

No. 728,254.

PATENTED MAY 19, 1903.

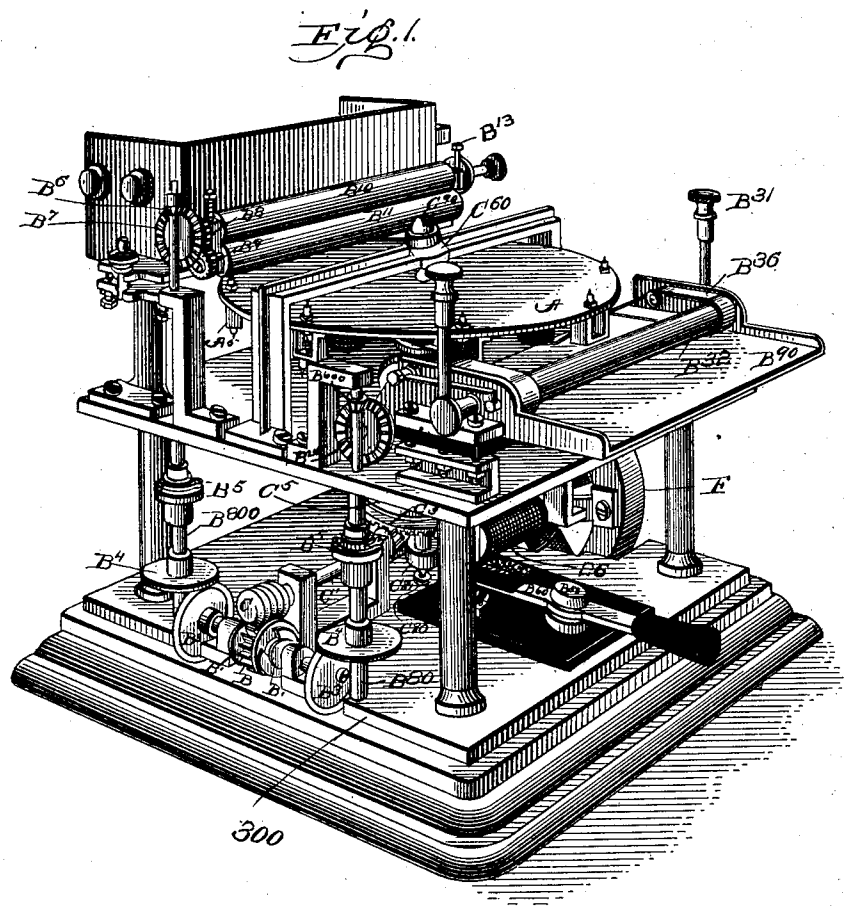
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

7 SHEETS—SHEET 1.



WITNESSES:
J. M. Fowler Jr.
F. T. Chapman.

INVENTORS:
Hans Liebreich,
John C. Francis
By *Lynn M. Smith*
Attorneys.

No. 728,254.

PATENTED MAY 19, 1903.

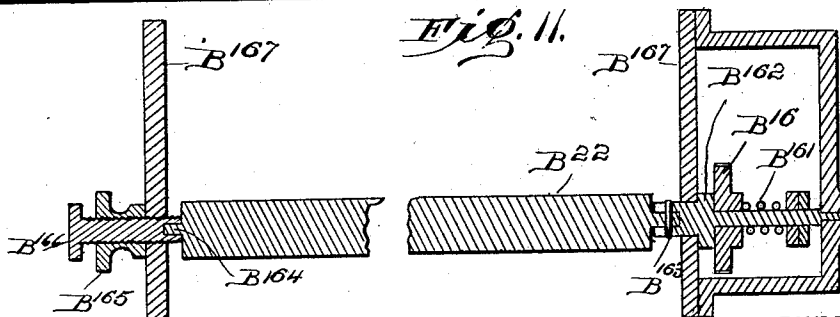
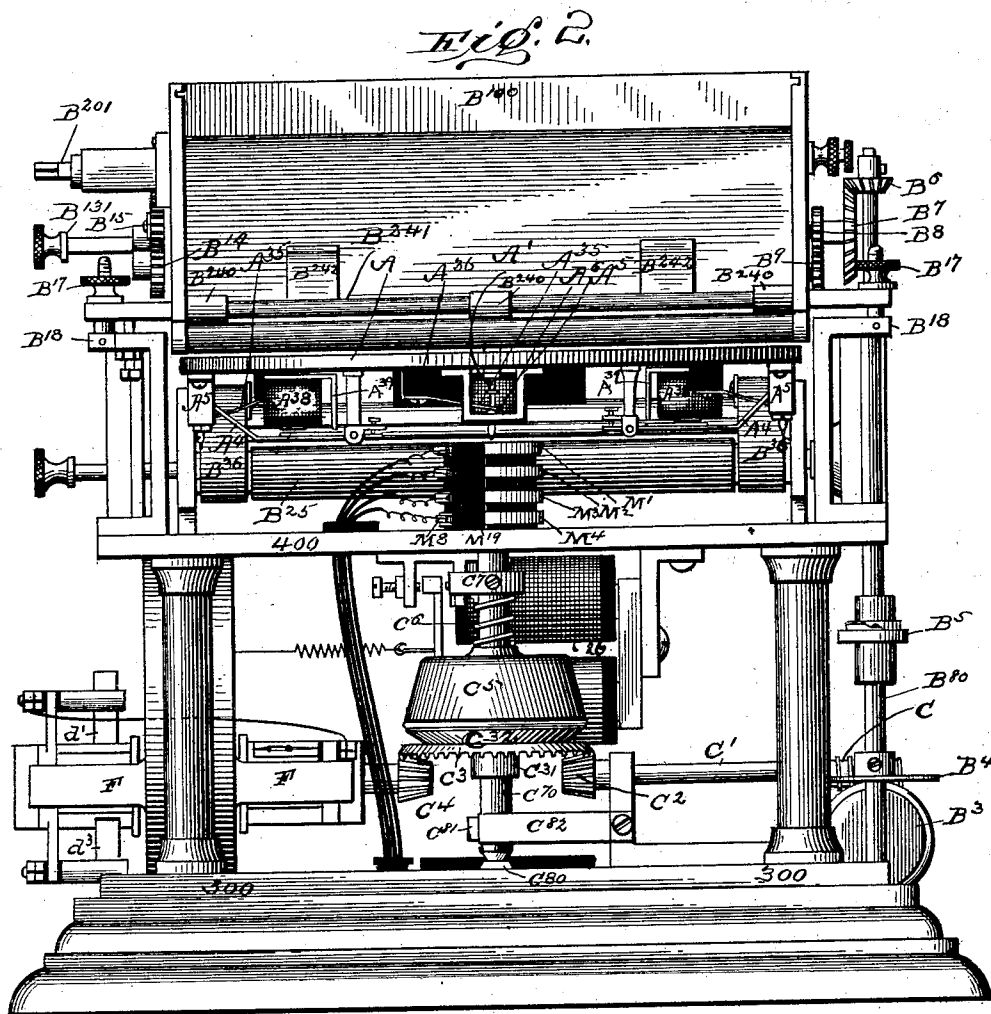
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

7 SHEETS—SHEET 2.



WITNESSES:
J. M. Fowler Jr.
F. J. Chapman.

INVENTORS
Hans Liebreich
John C. Francis
By *Lyon & Phipps*
Attorneys.

No. 728,254.

PATENTED MAY 19, 1903.

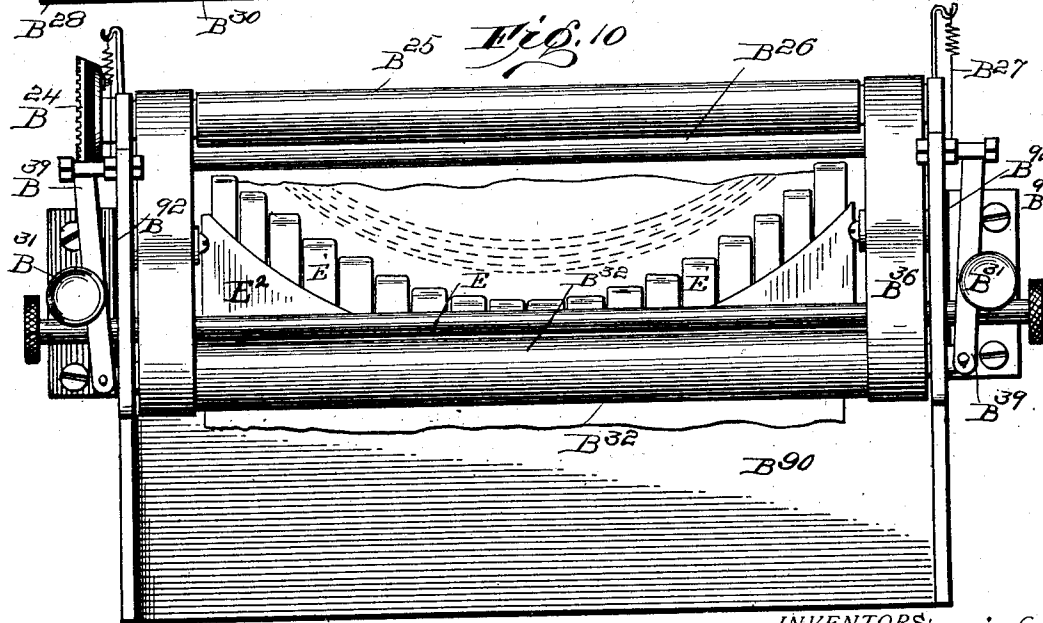
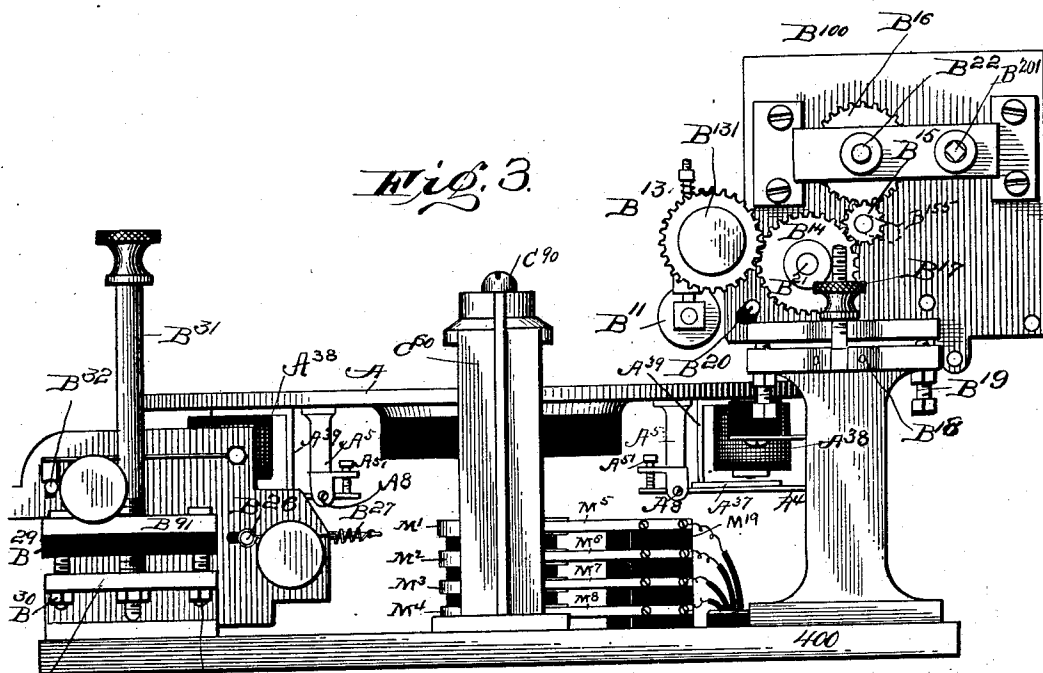
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

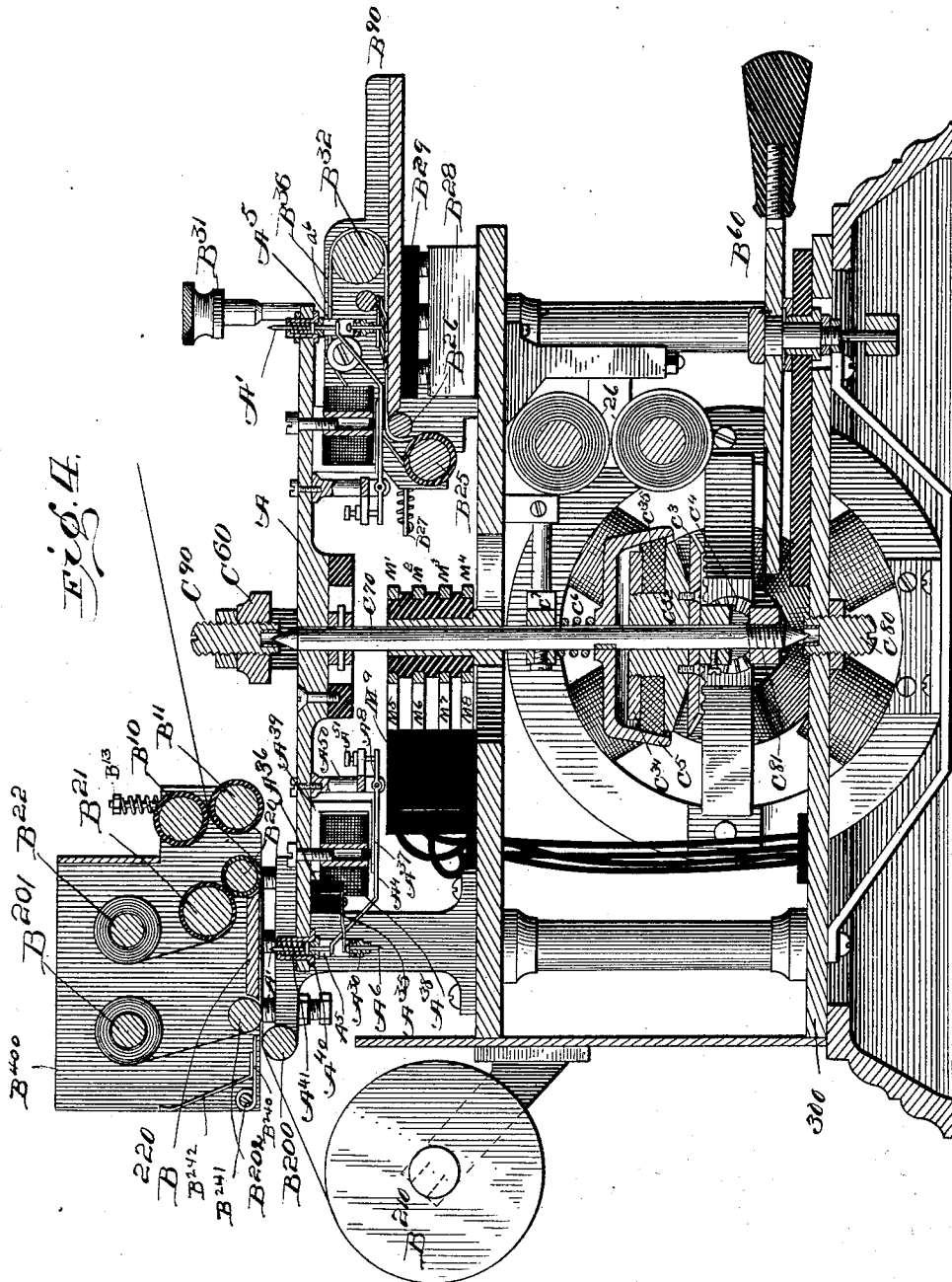
7 SHEETS—SHEET 3.



WITNESSES:

J. M. Fowler
J. G. Chapman

INVENTORS:
Hans Liebreich
John C. Francis
By *Lyons & Rissing*
Attorneys.



Witnesses:

J. M. Fowler Jr
G. J. Chapman

Inventors:
Hans Liebreich
John C. Francis

By

Lyons & Birring
Attys.

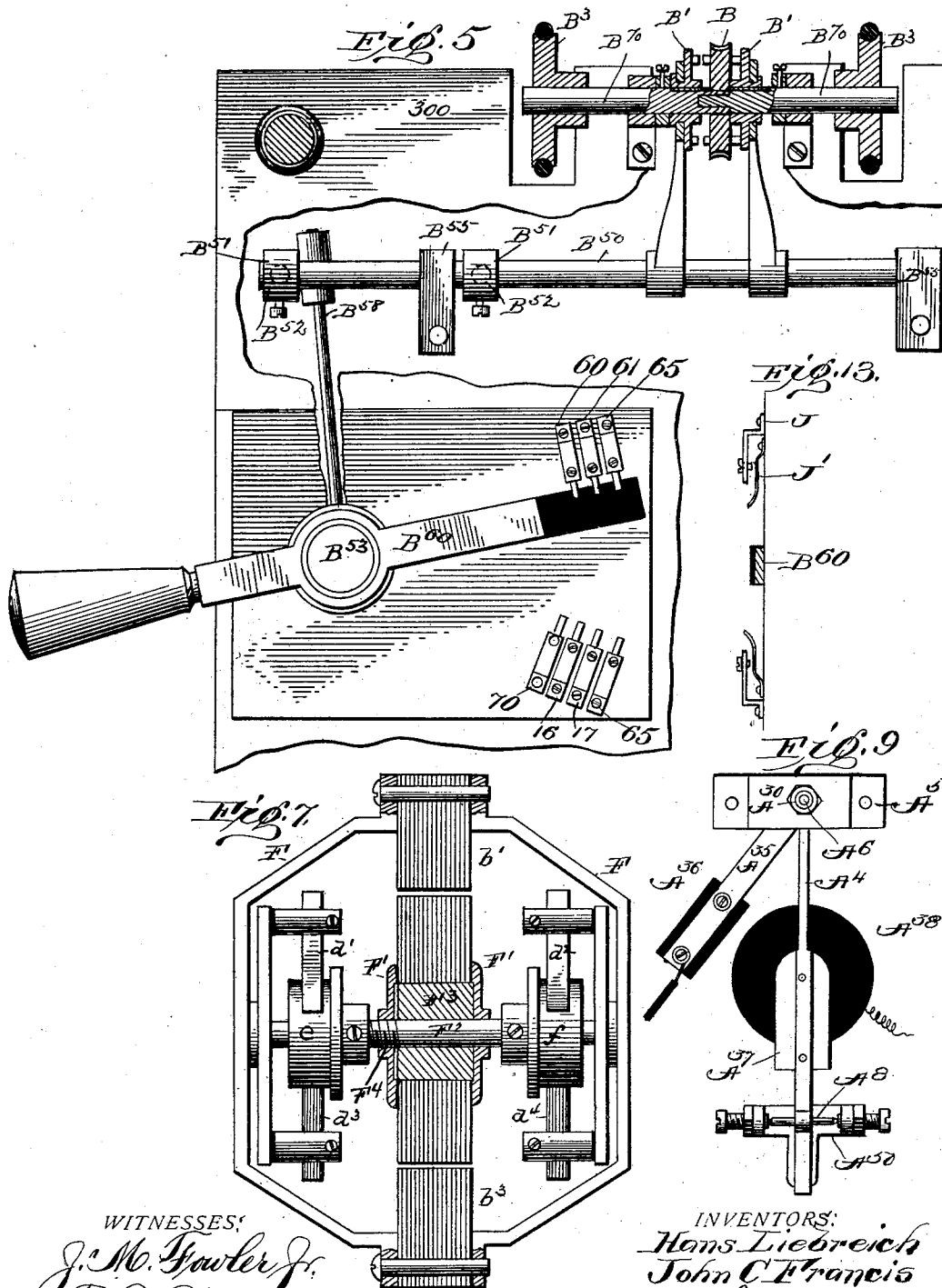
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

7 SHEETS—SHEET 5.



WITNESSES:

J. M. Fowler Jr.
F. T. Chapman.

INVENTORS:

Hans Liebreich
John C. Francis
By Lyons & Bassing
Attorneys.

No. 728,254.

PATENTED MAY 19, 1903.

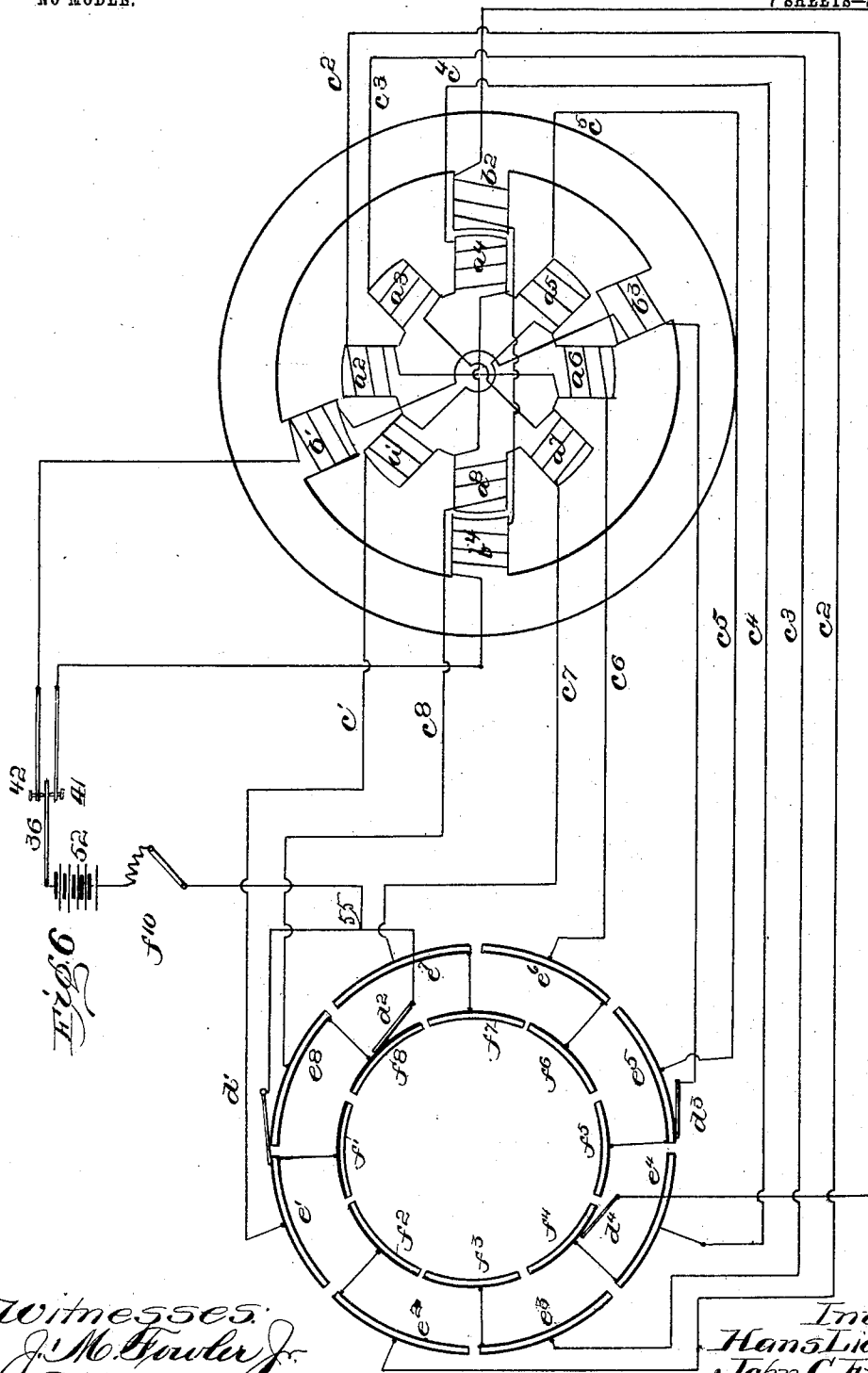
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

7 SHEETS—SHEET 6.



Witnesses:
J. M. Fowler Jr.
F. T. Chapman.

Inventors
Hans Liebreich
John C. Francis
By
Lyons & Spence
Attys.

No. 728,254.

PATENTED MAY 19, 1903.

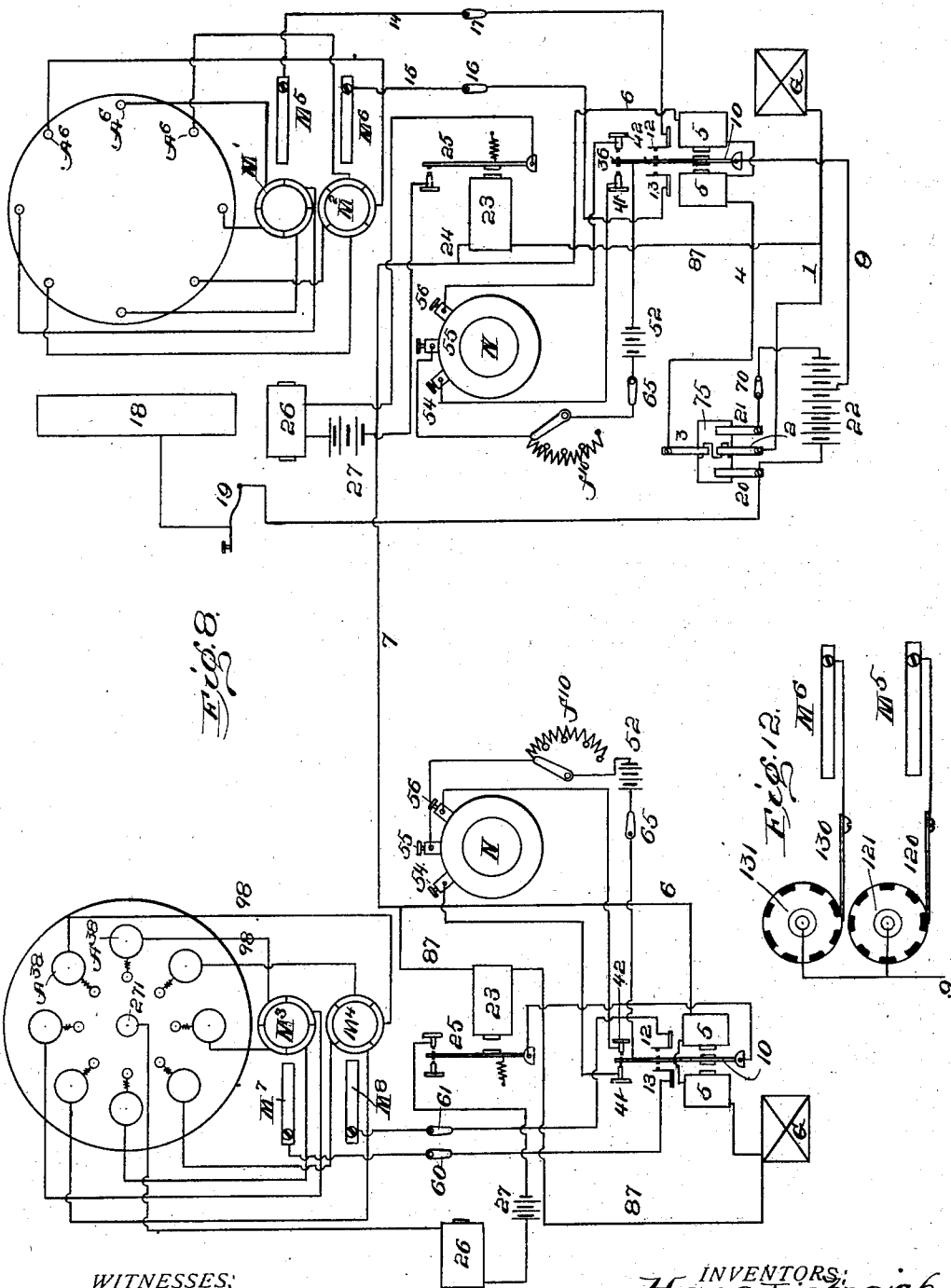
H. LIEBREICH & J. C. FRANCIS.

FACSIMILE TELEGRAPH.

APPLICATION FILED JUNE 14, 1900.

NO MODEL.

7 SHEETS—SHEET 7.



WITNESSES:

J. M. Fowler Jr.
H. T. Chapman.

INVENTORS:
Hans Liebreich
John C. Francis
By *Lynn & Bissell*
Attorneys.

UNITED STATES PATENT OFFICE.

HANS LIEBREICH AND JOHN C. FRANCIS, OF DETROIT, MICHIGAN,
ASSIGNORS TO AUGUST HELBIG, OF DETROIT, MICHIGAN.

FACSIMILE-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 728,254, dated May 19, 1903.

Application filed June 14, 1900. Serial No. 20,308. (No model.)

To all whom it may concern:

Be it known that we, HANS LIEBREICH and JOHN C. FRANCIS, citizens of the United States, and residents of Detroit, in the county of Wayne, in the State of Michigan, have invented certain new and useful Improvements in Facsimile-Telegraphs, of which the following is a specification.

The object of this invention is to produce a facsimile-telegraph, which for convenience will be called a "telescriptor." In such telegraphs a message or picture is written upon a conducting-surface with non-conducting ink or upon a non-conducting surface with conducting-ink. Transmitting points or contacts are then passed over the message to be transmitted in a certain prescribed fashion. Each time the message presents a conducting-surface an electrical impulse is sent out upon the line, or matters may be so arranged that an impulse is sent out upon the line when a non-conducting portion of the message comes against the transmitting-point. The electrical impulse which is thus sent over the line is caused to make a mark on a piece of receiving-paper at a point corresponding to that represented by the point on the transmitting-sheet which gave rise to the impulse. In this fashion a facsimile of the message or picture at the transmitting-station is recorded at the receiving-station.

In the present invention there are a series of transmitting-points fastened at equal distances about the circumference of a rotating disk or, what would be the same thing, fastened upon the ends of a series of radial arms. This disk or these radial arms all move in a plane perpendicular to a central axis upon which the disk or arms revolve. A strip or sheet of paper is positively moved in a direction perpendicular to the axis of rotation, but in a plane parallel to the plane of rotation of the transmitting-arms over a flat bed-plate or platen. A somewhat similar structure is used as a receiver.

Let us assume that we have four transmitting-points equally spaced about the circumference of a horizontal disk rotating on a vertical axis. Let us furthermore assume that we have a strip of paper moving in a plane parallel to the disk, but in a direction

at right angles to its axis, and let us assume that the width of the strip of paper is equal to the distance between two transmitting-points. If now we connect each transmitting-point with a corresponding section of a four-plate commutator and each receiving-point with a corresponding section of a four-plate commutator and move the receiver and transmitter synchronously, it will not be difficult to see that while one transmitting-point is tracing an arc of a circle across the transmitting-sheet of paper the corresponding recording-point is tracing a similar arc across the receiving-strip of paper. If then at any portion of this arc there is a conducting part of the message to be found, the circuit will be closed through the transmitting-point, its commutator-section, the line, and the receiving commutator-section and the recording-point will be caused to make its impression on the receiving-strip of paper at a point of its arc corresponding to that on the transmitting-arc represented by the conducting or non-conducting surface, as the case may be.

It is to be understood that the paper is moved at a much lower rate of speed than the rotating transmitter-disk. In actual practice it has been found that the machine which is illustrated in the drawings may have its transmitter-disk carrying two sets of four transmitting-points make seventy rotations in a minute and that the paper strip may be moved seven or even twelve inches in the same time. It will thus be seen that the paper moves a small fraction of an inch between the time that one transmitting-point begins at one side of the strip of paper and the time the next transmitting-point in order begins its work on the same side of the strip of paper. In other words, the entire length of the strip of paper is divided up into arcs of circles, which are a small fraction of an inch apart, and as the transmitting-point has some appreciable width it is manifest that the blank spaces between these arcs is considerably less than this small fraction of an inch above referred to; but every portion of the picture or message which happens to coincide with any portion of any one of this series of equidistant arcs of circles on the transmitting-strip is faithfully reproduced on the re-

ceiving-strip. It will be seen, therefore, that it is possible in this manner to send an accurate facsimile of a message or picture.

In a machine built according to the present invention it is preferred to have on the same rotary disk both the transmitting-points and the receiving-points. By this means one apparatus may be used both to transmit and to receive. It is also preferred to place the transmitting-points on one side of this rotary disk—say the lower side—and the receiving-points on the other side of the disk—say the upper side. Again, in the machine as built the transmitting-points are placed vertically under the receiving-points, although this is not essential, except for symmetry.

The transmitting-points are electrical contacts, as is the common practice in facsimile-telegraphs. While the receiving-points may under certain aspects of the invention also be electrical contacts acting upon chemical paper, it is yet preferred to construct these points so as not to carry a current, but to have them operated by the armatures of electromagnets in the receiving-circuits and to impinge against white paper backed by carbon-paper, so that the operation of receiving goes on very much as does the operation of making carbon copies in an ordinary typewriter.

Coöperating with the transmitting-points on the under side of the rotary disk is a platform for carrying the metallic transmitting-paper. There are a set of rolls upon this platform which move the transmitting-paper by gearing connecting the rolls with the main motor. There is also a set of metallic contact-springs carried on this platform, which serves to press against the transmitting-paper with an adjustable pressure, and thus to convey current thereto. Finally, this platform, which is carefully insulated from the main frame of the machine, may be lowered away from contact with the transmitting-points when fresh paper is to be inserted by a pair of vertical screw-rods. On the other side of the rotary disk and at the top thereof there is mounted a box or casing containing the rolls which operate the carbon-paper and white paper, respectively, and serve to draw the two along under the bottom of a platen, against which the receiving-points strike in the receiving operation. The box is made removable from the main frame of the machine. It carries a pair of rollers, from one of which the carbon-paper is unwound and onto the other of which it is wound. It also carries a set of rolls for moving the white receiving-paper along the carbon-paper. A slip-gear on the carbon-roll shaft serves to keep the amount of feed of the two papers uniform, so that the white and carbon papers are fed at the same rate of speed. Power is conveyed to all of these rolls from a set of gears driven by the main shaft.

Referring more in detail to the gearing which drives the receiving-paper feed and the

transmitting-paper feed, it may be said to consist in general of a worm-wheel driven from the main or synchronizing motor. This worm-wheel meshes with a worm-gear, with the opposite faces of which clutches coöperate. When one of these clutches is thrown into operation, power is conveyed to the transmitting-paper feed. When the other clutch is thrown into operation, power is conveyed to the receiving-paper feed. The mechanism for throwing one or the other of these clutches into operation is placed below the lower base-plate of the machine and is operated by a lever which acts to throw either the transmitting or the receiving circuits of the machine into operation. Thus by moving this lever into one position the transmitting-circuits are thrown into operation and at the same time the transmitting-paper feed is thrown into mechanical connection with the motor. By throwing the lever into the other position the receiving-circuits are thrown into action and the receiving-paper feed is thrown into mechanical connection with the motor.

The motor here referred to is of peculiar construction and has been especially designed for use with a facsimile-telegraph of the kind herein described. Broadly speaking, the motor has two pairs of field-poles, which are alternately thrown into action by a relay contained in the system of circuits, the relay at the receiving end operating in synchronism with the corresponding relay at the transmitting end. There are in the actual case four pairs of armature-poles, the circuits of which are connected to two commutators. When the relay above referred to is thrown to one side, one set of field-poles is thrown into action. At the same time through the intervention of the commutators that set of armature-coils which have their approaching points next to the field-poles are thrown into series with these field-coils and are thus energized to rotate the armature. The relay-tongue now flies to the other contact-point, and thus throws the other pair of field-poles into circuit. At the same time another set of armature-coils is thrown into circuit with the set of field-poles last mentioned, so that the armature is again rotated. It happens that each set of armature-coils is energized four times in a single rotation of the armature, although in alternation, and all of these actions are brought about by the peculiar action of the field-poles and the two commutators, which, as will be seen, have their sections staggered.

It may be said at this point that the motor just described conveys motion to a vertical shaft through a friction-clutch. It is, however, within the purview of the invention to substitute a magnetic clutch for the friction-clutch.

The main feature upon which stress is laid, so far as the circuit connections are concerned, is that a single line-wire is employed. This line-wire carries the currents which do

the writing or recording and at the same time carries the currents which serve to synchronize the motor. In the circuits shown in this application high-tension pulsating currents of opposite polarity are used to do the writing and low-tension pulsating currents of opposite polarity are used to do the synchronizing—that is to say, low-tension pulsating currents of opposite polarity are normally sent over the line to operate a polar relay, which controls a pair of local circuits, in which are placed the two pairs of field-coils of the synchronizing-motor above described. The motor is driven by a local source of energy; but the motors at the opposite ends of the line are kept in synchronous rotation by reason of the fact that their pairs of field-coils are alternately but simultaneously, so far as the opposite line ends are concerned, thrown into action by the vibrating parts of polar relays, which polar relays are energized by the low-tension pulsating currents of opposite polarity which pass over the line.

In further explanation of what has been above set out it may be said that a battery is used at the transmitting-station all of the cells of which are connected to a pole-changer. A portion of the cells of this battery, however, are normally short-circuited through the transmitting-points and the metallic paper under these points. Thus normally a low-tension pulsating current is sent to line. When, however, a portion of insulating-ink representing the message gets under these metallic points, then the short-circuit around a portion of this battery is broken and the whole battery acts to send high-tension pulsating currents out upon the line. These high-tension pulsating currents actuate a high-resistance magnet at the receiving end, which magnet has a resistance so high as not to be operated by low-tension pulsating currents. The high-resistance relay when actuated closes a local circuit through the magnets which operate the receiving-points. Thus it will be seen that while the synchronizing is done by low-tension alternating currents the writing is done by high-tension pulsating currents. These low-tension and high-tension pulsating currents are, as is well understood, currents of different character. It is possible, however, to use other kinds of currents of different character to effect the same final result, such a change in the character of the current requiring corresponding changes in the transmitting and receiving circuits. Thus, as is well understood, a differential effect may be obtained by direct currents of high and low tension or by a direct current and an alternating current or by a pulsating current of opposite polarity and a direct current, and so on.

It is to be understood that the transmitting-points are connected to the sections of a commutator mounted on the shaft on which the disk carrying them rotates. It is also to be understood that the magnets operating the

receiving-points are connected to the sections of a commutator mounted on the receiving-shaft. Thus if there are four transmitting-points on the rotary disk there will be four commutator-sections, each ninety degrees in extent, at the transmitting-station. There will be four similar commutator-sections at the receiving-station. A single brush bears on each commutator, which brushes are connected to line. Matters are so arranged that when a certain transmitting-point is on the slip of metallic transmitting-paper the brush connected to line bears on the commutator-section connected to this transmitting-point. Similarly at the receiving end the corresponding brush rests on a section of the commutator connected to a magnet the receiving end energized by which is under the receiving-paper. By this simple expedient a single line does the work of four lines.

Manifestly one of the most essential parts of a facsimile-telegraph system is to get as high a speed as possible without interfering with satisfactory reproduction. The rotating disk, with its transmitting and receiving points coöperating with a perfectly flat sheet of paper, offers an excellent means for rapid and successful reproduction when combined with the proper elements. In order to increase the speed, however, the following expedient has been adopted: There are eight transmitting-points on the disk. Instead of using eight transmitting-points as a single set they have been divided into two sets, the first, third, fifth, and seventh transmitting-points belonging to one set and the second, fourth, sixth, and eighth transmitting-points belonging to the other set. By means of a vibrating relay, or preferably by means of a pair of circuit-breaking wheels which revolve with great rapidity, the current is sent through the brush and commutator-section first into the transmitting-point of one set and then into the transmitting-point of another set. This, however, is done with such rapidity that current is substantially on one transmitting-point of each set at the same time. The paper is made equal in width to a quarter of the circumference of the transmitting-disk, so that there are always two transmitting-points, one of each set, on the paper. It follows that the message is substantially traced over with a distance between the arcs made by successive transmitting-points just half as great as though but one set of transmitting-points were employed. This makes it possible to use a very much higher speed of transmission and still to get equally good reproduction.

A unison-magnet is employed in the local circuit which is controlled by the high-resistance relay which does the writing. Any usual form of snail unison-stop may be employed.

In the drawings, Figure 1 is a perspective view. Fig. 2 is a rear elevation. Fig. 3 is a side elevation of the paper-feeds at the top of the machine. Fig. 4 is a central longitu-

dinal section. Fig. 5 is a detailed sectional plan of the mechanism for shifting power between the transmitting and receiving paper feeds and for operating the electrical switches for the transmitting and receiving circuits. Fig. 6 is a diagram of the motor-circuit. Fig. 7 is a section of the motor. Fig. 8 is a diagram of the transmitting and receiving circuits connected, as they are, by a single main line. Fig. 9 is a detail of the transmitting and receiving points and their operating mechanisms. Fig. 10 is a plan of the transmitter-paper feed. Fig. 11 is a detail of the roll on which the carbon-paper is wound. Fig. 12 is a detail of a modified form of certain circuit connections, and Fig. 13 is a detail of the switches shown in Fig. 5.

The synchronous motor.—Each combined transmitting and receiving apparatus is driven by an electric motor of peculiar construction, which preferably takes its energy from a local source of electrical power. The motor at one end of the line, however, is kept in synchronism with the motor at the other end of the line by a peculiar means of sending the local source of electrical energy first into one set of field-windings and then into another set of field-windings, thus producing what theoretically might be considered a stepwise rotation of the armature in the motor, but what is in reality a uniform rotation.

The construction of the motor is shown in Fig. 7 in a sectional view, and the connections for the motor are shown in Fig. 6. Examining Fig. 7 we see a framework F , between which are clamped the field-poles b' b^3 and, although they do not appear in section, the field-poles b^2 b^4 . These poles are made of laminated iron plates in a manner which is well understood, and they are each surrounded by a coil of wire. The armature-poles are clamped between brass plates F' on a shaft F^2 , there being a block of insulating material F^3 to insulate the several pole-pieces of the armature from the armature-shaft. A nut F^4 serves to firmly bind all of the pole-pieces of the armature, the insulating-piece F^3 , and the brass plates F' firmly together. There are two commutators on the shaft F^2 , one at each end. The sections of one of these commutators have been lettered e' e^2 e^3 , &c., and the sections of the other have been lettered f' f^2 f^3 , &c. It is to be observed that the commutator-sections e' e^2 e^3 , &c., are staggered with reference to the commutator-sections f' f^2 f^3 , &c. Brushes d' d^2 d^3 d^4 bear on the commutators e f .

In order to understand the mode of operation of this motor, reference is made to Fig. 6. It is seen at once that there are four field-poles, which means two pairs of field-poles and eight armature-poles, or, what is the same thing, four pairs of armature-poles. Thus the field-pole b' is connected to the field-pole b^3 and the field-pole b^4 is connected to the field-pole b^2 . Again, the armature-poles a' a^5 are con-

nected together, as are a^2 a^6 , a^3 a^7 , and a^4 a^8 . Again, the armature-poles a' a^2 a^3 to a^8 are connected by the wires c' c^2 c^3 to c^8 to the commutator-sections e' e^2 e^3 to e^8 , as appears at once from the figure. Again, the commutator-sections e' e^2 e^3 to e^8 are connected, respectively, to the commutator-sections f' f^2 f^3 to f^8 . This is another way of saying that the wires c' c^2 c^3 to c^8 are connected both to the commutator-sections e' e^2 e^3 to e^8 and to the commutator-sections f' f^2 f^3 to f^8 . We observe that the commutator-sections f are staggered with respect to the commutator-sections e —that is, the sections f are placed halfway between the sections of e . It is also seen that the brushes d' d^2 are electrically connected to one pole of the local source of energy 52. The brush d^3 is connected in series to the field-poles b^3 b' and to the contact 42. The brush d^4 is connected to the field-poles b^2 b^4 and to the contact 41. The pair of brushes d' d^3 are displaced angularly with respect to the pair of brushes d^2 d^4 by the amount indicated in Fig. 6. Manifestly, however, if it were desired to have these brushes in line it would merely be necessary to still further displace the commutator-sections e with respect to the commutator-sections f .

It is to be understood that the tongue vibrates very rapidly between the stops 41 and 42. In practice eighty vibrations per second have been used. It is further assumed that the tongue 36 at one end of the line is vibrating in synchronism with the corresponding tongue at the other end of the line.

Let us suppose that the tongue 36 is in contact with the stop 42. Current is found to pass from the battery 52 to the tongue 36, the stop 42, the field-pole b' b^3 , the commutator-brush d^3 , the wire c^5 , the armature-coils a^5 a' , the wire c' , the commutator-section e' , the commutator-brush d' , to the other pole of the battery. It is seen, therefore, that the field b' and b^3 are energized at the same time as are the armature-poles a' a^5 , so that the armature is attracted by the field and is rotated thereby one-sixteenth of a circumference. When the armature-poles a' a^5 , however, have come to registration with a field-pole b' b^3 , the tongue 36 flies to the stop 41, putting into circuit the field-poles b^4 b^2 and the armature-poles a^7 a^3 . It will be found, in fact, that the field-pole b^4 begins to attract the armature-pole a^7 at just the time when the upper corner of the armature-pole a^7 , as seen in Fig. 6, comes next to the lower corner of the field-pole b^4 . Thus it will be seen that the pairs of field-poles do the work of pulling the armature-poles during such portions of the revolution as by their juxtaposition to the armature-poles they will be enabled to act with the most power. There will be no dead-points, for the reason that as soon as one pair of field-poles has done its work and drawn the armature-pole into position immediately under it, which would be a dead-point for these specified field and armature poles, the other pair of field-poles is

thrown into circuit and acts on another pair of armature-poles.

It will be seen that the field-poles are displaced angularly a distance measured by any whole number plus one-half times the distance between two consecutive armature-poles.

It is observed that the field-windings $b' b^3$ are in series with the stop 42 and that the armature-windings which happen to be energized at the same time as are the field-windings $b' b^3$ are thrown into series with these field-windings by means of the commutator and the brushes mounted thereon. So it is seen that the field-windings $b^4 b^2$ are in series with the stop 41 and are thrown into series relation with such armature-windings as may be energized to coact with these field-windings through the commutators and their brushes. Thus it will be seen that this motor consists of two pairs of angularly-displaced poles, which are alternately energized by a tongue which is in rapid vibration or in some similar manner. It further consists of commutators and brushes having a staggered relation to each other in order that the armature-coils may be energized, not successively, but in their proper time relation. Thus it is found that the coil a' is energized to coöperate with the field-pole b' . Thereupon the armature-coil a^7 is energized to coöperate with the field-pole b^4 , then the armature-coil a^8 is energized to coöperate with the field-pole b' , and following this the armature-coil a^6 is energized to coöperate with the field-pole b^4 —that is to say, the armature-coils are not energized successively according to their position around the circumference of the circle, but alternately. Each pair of armature-coils, however, is energized four times in a single complete rotation of the armature to coöperate in turn with each of the four field-poles.

The advantages of this motor have, it is thought, been sufficiently indicated above. It need merely be said that the motor is one which can be revolved very rapidly indeed, which has a strong pull at all times by reason of the fact that it does not act on armature-poles which are removed at any considerable distance from the field-poles, and that it is particularly useful as a synchronous motor in facsimile telegraph instruments, since it is possible to energize it with a local source of current and to keep it in synchronism with the motor at the other end by merely synchronizing the movements of a vibrating tongue or other similar part. It may be observed, in conclusion, that I use a rheostat f^{10} in the local circuit in order to adjust the current to such strength as will give a uniform rotary motion.

The transmitting and receiving mechanism.—The motor, which has just been described, conveys power through its shaft to a bevel-gear C^4 , which turns a bevel-gear C^3 , which is loose upon the shaft, resting upon a

collar C^{31} . The block C^{32} is rigidly secured to the gear C^3 . Fastened to the block C^{32} by a screw-cap C^{34} is a leather friction-pad C^{35} , forming a clutch-face, against which the inside surface of a conical clutch C^5 is pressed by means of a spring C^6 . The upper end of this spring abuts against the stop C^7 , which is rigidly screwed to the shaft C^{70} . The stop C^7 also serves as a unison-stop, any common form of unison device being employed. The lower end of the shaft C^{70} is stepped into an adjustable agate bearing C^{80} and the upper end is stepped in an adjustable agate bearing C^{90} , which is secured to the cross-bar C^{60} . As these agate bearings insulate the shaft C^{70} from the frame of the machine a collar C^{81} is screw-threaded onto the lower end of the shaft C^{70} , against which collar a spring bears. The purpose of this spring is both to convey current from the frame 300 to the shaft C^{70} and also in a measure to steady the shaft. The shaft C^{70} carries four commutators $M' M^2 M^3 M^4$, against which bear brushes $M^5 M^6 M^7 M^8$, secured to a block of hard rubber M^9 . Two of these commutators coöperate with the receiving parts of the instrument and the other two commutators coöperate with the transmitting parts of the instrument. To the top of the shaft C^{70} is secured the disk A, which carries the transmitting-points and the receiving-points for the transmitting and receiving operations. It may here be said that the transmitting-points A^6 project from the under side of the disk, coöperating with paper which is mounted to move below the disk, and that the receiving-points A' project above the disk, coöperating with paper that is mounted to move above the disk. The part A has been described as a disk. In the machine as constructed this part is a disk; but manifestly a series of radial arms might be used instead of a disk, or a skeleton of a disk could be employed. In all these cases, however, and this is the essential point, the transmitting and receiving points move in a plane perpendicular to the axis of rotation C^{70} . The transmitting and receiving points are, in fact, parallel to the axis of rotation and coöperate with transmitting and receiving paper which move in a plane parallel to the plane of the disk A and perpendicular to the axis of rotation of the disk. There are eight of the transmitting-points A^6 projecting below the disk A and there are eight receiving-points A' projecting above the disk. In some of the figures, however, all of these points have not been shown, so as not to confuse the illustration. It is understood that a larger or smaller number of transmitting and receiving points may be employed.

It will be sufficient to describe a single transmitting-point and a single receiving-point and the mechanism connected therewith to get an idea of all the rest, since they are made alike.

A rectangular bracket A^5 is secured to the

underside of the disk A. A teat A³⁰ is screwed into the under face of this bracket and the transmitting-pin A⁶ slides within the teat. A leaf-spring A³⁵ presses down upon this pin, so as to hold it in contact with the transmitting-paper. At the same time this spring A³⁵ is secured to the under side of an insulating-block A³⁶, to which one of the circuit-wires is connected—that is to say, the spring A³⁵ serves both to hold the transmitting-point to its work and to convey current thereto. The transmitting-point is tipped with iridium to avoid wear. Between the legs of the bracket A⁵ there is screwed a thimble A⁴⁰, within which slides the receiving-point A', held downward by a spring A⁴¹. This point A' is pressed upward by the lever A⁴, which is hinged at A⁸ to a bracket A⁵⁰, secured to the under side of the disk A. A set-screw A⁵¹ coöperates with the back end of this lever and serves to regulate its motion. The magnet A³³, which is also secured to the under side of the disk A, has a yoke-shaped pole-piece A³⁹, coming down to the front pole-face of the magnet. The armature A³⁷ of the magnet is secured to the lever A⁴. It will thus be seen that when the magnet is energized the lever A⁴ is drawn upward, and thereby pushes upward the receiving-point A' to make its impression on the under face of the paper held against the receiving-plate B²⁰. The coil of the magnet is connected in a manner which will hereinafter be pointed out. The use of both poles of the magnet instead of the single pole increases the speed and power of the magnet.

It is convenient to have the transmitting-points A⁶ immediately under the receiving-points A'; but manifestly the transmitting-points could be displaced with reference to the receiving-points. It is only necessary that the transmitting-points be spaced equally around the circumference of the disk and that the receiving-points be also displaced equally around the circumference of the disk. In this case the transmitting and receiving disks would rotate with different relation to each other in order that the transmitting-points and the receiving-points may be correspondingly brought into synchronism. So, too, it is manifestly very convenient to have the transmitting-points on one surface (the under surface) of the disk and the receiving-point on the other surface (the upper surface) of the disk. It is clear, however, that the apparatus might be so arranged as to have the transmitting-points at the top of the disk and the receiving-points at the bottom of the disk. So, too, although this would not be so convenient an arrangement, it would be possible to have both transmitting and receiving points on the same side of the disk A. In this case, however, it would be necessary to depress the transmitting-points when the receiving-points were in action, and vice versa, and it would be, furthermore, necessary to have the transmitting-paper

rolls and the receiving-paper rolls on the same side of the disk A instead of on opposite sides, as now shown.

The paper-feeds.—We have now to describe the gearing by which power is conveyed from the motor power-shaft to the rolls which operate the metallic paper when the apparatus is used as a transmitter or which operate the carbon-paper and receiving-paper when the apparatus is used as a receiver.

The synchronous motor rotates the bevel-gear C⁴, Fig. 2, meshing with a gear C³, which is loose on the vertical shaft C⁷⁰, which gear C³, meshing with another bevel-gear C², drives a shaft C', to which is secured the worm C, Fig. 1. This worm C meshes with a worm-wheel B, which slides loosely upon two separate shafts B⁷⁰, stepped into each other, as seen in Fig. 5. Upon these shafts B⁷⁰, just referred to, there are splined clutch-plates B', having projections on their faces toward the worm B, which register with other projections on the sides of this worm-wheel. Manifestly, however, any other form of engaging devices might be employed and other forms of clutch might be substituted. On the under side of the base-plate 300 of the apparatus is supported a shaft B⁵⁰, sliding in bearings B⁵⁵. Upon collars B⁵¹ are supported pins B⁵², which serve to slide the shaft in either one direction or the other when they are moved by the arm B⁵³, which is fast to the same shaft B⁵⁰ upon which the switch-lever B⁶⁰ is mounted. It may here be said that this switch-lever when thrown in one position operates switch-contacts which put the transmitting-points into circuit and when moved in the opposite direction operate switches which put the receiving-magnets into operation. To the shafts B⁷⁰ are secured friction-wheels B³, which operate upon friction-disks B⁴, secured to vertical shafts B⁸⁰ B⁸⁰⁰, Fig. 1. Gear-wheels might, however, be employed. These vertical shafts B⁸⁰ B⁸⁰⁰ are divided and connected together by the pawl-and-ratchet couplings B⁵, the idea being that the two sections of which the shafts B⁸⁰ B⁸⁰⁰ are composed move as one when the rotation is in one direction—that is, when the rotation is in the direction to cause the pawl mounted on the coupling B⁵ to positively engage its ratchet. When the rotation is in the opposite direction, the pawl slides idly on the ratchet. The purpose of this will be explained later on. The upper end of the shaft B⁸⁰⁰ carries a bevel-gear B⁶, which meshes with a bevel-gear B⁷, secured to the shaft carrying the roller B¹⁰. There is a gear B⁸ behind the gear B⁷, secured to the same shaft. This roller B⁸ meshes with a gear B⁹, secured to a shaft carrying a roller B¹¹. This roller B¹¹ has its bearings connected to rods B¹³, projecting up through apertures in bearings and having springs secured around their tops, so as to press the roller B¹¹ against the roller B¹⁰ with a spring-pressure. On the opposite side of the roller B¹⁰ is secured a gear B¹³¹, as seen

in Fig. 3. This gear B¹³¹ meshes with a gear B¹⁴, carrying the shaft of a roller B²¹. The gear B¹⁴ meshes with an idle gear B¹⁵, which we may make adjustable in a slot B¹⁵⁵, (indicated by dotted lines,) so as to free it from contact with the gear B¹⁴ when desired. The idler B¹⁵ meshes with a gear B¹⁶, secured to the shaft of a roller B²².

Examining the sectional view of Fig. 4 it is to be observed that carbon-paper, such as is used in an ordinary type-writer, is wound upon the roll B²⁰¹ and that white paper is wound upon the roll B²¹⁰, which is carried in bearings on the back cover of the machine, which cover has not been shown, except in the sectional view. The white paper and carbon-paper are together passed loosely over the loosely-revolving idle rollers B²⁰⁰ and B²⁰² and are drawn across the under surface of the plate B²²⁰. The carbon-paper passes over the roll B²⁰, which is not positively driven, and under the roll B²¹, which, as has been before explained, is driven by the gear B¹⁴. The carbon-paper is then wound on the roll B²², which is driven by the gear B¹⁶. The white paper, on the other hand, passes over the roll B²⁰ and between the rolls B¹⁰ and B¹¹, which are driven by the gears before described. The rolls B¹⁰, B¹¹, and B²¹ are covered with rubber or similar yielding material to produce traction.

It is understood that when the writing-point A' passes under the plate B²²⁰ and a current is at the same time sent through the magnet A³⁵ the writing-point A' will be pressed up against the carbon-paper and make a mark upon the white paper underneath, which will either be a dot or a portion of the arc of a circle, according as the current energizes the magnet A³⁵ momentarily or for a more considerable period of time. It will also be understood that the carbon-paper is drawn off from the roll B²⁰¹ and is gradually wound up on the roll B²². When the roll B²⁰¹ is empty and the roll B²² is full, the gear B¹⁵ by reason of its adjustable mounting is thrown out of mesh and the carbon-paper is wound back on the roll B²⁰¹. When the roll B²⁰¹ is again full, the gear B¹⁵ is put in contact with its coöperating gears and the apparatus is again ready to receive. The plate B²⁴⁰, which swings on a shaft B²⁴¹, is pressed against the paper on the roll B²⁰² by the springs B²⁴², and thus acts as a tension device to keep the paper flat under the plate B²²⁰. (See Figs. 2 and 4.)

At this point it may be mentioned that the carbon-paper, the rolls for moving it, and the rolls B¹⁰ B¹¹ for drawing the white paper along are all mounted in a box or case B⁴⁰⁰. This case B⁴⁰⁰ rests upon screws B¹⁹, which serve to regulate the height of the box. The case is secured in position by the swinging bolt and nut B¹⁷, hinged to the main frame of the machine at B¹⁸ in a manner which the drawings make clear. By this construction it is possible when the apparatus is used as a re-

ceiver to unscrew the nut B¹⁷ and to swing the bolt on which it is mounted down upon the hinge B¹⁸ and then to remove the box B⁴⁰⁰, with all of its rolls, gears, and carbon-paper, for the purpose of introducing fresh rolls of white or carbon paper into the machine.

Examining Fig. 11, we find the roll B²², upon which the carbon-paper is wound. This roll is driven by the gear B¹⁶; but the gear is loose upon the roll-shaft and is pressed against said shaft or a shoulder thereon by a spring B¹⁶¹. As the roll of paper increases in size the slipping of this gear permits the same linear length to be wound upon it in corresponding periods of time, despite the fact that the radius of the circle on which the paper is wound is increasing in size. In Fig. 11 is also shown a means for making the roll B²² removable. One end of this roll has a pin B¹⁶³, sliding in a slot in the part B¹⁶²—that is to say, the roll B²² and the part B¹⁶² must necessarily turn together; but the roll can be removed by sliding it out of the slot. In order to enable this to be done, the other end of the roll is provided with a pin B¹⁶⁴, fitting in an aperture in a screw-rod B¹⁶⁶, which screw-rod is locked into place by a lock-nut B¹⁶⁵. By unscrewing the lock-nut and screw the pin B¹⁶⁴ is disengaged from its orifice, and the pin B¹⁶³ may be removed from the slot with which it engages. By this means the roll B²² may be taken out of the machine to put in a fresh supply of paper. The roll B²⁰¹ is made in the same manner and is also provided with a square end, as seen in Fig. 3, for returning the paper to itself after it has been wound up on the roll B²².

Coming now to a description of the transmitting-feed, we find the gear B⁶⁰⁰ at the upper end of the shaft B⁸⁰ to drive the gear B²⁴, which gear is secured to the shaft of a roller B²⁵. Coacting with this roller and pressed thereagainst by spring B²⁷ is a roller B²⁶. Rubber bands B³⁶ pass over the roll B²⁵ and convey power to the roll B³², which is held elastically against the bed-plate by the spring B³⁹.

Turning to the sectional view, Fig. 4, it will be understood that the metallic paper passes under the roll B³² and then under the springs E', attached to the rod E, which serve to convey current to the paper. The metallic paper then passes along under the transmitting-point A⁶ and then passes between the rolls B²⁵ B²⁶, whence it is drawn forward and out of the machine—that is to say, the transmitting-paper leaves the machine at about the point at which it entered it.

In order that the metallic transmitting-paper may be fed into the machine at the start without coming in contact with the transmitting-points A⁶, I make the entire structure carrying the rollers B²⁵ B²⁶ B³² and the transmitting-platen adjustable up and down. The standards B²⁸ are secured to the upper base-plate 4⁰⁰ of the machine. Bolts B³⁰ pass through a plate B²⁹ of vulcanite or the like,

which passes entirely under the transmitting-platen B^{90} . These bolts B^{90} also pass through a block B^{91} , which, however, is insulated from the plate B^{90} by the mica or other insulating-sheet B^{92} . The screw-rod B^{31} has a shoulder abutting against the plate B^{28} , but is threaded into the plate B^{91} . By moving these screw-rods B^{31} simultaneously the plates B^{91} may be lowered, and with them is lowered the transmitting-plate B^{90} , which is mechanically attached to but insulated from the plates B^{91} . Thus the transmitting-plate may be lowered out of contact with the transmitting-points A^6 when the transmitting-paper is first to be inserted into the machine. The contact-springs E' , as shown in Fig. 10, cooperate with the transmitting-paper in a double capacity. First, they convey current thereto, and, second, they act to adjust the tension which is exerted on the paper as it is drawn along by the rolls. These springs E' are all rigidly fastened either to a plate E^2 , which is fastened to the rod E , or they are fastened directly to the rod E . This rod is mounted in the side plates by having screw-threaded apertures in the ends of the rods into which the bolts B^{32} are screwed, or they may be fastened in any other proper manner.

The purpose of the ratchet-and-pawl coupling B^5 will be readily understood. When the message has been received and it is desired to draw the paper containing it out from under the receiving-platen, the thumb-nut on the roll B^{10} is operated to rotate the roller. This, however, would communicate motion to the gears B^8 B^6 , and if the shaft B^{80} were in one piece it would communicate motion to the friction-wheel B^3 ; but by having the ratchet-coupling B^5 the upper portion of the shaft B^{80} is enabled to rotate without rotating the lower portion of the shaft. By this means it is possible to quickly wind off paper from between the rolls B^{10} B^{11} without conveying any motion to parts beyond the ratchet-coupling B^5 .

It may here be stated that instead of using paper having a metallic surface a paper may be used in which the metallic particles are mixed in with the pulp from which the paper is made, so that the metallic portions of the paper are distributed uniformly throughout the body of the paper. By this means a better result is obtained. The result of all this is that when the switch-lever B^{60} is thrown into one position, so that the transmitting-circuits are in operation, the worm-wheel B engages with the clutch to the right in Fig. 1, which means that motion is conveyed to the paper-feeding devices for the transmitting operation. When the lever B^{60} is thrown to the opposite position, so as to put the receiving-circuit into connection, the worm B is made to engage the clutch to the left of it in Fig. 1, and motion is conveyed to the paper-feeding devices, which actuate the carbon-paper and the white paper which are used in the receiving operation.

The circuit connections.—We have now to examine the circuit connections, which are shown diagrammatically in Fig. 8. As has been before said, there is but a single main line 7, which connects the receiving and transmitting stations. In order that the principle of the circuit connections may be readily understood, there has been shown on the right of Fig. 8 all of the circuits which are used in transmitting, and there has been shown on the left of this figure all the circuits which are used in receiving. It is to be understood that a single instrument built in accordance with this invention—such, for instance, as is shown in Fig. 1—is capable both of transmitting and of receiving, and that it will contain, therefore, not only the transmitting-circuit shown on the right of Fig. 8, but also the receiving-circuits shown on the left of said figure, omitting, of course, any mere duplications, such as the synchronous motor, of which there is but one to one combined transmitting and receiving instrument.

It will be explained later on how, by the operation of the main switch, which mechanically throws the transmitting-paper feed or the receiving-paper feed into operation, there are closed at the same time certain switches which cut in the receiving-circuits of the instrument and cut out the transmitting-circuits, or vice versa.

Starting from ground at the transmitting-station in Fig. 8 we pass along the line 1 to the contact-spring 2 of a rotary pole-changer 75. The springs 20 and 21 of this pole-changer are connected with the opposite sides of the main battery 22. This type of pole-exchanger is so common that it will be readily understood that we pass from the spring 2 to the spring 21, the switch 70, through all the cells of the battery 22, the spring 20, the spring 3, the wire 4, the polarized relay 5, and the wire 6 to the line 7. When the pole-changer 75 is in one position, a positive impulse will be sent upon the line. When it is in the next position, a negative impulse will be sent upon the line.

So far as the parts which have just been described are concerned it will be found that the impulses of opposite polarities which are sent upon the line from the battery 22 are represented by the full strength of all the cells of the battery. As a matter of fact, however, some of the cells of this battery—in the cases shown the five cells to the left—are short-circuited so long as a metallic portion of the transmitting strip or message is under a transmitting-point. This short circuit runs through the wire 9, lever 10, springs 12 or 13, as the case may be, through the wires 14 15 and brushes M^5 M^6 , as the case may be, through a commutator-section of M' or M^2 , and the transmitting-points connected therewith, as the case may be, to the terminal-plate 18, through the unison-key 19 and back to the other pole of the battery. Therefore the pulsations which are normally sent out upon

the line from the battery 22 are not measured by the strength of all the cells in the battery combined, but only by the three right-hand cells in Fig. 8, which are not short-circuited.

It is to be understood that the transmitting-points A^6 are divided into two sets, the first, third, fifth, and seventh points being connected with the sections of the commutator M' and the second, fourth, sixth, and eighth points being connected to the commutator M^2 . It is noticed that the plates of these commutators have a staggered relation to each other, which is due to the fact that the positions of these plates around the circumference correspond to the positions of the contact-points with which the plates are connected.

As the transmitting-strip of paper is equal in width to the distance between two transmitting-points displaced ninety degrees, it follows that two transmitting-points are always on the transmitting-strip. With such a form of lever as shown at 10, vibrating between contacts 12 13, current will first be thrown onto one set of contact-points A^6 and then upon the other set of contact-points A^6 , so that as two contact-points A^6 , one from one set and one from the other set, are traveling across the transmitting-paper first one and then the other has current supplied to it; but a better form of means for supplying current alternately to the brushes M' M^6 , and thereby to the two sets of transmitting-points, is shown in Fig. 12. The wire 9, that leads from the battery 22, is tapped in multiple to break-wheels 121 131, which break-wheels have their insulations in staggered relation. Current then passes out either to the brush 120 or to the brush 130, resting on the break-wheels, and thence to the brushes M^5 M^6 , resting on the commutators M' M^2 . By this means it is possible to send the pulses from the battery 22 through the two brushes M^5 M^6 and commutators M' M^2 to the two transmitting-points of opposite sets that happen to be on the transmitting-paper with such rapidity that for all practical purposes each transmitting-point of the two transmitting-points that are at the same time resting on the transmitting-paper are continuously energized. The paper may therefore be moved longitudinally at a very much higher rate of speed than was heretofore possible.

It has been explained how the three cells of battery of 22 to the right normally send pulsations of opposite polarity out upon the line 7. It has just been explained how the five cells of battery of 22 are short-circuited at the contacts of A^6 and 18 when the metallic part of the transmitting-paper is in contact with A^6 . When now an insulating part of the transmitting-paper—that is, a portion of the message which is written in insulating-ink—comes in contact with A^6 , the short circuit around the five cells of the battery 22 to the left is broken at 18 A^6 , and this battery

22 sends a pulsatory current measured in strength by all of its eight cells out upon the line. The pulsatory current which comes from the battery 22 acts upon the polar relay 5 and throws the lever 10 alternately in opposite directions. This lever 10 alternately contacts with the springs 12 13, which are connected with the brushes M^5 M^6 and the sets of transmitting-points, as has been fully explained. The lever 10 also carries a piece 36, which is insulated therefrom and which co-operates with contacts 41 42. One pole of the local battery 52 is connected to the piece 36. Assume that the lever 10 is thrown to the right. The current from the battery 52 passes through a rheostat f^{10} to the terminal 55. This corresponds to the point 55 in Fig. 6. It then passes through one set of field-coils and armature-coils of the motor to the binding-post 56 to the contact 42 and back to the other pole of the battery. When the lever 10 is thrown to the left, the current from the battery 52 passes to the terminal 55 through the other set of field-magnets of the motor and another set of armature-coils coacting therewith, thence to the terminal 54 and the left-hand contact 41. The motor N thus has its pairs of field-coils alternately energized as the lever 10 oscillates back and forth. Since, however, the pulsations which oscillate the lever of the polarized relay 5 at the transmitting-station go out upon the line and go down through the polarized relay 5 at the receiving-station, thus oscillating the two levers 10 in unison, and since the motor at the receiving-station has its contacts 54, 55, and 56 connected to a battery and contacts 42 in precisely the same way as the motor at the transmitting-station, it follows that these two motors N at the transmitting and receiving station rotate in unison.

The magnet 23, which is in a tap 87 from the main line 7, and therefore in parallel with the polarized relay 5, is wound of such high resistance as not to be effected by the low-tension pulsatory currents which come over the line from the part of the battery 22, but so as only to be effected by the high-tension alternating current from all of the battery 22, which we have called the "writing-currents." When one of these high-tension currents comes over the line, the magnet 23 attracts its armature 25 and closes a local circuit through a local battery 27, a unison-magnet 26, the common terminal 271, and through one or other of such two of the receiving-magnets A^{38} as happen to be under the receiving-paper. From these two receiving-magnets the current passes by wires 98 to the plates of the commutator M^3 or M^4 , to the brushes M^7 or M^8 , and to the contacts 12 or 13, through the lever 10 back to the lever 25. Since now the commutators M^3 M^4 rotate synchronously with the commutators M' M^2 , and since, furthermore, the lever 10 at the receiving end oscillates synchronously with the lever 10 at the transmitting end, it follows that if a high-

tension pulsatory current is sent out upon the line by the breaking of a short circuit by a transmitting-point in a given position current will be sent through the recording-magnet A^{38} when and during the time that it is in a position exactly corresponding to that of the transmitting-point. The receiving-point, actuated by the magnet A^{38} , will thus make a facsimile impression.

It is almost needless to say that in case the modification of Fig. 12 is used in place of the contact-springs 12 13 at the transmitting-station the modification represented by Fig. 12 is used instead of the springs 12 13 at the receiving-station.

It remains to explain the action of the unison-stop, which is operated by the magnets 26 and key 19. These unison-stops are used at the beginning of the operation only to see that the machines start off from the same initial position. The magnet 26 operates an armature-lever, which coöperates with a snail-groove on the central driving-shaft of the machine. Such a snail-groove is too common a form of unison device to need any further description, so far as its mechanical construction is concerned. It is only necessary to describe the electrical operation.

Assuming the apparatus to have the proper switches closed, the key 19 is depressed for a number of seconds. The result of this is that the short circuit for the high-tension pulsatory current is broken for a considerable period of time, so that the high-tension pulsatory currents go out upon the line for a considerable period of time, and passing through the ground-tap 87 energize the high-resistance relay 23 to close the local circuit containing the battery 27 and the unison-magnet 26 for a number of seconds. This gives the unison-stop, through its snail-path, time to act to bring both receiver and transmitter into corresponding positions.

Attention is called to the switches 16 17 in the circuits to the brushes $M^5 M^6$ at the transmitting-station and to the switch 70 in the battery-circuit 22. Manifestly when the apparatus is to be used as a transmitter all of these switches must be closed. So, too, attention is called to the switches 60 61 at the receiving-station, which are in the circuit of the brushes $M^7 M^8$. These switches must be closed when the apparatus is to be used as a receiver, but must be opened when the apparatus is to be used as a transmitter. The switches 65 in the local circuit of the motor N should be closed when the apparatus is receiving or transmitting, but should be opened when the apparatus is out of action. These switches are all operated from the common lever which manipulates the paper-feeding gearing, as has been before explained.

While a battery with a differing number of cells has been described to produce high and low tension pulsating currents of opposite polarity, it is readily understood that other forms of generators may be used. So,

too, an alternating-current generator may be used instead of the battery and pole-changer 75. It has been before explained that other types of current differing in kind may be used instead of the high and low tension pulsatory currents.

Turning now to Fig. 5 we see the central switch-lever B^{60} , which operates switches 60, 61, and 65 on the left and switches 70 16 17 65 on the right. By examining Fig. 8 the meaning of these various switches in the circuit connections is ascertained. Each of these switches may be constructed, as shown in Fig. 13, of a back contact J and a spring J', having a trend away from the back contact J. Thus in the position of the switch B^{60} shown in Fig. 5 all of the switches 70, 16, 17, and 65 on the lower side will have their circuits broken. On the other hand, the switches on the upper side will have their circuits made by reason of the fact that the switch B^{60} presses the springs J' against the back contact J. It will thus be seen when the switch B^{60} is in the position shown in Fig. 5 that the receiving-circuits are in operation, and it will further be seen that when this switch is depressed and thrown to the other position the transmitting-circuits will be in operation.

It need merely be remarked that when the switch B^{60} is in the central position the motor-circuit is completely broken, being made neither through the upper or the lower switch 65 of Fig. 5.

What we claim is—

1. In a facsimile-telegraph, a motor having a pair of field-coils alternately energized and a series of armature-coils alternately energized to coöperate with the pairs of field-coils, substantially as described.
2. In a facsimile-telegraph, a motor having a pair of field-coils alternately energized, a series of armature-coils, two commutators having their sections connected to the armature-coils in a staggered fashion and brushes co-operating therewith to energize the armature-coils alternately, substantially as described.
3. In a facsimile-telegraph, a motor having a pair of field-coils and a series of armature-coils, the field-coils being displaced angularly by an arc which is measured by a whole number plus one-half times the distance between two armature-coils, and means for energizing the field-coils and armature-coils in coöperative alternation, substantially as described.
4. In a facsimile-telegraph, a motor having a pair of field-coils having one end alternately connected to one pole of a battery, a series of armature-coils, two commutators having their sections connected to sections of the armature-coils in a staggered fashion, a pair of brushes electrically connected to the other pole of the battery and a pair of brushes connected to the other end of the field-coils whereby the field-coils are thrown into series relation with such armature-coils as are acted upon by them, substantially as described.
5. In a facsimile-telegraph, a motor having

a pair of field-coils with given ends connected to two contacts, a pair of commutators having two brushes connected to the other ends of the field-coils and their sections connected to the armature-coils, a battery having one of its poles alternately connected to the two contacts and the other poles connected to the other two of the commutator-brushes and a rheostat in circuit with the battery, substantially as described.

6. In a facsimile-telegraph, a motor having a pair of field-coils connected on one side to a pair of relay-contacts and on the other side to a local battery and a relay for sending the battery-current through the field-coils in alternation, substantially as described.

7. A metallic paper for use in facsimile-telegraphs having metallic particles embedded in and uniformly distributed through the paper, substantially as described.

8. A facsimile-telegraph comprising a disk mounted to rotate about an axis, a double series of transmitting-points thereon, another disk mounted to rotate about an axis, a double series of recording-points thereon, a single main line a source of energy at the transmitting-station, means for throwing the source respectively to one or other sets of transmitting-points in rapid alternation and means at the receiving-station for operating the sets of recording-points alternately in synchronism therewith, substantially as described.

9. A facsimile-telegraph comprising points for transmitting or receiving, an electric motor having pairs of field-coils for driving the motor, a local battery connected through brushes and commutators to one end of the pairs of field-coils and a relay for closing the battery alternately through the other ends of the field-coils, substantially as described.

10. A facsimile-telegraph comprising transmitting-points and receiving-points, each mounted to rotate about an axis, paper-feeds in planes perpendicular to these axes, a single main line connecting them, electric motors having pairs of fields for driving the points, a relay controlling a local battery for alternately energizing the fields, means for sending currents of one character for writing purposes, and means for sending pulsatory currents of another character for operating the relay to alternately energize the fields of the motor, substantially as described.

11. A facsimile-telegraph comprising transmitting and receiving points, each mounted to rotate about an axis, paper-feed in planes perpendicular to these axes, a single main line connecting them having brushes, electric motors for driving the points, means for sending low-tension pulsatory currents over one branch of the line to synchronize the motors, a high-resistance relay controlling a local circuit through the recording devices in another branch of the line, and means for sending high-tension impulses to operate this relay, substantially as described.

12. A facsimile-telegraph comprising trans-

mitting-points and receiving-points, each mounted to rotate about an axis, paper-feeds in planes perpendicular to these axes, a single main line connecting them, means for sending high-tension currents for writing purposes, and means for sending low-tension pulsatory currents for synchronizing purposes, substantially as described.

13. A facsimile-telegraph comprising transmitting-points and receiving-points, each mounted to rotate about an axis, paper-feeds in planes perpendicular to these axes, a single main line connecting them, electric motors having pairs of alternately-energized fields for driving the points, means for sending currents of one character for writing purposes and means for sending pulsatory currents of another character to cause the alternate energization of the fields of the motor, substantially as described.

14. A facsimile-telegraph comprising transmitting-points and receiving-points, each mounted to rotate about an axis, paper-feeds in planes perpendicular to these axes, a single main line connecting them, means for sending high-tension currents for writing purposes and means for sending low-tension currents for synchronizing purposes, substantially as described.

15. A facsimile-telegraph comprising transmitting and receiving points, each mounted to rotate about an axis, paper-feeds in planes perpendicular to these axes, a single main line connecting them, means for sending low-tension currents through one branch of the line for synchronizing purposes, a high-resistance relay, controlling a local circuit through the recording devices, in another branch of the line, and means for sending high-tension impulses to operate this relay, substantially as described.

16. A facsimile-telegraph comprising a disk rotating on an axis, a double series of transmitting-points and a separate double series of receiving-points mounted on the disk, four commutators connected symmetrically to the sets of points or their operating means, paper-feeds in planes perpendicular to the axis for coöperating with the points, a single main line, and means for throwing either one or other series of points into coöperative relation with the line in rapid alternation, substantially as described.

17. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a separate series of receiving-points mounted on the disk, a commutator on the axis connected to the transmitting-points, a commutator connected to the means for operating the receiving-points and paper-feeds in planes perpendicular to the axis for coöperating with the respective points, substantially as described.

18. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a separate series of receiving-points mounted on the disk and paper-feeds

in planes perpendicular to the axis for co-operating with the transmitting and receiving points, respectively, substantially as described.

19. A facsimile-telegraph comprising a disk rotating on a vertical axis, a series of transmitting-points mounted to project from the under side of the disk, a series of receiving-points mounted to project from the upper side of the disk, and paper-feeds in planes perpendicular to the axis, below and above the disk respectively for coöperating with the transmitting and receiving points, substantially as described.

20. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a separate series of receiving-points, mounted on the disk but on respectively opposite sides thereof, and paper-feeds in planes perpendicular to the axis and on opposite sides of the disk respectively for co-operating with the transmitting and receiving points respectively, substantially as described.

21. A facsimile-telegraph comprising a disk rotating on an axis, a set of recording-points on the disk and for operating them, and a feed for carbon-paper and a feed for ordinary paper mounted in a movable case, substantially as described.

22. A facsimile-telegraph comprising a disk rotating on an axis, a set of recording-points on the disk and means for operating them, a feed for carbon-paper comprising a pair of rolls and a winding-roll having a slip-gear for operating it, a feed for ordinary paper comprising a pair of rolls to move the ordinary paper at the same speed as the carbon-paper and gearing for driving the several rolls, substantially as described.

23. A facsimile-telegraph comprising a disk rotating on an axis, a set of recording-points on the disk and means for operating them, a feed for carbon-paper comprising a removable winding-roll having a slip-gear for operating it, a feed for ordinary paper comprising rolls to move the ordinary paper at the same speed as the carbon-paper and gearing for driving the several rolls, substantially as described.

24. A facsimile-telegraph comprising a disk rotating on an axis carrying a series of transmitting-points, a transmitting-paper platen mounted in a plane perpendicular to the axis and means for raising and lowering the platen, substantially as described.

25. A facsimile-telegraph comprising a disk rotating on an axis carrying a series of transmitting-points, a transmitting-paper platen insulated from the main frame of the machine, mounted in a plane perpendicular to the axis and adjustable from and toward the transmitting-points, substantially as described.

26. A facsimile-telegraph comprising a disk rotating on an axis carrying a series of transmitting-points, a transmitting-paper platen insulated from the main frame of the ma-

chine, mounted in a plane perpendicular to the axis, and a pair of screw-rods for raising and lowering the platen, substantially as described.

27. A facsimile-telegraph comprising an upper and lower bed-plate, a vertical shaft carrying a disk above the upper bed-plate, transmitting-points and separate receiving-points on the disk, paper-feeds mounted on the upper bed-plate coöperating therewith, a motor mounted on the lower bed-plate, gearing between the motor and vertical shaft having a friction-clutch as a part and a unison-stop on the vertical shaft, substantially as described.

28. A facsimile-telegraph comprising an upper and a lower bed-plate, a vertical shaft carrying a disk above the upper bed-plate, transmitting-points and separate receiving-points on the disk, paper-feeds mounted on the upper bed-plate coöperating therewith, a motor mounted on the lower bed-plate for driving the vertical shaft and trains of gearing connected with the motor for operating the paper-feeds in turn, substantially as described.

29. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a series of receiving-points mounted thereon, paper-feeds in planes at right angles to the axis, a motor, two trains of gearing connecting the motor with the paper-feeds respectively and means for throwing one or other trains of gearing into action, substantially as described.

30. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a series of receiving-points mounted thereon, paper-feeds in planes at right angles to the axes, a pair of vertical shafts for conveying motion to the paper-feeds, a horizontal shaft provided with clutches for conveying power to the vertical shafts in turn, substantially as described.

31. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a series of receiving-points mounted thereon, paper-feeds in planes at right angles to the axes, switches in the circuits of the transmitting and receiving instrumentalities, and a device for throwing the switches in the receiving-circuits and the receiving paper-feed simultaneously into operation and vice versa, substantially as described.

32. A facsimile-telegraph comprising a disk rotating on an axis, a series of transmitting-points and a series of receiving-points mounted thereon, paper-feeds in planes at right angles to the axes, a motor, two trains of gearing connecting the motor with the paper-feeds respectively, switches in the transmitting and receiving circuit of the instrument and a common means for throwing one or other trains of gearing into action and simultaneously operating the switches for the points whose paper-feed is thus brought into play, substantially as described.

33. A facsimile-telegraph comprising a disk rotating on a shaft, a series of transmitting and receiving points mounted thereon, paper-feeds therefor, trains of gearing for driving the paper-feeds, a power-driven wheel, a pair of clutches coöperating with its opposite faces for driving the trains of gearing respectively, and a sliding shaft having arms for operating the clutches, substantially as described.

34. A facsimile-telegraph comprising a disk rotating on a shaft, a series of transmitting-points and a series of receiving-points mounted thereon, circuits leading to the transmitting-points and to the receiving-point-operating mechanism respectively, sets of switches in these respective circuits and a switch-lever for operating either set at pleasure, substantially as described.

35. A facsimile-telegraph comprising a vertical shaft carrying a disk with transmitting-points and receiving-points, paper-feeds therefor, an electric motor driving a horizontal shaft gearing with horizontal gear-wheel on the vertical shaft, a second horizontal shaft carrying a pinion meshing at one end, with the horizontal gear-wheel and carrying a worm at the other end, a worm-wheel meshing with the worm and clutches for connecting the worm-wheel with either of the two paper-feeds, substantially as described.

36. A facsimile-telegraph comprising a

disk, a receiving-point sliding within a perforation in the disk and projecting above the same, a magnet mounted on the disk having an armature for operating the receiving-point, a bracket under the receiving-point, a transmitting-point sliding within a perforation within the bracket and a leaf-spring for conveying current thereto, substantially as described.

37. A facsimile-telegraph comprising a disk, a series of receiving-points projecting above the disk, magnets having armatures for operating the receiving-points mounted below the disk, a series of transmitting-points mounted in brackets below the receiving-points and springs for conveying current thereto, substantially as described.

38. A facsimile-telegraph comprising a disk, a series of transmitting-points projecting below the disk and a series of leaf-springs for conveying current to the points and for holding them to their work, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of two subscribing witnesses.

HANS LIEBREICH.
JOHN C. FRANCIS.

Witnesses:

ALEXANDER S. STEUART,
F. T. CHAPMAN.