No. 675,894.

Patented June 11, 1901.

F. H. LITTLEFIELD.

PRINTING TELEGRAPH.

(Application filed June 18, 1900.)

(No Model.)

9 Sheets—Sheet 1.

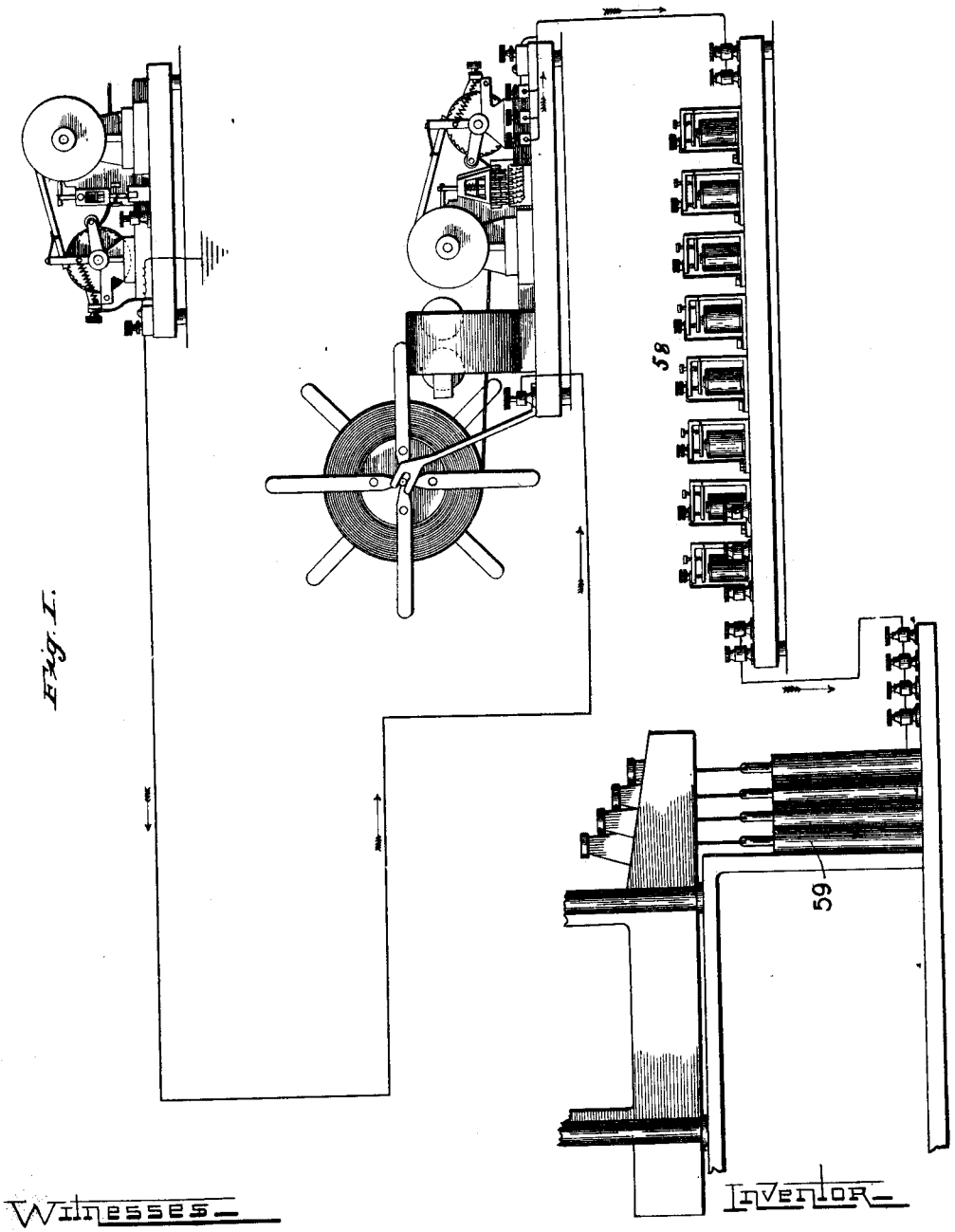


Fig. 1.

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By Cowell & Cowell

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No. 675,894. Patented June 11, 1901.

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PRINTING TELEGRAPH.

(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 2.

Fig. IX.

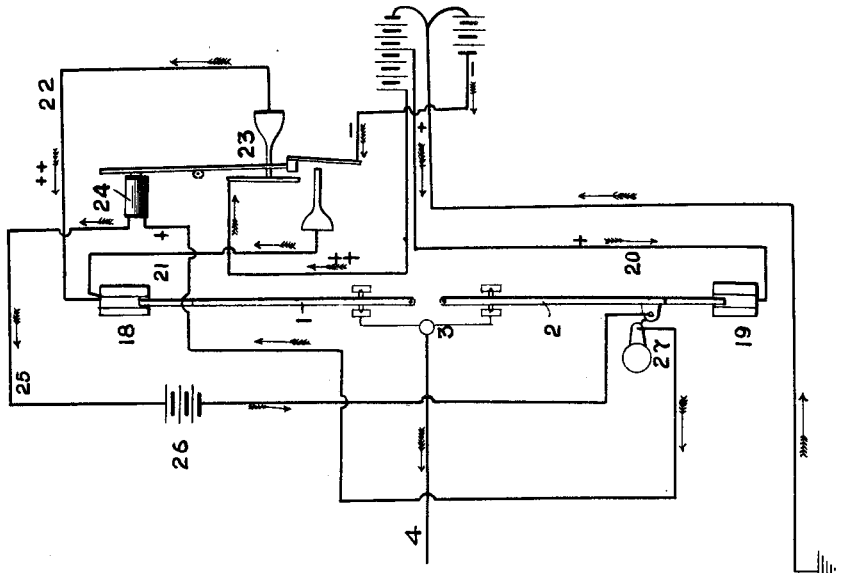
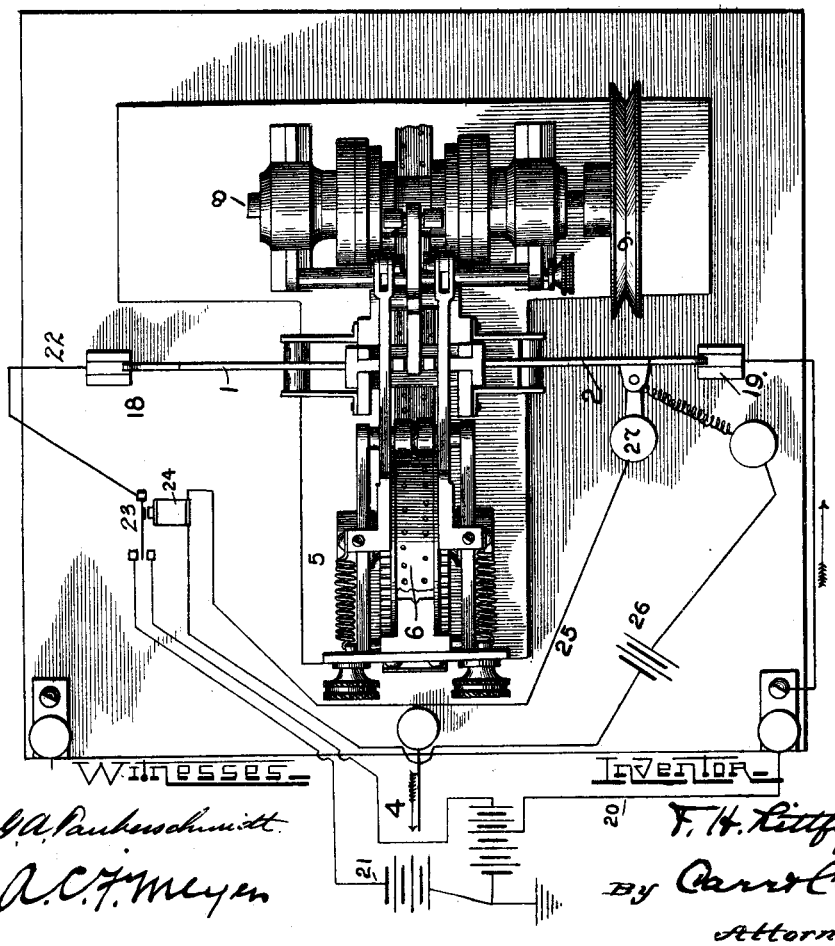



Fig. II.

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No. 675,894. Patented June 11, 1901.

F. H. LITTLEFIELD.

PRINTING TELEGRAPH.

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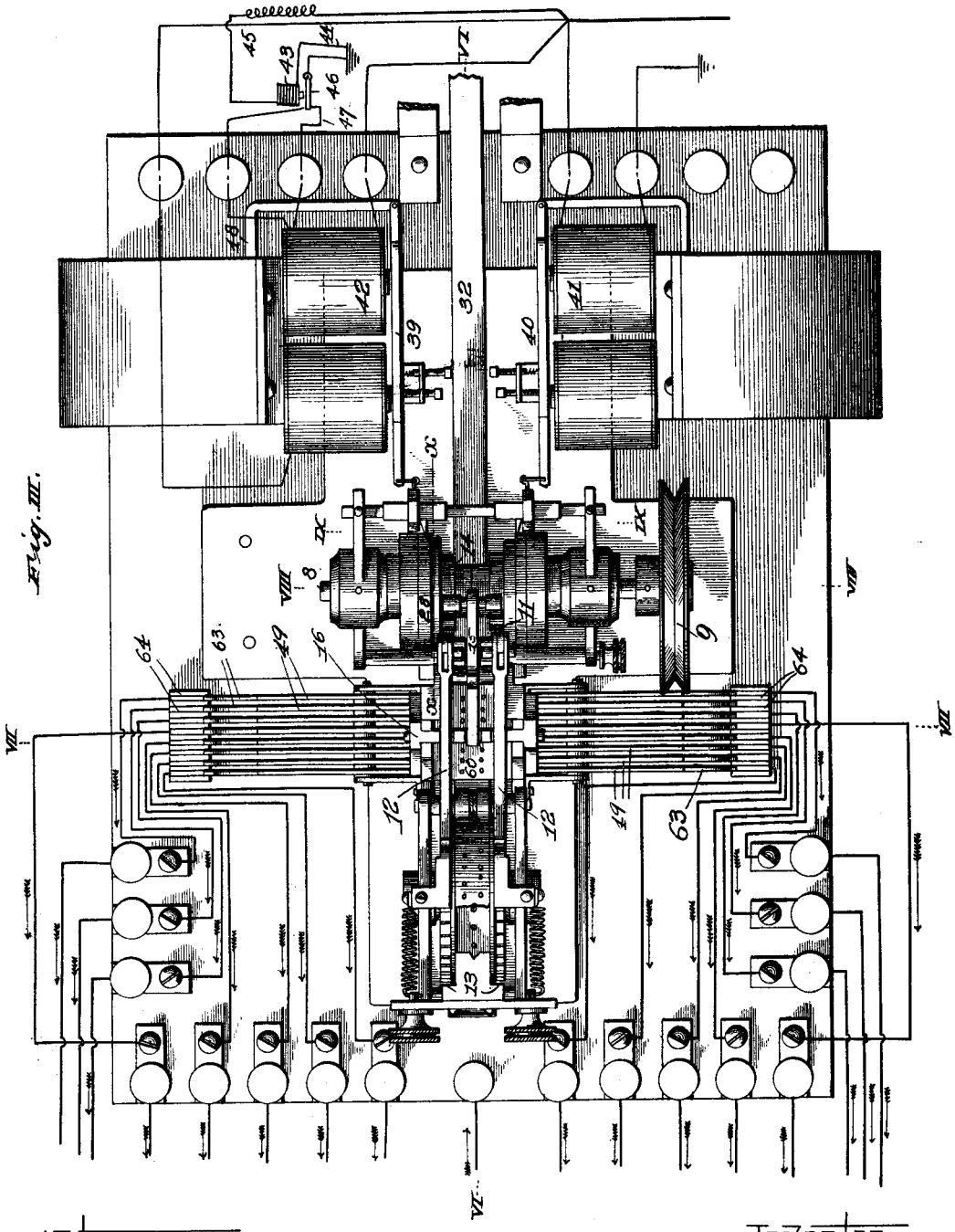
(No Model.) 9 Sheets—Sheet 3.

Fig. III.




Witnesses—

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No. 675,894. Patented June 11, 1901.

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PRINTING TELEGRAPH.

(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 4.


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No. 675,894. Patented June 11, 1901.

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(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 5.

Fig. V.

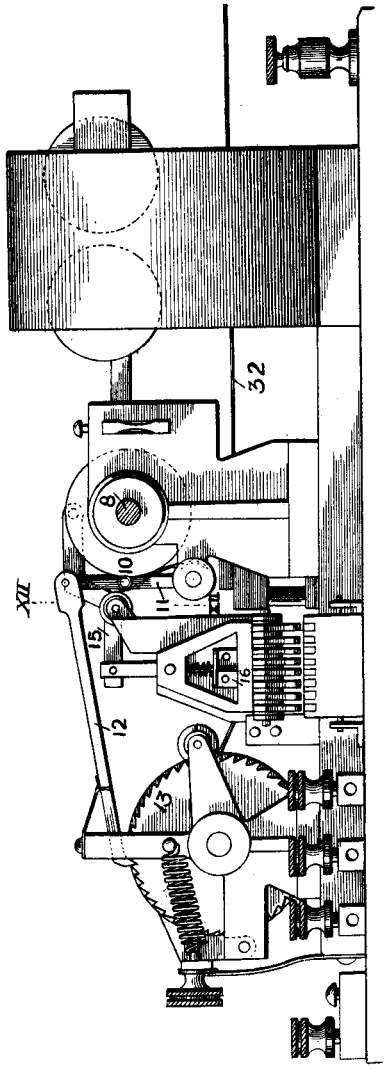
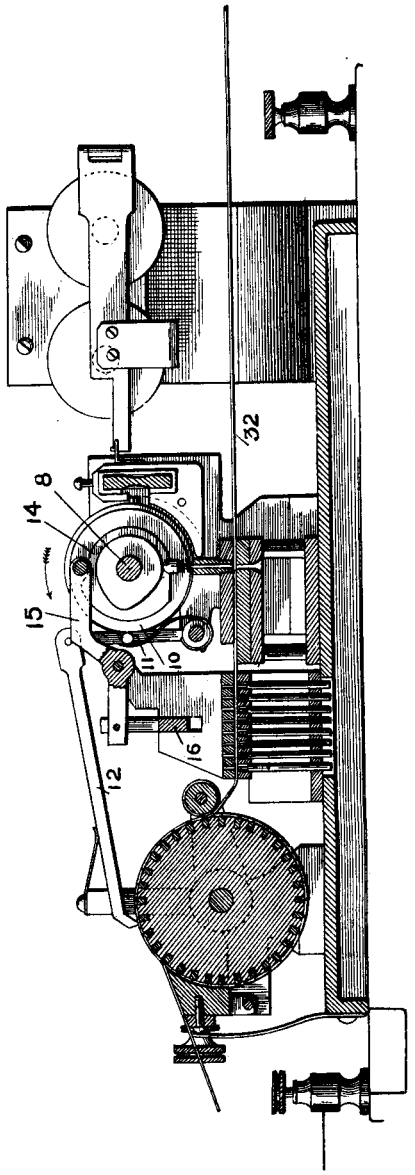



Fig. VI.




Witnesses.

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No. 675,894. Patented June 11, 1901.

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(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 6.

Fig. VII.

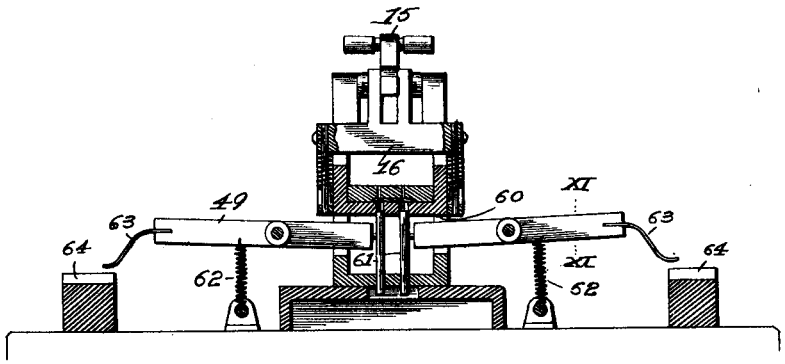



Fig. VIII.

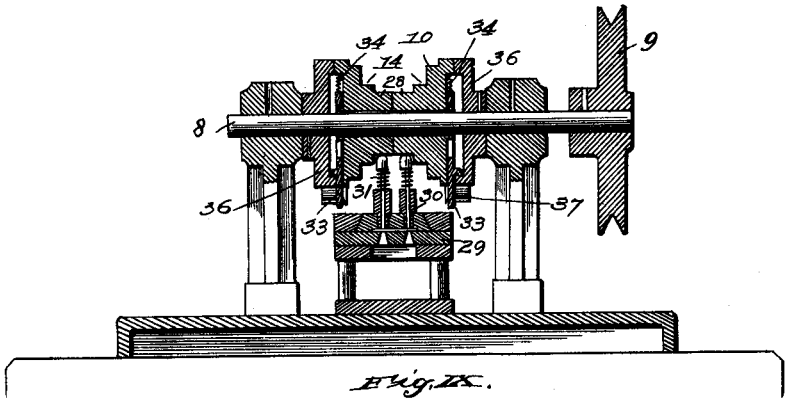
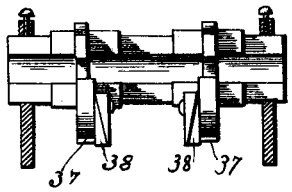



Fig. IX.

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No. 675,894. Patented June 11, 1901.

# F. H. LITTLEFIELD.

## PRINTING TELEGRAPH.

(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 7.

Fig. X.

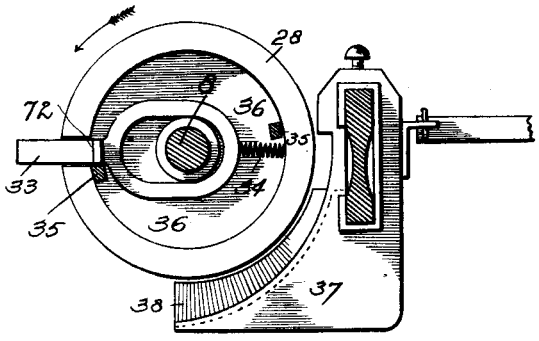



Fig. XI.

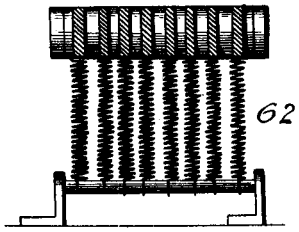



Fig. XII.

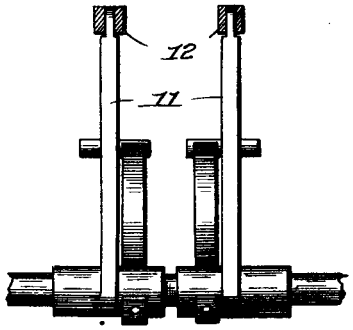



Fig. XIII.

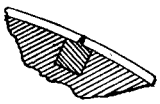
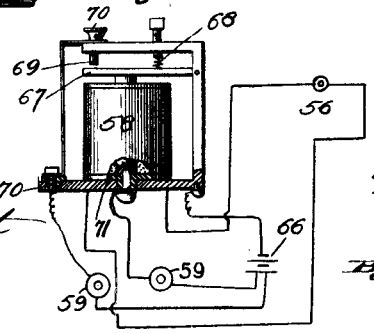


Fig. XIV.

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No. 675,894. Patented June 11, 1901.

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PRINTING TELEGRAPH.

(Application filed June 18, 1900.)

(No Model.) 9 Sheets—Sheet 8.

Fig. XIX.

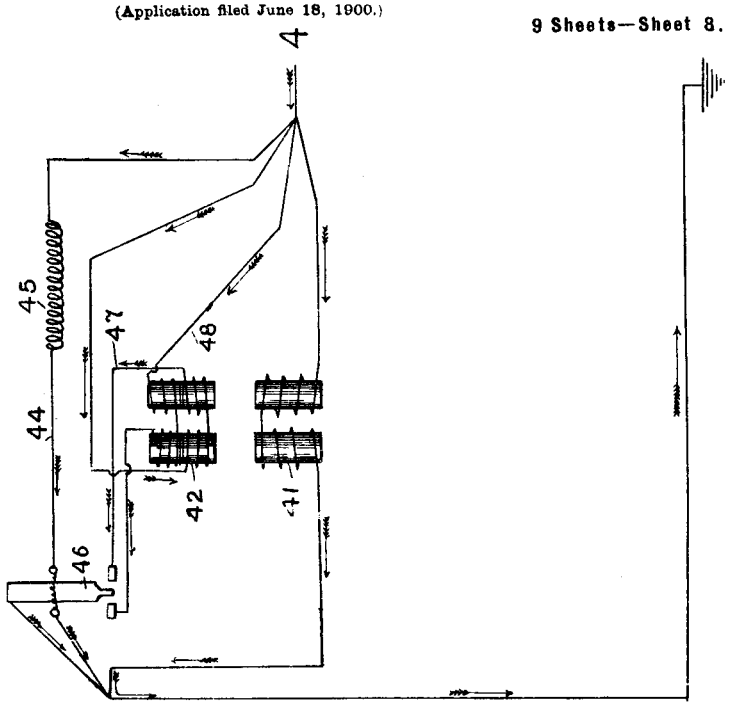
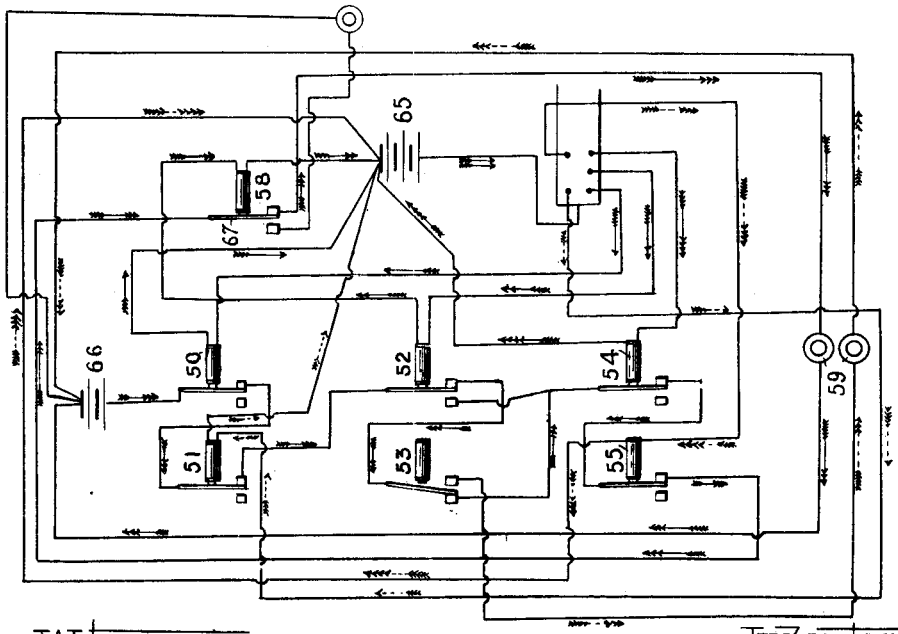



Fig. XX.

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No. 675,894. Patented June 11, 1901.

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PRINTING TELEGRAPH.

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(No Model.) 9 Sheets—Sheet 9.

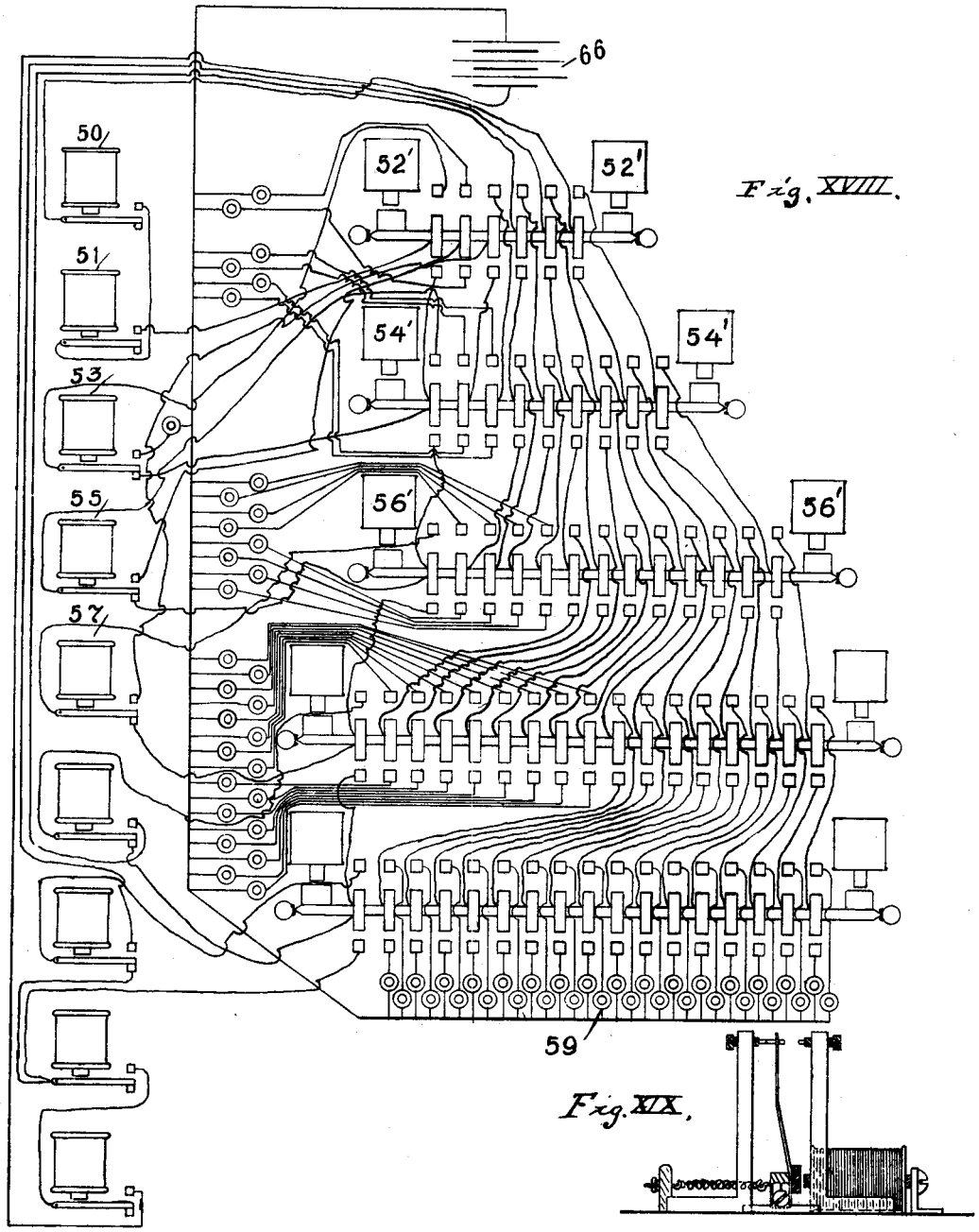


Fig. XVIII.

Fig. XIX.



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Jno. G. Thomson

Inventor—
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By Cass & Cass,
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# UNITED STATES PATENT OFFICE.

FREEMAN H. LITTLEFIELD, OF ST. LOUIS, MISSOURI, ASSIGNOR OF TWO-THIRDS TO MORDECAI YARNALL AND J. O. CHENOWETH, OF SAME PLACE.

## PRINTING-TELEGRAPH.

SPECIFICATION forming part of Letters Patent No. 675,894, dated June 11, 1901.

Application filed June 18, 1900. Serial No. 20,681. (No model.)

*To all whom it may concern:*

Be it known that I, FREEMAN H. LITTLEFIELD, a citizen of the United States, and a resident of the city of St. Louis, in the State of Missouri, have invented certain new and useful Improvements in Printing-Telegraphs, of which the following is a specification.

My invention relates to printing-telegraphs, and has for its principal objects to provide for the transmission of characters in facsimile perforations, to provide means for transcribing such facsimile perforations into the letters and characters represented by them, and to print such letters and characters in proper arrangement to constitute words, sentences, and paragraphs.

My invention consists in a transmitting instrument controlled by a perforated tape and in a receiving instrument controlled by a transmitted current and adapted to reproduce in facsimile the perforations of the tape of the transmitting instrument.

It further consists in a selecting device and a plurality of circuit-closing magnets arranged in permutation series and controlled by the selecting device so as to complete a separate circuit through a printing-magnet for each combination of perforations in the tape constituting a separate character.

It also consists in a selecting device hereinafter described.

It also consists in the combinations and arrangements of parts hereinafter described and claimed.

In the accompanying drawings, which form part of this specification, and wherein like symbols refer to like parts wherever they occur, Figure I is a general view of my system, including the instruments at the transmitting-station and at the receiving-station. Fig. II is a plan view of the transmitting instrument. Fig. III is a plan view of the receiving instrument and selecting-levers. Fig. IV is a diagrammatic view of the magnets of the selecting device and of the circuit-closing magnets of the permutation system. Fig. V is a side view of the receiving instrument. Fig. VI is a vertical central section of the receiving instrument on the line VI VI of Fig. III. Fig. VII is a vertical cross-section of the receiving instrument on the line VII VII of Fig. III. Fig. VIII is a vertical cross-section of the receiving instrument on the line VIII VIII of Fig. III. Fig. IX is a vertical cross-sectional detail of the receiving instrument on the line IX IX of Fig. III. Fig. X is a vertical sectional detail of the receiving instrument on the line X X of Fig. III. Fig. XI is a cross-sectional detail of the selecting-levers on the line XI XI of Fig. VII. Fig. XII is a detail on the line XII XII of Fig. V. Fig. XIII is a detail view of the tape-winding drum. Fig. XIV is a detail view of one of the permutation-magnets. Fig. XV is a diagram of the circuits of the transmitting instrument. Fig. XVI is a diagram of the circuits of the receiving instrument. Fig. XVII is a diagrammatic view representing the circuits of the selecting device and the manner in which it completes the circuit of one of the printing-magnets. To avoid confusion, only three pairs of selecting-magnets are illustrated in this figure and as much as practicable of the wiring is eliminated. Fig. XVIII is a diagrammatic view of a modification of my device, wherein the several series of circuit-changing magnets are replaced with electric switches mounted on the armatures of the respective selecting-magnets. Fig. XIX is an edge view of one of the magnets, showing the switch-contacts on the armature.

Like symbols refer to like parts wherever they occur throughout the drawings.

The transmitting instrument of my device comprises a pair of spring-actuated levers 1 2, carrying needles or styluses arranged opposite each other. Said levers are arranged to constitute circuit-closers for connecting the line-wire 4 to ground through an electrical generator. Said instrument is also equipped with a tape feeding or winding device 5, adapted to draw a perforated tape 6, of paper or other suitable material, lengthwise between said needles, and a perforated plate 3. This tape 6 is provided with a series of perforations representing various characters according to a predetermined code, in which two oppositely-arranged perforations constitute the means for separating the perforations into groups. When the tape intervenes be-

tween a needle and the plate 3, the circuit corresponding to that needle is broken by reason of the tape holding the needle-lever away from its contact-plate; but when a perforation is brought opposite the needle the needle enters said perforation and the contact-piece of its lever bears against the corresponding contact-plate, and thereby completes the circuit of the line-wire to ground. One of the needle-levers is connected to the positive pole of the battery at the transmitting-station and the other lever is connected to the negative pole of said battery, so that either a positive current or a negative current is transmitted to the line-wire, according as one needle or the other enters a perforation in the tape.

As the receiving instrument embodies all of the elements and the entire structural arrangement of the transmitting instrument, the drawings of said receiving instrument will serve to illustrate the construction of the transmitter.

The transmitting instrument consists of a framework having a horizontal shaft 8 journaled therein and carrying a belt-pulley 9 or other suitable means of connection to a driving power. Mounted on this shaft 8 is a cam 10, (or pair of cams,) against which bears a spring-pressed lever 11, to which is pivotally secured a push-rod or pawl 12. This pawl engages with the teeth of a ratchet-wheel 13, fixed to the tape-drum 5, which is journaled horizontally in the framework, whereby the drum is driven forward one space or step for each revolution of the shaft of the transmitting instrument. A second cam 14 (or pair of cams) is mounted on the driving-shaft 8 to coöperate with a spring-pressed lever 15, which is mounted in the framework and bears against said cam 14. The needles or styluses of the transmitting device are mounted on levers 1 2, journaled in the framework opposite each other, and these levers rest beneath the lever 15, (or a piece or frame 16, connected thereto,) so as to be actuated thereby. These needle-levers 1 2 have their needle or contact ends normally pulled up against the plate 3 by springs provided for the purpose and are depressed once in each revolution of the shaft of the transmitting instrument by means of the cam 14, operating through the interposed lever 15 and the frame 16 thereon. The outer ends of said needle-levers 1 2 are arranged to bear normally against insulated back stops 18 19 provided therefor. The perforated tape 6 is arranged to move under the plate 3 and above the needles on said levers 1 2, so that when the pressure of the depressing-lever 15 is released the needle ends of said levers 1 2 tend to rise against said tape. In case there is a perforation of the tape opposite the point of a needle the retracting-spring of the lever will pull the needle end thereof up through said perforation in the plate 3; but in case there is no perforation in the tape the pull of the spring is resisted by the tape itself and the needle end of the lever is held down. The back stop 19 of the needle-lever 2 is connected by a wire 20 to one pole of a transmitting-battery. The back stop 18 of the other needle-lever 1 is normally connected by a wire 21 to the opposite pole of a battery; but this last-mentioned back stop 18 has a normally open connection by a wire 22 to a battery of greater strength than the first-mentioned battery. All of said batteries are suitably connected to ground. The connections in the wires 21 22 are controlled by any suitable circuit-breaker or pole-changer 23, actuated by an electromagnet 24 in a local circuit 25. This local circuit 25 begins at a local battery 26 and runs thence to a contact-piece on the needle-lever 2 in position to contact with a fixed contact-piece 27 when the lever 2 is in contact with its back stop 19. From said fixed contact-piece 27 the circuit runs through the electromagnet 24 of the pole-changer back to the battery. Thus every time the lever of needle 2 is allowed to rise through a perforation in the tape the local circuit is closed and the magnet 24 is energized, and therefore the normal circuit from the back stop 18 of the lever 1 by wire 21 to the battery is broken and the normally open circuit by wire 22 is closed. So long as the needle of lever 1 bears against an imperforate portion of the tape that lever is held out of contact with its contact-plate and its circuit is thereby broken, so that it is immaterial what connections are made through the pole-changer. When, however, the needle of lever 1 rises through a perforation, a circuit is completed from the battery by wire 22 through the pole-changer and contact-plate 18 and needle 1 to the line-wire. The current through this circuit is the reverse of the normal current and is of the same polarity as the simultaneous current through the opposite needle. Thus a negative current or a positive current or a current of abnormal strength may be transmitted to the line-wire, according as one needle or the other or the two needles simultaneously are allowed to contact with their back stops.

The receiving instrument is similar to the transmitting instrument so far as regards the driving-shaft, the tape-drum, the cams, and connections for operating the tape-drum from the driving-shaft. The driving-shaft also has loosely mounted thereon a pair of cams 28 and a clutch or device for periodically fastening said cams to the shaft to move therewith. The framework has mounted therein a die-plate 29, two dies, and a punch 30 for each die, the two punches being mounted in position to be actuated by the loose cams 28, revolving on the shaft and being provided with springs 31 for retracting them. The receiving-tape 32 is drawn by the tape-drum over the dies and below the punches, so as to receive perforations along two lines or rows, according as one punch or the other is actuated by its cam.

The means for automatically operating the clutches for fastening the cams to the shaft are as follows: Each cam 28 is made hollow, and inside thereof is a locking-pin 33, which has an elongated slot therein to fit over the driving-shaft. This piece is pressed outwardly by means of a spring 34, provided for the purpose, and has its end extended outwardly through a slot in the periphery of the cam. A lug 72 is provided on this locking-pin 33 in position to be struck by a lug 35 on the face of a disk 36, fixed to the driving-shaft and constituting the other member of the clutch. In the path of the projecting pin is arranged a disengaging device consisting of a plate 37, having secured thereto an edgewise-beveled piece 38, whose surface gradually approaches the periphery of the clutch and constitutes a bearing surface or cam for crowding the clutch-pin inwardly, so as to disengage its lug from the lug of the fixed member of the clutch. The disengaging device is mounted to slide parallel with the shaft and is carried by the polarized armature 39 40 of electromagnets 41 42. There is one electromagnet for each of the clutch-engaging devices, and the armatures of said magnets are of opposite polarity. One of said magnets 41 is permanently connected to the line-wire. The other magnet is normally connected to the line-wire and to ground through a pole-changer 43. The electromagnet of this pole-changer is in a permanently-grounded shunt 44 from the line-wire and has a high-resistance coil 45 therein. The armature 46 of said magnet is connected to ground and in its retracted position bears against a terminal of one winding 47 of the electromagnet 42. When said armature is attracted forwardly, it contacts with the terminal of a reverse winding 48 of said electromagnet, which winding is also connected to the line-wire. Both of said magnets, being thus connected to the line-wire, are energized by the current therefrom, so that a current of normal strength will cause the energization of one or the other of said magnets, according to its polarity, and the energization of either magnet will cause the engagement of the corresponding clutch on the driving-shaft, so as to fasten the cam to the shaft, and thereby cause the operation of the punch to perforate the tape. When an abnormally strong current comes over the line, both of said magnets are operated simultaneously, the abnormal strength of the current being sufficient to operate the pole-changer 43, and thereby ground the winding 48 of the electromagnet 42. The current thus shunted through the winding 48 overcomes the polarity of the armature and attracts said armature, so as to cause the engagement of the cam and the operation of the tape-perforator, as above described. The receiving device is thus capable of punching in the tape-perforations in either of two rows or in both rows simultaneously, as desired, thus reproducing in facsimile the perforations of the transmitting-tape.

As the receiving instrument is capable of reproducing the facsimile perforations in the tape faster and with less interference from atmospheric conditions than a type-printing device, it is desirable to receive the messages on the tape and to provide devices at the receiving-station for translating the code characters and printing them in the ordinary alphabetical characters. For this purpose the perforated tape is drawn past a series of selecting-levers 49 at the receiving-station, which needles constitute circuit-closers, respectively, for a series of selecting-magnets 50 51 52 53 54 55 56 57, and these selecting-magnets in turn control the circuits of series of permutation-magnets 58, which permutation-magnets in turn control and complete the circuits of the printing-magnets or solenoids 59, so as to print the proper characters.

The perforated tape is passed over a tape-drum driven in any suitable way—such, for instance, as that described hereinbefore for the transmitting instrument. The tape is passed under a plate 60, having two parallel slots or rows of holes therein the same distance apart as the rows of perforations in the tape. Beneath said perforated plate are arranged the ends of two series of selecting-levers 49, one series being arranged for each row of perforations and the entire number of such levers being equal to the maximum number of perforations required to constitute a character plus four levers required for the separating perforations. The selecting-levers are each provided with a needle or pin 61, adapted to extend up through the corresponding perforation in the perforated tape and likewise through the perforation in the plate 60, and each of said levers is also provided with a spring 62, which tends to force the pins or needles upwardly through said perforations. The other end of each of said levers is furnished with a contact-spring 63, adapted to bear against its back stop 64 when the pin projects through the perforation in the tape, but arranged to be out of contact with its back stop when the pin bears against an imperforate portion of the tape. The several selecting-levers are all connected electrically to a battery or other electrical generator 65. The back stops 64 of said selecting-levers are also connected to the opposite pole of said battery or generator 65, so that there is a complete circuit whenever a contact-spring of any of said levers is in contact with its back stop. An electromagnet 50 51 52 53 54 55 56 57 is arranged in each of the circuits at some point between the generator and the back stop. Each of said last-mentioned magnets is provided with an armature normally in contact with a back stop, but adapted when attracted by its magnet to contact with a contact plate or stop provided therefor. The several selecting-magnets last mentioned

are arranged in pairs corresponding in position to the positions of their selecting-levers. The armature of one of the magnets 50 of the first pair is connected to a battery 66. The armature of the other magnet 51 of the first pair is connected to the fore stop or contact-plate of the armature of the first magnet 50 of that pair. The armature of the second magnet 51 53 55 57 of each pair of magnets is likewise connected to the forward contact-plate of the armature of the first magnet of the corresponding pair 50, 52, 54, and 56. The back stops of the armatures of both magnets of each pair of selecting-magnets 52 53 54 55 (excepting the first pair) are connected to the armature of the first magnet 54 56 of the next succeeding pair. Thus no circuit can be completed through said battery 66 except when the two magnets 50 51 of the first pair are energized so as to attract their armatures into contact with their forward contact-plates, and this condition exists only when oppositely-arranged perforations in the tape permit the first pair of selecting-levers 49 to rise simultaneously. In like manner no circuit can be completed from said battery unless a second pair of magnets is energized simultaneously, so as to attract their armatures against their forward stops, and this condition exists only when some pair of oppositely-arranged perforations in the tape permits a second pair of selecting-levers 49 to rise therethrough. The forward contact-plate of the second selecting-magnet of each pair 53 55, with the exception of the first and the last pairs, is connected in multiple to the said battery or generator 66, so as to complete a circuit therethrough, and in each multiple-arc is a separate solenoid or printing-magnet 59. The first or right-hand member of each pair of selecting-magnets 52 54 56 (after the first pair) is connected through a separate series of permutation-magnets 58 to said battery 65. The number of magnets in series with the first magnet 52 of the second pair of selecting-magnets is six. The corresponding magnet 54 in the third pair is in series with ten permutation-magnets. In the fourth pair the corresponding magnet 56 is connected through sixteen magnets, in the fifth pair through twenty-four magnets, and in the sixth and seventh pairs each through thirty-two magnets. The eighth or last pair has no permutation-magnets in series therewith.

The function of the permutation-magnet 58 is to complete a local circuit through one of the solenoids or printing-magnets 59, there being a separate solenoid or printing-magnet for each character to be printed. A suitable form of permutation-magnet is shown in Fig. XIV. In this construction the metal framework is connected to the solenoid-battery 66 and has a metal armature 67, retracted by a spring 68 to rest normally against a back stop 69, which is connected to an insulated pin 70, (or is itself insulated,) and this pin is connected, through a solenoid or printing-magnet 59, to the battery 66. The core 71 of the magnet is also insulated from the framework and is connected to the solenoid-battery through a solenoid or printing-magnet 59, whereby when the armature is attracted the former circuit is broken and a new circuit completed through the last-mentioned solenoid.

The arrangement and the wiring of the permutation-magnets are as follows: There are six series A B C D E F of permutation-magnets connected, respectively, to the first or right-hand member 52 54 of the several pairs of selecting-magnets, respectively, exclusive of the first and last pairs. The number of magnets 58 in the first series is six, and the number of magnets in each succeeding series is double the number of magnets in the series preceding it, less such number as are connected directly to printing-magnets. The frames or armatures of all of the magnets of the first series A are connected to the respective forward contact-plates of the second selecting-magnets of the several pairs, excluding the first and last pairs. Both the forward stop and the back stop of each permutation-magnet (except one) of the first series A is connected to the frame of a different permutation-magnet in the second series B, and in like manner both the forward stop and the back stop of each of the permutation-magnets (except two) of the second series B is connected to the frame of a separate magnet in the third series C, and so on through the remaining series, and both the forward stop and the back stop of each of the magnets in the last series and of each of the magnets in the preceding series not connected to magnets in succeeding series are connected through separate solenoids or printing-magnets 59 to the battery 66. Thus the forward stop of each second member of a pair of selecting-magnets 52 54, exclusive of the first and last pairs, is connected to the armatures 67 of one of the permutation-magnets of the first series A and is thence connected through one or more permutation-magnets through a printing-magnet to the battery, the circuit being open, however, at the forward contact-stop of the selecting-magnet. In case any of the permutation-magnets in the series is energized its armature is brought into contact with its forward stop, and thereby shunts the current through said armature into a different circuit, which likewise passes through a printing-magnet to the battery. The permutation-magnets are thus arranged not only in electrical series, but also in groups. The first group comprises only the first magnet of the first series A. The second group comprises the second magnet of the first series A and the first two magnets of the second series B. The third group comprises the third magnet of the first series A, the third and fourth magnets of the second series B, and the first four members of the third series C, and so

on, each group being headed by a different magnet of the first series and each successive group extending into one additional series of magnets, the number of magnets in each group after the first being two raised to a power equal to the number of the group, less one. This system is capable of indefinite extension; but in practice six groups will be amply sufficient for all requirements. It is noted that in this arrangement the second or left-hand member of each pair of selecting-magnets 53 55 (except the first and last) determines which group of magnets the solenoid-battery current shall enter; but the first or right-hand member of each pair of selecting-magnets 52 54 (except the first and last) determines the particular path of the circuit by controlling the armature-contact of the permutation-magnets. In this manner a different circuit is completed for the current for each different combination of perforations in the tape, so that by selecting the particular combinations or permutations of such perforations for the several characters and arranging the printing-magnets accordingly a definite code of characters can be formed which will be translated and printed in proper form by the printing-magnets.

Fig. XVIII represents a simple modification of the permutation system. In this modification the separate permutation-magnets in series with the selecting-magnets are dispensed with and the selecting-magnets are made to perform the functions of said permutation-magnets. For this purpose the connections of the selecting-magnets are the same as hereinbefore described; but the first magnet of each pair is replaced with a plurality of magnets arranged to coöperate upon an armature common to them in order to secure a greater attracting force for said armature and to equalize a pull upon the full length of the armature-bar. The armature of the first magnet of each pair of selecting-magnets is mounted on an insulating-bar pivotally mounted in the framework. This bar carries a number of contact-springs equal in number to the number of permutation-magnets replaced thereby, and contact-stops are mounted in the frame opposite said contact-springs respectively. Each contact-spring corresponds to the armature of a permutation-magnet in the system hereinbefore described, and the contact-springs of one series are electrically connected to the fore and the back stops of the contact-springs of the next preceding series, according to the method hereinbefore described. In this modification it is desirable to mount an extra contact-spring on each insulating-bar to make the contacts hereinbefore mentioned respecting the armatures of the selecting-magnets. This extra contact-spring and its fore and back stops are connected in the same way as the armature and the stops of the selecting-magnets hereinbefore described. The operation of this modification is the same as the operation hereinbefore described; but this modification has the special advantages of compactness, cheapness, and simplicity of construction and wiring and requires less power for its operation.

Any suitable mechanism may be used for mounting the printing-magnets and the parts operatively connected thereto. I prefer, however, to use an ordinary type-writer having soft-iron cores suspended from the respective type-levers and each contained in a solenoid adapted to be actuated. A mechanical tripping device, arranged in the path of the platen at the limit of its stroke, may be used to disengage said platen automatically, which will immediately be retracted to its former position by a spring or other automatic device.

Obviously my device admits of considerable modification, and I do not desire to limit myself to the details of arrangement or construction hereinbefore described.

What I claim is—

1. A telegraph transmitting instrument comprising two oppositely-arranged levers permanently electrically connected to the line-wire and adapted to coöperate with a perforated tape, and a contact-plate for each lever, the two contact-plates being connected to opposite poles of grounded batteries, substantially as described.

2. A telegraph-transmitter comprising a pair of levers connected to the line-wire and adapted to coöperate with a perforated tape, back stops for said levers connected to opposite poles of grounded electric generators, and a local circuit comprising a generator, a circuit-breaker controlled by one of said levers, and an electromagnet having an armature arranged to break the normal ground connection of the back stop of the opposite lever and to close a second circuit from ground through a generator of greater strength than the generator in the normal ground connection of the back stop of said opposite lever, substantially as described.

3. A telegraph-transmitter comprising a pair of oppositely-arranged levers electrically connected to the line-wire and adapted to cooperate with a perforated tape, back stops for said levers connected to ground through generators of opposite polarity, one of said back stops having a second normally open connection to ground through a generator of greater strength than the generator in its normal connection to ground, means controlled by the opposite lever for automatically opening the normal connection and closing the abnormal connection, means for feeding the tape step by step, and means for disengaging the levers from the tape at each progressive step, substantially as described.

4. A telegraphic instrument comprising a pair of oppositely-arranged levers electrically connected to the line-wire, and adapted to cooperate with a perforated tape, back stops for said levers oppositely connected to ground through a generator, one of said back stops having a second normally open connection

to ground through a generator of greater strength than the generator in its normal ground connection, means controlled by the aforesaid lever for automatically opening the normal ground connection and closing the abnormal connection, a tape-winding drum, a driving-shaft having cams thereon, and intermediate devices operated by said cams for intermittently actuating said tape-drum and said levers respectively, substantially as described.

5. A telegraphic instrument comprising a pair of oppositely-arranged levers electrically connected to the line-wire and adapted to cooperate with a perforated tape, back stops for said levers connected to ground through generators of opposite polarity, and one of said back stops having a normally open connection to ground through a generator of abnormal strength, a local circuit comprising a generator, a circuit-breaker controlled by one of said levers, and a pole-changing electromagnet adapted to break the normal ground connection and to close the abnormal connection, and means for intermittently feeding said tape and actuating said levers, substantially as described.

6. A telegraphic instrument comprising a pair of oppositely-arranged levers electrically connected to the line-wire, and adapted to cooperate with a perforated tape, back stops for said levers connected to ground through generators of opposite polarity, and one of said back stops having a normally open connection to ground through a generator of abnormal strength and of polarity opposite that of the normal ground connection, a local circuit comprising a generator, a circuit-breaker controlled by one of said levers, and a pole-changing electromagnet adapted to break the normal ground connection and to close the abnormal connection, and means for intermittently feeding said tape and actuating said levers, substantially as described.

7. A telegraph-receiver comprising a pair of electromagnets having oppositely-polarized armatures, one of said magnets having a reverse winding adapted to overcome the polarity of its armature when energized by an abnormally-strong current, and each of said magnets being arranged to control message-recording devices, substantially as described.

8. A telegraph-receiver comprising an electromagnet permanently connected to ground and to the line-wire, a second electromagnet having two reverse windings connected to the line-wire, an electric switch connected to ground, and adapted to contact alternately with the terminals of said reverse windings, and means for automatically controlling said switch, polarized armatures for said electromagnets and message-recording devices controlled by said armatures, substantially as described.

9. A telegraph-receiver comprising four shunts from the line-wire to ground, one of said shunts being of high resistance and having an electromagnet therein whose armature is permanently connected to ground, a second shunt connected to the back stop of said magnet and containing an electromagnet having a polarized armature, a third shunt connected to the fore stop of the armature of said first-mentioned magnet and containing a reverse winding of said second magnet, and the fourth shunt being permanently connected to ground through an electromagnet having an armature of opposite polarity to that of the second magnet, said polarized armatures being arranged to control message-recording devices, substantially as described.

10. In a telegraph instrument, a driving-shaft, a pair of tape-perforators, a pair of cams loosely mounted on said shaft and adapted to operate said tape-perforators respectively, a clutch for each of said cams, a pair of electromagnets having oppositely-polarized armatures arranged to actuate said clutches respectively to engage said cams, and means for causing said armatures to be attracted separately or simultaneously, substantially as described.

11. In a telegraph instrument, a driving-shaft, a pair of cams mounted loosely thereon, a spring-pressed locking-pin arranged to slide radially in each of said cams, disks fixed to said shaft and carrying lugs adapted to engage projections on said locking-pins respectively and thereby constitute clutches for said cams, two electromagnets having oppositely-polarized armatures adapted to be energized from the line-wire, and each of said armatures carrying a device for disengaging the corresponding locking-pin from the fixed disks, substantially as described.

12. In a telegraph instrument, a driving-shaft, a pair of cams mounted loosely thereon, a spring-pressed locking-pin arranged to slide radially in each of said cams, disks fixed to said shaft and carrying lugs adapted to engage projections on said locking-pins respectively and thereby constitute clutches for said cams, two electromagnets having oppositely-polarized armatures adapted to be energized from the line-wire, each of said armatures carrying a piece whose edge has a spiral curve located in the path of the corresponding locking-pin whereby it disengages said locking-pin from the fixed disk, substantially as described.

13. In a telegraph instrument, a driving-shaft, a pair of cams mounted loosely thereon, a spring-pressed locking-pin arranged to slide radially in each of said cams, disks fixed to said shaft and carrying lugs adapted to engage projections on said locking-pins respectively and thereby constitute clutches for said cams, two electromagnets having oppositely-polarized armatures adapted to be energized from the line-wire, each of said armatures carrying a piece whose edge is located in the path of the corresponding locking-pin whereby it disengages said locking-pin from the fixed disk, substantially as described.

14. In a telegraph instrument, a driving-shaft, a pair of cams mounted loosely thereon, a spring-pressed locking-pin arranged to slide radially in each of said cams, disks fixed to said shaft and carrying lugs adapted to engage projections of said locking-pins respectively and thereby constitute clutches for said cams, two electromagnets having oppositely-polarized armatures adapted to be energized from the line-wire, each of said armatures carrying a plate whose edge has a spiral curve arranged in the path of the locking-pin whereby the locking-pin is disengaged from the fixed disk, and said plate also carrying a stop for said locking-pin whereby the movement of the cam is prevented until the armature is attracted to release said pin, substantially as described.

15. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair, and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, substantially as described.

16. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair, and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, said circuit-changing devices comprising insulated contact-springs mounted on the armatures of the first magnet of each pair except the first and last pairs, and fore and back stops for said contact-springs, said contact-springs and stops being in the circuits of said printing-magnets, substantially as described.

17. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair and the fore stop of the armature of the second magnet of each pair except the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, said circuit-changing devices comprising insulated contact-springs mounted on the armatures of said magnets and fore and back stops therefor, the stops of some of said springs being directly connected to printing-magnets, and the stops of the other springs being connected to springs on the armature of the selecting-magnet of the next succeeding pair, substantially as described.

18. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair, and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, said circuit-changing devices consisting of electromagnets arranged in series with the respective first magnets of each pair excepting the

first and the last pair and having armatures adapted to bear against a plurality of electric terminals, substantially as described.

19. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair, and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, each of said first-mentioned electromagnets having in its separate connection a series of circuit-changing magnets whose armatures form part of said multiple arc, substantially as described.

20. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electrical generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armatures of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair, and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, said circuit-changing devices consisting of a series of electromagnets arranged in series respectively in the separate connections of each of said first-mentioned electromagnets, said circuit-changing magnets being arranged in groups equal to the number of pairs of said first-mentioned magnets less two and wherein the armature of one magnet of each group is connected to the fore stop of the armature of the second magnet of each pair of said first-mentioned magnets and wherein the stops of said armature of each group are connected in multiple through printing-magnets, substantially as described.

21. In a printing-telegraph, series of oppositely-arranged levers adapted to coöperate with a perforated tape, and connected to an electric generator, back stops for said levers separately connected to said generator, an electromagnet in each of said separate connections, armatures for said magnets, the armature of one of the magnets of the first pair being connected to an electrical generator, and the armature of the second magnet of each pair being connected to the fore stop of the armature of the first magnet of the corresponding pair, and the back stops of the armature of both magnets of each pair being connected to the armature of the first magnet of the next succeeding pair and the fore stop of the armature of the second magnet of each pair excepting the first and last pairs being connected in multiple to the electrical generator to which said first-mentioned armature is connected, and a printing-magnet in each multiple arc, and circuit-changing devices controlled by said magnets for completing the circuit of a printing-magnet, said circuit-changing devices consisting of circuit-changing magnets arranged in separate circuits of the first magnet of each pair of said first-mentioned magnets respectively excepting the first and last pair, and the number of magnets in the series of the second pair being equal to the number of pairs less two, and the armatures of each magnet of said series being connected respectively to the fore stop of the second magnet of each pair except the first and last pair, and the number of magnets in the series of the third pair being double the number of magnets in the first series less two, and the number of magnets in each succeeding series being double the number of magnets in the series preceding it less the number of magnets connected directly to the printing-magnets, and the stops of the armature of each magnet of each series being connected to the armatures of two magnets of the next succeeding series or directly to the printing-magnets, substantially as described.

22. In a printing-telegraph, a system of permutation-magnets comprising a plurality of series of circuit-changing magnets arranged in groups wherein the circuits controlled by two magnets of each series are alternately connected to the terminals of one magnet of the preceding series, and automatically-controlled selecting-magnets adapted to complete the battery-circuit to the armature of the first magnet of one group and to energize the permutation-magnets according to a predetermined code, substantially as described.

Signed at St. Louis, Missouri, June 12, 1900.

FREEMAN H. LITTLEFIELD.

Witnesses:
CHAS. E. WISE,
JAMES A. CANN.