stopped, though the armature itself can continue to rotate. The depression of a second key causes the first key to be raised. The currents actuate a ratchet-wheel mechanism at the receiving station, whereby the hand on a small dial is moved on letter by letter. A noticeable feature in the modern ABC indicator, as well as in all modern forms of telegraph instruments, is the adoption of “ induced ” magnets in the moving portion of the apparatus. A small permanent magnet is always liable to become demagnet­ized, or have its polarity reversed by the action of lightning. This liability is overcome by making such movable parts as require to be magnetic of soft iron, and magnetizing them by the inducing action of a strong permanent magnet. Although formerly in very extensive employment, this instrument is dropping out of use and the “ sounder ” (and in many cases the telephone) is being used in its place.

At offices where the work is heavier than can be dealt with by the ABC apparatus, the “ Single Needle ” instrument has been very largely employed; it has the advantage of slight liability to derangement, and of requiring very little adjustment. A fairly skilled operator can signal with it at the rate of 20 words per minute. The needle (in the modern pattern) is of soft iron, and is kept magnetized in­ductively by the action of two permanent steel magnets. The coils are wound with copper wire (covered with silk), 10 mils. in diameter, to a total resistance of 200 ohms. The actual current required to work the instrument is 3∙3 milliamperes (equivalent approximately to the current given by 1 Daniell cell through 3300 ohms), but in practice a current of 10 milliamperes is allowed. A simple, but important, addition to enable the reading from the instrument to be effected by sound is shown in fig. 13; in this arrangement the needle strikes against small tubes formed of tin-plate. Although a most serviceable instrument and cheap as regards main­tenance, the “ single needle ” has (except for railway telegraph purposes) been discarded in favour of the “ sounder,” to secure the advantage of using one general pattern of apparatus, as far as possible, and to avoid the necessity of two different types of instrument being learnt by the telegraphist.

The well-known code of signals (fig. 14) introduced by Morse is still employed in the United States and Canada, and the international code in vogue in Europe differs only slightly from it.

The instruments used for land tele­graphs on this system are of two types—“ sounders," which indi­cate by sound, and “ recorders,” which record the signals.

Recorders vary in details of construction, but all have the same object, namely, to record the intervals during which the current is applied to the line. In the earlier forms of instrument the record was made by embossing lines on a ribbon of paper by means of a sharp style fixed to one end of a lever, which carried at the other end the armature of an electromagnet. The form of Morse recorder almost universally used in Europe makes the record in ink, and hence is sometimes called the “ink-writer.” This method has the advantage of distinctness, and so is less trying to the eyes of the operators. Although the "ink-writer ” is still in use it is practically an obsolete instrument, and has been displaced by the “ sounder.”

Operators who used the recorder soon learned to read the message by the click of the armature against its stop, and as this left the hands and eyes free to write, reading by sound was usually preferred. Thus, when it is not necessary to keep a copy, a much simpler instrument may be employed and the message read by sound. The earliest successful form was “ Bright’s bell ” sounder, which consisted of two bells of distinct tone or pitch, one of which was sounded when the current was sent in one direction and the other when it was reversed. This instrument was capable of giving very considerable speed, but it was more complicated than that now in use, which consists only of an electro­magnet, with its armature lever arranged to stop against an anvil or screw in such a way as to give a distinct and somewhat loud sound. Dots and dashes are distinguished by the interval between the sounds of the instrument in precisely the same way as they are distinguished when reading from the recorder by sound. Fig. 15 shows the modern pattern of “sounder” as used by the

British Post Office. The magnet is wound to a resistance of 40 ohms (or 900 ohms when worked from accumulators), and the instrument is worked with a current of 400 milliamperes (25 milli­amperes with accumulators).

*Methods of Working Land Circuits.—*The arrangement on the “ open-circuit ” system for single-current working is shown in fig. 16, in which L1 represents the line, G a galvanometer, used simply to show that the currents are going to line when the message is being transmitted, K the trans­mitting key, B the battery, I the receiving instrument, and E the earth-plate. The complete circuit is from the plate E through the instrument I, the key K, and the galvanoscope G to the line L1, then through the corresponding instruments to the earth-plate E at the other end, and back through the earth to the plate E. The earth is always, except for some special reason, used as a return, because it offers little resistance and saves the expense and the risk of failure of the return wire. The earth-plate E ought to be buried in moist earth or in water. In towns the water and gas pipe systems form excellent earth