No. 714,382. Patented Nov. 25, 1902.

C. W. KRAGH.

REGULATING DEVICE FOR DYNAMO ELECTRIC MACHINES.

(Application filed Sept. 9, 1899.)

(No Model.)

5 Sheets—Sheet 1.

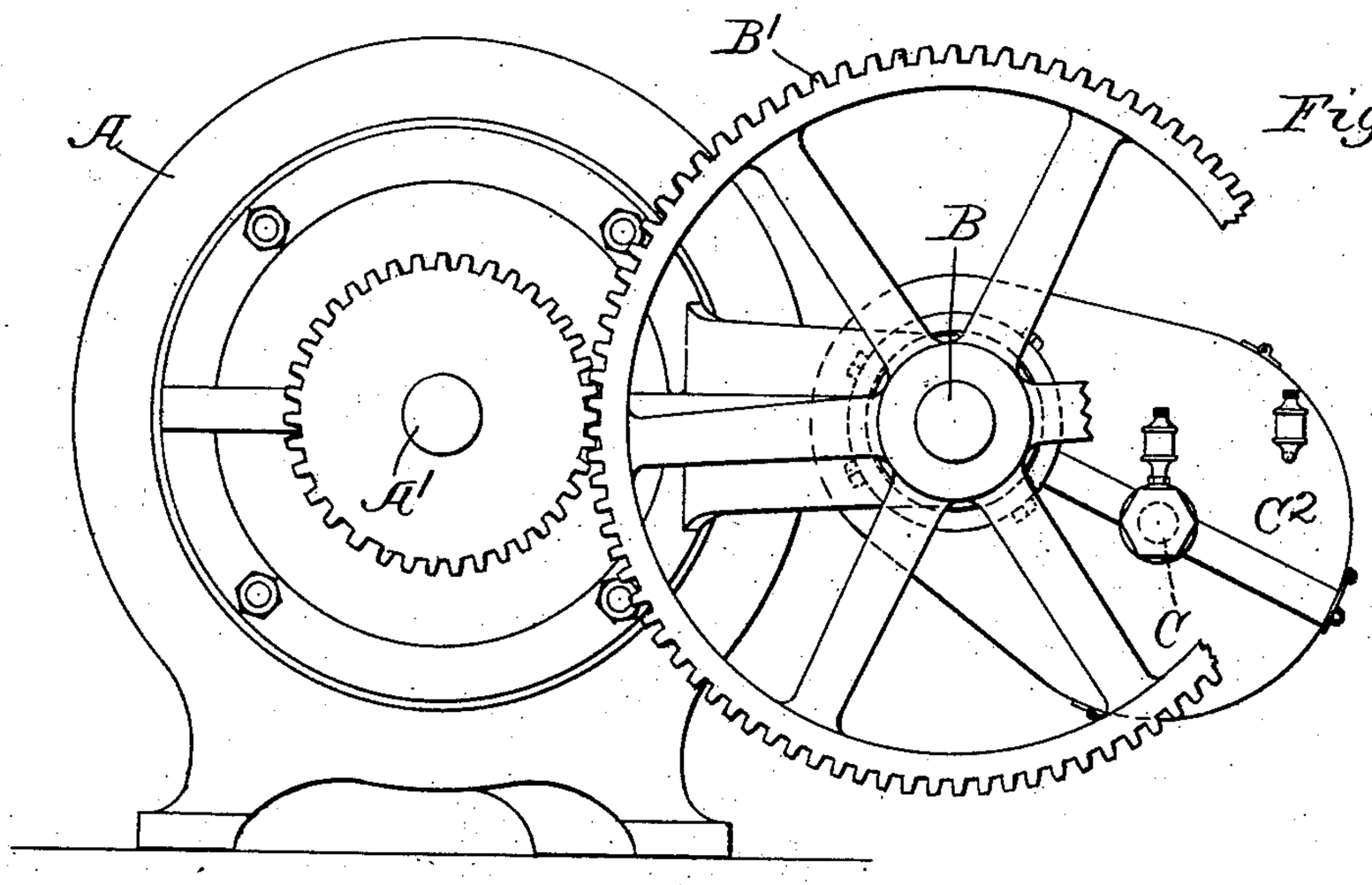

Fig. 1.

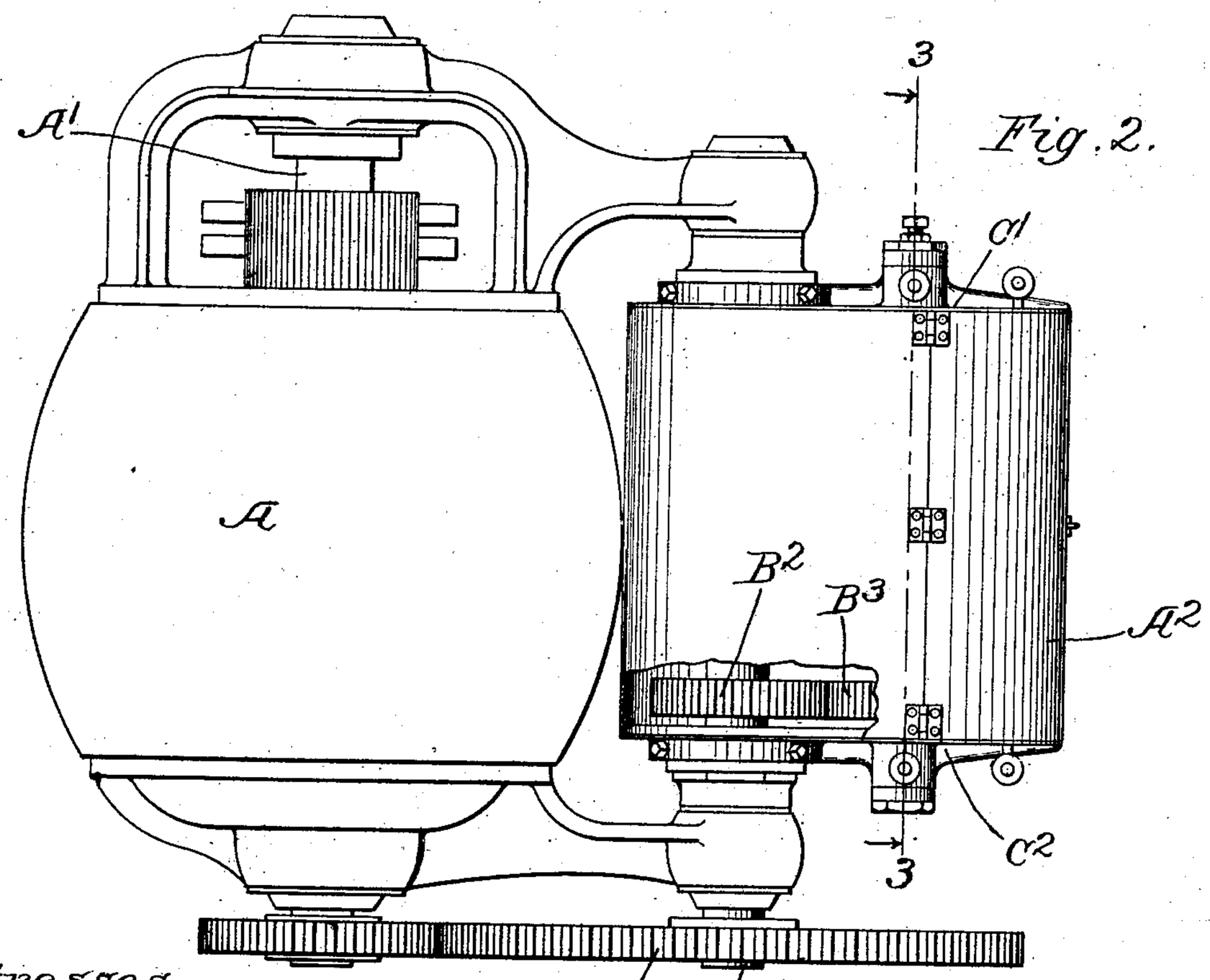

Fig. 2.

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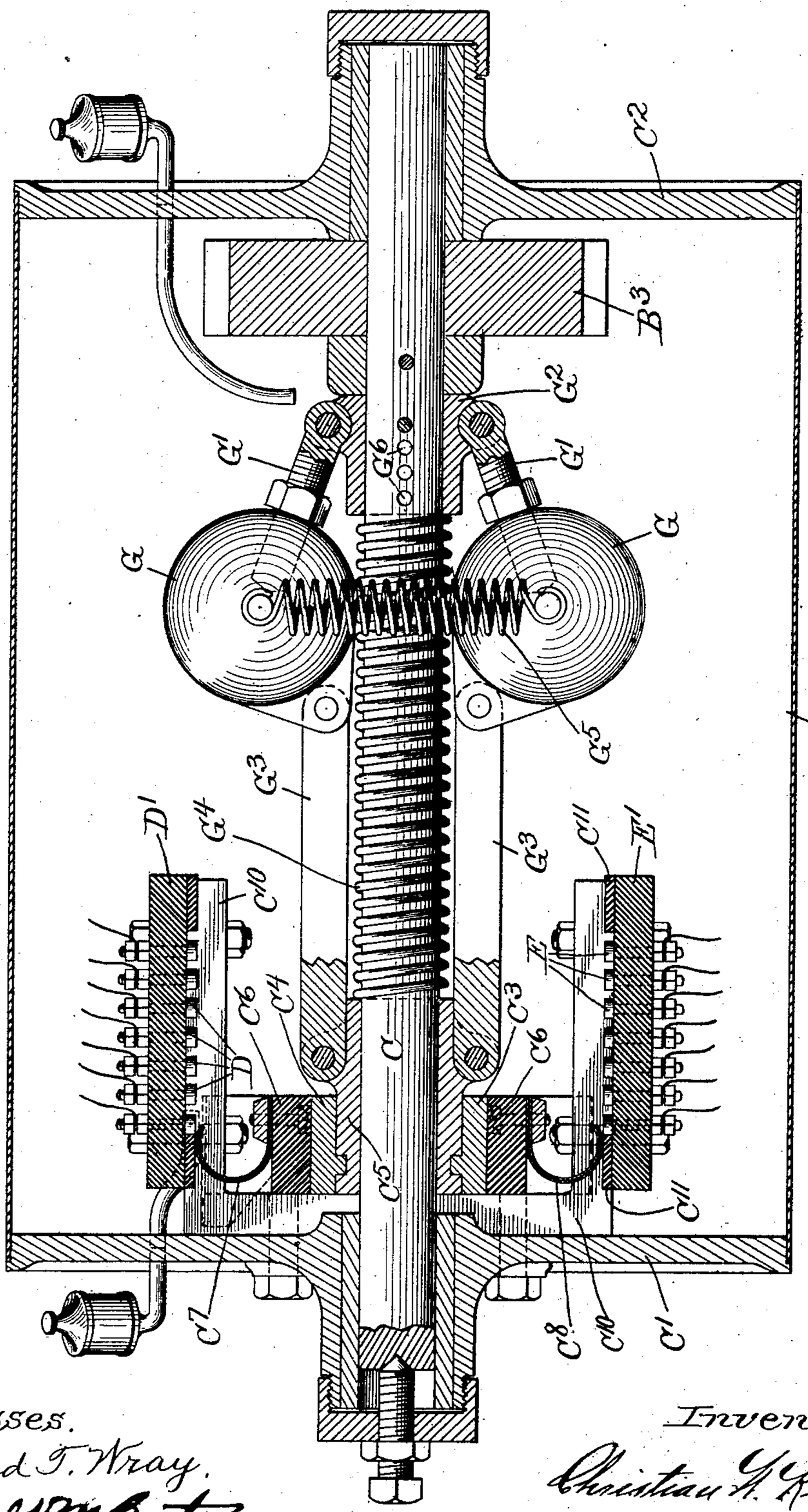
(No Model.) 5 Sheets—Sheet 2.

Fig. 3.



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(No Modol.) 5 Sheets—Sheet 3.

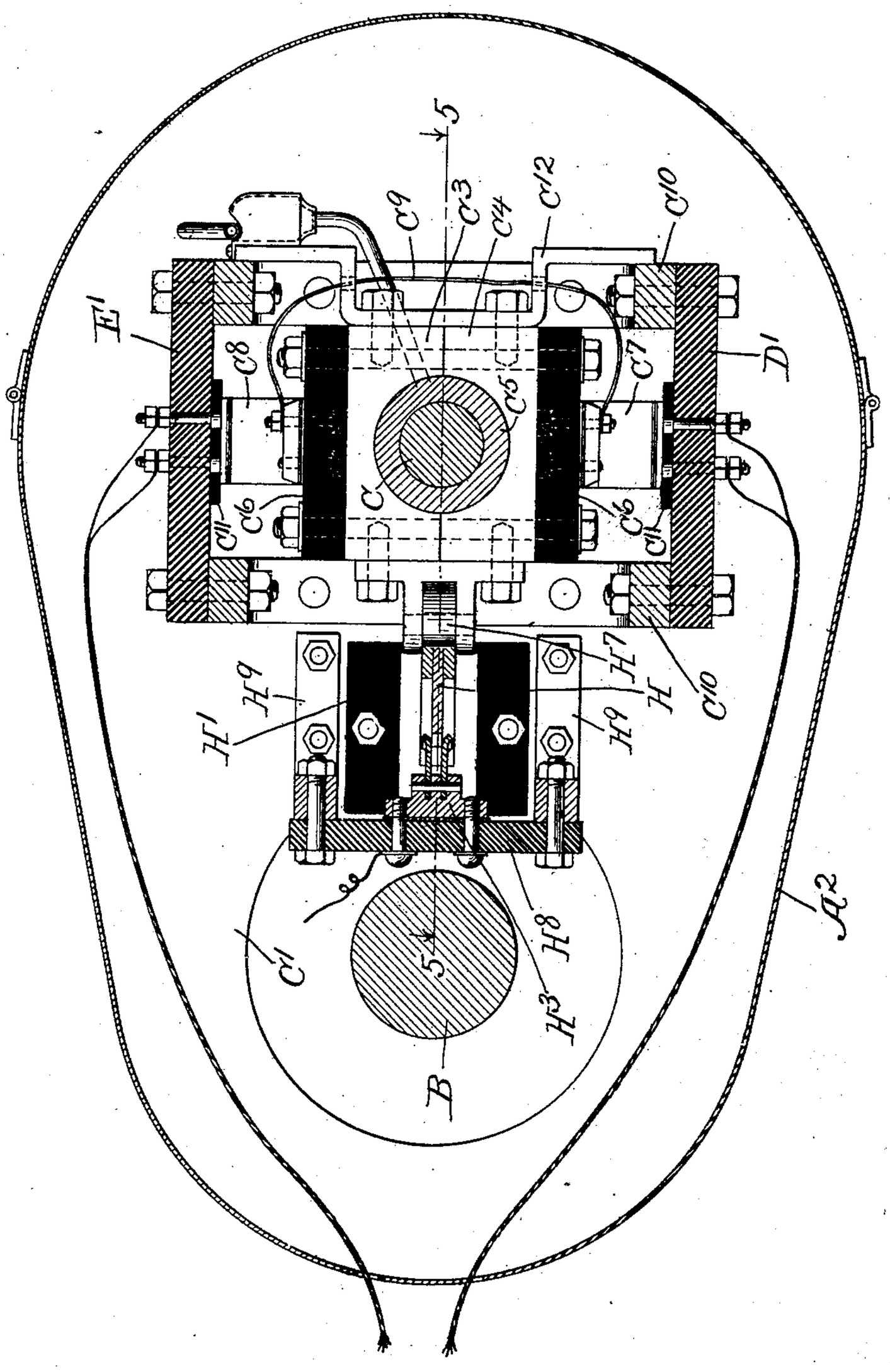

Fig. 4.

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(No Model.) 5 Sheets—Sheet 4.

Fig. 5.

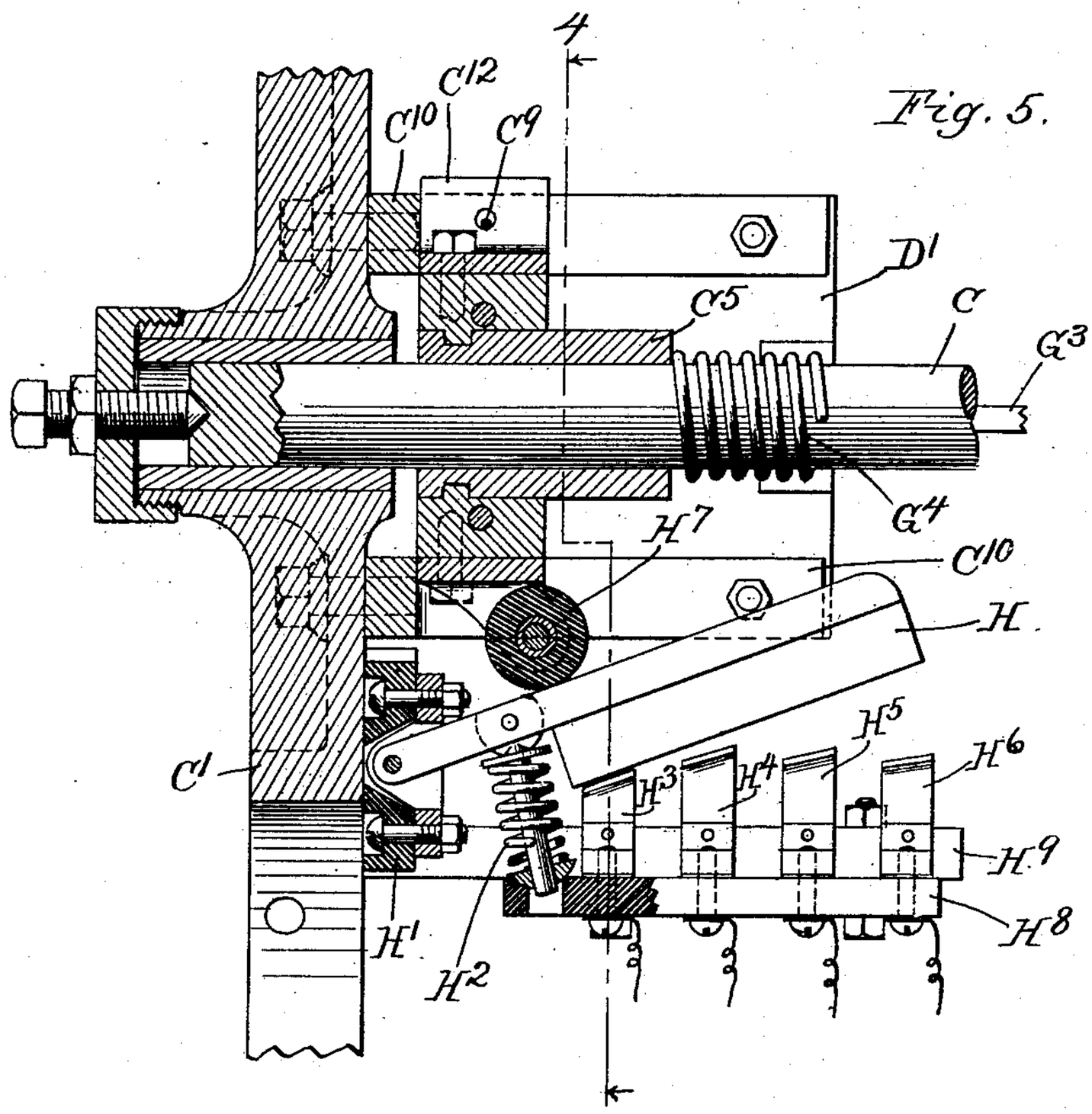
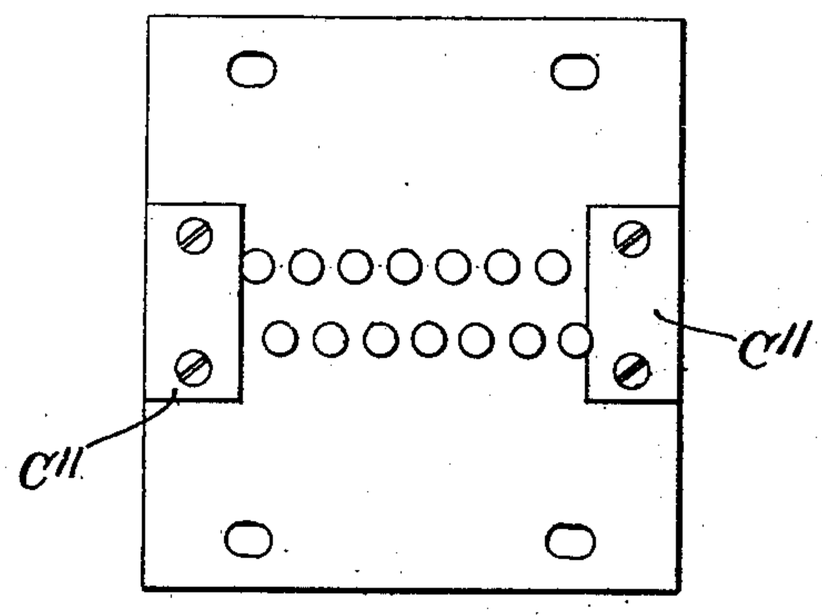


Fig. 6.



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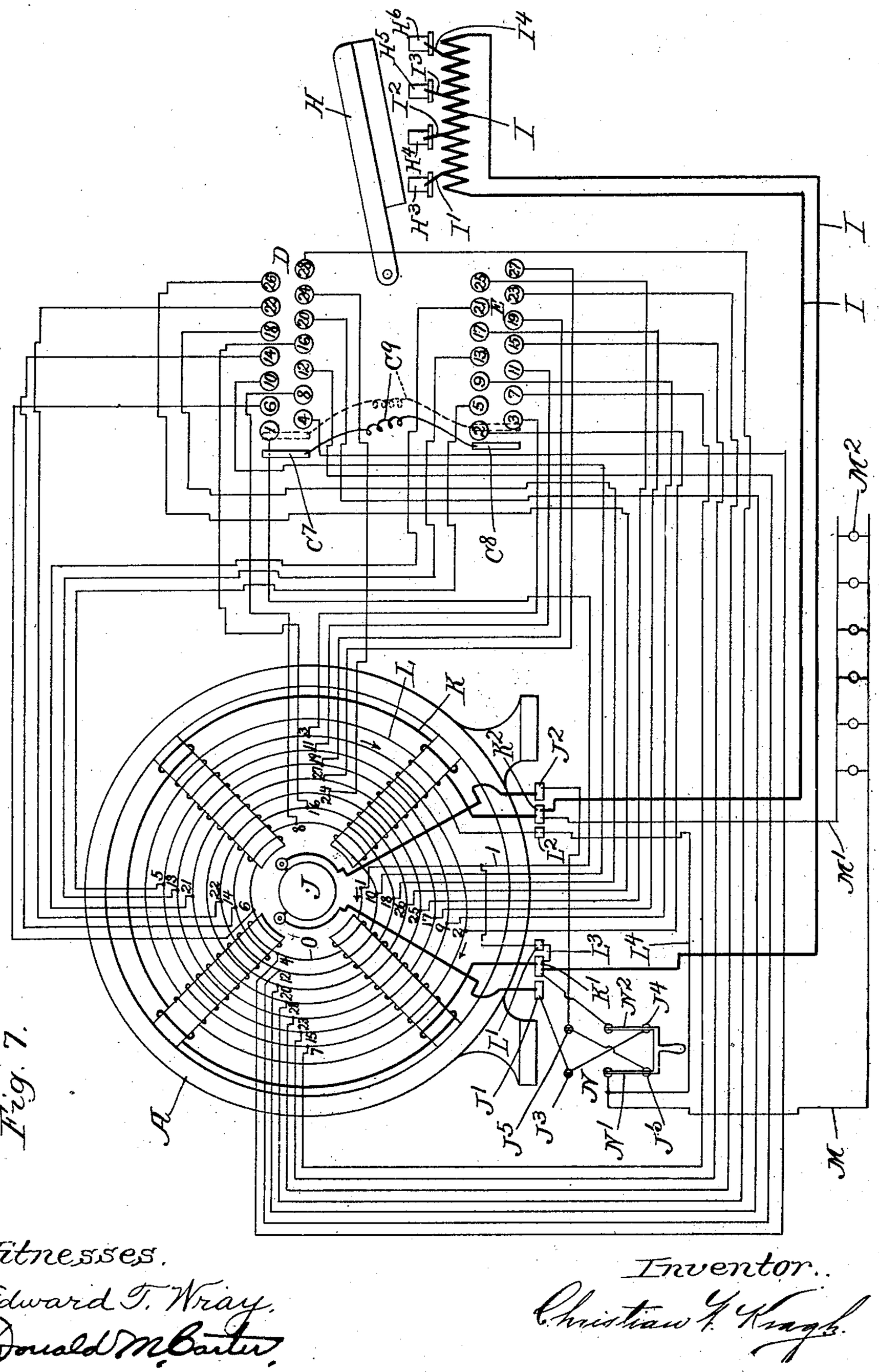

Fig. 7.

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UNITED STATES PATENT OFFICE.

CHRISTIAN W. KRAGH, OF MADISON, WISCONSIN, ASSIGNOR TO THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, OF MADISON, WISCONSIN, A CORPORATION OF WISCONSIN.

REGULATING DEVICE FOR DYNAMO-ELECTRIC MACHINES.

SPECIFICATION forming part of Letters Patent No. 714,382, dated November 25, 1902.

Application filed September 9, 1899. Serial No. 729,904. (No model.)

To all whom it may concern:

Be it known that I, CHRISTIAN W. KRAGH, a citizen of the United States, residing at Madison, in the county of Dane and State of Wisconsin, have invented a certain new and useful Improvement in Regulating Devices for Dynamo-Electric Machines, of which the following is a specification.

My invention relates to regulating devices for dynamo-electric machines, and has for its object to provide a new and improved device for this purpose.

My invention is illustrated in the accompanying drawings, wherein—

Figure 1 is a view showing one form of my regulating device in position upon a dynamo-electric machine. Fig. 2 is a plan view of the construction shown in Fig. 1. Fig. 3 is an enlarged sectional view on line 3 3, Fig. 2. Fig. 4 is an enlarged sectional view on line 4 4, Fig. 5. Fig. 5 is a section on line 5 5, Fig. 4. Fig. 6 is an enlarged detail view of one of the contact-plates used in the controlling device. Fig. 7 is a diagrammatic view showing the various electrical connections.

Like letters refer to like parts throughout the several figures.

My invention is adapted to be used in connection with dynamo-electric machines of any description used as generators.

I have illustrated my invention as used in connection with a given generator, and when so applied my invention is particularly adapted to automatically regulate the machine, so as to permit it to be driven at varying speeds without materially affecting its proper operation. As a common instance illustrating the effect of a varying speed upon dynamo-electric machines, reference may be had to the ordinary "constant-potential" machine, which operates in connection with a system of translating devices requiring a current having a constant electromotive force. It will be seen that such a machine cannot be properly driven at varying speeds, for the reason that, other conditions being equal, the electromotive force varies with the speed. When such a machine is used, for example, for lighting railway-trains, and is driven from the axle or some other part, so that the speed varies as the speed of the train, the variation in the electromotive force due to the variation in speed prevents the successful operation of the machine. This is also the case, for example, when such a machine is driven by means of a windmill, water-wheel, or the like.

I have suggested the foregoing examples for the purpose of more clearly presenting my invention; but it is of course evident that various other evils, which will readily occur to those versed in the art, may be remedied by means of my invention.

Referring now to the drawings, wherein I have shown my regulating device in connection with a dynamo-electric machine for generating currents with a constant electromotive force, I have illustrated a compound dynamo-electric machine having a series and a shunt winding. In addition to the series and shunt windings I provide a divided or variable resistance in series with the shunt-coil and adapted to be automatically controlled as the speed varies, so as to keep the electromotive force substantially constant. I prefer to arrange this resistance as illustrated in the drawings, wherein it is applied to the field-magnets and wound in a counter or opposite direction to the main shunt-winding—that is, so that the current in said coil travels in one direction around the field-magnet, while the current in the main shunt-winding travels in the opposite direction, so as to produce a double or compound resisting effect—namely, the resistance due to the conductor itself and the resistance due to the magnetic opposition to the main shunt-winding. This resistance, which in this construction may be termed the "counter-shunt" coils, is divided into sections and connected with a series of contacts, so that the number of coils or the amount of resistance produced may be varied by connecting different contacts together. These contacts are connected by means of brushes or contacts operated by an automatic device controlled by the speed of the machine. It is of course evident that various constructions for this purpose may be used, and I have illustrated

a construction of simple form in order to make my invention clear.

Referring now to Figs. 1 and 2, I have shown the dynamo-electric machine A, having its armature-shaft A′ operatively connected with the shaft C, associated with the regulating device. It is of course evident that this connection may be made in any way that permits the speed of the shaft C to vary in proportion to the speed of the armature-shaft. The shaft C may consist simply of the armature-shaft A′ prolonged. In cases where such a construction is not desirable said shaft C may be located in some different position. In Fig. 1 I have shown this connection as being made by an intermediate shaft B, which is connected by the gear B′ with the armature-shaft and by the gears B^2 B^3 with the shaft C. This shaft C is mounted in suitable bearings in the plates C′ C^2 and carries a contact device C^3, adapted to move therealong. This contact device may be constructed in any desired manner, and, as shown, consists of a split block C^4, connected with a sliding collar C^5 on the shaft, the connection being such that the collar may be rotated within the block, but moves the block with it when moved along the shaft. This result may be obtained by providing the collar with an annular groove, as shown, the block being provided with projections which extend into this groove. Attached to this block and insulated therefrom by the insulating-pieces C^6 are contact-brushes or the like, C^7 C^8. These brushes are electrically connected together by means of some suitable conductor—as, for example, the insulating-conductor C^9. (Shown in Fig. 4.) Associated with this contact device are a series of insulated contacts D E, which are suitably connected in circuit with the divided resistance, the parts arranged so that the resistance may be varied by moving the contact device along said contacts, so that the brushes C^7 and C^8 engage them. These contacts—as shown, for example, in Figs. 3 and 4—are mounted upon the insulating pieces or plates D′ E′. It is of course evident that any desired number of contacts may be used and that they may be arranged in any suitable manner, such details depending upon the conditions to be met. In the present instance I have shown twenty-eight of these contacts. The contact-plates are held in proper relation to the contact device in any suitable manner. As herein illustrated, said contact-plates are mounted upon the brackets C^{10} C^{10}, which are rigidly fastened to the end plate C′. When the contacts are raised above the surface of the plates, as shown, I prefer to provide at each end of the series of contacts the insulating-plates C^{11}, which are substantially on a level with the engaging faces of the contacts. Attached to the block C^4 is a suitable guide-piece C^{12}, which normally slides along the upper bracket C^{10}, as shown in Fig. 4, and which prevents the contact device from rotating with the shaft. Some suitable device is associated with the sliding collar C^5, by means of which it is automatically moved along the shaft in response to variations in the speed of the armature of the dynamo-electric machine. Any desired construction for this purpose may be used, and, as herein shown, I have provided a centrifugal governor comprising the two balls G adjustably connected to the arms G′, which are pivoted to the collar G^2, attached to the shaft C, so as to rotate therewith. Said balls are also connected, by means of the pivoted arms G^3, with the sliding collar C^5, to which the contact device is connected. A suitable resisting device—such, for example, as the spring G^4—is associated with the parts so as to resist the movement of the sliding collar. A suitable spring or springs G^5 may be connected with the balls G, so as to aid the spring G^4. It will be seen that by this construction the parts may be arranged so that when the speed increases above a predetermined amount the governor-balls will fly out and move the contact device forward, so as to connect certain of the contacts D and E, the distance which the contact device is moved depending, of course, upon the speed of the shaft C. If the speed decreases, the springs will tend to move the contact device back to its initial position. I prefer to have the collar G^2 adjustably connected with the shaft C in order that the device may be adjusted for different variations in speed. This result may be obtained in any desired manner—as, for example, by providing a series of holes G^6 for the fastening-pin which connects the sleeve to the shaft. When my invention is used in connection with a compound-wound machine, I prefer to provide a means for controlling the series field-winding so as to regulate its effect to correspond with the change of speed. Any suitable means for this purpose may be used. As shown in the drawings, I provide a mechanism for varying the effect of the series winding of the field-coil, said mechanism being operated through the same means as the contact device for the shunt-circuit. This mechanism consists of a pivoted arm H, connected to the plate C′, preferably by means of the insulating-piece H′ and provided with a suitable retracting-spring H^2. Opposed to this arm are a series of contacts H^3 H^4, &c., the number depending upon the conditions to be met. The arm H is so arranged with relation to said contacts that it may be successively brought into contact with them. One arrangement to produce this result is shown in Figs. 4 and 5. In this construction the contact device C^3 carries an insulating-roller H^7. The arm H is arranged so as to be in the path of this roller and is in an inclined position, so that as the roller is moved forward the arm is moved gradually downwardly and successively engages the opposed contacts. In order to insure proper contact between the parts, I provide the arm H with a

knife-edge, which is received between the two spring parts of the contacts. The contacts H^3 H^4, &c., are mounted upon an insulating-strip H^8, which is attached to the plate C′ by means of the brackets H^9. As shown in the drawings, the series winding is provided with a resistance-shunt I, connected across its terminals, and the winding and shunt are so arranged that the series winding develops the proper strength for a minimum speed of the machine when all the shunt resistance is in circuit. This shunt resistance is divided up into sections—as shown, for example, in Fig. 7—and these sections are connected to the contacts H^3 H^4 H^5, &c., by means of the conductors I′ I^2, &c. It will thus be seen that as the arm H is moved downwardly, so as to successively engage the opposed contacts, portions of this shunt resistance are successively cut out of circuit, thus permitting more current to flow across the shunt and less to flow through the series winding. The series winding will thus be correspondingly reduced in strength. The regulating mechanism associated with the shaft C may be inclosed in a suitable case A^2.

I have illustrated in Fig. 7 in a diagrammatic manner the various circuits when the parts are connected in operative relation to each other. In this view I have shown the contacts D and E flattened out, so as to be in the same plane in order to show them upon one sheet and have omitted the mechanism for moving the contact device. I have also omitted all the other mechanism which would tend to complicate this figure. As illustrated, the circuit leading from the armature J is connected with the binding-posts J′ J^2. The series coil K has its terminals connected to the binding-posts K′ and K^2, while the main shunt-winding L has its terminals connected to the binding-posts L′ L^2, the connection to the terminal L′ being made through the conductor 1, connected with the first of the contacts D. The shunt resistance I is connected across the terminals K′ K^2, as shown. The main shunt-winding is connected with the series circuit by the conductor L^3, which connects the binding-posts L′ and K′, and the conductor L^4, which connects the binding-post L^2 with the main-line conductor M. The other conductor M′ of the main line is connected to the terminal K^2, the translating devices M^2 being connected with the two main conductors. I have illustrated the circuits in this figure so that the current may be reversed, and have shown for this purpose a reversing-switch N. This switch may be of the usual construction, having the two pivoted contact-arms N′ N^2, one of which is connected with the main-line conductor M, while the other is connected with the binding-post K′. The binding-post J′ is connected to the binding-posts J^3 and J^4 of the switch, while the binding-post J^2 is connected with the binding-posts J^5 and J^6 of the switch. The controlling resistance in the shunt-circuit, which in the present instance constitutes the counter shunt-coil O, is wound upon the field-magnets, so as to act in opposition to the main shunt-winding. The contacts D and E are connected to the counter shunt-coil at different points, so that parts of this coil may be successively cut out of circuit by moving the brushes C^7 and C^8 along said contacts. In order to facilitate the tracing of the circuits, I have indicated the conductors which lead from said contacts to the counter shunt-coil by the figures from 1 to 28, inclusive, there being twenty-eight contacts, and I have placed these figures on the drawings at both ends of these conductors—namely, at the ends where they connect with the counter shunt-coil and at the ends where they connect with the contacts D and E.

I have shown in detail a construction embodying my invention and have illustrated such construction in a partly-diagrammatic manner to make its application clear; but it is of course evident that the parts may be greatly varied in form, construction, and arrangement and that some of the parts may be omitted and others used with parts not herein shown without in any manner departing from the spirit of my invention. These various constructions and the various applications of my invention will readily occur to those versed in the art, and I have therefore not considered it necessary to set them out in further detail.

The use and operation of my invention are as follows: When the dynamo-electric machine is used as a generator, it is connected with the driven device, which runs at a variable speed, in any suitable manner, so that the armature is rotated. Since the shaft C is connected with the armature-shaft of the machine, said shaft will in turn be rotated at a speed which varies as the speed of the armature-shaft. The regulating mechanism is preferably so adjusted and arranged as to remain substantially inoperative until the speed of the armature-shaft approximates the minimum speed at which the dynamo-electric machine is to operate. Up to this point I prefer to have all the counter shunt-coils in circuit. When the speed of the armature-shaft reaches the minimum speed at which the machine is to operate, the regulating device acts to move the contact device C^3 so that the brushes C^7 and C^8 connect the first of the contacts D with the first of the contacts E. When the parts are in this position, I prefer to have all of the counter shunt-coils short-circuited, so as to be out of circuit. If now the speed of the armature-shaft rises, the brushes C^7 and C^8 are drawn farther along the contacts, each movement cutting in a portion of the counter shunt-coil, so as to throw resistance in the shunt field-circuit. This added resistance counteracts the effect of the increasing speed by decreasing the strength or effect of the shunt field-circuit. As the contact device is moved forward by the increase in

speed the arm H is moved down, so as to cut out a portion of the resistance across the terminals of the series winding, thus decreasing the strength of said winding. It is of course evident that the parts may be so adjusted as to keep the strength of the series and shunt windings in proper relation to each other. It is further evident that the several circuits may be so arranged as to produce, for example, a constant electromotive force, and yet permit a great variation in speed.

Referring now to Fig. 7, I have shown the brushes C^7 and C^8 in full lines in the position which they occupy when the machine is at rest or before the armature has attained the minimum speed at which the machine is to operate. Under these conditions, as before stated, all of the counter shunt-coils are in circuit with the main shunt, and the circuits will be traced as follows: from the armature J to binding-post J′, thence to switch N and binding-post K′. The circuit here divides, a portion passing around the series winding K from binding-post K′ to binding-post K^2. Another portion of the current passes through the resistance-shunt I across the terminals K′ and K^2. These two portions then unite and pass out on the main conductor M′, thence through the translating devices M^2, thence through main conductor M to switch N, and thence to binding-post J^5 and back to the armature J. Another portion of the current passes from the binding-post K′ by conductor L^3 to binding-post L′ and thence by way of conductor 1 to the inner end of the counter shunt-coil, thence through all of said coils and through the main shunt-winding to binding-post L^2, and thence by conductor L^4 back to the main circuit. When the speed reaches the minimum speed at which the machine is to operate, the governor-balls fly out, so as to move the brushes C^7 and C^8 until they connect the first contacts of the series D and E, as shown in the first dotted position in Fig. 7. All of the counter shunt-coils are now cut out of circuit. The main circuit will be traced as hereinbefore set out. The shunt field-circuit will be traced as follows: from binding-post K′ to binding-post L′, thence to conductor 1, thence to brush C^7, thence to brush C^8, thence by conductor 2 to the main shunt-winding at the point where said conductor connects therewith, and thence in the direction of the arrow around the main shunt-winding L to the binding-post L^2, and thence by conductor L^4 to the main circuit. If now the speed increases sufficiently to move the brushes C^7 and C^8 in contact with the contacts connected with conductors 4 and 5, a portion of the counter shunt-coils will be cut in circuit with the main shunt-winding. The field shunt-circuit will then be traced as follows: from binding-post K′ to binding-post L′, thence through conductor 1 to the point where it connects with the counter shunt-coil O, thence through a portion of the counter shunt-coil in the direction of the arrow to the point where the conductor 4 is connected therewith, thence through conductor 4 back to the brush C^7, thence to brush C^8, thence through conductor 3 to the point where said conductor connects with the counter shunt-coil, thence in the direction of the arrow through said counter shunt-coil to the main shunt-winding at the point 2, thence through said main shunt-winding back to the main circuit. It will be noted that the current while passing through the two portions of the counter shunt-coil is passing around the field-magnets in a direction opposite to that in which it passes around them while traversing the main shunt-winding. This arrangement produces a double or compound effect in reducing the strength of the field, as hereinbefore stated, due, first, to the resistance of the conductor itself, and, second, to the counteracting effect on the field-magnets. If the speed now continues to increase, the brushes will be moved farther along and more of the counter shunt-coils inserted in the shunt-circuit until the maximum speed at which the machine operates is reached, in which event all of the counter shunt-coils will be in circuit. These circuits will be readily traced and it is thought need no further explanation. In the meantime the resistance across the terminals of the series winding will be gradually cut out of circuit by the arm H, so as to keep the two field-windings in proper relation to each other. After the speed has risen above the minimum speed at which the machine operates and the speed is then decreased the brushes C^7 and C^8 will be moved back over the contacts, so as to cut out a proper amount of the counter field-coils, thus keeping the effect, as it were, of the field-coils substantially constant throughout the variations in speed for which the regulating device is adapted.

I claim—

1. The combination with a dynamo-electric machine of a regulating device comprising a coil of wire of sufficiently high resistance to act as a controlling resistance and wound upon the field-magnet of the machine in an opposite direction to the exciting field-magnet coil, and means for cutting this resistance-wire into the circuit so that it simultaneously acts in two ways to reduce the effect of the exciting field-magnet coil, first, by decreasing the current flowing therethrough due to the resistance interposed, and, second, by decreasing the magnetic effect of the exciting-coil.

2. A regulating device for dynamo-electric machines, comprising a variable resistance connected in circuit with the machine, a controlling device therefor, comprising a rotatable shaft operatively connected with a moving part of the machine, a device responsive to variations in the speed of said shaft, a series of separated contacts on each side of the shaft, a connecting device movably mounted

on the shaft and adapted to connect said separated contacts, said connecting device attached to the device responsive to variations in the speed of the shaft, so as to be moved thereby, substantially as described.

3. A regulating device for dynamo-electric machines, comprising a variable resistance connected in circuit with the machine to be regulated, a shaft connected with the armature of the dynamo-electric machine so as to be rotated thereby, a speed-reducing mechanism between said shaft and said armature, a contact device mounted on said shaft and adapted to be moved therealong, a series of contacts coöperating with said contact device and connected with said variable resistance, and a controlling device connected with said contact device and responsive to variations in the speed of the armature of the dynamo-electric machine.

4. The combination with a compound-wound dynamo-electric machine of a regulating device, comprising a counter shunt-coil connected in series with the main shunt-winding, a varying device for varying the effect of the counter shunt-coil, a circuit-varying device for simultaneously varying the effect of the series winding, and a controlling device connected with said varying devices, said controlling device responsive to variations in the speed of the armature of the dynamo-electric machine.

5. The combination with a compound-wound dynamo-electric machine of a regulating device, comprising a counter shunt-coil in series with the main shunt-winding, a series of contacts connected with said counter shunt-coil at different points, a contact device adapted to coöperate with said contacts so as to vary the effect of the counter shunt-coil, a varying device for varying the effect of the series winding, and a controlling device responsive to variations in the speed of the armature of the machine, said controlling device connected with the parts so as to simultaneously actuate said varying device and produce a relative movement of said contacts and contact device.

6. The combination with a dynamo-electric machine of a variable resistance wound upon the field-magnets of said machine, so as to act counter to the energizing-coils of said field-magnets, a series of contacts connected with said resistance at different points, a rotatable shaft carrying a contact device adapted to be moved along said contacts so as to vary said resistance, a centrifugal governor on said shaft and connected with said contact device so as to move it along said contacts when the speed varies in a predetermined manner.

7. The combination with a compound-wound dynamo-electric machine of a counter shunt-coil in series with the main shunt-winding, a series of contacts connected at different points to said counter shunt-coil, a rotatable shaft carrying a movable contact device adapted to coöperate with said contacts, a centrifugal governor connected with said contact device so as to move it along said contacts when the speed varies in a predetermined manner, a varying device for varying the effect of the series winding, and a connection between said centrifugal governor and said varying device so that it is operated simultaneously with said contact device, whereby the series and shunt windings are kept in proper adjustment during the varying speed.

8. The combination with a compound-wound dynamo-electric machine of a regulating device, comprising a variable resistance connected in circuit with the shunt-winding, a varying device therefor, a circuit-varying device for simultaneously varying the effect of the series winding, and a controlling device connected with said varying devices and responsive to variations in the speed of the machine.

CHRISTIAN W. KRAGH.

Witnesses:
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AUGUST J. BUENZLI.