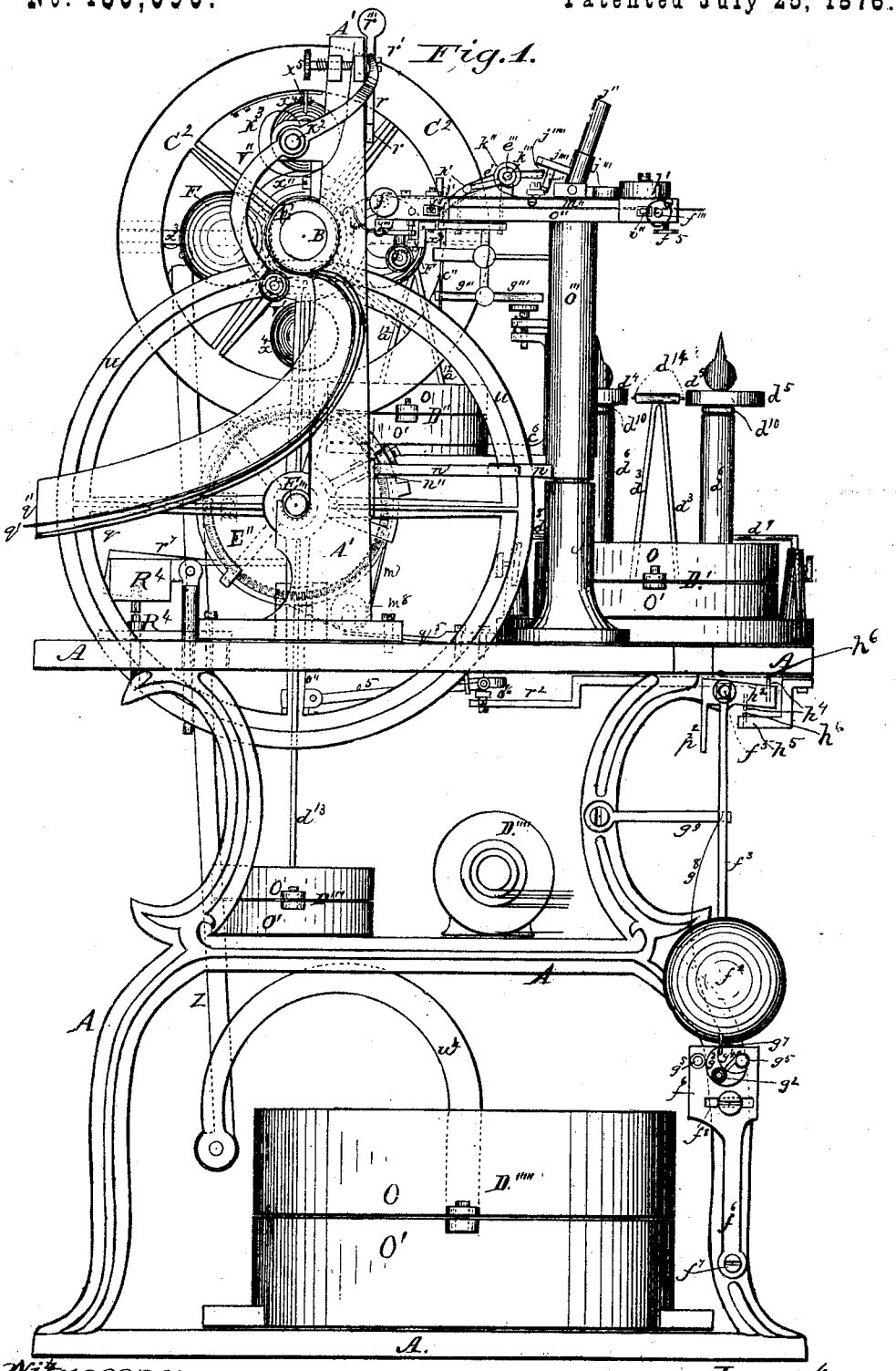
6 Sheets—Sheet 1.

R. E. HOUSE.

ELECTRIC TELEGRAPH APPARATUS.

No. 180,090. Patented July 25, 1876.

Fig. 1.



Witnesses:
M. Church
F. McKenny.

Inventor:
Royal E. House
By Hill & Ellsworth.
His Attys.

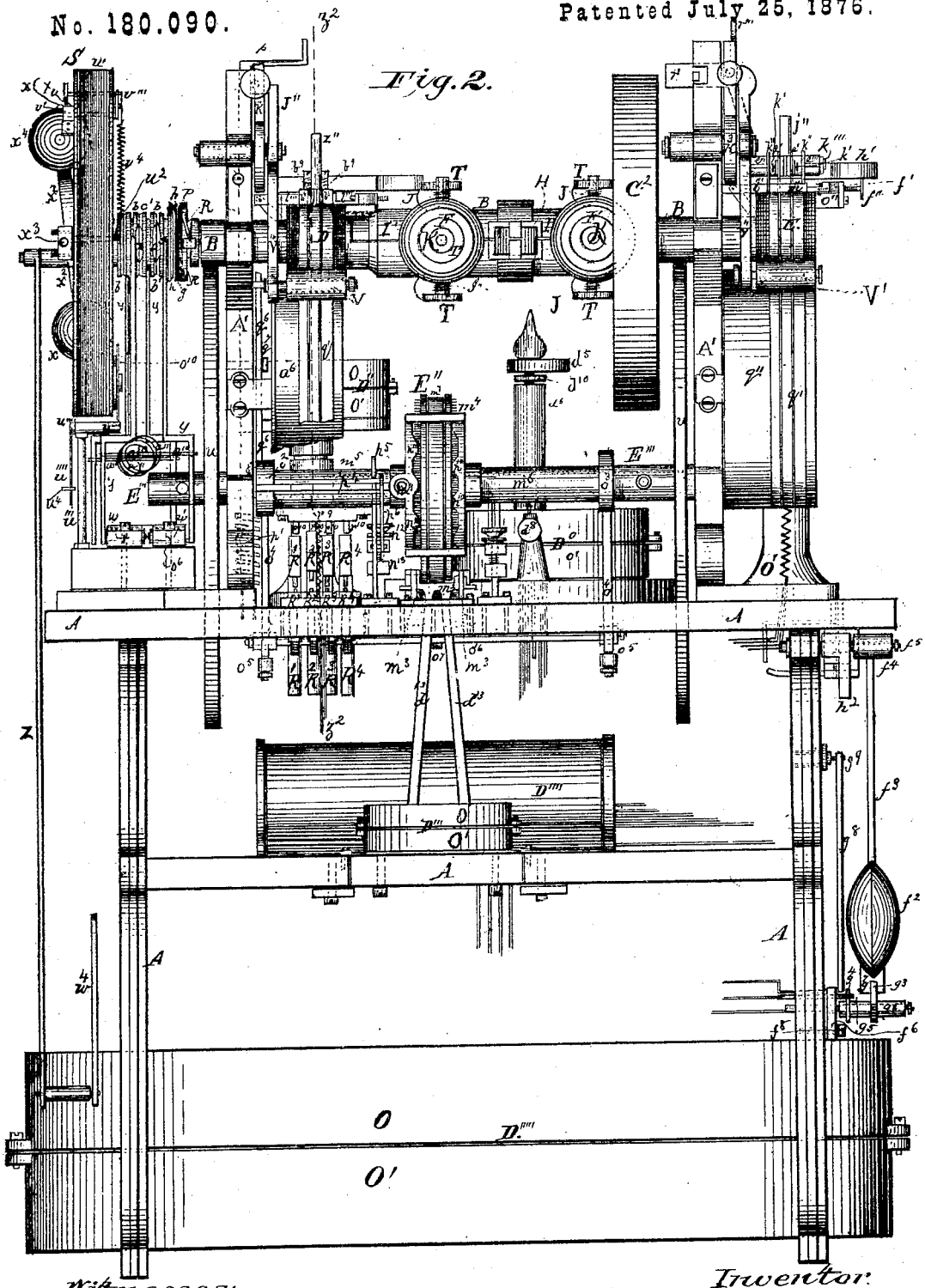
6 Sheets—Sheet 2.

R. E. HOUSE.

ELECTRIC TELEGRAPH APPARATUS.

No. 180,090. Patented July 25, 1876.

Fig. 2.



Witnesses:
M. Church
F. McKenny

Inventor:
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R. E. HOUSE.

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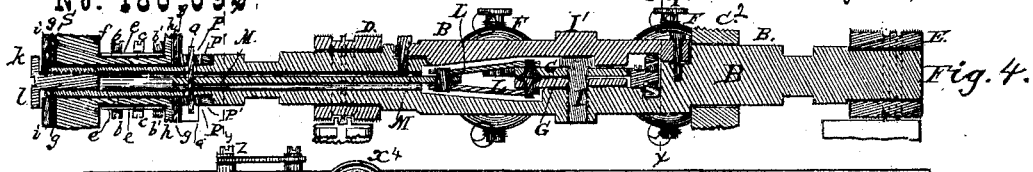

Fig. 4.

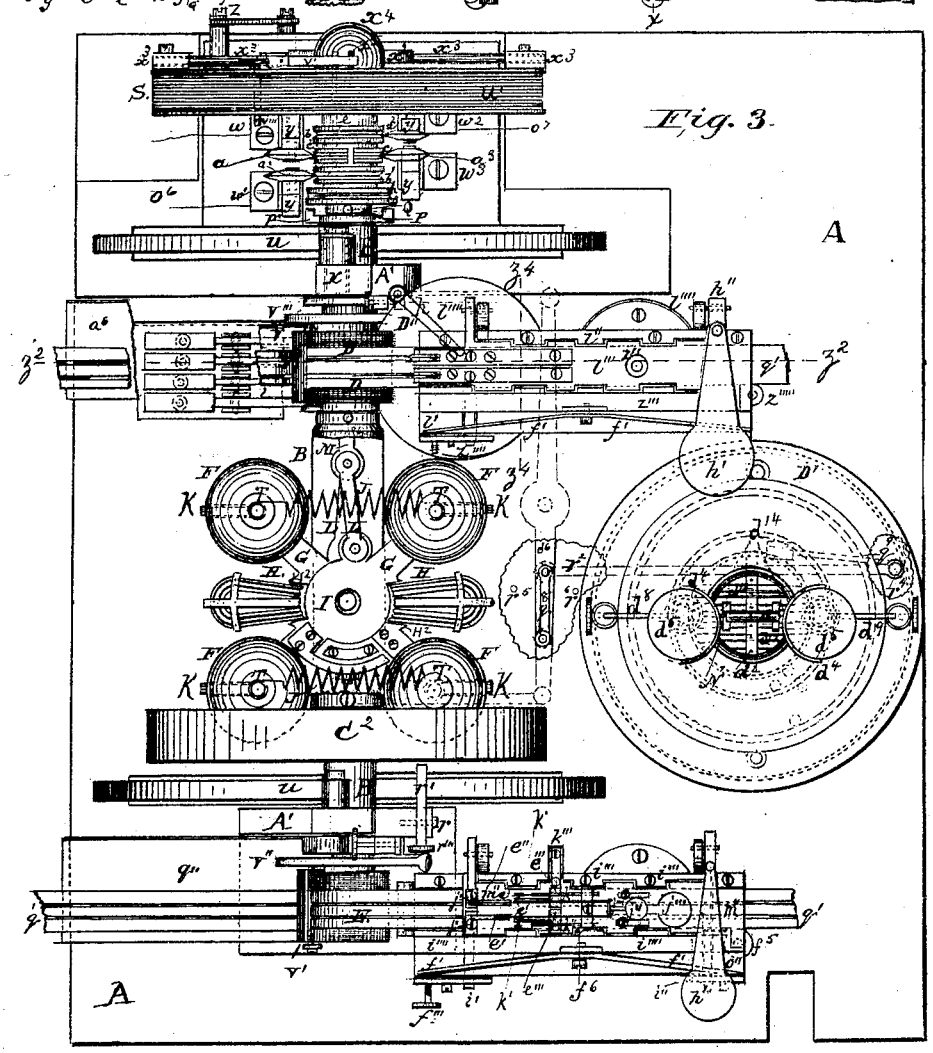

Fig. 3.

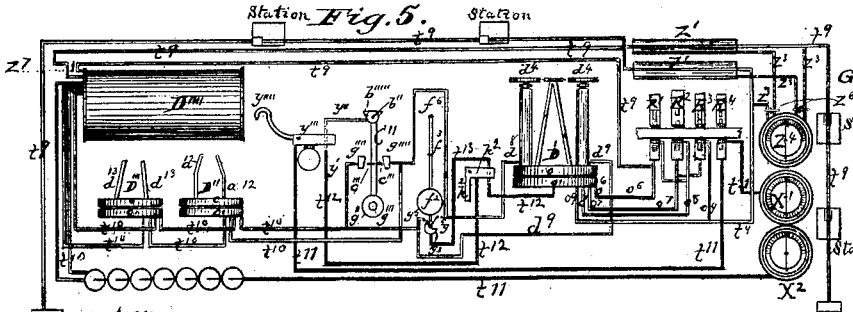

Fig. 5.

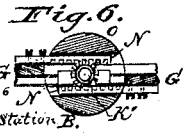

Fig. 6.

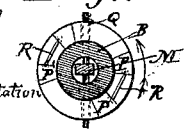

Fig. 7.

Witnesses:

H. C. Church

F. M. Kenny

Inventor:

Royal E. House

By Hill & Ellsworth

His Attys.

R. E. HOUSE.

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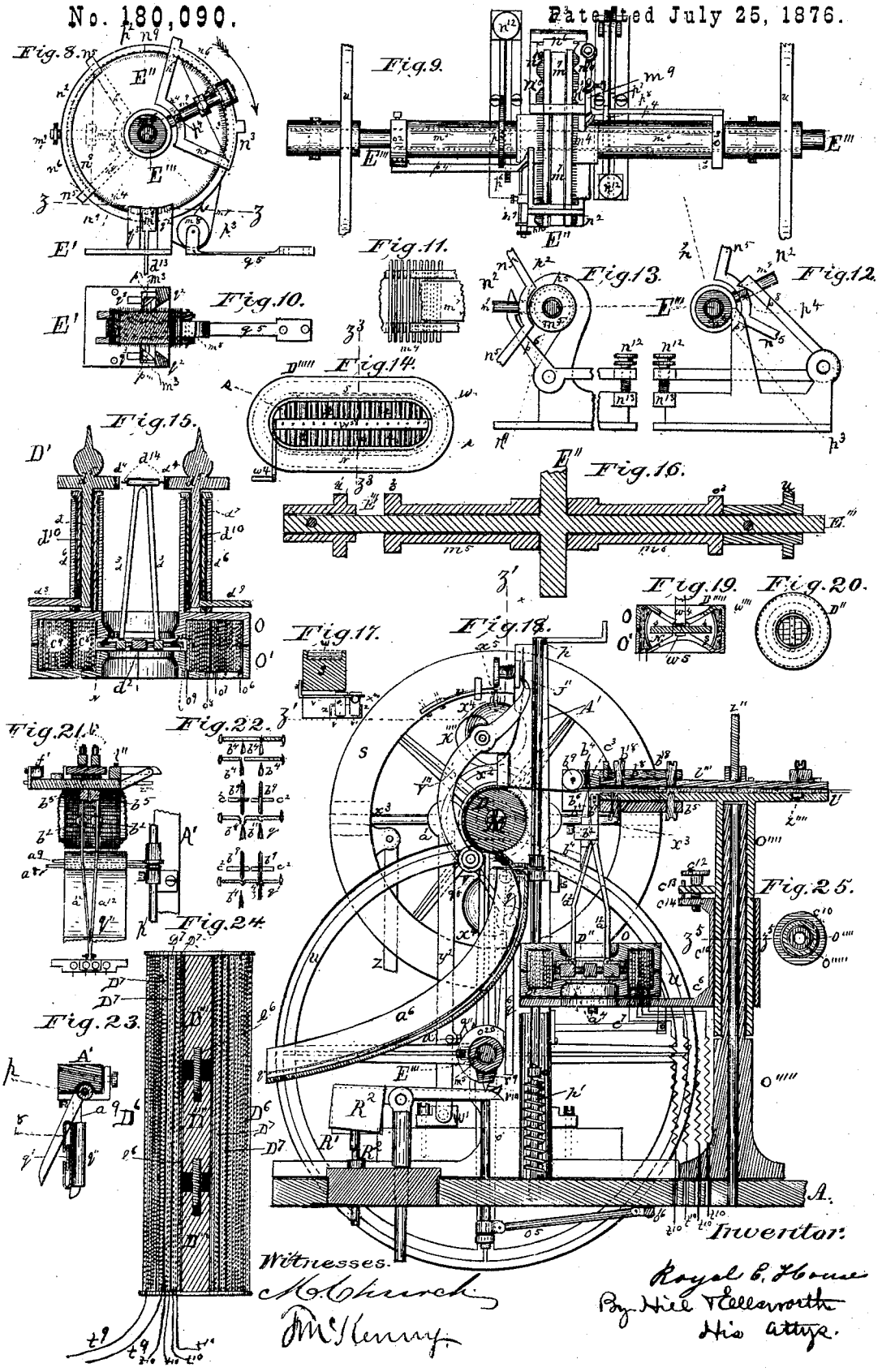


Witnesses.
M. Church
W. McKenny.

Inventor:
Royal E. House
By Hill & Ellsworth
His attys.

R. E. HOUSE.

ELECTRIC TELEGRAPH APPARATUS.

No. 180,090. Patented July 25, 1876

Fig. 26.

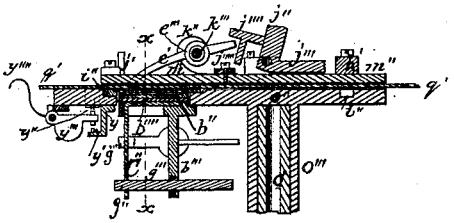


Fig. 27.

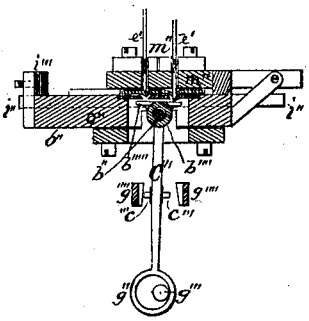


Fig. 28.

Fig. 29.

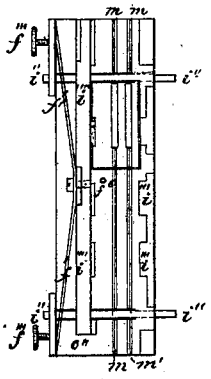
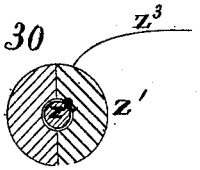


Fig 30



Witnesses:

M. L. Church

J. M. McKenny

Inventor:

Royal E. House

By Hill & Ellsworth,

His Attys.

6 Sheets—Sheet 6.

R. E. HOUSE.

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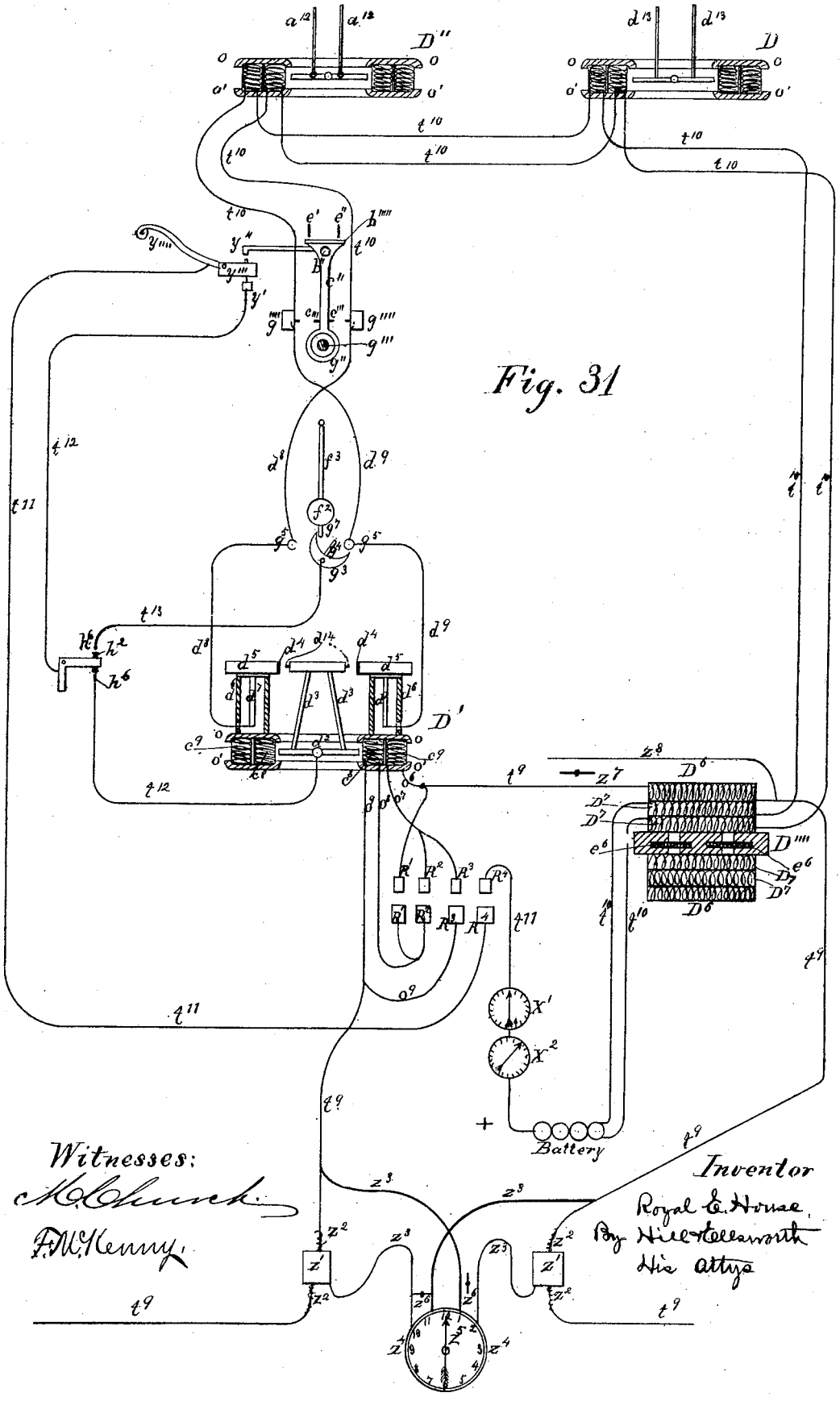

Fig. 31

Witnesses:
M. L. Church
F. W. Kenny

Inventor
Royal E. House
By Hill Kellogg & Smith
His Attys

UNITED STATES PATENT OFFICE.

ROYAL E. HOUSE, OF BINGHAMTON, NEW YORK.

IMPROVEMENT IN ELECTRIC-TELEGRAPH APPARATUS.

Specification forming part of Letters Patent No. **180,090**, dated July 25, 1876; application filed February 20, 1874.

To all whom it may concern:

Be it known that I, ROYAL E. HOUSE, of Binghamton, in the county of Broome and State of New York, have invented a new and useful Automatic Reproducing Record Telegraph for Postal Service; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming part of this specification, in which—

Figure 1, Sheet 1, is an end elevation of the apparatus. Fig. 2, Sheet 2, is a front elevation. Fig. 3, Sheet 3, is a top-plan view. Fig. 4, Sheet 2, is a longitudinal section of the driving shaft and its attachments. Fig. 5, Sheet 3, is a diagram showing a telegraph-line, its ground-plates, and five intermediate stations, one of which is provided with all the electric connections used at each station. Fig. 6, Sheet 3, is a transverse section of the driving-shaft, taken in the line *x x*, Fig. 4. Fig. 7, Sheet 3, is a similar section of the shaft, taken in the line *y y*, Fig. 4. Fig. 8, Sheet 4, is a side elevation of the registering-wheel, showing the calling-in frame, together with the tension and setting devices for the pins of the wheel. Fig. 9, Sheet 4, is a top-plan view of the registering-wheel and its devices mounted upon the counter-shaft. Fig. 10, Sheet 4, is a horizontal section of the registering-wheel, taken in the line *z z*, Fig. 8. Fig. 11, Sheet 4, is a detached section of the registering-wheel with the pins aligned. Figs. 12 and 13, Sheet 4, are elevations, respectively, of the devices for unlocking the throwing-out and calling-in frames from the pins of the registering-wheel. Fig. 14, Sheet 4, is a top-plan view of the magnet from which the main shaft of the apparatus is driven. Fig. 15, Sheet 4, is a central vertical section of the receiving-magnet. Fig. 16, Sheet 4, is a longitudinal section of the counter-shaft and sleeves of the calling-in and throwing-out frames. Fig. 17, Sheet 4, is a section taken through the rim of the driving-wheel in the plane of the line z^1 z^1, Fig. 18. Fig. 18, Sheet 4, is a vertical section of the apparatus through the line z^2 z^2, Figs. 2 and 3. Fig. 19, Sheet 4, is a transverse section of the driving-magnet through the line z^3 z^3, Fig. 14. Fig. 20, Sheet 4, is a top-plan view of the reproducing-magnet, with the slitting-knives and their upright arms removed. Fig. 21, Sheet 4, is a transverse vertical section of the guide-bed for the reproducing-instrument, taken in the line z^4 z^4, Fig. 3, showing the slitting-knives in elevation. Fig. 22, Sheet 4, shows the several positions of the slitting-knives and embossing-rollers of the reproducing mechanism. Fig. 23, Sheet 4, is a top-plan view of the shears for cutting the fillet of paper, and a transverse section of the guide for directing the paper away from the reproducing devices. Fig. 24, Sheet 4, is a longitudinal section of the induction-coil. Fig. 25, Sheet 4, is a transverse section of a guide-bed, taken through the line z^5 z^5, Fig. 18. Fig. 26, Sheet 5, is a longitudinal section of the transmitting guide bed. Fig. 27, Sheet 5, is a transverse section of the same, taken in the line *x x*, Fig. 26. Fig. 28, Sheet 5, is a transverse section for the supports of such bed. Fig. 29, Sheet 5, is a top-plan view of the bed. Fig. 30, Sheet 5, is a transverse section of one of the lightning-arresters; and Fig. 31, Sheet 6, is a diagram showing all the electric connections of the apparatus, together with all the parts of the latter necessary for tracing the course of the currents.

Similar letters of reference in the accompanying drawings denote the same parts.

My invention has for its object to automatically transmit a telegraph message recorded in a fillet of paper, and to automatically reproduce fac-simile copies of such record at any or all the stations of the telegraph-line.

To this end the invention consists, first, in the system of communicating message-symbols by means of straight slits in a fillet of paper arranged alternately in two parallel lines, each slit representing a symbol distinguishable by its length from all the other symbols.

It further consists in the method of automatically transmitting electric-telegraph symbols by alternate reversed currents sent through the main wire by the vibrations of a local circuit-changer, operated by the moving fillet of paper containing the message-slits.

It further consists in the automatic transmission of telegraph-symbols by alternate electric currents induced in the main wire by a moving fillet of paper containing two paral-

lel rows of message-slits, through which two track-fingers alternately drop as the paper moves, to operate a local vibrating circuit-changer.

It further consists in the mechanism and combination of mechanisms by which the messages are transmitted.

It further consists in the mode or method of automatically reproducing electric-telegraph symbols by the alternate reciprocations of two slitting-knives through a fillet of paper moving over them, the length of the slits corresponding with the period of time each knife is, in turn, held through the paper, so that the slits reproduced in the fillet of paper at the receiving-station shall be fac-similes of those forming the record at the transmitting-station.

It further consists in controlling the electric currents induced in the main line by the length of the message-slits in the record, so that the length of time between each current will exactly correspond to the distance between the beginning of one slit and the beginning of the next adjoining slit in the opposite row.

It further consists in the mechanism and combination of mechanisms for reproducing the message-symbols, and controlling the electric currents in the main line.

It further consists in the combination of the transmitting and reproducing mechanisms.

It further consists in the mode or method of connecting and disconnecting the stations of the telegraph-line—that is to say, in the mode or method of calling a station into connection with a transmitting station to receive a message, and of throwing the receiving-station out of communication with the transmitting-station after the message has been sent.

It further consists in the mechanism and combination of mechanisms for connecting and disconnecting the stations of a line.

It further consists in the combination of the transmitting and reproducing mechanisms, and the mechanism for connecting and disconnecting the stations of a line.

It further consists in the mode or method of automatically joining the two helices of the receiving-magnet when a message is being received at a station, for the purpose of increasing the power of the magnet when receiving a message by decreasing the conducting resistance in the receiving-magnets of all the other stations of the line within reach of the current.

It further consists in the mode or method of automatically disconnecting the two helices of the receiving-magnet, and joining them separately to the main line, when their station is not receiving a message, for the purpose of offering less resistance to the passage of the line-current through them.

It further consists in the mechanism and combination of mechanisms by which the helices of the receiving-magnet are automatically joined and separated.

It further consists in the mode or method of notifying the operator at a transmitting-station that a receiving-station is called into communication with such transmitting-station, and is ready to receive the message.

It further consists in the mechanism and combination of mechanisms by which such notification is effected.

It further consists in the combination, at a telegraph-station, of a calling-in magnet, a reproducing-magnet, a receiving-magnet, and their electric connections.

It further consists in the combination, at a telegraph-station, of a receiving-magnet, a calling-in magnet, and an induction-coil interposed in the main wire.

It further consists in the combination, at a telegraph-station, of a receiving-magnet, a calling-in magnet, a reproducing-magnet, an induction-coil, and two primary helices arranged within the induction-coil.

It further consists in the construction of the several magnets.

It further consists in their combination with various parts of the apparatus.

It further consists in equalizing the force of the main-line currents, for the purpose of securing the automatic formation of the message-symbols of the requisite relative sizes throughout the whole line, and to prevent like message-symbols from differing in length when formed by the current passing through either primary helix of the induction-coil.

It further consists in the construction of the induction coil with the double helix, connecting the local battery with the calling-in magnet of a station.

It further consists in the combination of an adjustable magnet with the induction-coil.

It further consists in winding the corresponding helices of the calling-in magnet, the reproducing-magnet, the receiving-magnet, and the primary helices of the induction-coil in the same direction, so that the electric currents shall each move through the circuit of like helices in the same direction at each station and at all the stations of the line.

It further consists in the mode or method of establishing a uniform movement of the paper fillets at all the stations of a telegraph-line.

It further consists in the mode or method of providing a standard measure of time at all the stations of the line, for the purpose of determining the speed of the driving-shafts.

It further consists in the mechanism and combination of mechanisms for effecting such results.

It further consists in the mode or method of cutting off a reproduced record from the fillet of paper on the guide-bed of the reproducing mechanism.

It further consists in the employment of lightning-arresters of peculiar construction to conduct strong atmospheric currents along

the main line past a station, and prevent them from injuring the receiving-magnet, and to direct the message-currents into the receiving-magnet, and prevent them from passing the station.

It further consists in the means employed for joining the lightning-arresters to the main line at a station.

It further consists in the means employed for ascertaining any defect in the insulation of the lightning-arresters.

It further consists in the method of graduating the power of a local battery and determining the amount of such power; and it consists, finally, in the construction and combination of various parts of the apparatus, as I will presently describe.

Having thus set forth the general principles of my invention, I will now describe one means by which it may be carried into practice, beginning with the transmitting mechanism, which is constructed and operates as follows:

In the accompanying drawings, A is the frame of the instrument, constructed in any suitable manner, and provided with two uprights, A′, which support the main driving-shaft B. This shaft is employed to operate two sets of feeding devices—viz., one set by which the fillet of paper containing the record is fed through the instrument for transmitting a message, and the other set for feeding along another fillet of paper, in which a received message is recorded, so as to constitute a fac-simile of the record from which the message was sent.

For a proper understanding of the invention, and to prevent confusion in description, it is necessary to bear in mind that each station along a telegraph-line is provided with two instruments in addition to the one by which the record is first made—to wit, one for transmitting and receiving and one for reproducing a transmitted message. It is evident, therefore, that a message may be received and reproduced at one station without being transmitted to another.

The shaft B is supported in its bearings upon friction-wheels *u*, placed within the uprights of the frame, and is provided with a fly-wheel, C^2, and the cylinders D E. These cylinders, in connection with pressure-rollers, are employed to feed the fillets of paper through the transmitting and reproducing instruments, and are each formed with several rows of teeth to take hold of the paper, and with two peripheral grooves to receive the embossed tracks in the fillets. The grooves should be the same distance apart, in order to register with each other and the grooves in the cylinder of the recording-instrument, so that the embossed tracks in the paper containing the record may fit the grooves of all the cylinders.

The shaft is driven by two collars connected thereto, so as to clamp the hub of the driving-wheel between them by frictional contact, and transmit its motion to the shaft. The wheel is driven by electro-magnetism, as I will presently describe. For the purpose of controlling the speed of the shaft, I regulate the frictional contact of the collars and hub of the driving-wheel by means of a governor, consisting of the crossed levers G, carrying balls F upon their ends, and pivoted together upon the shaft between the cylinder D and fly-wheel C^2 by a screw or pin, I. One-half of the shaft is cut away for this purpose, and after the parts have been applied a protecting-cap, I′, is placed over them upon the shaft, as shown in Fig. 4. L L are short links, pivoted at one end to the upper and lower governor-levers, and at the opposite end to a rod, M, extending within the shaft toward the hub of the driving-wheel S, the shaft being made hollow for this purpose. The other end of the rod carries a pin, Q, which projects through a slot in the shaft, so as to connect with an exterior collar or ring, P. This collar is adapted to slide freely upon the shaft, and is formed upon opposite sides with two projections, each containing a conical recess. A second ring, P′, is mounted upon the shaft, but is fixed thereto between the ring P and fly-wheel. It is also provided with projections having conical recesses, and the two rings are united by pointed pins R, placed between them, with their points in the conical recesses. This arrangement is employed to prevent the holding and guiding pin Q from binding within the slot of the shaft when the collar P is being moved by the governor.

The driving-wheel S is made with a long hub fitting loosely upon the shaft, and terminating at its inner end in a grooved pulley, *h*. *i* is a collar or plate mounted upon the end of the shaft, so as to bear against the flat outer end of the wheel-hub, and held in place by the enlarged head of an adjusting-screw, *l*, fitting into the end of the shaft. The collar is prevented from turning upon the shaft by a short tongue projecting from its inner circumference into a slot or groove in the shaft, which slot should be of sufficient length to permit the adjustment of the collar and wheel when required. The two collars P and *i* clamp the hub of the driving-wheel between them, and thereby transmit its motion to the shaft. *g g* are washers of cloth, leather, or other suitable material, placed upon the shaft between the collars P *i* and the ends of the wheel-hub, for the purpose of increasing the friction between such parts and preventing wear. H are bent springs, interposed between the governor-levers upon opposite sides of the shaft, and exerting their force outward, so as to spread the levers apart, and hold the collar P and wheel-hub against the outer collar *i*—or, in other words, to preserve the frictional connection between these two collars and the hub by spreading the governor-levers, so as to straighten the toggle-joint formed by the connecting-rod M and links L. When the speed of the shaft becomes too high, the governor-balls are thrown outward by centrifugal force, overcoming the tension of the springs H, and

causing the links L to spread apart, and, by retracting the connecting-rod M, withdraw the collar P from the wheel-hub. This breaks the frictional connection between the two, and allows the shaft to decrease in speed until a reduction of the centrifugal force causes the governor-balls to approach the shaft, and again establish the connection. The force with which the wheel-hub is clamped between the collars is regulated by adjusting the collar *i* upon the shaft, so as to press the hub with greater or less strength against the collar P when the shaft is at rest. This pressure, of course, is continued for a longer or shorter period, according to the adjustment, when the shaft is in motion. The bent springs counterbalance the centrifugal force of the governor-balls until the shaft has attained or nearly attained the speed requisite for feeding the fillet of paper in transmitting and recording a message, and their tension may be adjusted by any suitable means to regulate the centrifugal force required for throwing out the governor-balls and disconnecting the friction-collars from the wheel-hub—or, in other words, to determine the speed at which the shaft shall run to feed the paper; but as the weight of the balls is considerable, and a strong spring is necessary to counterbalance their centrifugal force, and as the spring requires a very delicate adjustment, I prefer to construct the apparatus in such manner that the stout bent springs shall operate to counterbalance the centrifugal force of the balls up to nearly the speed required, and that additional auxiliary springs, capable of fine adjustment, shall be employed to furnish the force that is necessary, over and above the force of the bent springs. These auxiliary springs J J are made in the form of spirals, and are arranged to connect two governor-balls across the shaft, being secured to adjustable friction-pins T, which are held in the balls by set-screws K. By means of the set-screws and friction-pins, the tension of the springs J can be finely adjusted to determine the force required, in excess of the bent springs, to counterbalance the centrifugal force of the balls that is necessary for disconnecting the friction-collars and wheel-hub. The speed of the shaft, and therefore the movement of the paper, can be correctly gaged to correspond in all the instruments along the telegraph-line, and thereby insure accuracy in transmitting, recording, and reproducing a message—or, in other words, so that the slits in the fillet of paper, which constitute the recorded message, shall be of the same length for the respective signs at all the stations.

The distance to which the governor balls are thrown out centrifugally is fixed by arms H^2, arranged between the bent springs, or by any other device suitable for the purpose. N N are racks projecting transversely of the shaft from that part of the governor-levers next the fly-wheel, to engage, respectively, with the upper and lower side of a pinion, K′, which is mounted within the shaft so as to rotate at right angles thereto.

This arrangement of mechanism is employed to equalize the movements of the governor-balls, and is best shown in Fig. 6 of the drawings. An equivalent of this device would be an arm from each lever extending toward each other from opposite sides of the shaft, and articulated to opposite ends of a lever pivoted in the center to the shaft, which construction I propose to use when desired.

Motion may be imparted to the shaft B in a variety of ways, one of which consists in connecting the motor to the grooved pulley *h* by a band; but for convenience and economy I employ electro-magnetism, in the following manner: On the long hub of the driving-wheel is placed an insulating-cylinder, *e*, provided with two grooved metal bands, *b* b^1, and with two grooved intermediate half-bands, *c* c^1, which are detached from each other at the ends. These various bands are arranged parallel to each other, the outer one, *b*, next the wheel, and the inner one, b^1, on the inner end of the hub.

w w^1 w^2 w^3 are metallic joints attached to the frame of the machine, beneath the driving-wheel, to support upright arms y^2 in front and rear of the hub, and *a* a^1 a^2 a^3 are beveled rollers, hung upon the upper ends of the upright arms, so as to fit within the grooved bands in the following order, viz: the roller *a* within the half-band c^1, the roller a^1 upon the same side of the hub within the band b^1, the roller a^2 within the band *b*, and the roller a^3 within the half-band *c*.

a^{10} are insulating-eveners, connecting each pair of upright arms y^2 upon opposite sides of the hub, and a^{11} is a spiral spring, connecting the two eveners, so as to draw the arms toward the wheel-hub, and press the beveled rollers equally against the grooved bands.

The positive and negative poles of the battery employed are connected, respectively, to the joints *w* and w^3, while the two remaining joints, w^1 w^2, receive, in the order named, the ends o^6 and o^7 of a helix placed within a magnet, D′′′′′, which is suitably arranged upon the frame, and properly insulated therefrom. This magnet is composed of two covers or plates, O O′, of soft iron, mounted one upon the other, so as to inclose the helix between them; but the helix is insulated from the covers, and its convolutions are insulated from each other.

w^5 is a rock-shaft, (shown in Fig. 14,) arranged diametrically of the covers, and provided with a series of permanent magnets, *s*, which are alternately attracted and repelled to oscillate the shaft when the charge of electricity from the battery is sent through the helix to magnetize the covers. w^4 is an upright rod firmly fixed to the rock-shaft of the magnet, and jointed at its upper end to an arm, Z, which, in its turn, is pivoted to wrist-pin on the side of the driving-wheel.

By this means the driving-wheel is rotated

when the rock-shaft is oscillated by the changes of polarity in the magnet. By giving the permanent magnets *s* a long oscillation within the soft-iron covers, and arranging the wrist-pin of the driving-wheel to correspond therewith, more power is obtained from the same magnet than could be obtained if the oscillations were short. For this purpose the covers are so constructed that the distance between them shall be greatest at the arcs through which the ends of the parallel magnets move, as shown in Fig. 19.

The simplest method of effecting this change of polarity is to send the charge from the battery through the positive roller *a* and its half-band c^1; thence through the whole band *b*, such bands being suitably connected, and from the band *b*, through the roller a^2 and its arm, to the end o^7 of the helix. This tips the parallel magnets in one direction to move the driving-wheel, and as the latter rotates it brings the half-band c^1 in contact with the negative roller a^3, and the half-band *c* in contact with the positive roller *a*. The band b^1, having a suitable connection with the half-band *c*, conducts the current to the roller a^1, and thence to the end o^6 of the helix, for the purpose of changing the polarity of the magnet and oscillating the rock-shaft in the opposite direction. By this constant change in the polarity of the magnet the rock-shaft is oscillated to rotate the driving-wheel continuously, as above stated.

For the purpose of equalizing and regulating the speed of the shaft I employ a governor in connection with the driving-wheel, and to prevent an unnecessary waste of power generated by the battery I employ a resistance-coil in connection with the governor. This governor is composed of a ring, x^2, held at the face of the driving-wheel by radial arms x^3, which together form a rock-shaft, having its bearings at the rim of the wheel, but insulated therefrom. The ring is further provided upon opposite sides, at right angles to the shaft, with two governor-balls, x^4, arranged in line with each other, one being adapted to carry a platina-faced conducting-roller, x^5. The normal position of the governor is such as to hold the two balls at an angle with the face of the driving-wheel, and is effected by means of an adjustable spiral spring, v^4, connecting the end of an adjusting-pin, v''', at the inner face of the wheel, with an arm, u^2, projecting from the ring inward toward the wheel-hub. The tension of this spring pulls the inner end of the arm outward toward the face of the wheel, and, therefore, holds the two balls inclined to its axis of rotation. *v* v' are conducting-springs, insulated from and arranged beside each other upon the wheel outside the governor. One end of each is secured to, but insulated from, the wheel, while the opposite end is free and lies in the path of the governor-roller x^5. When the driving-wheel is at its lowest speed the governor-balls occupy their greatest inclination to its face, and hold the roller x^5 outside and out of contact with the conducting-springs. As the speed increases the governor is thrown in by centrifugal force to a position nearer at right angles to the axis of rotation, and, therefore, carries the roller in contact, first, with the outer spring v', and then with the inner spring *v*. The tendency of the spring v^4 is to counterbalance the centrifugal force of the governor, and return it to its normal position, as above stated. The outer spring v' has electric connection with the half-band c^1 on the wheel-hub, and the governor-ring has a similar connection with the whole band *b*. When, therefore, the current of electricity is sent through the positive roller *a* into the half-band c^1, it passes from the latter to the outer spring v', and if the driving-wheel is moving at low speed, so as to carry the roller x^5 in contact with such spring, the current passes along the spring to the roller, thence down the roller-arm to the ring, and into the band *b*. From the band *b* it passes to the helix for oscillating the permanent magnet, the rotation of the driving-wheel changing the direction of the current from the positive roller to the half-band *c* and band b^1, the two being directly connected, and, therefore, changing the polarity of the magnet, and continuing the rotation of the wheel, as hereinbefore described.

Now, if the governor-roller should constantly maintain its contact with the outer conducting-spring v', the speed of the driving-wheel would increase until it attained too high a velocity for practical purposes. This is apparent from the fact that after the first change in the polarity of the magnet the wheel acquires a certain momentum, which effects the next change a little sooner, and so on, until the wheel would be accelerated to such an extent as to make the current of electricity through the magnet almost continuous. This, of course, would consume the whole power of the battery, and therefore exhaust it much sooner than if only that power, or approximately that power, is employed to drive the wheel at the requisite speed.

To prevent this exhaustion and waste of power, the inner spring *v* is employed, in connection with a resistance-coil, w', which, for convenience, is wound upon the periphery of the driving wheel, although it may be located at any point upon the frame of the instrument by suitable means. One end of the resistance-coil is connected to the inner spring *v*, and the opposite end to the outer spring v'. When the speed of the wheel becomes so great that its centrifugal force carries the governor-roller inward, in contact with the inner spring *v*, and so breaks the circuit through the outer spring v', the positive current passing from the half-band c^1 to the outer spring v', as above described, goes through the resistance-coil to the inner spring *v*, thence to the governor-roller, and so on to the magnet, following the course already described.

Since the short circuit formed by the gov-

ernor-roller and outer spring is broken by the centrifugal force of the governor, the only course for the current to follow is through the resistance-coil. This diminishes the current somewhat, and therefore slackens the speed of the wheel to a slight extent, and allows the governor-roller to move outward toward the outer spring v', and again break the circuit through the resistance coil. The governor-roller, therefore, acts as a circuit-breaker, breaking the circuit with one spring and closing it with the other alternately. It maintains a constant vibration from one to the other, rapidly throwing the resistance-coil into and out of the circuit, and consequently sustaining the wheel at a uniform velocity without exceeding the minimum quantity of battery-force required to perform the work.

When the instrument is at rest, the spring v^4 holds the governor-roller outward from the shaft B, and breaks the connection with both springs v and v'. To start it in motion, I have provided a holder, o^{10}, pivoted to the inner face of the fly-wheel, being insulated therefrom. By turning down this holder it presses against the inner governor-ball, and forces the governor-roller inward in contact with the outer spring v', to close the circuit from the battery to the magnet. After the wheel has acquired momentum, the holder o^{10} is automatically thrown back against the wheel by coming in contact with a trip or stop, w'''', pivoted to a short upright, w''', of the frame beneath the driving-wheel. The stop is weighted, as shown at w^4, so as to keep it out of contact with the holder until it is swung into the path of the latter by the operator.

When the power of the battery is too slight to impart the requisite motion to the driving-wheel, the governor-roller is thrown inward by the counterbalancing-spring v^4, to break the circuit and stop the instrument, thus preventing it from transmitting or recording at too low a speed.

An induction-coil and local battery are placed at each station, and the main line is operated by passing a current from the battery alternately through two helices contained within the coil, but wound in opposite directions, as I will more particularly point out at its proper place herein. In transmitting a message, therefore, from one station to another, the main line is worked by an induced current alternately reversed. The mechanism for effecting this reversion is constructed as follows, being operated by the fillet of paper containing the record to be transmitted as it is drawn through the instrument by the feed-cylinder E when the driving-shaft revolves.

O'' is a guide-bed, having a sleeve, O''', secured to its under side, so as to fit over an upright shaft, o', upon the main frame, and hold the bed in a horizontal position in line with the feed-cylinder E in rear thereof.

The upright shaft is insulated from the main frame, and a front projection, n, of the sleeve is connected by a flat spring, n', with an adjustable holder, n'', attached to one of the front uprights of the frame. This forms a yielding connection, and permits a slight lateral swing to the bed, for the purpose of compensating for any irregularities in the movements of the paper containing the record to be transmitted, and to insure the proper guidance thereof to the feed-cylinder. The extent of this lateral swing is regulated by adjusting the holder n'' upon its upright. m m', Fig. 29, are two parallel grooves formed longitudinally in the upper surface of the guide-bed to receive the embossed tracks made in the record by the recording-instrument. They are necessarily the same distance apart as the grooves in the feed-cylinder, and are also in line therewith, as shown. i''' is the inner side of the guide-bed, raised somewhat, and made adjustable by any convenient means to regulate its position for guiding the edge of the paper, so that the embossed tracks shall be directed and held within the grooves of the bed. This adjustable side is also formed with recesses along its inner edge, as shown in Fig. 29, for the purpose of preventing the edge of the paper from curling up or wrinkling as it is drawn over the bed. i'''' is a pressure-bar arranged upon the opposite edge of the guide-bed, being secured to cross-bars i' i'', which slide within deep transverse grooves cut in the bed. The cross-bars are formed with shoulders to bear against the edge of the moving paper and hold it up to the gage-side i''', while springs f', attached to the outer edge of the bed and bearing against the pressure-bar, cause the shoulders to act with a yielding pressure, and therefore conform to the varying width of the paper. The pressure of the bar is regulated by set-screws f'''' passing through the outer fixed edge of the bed, so as to bear against the springs, and the movement of the bar toward the gage-side, after the paper has passed out, is limited by a pin, f^6, driven into the bed near the outer groove, as shown. m'' is a cover hinged at the inner edge of the guide-bed to hold down the fillet of paper, the amount of pressure with which it bears upon the latter being regulated by a set-screw, f^5, passing upward through the bed, so that the cover shall rest upon its point. The cover may be held down by a spring, if desired; but I prefer to employ a weight, h', pivoted to one of the hinges, so that it may be swung round to regulate the weight of the cover on the adjusting-screw f^5.

The ends of the cross-bars i' i'' project through the adjustable gage-side i''' of the bed, just beneath the upper leaves of the cover-hinges, and, when the cover is thrown open, these upper leaves bear against the projecting ends of the bars and force back the guide-shoulders, thus preparing the bed to receive the paper fillet containing the record for transmission.

Two parallel V-shaped ribs or rails extend along the under side of the cover in such a position as to fit into the grooves of the bed, for

the purpose of properly-guiding the fillet of paper and preserving the form of the embossed tracks therein as it is drawn along over the bed.

k''' is a short horizontal shaft, so secured to the edge of the cover as to extend across the middle thereof, and $e''' e'''$ are hubs mounted loosely thereon. $e' e'$ are light metallic track-fingers secured to the hubs parallel to each other and extending forward of the same, so that their points shall project down through openings in the cover and its ribs, and rest in the embossed tracks of the paper fillet on the bed beneath.

Each hub is also provided with a short arm, extending along the track-fingers, and the arms carry set-screws k' at the end, the points of which bear against the sides of such fingers.

j' is a block secured to the cover in front of the fingers, and formed with narrow slots, through which the ends of the fingers pass. These slots guide the fingers in the embossed tracks of the paper, while the set-screws k' serve to accurately adjust the position of the fingers within the tracks, and prevent friction against the sides of the slots.

Springs k'', secured at one end to the hubs of the fingers, and at the other end to a suitable part of the cover, hold the fingers down within the tracks with a yielding pressure.

j'' is the handle, pivoted to the top of the cover in rear of the track-fingers, and provided with a weighted extension, j''', which holds it in an upright position by resting upon the cover in rear of the pivot.

The front of the handle near the pivot is formed with a right-angular projection, as shown in Fig. 26, one arm, j'''', of which extends over the short rear ends of the track-fingers, and, when the handle is swung forward, bears down upon them to raise the points from the tracks of the paper. The other arm, j''''', extends downward, and limits the forward movement of the handle by coming in contact with the cover.

If desired, the track-fingers may be connected with the cover in many different ways without departing from the principle of my invention in this regard, which consists in adapting such track-fingers to press upon the embossed tracks of the paper with a yielding action, and to be raised for the insertion of the record in the guide-bed.

b''' is a fixed pin upon the under side of the guide-bed in front of the sleeve, and g''' is a permanent magnetic bar, secured centrally to the lower end of the pin, so as to lie in a horizontal position. b'' is a short horizontal shaft secured to the under side of the guide-bed to receive the hub b'''' of a pendent arm, C″, and form a bearing, upon which said arm swings from side to side under the guide-bed. The lower end of the arm terminates in a soft-iron ring, g'', through which the magnet g''' projects to limit the lateral swing of the arm.

b''''' is a steel or other rock-bar, extending across the top of the hub, with its ends immediately beneath the points of the track-fingers.

When the fillet of paper containing the record is moved over the guide-bed, the points of the track-fingers alternately pass down through the slits which form the record, and lie along the embossed tracks, and bear upon the ends of the rock-bar, to oscillate the swinging arm C″.

$c''' c'''$ are platina hammers, secured to opposite sides of the swinging arm C″, to alternately strike the faces of two platina anvils, $g'''' g''''$, when the arm is vibrated. The anvils are supported by arms pivoted to opposite sides of the fixed pin b''', being insulated therefrom and from each other. They are also made adjustable by any suitable arrangement of devices. In this instance their inner faces are inclined downward and outward, so that the adjustment may be effected by swinging the arms on their pivots to raise and lower the anvils. Each anvil is connected to the local battery by a separate wire, t^{10}, which passes first through one helix of the reproducing-magnet, then through one helix of the calling-in magnet, and lastly through a helix contained in the induction-coil.

y is a bent support, secured to the under side of the guide-bed in front of the vibrating arm C″, and bearing upon the upper side of its arm a platina point, y'. Another like point, y'', is placed opposite the first upon the under side of the guide-bed, and the two points are properly insulated from each other. y''' is a bent lever, hung to the lower front edge of the guide-bed, in such a manner that the platina hammers on the upper and lower sides of its rear end shall alternately strike the points $y' y''$. This end of the lever is weighted, so that its lower hammer shall bear upon the lower platina point when at rest. The opposite end extends upward a little above the level of the guide-bed, where it terminates in a scroll or curvature, y'''', over which the record-fillet passes when drawn along by the feed mechanism. The weighted lever is insulated from the guide-bed, and connected by a wire, t^{11}, with that pole of the local battery opposite the pole with which the wires t^{10} of the anvils $g'''' g''''$ are connected; or, in other words, the wire from the weighted lever is connected with the positive pole of the battery, and the wires from the anvils $g'''' g''''$ are connected with the negative pole.

V″ is a lever, pivoted at K^2 to one of the uprights of the frame above the feed-cylinder E, and carrying at its lower end a horizontal pressure-roller, V′, covered with leather or other suitable material. A spring, K^3, attached at one end to the frame or to the pivot K^2, and bearing with its opposite end upon the lever, holds the pressure-roller against the feed-cylinder with a yielding pressure, so that the teeth or points of the latter shall seize and feed the paper along without danger of its slipping. The spring K^3 is made adjustable by

any suitable means to regulate the pressure of the roller against the cylinder. The upper arm of the roller-lever terminates in a finger-piece, adapted to engage with a latch, $r\,r'\,r'''$, pivoted to the upright of the frame, for the purpose of holding the pressure-roller out of contact with the feed-cylinder when desired.

When a message is to be transmitted the fillet of paper in which it has been cut by the recording-instrument is placed upon the guide-bed under the cover, and passed to the feed-cylinder over the curved upper end of the weighted lever y'''. The pressure-roller is then let down to hold the paper up against the feed-cylinder, which is in motion, as already explained. As the fillet of paper is drawn along, its tension bears down the curved end of the weighted lever y''', and throws up its inner end, so that the upper platina hammer thereon shall be held in contact with the upper platina point y'' on the guide-bed. The points of the track-fingers, riding along in the embossed tracks of the paper, drop through the slits therein, to alternately press down the ends of the rock-bar b'''', and move the pivoted arm C″ to the right and left.

The permanent magnet g''' at the end of the pin b''' attracts the soft-iron ring forming the lower end of the arm C″, and holds it against recoil or rebound until the arm is again moved by the alternate pressure of the track-fingers. These vibrations of the arm C″ carry its hammers $c'''\,c'''$ alternately in contact with the anvils $g''''\,g''''$, and thus establish a circuit from the positive pole of the local battery, through the weighted lever y''', to one or the other of the wires attached to the anvils, and from these wires through the helices of the recording and calling-in magnets above named; thence through the helices of the induction-coil in the main line, and back to the negative pole of the battery. The vibrations of the arm C″ therefore make and break the circuit through the wires of the anvils $g'''\,g'''$, and thus alternately reverse the direction of the current induced in the main line; or, in other words, the currents are alternately sent through the helices of the induction-coil in opposite directions to induce alternately-reversed currents in the main line. The length of time during which the currents are induced through the main line depends upon the length of the slits in the record, which, of course, retain the track-fingers in contact with the ends of the rock-bar a proportionate length of time. As the signs which constitute the message-symbols are formed by slits of different lengths in the fillet of paper, it follows that the time between the duration of the electric currents induced in the main line will exactly correspond to the distance between the beginning of one slit and the beginning of the next adjoining slit in the opposite row of the record from which they are produced, as above set forth. If, therefore, these induced currents are made to produce other slits in a fillet of paper, such slits will be fac-similes of those in the first fillet or transmitted record. This reproduction of a transmitted record at any of the stations along the telegraph-line forms a succeeding step in my invention, which I will presently describe.

g'' is a curved guide, secured to one of the uprights of the frame beneath the feed-cylinder E, for the purpose of directing the fillet of paper away from the guide-bed and out of the instrument after the record has been transmitted. After the fillet of paper has passed out of the instrument or ceases to move, the pressure upon the curved end of the weighted lever y''' is relieved, and its weighted end drops down so that the platina hammer on its under side shall rest upon the platina point y'. This breaks the connection with the upper point y'', and sends the current from the local battery to the receiving-magnet D′ through a wire, t^{12}, connecting the oscillating shaft d^2 of such magnet with the lower platina point y'.

Each station on the line is provided with a magnet, by which the message transmitted from another station is received and communicated to the reproducing magnet or instrument. The receiving-magnet is indicated by D′ in the drawings, and is composed of two annular covers, O O′, of soft iron, mounted one upon the other, so as to inclose two helices, c^8 and c^9, between them, as shown in Fig. 15, one helix being placed within or surrounded by the other. They are wound in the same direction and insulated from the covers and from each other, while the convolutions of each are also properly separated by insulation.

o^6 and o^7 are, respectively, the outer and inner ends of the outer helix, and o^8 and o^9 are, respectively, the outer and inner ends of the inner helix. The inner helical wire is made considerably shorter than the outer, and therefore possesses only about one-fourth the conducting resistance of the latter, so that when a current is sent through both helices simultaneously it will contain more magnetic power in proportion to the conducting resistance of the helices than it would if the length of the two helical wires were equal. The outer end o^6 of the outer helix and the inner end o^9 of the inner helix are connected directly with the main telegraph-wire t^9, as shown in Fig. 31, while the inner end o^7 of the outer helix and the outer end o^8 of the inner helix are adapted to be automatically connected when a message is received and reproduced, but separated when the station to which they belong is not receiving a message, as I will hereinafter describe. d^2 is a rock-shaft, arranged across between the covers, and supported at the ends by knife-edges secured to the lower cover. It is provided with a series of permanent magnetic needles, d^{12}, placed parallel to each other, which are alternately attracted and repelled to oscillate the shaft when the induced current in the main line is sent through the helices $c^8\,c^9$ to magnetize the covers. d^3

is an upright arm, mounted upon the magnetic needles, and carrying a cross-bar at its top. The ends of the cross-bar are provided with platina hammers d^{14}, which, when the arm is vibrated by the magnetic needles, alternately strike against platina anvils d^4 upon the faces of the collars or rings d^5. These rings are fixed eccentrically to the tops of stems d^7, which, in their turn, are supported in upright tubular bearings or shafts d^6, mounted upon the upper plate O of the magnet. The eccentrics are insulated from the soft-iron covers, and from the tubular bearings, by means of insulating-tubes d^{10} d^{10}, placed around the stems within the bearings, as shown in Fig. 15, so as to hold the lower ends of the stems above and out of contact with the magnet-cover O. The insulating-tubes are each formed with a flange at its upper end, which holds the eccentrics out of contact with the top of the tubular bearings, and therefore insulates one from the other. Any other method of insulation may be adopted, of course, the object being to insulate the eccentrics from the magnet-covers and tubular bearings. By means of the eccentrics the position of the anvils can be adjusted to regulate the throw of the hammers upon the vibrating arm when desired, the eccentrics being held in place by the frictional contact of their stems with the insulating-tubes. The stems of the eccentrics are connected by wires d^8 and d^9 with the anvils g'''' g'''' of the transmitting-instrument, or with the wires of such anvils, as shown in Fig. 31. The wires d^8 and d^9 pass through the sides of the tubular bearings d^6, and are properly insulated therefrom.

When a message is to be received at the designated station, the weighted lever y'''' of the transmitting-instrument rests down upon the platina point y', which, as hereinbefore stated, is connected by a wire with the shaft d^2 of the receiving-magnet, and the inner and outer helices of the latter are automatically joined, so as to form one long helix interposed in the main line. The induced currents or pulsations of the main line, which constitute the measure of the message-symbols transmitted, and the index of those reproduced, are alternately sent through the long helix in opposite directions, to oscillate the shaft d^2 of the receiving-magnet, by changing the polarity in its soft-iron covers for each symbol.

The oscillations of the shaft vibrate the upright arm d^3, and carry its platina hammers d^{14} alternately in contact with the platina anvils on the eccentrics d^5. When this contact is effected, the electric current from the positive pole of the local battery passes, through or along the wire t^{12}, Fig. 31, and intermediate devices, to the shaft d^2 and its arm d^3; thence through the eccentrics and stems to the wires d^8 and d^9, and from thence along the wires of the anvils g'''' g'''' through the reproducing and calling-in magnets, and finally through the primary helices of the induction-coil to the negative pole of the battery.

It will thus be seen that the polarity of the receiving-magnet is changed by the reversal of the currents in the main line, while the calling-in and reproducing magnets are worked by the direct or primary current from the local battery. The action of the primary current upon the reproducing-magnet and its devices is continued as long as the contact is maintained between the hammers and their respective anvils in the receiving-magnet, and this contact continues in each case until the shaft d^2 is oscillated by the reversal of the currents in the main line, which, as above described, is effected by the track-fingers of the transmitting-instrument working in the slits of the record being transmitted, to vibrate the circuit-changing arm C''. The duration of the contact between the hammers and anvils of the receiving-magnet, being thus governed by the lengths of slits in the record transmitted, causes the reproducing devices to remain in action a corresponding length of time, as I will presently show in describing their construction and operation. Therefore the record from which the message is sent at the transmitting-station will be reproduced in fac-simile at the receiving-station.

The primary helices of the induction-coil are all so wound with respect to such coil that the currents which they induce therein (by the passage through them of the primary current from the local battery) shall be in prolongation of the respective pulsations or currents which send the message. For example, in transmitting a message one current forming a symbol will move along the main wire—say, eastward—and the current from the local battery at the receiving-station will pass through the various instruments at that station, and through its proper helix in the induction-coil back to the battery; but its direction through the helix will be such as to induce an eastward current in the main line in prolongation of the symbol-current; and when the symbol-current is reversed, the current in the induction-coil will be also reversed. The winding of the induction-coils and their helices must be, respectively, the same at all the stations of the main line, so that each induced current in such line shall be in the same direction from each induction-coil, to augment and re-enforce the message-currents by the local battery at each station of the line between the transmitting and receiving stations.

D^6 represents the induction-coil interposed in the main wire t^9 t^9, and D^7 D^7 the helices wound therein, one within the other, around a central core, D'''', of soft iron. They are each joined to the local battery, the calling-in and reproducing magnets, as hereinbefore described, and are of such length and size as to produce by one battery an equal amount of magnetism in the core.

The core or magnet of the induction-coil is made in several sections, joined together at the ends, in line with each other, by means of adjusting-screws e^6. This construction enables the sections to be adjusted within the limit of the screws, to regulate the time required for magnetizing and demagnetizing the several sections.

In order to increase the quantity of the induced current, additional sections are employed, and the coil increased in length instead of in diameter. This permits the use of thicker wire without increasing the conducting resistance of the induction-coil as much as would be the case if the coil were increased in diameter instead of in length.

The special advantage arising from the use of a double or compound helix, in connection with the induction-coil and one battery, is, that it insures uniformity in the force of the currents induced in the main line, and therefore secures the automatic formation of the message-symbols of the requisite relative sizes throughout the whole line; or, in other words, the currents from one battery will be the same in force, whether passed through one or the other helix, and will consequently prevent like message-symbols from differing in length when formed by the passage of the current through either helix.

Two batteries—one for each helix—could not be practicably employed, because of the constant liability of the current from one to differ in force from the current from the other, thereby preventing their uniform action, and destroying the possibility of automatically making the message symbols of the requisite sizes.

If an adjustable resistance-coil were used in connection with an ordinary galvanometer in each circuit, and the resistance adjusted to make the currents equal, the two batteries might work very well at first, and for a limited time; but as the batteries would diminish in force irregularly, the same difficulties arising from want of uniformity in the force of the two currents would occur, unless the resistance were constantly adjusted by suitable means. If but one primary helix should be used in the induction-coil, and the primary current should be broken and closed by one of the platina anvils and hammers, the advantage of using the power of the local battery to demagnetize the iron core in the induction-coil would be lost in the transmission of each message-symbol; or, if a reverser should be substituted, so as to be operated by the receiving-magnet to reverse the primary current of a single primary helix in the induction-coil at each transmission of a message-symbol, there would be an occasional imperfect reversion of the symbol currents in the consequence of the lack of power in the receiving-magnet to work the reverser.

In transmitting a message, the station to which it is sent for reproduction is first "called in"—that is to say, put in communication with the transmitting-station through the main wire.

To accomplish this, each station on the telegraph line is provided with two distinct signals, not employed at any other station—to wit, one for throwing the reproducing devices into operation, and the other for throwing them out of operation. These signals consist in the repetition of a message-symbol a greater number of times than it is formed consecutively in any one word. For example, the repetition of the letter A four times may be the signal for calling in one station, and the repetition of the letter B four times the signal for calling in another station, and so on. These signals are cut in the record the same as the other message-symbols, but are only effective to control the reproducing devices at the station for which they are designed, or for which they form the index.

When a record or fillet of paper is cut for transmittal to a particular station, the calling-in signal for that station is cut just in front of or before the message, and the signal for throwing out the station, or rather its reproducing devices, is cut in the paper immediately after the message, so that when the record is laid in the guide-bed at the transmitting-station, and the feeding devices set in motion, it will automatically call in the proper receiving-station, transmit the message thereto, and then throw its reproducing devices out of operation.

The mechanism for calling in a station and for the reproduction of a message thereat is constructed as follows: D″ is the magnet of the reproducing devices, and D‴ the calling-in magnet. The latter is arranged under the frame of the instrument, in line with the registering-wheel, and the former has a special arrangement, as I will presently show. These magnets are each composed of two soft-iron annular covers, O O′, inclosing two helices wound one within the other, and of oscillating cross-shafts carrying permanent magnet-needles, the construction in these several respects being the same as the receiving-magnet D′.

The outer ends of the two helices in the magnet D″ are, respectively, joined to the wires of the anvils g'''' g'''' in the transmitting mechanism, while the inner end of the outer helix and the inner end of the inner helix are joined, respectively, to the outer ends of the two helices in the magnet D‴. The inner ends of these latter helices are connected, respectively, with the two primary helices in the induction-coil, as shown in Fig. 31.

The winding of the corresponding helices in the magnets D″ D‴, as well as in the receiving-magnet D′, must be in the same direction at all the stations, in order to maintain the same direction for each current throughout the line. d^{13} d^{13} are upright arms mounted upon the parallel needles of the calling-in magnet D‴, upon opposite sides of the cross-shaft,

so as to extend upward through an opening in the bottom of the frame, as shown in Fig. 2. The upper ends of the arms are united at the top by a cross-bar, m^2, the ends of which carry metallic plates m^3, having faces inclined toward each other from opposite sides of a registering pin-wheel, E″, as shown in Figs. 8 and 10.

When the primary current from the local battery is alternately sent through the helices of the calling-in magnet, it oscillates the shaft thereof by the magnetism of the soft-iron covers, and therefore vibrates the plates m^3, to alternately strike the ends of the pins and drive them through the wheel. This wheel is firmly keyed to a counter-shaft, E‴, having its bearings in the two front uprights of the frame beneath the driving shaft B and parallel therewith. The counter-shaft E‴ is provided with friction-wheels u, which support the driving-shaft B, and therefore communicate its motion to such counter-shaft. Any other convenient means may be employed for driving the counter-shaft from the shaft B; but I prefer the friction-wheels as being the most simple and affording the minimum amount of friction.

The wheel E″ is constructed with a grooved periphery, and through the parallel flanges thereby formed at the edges are passed a series of transverse pins, m^4, so as to move freely from side to side. The pins lie parallel to each other, and form a row entirely around the wheel, with their ends projecting a little beyond the faces of the latter. m^7 is a band, passing around the wheel between the flanges, and bearing upon the pins to keep them in place, save at the bottom of the wheel, where the pins receive upon their ends the action of the inclined plates m^3. At this point the band extends below the wheel around a pulley, m^8, and the pins are thus relieved from its pressure. The pulley is mounted upon a spring, q^5, secured to the frame of the instrument under the wheel, and adapted for adjustment by any suitable means to regulate the tension of the holding-band. The pulley and spring are arranged slightly in rear of the wheel, as shown in Figs. 1 and 8.

m^5 and m^6 are two sleeves, mounted loosely upon the shaft E‴, one on each side of the wheel, and provided with radial arms m^9, projecting to the front and rear of the shaft upon opposite sides of the wheel. Two frames, n^2 and n^3, are mounted one upon each of these arms, so as to move freely toward and from the sleeves. They are constructed substantially alike, and for this reason it is only necessary to give a detailed description of one in order to a full understanding of both.

The frame n^2, which is the one I have selected for description, is composed of the following parts, to wit: Nearest the sleeve is a segmental brace or guide, n^4, fitted upon the radial arm m^9, and carrying at its ends two radial diverging arms, n^5, which extend to the periphery of the wheel, and are there secured to one edge of a slotted segmental strip or plate, n^6. This plate lies in a plane at right angles to the diverging arms, and extends laterally over the wheel, so that the latter shall project slightly through its slot, as shown, the lower end of the frame being curved or bent outward to prevent it from coming in contact with the band when moved forward with the wheel.

The inner proximate edges of the slot are formed with several projections, n^{10}, which are held down upon the ends of the pins upon each side of the wheel by the tension of a flat spring, n^8, connecting the two diverging arms of the frame, and secured centrally to the radial arm m^9 of the sleeve. The frames are thus supported upon and by the pins with a yielding pressure, so that the wheel shall revolve and carry the pins out from under the projections without moving the frames. The frames thus remain stationary, while the wheel revolves until such times as the projections are locked to the pins for the purpose of moving the frames.

The projections n^{10} are not arranged directly opposite each other across the slots; but the spaces in one edge are opposite to and receive the projections in the other edge.

The frame n^2 is employed for calling a station into the main line to receive and reproduce a message, and the frame n^3 is employed to throw the station out of communication with the transmitting-station when the message has been sent. The frame n^2, therefore, is the medium to be influenced by the calling-in symbols cut in the record immediately preceding the message to be transmitted, and the frame n^3 is the medium to be influenced by the throwing-out symbols cut in the record immediately after the message.

When it is desired to call in a station for the reception and reproduction of a message, the signals for such station are first transmitted and actuate the receiving-magnet at the receiving-station, so as to send the primary current from the local battery through the calling-in and reproducing magnets. The vibratory changes of the track-fingers at the transmitting-station change the polarity of the several magnets at the receiving-station, as already explained, to oscillate their respective cross-shafts. This oscillation of the cross-shaft in the calling-in magnet vibrates the upright arms d^{13}, and causes the inclined plates m^3 thereon to alternately strike the ends of the pins in the revolving wheel E″ and move them through the flanges in opposite directions. The pins are, therefore, set by the calling-in signals, and when the wheel has revolved far enough to bring the set pins round to the frame n^2 they will not lie under the projections n^{10}, but within the spaces between them. The projections being thus removed from under the pins, the tension of the spring n^8 pulls the frame n^2 toward the sleeve m^5 within the path of the set pins, so that the lat-

ter shall bear against the notched lower edges of the projections n^{10}, when the wheel revolves in the direction of the arrow, Fig. 8, and carry the frame n^2 with them about two-fifths of a revolution of the wheel. It is then again moved out from the sleeve and remains stationary outside the pins of the moving wheel until it is carried back by suitable means to the point from whence it started. This backward movement takes place only after the message has been received and reproduced, and the frame n^3 is being moved by the throwing-out signals. In the frame n^3 the upper edges of the projections n^{10} are notched instead of the lower edges, as in the frame n^2, and the arrangement of the notches is necessarily different in the two frames in order to indicate different signals.

The configuration of the projections in each frame of a station must correspond to the calling-in and throwing-out signals which represent that station. For example, if the repetition of the symbol for letter A four times is the signal for a station, then the outlines described by the projections of its frames must be the same as the outlines described by the pins m^4 under the impulses of the reciprocating setting-plates m^3, induced, continued, and governed by such repetitions of the symbol. When, therefore, the wheel at the receiving-station revolves so that the outlines of the pins coincide with those formed by the projections on one or the other of the frames, the latter will be drawn toward the sleeve to engage with the pins, as above described.

The throwing-out signal may be the same as the calling-in signal of the same station; but if the latter is the repetition of a letter several times, say A four times, then it would perhaps be preferable to increase the number of repetitions for the former, say A five times; but I prefer to employ a different letter for the throwing-out signal.

Each station must have its separate signal, and its frames must be made to correspond therewith, so that the signal from one station shall never operate or otherwise affect the frame at another station, and each station is provided with the signals for all the others. Since, however, in transmitting a message from one station, all the magnets at all the other stations of the line are affected by the change in the direction of the transmitting-current, it follows that the pins m^4 at every station, including that which transmits the message, will be displaced by the reciprocations of the plates m^3, but that only the frame n^2 at the called station will be affected to set the reproducing mechanism in motion.

To restore the alignment of the pins, with their ends in the same plane upon opposite sides of the wheel, two beveled uprights, q^2, are secured to a plate, E′, on the bed of the instrument, and rise upon each side of the wheel, adjoining the path of the pins. The plate E′ is fastened to the bed of the frame, in front of the tension-roller m^6, and holds the uprights in rear of the reciprocating setting-plates m^3 on the arms of the calling-in magnet, so that the rotation of the wheel shall carry the pins between the uprights before receiving the action of the plates. The uprights are beveled from the rear inward toward the wheel, the widest space between them being a little greater than the whole space occupied by the pins when driven to the right and left, and the narrowest space just sufficient to allow the passage of the pins between them when their ends are in line each side the wheel. When, therefore, the pins have been moved by the setting-plates, the wheel carries them round to the beveled uprights q^2, by which they are again ranged in line with each other preparatory to the next action of the plates. Thus the pins are aligned at each revolution of the wheel at every station. There is a liability that the action of the setting-plates will drive the pins too far through the wheel to properly register with the frames; and to prevent this two other beveled uprights, q^3, are employed, rising from the bed of the instrument, or from the plate E′, upon opposite sides of the wheel, in front of the setting-plates, as shown in Figs. 8 and 10. They are placed farther apart than the uprights q^2, but are beveled in the same direction, their inner edges being separated just far enough to permit the passage of the pins when set to the proper point. If, however, the pins are driven too far by the setting-plates, they will strike the beveled faces of the uprights, and be moved back thereby, through the wheel, into the proper position for registering with the frames.

In case the uprights q^2 and q^3 are mounted upon the plate E′, the latter should be slotted for the passage and movement of the vibrating arms d^{13}, which carry the setting-plates.

The calling-in frame n^2 is so arranged that its lower diverging arm n^5 shall stand at a point, n^9, at the front of the wheel. It therefore starts from this point when drawn toward the sleeve m^5 to engage with the pins m^4, and moves forward with the sleeve and wheel until its upper diverging arm n^5 reaches a point, p^2, at the top of the wheel, when it is disconnected from, and thrown outside of, the pins by the following mechanism, there to remain until the message has been received and reproduced.

p^4 is a rod, secured at one end to the segmental brace n^4 of the frame, from which it extends to a collar, o^2, formed upon the outer end of the sleeve m^5. Its outer end fits within a radial slot of the collar, so as to work freely toward and from the sleeve with the movements of the frame. When the frame n^2 is moving forward with the wheel, and just before its upper diverging arm reaches the limit p^2 of its throw, the point of an upright cam or arm, p^5, secured to the bed of the instrument, so as to curve from the rear over the top of the sleeve m^5, passes between the latter and

the rod p^4, as shown in Fig. 13 of the drawings. The rod then rides along the outer edge of the cam, and is moved by its increasing width outward from the sleeve until the frame n^2 reaches the point p^2, when it is entirely disconnected from, and thrown outside of, the engaging-pins, and ceases to move with the wheel. The cam holds the projections of the frame out of contact with the pins, to prevent the wear of these parts by friction, and to guard against their casual movement by catching into each other.

The throwing-out frame n^3 is also connected by a rod, p^4, to a collar, o^3, at the end of the sleeve m^6, and, being arranged in rear of the shaft E''', starts from a point, n^9, at the upper side of the wheel, when drawn toward the sleeve to engage the set pins. It stands with its upper diverging arm n^5 at the point n^9, and its forward movement, with the wheel, terminates when the lower diverging arm n^5 reaches a point, p^3, at the back of the wheel. At p^3 the frame n^3 is thrown outside of, and held out of contact with, the engaging-pins, and ceases to move with the wheel, by means of an upright pointed cam, p^7, mounted upon the bed of the instrument, as shown in Fig. 12, the operation being the same as the operation of the frame n^2. p^6 and p^8 are angular levers, pivoted at their angles to the sides of the upright cams p^5 and p^7, respectively. They are arranged in opposite directions, so that their upper ends shall lie one in front of the sleeve m^5, and the other in rear of the sleeve m^6. Their lower ends are weighted and provided with adjusting-screws n^{12}, which are adapted to rest upon bearing-surfaces n^{13}, formed upon extensions of the upright pointed cams, as shown in Figs. 12 and 13.

When the throwing-out frame stands at its highest point upon the wheel, out of contact with the pins, the front side of the bar p^4 rests upon the upper end of the lever p^8, to lock the frame against forward movement until it is drawn toward the sleeve. When this takes place the bar also moves inward and clears the end of the lever, thereby releasing the frame, so that it can move forward with the wheel to the point p^3, as above described.

The upper end of the lever p^6, in order to lock the calling-in frame n^2, passes up in front of the bar p^4, and is notched or recessed to fit over such bar, when the frame is at its lowest point upon the wheel, out of contact with the pins. The catch-lever thus locks the frame against any forward movement until the throwing-out signal for the station is received, when the bar p^4 moves inward to clear the end of the lever and release the frame, so that it may move forward with the wheel, the same as the frame n^3.

The upper ends of the two locking-levers are prevented from moving with or following the bars p^4 inward by means of the adjusting-screws n^{12}, which screws also serve to regulate the distance between the levers and sleeves for the passage of the frame-bars p^4. The frames are arranged to move forward with the wheel at different times, and to move back against its revolution one after the other—that is to say, when the calling-in frame is moving forward with the wheel the throwing-out frame is riding back clear of the pins, and when the throwing-out frame is moving forward the calling-in frame is moving back to its normal position.

The mechanism for moving the frames back consists of two arms, o^4 o^4, secured, respectively, to the outer ends of the sleeves m^5 and m^6, so as to extend downward through slots in the bed of the instrument, where they are pivoted by rods o^5 to the extremities of a long lever or working-beam, o^{16}, hung at its center to the rear under side of the bed. When, therefore, the movement of either frame operates its supporting-sleeve, the working-beam, through its connecting parts, will move the sleeve of the other frame in the opposite direction.

For the purpose of securing accuracy and certainty in the operation of the frame, the movements of the working-beam are sharpened and quickened by the action of a jointed spring-lever, in the following manner: r^2 is the lever, secured at its rear end r^4 to the instrument, and extending forward to connect with one arm of the working-beam by a short pivoted rod, q^8. A spring, q^9, secured to the bed of the instrument, forces the lever toward the connecting-rod, and when the oscillations of the working-beam carry its arm in front and rear of the joint formed by the lever and rod, the spring acts to throw it quickly against the front or rear stop-pins r^5 r^6, which limit the sweep of the beam, as shown in Fig. 3.

The reproducing devices are constructed and operate as follows: l' is a guide-bed, secured to a tubular bearing, O'''', which fits upon an upright shaft, O''''', at the rear of the instrument, so as to hold the guide-bed in line with the feed-cylinder D. The upright shaft is insulated from the main frame, and the guide-bed, in its general features, is constructed the same as the guide-bed of the transmitting devices—to wit, with an adjustable gage-side, l'', an adjustable spring pressure-bar, z''', and a weighted cover or pressure-piece, l''', having a handle, z'', and adapted to operate the sliding cross-bars z'''' when swung open, and to bear upon the point of an adjusting-screw, z''''', in the bed when closed.

c^6 is a shelf or arm, attached by a sleeve, c^{10}, to the tubular bearing of the guide-bed, and extending forward under the latter to support the reproducing-magnet D'', as shown in Fig. 18. A short arm, c^{13}, projecting from the tubular bearing carries a set-screw, c^{12}, which enters a corresponding arm, c^{14}, of the sleeve, to support the shelf and regulate the position of the magnet-knives with respect to the guide-bed. c^7 is a flat spring, connecting the shelf with an adjustable holder upon one

of the uprights of the frame, to permit a slight lateral swing of the guide-bed and magnet, for the purpose of compensating for any irregularities in the movements of the paper fillet over the guide-bed.

a^4 are blocks mounted upon the permanent magnetic needles of the magnet D″ upon opposite sides of the rock-shaft, to limit the oscillations of the latter by contact with the covers O O′, and support the pivoted upright arms a^{12}.

b^6 are guide-blocks secured to the front end of the bed, in continuation thereof, and grooved vertically to receive the upper ends of the arms a^{12}, which are curved or bent so as to stand parallel to each other within the grooves. The upper ends of the arms are also slotted for the passage of pins b^7, which extend through the blocks to guide the movements of the arms.

b^4 b^4 are pointed reversible slitting-knives, adjustably attached to the arms a^{12} by means of the slotted blocks and set-screws b^2, so that their points shall project through the grooves in the guide-blocks above the upper surface of the bed, when the arms are reciprocated by the oscillations of the needles in the magnet D″. The cutting-edges of the knives stand at the rear next the guide-bed, so as to slit the fillet of paper as it is drawn along by the cylinder.

b^8 b^8 are guide-blocks, secured to the cover of the guide-bed by means of set-screws b^{13}, so that their slots shall register with the slots in the guide-blocks b^6.

Each block b^8 carries an embossing roller or style, b^9, to bear down, under the weight of the cover, upon the fillet of paper as it passes over the bed, and form parallel grooves therein by pressing it into the grooves of the lower blocks b^8. The rollers also expand or widen the slits in the record. The guide-blocks b^6 are properly grooved for this purpose, such grooves being the requisite distance apart to register with the grooves in the feed-cylinder D, and the grooves of the transmitting devices. Any preferred design may be given to the embossed tracks in the paper, by giving a corresponding form to the grooves in the guide-blocks b^8, or to the periphery of the embossing-rollers.

India-rubber blocks c^3 are secured within the guide-blocks b^8, to bear down upon the points of the slitting-knives, and insure their cutting, such bearing-blocks being adjusted by set-screws b^4.

V is a pressure-roller covered with leather or other elastic material, and mounted upon the lower end of a lever, V‴, so as to hold the fillet of paper in contact with the front side of the feed-cylinder D when the paper is being drawn forward. The lever is pivoted centrally to one of the uprights of the frame, and carries one end of an adjustable spring, K‴′, the other end of which is secured to the pivot, the purpose of such spring being to bear the pressure-roller against the feed-cylinder. The upper end of the lever terminates in a finger-piece, J″, by pressing upon which the roller V is removed from contact with the feed-cylinder, in which position it may be held, when desired, by any convenient locking device.

q^6 is a lever hung at q^7 to the upright of the frame beneath the feed-cylinder, with its upper end lying against the inner side of a pin projecting from the end of the pressure-roller V, and its lower end against a cam, o^{20}, mounted upon the sleeve m^5 of the calling-in frame. The form and position of this cam upon the sleeve are such as to throw the upper end of the lever q^6 forward, and hold the pressure-roller V out of contact with the feed-cylinder, when the paper fillet is not in operation over the reciprocating slitting-knives.

The reproducing mechanism is made ready for operation to reproduce a message by laying a plain uncut fillet of paper upon the guide-bed, under the weighted cover, passing over the feed-cylinder D, downward behind the pressure-roller.

When the signal for calling in the station causes the calling-in frame n^2 to move forward with the registering-wheel, the sleeve m^5 moves with it, as already described, and carries the short radius of the cam o^{20} against the lower end of the lever q^6. This releases the pressure-roller V, so that its spring K‴′ shall bear the fillet of paper against the feed-cylinder D, to be fed forward.

As already explained, the induced or message currents of the main line operate the receiving-magnet, while corresponding currents direct from the local battery of a station operate the calling-in and reproducing magnets at every change in the message currents. When, therefore, the polarity of the reproducing-magnet is changed, the slitting-knives are alternately reciprocated through the moving paper to form the slits therein. The length of such slits corresponds to the period of time each knife is held upward, while the paper is moving at a uniform rate of speed, and the duration of their respective upward throws ceases only with the changes of the track-fingers in the transmitting-instrument. It therefore follows that the slits reproduced in the fillet of paper at the receiving-station will be fac-similes of those forming the record at the transmitting-station, provided the fillets of paper move at the same speed.

The method of effecting a uniform movement of the paper at all the stations I will presently describe.

The calling-in frame of the receiving station is held forward upon the registering-wheel until all the message has been received and the throwing-out frame brought into action, when it moves back upon the wheel, so that the cam o^{20} shall again operate the lever q^6 to throw the pressure-roller V out of contact with the feed-cylinder, and stop the further

movement of the paper until the station is called in again.

a^6 is a curved guide, secured to one of the uprights of the frame beneath the feed-cylinder, for directing the fillet of paper out of the instrument, and a^8 a^9 are the blades of a pair of shears for cutting off the paper after it has left the cylinder. The upper end of the curved guide is formed with a loop to direct the paper down between the blades, which occupy a horizontal position just under its lower edge. The lower blade a^9 is attached to the upright of the frame, and the upper movable blade a^8 is attached to an upright rod, p, so as to work over the edge of the fixed blade.

The rod p is held in a vertical position against an adjoining upright of the frame by suitable guides, and is formed with a crank or handle at its upper end, by which it is operated to swing the blade a^8 inward in contact with the fixed blade and cut off the fillet of paper. Its lower end is surrounded by a coiled spring, p', one end of which is made fast thereto, and the outer end is secured to the bed of the instrument. The tension of this spring is such as to throw open the blades of the shears after the rod p has been released, and to press the swinging blade down upon the fixed blade, for the purpose of insuring the proper cutting action.

The fixed blade occupies a position against a shoulder formed in the curved guide, as shown in Fig. 23, or is otherwise connected to the latter in such a manner that its cutting-edge shall lie behind the plane of the guide, out of the path of the paper from which the strip or record has been cut. By this provision the end of the paper is prevented from catching on the blades of the shears or flying out of the guide-loop after the record is cut off.

When a message is being received and reproduced at a station, the two helices of the receiving-magnet are automatically connected to form one helix, for the purpose of increasing the power of the magnet to effect the changes in the polarity of the reproducing-magnet. When the station is not receiving a message, the helices of its receiving-magnet are disconnected and joined separately to the main line, for the purpose of offering less resistance to the passage of the line-current through them. Therefore, the power of a receiving-magnet is increased, when receiving a message, by the decrease of conducting resistance in the receiving-magnets of all the other stations within reach of the line-current.

The mechanism for automatically connecting and disconnecting the two helices is constructed and operates as follows: R^1 R^2 R^3 are three bent levers, pivoted to a corresponding number of uprights secured to the frame of the instrument, being insulated therefrom, and arranged in front of and below the sleeve m^6. The front ends of the levers are weighted and provided each with a platina hammer, to rest down upon corresponding platina anvils in the standards, while their rear ends terminate within the path of a series of cams, r^{10}, secured by an insulating-strip, r^9, to the sleeve m^6, as shown in Fig. 2.

The outer end o^8 of the inner helix in the receiving-magnet is bifurcated or branched to connect with the anvils of standards R^1 and R^2, and the inner end o^9 of such helix, after joining the wire t^9 of the main line, connects with the anvil of the standard R^3. The inner end o^7 of the outer helix is branched to connect with the hammers of the levers R^2 and R^3, and the outer end o^6 of such helix, after joining the main wire t^9, connects with the anvil in lever R^1. The inner ends of the weighted levers are so curved or provided with projections that when a station is called in to receive a message, and the sleeve m^6 rotates forward with the calling-in frame, the cams r^{10} will raise the hammers of levers R^1 and R^3 and permit the hammer of the lever R^2 to rest down upon its anvil. This forms a connection between the inner end of the outer helix and the outer end of the inner helix, and makes of them a continuous helix during all the time a message is being received and reproduced. After the message has been received, and the receiving-station thrown out of communication with the transmitting-station, the cams operate to raise the hammer R^2, and permit the hammers R^1 and R^3 to drop down upon their respective anvils. The two helices are thus separated so that the current of the main line shall pass through both simultaneously.

A fourth platina anvil and lever-hammer, R^4, are arranged beside the others and interposed in the wire t^{11}, which connects the local battery with the curved lever y''' of the transmitting devices, one end of the wire being connected to the hammer, and the other end to the anvil. The function of these devices is to notify the transmitting-station that the receiving station has been called in and is ready to receive the message. For this purpose the rear end of the lever is notched to form one or more teeth, so that, when the sleeve m^6 moves forward, as above described, one of its cams, r^{10}, will strike the teeth, and then fall into the notches behind them. When in contact with a tooth, it presses down the rear end of the lever, and raises the hammer at the front end out of contact with the anvil to break the circuit between the local battery and the lever y''', and when it passes into the notches the hammer is released and drops down upon the anvil to make the circuit. By this means the circuit is rapidly made and broken one or more times in succession, according to the number of teeth and notches in the lever, and the result is that, when the circuit is made, the current from the local battery of such receiving-station passes through the calling-in magnet, the reproducing-magnet, and the helices of the induction-coil, back to the opposite pole of the battery, as already explained, thereby inducing a current in the main line at the receiving-station. The effect of this induced current

is to oscillate the upright arms of the receiving-magnet back at the transmitting-station, and so assure the operator there that the receiving-station is called in ready to receive the message. After these preliminary signal-changes in the circuit of the local battery at the receiving-station the contact of the hammer and anvil is necessarily continued while the message is being received and when the station is thrown out.

To establish a uniform movement of the fillets of paper at all the stations of a line, the driving-shafts B are adjusted to the same speed, which is measured by the vibrations of a pendulum at each station in the following manner:

f^6 is a wide metal bar, pivoted at its lower end to one of the legs of the instrument under or near the transmitting devices, and slotted at its upper end for the passage of a set-screw, f^8, by which it may be adjusted to the right or left. f^2 is the pendulum, hung from the bottom piece of the frame, but insulated therefrom so that the flat piece g^7, at the lower edge of the weight, shall alternately strike the upright points of a crescent-shaped metal trip-plate, g^3, when the pendulum is vibrated. The trip-plate is secured to a long sleeve, g^2, mounted upon a front-projecting pin of the upright bar. The inner end of the sleeve carries an upright platina-faced arm, g^4, which is thrown alternately to the right and left against platina-faced stop-pins g^5, when the pendulum is vibrated to oscillate the trip-plate and its sleeve. The stop-pins are secured to the upright bar upon opposite sides of the sleeve, being properly insulated from the bar, and are connected respectively by the wires d^8 and d^9 to the wires t^{10}, which join the anvils of the transmitting devices to the helices of the reproducing-magnet. The upright bar is insulated from the frame, and the trip-plate is insulated from the bar by suitable means.

h^2 is a weighted right-angular finger-piece, hung upon the pivot f^5 of the pendulum, so that its weighted end shall extend within the space formed between the bottom of the frame A and an angular arm, h^5, secured thereto, as shown in Fig. 1. The upper and lower sides of the finger-piece are provided with a platina point or hammer, h^4, to bear alternately against corresponding points or anvils h^6 in the frame and arm. Its normal position holds the two lower points in contact, and disconnects the two upper points.

The wires t^{11} and t^{12}, from the local battery, connect the lower point in the arm h^5 with the rock-shaft of the receiving-magnet D′ and a wire, t^{13}, connects the upper point in the frame with the crescent-shaped trip-plate. To form the circuit from the battery to the trip-plate, (the lever y''' of the transmitting devices being down upon its lower anvil,) the operator presses his finger upon the weighted finger-piece, so as to raise the weighted end in contact with the wire t^{13}, and lift it from contact with the wire of the receiving-magnet. This throws the latter out of the circuit, and sends the current from the battery along the sleeve of the trip-plate to its arm g^4. The pendulum, being next set in motion by the operator, will vibrate quite a number of times to oscillate the arm g^4 against the stop-pins, and send the current alternately through the wires d^8 t^{10} and d^9 t^{10}, to reciprocate the slitting-knives of the reproducing-magnet. The length of time the knives are held projected through a moving fillet of paper depends upon the length of the pendulum vibrations, while the length of the slits depends upon the speed of the paper through which the knives are held. If, therefore, the vibrations are known, the speed of the paper can be readily ascertained to determine the length of the slits. For example, if the instruments of the line, when made and put up, are adjusted to run off two feet of paper at every four beats or half-vibrations of the pendulum, and it is desired to change the movement of the paper to one foot per second, the operator adjusts the speed of the driving-shaft so that it shall feed the paper three inches for every beat of the pendulum. If the paper is to be moved four feet per second, the operator adjusts the speed of the shaft to feed one foot for every beat of the pendulum. The method of determining when the paper is moving at the requisite speed is to measure the slits produced at every beat of the pendulum.

All the pendulums of the line are made alike, so that their vibrations shall be equal, and thereby furnish a standard measure of time at all the stations. If any change is required in the speed of the paper, all the stations are notified from the main office, and the required change specified. The operators then regulate the speed according to the beats of the pendulum, as above described. By this means the paper at all the stations is made to move at the same speed, to transmit and reproduce fac-simile records.

g^9 is a horizontal arm attached to the frame A near the pendulum, and g^8 is a long thin spring connecting its outer end to the oscillating arm g^4, to prevent the recoil of such arm when thrown against the stop-pins by the pendulum. The holding-arm g^9 is adapted for adjustment by any suitable means, to regulate the tension of the spring.

The set-screw f^7, which secures the upright bar f^6 in place, also permits the lateral adjustment of the bar to hold the vertical axis of the pendulum, when at rest, in line with the center of oscillation of the trip-plate, for the purpose of preventing the arm g^4 from striking one stop-pin sooner than the other when the pendulum vibrates. This equalization in the deflection of the bar g^4 from the vertical line of the pendulum insures uniformity in the length of the slits, by which the required speed of the paper is ascertained. Without it the length of the slits would be unequal, and could not afford a correct guide for the purpose.

In order to prevent atmospheric electricity upon the main wire from passing through the receiving-magnet of a station, to burn the helices or otherwise injure the instrument, a lightning-arrester, Z^1, shown in Figs. 30 and 31, is interposed in opposite ends of the main wire as it enters the magnet from each side of the station. They are each composed of two grooved half-cylinders of metal, clamped together upon a piece of fine insulated wire, Z^2, placed in the main wire, and the outside of each cylinder is joined, by a large wire, Z^3, to the opposite end of the main wire, beyond the opposite cylinder, so as to conduct a strong atmospheric current along the main line past the station, without permitting it to enter and burn the fine wire of the receiving-magnet. The insulation of the wires Z^2 is sufficient to direct the induced message-currents into the helices of the receiving-magnet and prevent them from passing the station through the arresters; but this insulation is entirely overcome by the strength of the atmospheric currents, which therefore pass the station without the liability of injuring the instruments, as above stated.

The ends of each wire Z^3 are joined to a helix, Z^4, and the helices are arranged one within the other, in the same manner as those heretofore described. Z^5 is a magnetic needle pivoted to a dial-plate placed within the axial aperture of the helices. The needle stands at a certain predetermined point upon the dial, when the insulation of the wires Z^2 is perfect and the line in working order; but when the insulation becomes defective, from any cause, the needle will be deflected to the right or left by the escape of the message-current through one or the other of the lightning-arresters. The extent of the deflection shows upon the dial the extent of the defect, and indicates the needed repairs.

Z^6 are switches pivoted to suitable insulated supports, between the ends of each wire Z^3, as they join the helical wires, (shown clearly in Fig. 31.) The switches, when turned to connect both branches or ends of a wire, cut off the current from the helices; but, when turned out of contact with such branches, allow the current to pass through the helices. They are usually arranged to keep the currents cut off, and are only turned to let them pass through the helices when the insulation is to be tested by the magnetic needle and dial. This, however, is not absolutely necessary, because they may or may not stand normally cut off, as preferred or found most desirable. X^1 is an adjustable resistance-coil, provided with an index-finger and dial, and inserted in the local line, as shown in Fig. 31. The object of this arrangement is to enable the operator to graduate the conducting resistance in the local circuit so that the surplus power of the battery may be utilized, and the working-force of the battery kept the same during the latter part of its use, as when the battery is first put up. The deflection of the index-finger upon the dial shows the amount of resistance. When the power of the battery is great, the resistance is made proportionally great, and as the power decreases, the resistance is also decreased, until no surplus power exists, thereby maintaining a uniform working-power.

To determine the amount of battery-power, an ordinary galvanometer, X^2, is connected to the resistance-coil X^1, so as to form a part of the local circuit, as shown in Figs. 5 and 31. By means of the resistance-coil the operator is enabled to adjust the conducting resistance in the local circuit so that the needle of the galvanometer will be deflected to a point on its dial that indicates sufficient power of the battery to produce induced currents along the main line suitable for the automatic transmission of messages.

When it is desired to cut out the induction-coil at a station, for the purpose of adjusting the movements of the paper by the pendulum, a pivoted switch, Z^7, is inserted in the wire of the induction-coil, between its commencing and terminating ends, as shown in Fig. 5, or by inserting it in a branch wire, Z^8, connecting such ends, as shown in Fig. 31.

The paper fillets for both the original and reproduced records are prepared for use by treating them with an extra sizing of glue, in order to prevent them from being torn by the knives during the slitting operations.

The drawings herein illustrate one form of my invention, but I desire it understood that I do not confine myself to such form, so long as I do not depart from the principle of my invention.

I claim as my invention—

1. In electric telegraphs, the system of communicating message-symbols by means of straight slits in a fillet of paper arranged alternately in two parallel lines, each slit representing a symbol distinguishable by its length from the other symbols.

2. The mode or method of automatically transmitting electric telegraph-symbols by means of a moving fillet of paper containing two parallel rows of message-slits, which vibrate a local circuit-changer, to send alternate reversed currents on the main wire, substantially as described.

3. The automatic transmission of telegraph-symbols by alternate induced electric currents, caused to pass on the main wire by a moving fillet of paper containing two parallel rows of message-slits, through which two track-fingers alternately drop as the paper moves to operate a local vibratory circuit-changer, substantially as described.

4. The mode or method of automatically reproducing electric telegraph symbols by the alternate reciprocations of two slitting-knives through a fillet of paper moving over them, the length of the slits corresponding with the period of time each knife is in turn held through the paper, and the duration of the respective throws continuing until the track-fingers change at the transmitting-station, so that the slits re-

produced in the fillet of paper at the receiving-station shall be fac-similes of those forming the record at the transmitting-stations, substantially as described.

5. Controlling the electric currents induced in the main line through the medium of the moving record and vibratory circuit-changer by the length of the message-slits in the record, so that the length of time between each current will exactly correspond to the distance between the beginning of one slit and the beginning of the next adjoining slit in the opposite row, substantially as described.

6. The transmitting and reproducing mechanism of an automatic telegraph apparatus, operated from the same driving-shaft by two fillets of paper moving at equal speed, substantially as described, for the purpose specified.

7. The feeding mechanism for the transmitting and reproducing devices, mounted upon the same driving-shaft, substantially as described, for the purpose specified.

8. The toothed feed-cylinders D E, each constructed with two parallel peripheral grooves, the grooves in one being the same distance apart as those in the other, substantially as described, for the purpose specified.

9. The driving-shaft B, having its bearings upon the friction-wheels mounted upon a counter-shaft beneath it, substantially as described, for the purpose specified.

10. The shaft B, driven by two friction-collars, or other surfaces mounted thereon, so as to clamp the hub of the driving-wheel or other motor between them, and transmit its motion to the shaft, substantially as described.

11. The combination of a governor with the friction-collars, for the purpose of controlling the speed of the shaft by regulating the frictional contact of the collars with the hub of the driving-wheel, substantially as described.

12. The governor, consisting of the crossed ball-levers G, pivoted to the driving-shaft, the bent springs H, and the adjusting-springs J J, substantially as described.

13. The governor, connected to the friction-collar P by means of the links L L, the connecting-rod M and the pin Q, the links and connecting-rod extending longitudinally within the hollow driving-shaft, substantially as described.

14. The toggle-joint, formed by the combination of the connecting rod and links L with the governor-levers, substantially as described.

15. The combination of the ring P′ and pivoted pins R, with the friction-collar P, to prevent the guide-pin Q from binding within the slot of the driving-shaft when the collar P is moved by the governor, substantially as described.

16. The combination of the soft washers *g g*, with the friction collars P *i* on the hub of the driving-wheel, substantially as described, for the purpose specified.

17. The friction-collar *i*, held upon the end of the driving-shaft so as to bear against the outer end of the driving-wheel hub, substantially as described.

18. The friction-collar *i*, adapted for adjustment to regulate the pressure of the wheel-hub against the friction-collar P, substantially as described, for the purpose specified.

19. The combination of the bent springs H with the governor, to counterbalance the centrifugal force of the balls when in motion, until the driving-shaft has reached or nearly reached the speed required for feeding the fillets of paper in transmitting and reproducing a message, substantially as described.

20. The bent springs H of the governor, adapted for adjustment by suitable means to regulate the centrifugal force necessary for throwing out the governor-balls, and thereby determining the required speed of the driving-shaft to feed the paper, substantially as described.

21. The auxiliary springs J J, combined with the bent springs of the governor, and adapted for adjustment to determine the force required in excess of the bent springs, to counterbalance the centrifugal force of the governor-balls, which is necessary for disconnecting the friction-collars from the driving-wheel hub, substantially as described.

22. The governor-levers, having an equalized movement upon opposite sides of the driving-shaft, for the purpose specified.

23. The combination of the racks N N and pinion K^1 with the governor-levers and driving-shaft, for equalizing the movements of the governor-levers, substantially as described.

24. The arms H^2, combined with the driving-shaft, to limit the outward throw of the governor-levers, substantially as described.

25. The combination of the oscillating rock-shaft of the electro-magnet D′′′′′ with the driving-wheel of the shaft B, substantially as described, for the purpose specified.

26. The magnet D′′′′′, having its covers constructed, as described, to permit a long oscillation of the permanent magnets *s* between them, for the purpose specified.

27. The circuit-changer, consisting of the grooved whole and half bands *b b′ c c′*, mounted upon the insulated sleeve *e* of the driving-wheel hub, combined with the conducting-rollers *a* a^1 a^2 a^3, having electric connection with the battery and the helix of the magnet D′′′′′, substantially as described.

28. The grooved half-bands *c′ c*, separted from each other upon the sleeve of the wheel-hub, and joined, one to the whole-band *b*, the other to the whole band *b′*, substantially as described, for the purpose specified.

29. The conducting-rollers *a* a^1 a^2 a^3, supported upon the joints *w* w^1 w^2 w^3 by the upright arms y^2, so as to hold the rollers *a* a^1 within the grooves of the bands *c′ b′* upon one side the wheel-hub, and the rollers a^2 a^3 within the grooves of the bands *b c* upon the opposite side of the hub, substantially as described, for the purposes specified.

30. The insulating-eveners a^{10}, combined with the upright arms y^2, to connect each pair upon opposite sides of the wheel-hub, substantially as described.

31. The combination of the spring a^{11} with the insulating-eveners, to draw the upright arms toward the wheel-hub, for the purpose of holding the conducting-rollers with equal force within the grooved bands, substantially as described.

32. The combination of an electric governor with the driving-wheel, for the purpose of equalizing and regulating the speed of the driving-shaft to feed the fillets of paper in transmitting and reproducing a message, substantially as described.

33. The combination of an oscillating electric governor with the driving-wheel, substantially as described.

34. The combination of a resistance-coil with the electric governor, to prevent unnecessary waste of the battery-force required to operate the driving-shaft, substantially as described.

35. The arrangement of the resistance-coil upon the driving-wheel, substantially as described, for the purpose specified.

36. The electric governor consisting of the ring x^2, provided with two governor-balls and the supporting-arms $x^3 x^3$, forming a rock-shaft, substantially as described, for the purpose specified.

37. The electric governor, mounted upon the face of the driving-wheel by means of its insulated rock-shaft, substantially as described.

38. The electric governor mounted upon the face of the driving-wheel, so as to stand at an angle therewith when at rest, substantially as described, for the purpose specified.

39. The combination of the insulated conducting-springs $v\ v^1$ with the driving-wheel, substantially as described.

40. The combination of the roller x^5 with one of the balls of the oscillating governor, substantially as described.

41. The combination of the oscillating electric governor with the driving-wheel and resistance-coil thereon, to throw the latter into and out of the circuit through the driving-magnet D'''', for the purpose of maintaining the driving-wheel at a uniform velocity without exceeding the maximum quantity of battery-force required for operating the driving-shaft, substantially as described.

42. The combination of the inner spring v with the whole and half bands on the hub of the driving-wheel, and with the governor-ring, for the purpose of forming a circuit from the battery to the driving-magnet when the driving-wheel is moving at such low speed as to carry the governor-roller x^5 in contact with the spring, substantially as described.

43. The combination of the resistance-coil and outer spring v^1 with the inner spring and its connections, to send the current through the resistance-coil when the driving-wheel is moving at such high speed as to carry the governor-roller x^5 in contact with the spring v^1, substantially as described, for the purpose specified.

44. The combination of the spring v^4 with the driving-wheel and electric governor, substantially as described, for the purposes specified.

45. The holder o^{10}, pivoted to the driving-wheel, to press the governor-roller outward in contact with the inner spring v, and thus close the circuit from the battery to the magnet, for the purpose of starting the driving-wheel in motion, substantially as described.

46. The holder o^{10}, adapted to be automatically turned back from the governor-roller by means of a trip or stop, w'''', with which it comes in contact when the wheel rotates, substantially as described.

47. The trip or stop w'''', pivoted to a short upright, w''', of the frame, and weighted at one end so as to hold it out of operation until moved into the path of the holder by the operator, substantially as described.

48. In the transmitting-instrument, the combination of a feed-cylinder with the guide-bed and track-fingers, for the purpose of drawing the fillet of paper containing the record over the bed to operate the track-fingers, substantially as described.

49. In the transmitting-instrument, the combination, with a circuit-changer, C'', of a circuit-breaker, y''', having electric connection with the local battery, so that when the paper is moving over the circuit-breaker a current from the battery will be sent through the reproducing-magnet, the calling-in magnet, and the primary helices of the induction-coil, to induce alternate reversed message-currents in the main wire, substantially as described.

50. The combination of track-fingers or other devices for vibrating the circuit-changer to reverse the currents in the main line, while the fillet of paper is drawn over the guide-bed of the transmitting-instrument, substantially as described.

51. The circuit-changer C'', combined with the guide-bed of the transmitting-instrument, substantially as described, for the purpose specified.

52. The circuit-changer, articulated to the under side of the guide-bed, and formed with a rock-bar, b'''', across its hub, to receive the alternate action of the track-fingers, substantially as described, for the purpose specified.

53. The combination of the circuit-changer C'' with the two anvils $g''''\ g''''$, which are separately connected to the local battery of a station by wires $t^{10}\ t^{10}$ passing through the reproducing and calling-in magnets, and the primary helices of the induction-coil, substantially as described.

54. The two anvils $g''''\ g''''$, supported by the pendent arm b''' upon opposite sides of the circuit-changer, substantially as described.

55. The two anvils g'''' g'''', adapted for adjustment upon the pendent arm b''', substantially as described.

56. The anvils g'''' g'''', having electric connection with the stems of the eccentric anvils on the reproducing-magnet, substantially as described.

57. The combination of the permanent magnetic bar g''' with the soft-iron ring which forms the lower termination of the circuit-changer C'', for the purpose of preventing the recoil or rebound of the latter when it is thrown in contact with its anvils by the track-fingers, substantially as described.

58. The magnetic bar g''', supported within the soft-iron ring of the circuit-changer C'' by means of the arm b''' on the under side of the guide-bed, substantially as described.

59. The guide-beds O'' and l', swiveled or pivoted to the frame of the instrument so as to have a lateral swing controlled by a yielding connection for the purpose of compensating for irregularities in the movements of the paper fillets to the feed-cylinder, substantially as described.

60. The supports for the guide-beds, consisting of the tubular bearings fitting over upright shafts mounted upon, but insulated from, the frame of the instrument, substantially as described.

61. The yielding connection between the guide-beds and main frame, adapted for adjustment to regulate the lateral swing of the beds, substantially as described.

62. The combination of an adjustable gage side and an adjustable spring pressure-bar with the guide-beds O'' and l', substantially as described, for the purposes specified.

63. The adjustable gage sides of the guide-beds, formed with recesses along their inner edges, for the purpose of preventing the edges of the paper fillets from wrinkling or curling up as they are drawn over the beds, substantially as described.

64. The spring pressure-bars, each provided with two shouldered cross-pieces adapted to fit within deep transverse grooves of the guide-beds, so that their shoulders shall bear against one edge of the moving paper, and hold it up to the gage side, substantially as described.

65. The stop-pins inserted in each of the guide-beds to limit the forward movement of the pressure-bar after the fillet of paper has passed out of the bed, substantially as described.

66. The guide-beds O'' l', each provided with a hinged cover or pressure piece, to hold down the paper fillets as they pass over the beds, substantially as described.

67. The covers of the guide-beds O'' l', adapted for adjustment to regulate the pressure upon the paper fillets by means of set-screws, which support the covers upon their points after passing up through the guide-beds, substantially as described.

68. The covers of the guide-beds O'' l', adapted to be held down upon the screws by a weight or spring, substantially as described, for the purpose specified.

69. The combination of the shouldered cross-bars with the cover-hinges of the guide-beds, for moving back the spring pressure-bars when the covers are swung open to prepare the beds for receiving the paper fillets, substantially as described.

70. The flat spring n', adjustable holder n'', and front projection n, for connecting the sleeve of the guide-bed O'' to one of the uprights of the frame, substantially as described.

71. The guide-bed O'' of the transmitting-instrument, formed with parallel grooves m m' to receive the embossed tracks in the fillet of paper, substantially as described, for the purpose specified.

72. The guide-bed and feed-cylinder of the transmitting-instrument, formed with corresponding parallel grooves to receive the embossed tracks in the fillet of paper containing the record to be transmitted, substantially as described, for the purpose specified.

73. The combination of two parallel V-shaped ribs with the under side of the cover m'', to fit into the grooves of the guide-bed O'', for the purpose of properly guiding the fillet of paper and preserving the form of its embossed tracks therein as it is fed over the bed, substantially as described.

74. The combination of two spring track-fingers with the cover of the guide-bed O'', so that their points shall project down through the V-shaped ribs therein, substantially as described.

75. The spring track-fingers having an independent articulation upon the cover of the guide-bed O'' by mounting their hubs e''' e''' separately upon the short cross-shaft k''', substantially as described.

76. The combination, with the track-fingers, of the set-screws k' and their holding-arms, for the purpose of adjusting the lateral position of the track-fingers within the embossed tracks of the fillet of paper passing over the guide-bed, substantially as described.

77. The combination of the slotted guide-block j' with the cover m'', for the purpose of guiding the points of the track-fingers within the tracks of the paper passing over the bed, substantially as described.

78. The combination of a pivoted handle with the cover of the guide-bed O'', to raise the points of the track-fingers from contact with the fillet of paper without raising the cover, substantially as described, for the purpose specified.

79. The handle j'', pivoted to the top of the cover m'' in rear of the track-fingers, and provided with a weighted extension, j''', to hold it in an upright position, substantially as described.

80. The handle provided at its front with a right-angular arm, j'''' j'''', to limit the forward movement of the handle and bear down

the rear ends of the track-fingers, for the purpose specified.

81. The combination of the grooved guide-blocks b^6 with the guide-bed l' of the reproducing mechanism, substantially as described.

82. The combination of a grooved feed-cylinder with the ungrooved guide-bed of the reproducing mechanism, to draw the fillet of paper over the reproducing-knives, substantially as described.

83. The combination of an automatic pressure-roller with the feed-cylinder of the reproducing mechanism, substantially as described, for the purpose specified.

84. The combination, with the guide-bed l', of two reciprocating knives, operated by a magnet, substantially as described.

85. The shelf c^6, adapted for vertical adjustment upon the sleeve of the guide-bed l', to regulate the position of the reproducing-knives with respect to the upper surface of the bed, substantially as described.

86. The shelf c^6, combined with the flat spring c^7, to connect the sleeve of the guide-bed l' with an adjustable holder upon one of the uprights of the frame, substantially as described.

87. The shelf c^6, combined with the sleeve of the guide-bed l', to support the reproducing-magnet, substantially as described.

88. An electro-magnet provided with a rock-shaft to alternately reciprocate two pointed knives through the grooved blocks b^6 of the guide-bed when the polarity of such magnet is changed to oscillate the shaft, substantially as described.

89. The pointed slitting-knives b^4 b^4, supported upon the vibrating needles of the reproducing-magnet by means of the upright arms a^{12}, substantially as described, for the purpose specified.

90. The slitting-knives of the reproducing-magnet, guided vertically within the grooved blocks by means of the guide-pins b^7, and the supporting-arms a^{12}, substantially as described, for the purpose specified.

91. The combination of the embossing rollers or styles b^9 with the guide-bed l' and its cover, substantially as described, for the purpose specified.

92. The india-rubber blocks c^3, combined with the guide-blocks b^8, to bear down upon the points of the slitting-knives, substantially as described, for the purpose specified.

93. The grooved guide-blocks b^8, secured to the front of the cover, for the purpose of supporting the embossing-rollers, substantially as described.

94. The grooved guide-blocks b^8, adapted for adjustment to register their grooves with the grooves in the lower guide-blocks b^6 of the bed, substantially as described, for the purpose specified.

95. The combination, at a telegraph-station, of a calling-in magnet, a reproducing-magnet, a receiving-magnet, and their electric connections, substantially as described, for the purpose specified.

96. The combination, at a telegraph-station, of a receiving-magnet, a calling-in magnet, a reproducing-magnet, and an induction-coil interposed in the main wire, substantially as described.

97. The combination, at a telegraph station, of a receiving-magnet, a calling-in magnet, a reproducing-magnet, an induction-coil, and two primary helices within the induction-coil, substantially as described.

98. A compound receiving-magnet composed of two soft-iron covers inclosing two helices wound in the same direction, one within the other, and interposed in the main telegraph-line at each station by connecting to the wire thereof the inner end of the inner helix, and the outer end of the outer helix, substantially as described.

99. The receiving-magnet, provided with a series of parallel magnetic needles mounted between the covers upon a transverse rock-shaft, so as to oscillate, when the covers are magnetized and demagnetized, by the passage through the helices of the alternately reversed message-currents of the main line, substantially as described.

100. The parallel magnetic needles of the receiving-magnet, provided with an upright arm carrying two platina hammers, which, when the needles tip, are alternately thrown in contact with two platina-faced anvils supported upon, but insulated from, the covers of the magnet, substantially as described.

101. The reciprocating hammers of the receiving-magnet, having electric connection with the local battery for the purpose of operating the parts of the reproducing and calling-in magnets by the direct current from the battery, while the polarity of the magnet is changed to reciprocate the hammers by the alternate reversal of the message-currents in the main line, substantially as described.

102. Maintaining the contact between the hammers and anvils of the receiving-magnet at the receiving-station, by means of the track-fingers at the transmitting-station extending through the slits of the moving record to hold the circuit-changer in contact with one or the other of its anvils, substantially as described.

103. The anvils mounted upon the cover of the receiving-magnet, and insulated therefrom by means of the flanged insulating-tubes d^{10}, combined with the stems d^7 of the anvils, and the hollow upright shafts d^6, substantially as described.

104. The platina-faced anvils of the receiving-magnet, affixed eccentrically to their supporting-stems, for the purpose of adjustment, substantially as described.

105. The compound reproducing-magnet D″, provided with two vertically-reciprocating slitting-knives, substantially as described.

106. The compound calling-in magnet D‴, provided with two inclined laterally-vibrating plates, substantially as described.

107. The combination of an induction-coil and a double helix with one battery, to equalize the force of the main-line currents, for the purpose of securing the automatic formation of the message-symbols of the requisite relative sizes throughout the whole line, and to prevent like message-symbols from differing in length when formed by the passage of the current through either helix, substantially as described.

108. The combination, with the induction-coil, of an adjustable compound magnet connecting the local battery of a station with the calling-in magnet, substantially as described, for the purpose specified.

109. The induction-coil combined with the double helices wound therein, one within the other, around an adjustable core of soft iron, substantially as described, for the purpose specified.

110. The core of the primary helices D^7 D^7, made in several sections, which are adapted for adjustment by the holding-screws c^6, for the purpose of regulating the time required to magnetize and demagnetize them, substantially as described.

111. The receiving-magnet, the calling-in magnet, the reproducing-magnet, and the primary helices of the induction-coil, having their corresponding helices wound in the same direction at a station, so that the currents from the local battery shall each move through the circuit of like helices in the same direction, substantially as described.

112. The receiving-magnet, the calling-in magnet, the reproducing-magnet, and the primary helices of the induction-coil, having their corresponding helices wound in the same direction at all the stations of the telegraph-line, for the purpose of maintaining the same direction for each current throughout the line, substantially as described.

113. The platina-faced anvils of the receiving-magnet, having separate electric connections with the reproducing-magnet, substantially as described, for the purpose specified.

114. The mode or method of calling a station into communication with a transmitting-station to receive a message, by means of a calling-in magnet at the receiving-station, which is operated by the transmitted signal to set the reproducing devices in operation, substantially as described.

115. The mode or method of throwing a receiving-station out of communication with a transmitting-station, after the message has been sent, by means of a calling-in magnet, which is operated by the transmitted signal to throw the reproducing devices out of operation, substantially as described.

116. The mode or method of operating the calling-in magnet to call in the receiving-station, and throw it out of communication with the transmitting-station, by means of signal-slits cut in the fillet of paper in advance of, and following, the message-slits, substantially as described.

117. A calling-in frame at the receiving-station, adapted to be set in motion by the vibrating-plates of the calling-in magnet to operate the mechanism by which a fillet of paper is drawn over the reciprocating reproducing-knives, substantially as described.

118. A throwing-out frame at the receiving-station, adapted to be set in motion by the vibrating plates of the calling-in magnet, to throw out of operation the mechanism by which a fillet of paper is drawn over the reproducing-knives, substantially as described.

119. The combination of a registering-wheel with the calling-in frame, the throwing-out frame, and the vibrating plates of the calling-in magnet, substantially as described, for the purpose specified.

120. The calling-in and throwing-out frames, mounted upon opposite sides of the registering-pin wheel, and constructed to engage and move with the pins, when the latter are properly set by the vibrations of the setting-plates, substantially as described, for the purpose specified.

121. The calling-in and throwing-out frames, mounted upon sleeves of the shaft E‴, and connected by suitable mechanism, so as to move forward with the registering-wheel at different times, and move back against its revolution, one after the other, substantially as described, for the purpose specified.

122. The calling-in and throwing-out frames, connected by suitable intervening mechanism, so that when the former is moving forward with the wheel the latter is riding back against its revolution, and vice versa, substantially as described, for the purpose specified.

123. The combination of the working-beam and connecting-rods with the sleeves of the calling-in and throwing-out frames, for the purpose of moving them in opposite directions, substantially as described.

124. The combination of a spring-lever with the working-beam, to sharpen and quicken its movements, substantially as described.

125. The calling-in and throwing-out frames, each constructed of a slotted segmental registering-plate, supported from the sleeves of the shaft E‴, so that the registering-wheel shall project through the slots, substantially as described.

126. The calling-in and throwing-out frames, having their acting edges configured to correspond with the signals which represent a station—that is to say, having outlines the same as those described by the pins of the registering-wheel under the impulses of the reciprocating plates m^3, when the pins are set by the proper signals from the transmitting-station, substantially as described.

127. The calling in frame, adapted to cause the pressure-roller to be thrown in contact with the cylinder, to feed the paper over the reproducing-knives when moved forward by the registering-wheel, substantially as described.

128. The throwing-out frame, adapted to remove the pressure-roller from contact with the cylinder D, to stop the feed of the paper over the reproducing-knives when moved forward by the registering-wheel, substantially as described.

129. The pivoted lever q^6, combined with the pressure-roller V and the cam o^{20}, on the sleeve of the calling-in frame, substantially as described, for the purpose specified.

130. The combination of the springs n^8 with the calling-in and throwing-out frames, to draw them toward the shaft E''' for the purpose of engaging the ends of the pins in the registering-wheel, when such pins are properly set, substantially as described.

131. The registering-wheel constructed with peripheral flanges containing the parallel setting-pins, substantially as described.

132. The combination of the holding-band m^7 with the registering-wheel and its setting-pins, substantially as described, for the purpose specified.

133. The combination of the tightening-pulley and spring with the holding-band m^7, substantially as described, for the purpose specified.

134. The beveled uprights q^2, combined with the registering-wheel, to restore the alignment of the setting-pins, substantially as described.

135. The beveled uprights q^3, combined with the registering-wheel, to correct any excess in the throw of the pins when set by the reciprocating plates, substantially as described.

136. The combination of the sliding horizontal rods p^4 and the upright cams with the calling and throwing frames, for the purpose of disconnecting them from the pins of the registering-wheel when they have reached the limit of their forward throw, substantially as described.

137. The combination of the automatic locking-levers p^6 and p^8 with the calling-in and throwing-out frames, substantially as described, for the purpose specified.

138. The automatic locking-levers p^6 and p^8, adapted for adjustment, substantially as described, for the purpose specified.

139. The shaft E''' of the registering-wheel, provided with friction-wheels u, by which it is driven from the upper shaft B, substantially as described, for the purpose specified.

140. The mode or method herein described of automatically joining the two helices of the receiving-magnet when a message is being received at a station, for the purpose of increasing the power of the magnet when receiving a message by the decrease of conducting-resistance in the receiving-magnets of all the other stations within reach of the current.

141. The mode or method herein described of automatically disconnecting the two helices of the receiving-magnet, and joining them separately to the main line when their station is not receiving a message, for the purpose of offering less resistance to the passage of the line-current through them.

142. The insulated levers R^1 R^2 R^3, having electric connection with the outer helix of the receiving-magnet, and the main wire joining such helix, combined with the insulated anvils R^1 R^2 R^3, having electric connection with the inner helix and its main wire, substantially as described, for the purpose specified.

143. The combination of the calling-in frame with the insulated conducting levers and anvils R^1 R^2 R^3, substantially as described, for the purpose specified.

144. The combination of the throwing-out frame with the insulated conducting levers and anvils R^1 R^2 R^3, substantially as described, for the purpose specified.

145. The insulated cams r^{10}, combined with the sleeve of the calling-in frame, for the purpose of connecting and disconnecting the levers R^1 R^2 R^3 and their anvils, substantially as described, for the purposes specified.

146. A circuit-breaker, interposed in the local wire of the receiving-station, and operated by the movements of the calling-in frame to make and break the local circuit of such station one or more times in rapid succession, for the purpose of inducing a return current in the main line which shall oscillate the arms of the receiving-magnet back at the transmitting-station, and thus notify the operator there that the receiving station is called in ready to receive a message, substantially as described.

147. The local circuit-breaker, consisting of the insulated hammer-lever and anvil R^4, interposed in the local wire, and operated by one of the cams r^{10} on the sleeve of the calling-in frame, substantially as described.

148. The hammer-lever R^4 of the local circuit-breaker, having its rear end notched, for the action of the cam r^{10}, substantially as described, for the purpose specified.

149. The mode or method of providing a standard measure of time at each station of a telegraph-line by means of a pendulum, whose vibrations reciprocate the slitting-knives of the several reproducing-magnets through a moving fillet of paper, a given number of times for each vibration, substantially as described.

150. The mode or method of establishing a uniform movement of the paper fillets at all the stations of a telegraph-line by means of the several driving-shafts, whose speed is adjusted to the measure of time furnished by the pendulum at each station, substantially as described.

151. A pendulum for opening and closing the circuit of the reproducing-magnet, to alternately reciprocate the slitting-knives in a given time, for the purpose of cutting slits in

a moving fillet of paper, and thereby enabling the operator to determine the speed of the driving-shaft by measuring the length of the slits, substantially as described.

152. The combination of the pendulum f^2 g^7, with a circuit-changer, for sending alternate currents from the local battery to the reproducing-magnet of a station, substantially as described.

153. The local circuit-changer, consisting of the pivoted trip-plate g^3, and its upright arm g^4, arranged within the path of the pendulum, so that the lower end thereof shall strike the upright points of the plate, and throw the arm alternately in contact with stop-pins g^5, the trip-plate having electric connection with the local battery, and the stop-pins with the reproducing-magnet, substantially as described.

154. The combination of a spring, g^6, with the upright arm of the trip-plate, to prevent the recoil of the arm when thrown in contact with the stop-pins, substantially as described.

155. The stop-pins g^5, and the trip-plate and arm, supported upon the main frame of the instrument by the upright bar f^6, the trip-plate and arm being insulated from the bar, and the latter being insulated from the frame, substantially as described, for the purpose specified.

156. The bar f^6, adapted for lateral adjustment, for the purpose of equalizing the throws of the tripping-arm g^4 from its center of oscillation, and thereby insuring uniformity in the length of the slits, by which the speed of the paper and driving-shaft is determined, substantially as described.

157. The weighted finger-piece h^2, arranged in the local line, to send the current either to the crescent trip-plate of the pendulum, or to the oscillating shaft of the receiving-magnet, substantially as described, for the purposes specified.

158. The curved guides q'' a^6, secured to the uprights of the frame beneath the feed-cylinders for directing the paper records out of the instrument, substantially as described.

159. The combination of the shears with the guide a^6, substantially as described, for the purpose specified.

160. The shears, consisting of the lower blade a^9 attached to an upright of the frame, so as to lie against a shoulder formed in the curved guide a^6, and of the upper swinging blade a^8 attached to the upright turning-rod p, substantially as described.

161. The combination of a coiled spring, p^1, with the upright turning-rod p, for the purpose of pressing one blade of the shears against the other when in the act of cutting, and to throw open such blades when the cutting action ceases, substantially as described.

162. The lightning-arresters Z^1, interposed in opposite ends of the main line at a station, to conduct a strong atmospheric current along the main line past a station without entering the receiving-magnet, and to direct the weaker induced message-currents into the receiving-magnet and prevent them from passing the station, substantially as described, for the purpose specified.

163. The lightning-arresters Z^1, each composed of two grooved half-cylinders of metal clamped upon a fine insulated wire, Z^2, placed in the main line, substantially as described.

164. The mode or method of joining the two lightning-arresters to the main line at a station by means of the wires Z^3 and helices Z^4, substantially as described.

165. The index-finger Z^5 and its dial-plate, combined with the helices of the lightning-arresters, substantially as described, for the purpose specified.

166. The combination of the switches Z^6 with the connecting-wires Z^3 of the lightning-arresters, substantially as described, for the purpose specified.

167. The combination of an index and dial with the graduating resistance-coil, to register the amount of resistance to the passage of the battery-current, substantially as described.

168. The combination of a graduating resistance-coil and a galvanometer, to equalize and determine the power of the battery, substantially as described.

169. The pivoted switch Z^7, in combination with the wire of the induction-coil, substantially as described, for the purpose specified.

ROYAL E. HOUSE.

Witnesses:

J. W. KEITH,

JON. F. BARRETT.