No. 757,377. PATENTED APR. 12, 1904.

J. D. WHITE.

PRINTING TELEGRAPH RECEIVER.

APPLICATION FILED AUG. 29, 1903.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

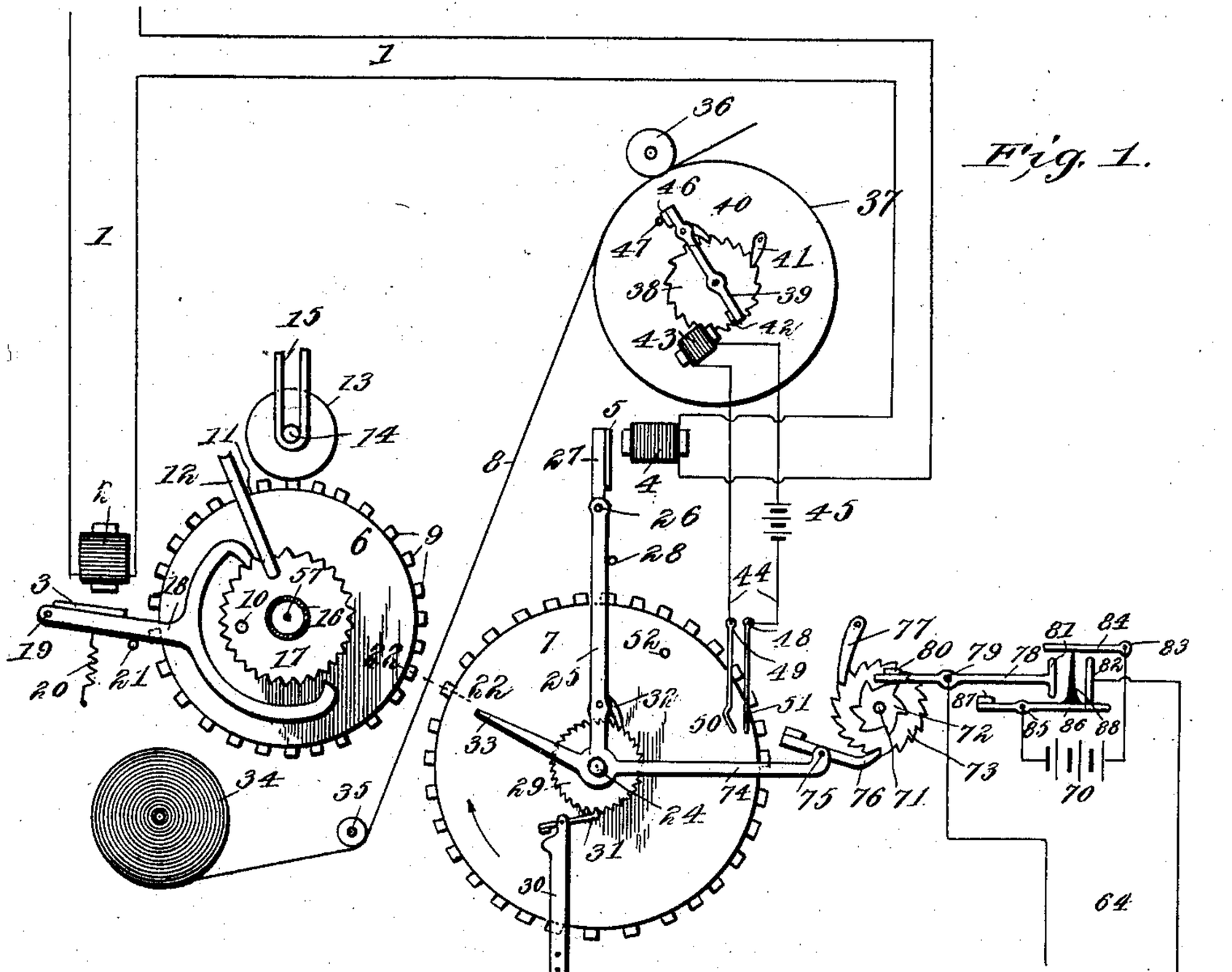
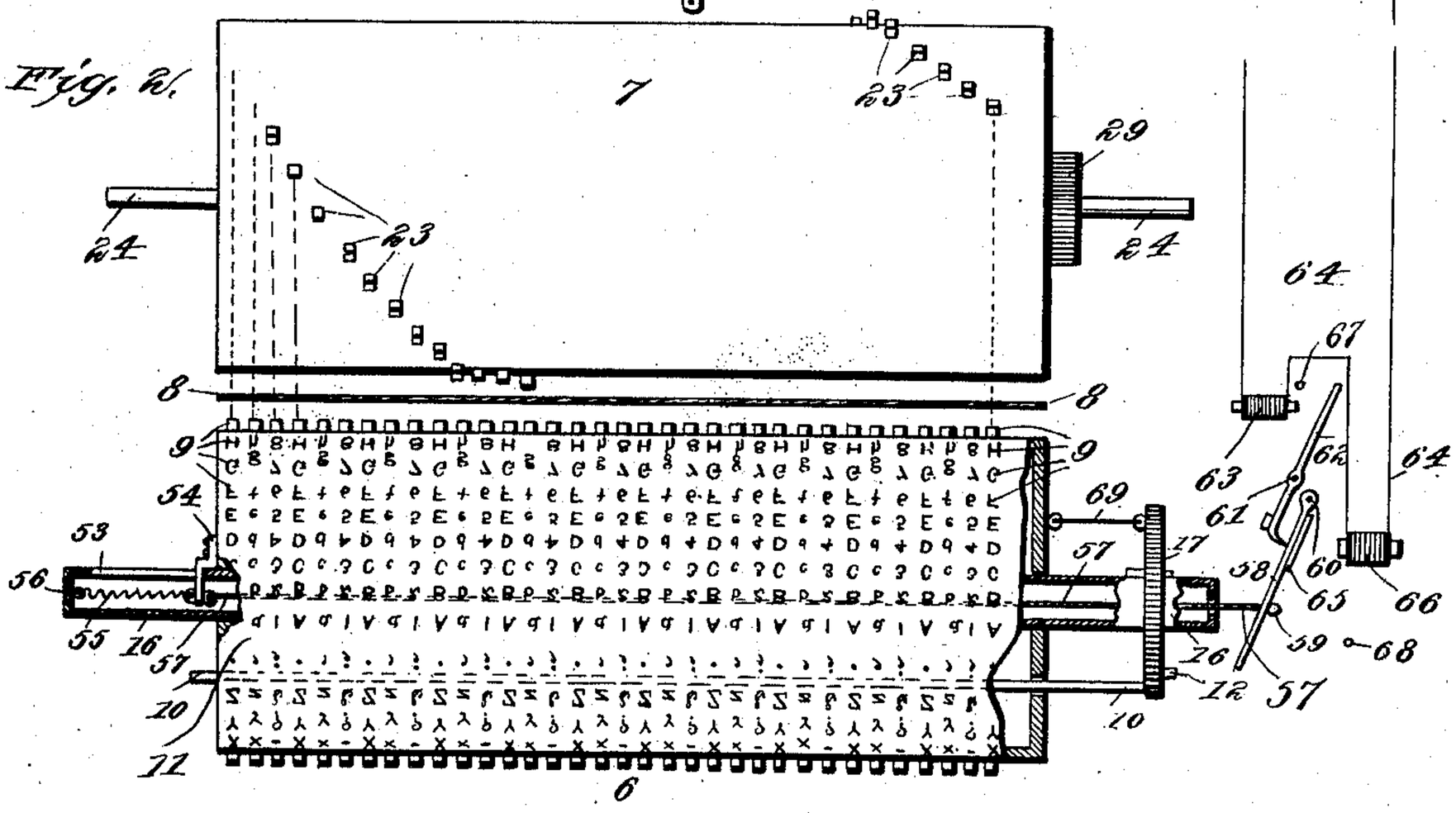


Fig. 2.



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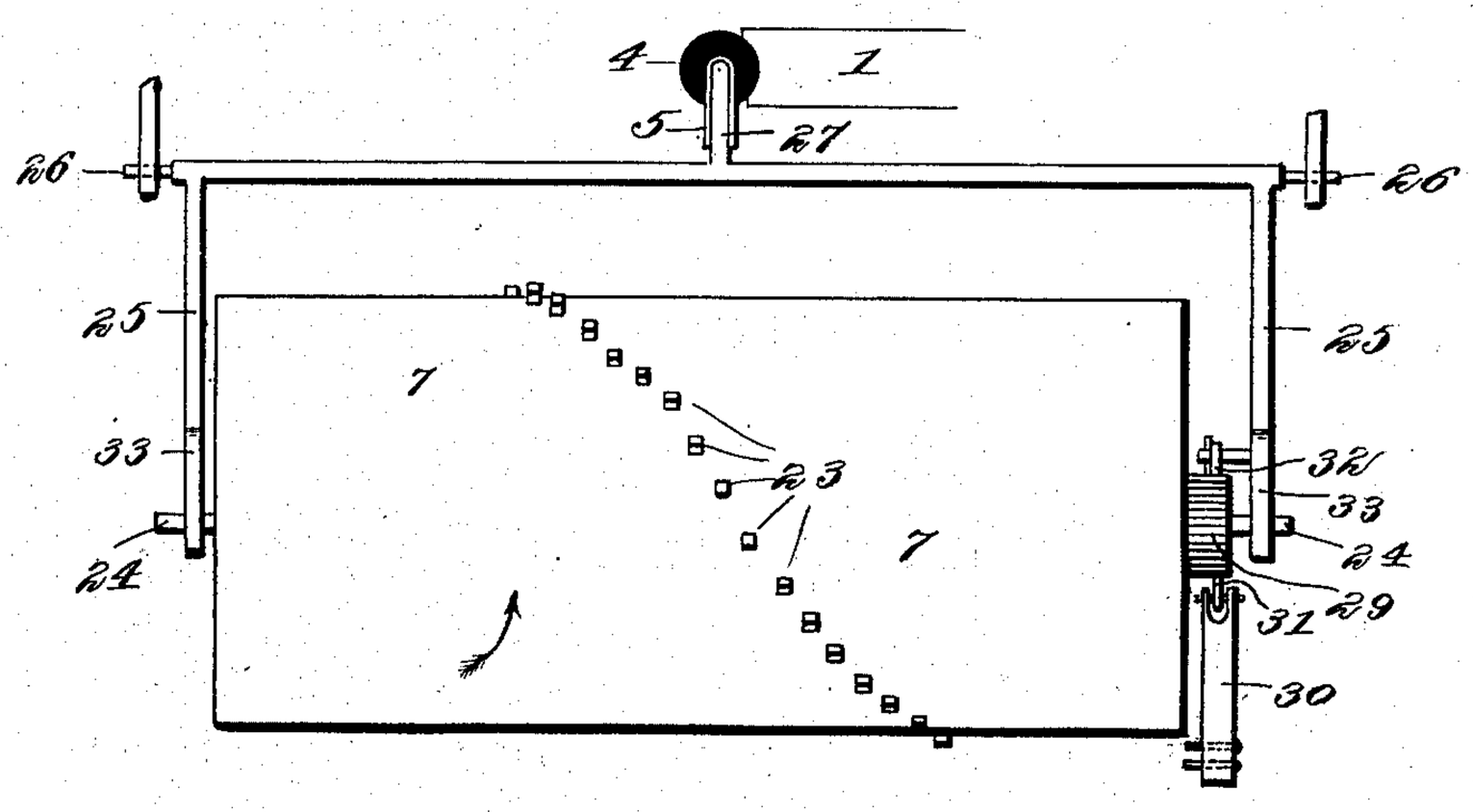
NO MODEL. 3 SHEETS—SHEET 2.

Fig. 3.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 4.

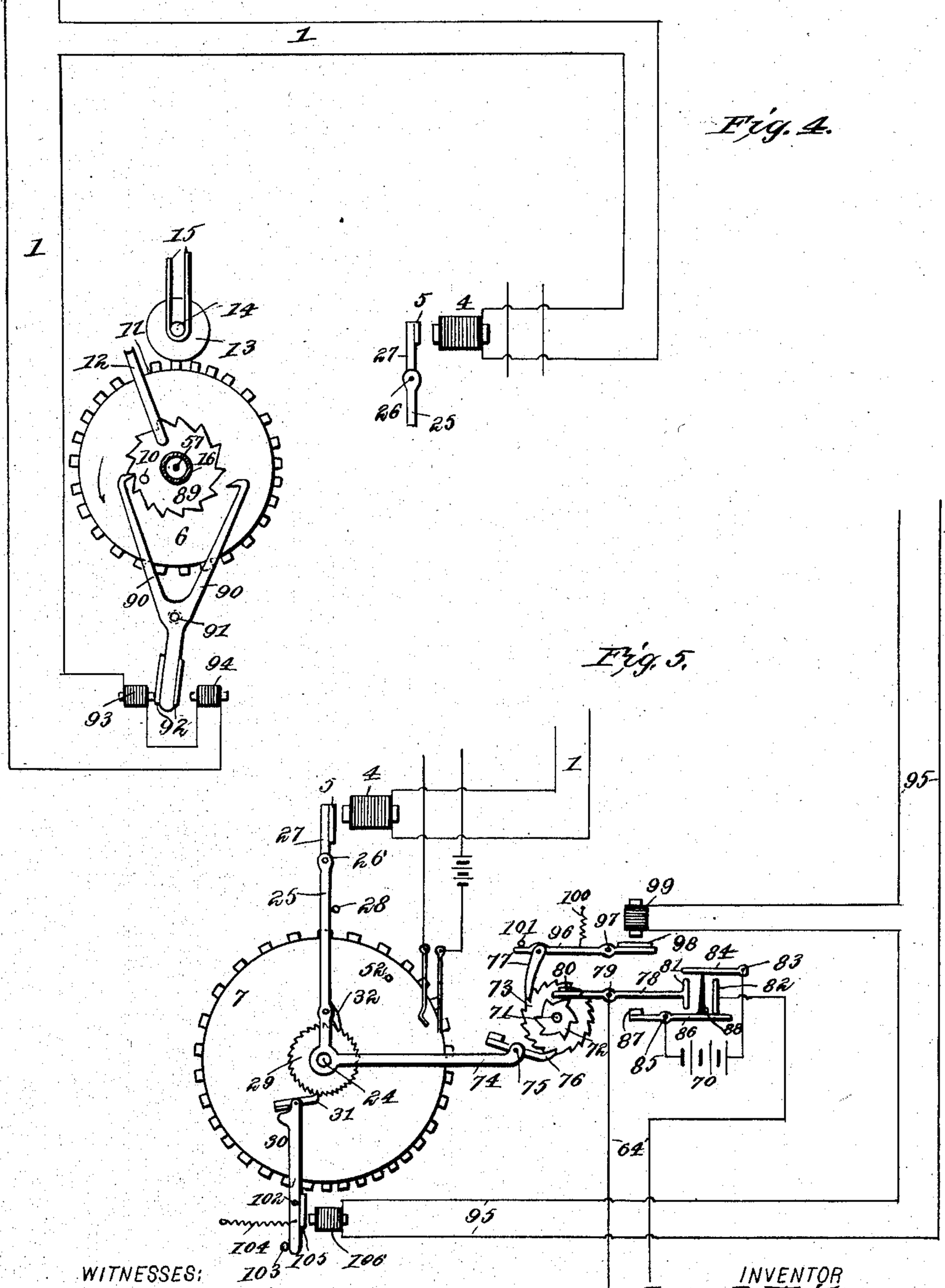

Fig. 5.

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UNITED STATES PATENT OFFICE.

JAMES DUNDAS WHITE, OF LONDON, ENGLAND.

PRINTING-TELEGRAPH RECEIVER.

SPECIFICATION forming part of Letters Patent No. 757,377, dated April 12, 1904.

Application filed August 29, 1903. Serial No. 171,201. (No model.)

To all whom it may concern:

Be it known that I, JAMES DUNDAS WHITE, a British subject, residing at 50 Clanricarde Gardens, London, England, have invented new and useful Improvements in Printing-Telegraph Receivers, of which the following is a specification.

My improvements relate to printing-telegraph receivers which print the characters in lines across the paper and are so contrived that in each line of print the characters are printed successively from left to right across the paper without corresponding lateral movement of the type or converse lateral movement of the paper, the paper being only moved up at the end of each line so as to be ready for the next line. A simple form of such a printing-telegraph receiver is described in my patent of the United States for improvements in printing-telegraph receivers, No. 743,122, dated November 3, 1903, and a more complex one is described in my patent of the United States for improvements in printing-telegraph receivers, No. 751,363, dated February 2, 1904.

The objects of my present invention are to provide a printing-telegraph receiver somewhat resembling those others, but so contrived that as compared with the first of them the range of characters is trebled without the amount of the step-by-step movement being increased, with the result that the same amount of step-by-step movement which in the first invention is utilized to give a certain number of letters and in the second invention is utilized to give the same number of letters and an equal number of figures is in this invention utilized to give the same number of capitals, an equal number of small letters, and an equal number of figures, and also to provide suitable means for printing from any of these three kinds of characters continuously and for changing from any one series to any other series at will.

The printing-telegraph receiver which forms the subject-matter of this application differs in various ways from those described in the specifications referred to, and will best be described by independent description. For simplicity I shall describe the mechanism as operated by an electromechanical device by which the rotation of the type-cylinder is effected by currents of one polarity sent along a single wire, while the other cylinder is operated by currents of the opposite polarity sent along the same wire; but I do not limit the operation of the invention to this particular device. It may also be operated by any of the other electromechanical devices used in printing-telegraph receivers to rotate type-wheels and to effect printing, and variations illustrating how some of these may be applied to it are also shown.

I attain the objects of my present invention by the mechanism and electromechanism shown in the accompanying drawings, in which—

Figure 1 is a diagrammatic side view of the apparatus. Fig. 2 is a view from above of the type-cylinder and the hammer-cylinder with the paper between them and of certain other fittings. Fig. 3 is a view of the rocking frame and the hammer-cylinder as seen from the side adjacent to the type-cylinder, and Figs. 4 and 5 show details of modifications.

A certain circuit in Fig. 1 is shown extended to alined contiguity to the corresponding portion of the same circuit in Fig. 2 in order to illustrate the coaction of the combined devices, whereby the momentum of one moving part (shown in Fig. 1) is utilized for the movement of another moving part, (shown in Fig. 2,) which latter part moves in a different plane and requires more motive power than the actual momentum of the former moving part would supply.

1 is the main wire, along which currents of either polarity may be sent from an ordinary transmitter. In this circuit is the electromagnet 2, which attracts the armature 3, and the electromagnet 4, which attracts the armature 5. The armatures are so magnetized and set and the electromagnets so wound that a current of one polarity (which I shall call the "positive current") causes the electromagnet 2 to attract the armature 3, but does not cause the electromagnet 4 to attract the armature 5, while a current of the other polarity (which I shall call the "negative current") causes the electromagnet 4 to attract the armature 5, but does not cause the electromagnet 2 to attract

the armature 3. These two electromechanical devices operate, respectively, the type-cylinder 6 and the hammer-cylinder 7, between which is arranged the paper 8.

The type-cylinder 6, which is preferably a hollow cylinder of light metal, has along its surface a succession of longitudinal rows of type 9 9. Each row has three different characters, which are repeated successively on a straight line and which I shall call, respectively, "capitals," "small letters," and "figures," using (in accordance with the drawings) the term "capitals" to include the capital letters and the full stop, the term "small letters" to include the small letters and the comma, and the term "figures" to include the figures, fractions, and various marks of punctuation, as well as other signs. Each longitudinal row has different characters from every other row, progressing in regular alphabetical and numerical order around the cylinder. Every row has the same number of characters, and that number exceeds by two the number of letter-spaces which it is proposed to have in the line of print. In the drawings the number of characters in each row is thirty-four. These rows of type are parallel to the axis of the cylinder, and they are placed round it one beside another, so that the general effect resembles that of a series of capital-wheels, small-letter wheels, and figure-wheels repeated in regular alternation along the same axis, all the capital-wheels and the small-letter wheels being similarly set and all the figure-wheels being similarly set, so that one capital, the corresponding small letter, and one figure follow successively and constitute a group which is repeated successively in the same order through each row. These longitudinal rows of characters may be of any convenient number. In the drawings they are represented as twenty-eight, of which twenty-seven are occupied by characters, (letters and figures,) while the remaining one, (marked 11,) which corresponds to spacing, is blank. From the toothed wheel 17 (presently to be described) at the end of the cylinder opposite that blank line projects an arm which is bent round, as shown at 12, the bent part being sufficiently far out to allow it as the cylinder is revolved to pass clear of the hammer-cylinder 7 of the paper 8 and of the inking-cylinder 13, which latter is kept in position by its axle 14 being in the slotted frame 15 and which inking-cylinder rests on the type-cylinder 6, inking it as it revolves. This inking-cylinder is fitted so that it can slide along its axis sufficiently to allow of its being slid by the pressure between it and the type-cylinder 6, when the latter is reciprocated longitudinally, as will be presently described.

The type-cylinder is set on a hollow axle 16, at one end of which is the toothed wheel 17, from which projects at right angles the arm 10, which passes through the cylinder in such a way that the cylinder revolves with the toothed wheel, but may be reciprocated backward and forward along the axle 16, as hereinafter described. The toothed wheel 17 is actuated by the "push-and-pull" bifurcated lever 18, pivoted at 19 and having attached to it the armature 3. The two arms of this lever engage alternately the toothed wheel from opposite sides. As often as the electromagnet 2 attracts the armature the lever is pulled up, and as often as the magnet ceases to operate the spring 20 causes the lever to return to the stop 21. Thus as often as the circuit 1 is closed by a positive current and opened again the arms of the lever alternately act upon the wheel. The proportions of the parts are such that successive movements of this kind bring the successive rows of type 9 9 successively to the position indicated by the dotted line 22, which I shall call the "printing level." By this step-by-step mechanism successive positive impulses serve to bring the required rows of characters to the printing level.

The hammer-cylinder 7 is a light cylinder of about the same length as the other, having around it, arranged as a single-turn spiral, a series of projections 23 23, which I shall call the "hammers" or "impact-faces" and which are of the same number as the number of the letter-spaces which it is proposed to have in the line of print. In the drawings they are represented as thirty-two. These hammers, while set spirally round the hammer-cylinder, are so set that each is in line with one of the circular series of characters on the type-cylinder and that the hammers on the one cylinder are approximately of the same length and breadth as the characters on the other. The circular series on the type-cylinder, as already said, are in number more by two than the number of letter-spaces which it is proposed to have in the line of print, and are thus more by two than the number of hammers on the hammer-cylinder. Hence there will be two series which have no hammers in line with them. These "excess" series will be either the two on the extreme left (as in the position shown in the drawings) or the one on the extreme left and the one on the extreme right or the two on the extreme right, according to whether the type-cylinder is in what may be called the "normal" position, as shown in the drawings, or whether it has been reciprocated to what may be called the "middle" position or to what may be called the "right" position, as will presently be considered.

The hammer-cylinder 7 is on the axle 24, journaled in the rocking-frame 25, which latter is pivoted at 26 about a stationary center and has above it the rigid extension 27, on which is located the armature 5. The general arrangement is such that as often as a negative current is sent along the line 1 the electromagnet 4 attracts the armature 5, so that the frame 25, carrying the hammer or im-

pact-cylinder 7, is rocked about the center 26 toward the type-cylinder 6, the paper 8 being between them. The parts of the cylinders which thus come into contact are, of the hammer-cylinder, the impact-face which is at the printing-level, and, of the type-cylinder, the opposite character of the row which is at that time at the printing-level. The rocking parts fall back when the current ceases, and the stop 28 prevents them falling back too far. Besides this rocking movement the cylinder 7 has a rotary movement on its axis which is effected as follows: On the end of the cylinder is the ratchet 29, which has as many teeth as there are impact-faces on the cylinder. The stationary upright 30 carries a pawl 31, which engages the teeth of this ratchet, the proportions being such that when the hammer-cylinder falls back after each stroke the ratchet 29 (which is kept from reversing by the detent-pawl 32) is caught by the pawl 31 and moved round the space of one tooth, so that the impact-face which was at the printing-level is moved on and the face next below it is brought to the printing-level ready for the next stroke. From the arrangement of the impact-faces it will be seen that this next face, besides being below the other, is on the right side of it, with the general result that as stroke after stroke is made the printing passes along from left to right (as viewed from where the type-cylinder is) and the last impact-face on the right is followed by the first on the left, thus beginning a new line. Thus the printing in the manner described is effected by negative currents through the wire 1, while the nature of the characters printed is determined by the position of the type-cylinder 6, which is controlled by positive currents along the same wire.

The following arrangements are made for spacing: From the rocking frame 25 projects the arm 33, which moves with it, but does not effect anything except when the frame 25 is rocked toward the type-cylinder 6 and the blank row 11 is at the printing-level. When that happens, the projecting arm 33 comes against the projecting arm 12, and the proportions are such that this prevents the frame 25 and the hammer-cylinder 7 from going as far as they otherwise would, but still allows them to go far enough for the return movement to cause the ratchet 29 to be caught and turned the space of a single tooth by the pawl 31, thus revolving the hammer-cylinder as if a character had been struck, and causing spacing without printing.

Before a new line of print is begun the paper must be spaced up for it, and the general arrangement of the paper may now be described. The paper 8, which is of a flexible character, is fed from the roll 34 round the roller 35, thence passes between the type-cylinder 6 and the hammer-cylinder 7, and is held between the small roller 36 and the large roller 37. On the end of the roller 37 is the ratchet 38, actuated by a lever 39 through a pawl 40 and kept from reversing by a detent-pawl 41. On one end of the lever 39 is the armature 42, opposite which is the electromagnet 43 in the circuit 44, in which is the battery 45. As often as this local circuit is closed the electromagnet 43 attracts the armature 42, so that the lever 39 is moved, and the pawl 40 sends the ratchet 38 and the attached roller 37 a step round, while as often as the circuit 44 is interrupted the magnet ceases to attract the armature and the counterpoise 46 causes the lever 39 to return to the stop 47. The proportions are such that each step of the ratchet sends the paper up sufficiently far for a new line of print to be begun. The arrangement for closing this circuit 44 at the right time is as follows: From the terminals 48 and 49 are suspended two light strips of metal 50 and 51, which are conductors of electricity. Normally they hang just clear of one another; but as often as the projection 52 on the end of the cylinder 7 (which projection is such as not to interfere with the rotation of the cylinder) comes to a certain place in the course of its rotation it encounters the strip 50, which it pushes against the strip 51, thus closing the circuit 44 and spacing up the paper. The projection 52 is so placed as to do this only when the frame 25 and the hammer-cylinder 7 revert to the normal position after the stroke in which the hammer on the extreme right of the cylinder has been at the printing-level, so that the paper is spaced up between that stroke and the next stroke which begins the new line.

If the type-cylinder were not slid longitudinally, successive strokes of the hammer-cylinder would print capitals, small letters, and figures successively in recurring groups. In order to secure the printing of capitals continuously or of small letters continuously or of figures continuously and to provide for changing from any one of these classes to any other at will, the following devices are used.

It has been said already that the fittings are such that the type-cylinder 6 while revolving with the toothed wheel 17 can be reciprocated backward and forward along the axle 16. This reciprocation is effected as follows, (see Fig. 2:) The axle 16 is made hollow, so that a spring can be placed in it and aline or wire led through it. Along it at one end is the longitudinal slot 53, in which slides the projection 54 on the cylinder 6, to which projection is attached at one side the helical spring 55, which lies in the hollow axle 16 and connects one extremity of that axle, as shown at 56, to the projection 54. To the other side of the projection 54 is attached the line or wire 57, which passes in the other direction through the hollow axle 16 and is led through a hole at the end of the lever 58, on the other side of which lever it

terminates in the rounded stop 59, the general arrangement being such that the line can revolve freely in the hole, but that the stop will not draw through it. The lever 58 is pivoted at 60, and near it, pivoted at 61, is the articulated finger 62, which is of soft iron and acts as an armature to the electromagnet 63 in the circuit 64. This finger moves in one direction with the lever 58 and in the other direction independently of the lever. Lower down on the lever 58 is the magnetized armature 65, opposite the electromagnet 66, which also is in the circuit 64. The general arrangement of these two magnets and armatures is such that when a current of one polarity (which I shall call the "positive" current) is sent through the circuit 64 the electromagnet 63 attracts the armature 62, but the electromagnet 66 does not attract the armature 65, and that when a current of the opposite polarity (which I shall call the "negative" current) is sent through the circuit 64 both these electromagnets attract their respective armatures. When the electromagnet 63 attracts the finger 62, it moves that finger, and with that finger the lever 58, the range of movement thus given being restricted by the stop 67, which the finger 62 encounters; but when both the magnets attract their armatures there is this additional effect that the electromagnet 66 attracts the armature 65, and thereby causes the lever 58 to move farther on (the articulated finger 62 not interfering with such further movement) and that further movement is restricted by the stop 68. Thus when a positive current is sent through the circuit 64 the lever 58, the wire 57, and the type-cylinder 6 are moved a certain distance along. When a negative current is sent through the circuit 64, they are moved a greater distance along, and when the circuit 64 is interrupted the lever is released and the spring 55 (which is extended by the movements just described) causes the type-cylinder, the wire, and the lever to revert to what may be called the "normal" position, at which they are shown in the drawings. Thus it will be seen that if the circuit 64 has alternately a positive current flowing through it, a negative current flowing through it, and no current flowing through it the type-cylinder will be correspondingly moved successively to what may be called the "middle" position, the "right" position, and the "left" (or normal) position, respectively. The first two movements are restricted by the stops, as described, and the movement to the left is restricted by an anchorage formed by the inextensible line 69, which connects the type-cylinder 6 with the toothed wheel 17 and which is successively slack, slacker, and tight, according to the positions of the type-cylinder. The parts are so proportioned and the stops so placed that the range of reciprocation of the type-cylinder 6 between the left position and the middle position is equal to the distance between the middle of one character and the middle of the next character in longitudinal series, and the range of reciprocation between the left position and the right position is twice that distance.

The two cylinders being set opposite one another, as described, the successive reciprocations of the type-cylinder (the step to the middle position, the step to the right position, and the return to the left position successively) change the apposition of the three kinds of character series in relation to the hammers, each successive movement bringing (if the series are arranged as shown in the drawings) figure series opposite the hammers to which capital series were last opposite, small-letter series opposite the hammers to which figure series were last opposite, and capital series opposite the hammers to which small-letter series were last opposite. (If the series are arranged in the other way these changes take place in the converse order.) Thus it will be seen that if characters are printed in continuous succession without any spacing being interposed and if between each printing stroke and the next the type-cylinder is moved longitudinally to the next of these three positions of reciprocation the same class of characters as was opposite the last-used hammer is brought opposite the hammer to be used next, and thus (by the continuous progression of the hammers, combined with the reciprocations of the type-cylinder) the characters printed (when no spacings are interposed) are capitals continuously, or small letters continuously, or figures continuously, according to the starting position. These reciprocations of the type-cylinder are effected by the electrical alternations in the circuit 64, which are effected as follows: In that circuit is the battery 70. Behind the hammer-cylinder 7 and journaled at 71 is the ratchet-wheel 72, attached to which and revolving with it on the same axis is the ratchet-wheel 73, which has three times as many ratchets as the ratchet-wheel 72. The ratchet-wheel 73 is actuated by the following device: On the back of the rocking frame 25 is the projecting arm 74, at the end of which and pivoted at 75 is the pawl 76, which as often as the frame 25 is rocked far enough catches on the tooth of the ratchet-wheel 73 next to the tooth on which it was before, so that the falling back of the frame 25 sends the ratchet-wheel 73 (which is kept from reversing by the detent-pawl 77) one step round. The proportions of the various parts are such that the pawl 76 catches on a fresh tooth as often as the frame 25 is rocked far enough to effect printing, but is not moved far enough so to catch when spacing only is effected—that is to say, when the movement of the rocking frame 25 is restricted by the projecting arm 33 coming into contact with the projecting arm 12.

With the ratchet-wheel 73 revolves (as al-

ready said) the ratchet-wheel 72, on which rests one end of a light lever 78, which is pivoted at 79 and has at one end the counterpoise 80, which tends to keep down that weighted end which rests on the ratchet-wheel 72. The arrangement is such that the successive steps round of the ratchet-wheel 73 (which has three times as many ratchets as the ratchet-wheel 72) rotates the ratchet-wheel 72, so as to move the lever 78 into three positions in regular succession, each step of the wheel 73 causing the lever 78 to move from one of these positions to the next. In the drawings the lever 78 is shown in what may be called the "middle" position, with its weighted end resting on the shoulder of a ratchet. The next step of the wheel 73 turns the wheel 72 so as to bring the point of that ratchet under that weighted end of the lever which is thus raised, while the next step of the wheel 73 turns the wheel 72 so that that ratchet comes clear of the weighted end of the lever, which then falls to its lowest position in the hollow of the next ratchet. The next step of the wheel 73 brings the lever to what I have called the "middle" position on the shoulder of that next ratchet, and so on continuously, the successive steps of the wheel 73 operating the wheel 72 so as to send the lever 78 to the three positions successively in regular repetition.

At the other end of the lever 78 is the T-piece 81, which is lowered when the weighted end is raised, raised when the weighted end is lowered, and is in the middle position when the weighted end is in the middle position, the movements following in that order. The lever 78 and the T-piece 81 are conductors of electricity and form part of what may be called a "three-phase" switch, designed to give three changes of circuit and arranged as follows: Opposite the moving T-piece 81 is the fixed T-piece 82, and pivoted at 83 is a light strip of metal 84, which tends to swing downward. Below, pivoted at 85, is the light lever 86, which has at one end the counterpoise 87, which tends to tilt upward the other end, on which is the non-conducting projection 88. With the exception of this projection 88 all the parts of the mechanism now being described are conductors of electricity. The projection 88 is slightly longer than the T-piece 82, and the T-piece 82 is slightly longer than the T-piece 81, the proportions being such as just to prevent the strip 84 and the lever 86 from being in contact with the T-piece 82 at the same time and just to allow the T-piece 81 to be clear of both the strip 84 and the lever 86 when the lever 78 is in the middle position. The poles of the battery 70 are connected, respectively, at 83 to the strip 84 and at 85 to the lever 86. The various parts are so proportioned that when the lever 78 and the T-piece 81 are in the middle position, as shown in the drawings, the T-piece 81 is just clear of both the strip 84 and the lever 86, the lever 86 presses against the lower end of the T-piece 82, and the non-conducting projection 88 raises the strip 84 just clear of the top of the T-piece 82, so that the circuit 64 is not closed. The next step of the ratchet-wheel 73 by raising the weighted end of the lever 78 lowers the T-piece 81, which then comes into contact with and depresses the end of the lever 86 on which is the non-conducting projection 88, thereby letting the strip 84 come into contact with the T-piece 82, and so closing the circuit 64 in such a way that the current flows, as what I have called a "positive" current, through that part of the circuit 64 on which are the electromagnets over the course 70 83 84 82 64 66 63 64 79 78 81 86 85 70. The next step, again, of the ratchet-wheel 73 lets fall the weighted end of the lever 78, thereby raising the T-piece 81, so that the latter comes into contact with the strip 84, which it lifts clear of the T-piece 82 and of the projection 88, while the same movement permits the lever 86 to tilt into contact with the T-piece 82, so that the polarity of the material part of the circuit 64 is reversed and the current flows, as what I have called a "negative" current, through that part of the circuit 64 on which are the electromagnets over the course 70 83 84 81 78 79 64 63 66 82 86 85 70. The next step, again, of the ratchet-wheel 73 brings the T-piece 81 back to what I have called the "middle" position, when the circuit is interrupted, as already described. Thus by the successive steps of the ratchet-wheel 73 the operative part of the circuit 64 has alternately a positive current flowing through it, a negative current flowing through it, and no current flowing through it, with the result that by means of the various devices already described the type-cylinder 6 is correspondingly reciprocated to the middle position, to the right position, and to the left position in regular succession. The momentary interruption of the circuit 64, which takes place at the reversal of polarity, is immaterial. Even if the cylinder slips back then it does so only for a moment.

It has already been said that either the full printing movement of the frame 25 or the restricted movement of it, which effects spacing, is sufficient to send the ratchet-wheel 29, and so the hammer-cylinder 7, one step around; but from what has just been said it will be seen that the full printing movement of the rocking frame 25 is sufficient to make the pawl 76 catch on a fresh tooth on the ratchet-wheel 73, so as to cause an alternation in the circuit 64 and a reciprocation of the type-cylinder 6, but that the restricted movement of the frame 25 (which movement effects spacing without printing) is not sufficient so to do. Thus it will be seen that (as already described) if a series of characters are printed without any interposed spacing they will be either

capitals continuously, or small letters continuously, or figures continuously, according to the starting position; but if a single spacing is made, the effect (besides spacing) is to make the next printed character be of a different class from the last. If two spacings are made consecutively, the effect (besides spacing) is to make the next printed character be of the third class, while if three spacings are made consecutively the effect (besides spacing) is to make the next following character be of the same class as the last. Thus if there are no spacings interposed or if there are three spacings interposed consecutively the same class of characters, capitals, small letters, or figures, as the case may be, is continued, and the change to one or other of the other classes is effected by interposing a single spacing or a double spacing, as the circumstances may require.

I have described this invention as having the type-cylinder operated by currents of one polarity and the hammer-cylinder operated by currents of the opposite polarity along the main circuit; but, as said before, the operation of the parts is not limited to this particular device. They may also be operated by any of the other electromechanical devices which are used in printing-telegraphs for operating the rotation of the type-wheels and for effecting the printing strokes. One of such alternative methods is shown in Fig. 4, in which the axle 16, the ratchet-wheel 89, (which takes the place of the toothed wheel 17 in the other drawing,) and the type-cylinder 6 are caused to rotate in the direction indicated by the arrow by a weight or by clockwork or by some other means, while the number of steps to which they are rotated is governed by the escapement 90, which is pivoted at 91 and engages on the ratchet-wheel 89, which has half as many teeth as the cylinder has longitudinal rows of type, the general arrangement being such that as the teeth of the escapement engage alternately on the ratchets the rows of type are brought successively to the printing-level. To the lower end of the escapement is fitted the magnetized armature 92, which is between the electromagnets 93 and 94 in the circuit 1, the general arrangement being that of a polarized relay of such a character that rapid reversals of polarity in the circuit operate the escapement which controls the step-by-step movement. The electromagnet 4 is made slower in operation than the electromagnets of the polarized relay, so that during the rapid reversals of polarity it is ineffective; but as soon as the reversals cease and the current flows in either direction continuously the electromagnet 4 attracts the armature 5, thus operating the rocking movement, with the results already described. In this modification the armature 5 is not magnetized, but is a plain piece of soft iron, and the general arrangement is such that the electromagnet 4, as already said, attracts it whenever a current flows through the circuit in either direction for a sufficient time.

A printing-telegraph receiver of this general description may also be operated by a two-wire system, the arrangement in that case being preferably such that the reciprocation of the type-cylinder 6 along the axle 16 besides being effected by the rocking movement, as described, can also be effected independently of that movement and that spacing without printing can be effected whichever row of type is at the printing-level. In that case there need be no blank row on the type-cylinder and the intercepting-arms 12 and 33 may be eliminated. The other variations for that case are shown in Fig. 5. The movements of the various parts are as previously described; but in addition to the circuit 1 there is another circuit 95, which is used to operate the reciprocation of the type-cylinder and also to effect spacing by means of the following devices; The detent-pawl 77 (which engages on the ratchet-wheel 73) instead of being pivoted at a fixed point, as shown in Fig. 1, is pivoted on the end of the lever 96 which is journaled at 97, and of which the other end carries the magnetized armature 98, opposite which is the electromagnet 99 in the circuit 95, the general arrangement being such that as often as the electromagnet 99 attracts the armature 98 the lever 96 is moved so that the pawl 77 is pressed down and made to send the ratchet-wheel 73 one step round, while when the attraction ceases the spring 100 causes the lever, with its armature and pawl, to revert to the normal position, the range of movement being restricted by the stop 101. As often as this is done the resulting movement of the ratchet-wheel 72 shifts the lever 78, and so makes the change in the circuit 64 which reciprocates the type-cylinder 6, so that by this means the type-cylinder 6 can be reciprocated independently of the rocking of the frame 25. It may also be reciprocated by that movement, the ratchet-wheel 73 being in that case operated by the pawl 76, as already described. The proportions of the various parts are such that both the pawl 76 and the pawl 77 rotate the ratchet-wheel 73 to the same extent, while from the nature of the arrangement it will be seen that when either of them is returning to its place the other acts as a detent to prevent the ratchet-wheel from reversing. There is also this other device. The part 30, carrying the pawl 31, instead of being fixed rigidly, as shown in Fig. 1, is journaled at 102. Its range of movement is restricted by the stop 103, against which it is normally kept by the spring 104, and on its lower end is the magnetized armature 105, opposite which is the electromagnet 106 in the circuit 95. The various parts are so proportioned that as often as the electromagnet 106 attracts the armature 105 the arm 30 is oscillated, so that the pawl 31

causes the ratchet-wheel 29 (and so the cylinder 7) to rotate one step, the spring 104 causing the arm 30 and the pawl 31 to revert to the normal position as soon as the attraction ceases. Thus spacing may be effected independently of the printing movement as well as in connection with it, as before described. The armatures 98 and 105 are so magnetized and set and the electromagnets 99 and 106 are so wound that as often as a circuit of one polarity (which I shall call the "positive" current) is sent through the circuit 95 the electromagnet 99 is caused to attract the armature 98, but the electromagnet 106 is not caused to attract the armature 105, while as often as a current of the opposite polarity (which I shall call the "negative" current) is sent through that circuit the electromagnet 106 is caused to attract the armature 105, but the electromagnet 99 is not caused to attract the armature 98. Thus the sending of a positive current through the circuit 95 reciprocates the type-cylinder, while the sending of a negative current through the same circuit operates spacing, and either of these supplementary movements may be made independently of the other and of what may be called the "principal" movements which are operated by means of the other circuit, as before described. Taking the first of these supplementary movements alone, it will be seen that the type-cylinder can be reciprocated so as to effect the change from letters to figures or from figures to letters independently of spacing. Taking the second of them alone, it will be seen that spacing can be effected without printing, whichever row of characters is at the printing-level.

Having now described my invention, what I claim as new, and desire to secure by Letters Patent, is—

1. An electromagnetic printing device, comprising a type-cylinder having circularly-arranged series of characters of three kinds disposed around the cylinder with the three kinds arranged side by side in circular series, and forming groups which are repeated along the length of the cylinder, electromagnetic devices for giving both a rotary and a variable longitudinal movement to said cylinder, a hammer-cylinder arranged parallel to the first-named cylinder and bearing a single row of spirally-arranged impact-faces, and electromagnetic devices for imparting to this cylinder a step-by-step rotary movement, and an integral lateral movement to deliver the printing blow, substantially as and for the purpose described.

2. An electromagnetic printing device, comprising a type-cylinder having circularly-arranged series of characters of three kinds disposed around the cylinder with the three kinds arranged side by side in circular series and forming groups which are repeated along the length of the cylinder, electromagnetic devices for giving both a rotary and a variable longitudinal movement to said cylinder, a hammer-cylinder arranged parallel to the first-named cylinder and bearing a single row of spirally-arranged impact-faces, electromagnetic actuating devices for this hammer-cylinder, the electromagnetic actuating devices for one cylinder being constructed and arranged to be operated by a current of one polarity and that of the other cylinder being constructed and arranged to be operated by a current of the opposite polarity, the sliding of the type-cylinder being effected by a variable subsidiary device and the hammer-cylinder being arranged to move laterally to deliver the printing blow, substantially as and for the purpose described.

3. An electromagnetic printing device comprising a type-cylinder having circularly-arranged series of characters of three kinds disposed around the cylinder with the three kinds arranged side by side in circular series and forming groups which are repeated along the length of the cylinder, electromagnetic devices for actuating the cylinder with a step-by-step rotary movement and also a variable longitudinal character-shifting movement, a hammer-cylinder arranged in movable bearings parallel to the first-named cylinder and bearing a single row of spirally-arranged impact-faces, and electromagnetic actuating devices for both rotating this hammer-cylinder with a step-by-step movement and also projecting it bodily toward the other cylinder to deliver a printing blow, substantially as described.

4. An electromagnetic printing device comprising a longitudinally-sliding type-cylinder having circularly-arranged characters of three kinds disposed around the cylinder with the three kinds arranged side by side in circular series and forming groups which are repeated along the length of the cylinder, electromagnetic devices for rotating this cylinder, a hammer-cylinder arranged in movable bearings parallel to the first-named cylinder and bearing a row of spirally-arranged impact-faces, electromagnetic actuating devices for turning the hammer-cylinder and swinging it bodily and laterally to deliver the printing blow, and an electromagnetic device acted upon by the lateral printing movement of the hammer-cylinder and in turn adjusting longitudinally the type-cylinder with a variable throw, substantially as described.

5. In an electromagnetic printing device, the combination of the type-cylinder bearing three kinds of characters disposed side by side in circular series and forming groups repeated along the length of the cylinder, a hollow axle carrying the said cylinder and having a rigidly-attached ratchet-wheel and connected to the cylinder as described for rigid rotation therewith and a longitudinal sliding motion of the cylinder thereon, a helical spring arranged in the hollow axle and connected to the

axle and the cylinder, a central pull-wire attached to the cylinder, a lever attached to the pull-wire and bearing a magnetized armature, an articulated armature-finger, two electromagnets operating respectively upon the magnetized armature and the armature-finger, a battery, circuit, and circuit-switching device, and a laterally-movable hammer-cylinder and mechanism for operating the circuit-switching device by the lateral movement of the hammer-cylinder, substantially as described.

6. In an electromagnetic printing device, the combination of the type-cylinder bearing three kinds of characters disposed side by side in circular series and forming groups repeated along the length of the cylinder, a hollow axle carrying the said cylinder and having a rigidly-attached ratchet-wheel and connected to the cylinder as described for rigid rotation therewith and also a longitudinal sliding motion of the cylinder thereon, a helical spring arranged in the hollow axle and connected to the axle and cylinder, a central pull-wire extending through the axle and attached to the cylinder, a lever attached to the pull-wire and bearing a magnetized armature, an articulated armature-finger, two electromagnets operating respectively upon the magnetized armature and armature-finger, a battery-circuit, a circuit-breaking and pole-changing arm, a pair of rigidly-connected ratchet-wheels, one of them having one-third the number of teeth of the other and working in the plane of and lifting the circuit-breaking and pole-changing arm with a three-phase movement, a three-phase switch operated by said arm, a laterally-moving hammer-cylinder having an arm and a pawl acting upon the ratchet-wheel which has the larger number of teeth so as to operate the three-phase circuit-breaking and pole-changing arm by the back-and-forth movement of the hammer-cylinder, substantially as and for the purpose described.

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