The automatic curb sender was originally designed by Lord Kelvin for the purpose of diminishing the effect of inductive re­tardation in long cables. In ordinary hand-sending the end of the cable is put to one or the other pole of the battery and to earth alternately, the relative time during which it is to battery and to earth depending to a great extent on the operator. By the automatic curb sender the cable is put to one or the other pole of the battery and then to the reverse pole for definite proportionate times during each signal. The cable is thus charged first positively and then negatively, or *vice versa,* for each signal. Owing to the difficulty of maintaining perfect balance on duplexed cables, curb sending is not now used, but the signals arc transmitted by means of an apparatus similar to the Wheatstone automatic transmitter used on land lines and differing from the latter only in regard to the alphabet employed; the signals from the transmitter actuate a relay having heavy armatures which in turn transmit the signals to the cable; this arrangement gives very firm signals, a point of great importance for good working. The actual speed or rate of signalling is given approximately by the formula, S = 120/ (KR), where S is the number of words per minute, R the total resistance of the conductor in ohms, and K the total capacity in farads. The speed of a cable is given in words per minute, the conventional number of five letters per word being understood, though in actual practice, owing to the extensive use of special codes, the number of letters per word is really between eight and nine; and this forms a considerable factor in lowering the earning capacity of a cable.

A relay capable of working at the end of a long cable has long been a desideratum. The difficulty experienced is that of securing a good electrical contact under the very slight pressure obtainable from an instrument excited by attenuated arrival-currents. In an instrument invented by S. G. Brown (Brit. Pat. 1434 of 1899) it is sought to overcome this difficulty by causing the point of a contact-arm, representing the siphon in the ordinary form of recorder, to traverse the cylindrical surface of a rapidly rotating drum. This surface is divided into two parallel halves by a short insulating space on which the arm normally rests, so that two separate conducting surfaces are provided, with either one of which the arm will make contact in its excursions in one direction or the other from the central position, the direction and duration of contact being governed by the motion of the suspended coil. The great reduction in friction and in electrical resistance of the contact thus effected between the recurved end of the arm and the rotating surface secures the transmission of signals at such a high rate of speed that the combination of this relay with a special form of curb sender allows of the re-transmission of signals into a second cable at a speed not less than that of the siphon recorder worked in the usual way. The special form of curb sender mentioned, termed the “ Interpolator,” has been devised so as to secure the correct re-transmission of any given number of consecutive ele­ments of a letter which are of the same sign, for when signals are received at the end of a long cable the relay arm will not return to its zero position between consecutive elements of the same sign, but will remain on the respective contact surface during the whole time occupied by such consecutive elements. The instrument consists of two cams, the form of which regulates the components of the curbed signal, one cam being for the dot element and the other for the dash element, which by their sequence give the letter signals; these cams, by means of clutches controlled by the relay, are mechanically rotated by clockwork, the speed of rotation being approximately adjusted to the rate of transmission of a single element, so that the requisite number of consecutive elements is transmitted corresponding to the duration of contact of the relay arm with the side controlling that particular element. By a modi­fication of this apparatus the message, instead of being immedi­ately re-transmitted into the second cable, can be punched on a paper slip, which can be inserted in the usual way into an auto­matic transmitter, so as to send either cable or Morse signals. Fig. 34 shows the effect of the interpolator in dissecting the con­secutive elements of any letter combination. Another instrument (see Brit. Pat. No. 18,261 of 1898) is what may be termed a magnifier, since signals so small as to be almost unreadable on direct record are rendered perfectly legible. The recorder coil is connected mechanically to a second similar coil, which is suspended between the poles of a laminated magnet, so that the motions of the two are similar. This magnet is excited by an alternating current, and the current induced in the second coil is after rectification sent through an ordinary siphon recorder. As the direction and intensity of this induced current are a function of the position of the second coil in its field, and as this position is determined by its mechanical connexion with the recorder coil, it is evident that, by a suitable choice of the electrical elements of the second coil and its alter­nating field, the indications on the siphon recorder can be magnified to any reasonable extent.

By means of a “ magnetic shunt” Brown succeeded in increasing the working speed of long submarine cables to the extent of 10 to 15 per cent. The magnetic shunt (which is connected across the receiving instrument) consists of a low resist­ance coil of some 2000 turns of insulated copper wire, enclosed in a laminated iron circuit, and connected at intervals to a number of terminals so that equal increments of inductance may be obtained. The use of the iron core renders it possible to produce a high inductive effect with a low resistance coil, and thus obtain the necessary slow time constant to which is due the success of this type of magnetic shunt on cable signals. The shunts usually em­ployed with the drum relay (referred to above) have each a resistance of about 30 ohms and an inductance of 20, 30 and 40 henrys re­spectively. The explanation of the action of the shunt is that all slowly varying currents affect the coil of the receiving instrument and its shunt in inverse proportion to their respective resistances; whereas with the comparatively rapid variations of current used in signalling the coil is forced at the beginning of each element of a signal to take *more,* and at the end of the element *less* of the total arrival current from the cable than would traverse it if the shunt were non-inductive.

For duplex working a “ magnetic bridge ” is used. This con­sists of a low resistance coil of copper wire enclosed in a laminated iron circuit similar to the magnetic shunt already de­scribed. The coil, however, is arranged so that the sending current enters an adjustable mid-point in the coil and passes through the two halves of the winding to the ends connected to the cable and artificial line respectively. The receiving instrument is joined up across these ends in the usual manner. The action of this bridge resembles the magnetic shunt in its effect on the received signals, as the direction of the winding is the same throughout its length, and. thus the full inductive action is pro­duced for curbing purposes. To the sending currents, however, the bridge offers only apparent ohmic resistance due to the fact that the current entering the mid-point of the winding flows through the two halves or arms in opposite direction, and, owing to the winding being on the same iron core, the mutual inductive effect of the two arms on one another neutralizes the. self-induction to the sending currents. The average total inductive value of these bridges to received signals is about 40 henrys, and the coil is so arranged that the arms contain three sections or blocks of winding each, two of which are joined up to strap connexions, and the