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TELEGRAPHY.

No. 481,247. Patented Aug. 23, 1892.

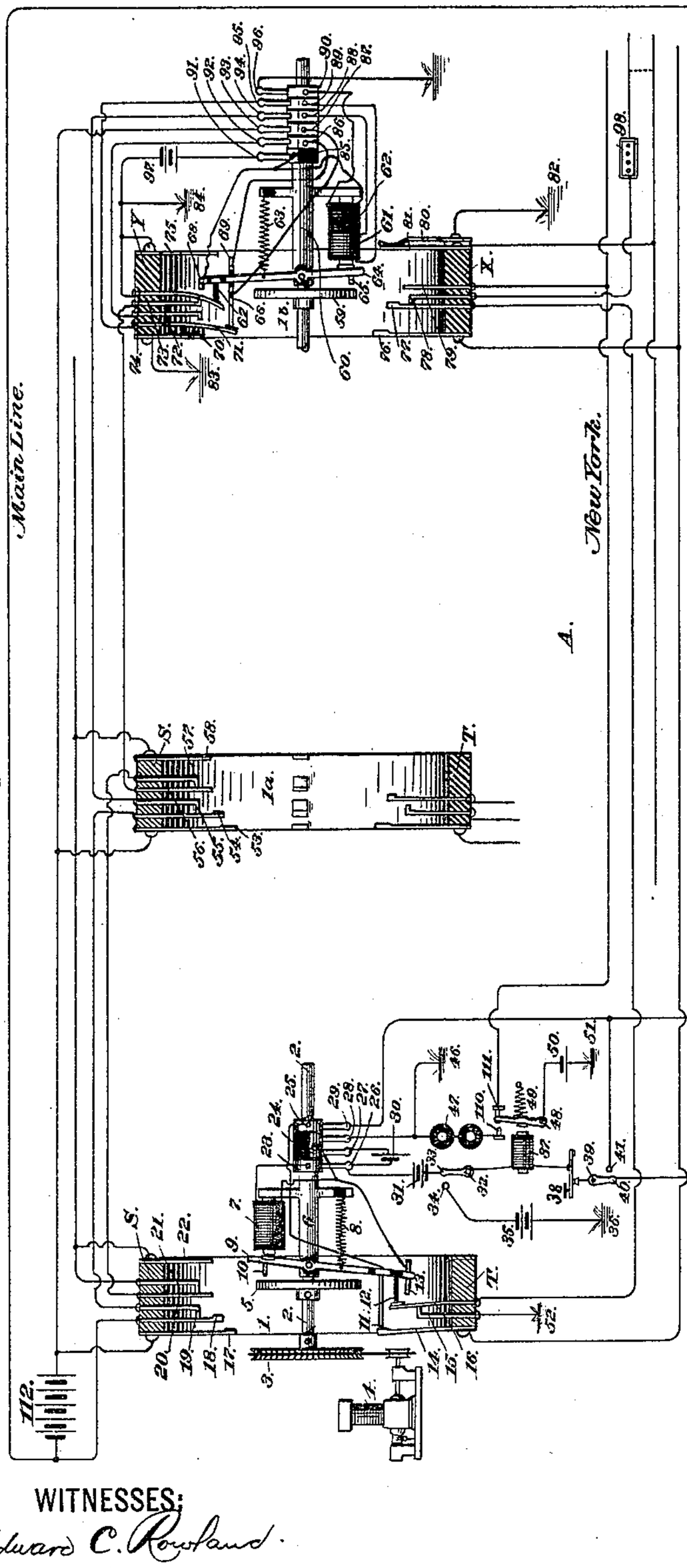

FIG. 1.

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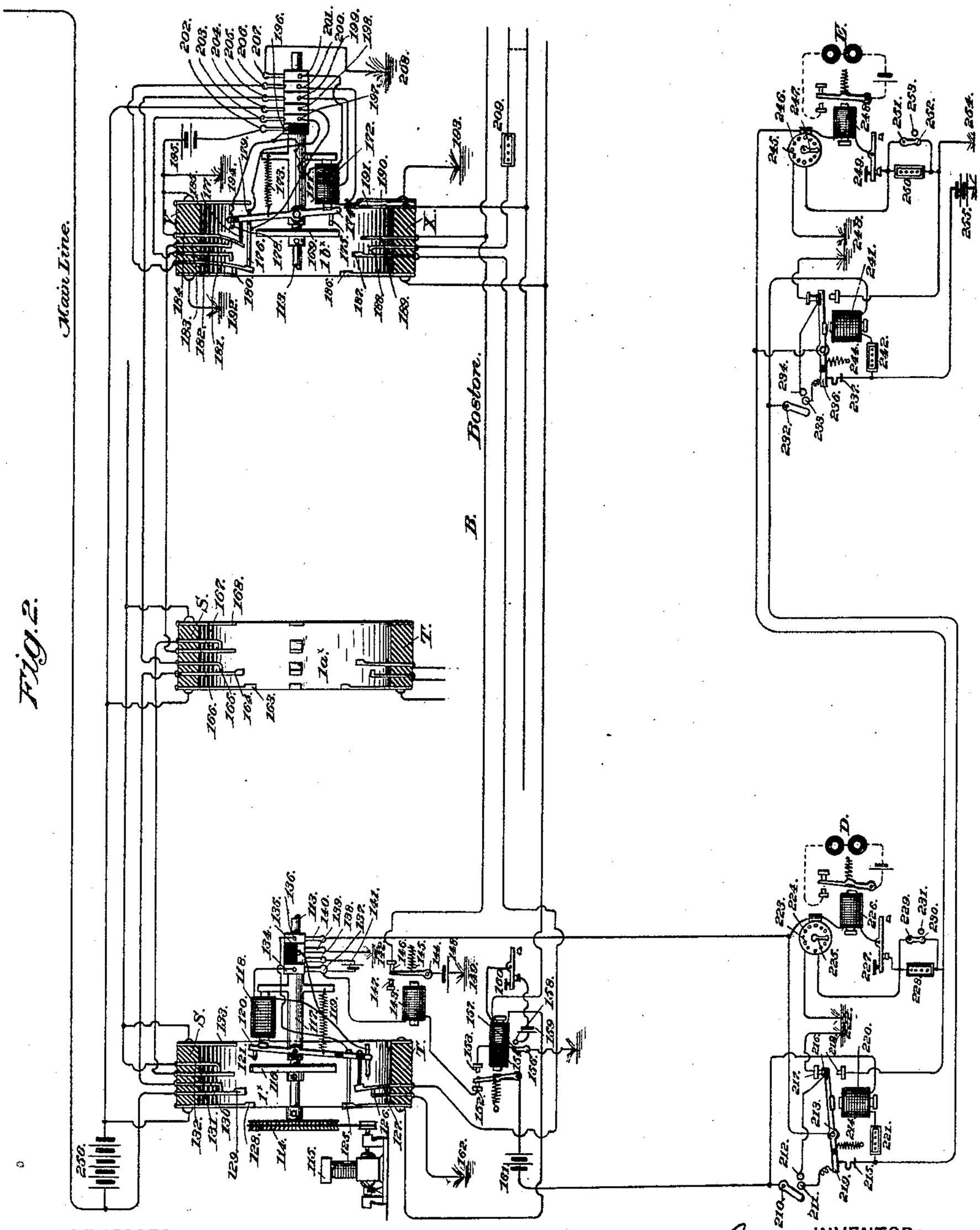

FIG. 2.

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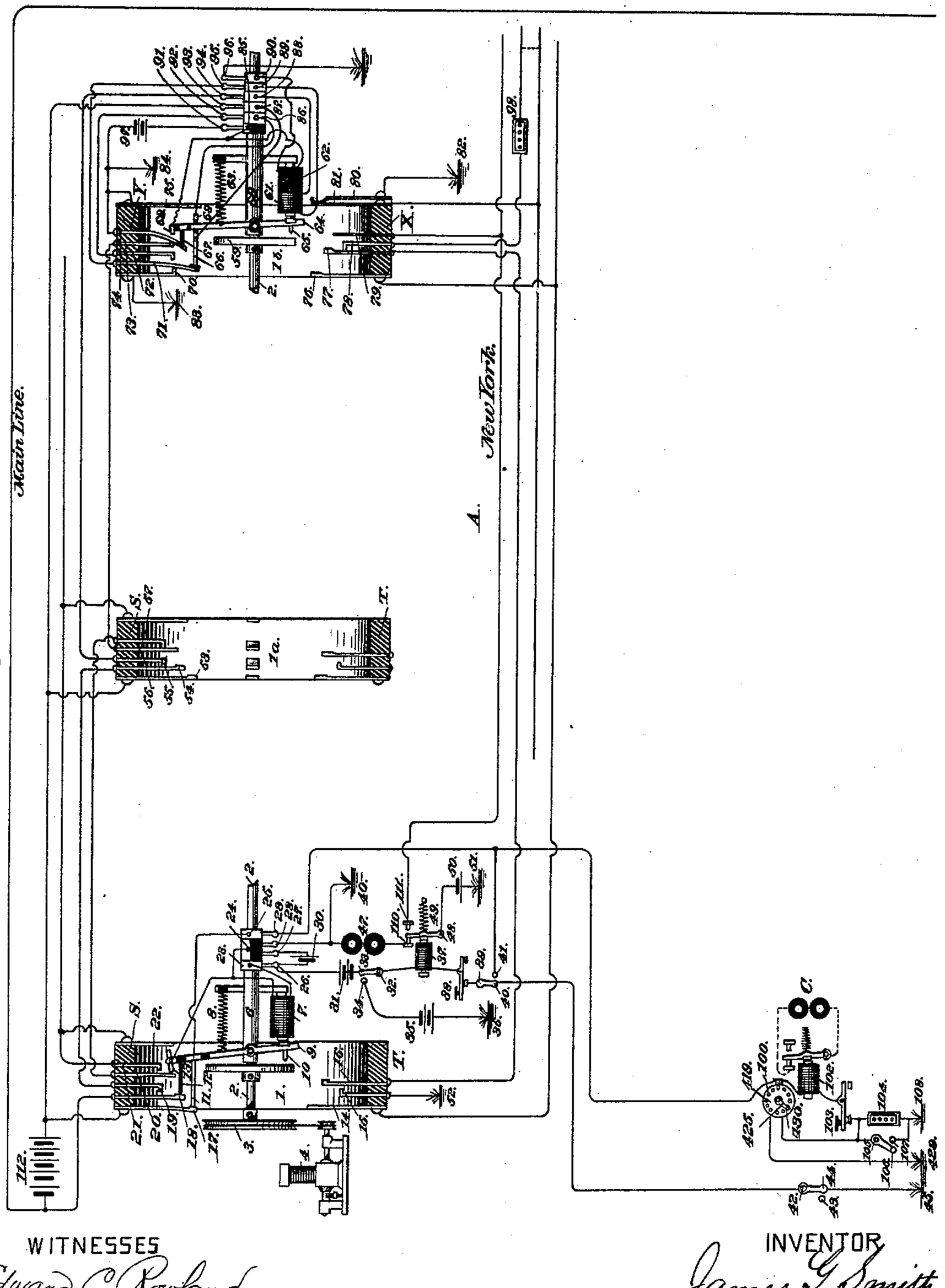

FIG. 3.

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(No Model.) 7 Sheets—Sheet 4.

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No. 481,247. Patented Aug. 23, 1892.

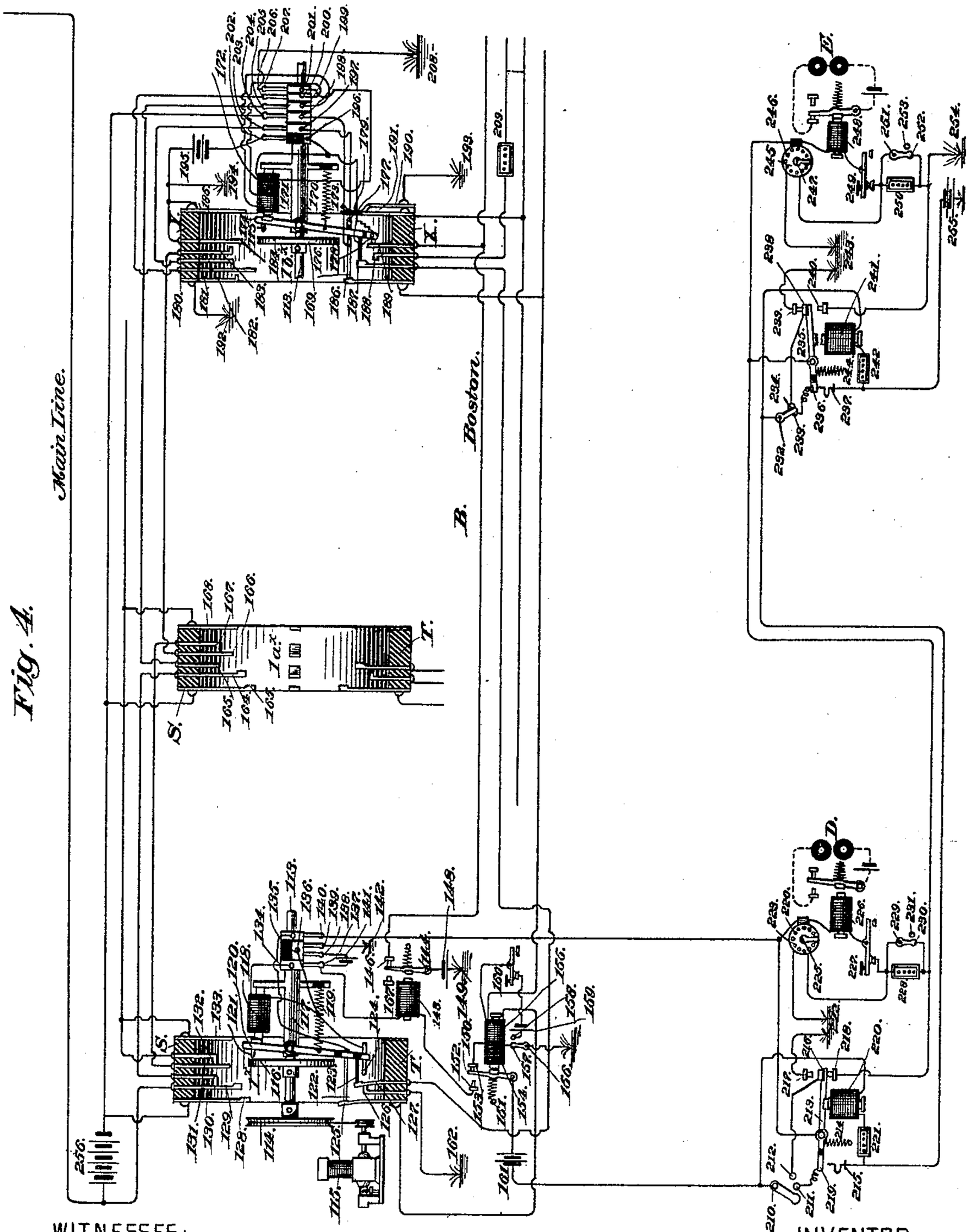

Fig. 4.

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(No Model.) 7 Sheets—Sheet 5.

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No. 481,247. Patented Aug. 23, 1892.

Fig. 5.

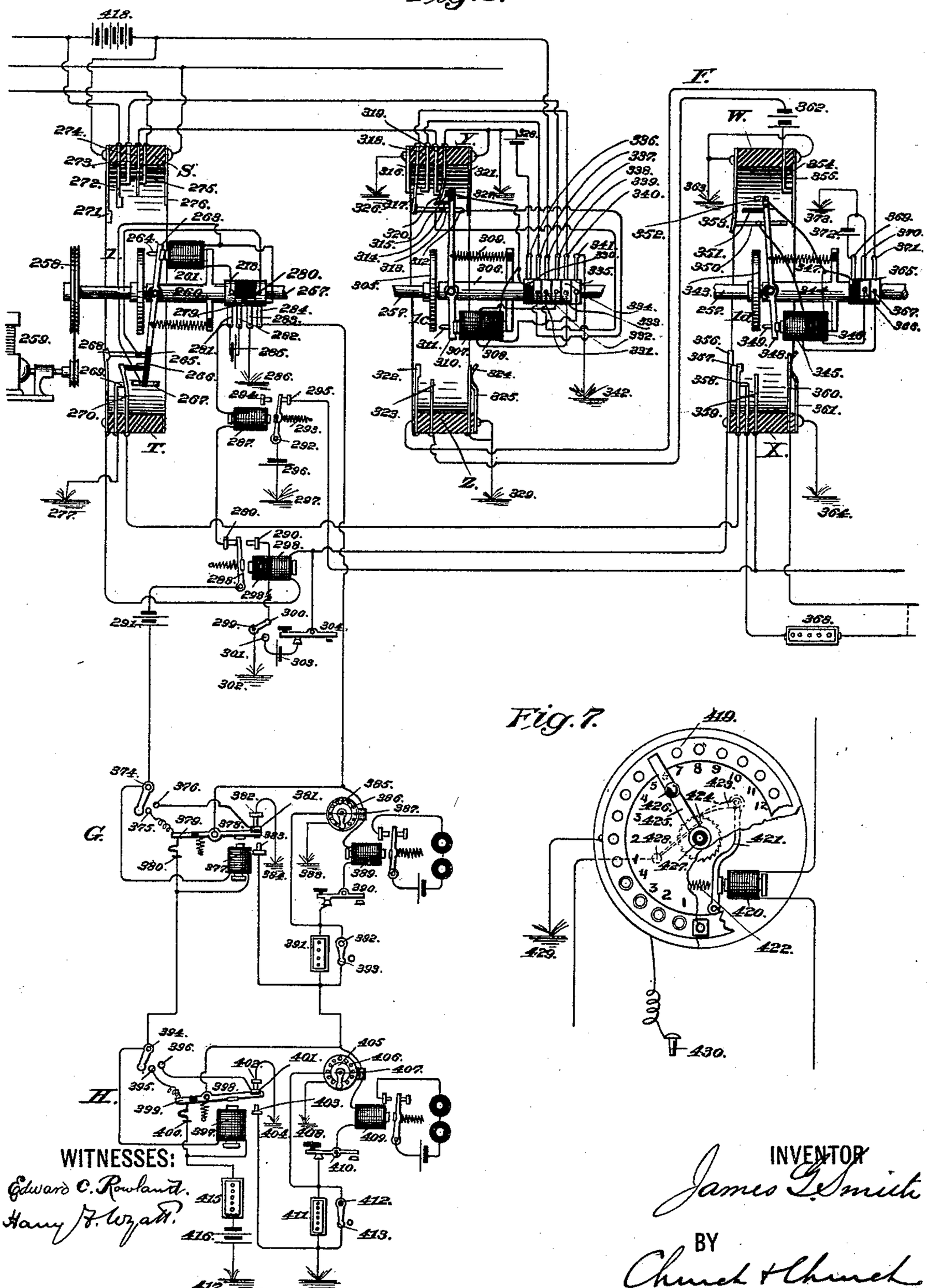

Fig. 7.

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(No Model.) 7 Sheets—Sheet 6.

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No. 481,247. Patented Aug. 23, 1892.

Fig. 6.

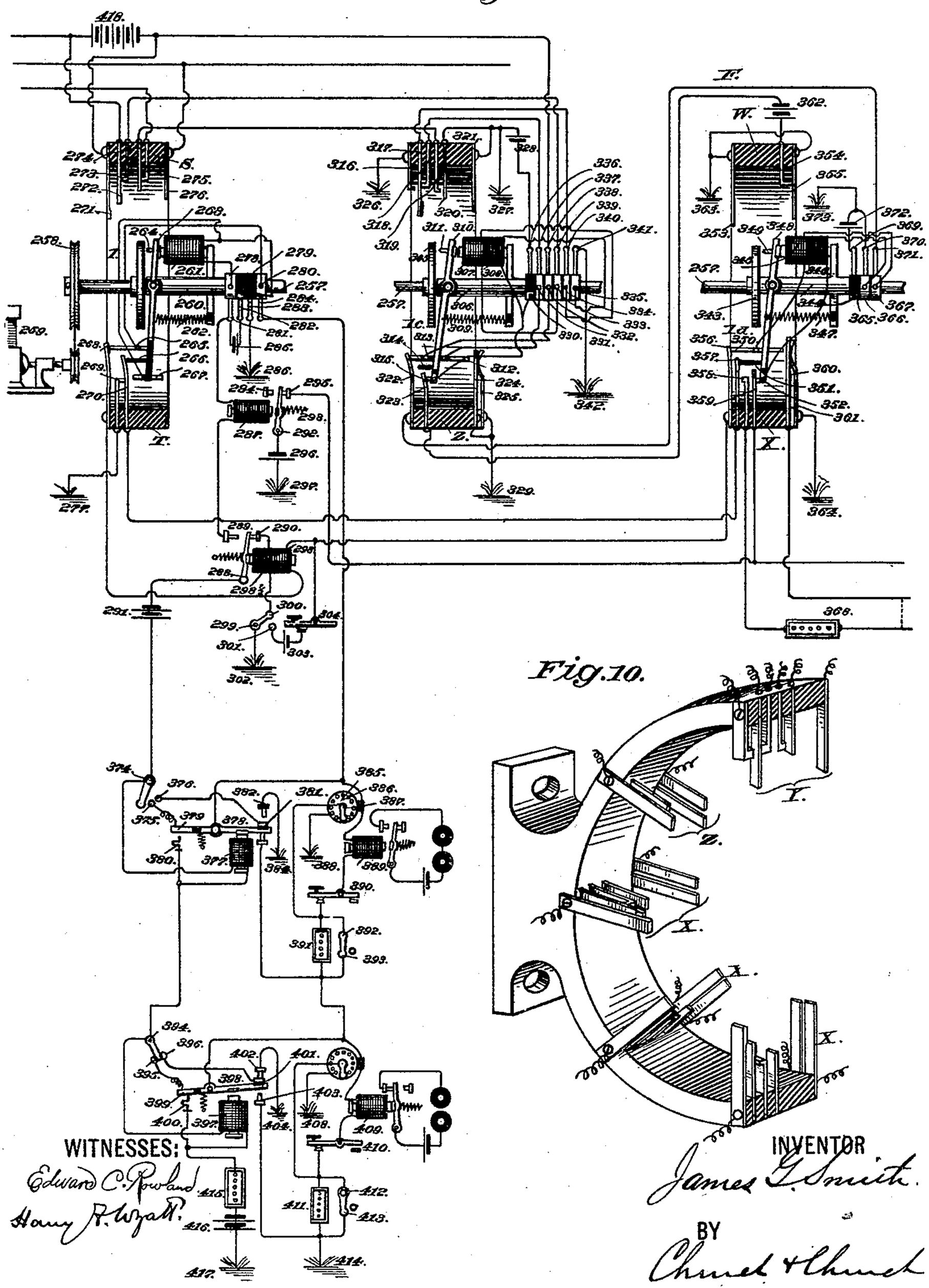

Fig. 10.

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TELEGRAPHY.

No. 481,247. Patented Aug. 23, 1892.

Fig. 8.

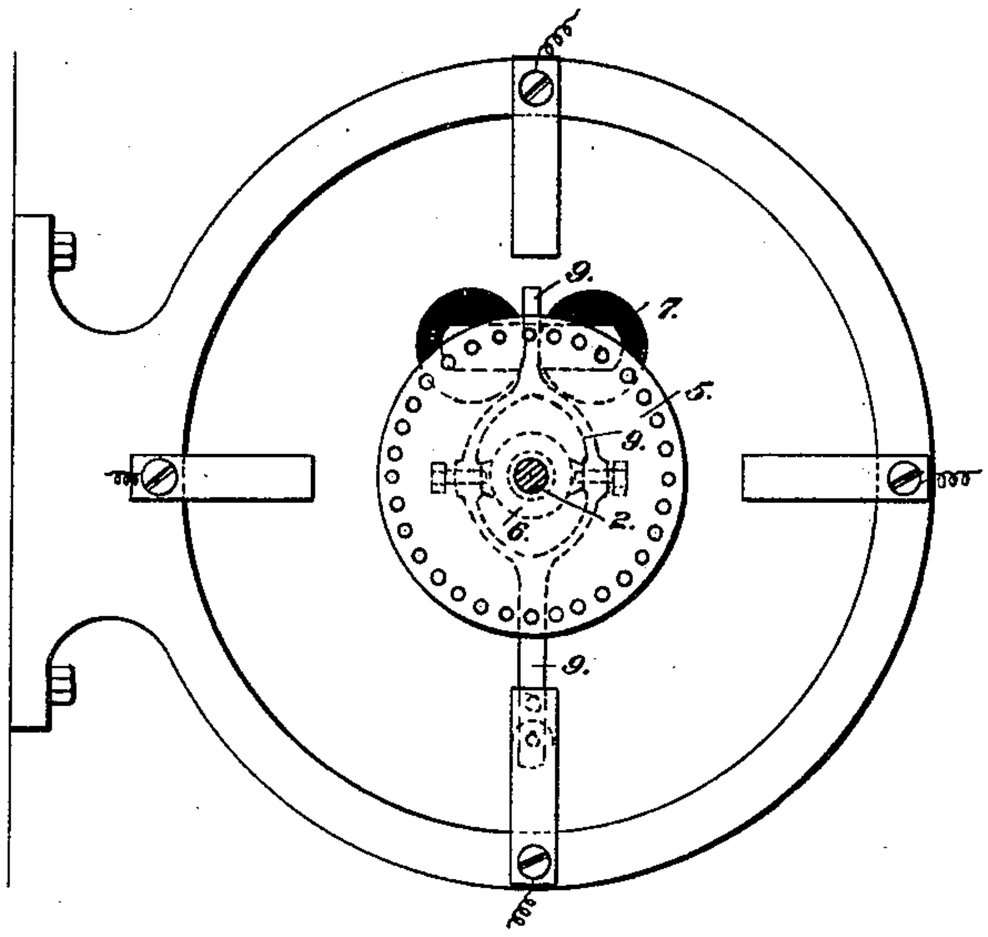
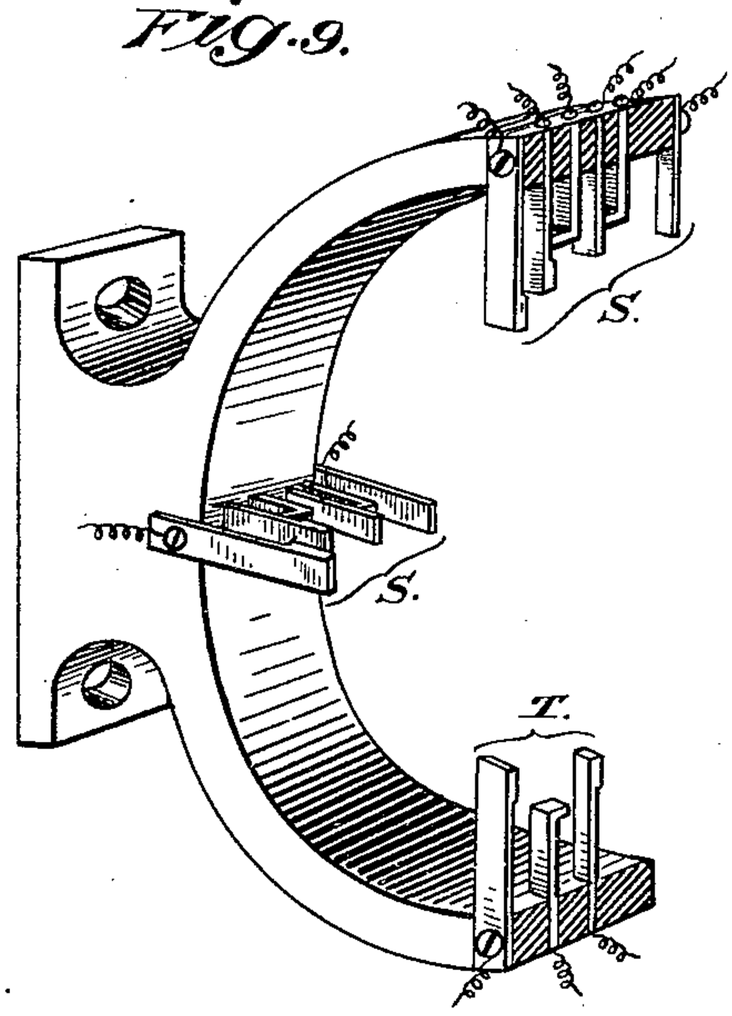


Fig. 9.



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UNITED STATES PATENT OFFICE.

JAMES G. SMITH, OF NEW YORK, N. Y.

TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 481,247, dated August 23, 1892.

Application filed November 2, 1889. Serial No. 329,087. (No model.)

To all whom it may concern:

Be it known that I, JAMES G. SMITH, of New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Telegraphy; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying drawings, forming a part of this specification, and to the figures and letters of reference marked thereon.

The maintenance of private telegraph-lines between persons in remote cities or districts is enormously expensive, considering the limited use that is made of such lines, there seldom being a day in which all the business transacted over a given line occupies the line more than an hour in the aggregate.

The object of my invention is to provide a system by which any one of a number of persons in one city or district may establish communication with any one of a number of persons in a remote city or district over one of a series of main lines at comparatively small expense to the individual, with the same privacy as can be secured by the use of a private line and without requiring any hand manipulation except on the part of the person calling and of the person being called, all else being accomplished automatically by suitable apparatus provided for the purpose.

Generally stated, my invention involves the use of a series of main lines extending between the remote cities or districts sought to be put in communication, a central station at each terminal of said main lines, a series of subscribers' circuits in each city or district, a series of switching apparatuses at each central station, one for each subscriber's circuit, adapted to automatically establish connection with any one of the series of main lines that happens at the time to be idle upon a proper signal from a local subscriber; another switching apparatus at each central station for responding to signals from the distant city or station over any one of the main lines and automatically connecting said main line with the local subscriber with whom the distant subscriber wishes to communicate, and an indicating apparatus at each subscriber's station for indicating that communication with the subscriber in the distant city or district is fully established.

It further involves the use of suitable apparatus for automatically cutting out all subscribers from any given main line except the subscriber first to gain connection therewith and of other apparatus for cutting out from each subscriber's circuit all those whose instruments are arranged thereupon save the one first to connect himself with the automatic switching apparatus belonging to that particular circuit, whereby strict privacy is secured to any subscriber while in communication with a subscriber in the remote city or district.

It further involves the use of auxiliary apparatus for increasing the capacity of the receiving apparatus at the central station, and it also involves the use of separate means by communication between the subscribers and the central station.

Having thus given a general notion of my improved system, I will now proceed to describe the same in detail with reference to the particular instrumentalities shown in the accompanying drawings.

Referring to said drawings, Figure 1 represents the apparatus at the main office of the system at one city, as New York, as shown at A, and a sub-station at the same city, (shown at C.) The apparatus, as shown in this figure, is in the position of rest, ready for operation. Fig. 2 shows similar apparatus at the main office in a distant city—say Boston—as shown at B, and two sub-stations D and E in the same city, Boston, both sub-stations being located in the instance shown on the same local-circuit wires connected in series. The sub-stations are thus shown for the purpose of illustrating the difference in the apparatus used when only one sub-station is placed on a local circuit, as in Fig. 1, and where two or more sub-stations are placed on one local circuit, as in Fig. 2. The apparatus in Fig. 2 is also shown as it appears when in a position of rest, ready for operation. Fig. 3 shows the same apparatus as Fig. 1, but with a portion of it in operated position. Fig. 4 shows the same apparatus as Fig. 2, but with a portion of it in operative position. Fig. 5 shows an arrangement by which the capacity

of a portion of the apparatus at a main office can be increased. It further shows a modification of the sub-station apparatus where more than one such sub-station is located on the same local circuit. The apparatus in this figure is also shown in a condition of rest. Fig. 6 shows the same apparatus as Fig. 5, but as it would appear when operated. Fig. 7 is a detailed illustration of the construction of a convenient form of the dial used at each sub-station for the purpose of controlling the automatic selection of the desired sub-station by the apparatus at the distant main office. Fig. 8 is an end view of the frame at the main office that supports the sets of contact-points, and also of the moving parts of the apparatus. Fig. 9 is a perspective sectional view of the same frame, showing a few of the sets of contact-points placed around the frame. The only difference in any of the frames is in the arrangement and number of the contact-points. Fig. 10 is a perspective sectional view of the frame 1^c, Figs. 5 and 6.

Similar letters and figures of reference in the several figures indicate the same parts.

Referring now to Fig. 1, the apparatus therein shown consists of two or more circular frames 1, 1^a, and 1^b, those marked 1 and 1^a being in every respect entirely alike and of any desired number and being referred to as 1 and 1^a simply for convenience of description. These frames have a mechanically-driven shaft 2, passing through but not connected with each frame, the shaft or shafts being kept constantly rotating by electric motor, as herein shown at 4, or by clockwork, weights, steam, hand, water, or other power. A band-wheel is herein shown at 3 attached to the shaft.

Attached at intervals around the frames 1 and 1^a are a series of sets of insulated contact-points, formed of metal strips, some rigid and the others flexible, all the sets being similar with the exception of one set, the similar sets (marked S on Fig. 9) each representing the connections to one of the main or trunk lines and the various strips and springs so arranged as to operate jointly to form connection by moving parts operated by the revolving shaft with that set's particular main line, and also to reserve that line to the substation then using it, and also to bring into use the main battery upon said line, as will all be more particularly described hereinafter. The dissimilar set (marked T on Fig. 9) has its strips and springs arranged differently, being the home set, at which the apparatus automatically comes to a stop, with the exception, of course, of the shaft. Each frame marked 1 and 1^a has a similar equipment of these sets of contact-points, and on each frame the number of such sets will correspond with the number of main or trunk wires employed in the system. The number of these frames 1 and 1^a at a main office, together with the whole apparatus for each, as shown at 1, corresponds to the number of local sub-station circuits at that end of the system, and the number of sets of contact-points upon each frame corresponds to the number of main wires employed, as aforesaid. The number of frames 1^b, however, corresponds to the number of main wires and not to the number of sub-stations, (as in the case of the frames 1 and 1^a,) and the number of sets of contact-points on each of the frames 1^b corresponds to the number of sub-station circuits (instead of to the number of main wires, as in the case of the frames 1 and 1^a)—that is to say, there is one frame 1^b at each end of each main wire, and on each of these frames are sets of contact-points corresponding in number and connected severally to the local sub-station circuits, the said contact-points forming the sets so arranged as to operate jointly with the moving parts when operated by the revolving shaft to form connection to that set's particular sub-station circuit.

Rigidly attached to the shaft 2, Fig. 1, and revolving with it and within (but not attached to) each of the frames 1 and 1^a is a disk 5, provided with holes in its face. In close proximity to this disk is a cylinder or sleeve 6, through which the shaft 2 runs. Pivoted upon such cylinder or sleeve and insulated therefrom is an armature-bar 9, provided at one end with a stud or projection 10, so arranged as to engage with the holes in the rotating disk 5, thereby rotating sleeve 6 and the attachments thereto, and having at its other end projections, as shown at 11, 12, and 13, insulated from each other, as shown, and the extreme one 13 projecting each side of the armature-bar 9. Also mounted upon sleeve 6 are the magnet 7 and the retractile spring 8, both arranged to operate armature-bar 9. The cross-bars or projecting arms 11, 12, and 13 are of such lengths and so arranged as to engage severally with their respective series of strips and springs forming the sets of contact-points 14, 15, 16, 17, 18, 19, 20, 21, and 22, Fig. 1, when in operation. Also mounted upon this sleeve 6 are the metal commutator-strips 23, 24, and 25, which are insulated both from the sleeve and from each other. One of these commutator-strips (shown herein at 24) is of sufficient width to receive two brushes upon its surface, the others having only one brush each, as shown. These latter commutators 23 and 25 pass completely around the sleeve; but the one 24, having two brushes bearing upon it, is only a segment of a cylinder, the remainder of the cylinder being composed of insulating material. The metallic segment 24 is placed at such a point that the brushes rest upon it only when the projecting arms 11, 12, and 13 of the armature-bar 9 are at the home set of contact-points, (shown at T.) The brushes are shown in this figure at 26, 27, 28, and 29. They are formed of metallic springs and are supported independently of said sleeve. These brushes have connections by wire, as shown, brush 26 with battery 30, and also with battery 31, and from the latter to switch 32,

thence on through magnet 37 to key 38, and thence by switch 39 to sub-station C. Brush 27 connects through battery 30 to brush 26, brush 28 with earth at 46, and brush 29 with the sub-station C, all as shown.

In passing I would state that for the purpose of enabling the main office A to communicate locally with the sub-station C, if at any time desirable, there is provided, as shown, battery 35, with earth connection 36, and further connection to stud 34 by switch 32, which when connected forms circuit for battery 35 through magnet 37 and key 38 to switch 39, and when the latter is thrown upon the stud 41 the circuit is completed to sub-station C. The local sounder-circuit for magnet 37 is completed by armature 48 with stud 110, sounder-magnet 47, battery 50, and earth 46 and 51. At the frame 1^b there is also shown the shaft 2, supplied with its fixed disk 59, similar to disk 5 at frame 1, and sleeve 60, the latter having mounted on it, as shown, the magnets 61 and 62, having a common core, the retractile spring 63, and the insulated armature-bar 64, provided with its stud 65 at one end, and its projections 66, 67, 68, and 69 at the other end so arranged as to operate, when desired, the contact-points 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, and 81. The contact-point 80, however, is not directly in line with the other contact-points of the set, but is placed in advance of them, so that the projecting arm 69 will form contact with it just prior to forming contact with 81. Also mounted upon this sleeve 60, but insulated from it and from each other, are the metallic commutator-strips 85, 86, 87, 88, 89, and 90, one of which (shown in this instance as 85) is only a small segment of a cylinder, the remainder being composed of insulation and so arranged that the brush of this commutator bears upon it to form connection only when the projections 66, 67, 68, and 69 arrive at the set of contact-points marked Y, which is the set at which they normally rest when the apparatus is not being operated. This set of contact-points will hereinafter be referred to as the "home set." Brushes similar to those described for frame 1 are shown here at 91, 92, 93, 94, 95, and 96, bearing upon their respective commutator-strips. These brushes have connections by wire, as shown and as will be more fully explained hereinafter.

The apparatus at sub-station C consists, as shown in Fig. 1, of a dial, which is more clearly shown in Fig. 7 and described in detail hereinafter. There is also provided, as shown at Fig. 7, a short metallic plug for insertion in the holes in the dial, so shaped that its head will project sufficiently to allow the arm 425 to pass over it, but at the same time touch it sufficiently to make contact therewith. There is also provided at C, as shown in Fig. 1, a relay-magnet 102, with its armature, local sounder, battery, and circuit-wires, as shown; also, key 103, rheostat 104, switch 105, with its studs 106 and 107, with wire connections running to earth at 108, as shown.

The main-line batteries are shown at 112 on Fig. 1, representing one terminus of the system, and at 256 on Fig. 2, representing the other terminus. Each main or trunk line is similarly equipped with batteries.

In Fig. 2, representing the distant end of the main lines—say Boston—the apparatus shown at frame 1^x at the main office B, is the same as shown at A, Fig. 1, at frame 1, with the exception of slight changes in the auxiliary parts of the frame, such changes being required when two or more sub-stations are placed on one local circuit in series, leading to such frame. In this latter case the sub-stations may be equipped, as shown at D and E, Fig. 2, such equipment being the same as shown at C, Fig. 1, with the addition of apparatus for the purpose of enabling any one sub-station when operating the line to cut out all other sub-stations located on the same local circuit with itself, thereby reserving the line privately to itself and avoiding interruption by others while so operating. This additional apparatus consists of an electro-magnet, (shown at 220 at D,) with its armature 213 centrally pivoted, the ends of the armature insulated from each other and having its action controlled by the stops 215, 217, and 218, one end of said armature provided with a metallic strip on the upper side, insulated from the armature, as shown at 216; also, rheostat 221 and switch 210 with its studs 211 and 212 with their connections, as shown. On each sub-station local circuit having more than one sub-station included therein the equipment is the same with the addition of a battery and ground connections at the last station farthest from the main office, as shown at 254 and 255 at E.

The apparatus represented in Fig. 5 illustrates that feature of the invention which comes into use when the number of sub-station circuits is greater than can be conveniently provided for by sets of contact-points on any one frame 1^b or 1^{bx}—that is to say, assuming the number of sub-station circuits to be five hundred, and assuming, also, that the size of the frame 1^b or 1^{bx} will not conveniently accommodate more than one hundred sets of contact-points, then the apparatus here shown provides for the other four hundred or any larger number.

The sub-station apparatus as shown in Fig. 5 is a modification of the sub-station apparatus shown in Figs. 2 and 4, the batteries therein having their poles in series, while in Figs. 2 and 4 they are opposed. The positions of the resistances are also transferred to the extreme end of the circuit, as shown. Frame 1, Fig. 5, and its auxiliary parts are the same as shown in Figs. 2 and 4. Frame 1^c is similar to frame 1^b or 1^{bx} of Figs. 1, 2, 3, and 4, with the addition of one or more sets of contact-points arranged as shown at Z.

The object of this set or sets of contact-points (shown at Z) is to enable connection to be made from the main line through the armature-bar at frame 1^c to the auxiliary switch or switches F, as best shown in Fig. 6. If desired, therefore, the whole or any portion of this frame 1^c can be equipped with these sets of contact-points Z, connecting with switches F, so that by placing one hundred such sets Z upon this frame 1^c one hundred auxiliary switches F can be brought into use, each switch F representing one hundred or more sub-stations, thus showing the almost unlimited capacity of the system. This auxiliary switch F consists of a similar frame, (marked 1^d,) provided with sets of contact-points arranged, as shown at X, on frames 1^b, Figs. 1, 2, 3, and 4, corresponding in number to the number of sub-stations to be accommodated on this particular switch. It also has a set of contact-points arranged as shown at W, representing the home set of that switch.

The shaft, sleeve, disk, armature-bar, &c., are the same as in 1^c; but the commutator strips and brushes, while of the same construction, are less in number, as shown.

The detail view of Fig. 7 represents the "dial" placed at each of the sub-stations, the perforations in the metallic plate being shown at 419, the electro-magnet at 420, and its armature-bar at 421, the latter having a retractile spring 422 and ratchet-pawl 423, engaging with the ratchet-wheel 424. The number of teeth or notches in the ratchet-wheel corresponds to the number of holes in the face of the plate, which is rigidly attached to the short shaft 427, supporting the metallic arm 425, having a handle, (shown at 426.) The brush 428 also bears upon the shaft 427. A limited number of the holes 1 to 4, immediately succeeding the zero-point of the dial, represent the several auxiliary switches at the distant city—such as shown at F, Figs. 5 and 6—and the other holes 1 to 12 represent the several sub-station circuits at the distant city. The handle 426 is employed to bring the arm around by hand to zero-point after use.

Having now described the several parts, I will proceed to describe their operation. Assuming that the operator at the station C, which is supposed to be at New York, desires to communicate with station E, which is supposed to be at Boston, the operation would be as follows: First, he would insert the brass plug 430, Fig. 7, in the hole in his dial-plate 419, representing the number of the local circuit at Boston upon which station E is located. He would then throw switch 42, Fig. 1, onto point 44, as shown in Fig. 3, and throw open switch 105 until connection with sub-station E has been completed, as will be presently described, when he would close said switch 105 again. The throwing of switch 42 onto point 44 would open another avenue for the current of battery 30, which has heretofore been locally energizing magnet 7 through brushes 26 and 27 and commutator-strips 23 and 24 with their wire connections to magnet 7, as shown, forming the complete local circuit of this battery 30. The result of thus weakening this local circuit is that the retractile spring 8 is enabled to overcome the magnet 7 and withdraw its end of the armature-bar 9, thereby bringing forward the other end, which is provided with the stud 10. This stud 10 then engages with one or the other of the holes in the disk 5, which is rotating by the movement of the shaft 2, to which it is rigidly attached, and the projecting arms 11, 12, and 13 at the other end of the armature-bar 9 leave the contact-points 14 and 16 of the home set T, and 13 engages in its rotation with the contact-points 22 successively of each set until said arm 13 arrives at the first set connected with a main wire not in use—for instance, the set S, Figs. 1 and 3. Meanwhile the sleeve 6, together with the parts attached to it, revolves with said disk, removing the segmental commutator-strip 24 from contact with the brushes 27 and 28, thereby breaking the local circuit of battery 30 and also breaking the earth connection 46 from circuit of battery 31. The circuit path of this battery 31 therefore now passes by brush 26 and commutator-strip 23 through magnet 7 to projection 13 of armature-bar 9 by wires, as shown, and thence to wire connected with the contact-point 22, thereby providing a ground at 84 at frame 1^b for battery 31, as follows: down contact-point 21, up contact-point 20, thence to contact-point 57 of frame 1^a, and up contact-point 56, thence in a similar manner through any other frames in the circuit, and finally to contact-points 73 and 74 to the earth 84. This circuit when so completed brings the apparatus to the position shown in Fig. 3 by energizing magnet 7, which attracts the bar 9, and thus withdraws stud 10 from disk 5 again, thereby freeing it from the motion of the continuously-rotating shaft 2, and the armature-bar and its connected parts stop with the projecting arms 11, 12, and 13, engaged with the contact-strips 17, 18, and 20, as shown. The result of this new position is, first, that the connection with the earth at 84 is maintained by the projecting arm 13 bearing against contact-point 20, instead of 22, at the same time that it presses contact-point 20 away from contact 21, thereby preventing any other sub-station from forming connection with this particular main line, and it is evident that the contact-points 22 and 20 and the projecting arm 13 must be so relatively adjusted that 13 engages with contact-point 20 before leaving contact-point 22 to maintain the circuit of battery 31 through magnet 7 unbroken; secondly, the result of this new position is that the insulated arm 12, pressing the contact-point 18 away from contact-point 19, breaks the connection of the main line at this point from the ground 83 of frame $1^{b\times}$; thirdly, the result is that the main battery 112 is thrown into the main-line circuit formed as

follows: from earth 108, Fig. 3, at sub-station C, through the dial, magnet, and other instruments at that station to brush 29 and commutator-strip 25, thence to projecting arm 11, which is now pressing against contact-point 17, and thence to battery 112 and main line, as shown, whence it travels to the distant end of the main wire, Boston, (shown at Figs. 2 and 4, (where it comes in down contact-point 129 of frame $1^{\times}$, up contact-point 130, thence through any number of frames $1^{a\times}$, by contact-points 164 and 165, and finally to frame $1^{b\times}$, by brush 205, commutator-strip 199, through magnet 171, thence to commutator-strip 200, and brush 206 to contact-points 181 and 180, and thence to ground at 192, and the result of the circuit so formed is to energize magnet 171, which is so arranged as to neutralize the magnet 172, locally energized, as shown, allowing the retractile spring 173 to withdraw its end of the armature-bar 174 and bring forward the other end bearing the stud 175, which then engages with the disk 169. As this disk is constantly rotating on the mechanically-driven shaft 113, the sleeve and its attachments consequently also rotate, and the projecting arms 176 and 177, having been withdrawn from engagement with the contact-points 181 and 184 of the home set Y, Fig. 2, the ground connection of the main line is broken at this point, but is maintained effectively, nevertheless, by the projecting arm 179 engaging with the contact-point 185, as follows: The contact-point 181, relieved of the pressure of the projecting arm 176, bears against contact-point 182, and the circuit then passes up this contact-point to brush 203 and commutator-strip 197, thence by wire, as shown, to projecting arm 179, which is bearing against contact-point 185, up which it passes to earth at 194. This is maintained only so long as the local circuit is energizing the magnet 172 by the contact of brush 202 with the segmental commutator-strip 196, and by the time this commutator-strip has passed from the brush by the rotation of the sleeve the projecting arm 179 passes beyond the contact-point 185. Consequently there is now no current passing through either of the two magnets 171 and 172, and the retractile spring 173 continues to hold the stud 175 engaged with the disk 169, thereby continuing the rotation of the sleeve, causing the projecting arm 179 to bear successively upon contact-points 190 and 191 of each of the sets of contact-points placed around the frame $1^{b\times}$, bearing against 190 before reaching 191, (in the same way as described heretofore of contact-points 80 and 81, Figs. 1 and 3,) and on reaching 190 of the set X, completing the main-line circuit to earth at 193, Fig. 4, thereby energizing the electro-magnet of the dial at the station C at New York, drawing forward its armature 421, Fig. 7. On leaving the contact-point 190, by the continued rotation of the apparatus, as described, the main-line circuit is again broken, the armature of the dial-magnet at station C is released, and is drawn back again by the retractile spring 422, Fig. 7, thereby moving the ratchet-wheel 424, Fig. 7, one tooth by the pawl 423, Fig. 7, moving the arm of the dial one hole. Immediately after leaving 190, Fig. 4, the projecting arm 179 engages with the contact-point 191, but passes from it to the other succeeding sets, repeating the same engagements with the contact-points 190 and 191 of each set until the arm 179 reaches the set corresponding to the number of the holes in which the plug is placed at station C, at which time the arm of the dial at C will have engaged with the inserted plug, thereby grounding the main line at 429, as shown in Fig. 3, thus cutting out the rheostat 104 from the circuit, thus increasing the strength of the main battery 112 by exactly the resistance that has been introduced by the rheostat 104, and which resistance is such that when so removed the increased current will energize the magnet 171 at frame $1^{b\times}$ at Boston, thereby withdrawing the stud 175 from the disk 169, causing the sleeve and its attachment to stop at that position with the projecting arms 176, 177, and 178 to form contact with the contact-points 186, 187, and 189 of set X, as shown at Fig. 4, causing the following simultaneous changes: The contact between the projecting arm 179 and the contact-point 191 is broken, thereby breaking the main-line circuit at that point, but not, however, until a new avenue is formed for it, coming in through the battery 256, Fig. 4, thence by wire, as shown, to brush 204, thence to commutator-strip 198, and thence by wire, as shown, to projecting arm 176, which has formed connection with contact-point 186, whence it is continued by wire, as shown, to contact-point 125 of set T at frame 1, which is in contact with the projecting arm 122 at frame 1, Fig. 4, whence it is continued by wire, as shown, to commutator-strip 136, thence by brush 140 and by wire, as shown, to dial-magnet at station D, thence to magnet 226, key 227, switch 229, contact-stud 230, and thence in a similar manner through any other sub-stations located upon the same sub-station circuit, finally terminating at the last station upon this local sub-station circuit, as represented at E, where it gets its ground, as shown at earth 254. It will be seen that the main-wire circuit as now formed does not include the magnet 171 of frame $1^{b\times}$; but the armature-bar 174 is still withheld from engaging with the disk 169 by the local circuit, formed as follows: Starting at earth 208, through brush 207 and commutator-strip 201 by wire, as shown, to magnet 172, thence by wire, as shown, to projecting arm 178, thence by contact-point 189, with which it is in connection by wire, as shown, to contact-stud 146 at frame 1, and thence through armature 144 to battery 148 and earth 149. The connection of any other main line with this particular local sub-station circuit through a corresponding set on its

frame $1^{b\times}$ is prevented at the same time by the insulated projecting arm 177 pressing the contact-point 187 away from the contact-point 188, thus breaking the wire connection to the earth at 162, Fig. 4, (frame $1^{\times}$,) which is common to all these sets X on the frames 1^{b}.

Interruption to station C at New York end is prevented as follows: The armature-bar 9, with its projecting arms, having moved away from the home set at T, as shown at frame 1, Fig. 3, the contact-point 16 of that set is no longer pressing against the contact-point 15 and the connection with the earth at 52 is thereby broken, preventing any other main-line circuit from being completed through that frame until the bar 9 again returns to the home set T, which will not be until the communication then in progress is concluded and the apparatus comes to its normal condition through the action of the operators at stations C and D, as hereinafter described.

Having now shown how station C at New York has established communication by main wire with station E through station D at Boston and also how both these stations are protected from interruption, it will now be shown how the operator at E cuts out the other sub-stations on the same circuit as himself without disturbing the apparatus at frame $1^{\times}$, Fig. 4. The main-line circuit has been shown to pass through magnet 155 at frame $1^{\times}$, Figs. 2 and 4, thereby energizing it and withdrawing its armature 150 from stop 152 against stop 153, Fig. 4, thus breaking the circuit of battery 141, formed through battery 161 and 255 to earth at sub-station E, and so preventing any action at the sub-station from affecting the apparatus at frame $1^{\times}$, Boston, but leaving the position of armature-bar 120 undisturbed, being held by the action of the local circuit of battery 141 through magnet 118. The connection of the armature 150, however, with the stop 153 completes the circuit of the battery 161 through the coarse-wound magnet 154 and down to station E through battery 255. It will be noticed, however, that these batteries 161 and 255 have their poles opposed, and consequently there is no current flowing on this circuit and energizing the magnets 241 at E and 220 at D. The stations upon this Boston sub-circuit are now in condition to answer the signal-call from the distant or New York station without disturbing the apparatus at their frame $1^{\times}$, as follows: Assuming that the signal calls for E, the operator at E immediately places the switch 232 in position to touch both the studs 233 and 234, as shown in Fig. 4. This at once cuts out all the other stations on this particular local circuit, securing entire privacy of communication between the operator at E and the distant station that has signaled him, as will be now explained. While this switch 232 was open the two batteries 161 and 255 were opposing and neutralizing each other, as already explained; but as soon as the said switch is placed on said two studs 233 and 234 a ground is provided at 243 for both—for battery 255 through stud 237, insulated end 236 of armature-bar 235, by wire to stud 233, over switch to stud 234, by wire to contact-point 238, (situated on but insulated from bar 235,) to stud 239, and thence by wire to ground 243. Battery 161 completes its circuit as follows: By wire, as shown, from the earth to switch 157, thence through magnet 154 to stud 153 and armature 150 to battery 161, thence by wire, as shown, to station D, through magnet 220 and rheostat 221, to switch 232 at E, to stud 234, and thence to ground at 243 by same connections as battery 255. It is evident, therefore, that whereas the two batteries 161 and 255 were opposing and neutralizing each other previously to the switch 232 being placed upon the two studs 233 and 234, directly said switch is so placed the current of battery 161 is passed through and energizes the magnet 220 at D, thereby drawing down the armature-bar 213, and so breaking the connection of the contact-points 216 and 217 and forming connection between the armature-bar 213 and stud 218, and manifestly in the same way passing through the corresponding magnets of any other sub-stations till it gets a ground at 243; but the current of battery 255 at E (the station signaled and where the switch 232 has been placed upon the studs) passes, as shown, around the magnet 241, thereby leaving the armature-bar in position unchanged, as shown, to form connections and effect the results just described, and also to prevent the shunting of the operating-instruments at station E.

The result of the armature-bar 213 being drawn down in the other sub-station, as shown at D, Fig. 4, is twofold: First, it prevents the operator there from accomplishing anything by any manipulation of his switch 210, as will be seen by inspection, and, secondly, it completely cuts out the operating-instruments at that station from the main-wire circuit as follows: Coming from brush 140 at the main (Boston) office it is diverted from the instruments at D by the avenue offered it by the wire running to the armature-bar 213, which being now in contact with the stud 218 the shunt round the operating-instruments is completed and the current is so carried direct to E, and passes through the operating-instruments there to ground 254, as shown.

In the foregoing description I have described the operation of the system where the sub-station signaled is the last one of two or more on a single local circuit. In the event of the station called being situated between the main office and the last station on the local circuit it is evident that the switch 232 would not be closed, and the battery 255 would thereby have to go through magnet 241 to get a ground and would draw down the armature-bar 235, putting station E into the condition shown at D in Fig. 4.

Assuming the desired communication between C and E to be ended, the release of the

apparatus and its return to its normal condition, ready for use again, is effected as follows: The operator at E opens the key 249 and throws off switch 232. He then replaces the switch 232 again for a few seconds and then leaves it disconnected. He then closes the key 249 again, and the apparatus is ready for the next call. The operator at C opens his key 103 and throws off and then on and off again his switch 42. The result of these movements is as follows: When the operator at C throws off his switch 42 from stud 44, the circuit of battery 31 is broken and the magnet 7 is de-energized and the stud 10 engages with the revolving disk 5, thereby rotating the projecting arms 11, 12, and 13 until the segment commutator-strip 24 comes round to form contact with the brushes 27 and 28, when the projecting arms will be opposite the home set T of the contact-points, as at first. Directly these brushes 27 and 28 come in contact with the commutator-strip 24 the local battery 30 again automatically energizes the magnet 7 and the stud 10 is again freed from the disk 5, thereby stopping the rotation of the projecting arms at the home set, as desired, and leaving them in contact with the contact-points 14 and 16, and with the strip 16 pressing against strip 15, Fig. 1, as previously described.

The frame $1^{b\times}$ at Boston is returned to its home set as follows: The key 249 at E being opened the main-line circuit is broken, the throwing off of the switch 232 from the studs 233 and 234 de-energizes magnet 154, and there is consequently no current flowing through either of the magnet-coils 154 and 155, so that the armature 150 is withdrawn against the stop 152, re-forming the circuit of battery 161 through magnet 143 to earth at 142. The subsequent throwing on again of switch 232 at E grounds the battery 161 and energizes magnet 143, thereby drawing armature 144 from stop 146, breaking the circuit of battery 148 through contact-point 189 (frame $1^{b\times}$) and projecting arm 178 and magnet 171, thereby de-energizing magnet 172 and allowing stud 175 to engage with disk 169, rotating the projecting arms till opposite the home set Y, when the commutator-strip 196 will come in contact with brush 202, whereupon the battery 195 again automatically energizes magnet 172, withdrawing the stud from the disk and bringing the apparatus to rest, with the projecting arm 176 upon the contact-point 181 and pressing it against 180 and arm 171 pressing contact-point 184 against 183, thereby leaving the whole apparatus again in position for use as at first, as shown at 1^{b}, Fig. 2.

We will now assume that communication is desired between C at New York and H, Figs. 5 and 6, which is a sub-station situated on a local circuit having more than one sub-station upon it, at a distant city where the number of sub-stations is so great as to render it necessary to increase the capacity of the apparatus for forming connections between the main lines and the sub-stations. This is accomplished by the apparatus shown in Figs. 5 and 6, where switch F is introduced for the reception of the sets of contact-points representing sub-station circuits in excess of the number that can be conveniently accommodated on frame 1^{c}. Fig. 5 represents the apparatus at the distant city in its normal position at rest. Fig. 6 shows the same in use. Frames 1 and 1^{c} of Figs. 5 and 6 are in every respect similar to frames 1 and $1^{b\times}$ of Fig. 4, with the exception that frame 1^{c} of Figs. 5 and 6 is equipped with as many different sets of contact-points as there may be auxiliary switches F, the contact-points of these sets being so arranged as to form the required connections with the auxiliary switches F. A convenient form of these additional sets is shown at Z on frame 1^{c}, Figs. 5 and 6, and are placed upon the frame next in succession to the home set.

The operation of forming connection with station H by means of this auxiliary switch F is as follows: The operator at C first places a plug in the auxiliary-switch hole of his dial-plate representing F. He then puts another plug in the sub-station hole representing the local circuit upon which H at the distant city is located. He then proceeds as previously described. The result is that the moving parts at frame 1^{c} will be set in motion in the same manner as hereinbefore described, and as soon as the arm of the dial at C comes into contact with the plug inserted in the auxiliary-switch hole the apparatus at frame 1^{c} stops, in the manner previously described, at the set of contact-points represented by the auxiliary-switch hole in the dial in which the plug has been inserted, as shown in Fig. 6, with the projecting arms in contact with the set of contact-points Z. The result of this is that a local circuit is formed as follows: From earth 342 to brush 341 and commutator-strip 335 through magnet 308 to projecting arm 315, thence through contact-point 323 to battery 362 at switch F, and thence by contact-points 354 and 355 to earth at 363. This circuit so formed energizes magnet 308 at 1^{c}, thereby holding the apparatus at rest in this position. At the same time the main-line circuit is continued by brush 338 and commutator-strip 332 of frame 1^{c} to projecting arm 313, contact-point 322, and thence by wire, as shown, to brush 371 at F, and so by commutator-strip 367 to and through magnet 345, thence by wire, as shown, to projecting arm 350, and thence by contact-point 353 to earth at 363, as shown in Fig. 5. Magnet 345 is thereby energized and neutralizes magnet 346, which is locally energized by battery 372, as shown, thereby allowing the stud 349 to engage with the rotating disk 343. The projecting arms are therefore carried round in the manner before described until the arm at the dial at C forms connection with the plug inserted in the hole representing the sub-station circuit upon which H is located, when

the projecting arm automatically stops in the same way, as heretofore explained, and the connection is formed as shown in Fig. 6. Station H can now be signaled from C at the other end, whereupon he proceeds as explained in description of operation at station E.

I will now describe the manner in which the apparatus at frames 1^c and 1^d are brought back to their normal position after communication is finished. The operators at the stations C and H proceed in the same way as before described, with the following results: The first thing to be done is to break the local circuit of battery 296, which is holding the projecting arms at frame 1^d, by energizing magnet 346. This is accomplished in the same way as described in the operation of the same parts in Fig. 4—viz., by the withdrawal of armature 292 from stop 295. The moving apparatus at frame 1^d then automatically revolves till it reaches its home point at W in the same manner as previously described, when it stops; but at the moment of reaching its home set the projecting arm 350 presses contact-point 355 away from contact-point 354, thereby breaking the circuit of battery 362, which has been energizing magnet 308 at frame 1^c, permitting the stud 311 to engage with the disk 305, thereby automatically starting the apparatus at this frame also on its return to its home point at Y, where it will automatically stop, as before described. The apparatus is now again in position for forming a new connection when desired. The term "series" as herein used is intended to cover two or more.

Having thus described my invention, I claim—

1. In a system of telegraphy, the combination of a transmitting local-subscribers' circuit, a main line, a receiving local-subscribers' circuit having a number of subscribers' stations arranged thereupon in series and having apparatus and connections by means of which any particular subscriber called may cut out all other subscribers on the same local-subscribers' circuit, an automatic switch actuated from the transmitting local-subscribers' circuit, and controlling circuit connections between said transmitting local circuit and main line, and a second automatic switch actuated by current on the main line and controlling circuit connections between the main line and the receiving local-subscribers' circuit, substantially as described.

2. In a system of telegraphy, the combination of a transmitting local-subscribers' circuit, a main line, a series of receiving local-subscribers' circuit, an automatic switch actuated from the transmitting local-subscribers' circuit, and controlling circuit connections between said transmitting local circuit and the main line, and a second automatic switch actuated by current on the main line and controlling circuit connection between the main line, a local auxiliary circuit, and an auxiliary automatic switch actuated by current on said auxiliary circuit, and controlling circuit connections between the auxiliary circuit and the receiving local-subscribers' circuit, substantially as described.

3. In a system of telegraphy, the combination of a transmitting local-subscribers' circuit, a main line, a series of receiving local-subscribers' circuits, an automatic switch actuated from the transmitting local-subscribers' circuit, and controlling circuit connections between said transmitting local-subscribers' circuit and the main line, a second automatic switch actuated by current on the main line, and controlling-circuit connections between the main line and a series of local auxiliary circuits, and an auxiliary automatic switch for each auxiliary circuit actuated by current on the latter, and controlling circuit connections between the auxiliary circuit with which it is connected and the appropriate local-subscribers' circuit, substantially as described.

4. In a system of telegraphy, the combination of a series of transmitting local-subscribers' circuits, a receiving local-subscribers' circuit, a main line common to all local-subscribers' circuits, a series of automatic switches, one for each transmitting local-subscribers' circuit, each actuated from its appropriate transmitting local-subscribers' circuit, and controlling circuit connections between said transmitting local circuit and the main line and cutting out all other transmitting local-subscribers' circuits from said main line, and a second automatic switch actuated by impulses transmitted over the main line from a distant transmitting local circuit, and controlling-circuit connections between the main line and the receiving local-subscribers' circuit, substantially as described.

5. In a system of telegraphy, the combination of a transmitting local-subscribers' circuit, a series of main lines, a receiving local-subscribers' circuit, an automatic switch actuated from the transmitting local-subscribers' circuit, and controlling circuit connections between the transmitting local-subscribers' circuit and any one of the main lines that happens to be idle and in order, a second automatic switch actuated by impulses transmitted over the automatically-selected main line from the distant transmitting-subscribers' circuits and controlling circuit connections between said main line and the receiving local-subscribers' circuit, substantially as described.

6. In a system of telegraphy, the combination of a series of transmitting local-subscribers' circuits, a receiving local-subscribers' circuit, a series of main lines common to all the local-subscribers' circuits, an automatic switch for each transmitting local-subscribers' circuit actuated from said circuit, and controlling circuit connections between the same and one or the other of the main lines and cutting out all other transmitting local-sub-

scribers' circuits from said selected main line, a second automatic switch actuated by impulses transmitted from the distant transmitting local-subscribers' circuit over the particular main line being at the time utilized, and controlling circuit connections between said main line and the receiving local-subscribers' circuit, substantially as described.

7. In a system of telegraphy, the combination of a transmitting local-subscribers' circuit, a series of receiving local-subscribers' circuits, a series of main lines common to all the local-subscribers' circuits, an automatic switch actuated from the transmitting local-subscribers' circuit, and controlling circuit connections between said transmitting local circuit and one or the other of the main lines, and a second automatic switch actuated by impulses transmitted from the distant transmitting local-subscribers' circuit over the selected main line, and controlling circuit connections between the particular main line being at the time utilized and one or the other of the series of receiving local-subscribers' circuits, substantially as described.

8. In a system of telegraphy, the combination of a series of transmitting local-subscribers' circuits, a series of receiving local-subscribers' circuits, a series of main lines common to all the local-subscribers' circuits, an automatic switch apparatus for each transmitting local-subscribers' circuit actuated from said circuit, and controlling circuit connections between the same and one or the other of the series of main lines and cutting out all other transmitting local-subscribers' circuits from said selected main line, and a second automatic switch apparatus actuated by impulses transmitted from a distant transmitting local-subscribers' circuit over the particular main line being at the time utilized, and controlling circuit connections between said main line and one or the other of the receiving local-subscriber circuits, substantially as described.

9. In a system of telegraphy, a series of transmitting local-subscribers' circuits, a series of main lines, a series of receiving local-subscribers' circuits, an automatic switching apparatus for each transmitting local-subscribers' circuit, operating upon a signal from a subscriber on its particular local circuit to connect the said circuit with one of the main lines that happens at the time to be idle and cutting out all other transmitting local-subscribers' circuits from said selected main line, a second automatic switching apparatus operated by the current on the main line to connect said main line with any predetermined receiving local-subscribers' circuit, and an apparatus at the transmitting local-subscribers' station for automatically arresting said second switching apparatus to make connection with said predetermined receiving local-subscribers' circuit, so that communication between the distant local subscribers may be carried on, substantially as described.

10. In a system of telegraphy, a series of transmitting local-subscribers' circuits, a series of main lines, a series of receiving local-subscribers' circuits, an automatic switch apparatus for each transmitting local-subscribers' circuit, operating upon a signal from any subscriber on said transmitting local-subscribers' circuit to connect said last-mentioned circuit with one of the main lines which happens at the time to be idle and to cut out all other transmitting local-subscribers' circuits from the main line so selected, a second automatic switching apparatus operated by the current on the main line, having a series of movable contacts and a series of stationary sets of contacts corresponding in number to the number of receiving local-subscribers' circuits, said series of movable contacts operating to cause an electrical impulse to be sent back to the transmitting local-subscribers' station each time a set of contacts belonging to a receiving local-subscribers' circuit is touched and passed, and an apparatus at the transmitting local-subscribers' station actuated by the impulses aforesaid and operating to arrest said second automatic switching apparatus when at the point for connection with the predetermined local-subscribers' circuit, so as to enable communication to be had between the transmitting local subscriber and the said predetermined remote receiving subscriber, substantially as described.

11. In a system of telegraphy, a transmitting local-subscribers' circuit, a main line, a series of receiving local-subscribers' circuits, an automatic switching apparatus for the transmitting local-subscribers' circuit, operating upon a signal from a subscriber on said local circuit to connect said circuit with the main line and throw a current-generator on said main line, a second automatic switching apparatus connected to the main line and operated by the current thereon and having a movable set of contacts and a series of sets of stationary contacts corresponding in number to the number of receiving local-subscribers' circuits, said movable set of contacts operating as it touches and passes each successive set of stationary contacts to ground the main line and send an electrical impulse over the same to the distant-transmitting local-subscribers' station, and an electro-mechanical apparatus at the transmitting local-subscribers' station, adapted to advance step by step under the aforesaid impulses and when the stationary set of contacts belonging to the predetermined receiving local-subscribers' circuit desired to be connected is reached by the movable set of contacts to afford a new path for the main-line current, which changes the electrical condition of the main circuit and causes the switching apparatus to be arrested while communication is being had between the distant local-subscribers' station.

12. In a system of telegraphy, a series of transmitting local-subscribers' circuits, a series of main lines, a series of receiving local-subscribers' circuits, an automatic switch apparatus for each transmitting local-subscribers' circuit, operating upon a signal from any subscriber on said local transmitting-subscribers' circuit to connect said last-mentioned circuit with one of the main lines which happens at the time to be idle and to cut out all other transmitting local-subscribers' circuits from the main line so selected, a second automatic switching apparatus connected to and operated from the main line and having a movable set of contacts, and a series of sets of stationary contacts corresponding in number to the number of receiving local-subscribers' circuits, said movable set of contacts operating as it touches and passes each successive set of stationary contacts to ground the main line and send an impulse to the transmitting local-subscribers' station, and an electro-mechanical apparatus at the last-named station, which advances step by step in response to the aforesaid electrical impulses until the set of contacts of the predetermined receiving local-subscribers' circuit is reached, whereupon a new path for the main-line current is afforded, which changes the condition of said main-line circuit and causes the arrest of the movable set of contacts of the switching apparatus, substantially as described.

13. In the herein-described system of telegraphy, the combination of a main line, a transmitting local-subscribers' circuit, an automatic switching apparatus by which said transmitting local-subscribers' circuit is connected to the main line, consisting, essentially, of the frame bearing the sets of stationary contacts, the continuously-rotating shaft having the perforated disk secured thereto, the sleeve mounted upon said shaft, carrying the armature-bar provided with contacts, as described, the electro-magnet, the spring and the commutators, the battery and circuit connections for holding the armature-lever normally disengaged from the rotating disk, the battery and circuit connections for disengaging the armature-lever from the disk when in position for connection with the main line, and the hand-switches and connections under control of the operator at the transmitting local-subscribers' station, all arranged and operating substantially as described.

14. In the herein-described system of telegraphy, the combination of a series of main lines, a transmitting local-subscribers' circuit, and automatically switching apparatus by which said transmitting local-subscribers' circuit is connected to one or the other of the main lines, said switching apparatus consisting, essentially, of the frame bearing the sets of stationary contacts, a continuously-rotating shaft having the perforated disks secured thereto, the sleeve mounted upon said shaft, carrying the armature-bar provided with contacts, as described, the electro-magnet, the spring and the commutators, the battery and connections for holding the armature-lever normally disengaged from the rotating disks, the battery and connections for disengaging the armature-lever from the disk when in position for connection with one or the other of the main lines, and the hand-switches and connections under control of the operator at the transmitting local-subscribers' station, all arranged and operating substantially as described.

15. In the herein-described system of telegraphy, the combination of a series of main lines, a series of transmitting local-subscribers' circuits, and a series of automatic switching apparatus, one for each transmitting-subscribers' circuit, each consisting, essentially, of a frame bearing the sets of stationary contacts, a continuously-rotating shaft having the perforated disks secured thereto, the sleeve mounted upon said shaft, carrying the armature-bar provided with contacts, as described, the electro-magnet, the spring and the commutators, the battery and connections for holding the armature-lever normally disengaged from the rotating disks, the battery and connections for disengaging the armature-lever from the disk when in position for connection with one or the other of the main lines, and the hand-switches and connections under control of the operator at the transmitting local-subscribers' station, all arranged and operating substantially as described.

16. In the herein-described system of telegraphy, the combination, with the main line and its battery, of the series of receiving local-subscribers' circuits and the automatic switching apparatus for establishing connection between said main line and one or the other of the receiving local-subscribers' circuits, said switching apparatus consisting, essentially, of the frame, with its series of sets of contacts corresponding to the number of receiving local-subscribers' circuits, the constantly-rotating shaft bearing the perforated disk, the sleeve mounted upon said shaft, carrying the armature-lever provided with contacts, as described, the electro-magnets, one of which is energized by the current of the main line and the other by the current of a local battery, the retracting-spring, and the commutators, with the commutator-brushes and circuit connections arranged and operating substantially as described.

17. In the herein-described system of telegraphy, the combination, with a main line, of a transmitting local-subscribers' circuit and automatic switching apparatus, by which said transmitting local-subscribers' circuit is connected to the main line, consisting of the frame with its sets of stationary contacts, the continuously-rotating shaft having the perforated disk secured thereto, the sleeve mounted upon said shaft, carrying the armature-bar provided with contacts, as described, the elec-

tro-magnet, the spring and the commutators, the battery and circuit connections for holding the armature-lever normally disengaged from the rotating disk, the battery and circuit connections for disengaging the armature-lever from the disk when in position for connection with the main lines, and the hand-switches and connections under the control of the operator at the transmitting local-subscribers' station, the battery on the main line, the series of receiving local-subscribers' circuit, the automatic swinging apparatus for establishing connection between the main line and one or the other of the receiving local-subscribers' circuits, said switching apparatus consisting, essentially, of the frame with its series of sets of contacts corresponding to the number of receiving local-subscribers' circuits, the constantly-rotating shaft bearing the perforated disk, the sleeve mounted upon said shaft, carrying the armature-lever provided with contacts, as described, the electro-magnets, one of which is energized by the current of the main line and the other by the current of a local battery, as described, the retracting-spring and the commutators with commutator-brushes and circuit connections, as described, and the apparatus at the transmitting local-subscribers' station for effecting the arrest of the switching apparatus and establishing connection with the desired receiving local-subscribers' circuit, consisting of the perforated dial, the metallic stud, the movable arm, the electro-magnet, and means for advancing the arm step by step by impulses sent over the main line, as described, and the rheostat and switches and circuit connections, substantially as set forth.

18. In the herein-described system of telegraphy, the combination, with the series of main lines, of the series of transmitting local-subscribers' circuits, the series of receiving local-subscribers' circuits, a series of automatic switching apparatus, one for each transmitting local-subscribers' circuit, by which any one of said transmitting local-subscribers' circuits may be connected to an idle main line, said automatic switching apparatus consisting of the frame and sets of stationary contacts, the continuously-rotating shaft having the perforated disk secured thereto, the sleeve mounted upon said shaft, carrying the armature-bar provided with contacts, as described, the electro-magnet, the spring and the commutators, the batteries and circuit connections, as described, means such as described for cutting out all the other transmitting local-subscribers' circuits from said selected main line, the automatic switching apparatus for establishing connection between the main line and one or the other of the receiving local-subscribers' circuits, said switching apparatus consisting, essentially, of the frame with the series of sets of contacts corresponding to the number of the receiving local-subscribers' circuits, a constantly-rotating shaft bearing the perforated disk, the sleeve mounted loosely upon said shaft, carrying the armature-lever and provided with contacts, as described, the electro-magnets and retractile spring for operating said armature-lever and the commutator-brushes and circuit connections, as described, and the apparatus at the transmitting local-subscribers' station for effecting the arrest of the distant switching apparatus and establishing connections between the main line and the desired receiving local-subscribers' circuit, consisting of the perforated dial, metallic stud, movable arm, the electro-magnet, and means for advancing the arm step by step by impulses sent over the main line, as described, and the rheostat, hand-switches, and circuit connection, substantially as set forth.

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Witnesses:
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