BAKEWELL'S ELECTRIC COPYING TELEGRAPH.

CHAPTER XXI.

Manipulation of the Electric Copying Telegraph of F. C. Bakewell of England—The Apparatus Described—Secrecy of Correspondence, its Advantages and Disadvantages.

MANIPULATION OF THE COPYING TELEGRAPH.

THERE have been many plans proposed for transmitting intelligence by electricity, and producing, at a given destination, a fac-simile of the writing presented at the sending station. The following seems to be the most practicable yet devised, and the inventor, Mr. F. C. Bakewell, of England, is confident that it will accomplish the great desideratum on lines of any length.

The copying telegraph transmits copies of the handwriting of correspondents. The advantages of this mode of transmission are, that the communications may be authenticated by the recognized signatures of the parties by whom they are sent. and as the writing received is traced from the original message, there can be no errors of transmission; for every letter and mark made with the pen is transferred exactly to the other instrument, however distant.

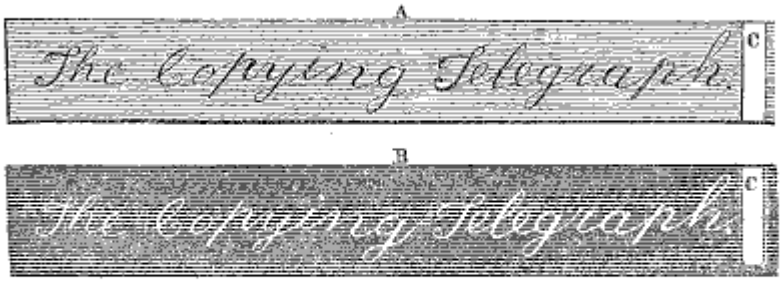
The electro-chemical mode of marking the paper, invented by Mr. Davy, is adopted in the copying process. The writing is copied on paper soaked in a solution of prussiate of potash and muriatic acid, a piece of steel wire serving for the pen. The paper is placed round a cylinder about six inches in diameter, and a steel wire, connected with the copper end of the voltaic battery, presses upon it, and is carried slowly along by a screw as the cylinder revolves. By this arrangement, when the voltaic current passes uninterruptedly from the wire through the paper to the cylinder which is connected with the zinc end of the battery, lines are drawn upon it at the same distance apart as the threads of the screw that carry the point. These

lines are in fact but one continuous spiral line, commencing at one end of the cylinder and ending at the other.

The communication to be transmitted is written on tin-foil, with a pen dipped in varnish. Thin sealing-wax varnish, made by dissolving sealing-wax in spirits of wine, answers the purpose best, as it dries very quickly. The letters thus written form on the conducting metal surface a number of non-conducting marks, sufficient to interrupt the electric current, though the deposit of resinous matter is so slight as not to be perceptible by the touch.

The message on tin-foil is fixed round a cylinder at the transmitting instrument, which instrument is a counterpart in its mechanical arrangements of the receiving one, and either of them may be used to transmit and receive messages. A metal style in connection with the voltaic battery presses on the tin-foil, and it is carried along by an endless screw as the cylinder revolves, exactly in the same manner as the steel wire that draws lines on the paper on the receiving instrument. The varnish writing, when it interposes between the style and the tin-foil, stops the electric current; consequently, at every part where the electric current is stopped by the varnish at one instrument, the steel wire ceases to make marks on the paper at the other station. Both instruments are so regulated that the cylinders rotate exactly together, therefore the successive breaks of the electric current by the varnish-letters cause corresponding gaps to be made in the lines on the paper; and the succession of these lines, with their successive gaps where the letters occur, produces on the paper of the receiving instrument the exact forms of the letters. The letters appear of a white or pale color on a ground of blue lines, there being about nine or ten lines drawn by the wire to make one line of writing. In the diagram, A shows the writing on tin-foil, from which the copy is made in the form shown at B.

Fig. 1.



It is essential to the correct working of the instruments that the cylinders should rotate exactly together. This synchronous movement of the two instruments is effected by means of regulating electro-magnets, aided by a "guide-line" on the transmitting cylinder.

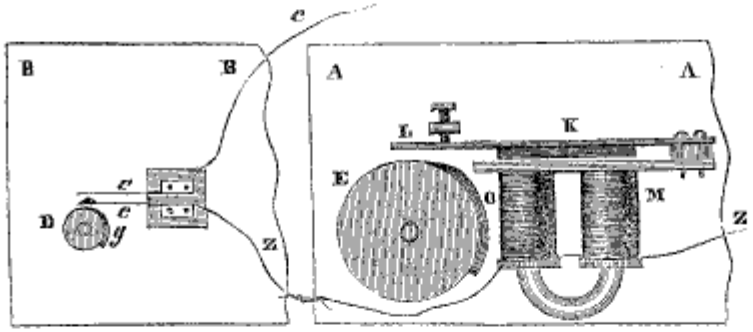
The moving power of each instrument is gravity, accelerated motion being prevented by a rapidly revolving fan, which produces a very steady movement of the cylinder. The speed may thus be very easily varied by adding or by taking off weight. The "guide-line" consists simply of a strip of paper pasted across the tin-foil at a right angle, as shown at c. That strip of paper effectually stops the electric current, and leaves a gap of equal breadth in each line drawn on the prepared paper of the receiving instrument. If the receiving instrument be moving at exactly the same speed as the transmitting one, these gaps in each line will be in the same relative positions, and will fall under each other on the receiving cylinder, making a broad white stripe corresponding with the strip of paper on the transmitting cylinder. But if the receiving cylinder be moving faster than the other, the gaps in the lines will not fall under one another, but every one will be farther toward the right hand. By noticing the position of these gaps on the paper, it may be seen exactly how much faster one instrument is going than the other, and weight may be taken off the receiving instrument until the gaps form a continuous stripe. In this manner the two instruments may be regulated to move together. It is immaterial at what distance apart they are; for if they be in the same room, or two hundred miles from each other, the same plan of adjustment must be adopted.

Supposing the mechanism of the instruments to be very good, and that there were no irregularities on the surfaces of the cylinders, the plan of regulating by means of the guide-line alone would be sufficient for the copying process. Legible writing may, indeed, be obtained in that manner, but not with sufficient accuracy and certainty to be depended on in ordinary working operations. To secure the requisite degree of accuracy and certainty, an electro-magnetic regulator is used. This may be brought into action by means of a second communicating wire, or by local action altogether; in the latter case a single wire only is required to work the copying telegraph. When two wires are employed, one of them is used for the electro-magnet that regulates the instruments, the other for transmitting the current that marks the paper by electro-chemical decomposition. The diagram will assist in explaining the mode

of regulating the instruments when a separate wire is used for that purpose.

THE APPARATUS DESCRIBED.

Fig. 2.



A side view only of the two instruments is given, without their stands or other mechanism than that which appears on the outside of each; the trains of wheels propelled by the weights being contained within the cheeks A A and B B, and the cylinders being on the opposite sides. The wheel D is fixed to the projecting arbor of a fast-moving wheel next to the fan, and it makes twelve revolutions to one of the cylinder. Two springs *e e*, insulated from the instruments by being mounted on wood, are connected by wires *c z* to the voltaic battery, and to the electro-magnet M on the other instrument. The other end of the coil of wire round the electro-magnet is fixed to the voltaic battery, so that when the two springs *e e* touch, the circuit of the battery is completed, and the electro-magnet is instantly brought into action. This occurs once every revolution of the wheel D, by the projecting part *g* pressing the two springs together. The wheel E on the instrument A is fixed on to the arbor of a wheel corresponding with that of D, and likewise makes twelve revolutions to one revolution of the cylinder.

The keeper K of the electro-magnet has an arm or lever L added to it, which reaches to the circumference of the wheel E, and, when the keeper is attracted by the magnet, rubs against a projecting part of the circumference O, and thus operates as a break to check the motion of the instrument. In regulating the instruments to rotate synchronously by these means, a heavier weight is put on A than on B, to cause it to rotate considerably faster than the other when the break is not applied. But when both instruments are set in motion, the lever being pulled down each time that the springs are pressed together by

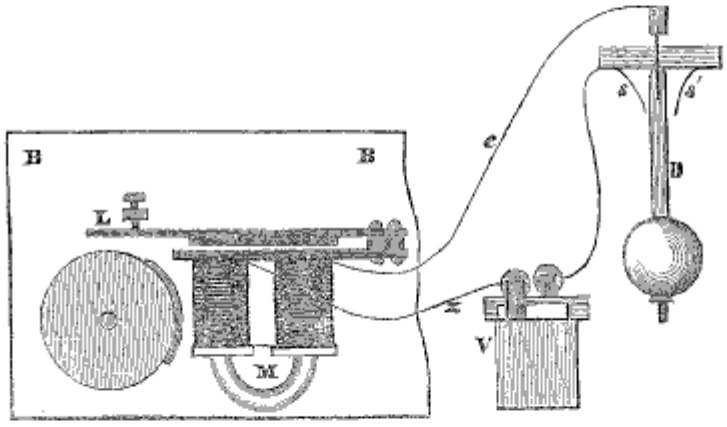
the wheel D, the break is thus put in operation just sufficiently to make the movements of the two instruments correspond. By this arrangement, it will be observed that one instrument regulates the other; and it has it under such complete control that if the speed of B be diminished, the movement of A will be retarded by the longer continued action of the break, and be made to rotate equally slowly, and even to stop by stopping the motion of B.

When the instruments are worked at a distance from each other, the electro-magnet M is put into action by a local battery, and the contact is made and broken by an intermediate small electro-magnet, as in Mr. Morse's telegraph. In that manner the copying telegraph has transmitted messages with perfect accuracy from Brighton to London.

When a single communicating wire only is used, the instruments are regulated independently of each other by means of pendulums. Clock-movements, with pendulums that beat four times in a second, are employed at each instrument. These pendulums at every vibration strike against springs, at each contact with which the electro-magnets which regulate the instruments are brought into action.

The arrangement of the mode of making and breaking contact by the pendulum will be easily understood by the diagram.

Fig. 3.



The pendulum D is connected by the wire *c* to the electro-magnet M. The springs *s s'* are connected with the voltaic battery V, from which a wire *z* connects with the other end of the coil of the electro-magnet. It will be evident, therefore, that when the rod of the pendulum vibrates against *s s'*, the voltaic circuit is completed through the magnet, which is

brought into action in regulating the instruments as rapidly as the pendulum beats.

The guide-line serves to indicate with the greatest accuracy whether the pendulums at two corresponding stations are beating together; for if one be vibrating faster than the other, the guide-line on the paper will be slanting instead of perpendicular; and by means of an adjusting screw to raise or lower the pendulum-bob, the two may be readily adjusted to beat together. In this manner a variation of even the thousandth part of a second may be observed and corrected.

It may probably be supposed, because the metal style has to pass over each line of writing nine or ten times to complete it, that the copying process must be necessarily slow; but it is, on the contrary, very rapid. A cylinder six inches in diameter will hold a length of paper on which one hundred letters of the alphabet may be written in a line. The cylinder revolves thirty times in a minute; and allowing ten revolutions to complete each line of writing, the rate of transmission is three hundred letters in a minute. Much greater speed than that has been obtained.

SECRECY OF CORRESPONDENCE.

One of the advantages which the copying process also possesses is the means it affords of maintaining the secrecy of correspondence. It is now customary for those who wish their communications not to be known to transmit messages in cipher, by which certain letters or figures have significations given to them which are only intelligible to the parties corresponding. This plan has the disadvantage of being liable to error, as the clerks are ignorant of the meaning of the symbols they transmit. By the copying telegraph the symbols made on the tin-foil are transmitted as accurately as if written in full, for no manipulation whatever is required, the effect being produced altogether by mechanism.

There is also a special mode of maintaining secrecy by transmitting the messages impressed on the paper invisibly. If the paper be moistened with diluted acid alone, the iron is deposited on the paper, but no mark whatever is visible, and the paper remains blank until it is brushed over with a solution of prussiate of potash, which instantly renders it legible. In this manner messages written with colorless varnish may be transmitted without any one seeing the contents; that part containing the name and address being alone rendered legible till the message is delivered to the person for whom it is intended.