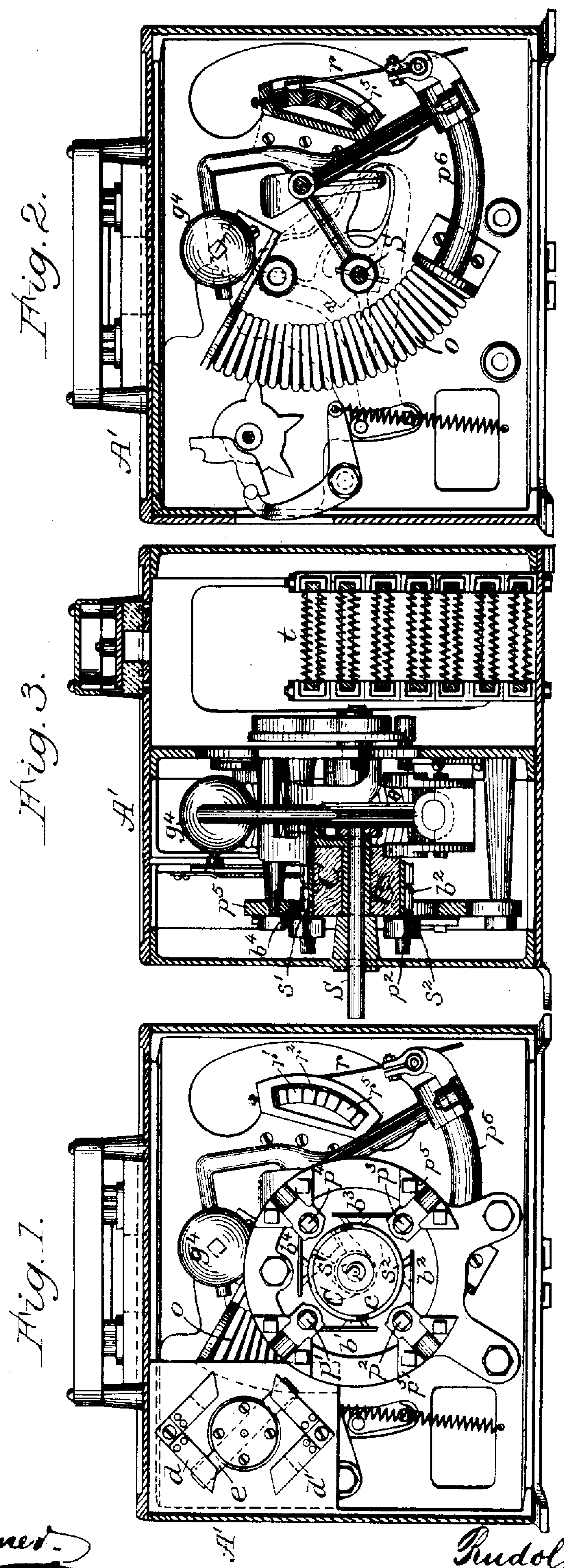
No. 609,016. Patented Aug. 16, 1898.

R. EICKEMEYER.

ELECTRIC ELEVATOR.

(Application filed May 3, 1892.)

(No Model.) 9 Sheets—Sheet 1.



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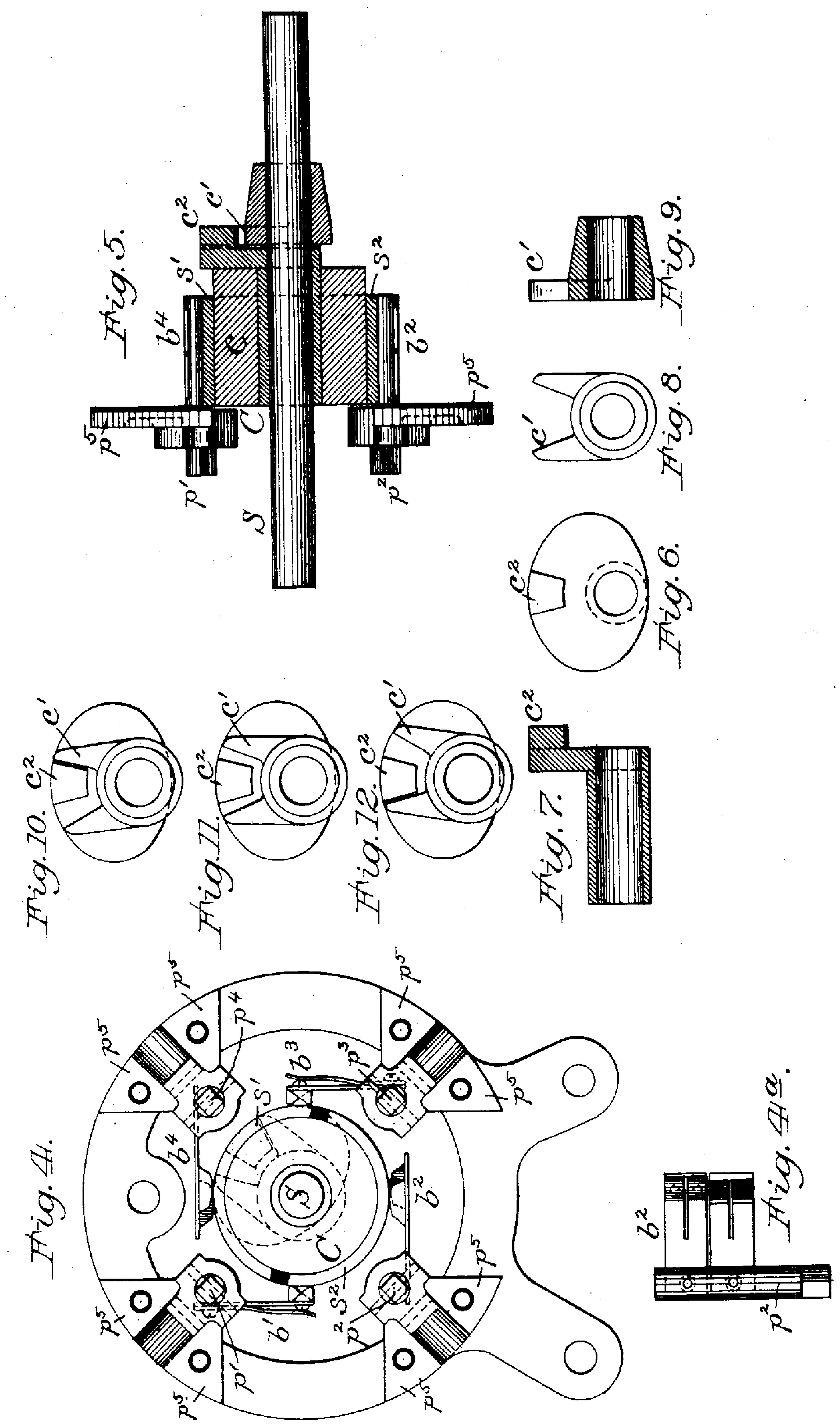

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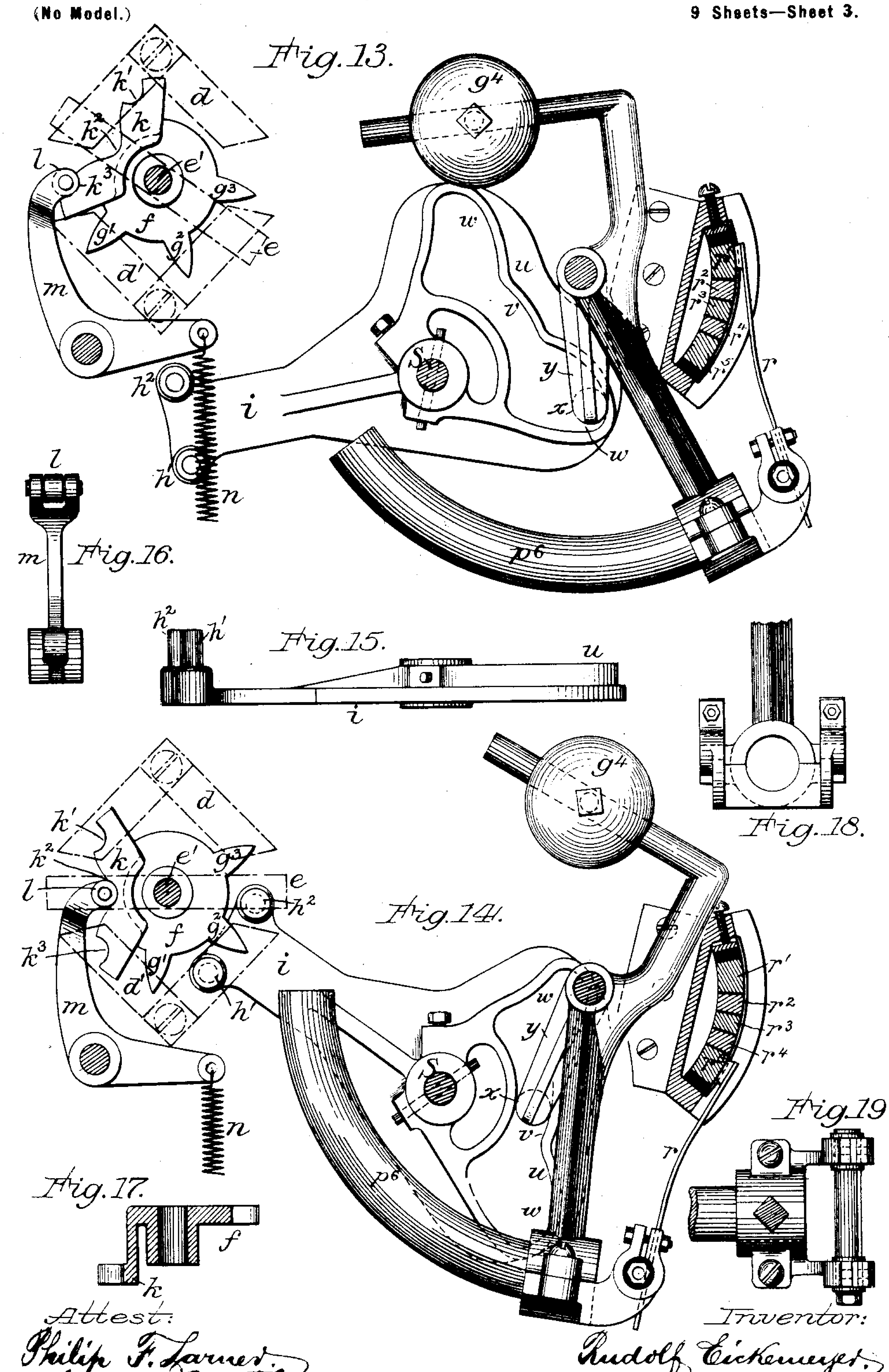

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(No Model.) 9 Sheets—Sheet 4.

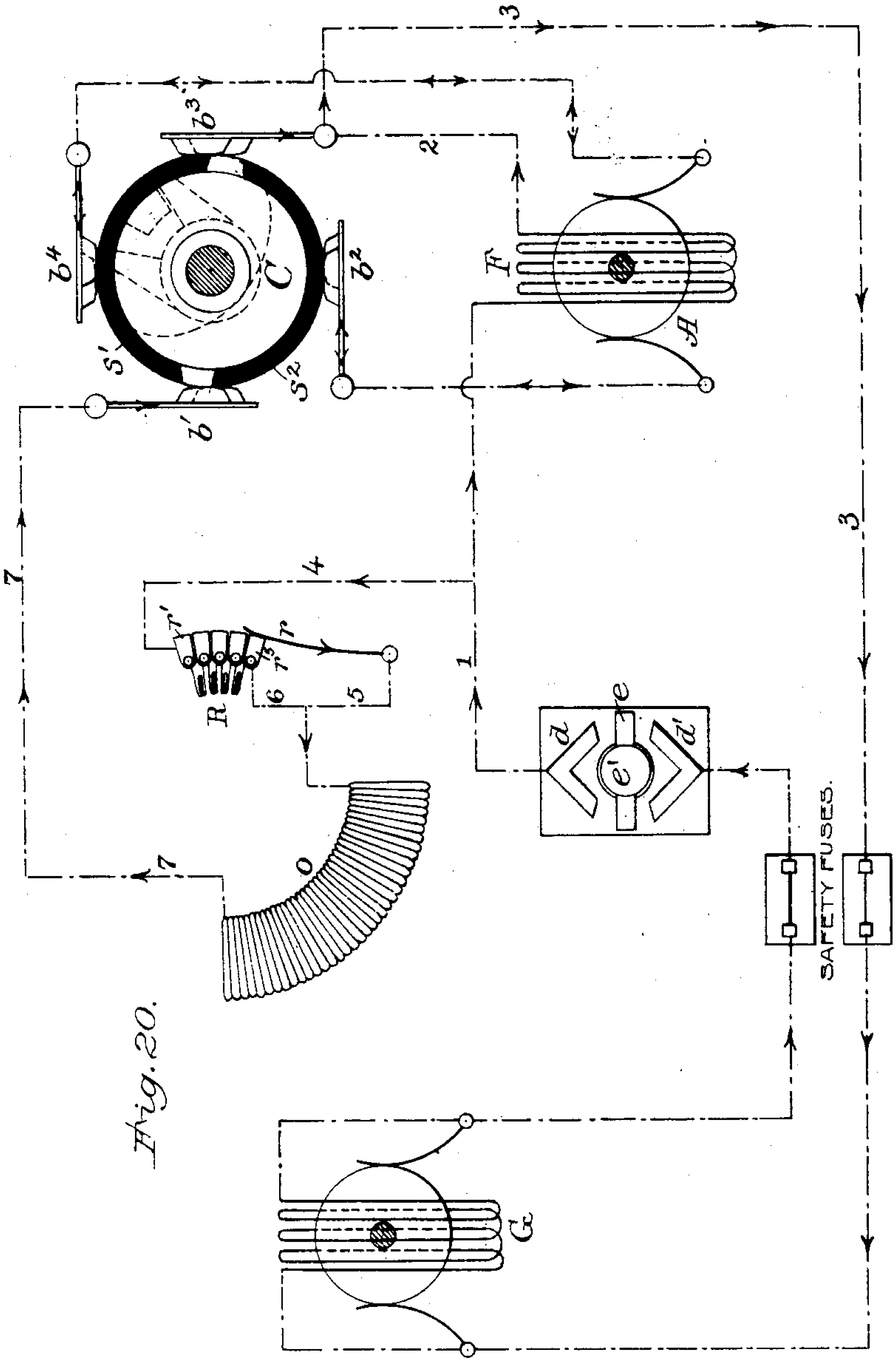

Fig. 20.

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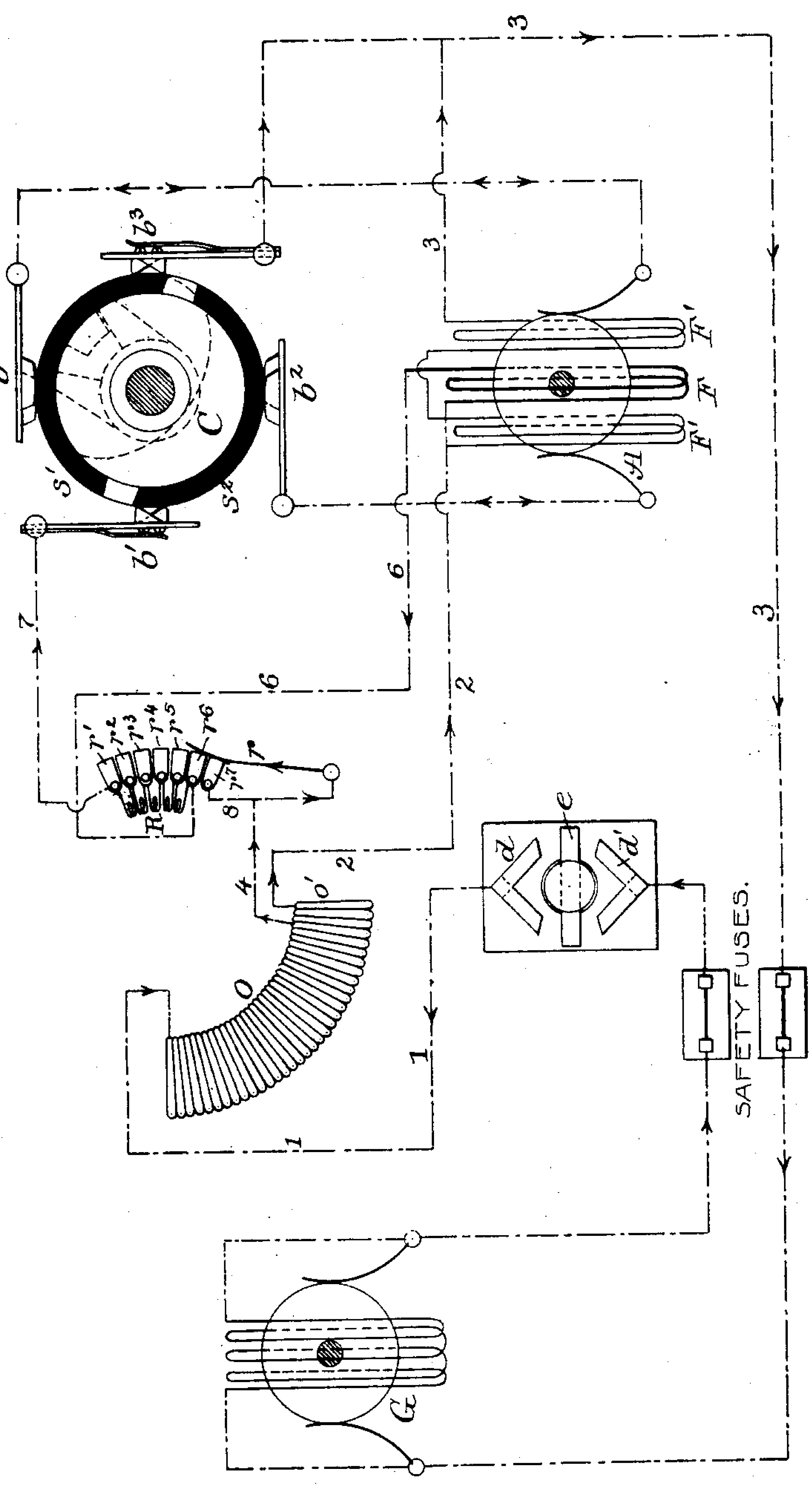
9 Sheets—Sheet 5.

Fig. 21.



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(No Model.) 9 Sheets—Sheet 6.

Fig. 22.

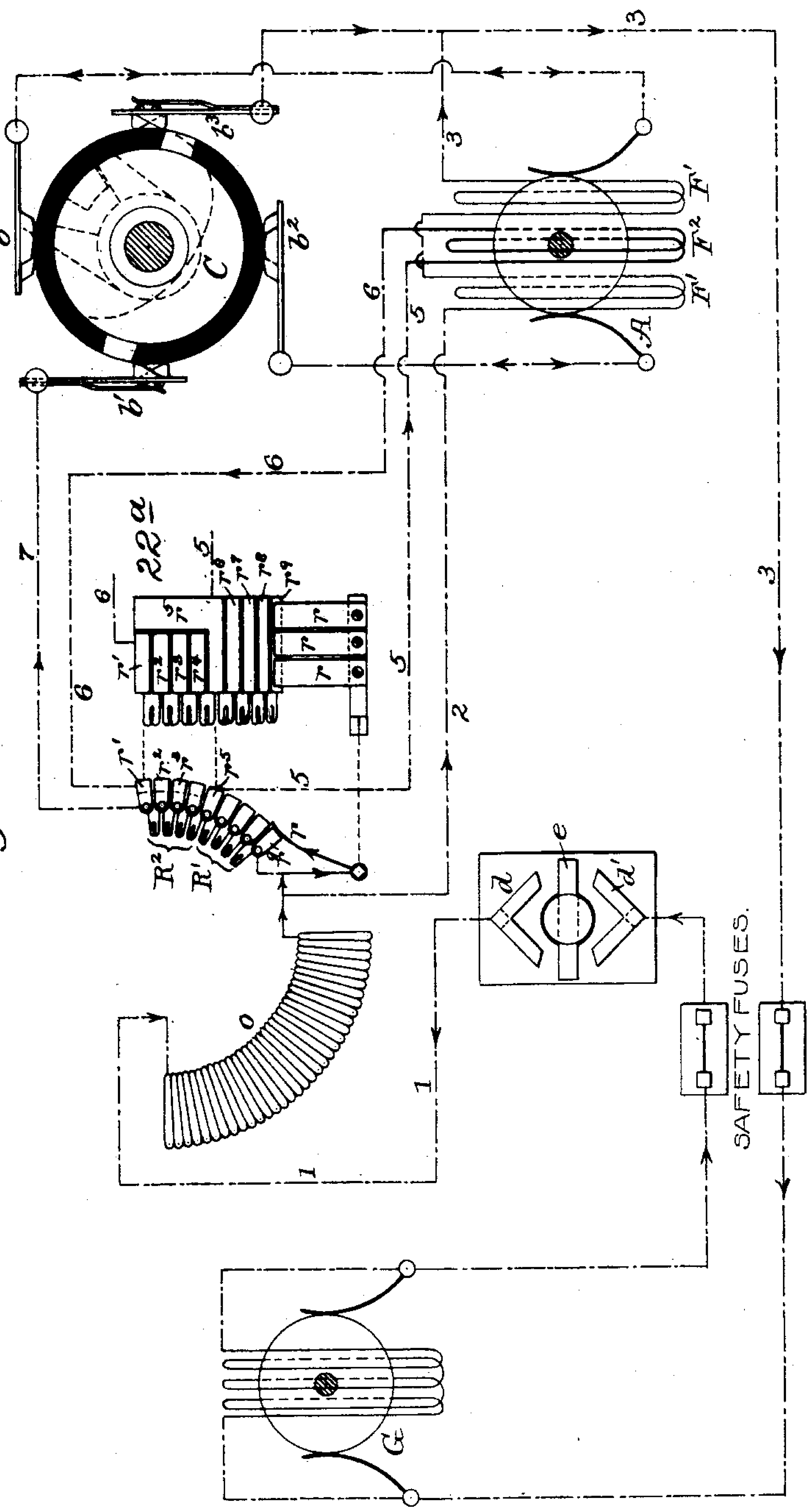

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Fig. 23.

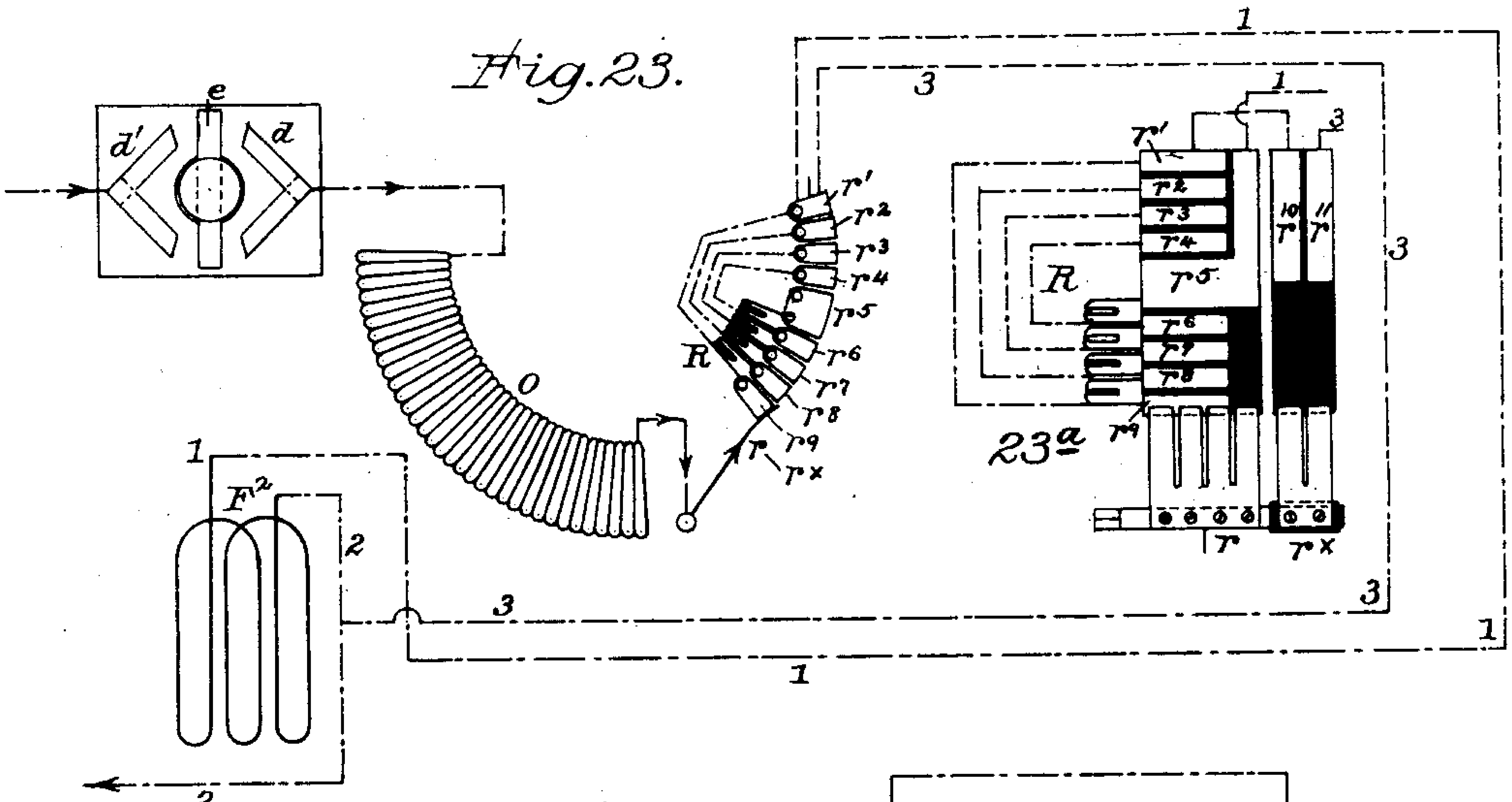
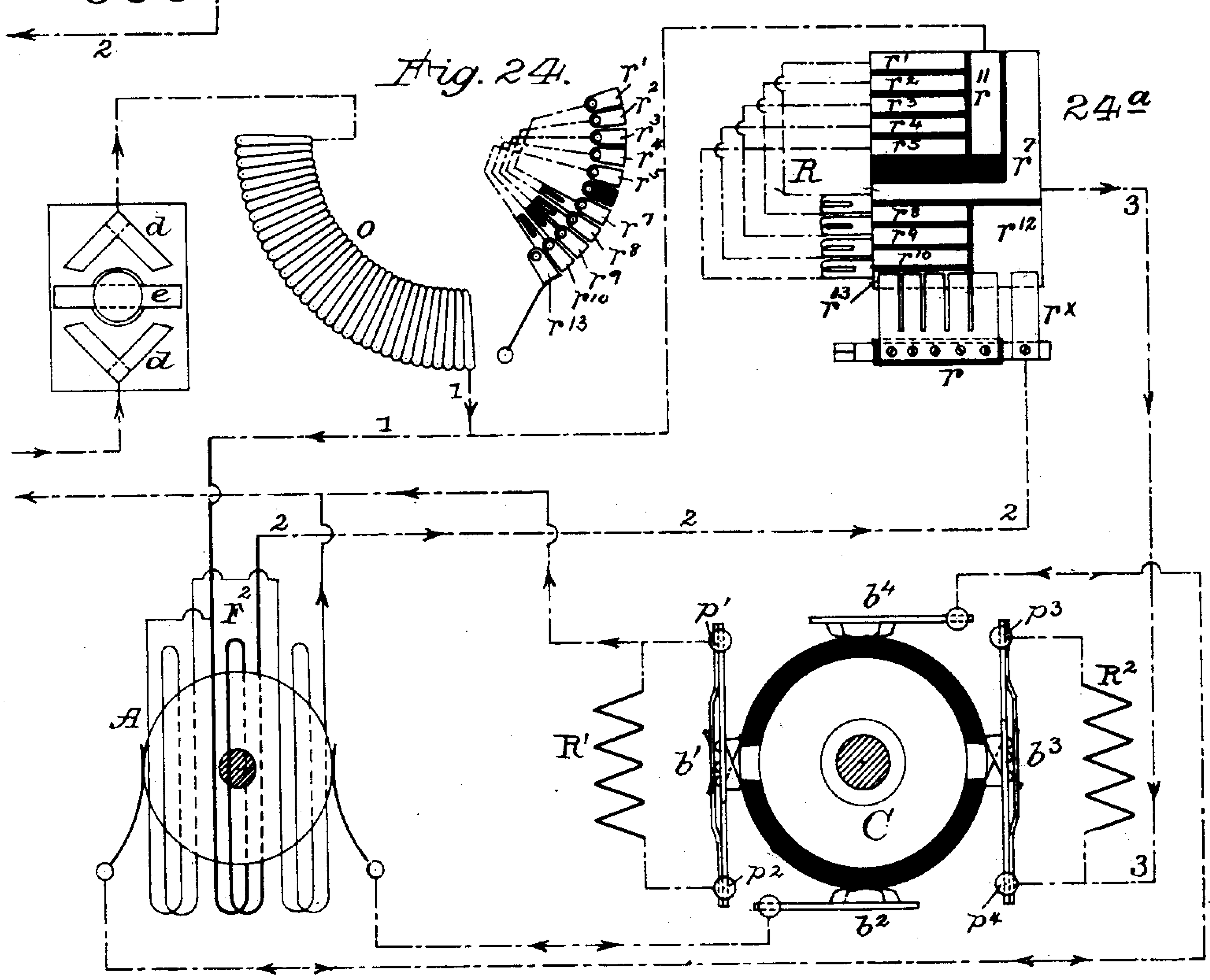


Fig. 24.



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No. 609,016. **Patented Aug. 16, 1898.**

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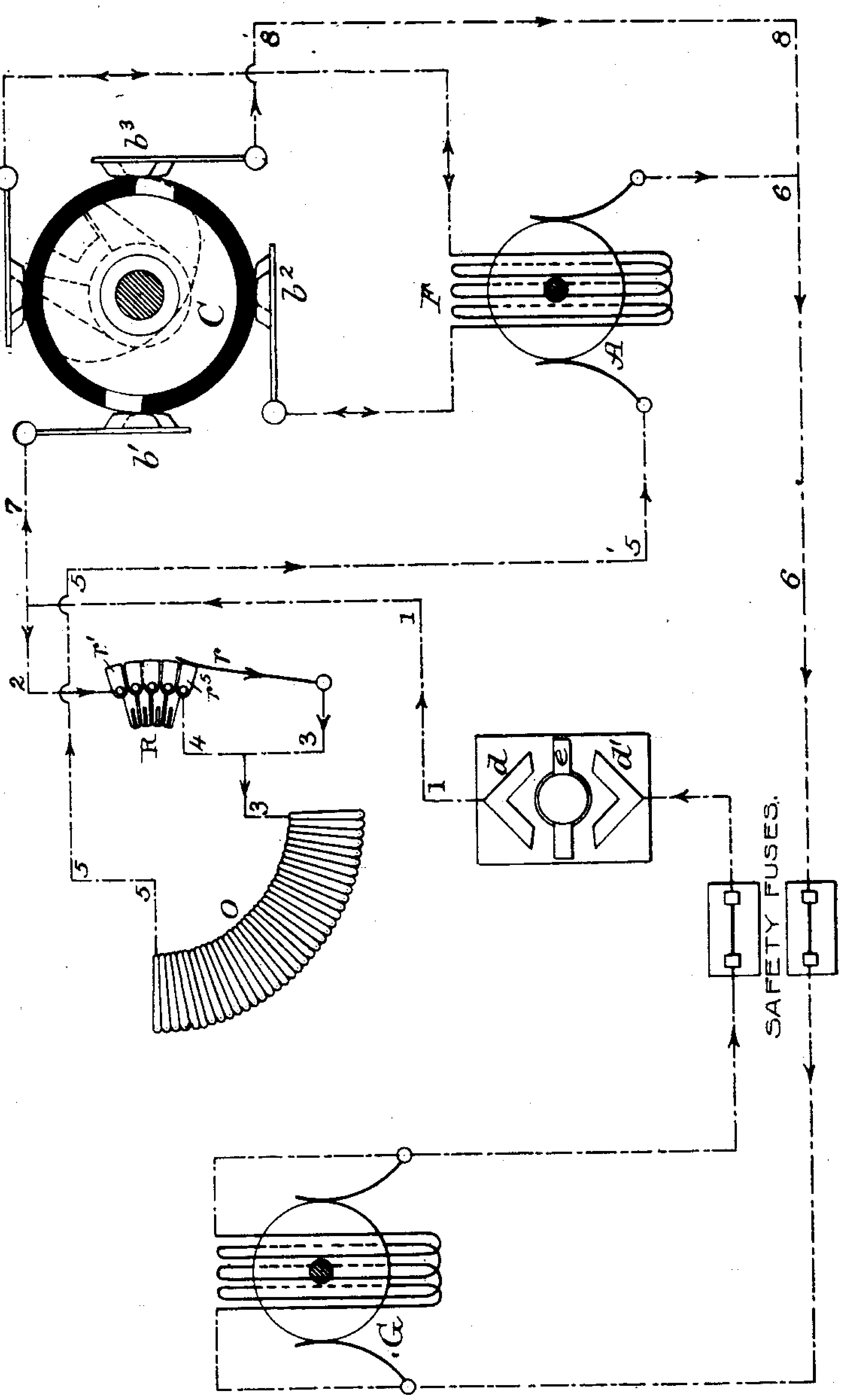
ELECTRIC ELEVATOR.

(Application filed May 3, 1892.)

(No Model.) 9 Sheets—Sheet 8.

Fig. 25.



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(No Model.)

9 Sheets—Sheet 9.

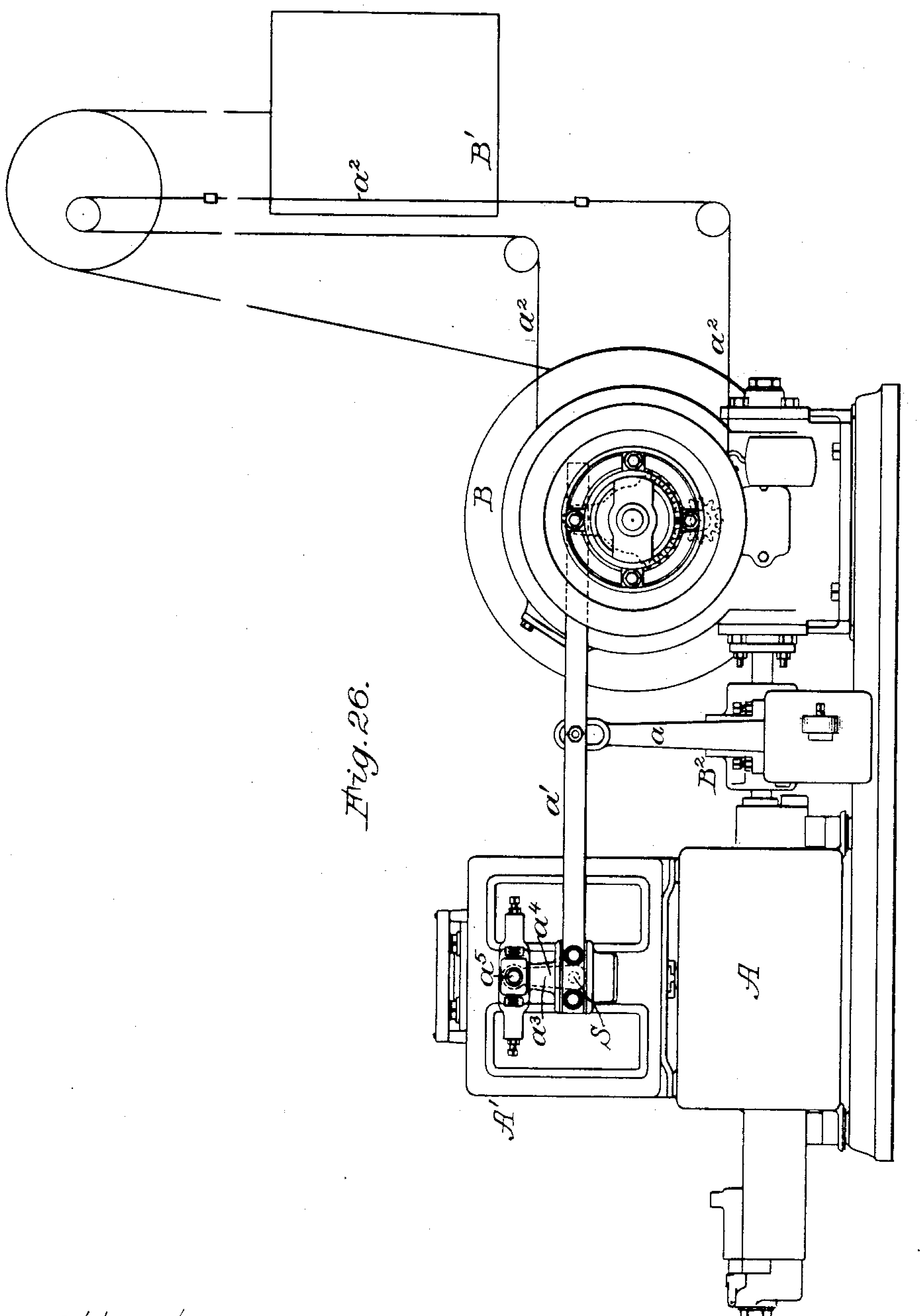

Fig. 26.

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UNITED STATES PATENT OFFICE.

RUDOLF EICKEMEYER, OF YONKERS, NEW YORK.

ELECTRIC ELEVATOR.

SPECIFICATION forming part of Letters Patent No. 609,016, dated August 16, 1898.

Application filed May 3, 1892. Serial No. 431,658. (No model.)

To all whom it may concern:

Be it known that I, RUDOLF EICKEMEYER, of Yonkers, in the county of Westchester and State of New York, have invented certain new and useful Improvements in Electric Elevators; and I do hereby declare that the following specification, taken in connection with the drawings furnished and forming a part of the same, is a clear, true, and complete description of the several features of my invention.

In a patent granted to me June 23, 1891, No. 454,462, I have disclosed certain improvements which enable the elevator-motor to be self-regulating as to speed and direction of motion. My present improvements relate to electric elevators of the same type. Some of the improvements are of value in elevators when a shunt-motor is used and others in elevator machinery when compound-wound motors are used. I maintain the current flow within safe limits, as in the former case, by automatically-operated resistance-coils, which are cut in and out of the circuit in such a manner as to maintain the strength of the current in the armature at such maximum as it can safely carry. I guard against damage from the disruptive discharge of the extra currents in the field-coils by so arranging the connections that the field-coils, though they may be disconnected from the line, are never broken, but at such times have their terminals connected by a shunt-circuit of comparatively low resistance, said shunt-circuit affording a path for the extra currents of practically no appreciable resistance in comparison with the resistance of the field-circuit. This safety-shunt may well be composed of the armature itself, and to attain this result I so arrange the connections that the armature is at all times in closed shunt-circuit with the field and both are connected and disconnected from the main line together, so when it is necessary to reverse the terminal connections of the armature to obtain a reverse motion of the motor it is done at a time when the motor is entirely disconnected from the main line.

Sheet 1, Figures 1, 2, and 3, show front view, longitudinal, and transverse sections of the regulator-box. Sheet 2, Figs. 4 to 12, show the armature-reversing mechanism on enlarged scale. Sheet 3, Figs. 13 to 19, show the automatic safety arrangement which limits the current. Sheets 4 to 8, inclusive, Figs. 20 to 25, show diagrams of the connections of the circuits of the motor and its controlling devices. Sheet 9, Fig. 26, illustrates in elevation so much of a complete elevator organization as is deemed necessary for the purposes of this specification.

In Fig. 26 the compound electric motor A, the hoisting-drum B and its gearing, and the elevator car or platform B′ are organized as in the well-known Otis elevators, the braking mechanism at B^2 being operated by means of a vertical vibrating lever a and the link or bar a', geared to a hand-wheel on the hoisting-drum shaft and controlled by the usual hand-line a^2, which engages with said wheel and is operatively accessible at the car, and is also adapted to be automatically operated by the car at both of its extreme limits of movement. The link or bar a' is also coupled with the regulator-box A′ for mechanically operating the same, because of its connection with the regulator-shaft S (shown in dotted lines) by means of a vertical arm a^3 on said shaft and a rigid vertical arm a^4, carried at the end of the link or bar a', said two arms being pivotally connected together, as at a^5, so that the longitudinal reciprocation of the link a', as by the hand-line a^2, will impart the limited rocking movement to the shaft S, which is required for mechanically operating the electric regulating and controlling devices within the regulator-box A′, and thereby starting, stopping, and reversing the motor A in exact harmony with appropiate variations in the operation of the braking mechanism.

On top of the resistance-box, beneath a detachable shield or guard, the appropriate screw-posts are located, and these are provided with suitable safety-fuses.

In Figs. 1 and 2, Sheet 1, the armature-controlling device or commutator C is shown to consist of a cylinder of insulating material c, loosely mounted on the regulator-shaft S and surrounded by four brushes b' b^2 b^3 b^4. These brushes rest upon the two copper segments s' s^2 on the commutator C, as shown in detail on Sheet 2 in Fig. 4 in front view and in longitudinal section in Fig. 5. These four sets of brushes b' b^2 b^3 b^4, with their brush-holder pins p' p^2 p^3 p^4, are mounted on insulated supports p^5. Two of the brushes b^2 and b^4 are connected with the armature-terminals, the other two, b' and b^3, with the main line, as will be explained more fully when describing the diagram of connections, Fig. 20, Sheet 4. One of said brushes b^2 is shown detached in Fig. 4^a, Sheet 2.

When by means of the regulator-shaft S the commutator C is turned to the right, the line-current passes from b^3 over segment s' through brush b^4 into the armature and from the armature through brush b^2 over segment s^2 and brush b' back into the line.

The brushes b' b^2 b^3 b^4 consist of two blades set one slightly in advance of the other, so that they make connection on one plate of the commutator-cylinder C before breaking away from the plate with which they were last in contact. This results in a momentary short-circuiting of the armature at the instant of a reversal of current direction through its coils. It is to be understood that at the time of this short-circuiting the brushes b' b^3 are already disconnected from the line by the cut-out switch e', as will hereinafter be described, while the extra current from the field-coil always finds a circuit either through the armature or through the closed contact on the commutator-cylinder C. Special provisions are made to avoid short-circuiting of the armature at every stoppage of the motor, to accomplish which the commutator C is mounted loosely upon the shaft S. On this shaft is mounted a double cam or fork c, Figs. 8 and 9, Sheet 2, which cams embrace the catch c^2, Figs. 6 and 7, rigidly connected to the commutator-cylinder C. The distance between this cam or fork and the width of the catch is such as to allow of considerable slack motion between the shaft S and commutator-cylinder C, so that in the operation of stopping the motor when the shaft S is carried back to the middle position or position of rest the commutator C does not follow exactly, but lags behind and does not arrive at the position where the short circuit of the armature is accomplished, but the armature is still left in circuit and in shunt relation to the field-winding's brush, said position being shown in Fig. 4 and in circuit, Figs. 20 and 21.

Now on starting the motor again in the same direction of rotation the shaft S makes a reverse rotation and the armature short circuit is avoided entirely. On the other hand, if the start is to be in the reverse direction the shaft S continues its revolution in the same direction as at first, and now the armature is momentarily short-circuited and then connected again with poles reversed to the first connection, after which a connection is established between brushes b^2 b^4 to the line. Therefore the relative positions between the cut-out and the commutator C have to be arranged so that the armature short circuit is taken off before the cut-out switch connects the motor with the line.

This connection between brushes b^2 and b^4 and the main line is established and broken by means of a quick-break cut-out switch, as at e d d', all as explained in my former patent application. The current after passing through a safety-fuse, as shown in Fig. 20, enters the block d', block d being connected to the motor-circuit. The connection between d' d is established by the arm e, which is mounted on the shaft e' with the toothed wheel f. (Shown in large size in Figs. 13 and 14 and in section in Fig. 17.) This toothed wheel f has but three teeth g' g^2 g^3, which are engaged by two pins h' h^2 on a lever i, which is fixedly carried on the main regulator-shaft S. This gear-wheel f has also a cam k, affording three cam-faces k' k^2 k^3, against which a jockey-wheel l at one end of a bell-crank lever m is forced by a spring n, as shown in Figs. 13 and 14, an edge view of this bell-crank lever m being shown in Fig. 16.

In a position of rest the jockey-wheel l rests in the notch k^2, and tooth g^2 stands between the pins h' and h^2 of lever i, as shown in Fig. 14. When starting the elevator, the regulator-shaft S is turned, and thereby the lever i is correspondingly swung, for instance, to the left. Then pin h^2 engages with the tooth g^2 and imparts motion to the gear-wheel f, thereby raising the jockey-wheel l out of the notch k^2 until it drops into notch k^3 and the bar i establishes connection between the plates d' and d. The lever i now being free continues its motion to one of its extreme positions, as shown in Fig. 13.

To stop the elevator and motor, the lever i is turned backward by means of shaft S, enabling pin h^2 to engage with tooth g^3, followed soon after by the pin h' engaging with tooth g^2. By this motion of the toothed wheel f the jockey-roller l is raised out of the cam-notch k^3 until it rests on the projection between the cam-notches k^3 and k^2. In this position the bar e still connects the plates d' and d, but at the next moment the spring n throws the jockey-wheel l into the cam-notch k^2 and forces the toothed wheel f, with a quick motion, to carry the arm e out of contact with the plates d and d', thus breaking the circuit and returning to the middle position of rest. (Shown in Fig. 14.) In the same way when the lever i is moved to the right hand the jockey-wheel l reaches the cam-notch k and the pin h' engages with the tooth g^2.

To guard against damage from abnormal currents, the safety device, which includes the solenoid o, with its iron core p^6, is employed. The main current traverses this solenoid o. The core p^6 is counterbalanced by the adjustable weight g^4, so that in the absence of current or the presence of only a normal amount of current the suction or inwardly-pulling power of the solenoid is insufficient to hold the core p^6 within it; but when an abnormal current traverses its coils the iron core is held, or, if then out, is quickly drawn within the solenoid. The core p^6 at its outer extremity carries a brush r, which bears on a number of insulated contact-plates r' r^2, &c., between which are connected resistance-coils, (shown as t in Fig. 3.) The main current enters through the top bar, and when the core p^6 is practically out of the solenoid passes directly through brush r and its contacts to the armature; but if the core p^6 is drawn into the solenoid the current first traverses the appropriate resistances before it arrives at the brush r. In this way an abnormal current automatically cuts in resistance and balances itself, so that if the motor is stalled or held at rest when under full current-pressure it can never receive an amount of current which will be damaging to its windings.

A cam is mounted on the regulator-shaft S, (marked u.) This cam is in this case integral with the lever i' and is provided with interior open spaces at both ends and a projection v in the middle, Figs. 13 and 14. Opposite to or in contact with this cam u there is a roller x, attached to a lever or arm y, which in turn is rigidly connected to the solenoid-core p^6 and its attached brush r. The operation of this arrangement is to mechanically throw the core p^6 into the solenoid o, when the apparatus is manipulated to stop the motor, and thus insure the presence of the resistance between the bars or plates r' in the circuit at the moment of starting, as shown in Fig. 14. Now on turning the shaft S for starting the motor the current traverses the resistance, which, being in circuit, keeps the first current rush always within the safety limit. The further turning of the shaft S brings the roller x opposite the appropriate open space w of the cam u, then leaving the solenoid-core p^6 free to adjust itself to the current strength in the circuit, the current at this time being strong enough to hold the core p^6 in the solenoid, and thus maintain all the resistance in circuit. As soon, however, as the motor gathers speed its counter electromotive force so decreases the strength of the main current that the solenoid is no longer able to hold the core p^6, which then gradually retires from the solenoid, progressively cutting out more and more of the resistance from the circuit by the movement of the brush r until when the motor reaches full speed it will be found that all the resistance has been removed from the circuit, as shown in Fig. 13, where all the resistance is cut out.

Series of coarse-wire field-coils may be connected between one or more of the bars r' r^2, &c., and be used as "starting-coils." These are cut out when the motor gathers headway, as has been already shown in the case of the resistances just above cited. When cutting out the series or starting field-coils, a part of the turns of the solenoid may be cut out simultaneously, so as to keep the magnetizing power of the solenoid unchanged in spite of the increase of current caused by the cutting out of the series coils.

Again, should the motor be overloaded or "stalled" any abnormal current in the solenoid will cause it to "suck" up the core p^6 and by inserting its attached resistance in the circuit prevent damage to the motor-windings.

To more completely illustrate the operation of the mechanism and its connections, Sheets 4 and 5, Figs. 20 and 21, are shown.

In Fig. 20 the current enters from line and generator G through a safety-fuse, through the cut-out switch e d d', over conductor 1. Thence a branch current passes through the motor-field F and back over conductors 2 and 3 and a second safety-fuse into the line. The main current passes over conductor or wire 4 to the top plate or bar r', thence through the resistances R until it reaches the brush r, or if the motor is running with normal speed and brush r rests on the top bar r' the current passes directly from wire 4, over bar r', through brush r, and thence over wire 5 to the solenoid o. A branch wire 6 connects the bottom bar r^5 with the solenoid, so that even if the brush r should be disabled the current will still have a path open through all the resistances R. From the solenoid o the current flows over wire 7 to the brush b' of the armature-reversing commutator C, over brushes b^2 or b^4, and through the armature the one or the other way, according to the position of the commutator C, and from the other brush b^3, wire 3, and safety-fuse back into the line.

In Fig. 21 a slightly-different arrangement is shown, the solenoid o being connected in series to the shunt-field, the motor A containing also a series or starting field-coil controlled by the solenoid o and brush r. Here the current enters over one safety-fuse and the cut-out e d d', over wire 1, through the solenoid o. Thence a branch current passes over the wire 2, through the shunt-field F' of the motor, and out and back over wire 3, through the second safety-fuse to the line and generator G, while the main current passes either over wire 2, also through the series field-coil F, back over wire 6, and through the resistances R to the top bar r', or if the brush r rests on one of the bars between r' and r^6 the current passes from o, over wire 4, leaving out a part o' of the solenoid, turns to brush r and to the bars between r^2 and r^6, and over resistances R to bar r', or in the event of the brush r resting on this bar r' then directly from r to r', and over wire 7 to the armature-reversing switch, a safety-wire 8 connecting, as before, with the bottom bar r^7.

It is exceedingly important that the armature-circuit should be reversed by a continuity-preserving device, so as to allow of no possible break at this point, as such break would be liable to cause great damage in the armature or other parts by reason of the currents of self-induction. To insure this continuity-preserving feature, each of the brushes b' and b^3 on the reversing-commutator switch C embodies two contact faces or brushes which are triangular in cross-section, one having a lead from its mate of somewhat more than the width of insulation between the plates of the commutator C, as best seen in Fig. 24, where the commutator is shown at the instant of reversal. Springs at the back of these brushes b' and b^3 serve to press them firmly against the commutator-plates.

In Fig. 24 and also in Figs. 20, 21, 22, 23, and 25 the copper conducting portions of the commutator C are shown in black.

Another arrangement of parts is shown in diagram Fig. 22, Sheet 6. In this arrangement the motor A is a compound-wound motor, having a shunt field-coil F' and a series field-coil F^2. The shunt field-coils are connected into the circuit in the same way as in Fig. 21 and left unaltered, while the series field F^2 is controlled by the solenoid o, which has in this case the double function of inserting resistance into the circuit and by resistance shunting more and more of the series coil from the circuit.

The solenoid-switch r r', &c., in Fig. 22 is shown in detail in a detached portion of the figure at 22^a in plane projection and also in an edge view, as in preceding figures. The middle bar r^5 is shown to be extended upward and connected with the wire 5, which is one terminal of the series coil, while the other series-coil terminal or wire 6 is connected to the top bar r'. Now the main current enters through the solenoid-brush r to the bottom bar r^9 (so long as the solenoid-core is drawn fully inward) and passes through the resistances R' to the middle bar r^5 and therefrom over wire 5 to series field-coil F^2 and thence over the wire 6 to the top bar r' and over wire 7 to the brush b' of the armature-reversing commutator C, while a small branch current passes from r^5 over resistances R^2 in shunt to the series field F^2 to top bar r', if there be between bars r^4 and r^5 a resistance connected in, as shown in Fig. 22. If this resistance between r^4 and r^5 is left out and r^4 and r^5 are insulated from each other, then the full armature-current passes through series field F^2. I prefer to connect r^4 and r^5 by a comparatively large resistance, so that the series field is always shunted by a resistance, which at the moment of breaking the circuit acts as a safety-shunt in taking off the extra current of the series field.

When the solenoid O begins to release its core, owing to decrease of current caused by a starting of the motor, the brush r cuts out successively the resistances R' until when brush r reaches bar r^5 the armature-current passes directly from the brush r over the wire 5, through the series field F^2, back over wire 6, and through wire 7 to commutator C.

If now the brush r continues its upward motion by passing over bars r^4 to r', it successively short-circuits the shunt-resistances R^2 of the series fields, and thereby shunts more and more current off the series field F^2 through the shunt-resistance R^2 until when the brush r bears on the top bar r' the series field F^2 is practically short-circuited. During this whole second part of this movement of the solenoid-brush r it maintains contact with bar r^5, which is extended upward, and thereby said brush maintains connection with the one terminal or wire 5 of the series field F^2, while the other terminal or wire 6 of the series field connects to the top bar r'. The other connections of this arrangement are the same as in Fig. 21.

The method of regulation shown in Figs. 23 and 24, Sheet 7, is essentially the same as that shown in Fig. 22, the main difference being that in Figs. 23 and 24 the resistances R, here used as a shunt for the series field F^2, were before used as starting resistances R'. The operation of these connections will be best explained by the plane development of the solenoid-switch r r', &c. (Shown in Figs. 23^a and 24^a.)

Insulated parts in Figs. 23 and 24 are represented in black. The solenoid-core carries two brushes r and $r^\times$, in the use of which the brush r carries the current into the solenoid-switch, while the other brush $r^\times$ is used merely as a short-circuiting brush and is insulated from the other brush and their holder-pins.

In Fig. 23 the armature-current passes through solenoid o to brush r and bar r^9, from these through resistances R to bar r^5, and from these over wire 1, through series field F^2, over wire 2 into the armature-switch commutator (not shown) until brush r' reaches bar r^5. Then when the brush r rests still on the lower part of r^5 the current passes from r over r^5 and wire 1 to the series field F^2 and over 2 to the armature.

As soon as brush r reaches the upper half of bar r^5 the short-circuiting brush $r^\times$ connects the two contact-plates r^{10} and r^{11}, thus providing a shunt-circuit for the field-coil F^2 through the resistance R, the top bars r' to r^4 being connected to the bottom bars r^9 to r^6, while bar r^{10} is connected to the bar r' and the bar r^{11} to the other terminal (or wire 3) of the field-coil F^2. By the further upward movement of the brushes the resistances R are gradually short-circuited again, and the current in the series field F^2 is decreased.

Should the motor be accidentally overloaded or stalled, the core will be promptly drawn into the solenoid, and this will first strengthen the series field and increase the torque of the motor until brush r, passing over r^5 to r^6, brings resistance R into the armature-circuit, and thus reduces the current down to a safe limit.

A slightly-different arrangement is shown in Fig. 24. Here the armature-current passes from the solenoid o over the wire 1 to the series field F^2, thence over the wire 2 to the brush $r^{\times}$, thence through the contact-plate r^{12} to the brush r and over bar r^{13} through the resistance R to bar r^7, and over the wire 3 to the brushes b^3 of the commutator C. When the solenoid-core is released, the resistances R are cut out first, and when the brush r rests on bar r^7 the current passes directly from r r^7 to the wire 3, and when the brush reaches the bar r^5, which is connected to r^{13}, brings in a short circuit through R for the series field F^2, which shunt is gradually short-circuited by the further upward movement of the brush r, the bars r' to r^5 being connected with the bars r^7 r^{13}. Fig. 24 shows another change on the armature-reversing commutator C, which I use for large motors, which sometimes run under a light load with great momentum, so that on a sudden reversal of the motor the armature short circuit is broken on C before the armature comes to a state of rest. A short-circuiting of the armature while revolving causes an intense current to circulate in its coils, which when broken by the double brushes b' and b^3 is on a further revolution of the commutator C apt to cause damage to these brushes. To guard against this, I do not short-circuit the armature completely at the moment of reversal, but, rather, close it through a suitable resistance R' and R^2. The two brushes of each set b' and b^3 are insulated from each other—as, for instance, by being mounted on separate pins p' p^2 and p^3 p^4. Connection between brush-pins p' and p^2 is made through a resistance R', while the pins p^3 and p^4 have a similar connection through resistance R^2.

It will be seen that in this case at the moment of short-circuiting during a reversal the short-circuiting is accomplished through the resistances R' and R^2 instead of being accomplished without the interposition of resistance, as in the first cases. This resistance materially diminishes the flow of current which is experienced when the armature is short-circuited during its revolution and prevents consequent damage to the brushes b' and b^3. At the completion of the reversal these resistances are short-circuited, both brushes resting on the same terminal plate on the commutator C.

Still another method of connections is shown in Fig. 25, Sheet 8. The motor A and its circuits are essentially the same as those shown in Fig. 20, Sheet 4; but in that figure the current in the shunt-field remains unchanged, while the armature-current is reversed for reversing the direction of rotation of the motor, whereas in Fig. 25 the current is constant in its direction through the armature and is controlled by the solenoid O and resistance R during the reversal of the current in the shunt-field of the motor by means of the commutator C. Now the line-current enters from the generator G via one safety-fuse and the cut-out e d d' over wires 1 and 2 to block r' and therefrom either directly or over the resistances R (according to the position of the solenoid-core) to the brush r over the wire 3, which is connected by 4 with contact-bar r^5 as a safety-shunt to the solenoid O, and then over wire 5 through the armature of the motor A and over wire 6 and via the other safety-fuse back into the line. From the wires 2 and 6 the wires 7 and 8 branch off to the brushes b' and b^3, bearing on the reversing-commutator C, from which the current enters the field-coil F via brushes b^2 and b^4 in one or the other direction, determined by the position of the switch C.

Having thus described my invention, I claim—

1. In elevator machinery, the combination with the traveling car-body or platform, of a compound motor, a resistance in shunt relation to the series coil of said motor, and a solenoid automatically controlling the magnetizing power of said series field-coil by gradually short-circuiting said resistance.

2. In elevator machinery, the combination with the platform or car, of a compound motor, a resistance in the armature-circuit, a solenoid automatically controlling the armature-circuit and the magnetizing power of the series field by first gradually cutting out the resistance in the armature-circuit, then shunting the series field by this same resistance, then gradually short-circuiting said resistance.

3. In elevating mechanism the combination with the moving car or platform, of an electric motor, a reversing-switch connected substantially as described, for reversing the appropriate current in the motor, and so short-circuiting that current that the short circuit is operative during such reversal, and inoperative during the operation of stopping the motor.

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