A.D. 1848 . . . . . N° 12,352.

Electric Telegraphs.

BAKEWELL'S SPECIFICATION.

TO ALL TO WHOM THESE PRESENTS SHALL COME, I, FREDRICK COLLIER BAKEWELL, of Hampstead, in the County of Middlesex, Gentlemen, send greeting.

WHEREAS Her present most Excellent Majesty Queen Victoria, by Her Royal Letters Patent under the Great Seal of the United Kingdom of Great Britain and Ireland, bearing date at Westminster, the Second day of December, One thousand eight hundred and forty-eight, in the twelfth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto me, the said Frederick Collier Bakewell, my exors, admors, and assigns, Her especial licence, full power, sole privilege and authority, that, I, the said Frederick Collier Bakewell, my exors, admors, and assigns, or such others as I, the said Frederick Collier Bakewell, my exors, admors, or assigns, should at any time agree with, and no others, from time to time and at all times during the term of years therein expressed, should and lawfully might make, use, exercise, and vend, within England, Wales, and the Town of Berwick-upon-Tweed, my Invention of "IMPROVEMENTS IN MAKING COMMUNICATIONS FROM ONE PLACE TO ANOTHER BY MEANS OF ELECTRICITY;" in which said Letters Patent is contained a proviso, that I, the said Frederick Collier Bakewell, should cause a particular description of the nature of my said Invention, and in what manner the same is to be performed, by an instrument in writing under my hand and seal, to be inrolled in Her said Majesty's High Court of Chancery within six calendar months next and immediately after the date of the said in

part recited Letters Patent, as in and by the same, reference being thereunto had, will more fully and at large appear.

NOW KNOW YE, that in compliance with the said proviso, I, the said Frederick Collier Bakewell, do hereby declare that the nature of my said Invention, and the manner in which the same is to be performed, are fully described and ascertained in and by the following statement thereof, reference being had to the Drawings hereunto annexed, and to the figures and letters marked thereon, that is to say:—

My Invention consists, in the first place, of methods of producing by means of electricity copies of writing, of print, or of other characters, symbols, or designs, for the purpose of telegraphic communications; and, secondly, of modes of breaking and renewing the electric connections with distant stations.

To carry into effect the first part of my Invention, the instruments employed are made as exactly alike as possible, so as to impart equal and steady rotary motions to cylinders on each instrument. Motion is given to the instruments by weights, accellerated velocity being prevented by rapidly revolving fans. The weights are so adjusted in relation to the fans that the cylinder of each instrument shall rotate in equal times as nearly as possible. Parallel to the cylinders are screws which turn with the cylinders, and on those screws are traversing nuts. To those nuts arms are attached, at the end of each of which there is a metal style or point that presses on the cylinder, and is carried by the rotation of the screw from one end of the cylinder to the other in a given number of revolutions. On to the cylinder of one of the instruments the communication to be transmitted is placed. The message is written with varnish or other substance that will not conduct electricity, on tin foil or other conducting substance, or the tin foil may be coated with a non-conducting body, and the writing be traced upon it with a point so as to expose the metal. On to the cylinder of the corresponding instrument the paper to receive the message is fixed. This paper is thoroughly moistened with a solution which electricity will readily decompose, and thus a mark is produced on it whenever the electric circuit is completed. The solution may be of various kinds; but the one I prefer is a mixture of one-third part of muriatic acid, one-third part water, and one-third part of a saturated solution of prussiate of potass. Or the paper may be saturated with diluted acid alone; and after the message is impressed on it, it may be dipped in a weak solution of red ferrocyanate of potass, in which case the writing will be invisible until brought out by the ferrocyanate. When a solution of prussiate of potass, or of the red ferrocyanate is used, the marking point of

the receiving instrument should be of iron or steel, and it should be connected with the positive pole of the voltaic battery. The points carried by the traversing nuts are insulated from the other parts of the instruments, and are connected with one of the wires from a voltaic battery, the cylinders being in connection with the other wire, so that the electric circuit can be completed only by passing through the point to the cylinder of each instrument. By this arrangement, whenever the point of the transmitting instrument is pressing on the exposed tin foil, the circuit is completed through the moistened paper on the cylinder of the receiving instrument, and a mark is made on the paper; but when the point of the transmitting instrument is pressing on the varnish writing, the circuit is interrupted and the marking ceases. In this manner, as the corresponding cylinders rotate, spiral lines, very close together, are drawn by the point of the receiving instrument, excepting in those places where the electric circuit is interrupted by the varnish; and if both cylinders rotate exactly together, the point of the transmitting instrument by passing several times over different parts of the same letter will cause the marking point to produce the forms of the letters on the prepared paper. It is essential to the success of the process, that the cylinders of the corresponding instrument should move synchronously. To effect this, I employ electro-magnets to regulate the rotations of the cylinders at certain invervals.

In the mode I prefer of doing this, the electro-magnets are brought into action by the intervention of pendulums, which are actuated by clockwork. Each instrument has in connection with it a pendulum, an electro-magnet, and a separate voltaic battery, which may consist of one or two pairs of plates about six inches square. The wires connected with these batteries are so arranged, that the pendulums as they vibrate make and break the electric circuit and bring the electro-magnets into action once or oftener at each vibration. Having by this means set in action the electro-magnets at equal intervals of time, I employ their power as regulators of the continuous movements of the cylinders in the following methods:—To the keeper of each electro-magnet an arm or small bent lever is fixed, the end of which nearly touches the outer rim of the cylinder where the keeper is attracted to the magnet, and is lifted from it by a spring when the magnetic action ceases. On to the outer rim of the cylinder there are placed several small projections at exactly equal distances, which projections catch or rub against the end of the lever when it is drawn down by the magnet, but pass freely when it is raised. In working the instruments they are so weighted that the cylinders rotate in a small degree faster than the speed they are to be permitted to attain, by which means the projections on the rim of the cylinder touch the bent lever before

the electro-magnetic action ceases; and the movements of each cylinder are regulated to correspond by retarding the motion every time that the pendulums bring the electro-magnets into action. The regulating check should never be so great as to stop the movements of the instrument; to prevent which the ends of the bent levers or regulating detents should be slightly inclined to the projecting studs.

The arrangement of the magnetic regulators may be reversed by causing the ends of the levers to be pressed towards the rims of the cylinders by springs, and to be drawn back by the electro-magnets instead of employing the force of the magnets directly as the controlling power. Or, the regulation of the instruments may be effected by causing the levers to give accellerating impulses to the projections on the cylinders, in which case the instruments should be so weighted as to move rather more slowly than the resulting motion required. Another mode of applying the electro-magnetic regulator is to cause either of the corresponding instruments at certain intervals of its revolution to bring into action at the distant station an electro-magnet by means of a secondary circuit. The mode of bringing electro-magnets into action by a secondary circuit is more fully explained in the description of that part of my Invention which relates to the breaking and renewing of electric circuits; I prefer however the plan of regulating with the aid of pendulums, because they act independently and with certainty at any distance. In any of the modes of applying the magnetic regulator above described, it might be brought to bear on a wheel either higher up or lower in the train than the cylinder, if found desirable.

As a means of ascertaining whether the distant cylinders are moving synchronously, I place a strip of paper or other non-conducting substance on the cylinder of the transmitting instrument, and if the cylinders be moving accurately, a straight and perpendicular line is produced on the receiving cylinder, but if one instrument be moving faster than the other or irregularly, the line will be slanting or irregular. By means of this "guide line" the person in charge of the receiving instrument is enabled to regulate it exactly in accordance with the transmitting instrument by regulating the pendulum and adjusting the weight. To start the instruments at the same instant, I adopt the following method:—A small electro-magnet formed by numerous coils of very fine wire is brought into action by the electric current transmitted along the telegraphic wires. To the keeper of this magnet a small bent lever is attached, which bears against the fan of the receiving instrument and keeps it from revolving as long as the magnet is in action, but when the electric circuit is momentarily broken by the starting of the transmitting instrument, the keeper falls back, and the fan being released the receiving instrument is

set in motion. Instead of employing a piece of soft iron for the keeper of this electro-magnet, a small permanent magnet may be used, the poles of which should be so placed that when the electric current passes the electro-magnet shall repel the permanent one and liberate the fan. This arrangement for starting the instrument is also applicable for sounding an alarum. To copy print with these instruments a portion of the printers' ink may be transferred from the printed paper to tin foil by pressure, or the tin foil may be printed on directly from types. In copying small print or small writing the cylinder of the receiving instrument should be of greater diameter than that of the receiving instrument, and the thread of the screw for the traversing nut should be coarser in proportion, so as to produce a magnified copy of the original for greater distinctness.

Another arrangement for copying by means of electricity may be adopted, which consists in the use of several points instead of only one or two, as in the mode before described. When several points are used with only one conducting wire, the points are placed close together, yet insulated from each other, the range of points being sufficient to cover the depth of one or more lines of writing. Similar ranges of points press on the message to be transmitted, and on the paper of the receiving instrument, and the electricity is caused to pass through the points alternately in rapid succession at corresponding points, in such manner that they may transmit the electric current at the same instant. The ends of the wires connected with the points are inlaid in a disc of ivory in a circular form, and are so arranged that wire springs attached to one of the rapidly revolving wheels of the instrument pass over them in succession, and thus transmit the electric current through the wires alternately. The synchronous successive transmissions of electricity through corresponding points are attained, as in the preceding arrangements, by the regulating power of electro-magnets, brought into action at certain intervals. In this plan of copying with several points the rotation of the cylinder must be much slower than that of the screw with the traversing nut, so that the electric current may pass through the range of wires about four times in the formation of each letter in the series of lines of writing covered by the points.

The accompanying Drawings of the arrangement for the copying telegraph, from Figure II. to Figure IV. inclusive, are made to the scale of half an inch to an inch. Figure I. is on the scale of about one inch to one foot. The same letters refer to the same parts in each.

Figure 1 is a front elevation of the copying telegraph (with a single point) mounted on its case; T is the frame containing the train of wheels for communicating motion to the cylinder C; P is the end of the arm, attached to the

traversing nut, with the point resting on the cylinder, the arm and screw being hidden from sight by the cylinder; M is the regulating electro-magnet; L, the bent lever, fixed to the keeper, which presses on the projecting studs on the wheel or disc R, which is here represented as fixed to the arbor of the cylinder, this plan being more convenient than having the projections placed on the rim of the cylinder, though either mode will answer equally; B is the pendulum, moved by clockwork, which makes and breaks the electric circuit of the voltaic battery v^1 to bring into action the magnet M. The starting magnet *m* is placed near the fan F; V^1, V^2, V^3, are the voltaic battery and connecting wires for the long circuit; v^1, v^2, v^3, v^4, are the quantity battery and wires connected with the regulating electro-magnet; A is the supporting case; and W, the weight.

Figure II. is a plan of the instrument; D is a small drum to wind up the weight. The cord passes over a pulley O, and is not fixed to the drum, but is wound round it a few turns, the cord being kept stretched by a small counterpoise. The object of this arrangement (which is more clearly shown in Figure VI.) is to confine the propelling action of the weight to the middle of the drum; but this is not essential to the correct working of the instrument; and an ordinary clock pulley is represented in Figure I. S is the screw, on which the nut N traverses, carrying the arm H and the point P. The thread of the screw must be proportioned to the size of the writing intended to be copied, as it should carry the point at least six or seven times over each letter, to bring out the form of the letters distinctly; M is the regulating magnet; J, the stand to which it is fixed; K, the keeper; L, the bent lever; E, E, the projections, against which the end of the lever rubs; G, G, are cog wheels, for giving motion to the cylinder C. The fan F should offer considerable resistance to the air, so as to increase the steadiness of the motion, which may be regulated to the rate of thirty revolutions of the cylinder per minute (though a much greater velocity is attainable); *m* is the starting magnet; and *r*, the bent lever which presses against the fan, and falls back when the corresponding instrument starts. It is desirable to connect the instrument with the wire V^3 as soon as it is started, to avoid resistance to the electric current in passing through the wire of the magnet *m*.

Figure III. represents the positions of the regulating electro-magnet and lever and the projecting studs, which are here shewn placed on the rim of the cylinder. J is the stand to which the electro-magnet is fixed; *u* is a spring to force back the keeper, when the electric circuit is broken, against the rest *t*, which should be moveable, so as to adjust the keeper within the striking distance of the magnet. The end of the lever should be made capable of being

adjusted at the proper angle to the projections E, E, and yet be quite firm. v^2, v^3, v^1, are the connecting wires of the voltaic battery for working the electro-magnet.

Figure IV. represents the instrument as seen behind, and shews more particularly the form of the bent lever L, and of the screw S, and transversing nut N.

Figure V. represents the plan of an arrangement for bringing the regulating electro-magnet into action by means of the pendulum. The letters *p*, *p*, show the back plate of the clockwork movement, to which plate ivory brackets *h*, *h*, are fixed, which project about an inch. B is a section of the pendulum rod, not far from the point of suspension, small pieces of platinum being fixed to each side, as indicated by the blue marks; *c*, *c*, are two small platinum wires joined to a cross wire *o*, which rests on indentures in the brackets, and slides very easily to either side; *n* is a wire of platinum, on which the wires *c*, *c*, rest, the wire *v* from one pole of the voltaic battery being connected with it; the wire from the other pole of the battery is connected with the clock plate. The pendulum B, being in metallic contact at its point of suspension with the plate *p*, when it strikes against either of the wires *c*, *c*, it completes the electric circuit of the voltaic battery through the wires *v*, *v*, and thus brings the electro-magnet into action at each vibration.

Figure VI. exhibits the positions of the drum, and the pulley for winding up the weight of the mechanism for propelling the cylinders of the copying instruments. D is the drum, round which the cord is twisted three or four times, and then it passes under the pulley *y*, being kept from slipping on the drum by the counterpoise *z*; O is the pulley over which the cord passes from the drum, the actuating weight being attached to the moveable pulley *x*.

Figure VII. is a plan of the arrangement for copying with several points. The positions of the cylinder and of the screw, with the traversing nut, are shewn reversed, and the cylinder, as will be observed, moves more slowly than the screw, the latter deriving its motion from a cog wheel attached to the arbor of the cylinder. On to the arbor of the wheel *b*, and outside of the frame T, another wheel *d* is fixed, which carries several wire springs *e*, *e*, two of which only are represented in the Drawing. The centre of this wheel is made of ivory, or other non-conducting substance, so as to insulate the wire springs from the instrument. The wires *a*, *a*, are conducted from the points, and are inlaid in an ivory disc, colored red, fixed to the frame of the instrument, so that the wire springs *e*, *e*, press against the ends of the wires in revolving. As the ivory disc insulates the wires from the instrument, the electric current passing through the wire V from the voltaic battery, is trans-

mitted by means of the spring wires *e*, *e*, through all the wires connected with the points in succession, and through the points to the cylinder. In the Drawing there are only seven wires shewn, the arrangement represented being for copying a single line of writing at each revolution of the cylinder. When the instrument is constructed for copying several lines during one revolution of the cylinder, the number of points must be increased, and the other arrangements must be made in accordance with the number of lines intended to be copied. The movement of the cylinder in that case being slower, and the regulating magnet being made to act on a wheel in the train moving faster than the cylinder.

The second part of my Invention, videlicet, that for breaking and renewing the electric circuits at distant stations is carried into effect by bringing into action at each station an electro-magnet, the keeper of which, when attracted, breaks the metallic connection between the instrument at that station and the earth, and throws the next station into circuit. In this manner the return circuit at each station in succession is broken until the place intended to be corresponded with is in electric connection with the transmitting station.

Figure VIII. represents an arrangement for breaking and renewing the circuits. The broken line A, A, A, A, colored dark red, is the main telegraph wire which connects all the stations on the line; N, N, N, N, are magnetic needles, one at each station, which are deflected by the primary current of electricity in A, A, either to the right hand or to the left, by reversing the connections with the poles of the voltaic battery in the usual manner. The dots *e*, *e*, on each side of the needles are the ends of platinum wires, against which the needles press when deflected. W^1, W^2, W^3, W^4, are wires from the small voltaic batteries V^1, V^2, V^3, V^4, each one consisting of one or two pairs of plates, which are connected with the electro-magnets M^1, M^2, M^3, M^4, and with the platinum wires. At each station a wire *h*, connected with A, A, is carried into the earth so as to form a return circuit, and in the branches from A to the earth, the telegraphic instruments E^1, E^2, E^3, E^4, are placed, and also small instruments T^1, T^2, T^3, T^4, actuated by clockwork, to make a revolution in three or more minutes, as may be found convenient. There are two pins *o*, *o* projecting from each of the wheels T^1, T^2, T^3, T^4, which catch against detents *d* fixed to the keeper of the magnets M^1, M^2, M^3, M^4. When either pin of the wheel rests on the detent, the connection between the wire A, A, and the earth is completed through the wires *p*, *p*, against which the springs *s*, *s*, press; but as soon as the detent is withdrawn and the wheel is set in motion the connection is broken, and it remains uninterrupted until the wheel has made half a revolution and the other pin rests upon the detent. Instead of using two

platinum wires in making the connection with the voltaic battery, the needle itself may be connected with the wire from one of the poles, and then it will complete the circuit by touching a single platinum wire connected with the other pole of the battery. This arrangement is shewn at the station marked B in Figure VIII. Though the magnetic needles are represented placed on the main line, they may be placed on the branch wire, by which arrangement the resistance of the coils of wire round them would be avoided at the more distant stations. To illustrate the practical operation of the plan, let L represent London, R, Rugby, C, Coventry, and B, Birmingham. If the operator in London wishes to communicate with Birmingham; he fixes the instrument T^1 to prevent it from turning, and then momentarily deflects the needle to the left hand. This movement completes the circuit of the small voltaic battery at Rugby, and brings into action the electro-magnet M^2, by which the detent is withdrawn, and the wheel T^2 being set in motion, the connection with the earth is broken at Rugby, and Coventry is placed in circuit. By repeating the operation Coventry is thrown out of circuit, and the communication with Birmingham is opened. Attention is then called at Birmingham by reversing the deflection of the needle, by which means another electro-magnet is brought into action, which withdraws the detent of an alarum. The operator at Birmingham then fixes the connections to prevent the circuit being broken by the further action of the needle, and he intimates, by a preconcerted symbol, that Birmingham is in circuit and is ready to receive the message. When two wires are used the arrangements of the connecting parts must be doubled, taking care that each wire is insulated from the other.

Figure IX. shews an arrangement for communicating with branch lines, so as to throw either branch into or out of circuit at the option of the operator at a distant station. The letters A, B, represent the main line of wire, and *y* the branch line. At the point of junction there must be placed an instrument T, nearly similar to the one before described, for breaking and renewing the circuit. The wire A is at all times in metallic connection with that instrument; therefore as either of the other wires B or Y is placed in metallic connection, the electric current is transmitted along that wire, and the connection with the other is cut off. When the instrument is resting on the detent *d*, the spring *a* attached to A presses on a rim of metal; the spring *b* attached to B presses on a metal stud in connection with A, and the spring y^1 attached to Y presses on an insulated wire which connects it with the earth through the spring y^2. In that position of the instrument the electric current passes along A, B, and is prevented from passing along Y. When the communication with Y is intended to be opened, the needle N is deflected to the right hand, or in a contrary

direction to that which breaks the other circuits. The instrument T being then put in motion by withdrawing the detent *d*, the spring *b* is shifted from the metallic stud, and presses on a rim of ivory or other non-conducting substance, and the spring *y* shifts from its insulated wire connected with the earth, and presses on metal connected at A, by which change of position Y is placed in circuit with A, and B is thrown out until the wheel T makes half a revolution, and rests again on the opposite pin. The shape of the pin which rests on the detent of this instrument is curved or sloping, in order that the detent may resume its hold on it within a limited time, and by the force of the spring *g*, push the instrument back to its original position. The object of this arrangement is to prevent the instrument from being set in motion when any of the needles on the line B beyond the point of junction are momentarily deflected to the right to sound an alarum. The instrument should be so regulated as to require a steady deflection of at least one second to free the pin from the detent. When two telegraph wires are used, the instruments at the junctions may be set in motion by the deflection of needles on the second wire. To enable any station on the branch Y to open a communication with A, there should be a connection between Y and the earth, which is cut off when the instrument is in motion.

Figure X shews an arrangement for effecting a communication between two branches and cutting off the connection with the main line. Two instruments T, U, are employed and the electric circuit is made through both when at rest. In the position represented, both instruments being stationary, the circuit is completed along A, B, but when they are both in motion the springs which are represented as pressing on metal (colored blue,) and on ivory (colored pink,) respectively shift on to ivory and metal, so that those which before conducted the electricity cut it off, and those which interrupted the circuit serve to complete it. In this manner A is cut off from the circuit which is completed through B, Y. To put either one or both instruments in motion, as required, the detent (or the pin which rests upon it) of the second instrument is made so curved that the instruments is not released from it by less than a steady deflection of two seconds. When at any place along the line B it is required to correspond with a station along Y, or the contrary, the needle is deflected steadily to the right-hand for two seconds and then the communication between the branches is opened until the instruments come to rest.

The copying telegraph affords peculiar facilities for the establishment of a system of transmission and delivery at regular times throughout the day, each station having its allotted times for receiving and transmitting communications from every other station on the line. In this manner transmissions and

deliveries might be arranged to take place every half hour if requisite, the intervals between each transmission being occupied in preparing the instrument with messages for the next despatch.

Having described my Invention, and the modes by which it may be carried into operation, I hereby claim,—

First, the general arrangements described and shewn in Figures I. to IV. and in Figure VII. for copying written or printed characters at a distance by means of electricity.

Second, the means described and shewn for obtaining synchronous continuous movements in distant instruments by the regulating agency of electro-magnets either with or without the application of pendulums.

Third, the use of previously concerted lines or marks in the transmitting instruments to serve as guides in regulating the corresponding instruments.

Fourth, the mode described of breaking the electric circuits at distant stations by means of local electro-magnets and local voltaic batteries broguht into action by the deflection of needles by the transmitting electric current, also the mode of renewing the circuits, by the mechanism described.

In witness whereof, I, the said Frederick Collier Bakewell, have hereunto set my hand and seal, this Second day of June, in the year of our Lord One thousand eight hundred and forty-nine.

FREDERICK COLLIER (L.S.) BAKEWELL.

AND BE IT REMEMBERED, that on the Second day of June, in the year of our Lord 1849, the aforesaid Frederick Collier Bakewell came before our said Lady the Queen in Her Chancery, and acknowledged the Specification aforesaid, and all and every thing therein contained and specified in form above written. And also the Specification aforesaid was stamped according to the tenor of the Statute made for that purpose.

Enrolled the Second day of June, in the year of our Lord One thousand eight hundred and forty-nine.

JEFFERSON.

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