3 Sheets—Sheet 1.

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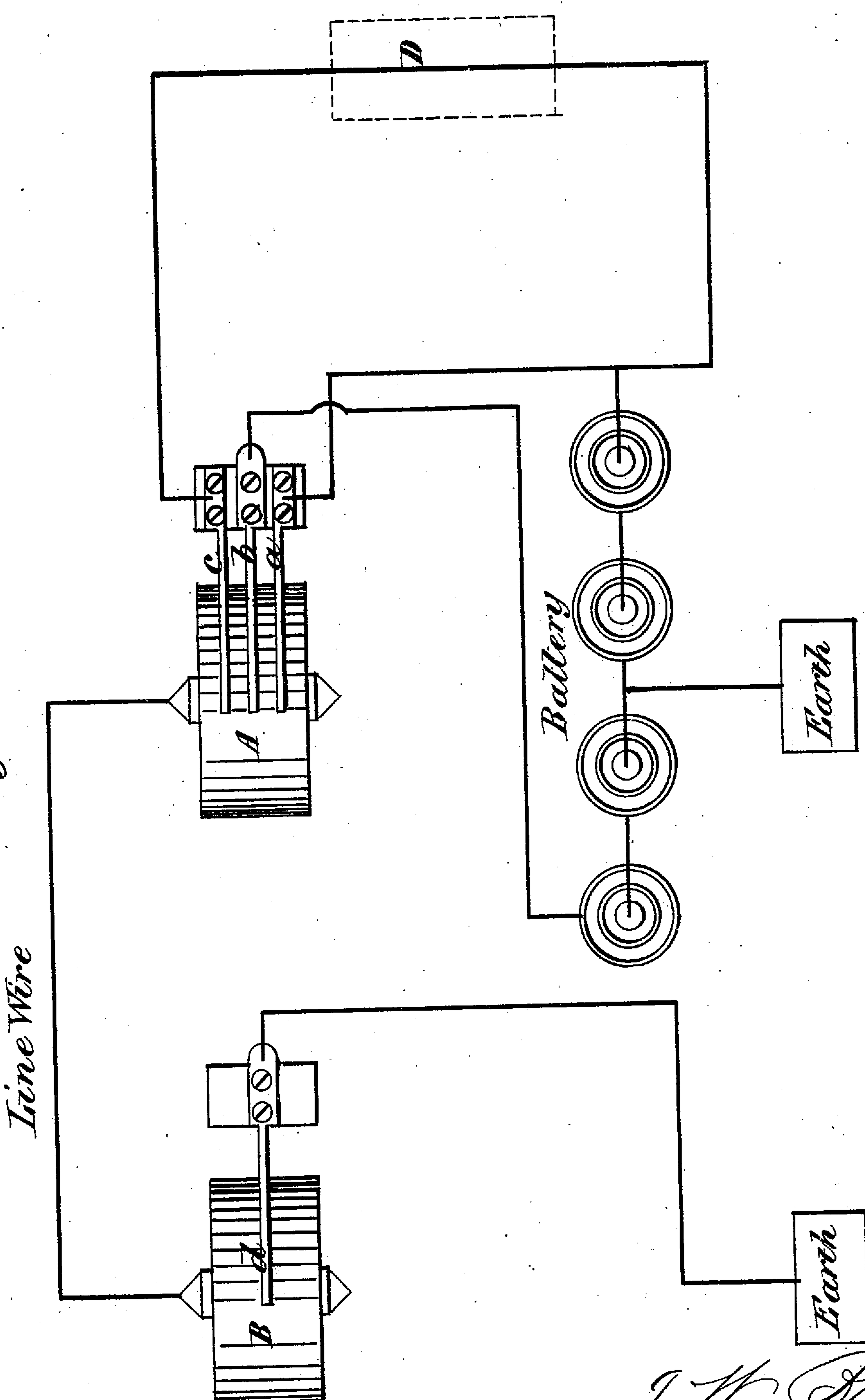
AUTOMATIC TELEGRAPHY.

No. 189,184. Patented April 3, 1877.

Fig. 1.



Witnesses:
Michael Ryan
Fred Haynes

J. W. Brown
by his Attorneys
Brown & Allen

N. PETERS, PHOTO-LITHOGRAPHER, WASHINGTON, D. C.

3 Sheets—Sheet 2.

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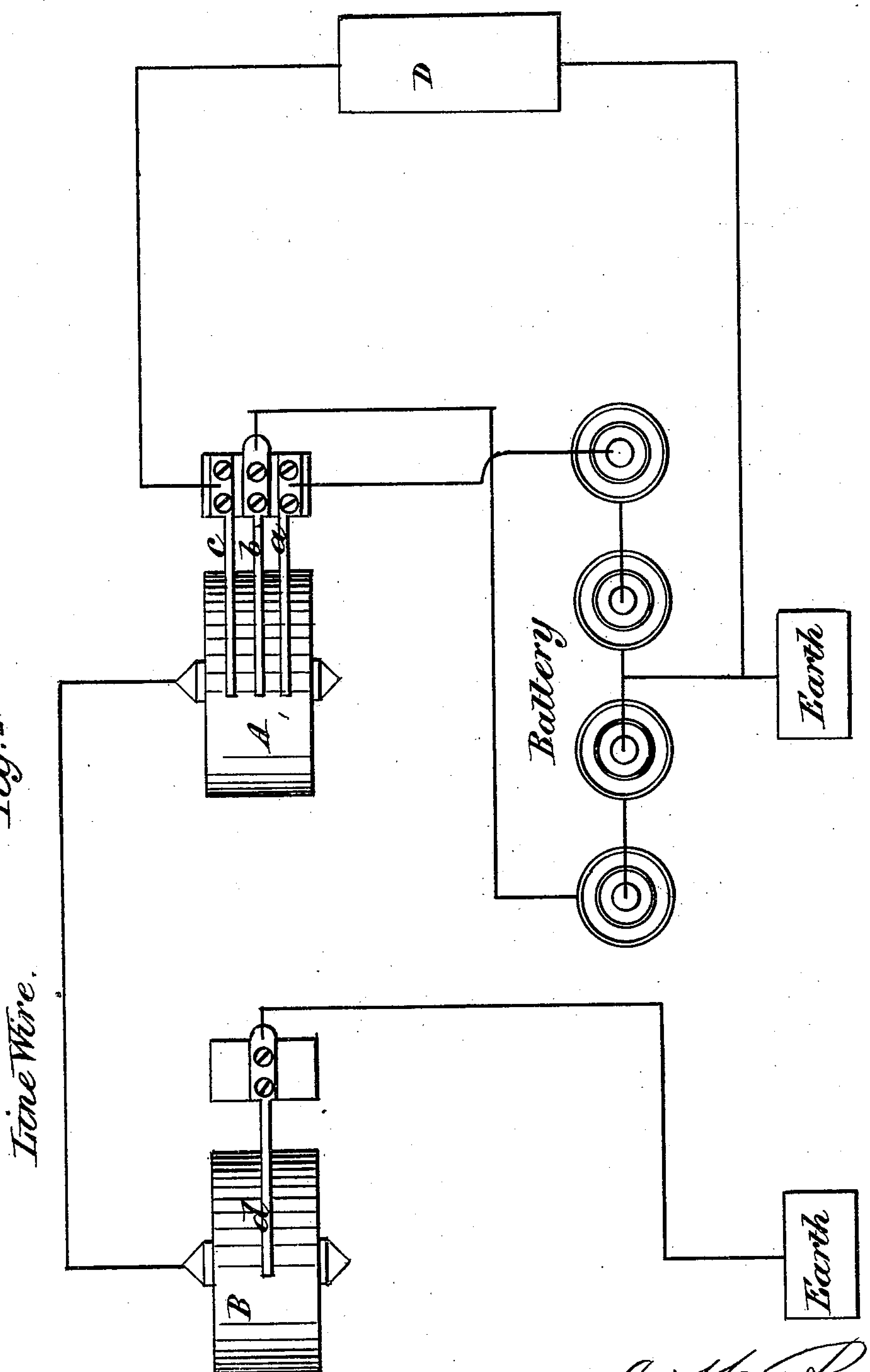

Fig. 2

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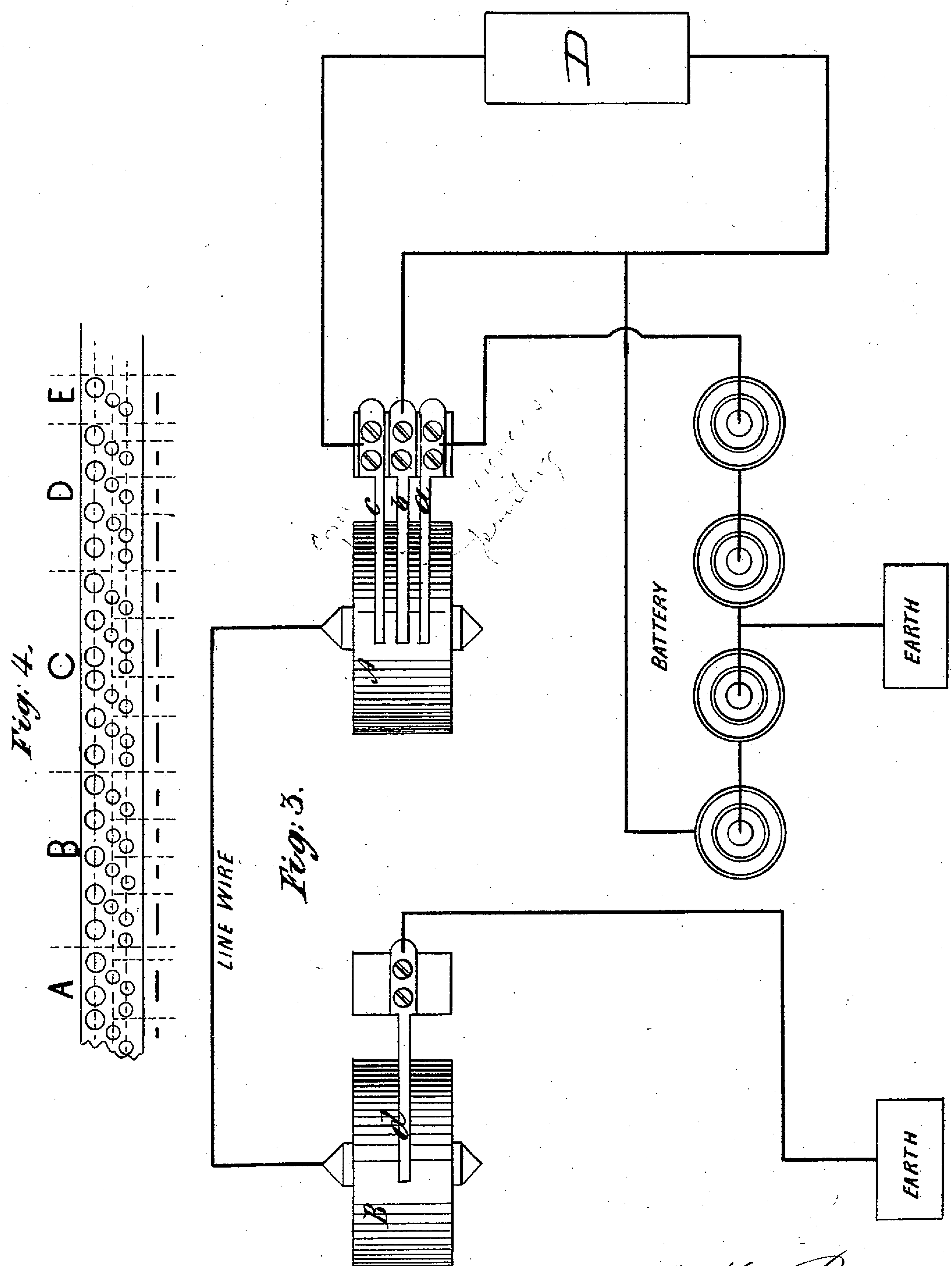

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UNITED STATES PATENT OFFICE.

JAMES WALLACE BROWN, OF PORT HURON, MICHIGAN.

IMPROVEMENT IN AUTOMATIC TELEGRAPHY.

Specification forming part of Letters Patent No. **189,184**, dated April 3, 1877; application filed May 21, 1875.

To all whom it may concern:

Be it known that I, JAMES WALLACE BROWN, of Port Huron, Michigan, United States of America, but at present of Leadenhall street, in the city of London, England, electrical engineer, have invented certain Improvements in Apparatus for Transmitting Telegraphic Signals, of which the following is a specification:

This invention relates to the working of chemically printing and recording telegraphs, the object being to increase the speed of transmitting to receiving-instruments telegraphic signals through long circuits, and, more especially, through submarine cables and under-ground wires. I accomplish this object by a peculiar kind of perforated ribbon or strip of paper, in combination with three transmitting pens, styles, or contact-points, (or their equivalents,) set abreast of and insulated the one from the other, as will be presently explained.

Before, however, I proceed to describe in detail the nature and operation of my invention, it will be well to explain the present state of telegraphy in its relation to chemically-recording telegraphs, as the adaptation of the invention to existing systems will be thereby the better appreciated.

In working chemical telegraphs great difficulty is experienced in producing legible telegraph-signals through long aerial circuits, cables, and under-ground wires, for the reason that as the telegraph-code is composed of dots and dashes, the wire is charged to a much higher potential when making dashes than when making dots. This unequal charging of the wire has the effect of running the dash into the dot that immediately follows it, and when the cable or wire is very long this dash is unduly prolonged, so much so that the whole letter, which should be composed of dots and dashes, is little better than one long dash.

If the cable or wire were of short length, comparatively speaking, this would not take place to any great extent, because the wire would discharge itself in so short a time that there would be no appreciable drag upon the signals. In long circuits, however, the wire will not discharge quickly enough, and hence the dragging out of the signals. Thus, as the length of the circuit increases, so is the difficulty of obtaining intelligible signals increased. By artificial means, however, this difficulty is remedied to a great extent.

The most common way of obtaining this result, when using single currents, is to put a leak in line beyond the transmitting-instrument—that is, to connect the line-wire to earth through a suitable resistance beyond the transmitting-instrument, so as to allow the line-wire, when battery-contact is broken, to discharge to earth through this resistance; but this plan has the disadvantage that the battery, when sending the printing-current to line, has to supply this leak or circuit between line and earth also; but as the resistance between the line and earth is reduced, so is the strength of current in the line-wire reduced.

Now, if the line-wire is of considerable length, it will take so long to discharge that it becomes necessary to make this leak between line and earth of very low resistance, in order to make the conditions of line right to insure good signals at the distant end. If a very powerful battery of low internal resistance, be used, the resistance between line and earth may be reduced in proportion; but this is limited, because beyond a certain limit it would be impossible to reduce this resistance between line and earth, for the reason that the strength of current in the line-wire would not be great enough to produce the signal at the distant end, and as the cable or wire is increased in length, so does this difficulty increase until you arrive at the limit where it matters not whether a powerful battery of low internal resistance, or a weak battery of high internal resistance, is used, the results being the same—unintelligible signals. Now, when this condition is reached, there is applied at the receiving-instrument a contrivance styled a "magnetic shunt," which consists of a series of electro-magnets, so arranged that it is possible to put in one or more electro-magnets in the shunt-circuit, the terminals of said shunt-circuit being connected to line-wire and earth, so when the printing-current acts upon or through the receiving chemical paper commencing to record the signal, it also acts through the magnetic shunt charging the electro-magnets, and in doing this part of the current is diverted from going through the receiving chemical paper; or, in other words, the total current that arrives at the receiving-instrument is split, and and in proportion to the resistance of the magnetic shunt, so it is understood that the amount of current going through the receiving chemical paper can be regulated, thereby using but just enough current to produce the signal at a given rate; but the great advantage of the magnetic shunt is (as is well understood) that when battery-contact is broken at the transmitting end it allows the electro-magnets of this magnetic shunt to discharge, and this discharge of the magnets takes place in the opposite direction through the receiving chemical paper to that current which made the signal. This being the case, it follows that this discharge of magnets cuts off this drag or prolongation of signals, producing legible signals; but it only does this where the fall of potential is in the same ratio as that of the line; but as it is almost, if not quite, impossible to secure this condition with the magnetic shunt in working long circuits, and more especially long submarine cables, the signals or dots and dashes are liable to run together, thus rendering them entirely unintelligible.

If the leak or resistance before mentioned between wire and earth at the transmitting-instrument be used in connection with the magnetic shunt at the receiving end over a given circuit the signals will be better than if one or the other is used alone; but the limit is soon reached, when the signals become imperfect and unintelligible.

In double-current systems, as ordinarily used, the results are less satisfactory than that of single currents with the aid of the magnetic shunt and leak at the transmitting end. In working double currents the same difficulty is experienced in making dots and dashes as in single currents. The wire is charged unequally, and the effect is, as before, dots and dashes run together; but better results are got by sending a strong initial current to line, followed by insulation in case of making a dash, and then a reverse current, to cut the dash, as it were, the right length, or, in other words, cut off the drag. This is technically termed "intermittent" currents, the object of it being to have the currents for making the dot and the dash of the same strength and duration; but in short circuits, to accomplish this object the signals have to be transmitted so slowly that there is no advantage gained. In longer circuits, or where the static capacity of line is great, and this system is used, it is found that the printing-current will be in excess; for instance, in transmitting R, (dot, dash, dot,) no current having been sent during the latter part of the preceding space, the line-wire is clear, and receives a full charge from the marking-current for the dot, the following reverse current is immediately succeeded by a marking-current for the dash, and during the remainder of the dash no current is sent to line. Two marking-currents are thus sent to one reversal, and the tendency is for the dot and dash to run together, because the marking-current, to commence the dash, being followed by insulation, charges the wire to such an extent that it cuts the reversal or neutralizes it so quickly that it has not time, or is not of sufficient strength, to cut off the drag of the dot. In the case of the dot following the dash, the reverse occurs. Owing to the long interval since the marking-current was sent, the line has become nearly *nil*, so when the reversal is sent to cut the drag, it charges the wire so highly that the marking-current to make the dot is shortened, and a reversal being sent immediately after cuts the dot so quickly that it will be out of proportion with the other signals—in fact, two reversals being sent to one marking-current.

There is another appliance used at the transmitting-instrument. It is a large resistance placed between battery and line, said resistance being adjusted to conditions of line, and so manipulated that when a current is sent to line of one name, by means of transmitting-instrument making battery-contact, this same current still passes through the resistance when battery-contact is broken, and continues until the transmitting-instrument sends a reverse current, it acting through the resistance in same manner as before; in fact, there is always a current to line. It is understood by this that the current through this resistance will, of course, prolong the dash after the initial current is sent; but the same objection exists as before—there is an inequality of charge. It is, in fact, sending permanent currents or double currents, as it is called, with the exception that two-thirds of the current is weakened in comparison to the first third, for during two-thirds of the time employed to make the dash the current has to act through a larger resistance, in addition to that of the line. This is styled sending compensating-currents.

Now, the difficulties in the above-mentioned plans of transmitting telegraphic signals are capable of removal, to a great extent, by adapting my invention thereto, it being thereby possible to work over long circuits, submarine cables, and under-ground wires at a much greater speed than is accomplished by the existing systems.

I will now first describe the application of my invention to the system of working chemically-recording telegraphs.

Figure 1 shows a transmitting and receiving instrument connected to opposite ends of a line-wire or cable. In their general construction they are similar to those in common use for transmitting and receiving messages automatically; but in this case there is applied to the transmitting-instrument three insulated transmitting-pens or styles, set abreast of each other, and in connection therewith I use a strip of perforated paper similar to that shown at Fig. 1ª.

A is the transmitting-drum, formed of metal, and rotated by clock-work or equivalent motive power. Bearing upon this drum are the three contact points, pens, or styles *a b c*, connected, respectively, with wires leading to the battery and to earth. B is the receiving-drum, which is similar to the transmitting-drum, but is fitted with but one pen or style, *d*. The office of this pen is to record signals upon chemical paper in the usual manner. The transmitting pens or styles are manipulated by the strip of perforated paper, Fig. 1ª, the perforations being peculiar in their arrangement. The three pens are insulated one from the other, each pen performing its work independently of the others.

This arrangement shows the application of the invention to the system of transmitting signals by means of simple reversals. The compensating-pen *c* and printing-pen *a* are connected together and are worked by a strip of the perforated paper, as before described. In this case the reversing-pen *b* is connected to the reverse pole of the battery, and thus, when it drops into a perforation, a reverse current is sent to line. To accomplish this I prefer to arrange my battery as shown, having the center of battery put to earth, using the extreme zinc pole to print, and the extreme copper for the reversal. A resistance-coil may be placed between the printing and compensating pen, as shown by dots at D in the figure, for the purpose of sending compensating-currents.

It will be seen that when the compensating-pen drops into a perforation, (which only occurs when making a dash,) it will send a much weaker current than that sent by the printing-pen; or, in other words, the printing-pen sends a strong initial current to line, followed by a weak current (which can be regulated by the amount of resistance introduced between the two pens) of same denomination. This prolongs the signal up to the limit when the printing-pen again enters a perforation. This will have the effect of governing the wire, as it were, and only allowing the potential to fall to a certain extent. The weak current from the compensating-pen would not alone be sufficient to prolong the signal, but serves to control the static condition of the line, and prolong the signal to a certain limited length. This obviates the necessity of having the full strength of current to line in making a dash, and thereby charging the wire to a greater degree than is required for making a dot. When the printing-pen drops into the last perforation of the dash it sends the current of full strength, so as to make the dash of sufficient length; but in doing this the wire does not become so highly charged as it would have been if the full strength of current had been sent throughout the signal, as in the previous case, where no resistance was interposed between the printing-pen and compensation-pen, the current which makes the dash charging the wire little, if at all, more than that which makes the dot, and the reversal being sent immediately after the signal to discharge the wire, thereby cutting off the drag. This plan allows of faster working over a given circuit than the present system of compensating-currents, for the reason that the compensation has only to make one-third of the dash, and the initial current will not have to charge the wire to so great an extent as in that system where the compensation has to make two-thirds of the dash, it being then necessary to transmit slowly enough to have the initial current sufficiently strong to charge the wire in proportion, the peculiarity of my plan being that I send a strong initial current followed by a weaker one, termed compensation, in the same direction, and then for the last third of the dash I send another current in the same direction as the initial current, followed by a reversal, the compensation making only the center of the dash. Of course, it is understood that I only have reference to those circuits where this peculiar form of compensation can be employed with profit either on other systems or my own, the arrangement of battery being the same as before.

I will now describe an arrangement by which I gain the advantage, in chemical telegraphy, of having the currents that make the dash of the same duration as that which makes the dot, the static electricity of the line-wire being utilized to make the center of the dash by filling up the interval which occurs between the two currents, in the same direction, which are sent to make the dash. In this case, as before, it will be seen that, by depending upon the static electricity to make only one-third of the dash, I can transmit telegraph-signals much more rapidly than where the static electricity is depended upon to make two-thirds of the dash, as I do not have to charge the wire so high with my first initial current.

I also derive another advantage by having the resistance between the compensating-pen and earth adjustable, as I obtain a larger margin to work upon—for instance, if the resistance is too small, and discharges the wire so quickly, at a given speed of working, that the dash is weak or split in the center, I can add more resistance until the dash is made perfect in the center at the same rate of speed as before, and, vice versa, the commencement and end of dash always being full.

In the arrangement shown at Fig. 2, the pens or styles *a* and *b* I connect with opposite poles of the battery, and the compensation pen or style *c* I connect with the earth, interposing a resistance-coil, D. The perforations in the ribbon (see Fig. 1[a]) are so arranged that one only of the pens shall be in contact at a time with the metal drum of the transmitting-instrument. When making a dash, I send first a strong initial current to line through the pen *a*, and thereby charge the line-wire to a high potential. When the pen *a* breaks contact with the drum A, by reason of a solid portion of the ribbon coming under the pen, the compensation-pen *c* drops into contact with the drum, a perforation of the traveling ribbon being brought under it. This has the effect of clearing the wire of static electricity, (the said pen being connected to earth.) If, however, no appreciable resistance were interposed between this pen and earth, the wire would discharge in so short a time that there would be only a dot produced at the receiving end; but by introducing a given resistance, as at D, between the pen and earth, the discharge of the wire will be retarded sufficiently to insure the prolongation of the signal at the receiving end up to a certain limit. To finish the signal or dash, a second strong current is now sent to line through the marking-pen *a*, and this is instantly followed by a current to line in the opposite direction, caused by the reversing-pen *b* dropping into a perforation in the ribbon.

In circuits that have great static capacity, and that will discharge through the compensation-pen and wire to earth during the interval between the two initial currents that make the dash, this arrangement may be used without the resistance-coils between compensating-pen and earth, it being supposed that the wire connecting compensating-pen to earth has no appreciable resistance, a reversal being sent immediately after the last initial current.

Fig. 3 shows an arrangement for sending reversals of varying strength, as may be required in center of dash, the printing and reversal pens being arranged as in Fig. 2. The object of this arrangement is to enable me to work over circuits where the static capacity is so great that the means just described will not discharge the wire during the interval that occurs between the two currents in the same direction which are used in making the dash.

The compensating-pen in this case is connected, through the adjustable resistance D, to the reverse pole of the battery. Now, in making a dash the printing-pen sends a current to line, commencing the dash. Immediately upon the printing-pen rising out of the perforation, the compensating-pen drops into a perforation, sending a reverse current to line. The strength of this reverse current is determined by the amount of resistance introduced between the battery and pen, and the amount of resistance to be introduced is determined by the static capacity of the line, the object being to have the resistance such that the current through it to line will discharge the wire at the point where the printing-pen again drops into a perforation, sending the second current for the dash, instantly followed by a full reversal, thus charging the wire equally in making dots and dashes.

It will be seen that in all these the dash is formed by four successive steps—first, a strong initial current; second, a compensating connection; third, a repetition of the initial current; and, fourth, a reverse current.

In each the second or compensation varies, according to the length or static capacity of the line, and hence are not alternations, in the ordinary sense of the word.

This compensation is, with a short line, or one of small static capacity, a weakened initial current; in a longer line, or one of greater static capacity, an entire disconnection from the battery and a momentary earth-connection; in the still longer lines, or those of greatest static capacity, a reverse current, weaker than that used in fourth step. Hence, I speak of these as means of compensation, or compensating connections.

It will be obvious to electricians that all which is accomplished by the three insulated pens may also be effected by three drums, insulated the one from the other, and corresponding to the three insulated pens before described, in which case the transmitting-pens would be all connected together, forming one which would be connected to the line-wire; but I prefer the three insulated pens, as being more simple in arrangement.

I would remark that the manner of piercing the strip or ribbon used to work the three pens or styles may be modified to suit varying circumstances.

In Fig. 1[a], which has been referred to throughout the foregoing description, the ribbon is shown as pierced to transmit the word "printed." When the static capacity of the line is great, and it is desirable to put the line-wire to earth between each signal, as well as on the middle of each dash, I use the strip or ribbon shown at Fig. 5. This figure shows the letters *a b c d e* as perforated for transmission.

Having now set forth the nature of my invention, and explained the manner of carrying the same into effect, I wish it to be understood that I claim—

1. In automatic telegraphy, the method of forming dashes, by, first, transmitting a strong initial current; second, compensating by weakening, cutting off, or reversing such current, as the state of line may determine, as explained; third, by transmitting a current identical with the initial current; and, finally,

a reverse current, equal in strength to initial current, substantially as set forth.

2. Combination of strip, perforated as described, the marking, compensating and reversing pens, the battery, and resistance, with circuit-connections, as described, whereby a dash is transmitted, by using, first, a strong initial current; second, the compensation therefor, as explained; third, a current similar to initial current; and, lastly, a reversing or clearing current.

London, the 26th day of April, 1875.

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