

each one, more attention is directed towards reducing the cost at the offices for which there are other kinds of apparatus somewhat more suitable.

It was said that the instruments working in the Berlin Telegraph-office gave good results, but that the cost of maintenance was high, the principal trouble occurring in the automatic typewriter. This was a recognized difficulty wherever the instrument was used until the inventor devised a specially strong typewriter, which it is claimed is proving to be quite satisfactory.

In the Central Telegraph-office, London, the Creed instrument was seen working upon two circuits to Newcastle. They have them working also upon the Edinburgh circuit. At the transmitting end of a circuit upon which these instruments are used the usual Wheatstone automatic apparatus and methods are employed. The messages are perforated either by the manual methods or by the use of the typewriter keyboard appliances, such as the Gell, that have been devised for that purpose. At the receiving end the signals, which can be received in the ordinary way on tape if desired, are made to work the Creed apparatus, which produces in perforated tape an exact copy of the perforated tape that was used at the despatching end of the circuit. The Creed machine is purely mechanical. The mechanism provides for actuating punches under the control of the line signals, for moving the receiving tape forward at a uniform speed, and for momentarily holding the tape during the act of punching and then promptly releasing it. Compressed air is employed for working the tappers that perforate the tape. The air-pressure is about 30 lb. to the square inch. The receiving relay has no local circuit. Its tongue is fitted with a light extension which opens and closes air-valves so that a piston is made to move from side to side. This movement operates rocking-levers, which control other similar valves. These admit more power to a piston, which also moves to and fro. This piston has levers attached, associated with which are steel strikers which cause the punches to perforate the tape. A small motor of about one-sixteenth of a horse-power is used to drive the paper-feed wheel. The current required for the relay is about 15 to 20 milliamperes. Tape has been perforated by this machine at 200 words a minute, but 100 to 120 words is nearer the actual working-rate. In some cases this re-perforated tape is passed away to another position for retransmission of the message to another station. This has been referred to as being done at Manchester. More usually the tape is passed through a Creed printer, so that a second tape which is running becomes marked with the message in roman characters. This printing is done at about 100 words a minute, although a higher speed of 135 words is claimed for it. The tape is gummed to message forms as it issues from the machine. An operator can gum these messages at rates varying, according to skill, from 150 to 200 messages an hour. A message is usually considered as consisting, on the average, of twenty words, including address and signature. The action of the printer is involved. The result, however, is that the perforated tape is fed forward by a star wheel rotated as required by the movement of a rack. There are selecting-needles which penetrate the perforations and control space-levers, so that any one of ten slide-valve plates can be made to occupy a certain position relatively to the others. The slide-valve plates are of steel, are thin, and fit closely to each other. They are each bored with numerous openings. Compressed air enters at the bottom of these plates, and according to the movement of any plate an opening is provided to a particular cylinder in which is a piston which operates a type-bar lever. Each combination of the plates admits air to a different cylinder, so that the printing-apparatus is under the control of the perforated tape.

For long submarine cable purposes Creed has arranged what is termed a "telegraph translator." It is a mechanical instrument. As is well known, long cables are worked by equal positive and negative impulses, so that when tape is used the positive currents are arranged for on one side of the feed-holes and the negative currents on the other. The received Wheatstone tape, being useless for cable purposes, is passed through the translator, and another tape is produced perforated so as to be suitable for passing to the cable the impulses in proper order. This second perforation can be done at the same speed as the first.

Cable work has to be performed with marked freedom from error. One cable company in London that was visited informed me that the Wheatstone transmitter, through which tape was being passed, was working into a circuit in which were two repeaters to the Atlantic cable-station in Ireland, where a Creed instrument was receiving the messages as perforated tape, and translating that into tape suitable for the cable. The messages reached the American end, therefore, without the delay that is unavoidable when they have to be written up and either perforated by hand or sent into the cable by hand at the originating end. This was said to give entirely satisfactory results, and the company had three circuits to Ireland so equipped.

Another cable company operating across the North Sea, and serving Russia, Denmark, Sweden, and Norway, was using Creed apparatus in its London office and at Newcastle, which was the terminus of the cable and of the land line in England. This company had two sets, one or the other being always working, and frequently both. A third set was kept as a standby in case of trouble arising. The circuits were being worked duplex at about eighty to ninety words a minute. One circuit, of 300 miles, was of iron overhead; the other, of 357 miles, 100 lb. copper underground. One man was attending to the receiver and gumming the messages, but when the flow of work is constant it is necessary to have two, as the speed mentioned implies about two hundred messages an hour. Three or four men were hand-perforating for each set. They can perforate up to eighty messages an hour. The messages average fifteen words.

The Creed was also being used at Newcastle, but not for translating purposes. The messages are tape-printed there as in London. This company had been using the Wheatstone receiver, and upon introducing the Creed apparatus found that they could reduce their staff practically by half. Perforating for the first transmission was done by hand. Men were seen perforating at fully twenty-five words a minute, and occasionally at a faster rate. They seemed to be well able to maintain the speed, and it was especially noticed how little time was lost. Typewriter key-