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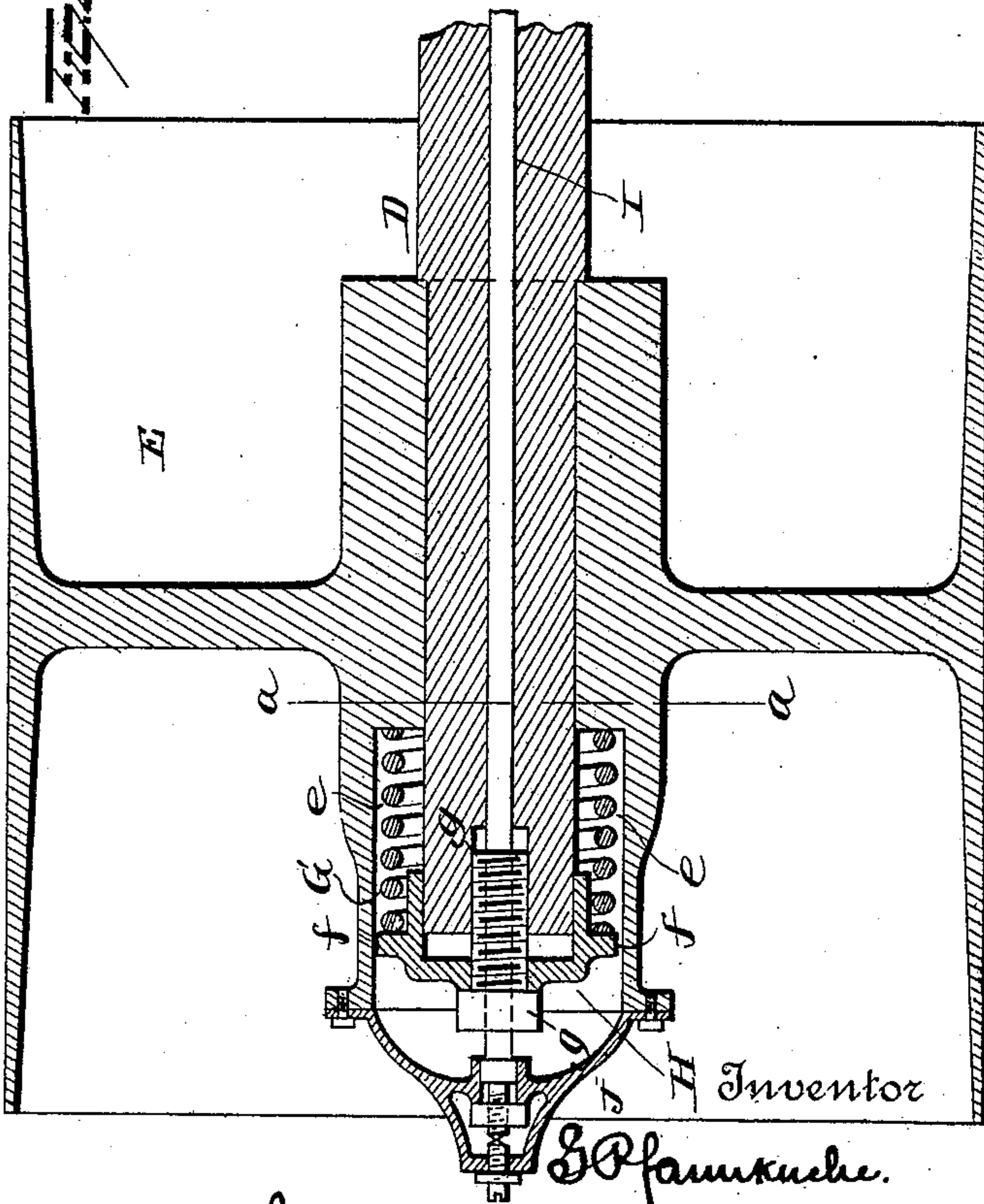
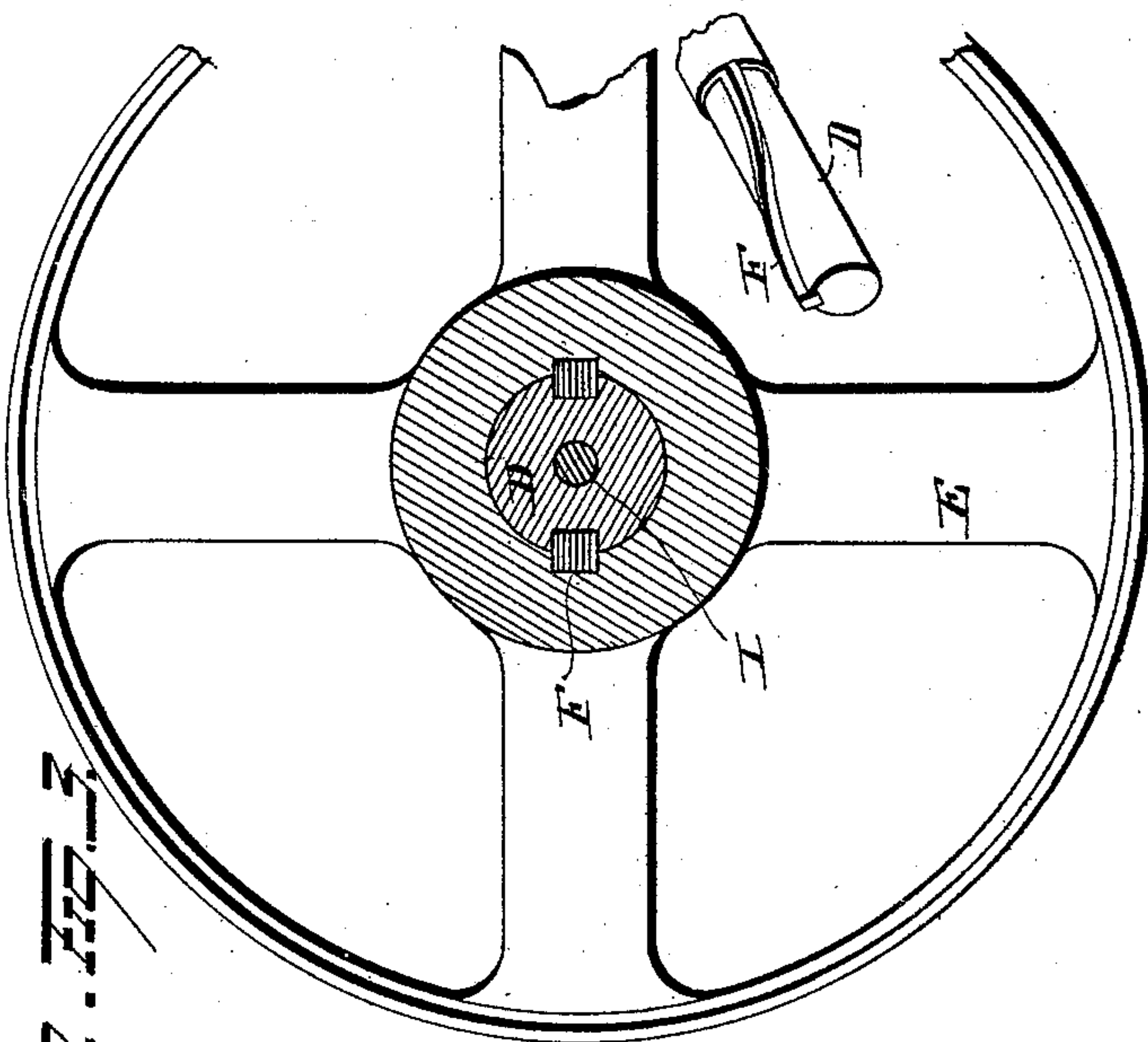
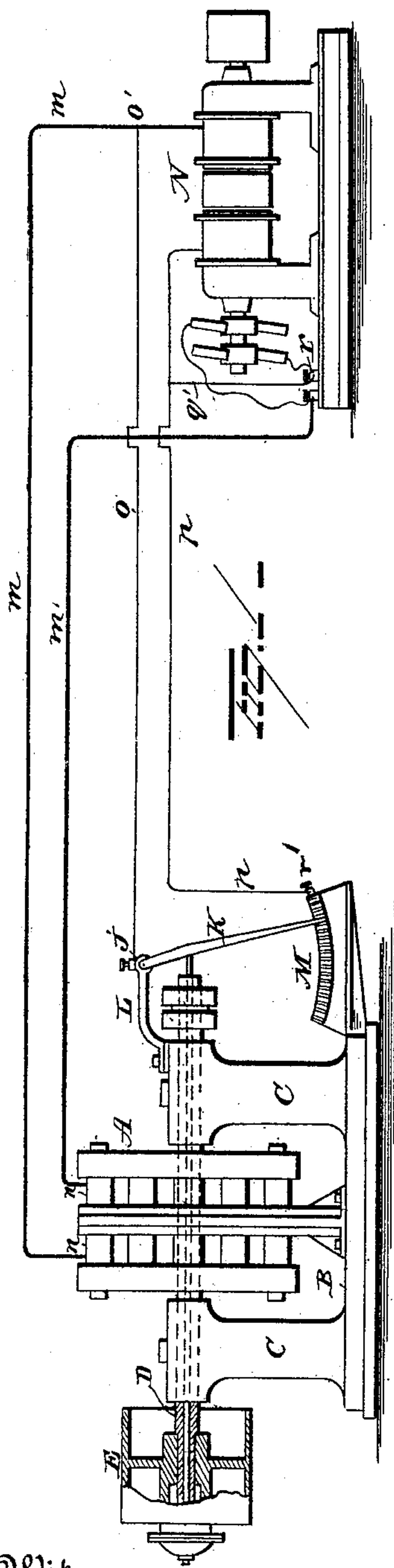
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G. PFANNKUCHE.

REGULATOR FOR ELECTRIC CURRENT GENERATORS.

No. 468,260.

Patented Feb. 2, 1892.



Witnesses  
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(No Model.)

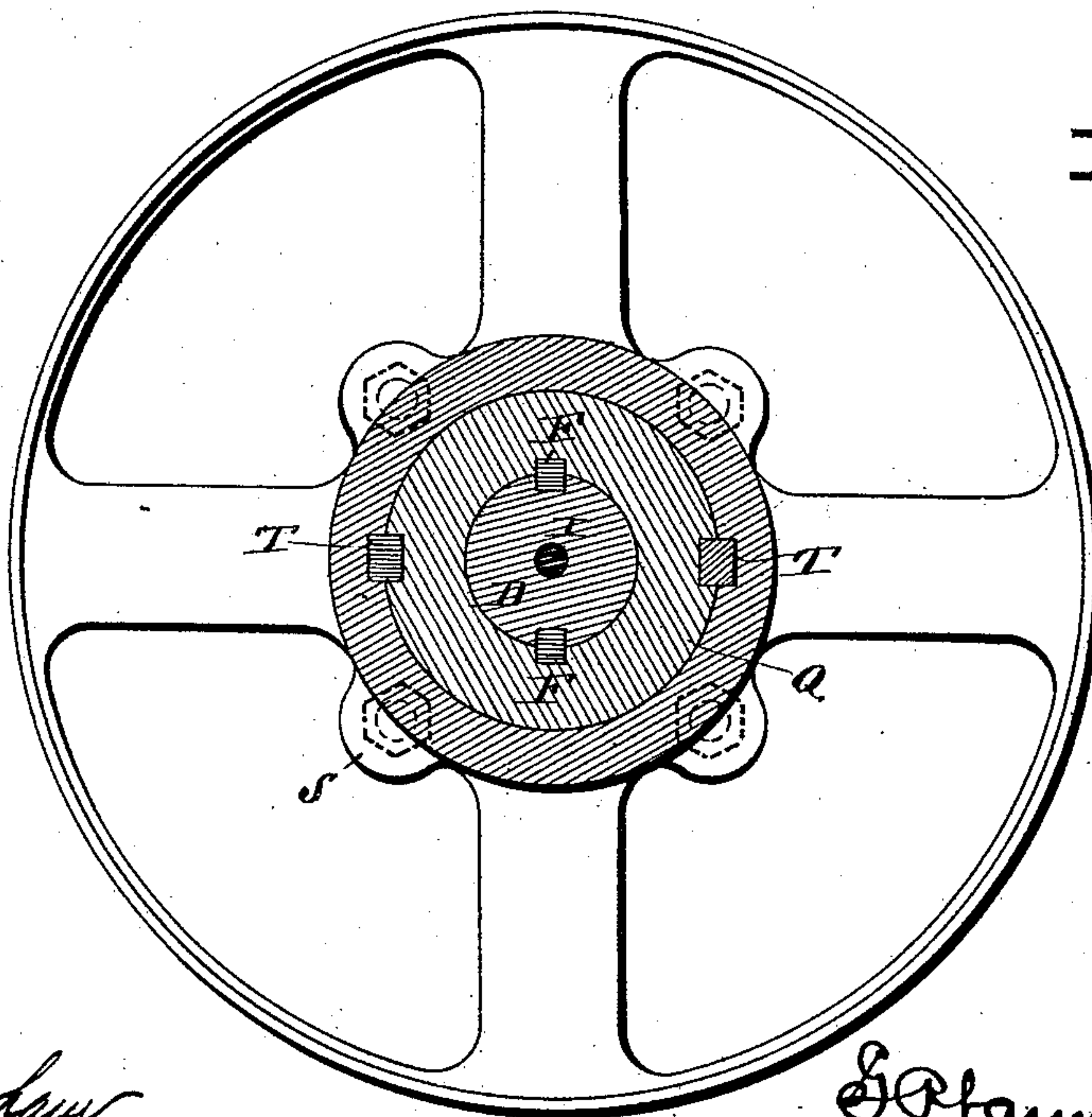
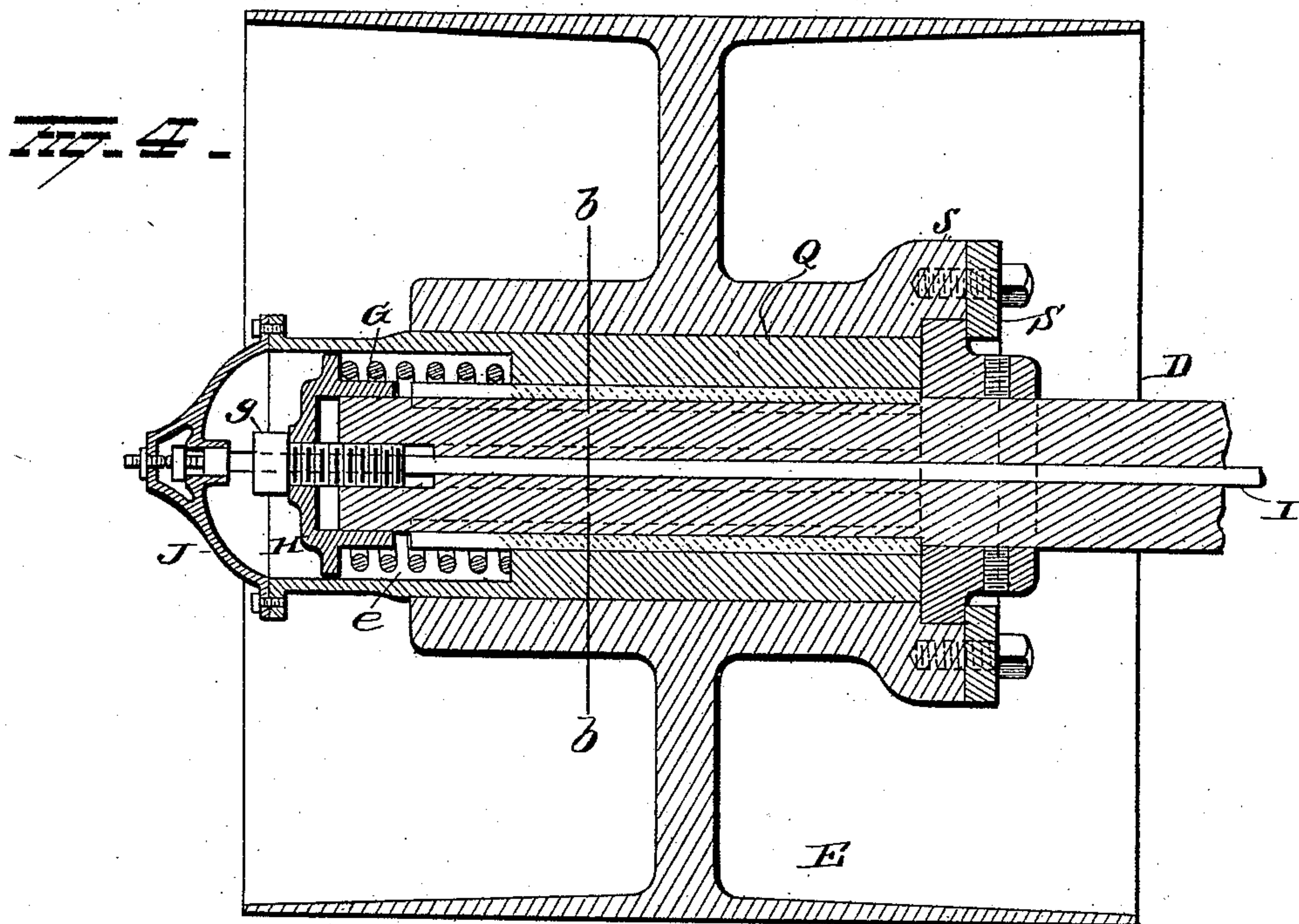
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(No Model.)

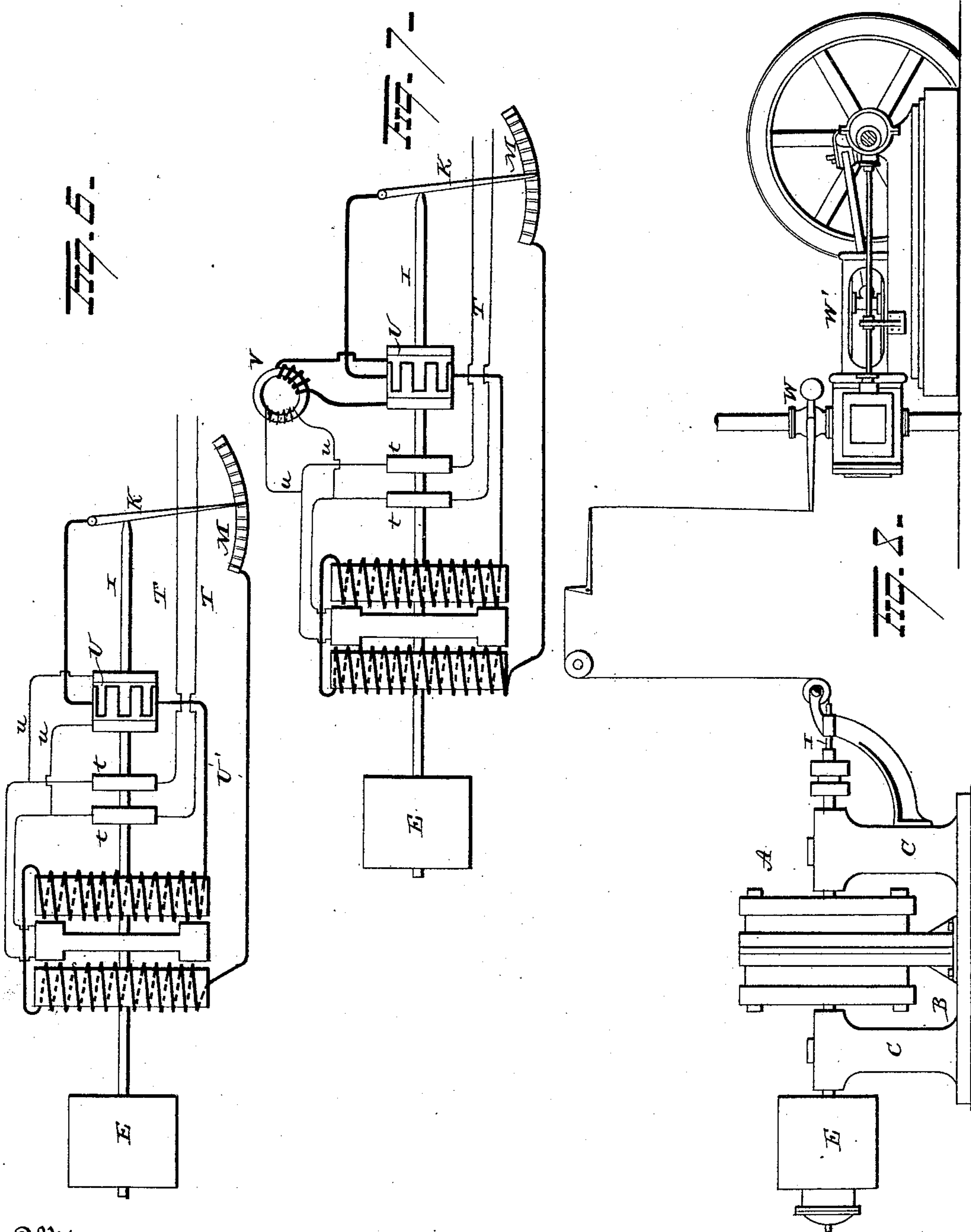
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# UNITED STATES PATENT OFFICE.

GUSTAV PFANNKUCHE, OF CLEVELAND, OHIO, ASSIGNOR TO THE BRUSH ELECTRIC COMPANY, OF SAME PLACE.

## REGULATOR FOR ELECTRIC-CURRENT GENERATORS.

SPECIFICATION forming part of Letters Patent No. 468,260, dated February 2, 1892.

Application filed June 22, 1889. Serial No. 315,283. (No model.)

*To all whom it may concern:*

Be it known that I, GUSTAV PFANNKUCHE, of Cleveland, in the county of Cuyahoga and State of Ohio, have invented certain new and useful Improvements in Regulators for Electric-Current Generators; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My improvement relates to an improvement in regulators for electric-current generators.

The object of the invention is to so regulate the action of the generator that the amount of current generated shall correspond to the varying work interposed in the main or working circuit and the consequent varying load imposed upon the generator.

A further object of the invention is to insure a more prompt, sensitive, and accurate regulation of the generator or dynamo-machine than it has been possible to attain by that type of regulators which is directly dependent for its operation on the variation in the current strength in the main or working circuit.

With these objects in view my invention consists in the combination, with the rotary shaft and band-pulley of a dynamo-electric machine, of suitable devices interposed between the shaft and band-pulley and actuated by the varying load imposed on the dynamo for regulating and controlling the strength of the field of force and causing it to balance or practically balance or correspond to the load on the dynamo, whereby the amount of current generated by the machine shall at all times correspond to the work interposed in the working circuit.

The invention further consists in certain features of construction and combinations of parts, as will hereinafter be described, and pointed out in the claims.

In the accompanying drawings, Figure 1 is a view, partly in side elevation and partly in longitudinal section, of one embodiment of my invention. Fig. 2 is an enlarged view, in longitudinal section, of the band-pulley and its regulating attachment. Fig. 3 is a transverse section of the band-pulley and shaft,

taken through line *a a* of Fig. 2. Fig. 4 is a longitudinal section of a modified construction of band-pulley and regulating attachment. Fig. 5 is a transverse section of Fig. 4, taken through line *b b* of Fig. 4. Fig. 6 represents a modification in which is employed a self-exciting alternating-current generator. Fig. 7 represents another modification wherein the current energizing the field-magnets of a self-exciting alternating-current generator is first reduced in tension and then straightened and sent to the field-magnets. Fig. 8 is another modification wherein the regulator operates to govern and control the prime motor which drives the dynamo.

A represents an alternating-current dynamo, which may be of any suitable form or construction.

B designates the bed-plate of the generator.

C C are upright standards in which the shaft D is journaled.

E represents a band-pulley, which is loosely mounted on the shaft D, so that it is free to slide endwise on the shaft, but is keyed thereto, so as to rotate with it.

F represents a key or feather, which is spiral in form and is secured to the shaft, the portion of the key projecting therefrom entering a corresponding spiral groove formed in the inner surface of the hub of the band-pulley. The outer end of the hub of the band-pulley is recessed, thereby forming an annular space between the hub and shaft, within which is placed a spiral spring G, which latter encircles the shaft. One end of the spring bears against the hub of the band-pulley, while its other and outer end bears against the outwardly-projecting flange *f*, formed on the cap H, which latter is fastened to the end of the shaft by the hollow screw-bolt *g*, entering the outer end of the shaft.

I represents a rod, which extends through the shaft D, the latter being bored out to receive it. One end of the rod I is suitably secured to a cap J, attached to the outer end of the band-pulley hub, while the opposite end of the rod is pivotally connected to an arm K, pivoted at *j* to the bracket-arm L. The free end of the arm K moves in contact with a re-



sistance-board M, to which a series of resistances is connected.

N is a self-exciting dynamo for exciting the field-magnets of the alternating-current generator, the field-of-force magnets  $nn$  of which are connected with the exciter by means of the conductors  $m$   $m'$ . A shunt-circuit  $o$  is connected at one end to the conductor  $m$  at  $o'$  and at its opposite end is connected to the bracket-arm L, which is suitably insulated from the standard of the alternating-dynamo. To one end of the resistance-board is connected a conductor  $p$ , the opposite end of which is connected to the field-magnet of the exciter. A conductor  $q'$  is attached at one end to the binding-post  $r$  of the exciter and at its opposite end to the conductor  $p$ . From the foregoing it will be understood that the resistance M is in a shunt-circuit to the field of the exciting-dynamo N, and hence when the arm K is at the outermost limit of its movement and in close proximity to the binding-post  $r'$  the maximum amount of current from the exciter will be shunted around its field-magnets by the conductor  $q$ , arm K, and conductor  $o$  to the conductor  $m$ , and thus the current of the exciter and the strength of the field-magnets of the alternating-current generator will be reduced to a minimum, which will result in a corresponding decrease in the electro-motive force of the current generated by the alternating-current generator. On the other hand, when the arm K is at its extreme limit of movement in the opposite direction the entire resistance connected with the resistance-board M is then included in the shunt-circuit, thereby developing the maximum amount of current from the conductor  $q'$  to the conductor  $p$  and through the field-magnets of the exciting-dynamo, which operates to strengthen the latter and thus increase the strength of the field-magnets of the alternating-current generator to their maximum, thereby raising the electro-motive force of the current produced by the latter.

Having described the construction and arrangement of the parts of my improved regulator in one of its many forms, I will now explain its operation. The angle or pitch of the feather F on the shaft D is such that the pulley E will have a tendency to move laterally and outwardly on the shaft, acting as a nut thereon when pressure is exerted upon the pulley, and this lateral movement will continue until it is checked or balanced by a counter-pressure. The amount of force which will move the pulley laterally on the shaft will depend on the angle of declination or the pitch of the feather or key, and the proper angle or pitch required in any given case can readily be determined by resorting to the data given in elementary hand-books on mechanical engineering. Now when the belt commences to turn the belt-pulley, and the alternating-current generator is running empty, being subjected to friction and windage only, the

belt-pulley will slide laterally on the shaft D a little distance and until its tendency to move laterally is arrested by the counter-pressure of the spring G, which exerts its force against the hub of the band-pulley and balances the force tending to move it laterally on the shaft. If the load on the alternating generator is increased to half of its full value, the band-pulley will slide laterally on the shaft still farther and until the spring G is compressed to one-half its length. With a full load on the generator the pulley will have moved laterally on the shaft to the extreme outer limit of its travel and the spring G will have been fully compressed, the counter-pressure of the latter balancing the outward thrust of the pulley. The parts are so arranged that the extent of lateral movement of the pulley on the shaft will at all times be proportional to the amount of power applied to the pulley and consumed in actuating the generator. In my improved alternating-current generators the work done in the external circuit is almost exactly proportional to the power consumed by the generator; and hence it follows that the extent of lateral movement or adjustment of the pulley E, rod I, and arm K is proportional to the amount of energy in the external circuit of the generator. When the load on the alternating-current dynamo is increased, the resistance to the rotation of the band-pulley is correspondingly increased and operates to impart a lateral movement to the band-pulley and cause it to slide outwardly on the shaft and thereby actuate the arm K through the rod I and switch additional resistance into the shunt around the field-magnets of the exciter and strengthen the current of the latter and consequently strengthen the field-magnets of the generator to such an extent as will raise the potential of the field to the desired amount. On the other hand, when the load on the alternating-current dynamo is decreased the band-pulley is subjected to a correspondingly-decreased load or pressure, and hence is moved inwardly on the shaft by the force of the spring G, thereby causing the arm K to move outwardly and switch such a portion of the resistance out of the shunt-circuit as will allow part of the current to be shunted around the field of the exciter and reduce the strength of the current generated thereby and correspondingly decrease the electro-motive force of the current generated by the alternating-current dynamo by decreasing the strength of its field. Thus it will be observed that by my improved regulator I am enabled to regulate and control the amount of current generated without employing solenoids or electro-magnets to be actuated by the varying current strength of the external circuit; but through the medium of the varying load on the generator and in the regulation of alternating-current dynamos my invention is of great value and importance, because I am enabled to avoid the use of alternating cur-



rents of rapid alternations for operating solenoids or magnets used in the ordinary forms of dynamo-regulators.

Figs. 4 and 5 illustrate a modified construction in which the band-pulley E, instead of being mounted directly on the shaft, is journaled on a sleeve Q, which is keyed to the shaft by a spiral key or feather F, so that while the sleeve Q rotates with the shaft it is moved endwise thereon, the same as the band-pulley in the construction hereinbefore described. In the modification under consideration the inner end of the band-pulley is connected by a flange s to a collar S, which is fastened to the shaft, whereby the band-pulley is prevented from having any lateral movement. The band-pulley is connected to the sleeve Q by means of a key T. By this construction the band-pulley transmits rotary motion to the shaft through the medium of the sleeve Q, which latter is free to move endwise on the shaft and effect the regulation of the dynamo in the manner hereinbefore explained.

In Fig. 6 I have shown my improved regulator as applied to a self-exciting alternating-current generator. The current from the armature is transmitted to the collector-rings *tt* and from thence is supplied to the external circuit T T. The shunt-conductors *uu* convey a portion of the alternating current generated by the dynamo to the commutator U, which straightens the current and supplies it to the circuit U' of the field-magnets. In the field-circuit is included a resistance-board M, and the resistance of the field-circuit is automatically varied by the regulator in the manner hereinbefore described, so that the strength of the field and the amount of current generated shall be proportional to the amount of work interposed in the working circuit.

Fig. 7 illustrates the same arrangement of regulating mechanism as is shown in Fig. 6, with the addition of a converter V in the shunt-circuit *uu*. Converter V operates to reduce the tension of the current conveyed to the commutator U and thus obviate the burning away of the commutator by excessive sparking.

Fig. 8 illustrates another embodiment of my improved regulator. In this construction the adjusting-rod of the regulator is connected

in any suitable manner with the throttle W of the prime motor W', which operates the dynamo, or the adjusting-rod may transmit motion to and regulate the cut-off or expansion valve of the prime motor and in either case govern it and cause it to transmit power to the dynamo, which shall be proportionate to the load on the dynamo.

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

1. The combination, with an electric-current generator, a separate exciting-dynamo, and a resistance included in a shunt around the field-magnets of the exciter, of a regulator combined with the shaft of the generator and constructed and adapted to be actuated by the varying load on the generator and automatically vary the resistance in the shunt-circuit of the exciter, substantially as set forth.

2. The combination, with an electric-current generator, a separate exciting-dynamo, a shunt around the field-magnets of the exciter, a variable resistance included in said shunt-circuit, a rod extending through the shaft of the generator, and devices connected with one end of the rod for varying the resistance in the shunt-circuit, of a band-pulley on the shaft, a spiral key or feather for connecting the band-pulley to the shaft, and a spring arranged to restrain the lateral movement of the band-pulley, substantially as set forth.

3. In combination with the armature-shaft of a dynamo electrical machine and the band-pulley mounted thereon in such a manner that its position relative thereto shall automatically vary with the varying load imposed on the said machine, a rod longitudinally movable through said shaft connected at one end with the regulating means and at the other with said band-pulley, and a spring surrounding said rod and interposed between a device movable with the band-pulley, and a shoulder on said shaft, substantially as described.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

GUSTAV PFANNKUCHE.

Witnesses:

W. A. PALLANT,  
W. D. POST.