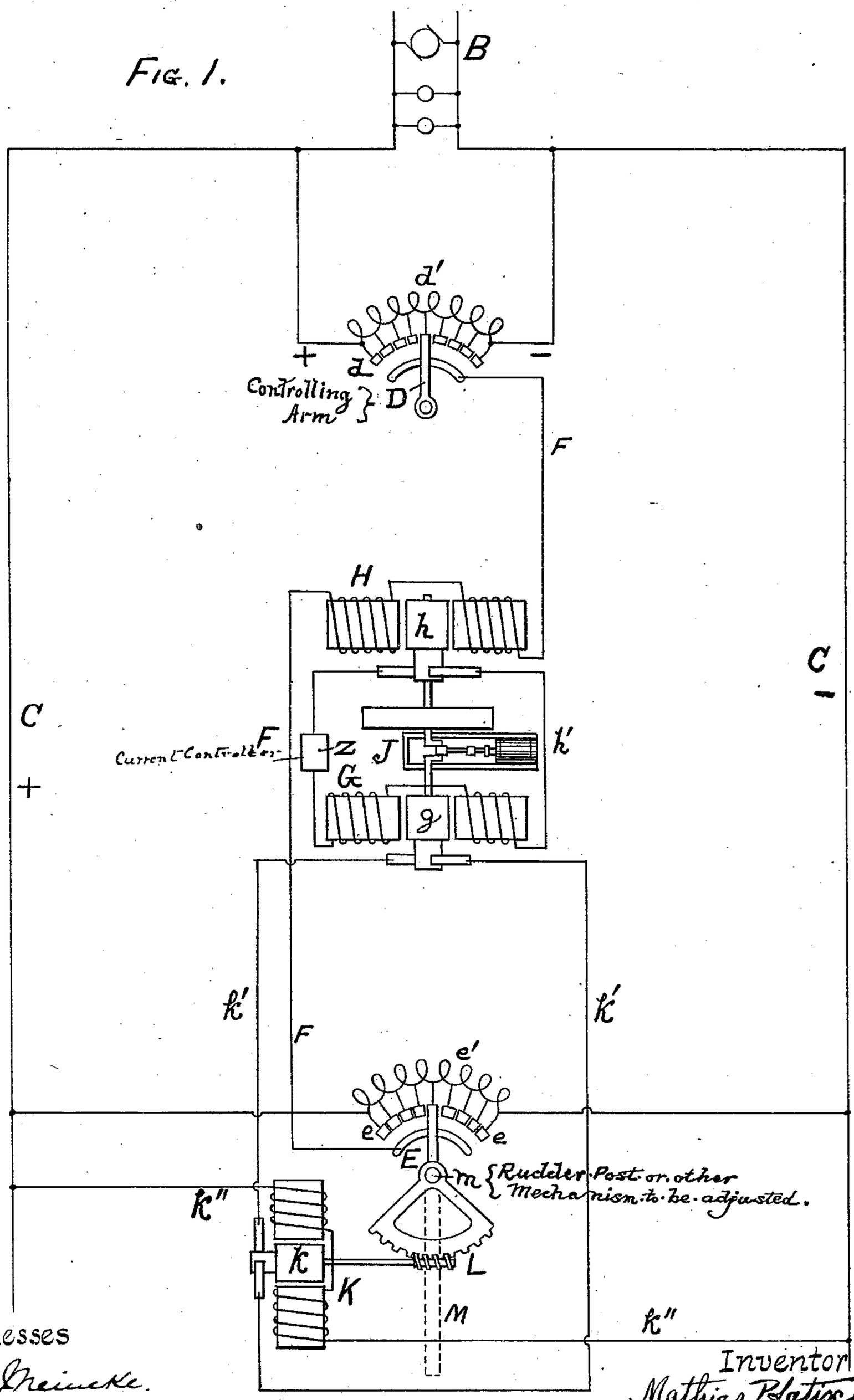
(No Model.) 6 Sheets—Sheet 1.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896.

Fig. 1.



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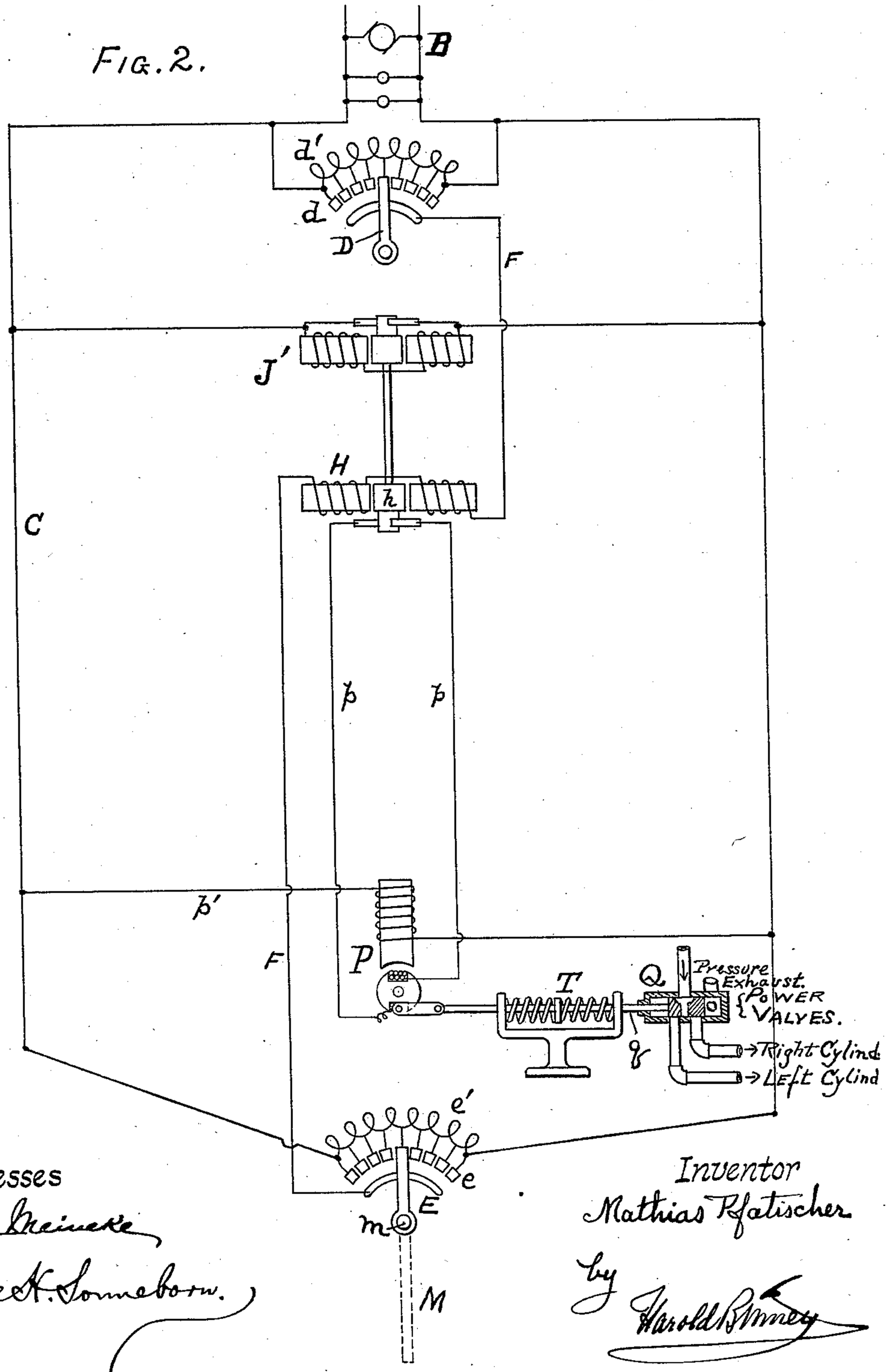
(No Model.) 6 Sheets—Sheet 2.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896.

FIG. 2.



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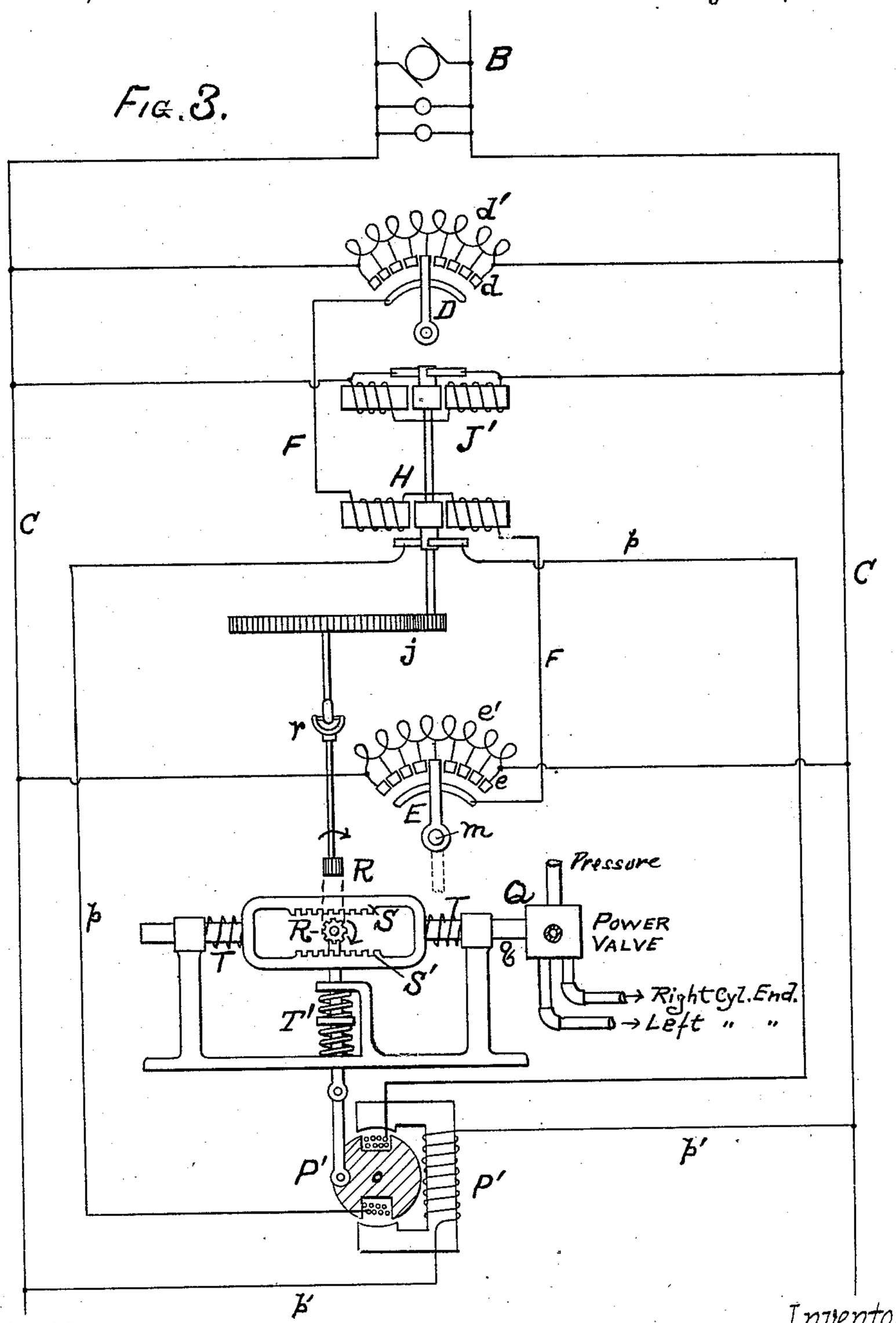
(No Model.) 6 Sheets—Sheet 3.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896.

FIG. 3.



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(No Model.)

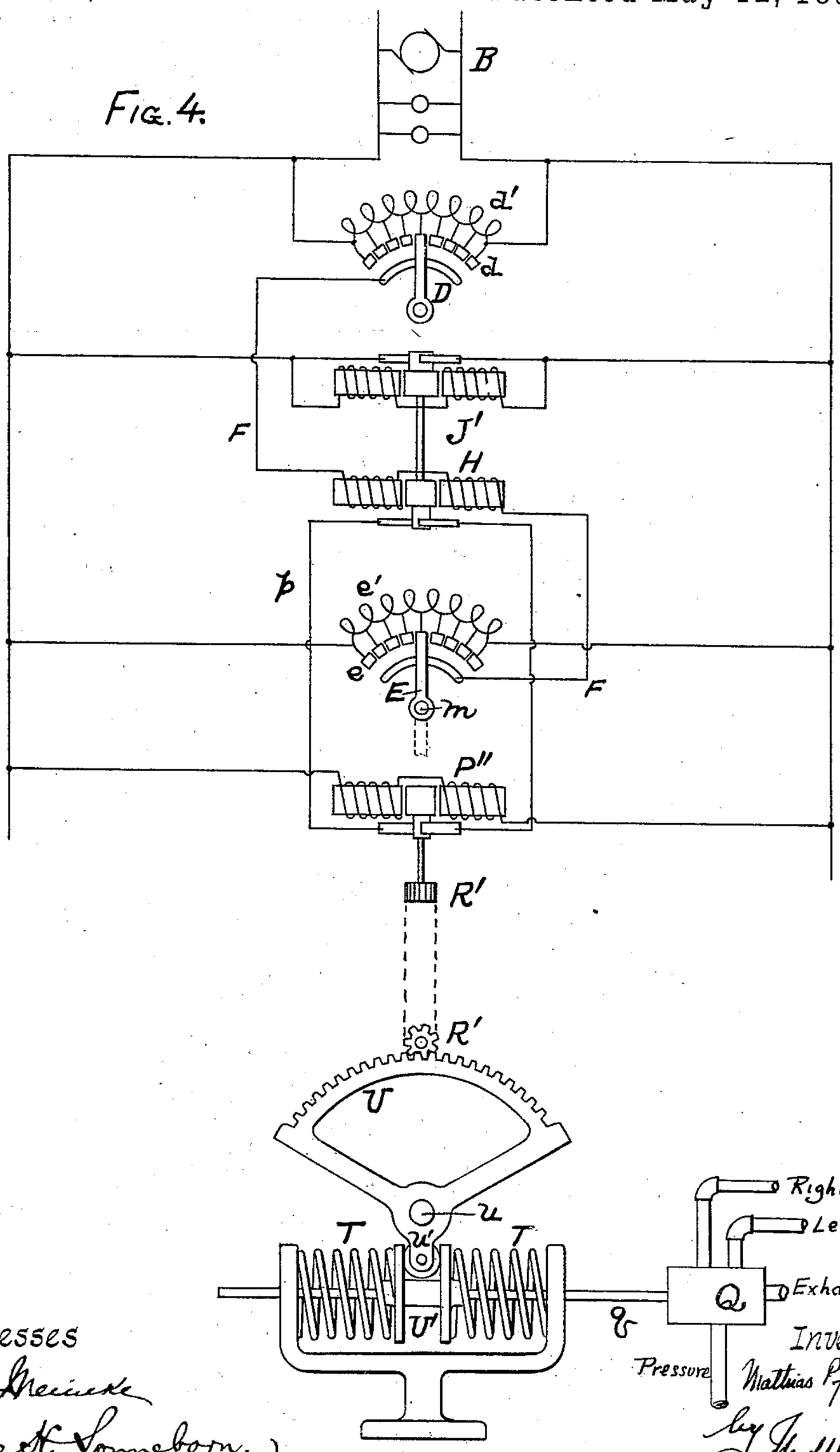
6 Sheets—Sheet 4.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896.

FIG. 4.



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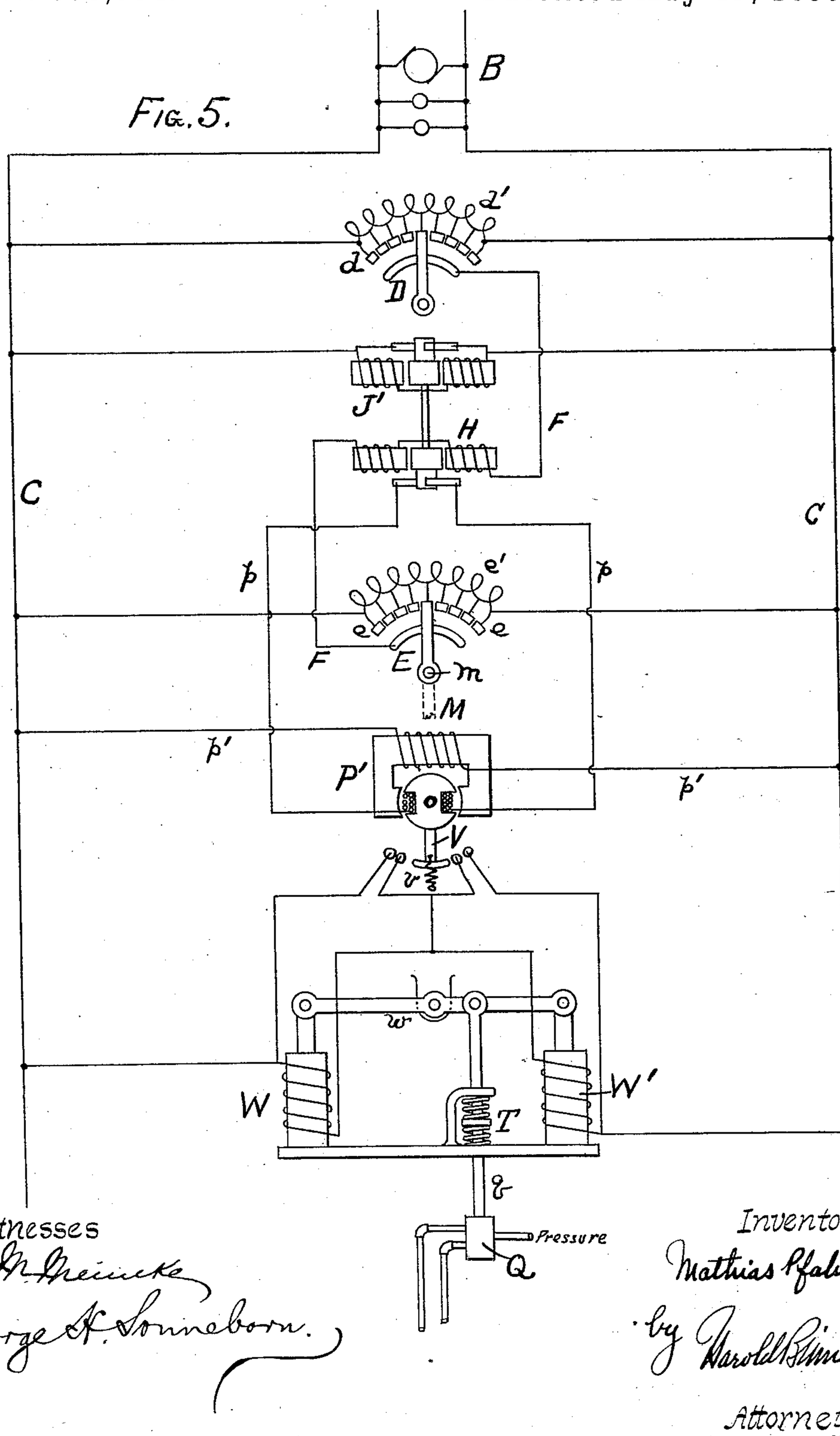
(No Model.) 6 Sheets—Sheet 5.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896.

Fig. 5.



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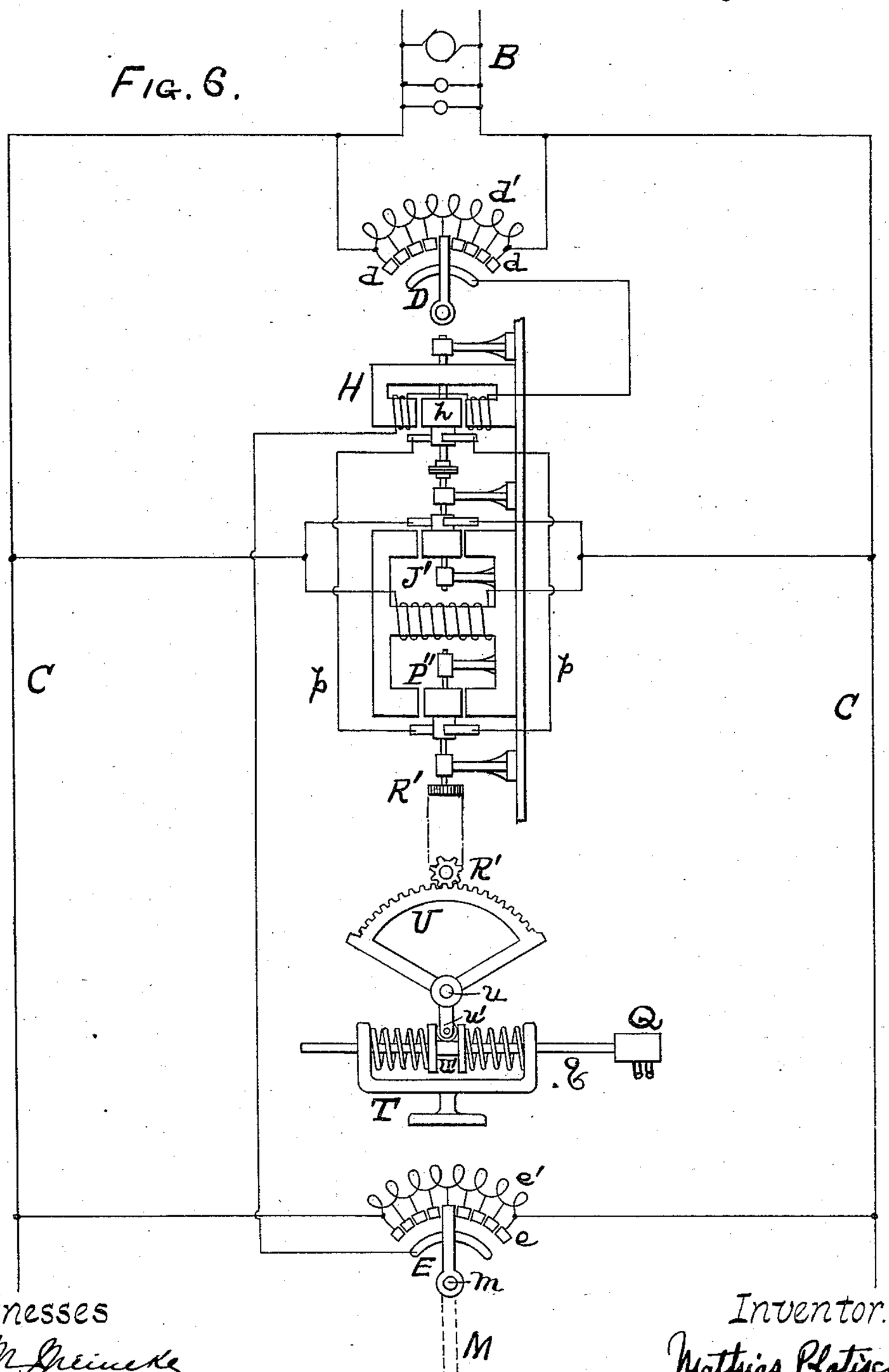
(No Model.) 6 Sheets—Sheet 6.

M. PFATISCHER.

ELECTRICAL STEERING GEAR.

No. 559,904. Patented May 12, 1896

FIG. 6.



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UNITED STATES PATENT OFFICE.

MATHIAS PFATISCHER, OF PHILADELPHIA, PENNSYLVANIA.

ELECTRICAL STEERING-GEAR.

SPECIFICATION forming part of Letters Patent No. 559,904, dated May 12, 1896.

Application filed December 26, 1895. Serial No. 573,330. (No model.)

To all whom it may concern:

Be it known that I, MATHIAS PFATISCHER, of Philadelphia, Pennsylvania, have invented certain new and useful Improvements in Apparatus for Controlling Steering-Gear for Ships or other Devices, of which the following is a description, referring to the accompanying drawings, which form a part of this specification.

The object of my invention is to produce a simple, reliable, and effective controlling apparatus for operating ship's steering-gears and other devices with great ease and delicacy from a distance. By "other devices" to which my invention is applicable I include signal apparatus for transmitting orders at a distance, devices for directing guns, and indeed all devices where it is desired to move and have absolute control over the position of an apparatus or parts of apparatus at a distance. The power, whether steam, water, or electricity, which does the work is controlled by my electrical controlling system. The controlling system is of so simple a nature that a single circuit from a handle by which the device is controlled to the engine, steering-gear, signal apparatus, or other mechanism which applies the power replaces the multiplicity of circuits heretofore found necessary. I am aware that single-wire signal and controlling systems have been employed heretofore, but in quite a different manner from the system which forms my present invention.

This present invention is an improvement upon the invention described in my pending application, Serial No. 560,448, filed August 24, 1895. Its nature and its essential features will be clearly apparent from the accompanying drawings and the following description.

In the drawings, Figure 1 shows in diagram my invention as applied to an electrically-actuated steering-gear, gun-mounting, or other adjustable device. Fig. 2 shows a modification of the invention as applied to steam-actuated mechanism. Figs. 3, 4, 5, and 6 show modifications of the same.

Throughout the drawings like letters of reference indicate like or equivalent parts.

Referring to Fig. 1, B indicates the electric generator of the whole system. Where my invention is applied to steering ships that are lighted by electricity, this generator B will be the generator which supplies the lighting and other circuits. It may, however, be a separate generator, if desired.

C C are the mains from which the several circuits lead. I have for convenience indicated that one is positive and the other negative, though of course I do not mean thereby to preclude the use of alternating currents, if it is desired to adapt the system to such current.

At D is shown the controlling hand-switch, and at E a switch moving with some part of the steering-gear, gun-mounting, signaling apparatus, or other mechanism to be controlled by the system. From the drawings and the following description it will be seen that the switch-arm E will be caused to follow the motions of the switch-arm D, and that as soon as the switch-arm D changes its position the switch-arm E follows to the corresponding position, and the mechanism to which the switch-arm E is connected is of course adjusted in a corresponding or proportionate manner. The two switch-arms D and E are connected by the conductor F, which I will call for convenience my "balance-wire" or "balance-circuit." The switches D and E bear upon and make contact with the series of fixed contacts *e* and *d*, connected with subdivisions of the two sets of resistances *e'* and *d'*, connected across between the mains C. From this it will be clear that no current will pass through the balance wire or circuit F so long as the switch-arms D and E are upon the contacts having equal potential. This is the normal condition of the circuit F when the apparatus is at rest. If, however, the switch-arm D is moved in one direction or the other onto the adjacent contacts, a current will flow through the circuit F in one direction or the other, corresponding to the movement of the switch-arm D. By means of this current I control the adjusting apparatus for the ship's rudder, gun, signal device, or other mechanism to be adjusted at *m*, and cause the same to be adjusted until the arm E is turned to a contact *e* of equal potential to that upon which the arm D rests, thereby causing the adjustment of the steering-gear, gun, signal device, or other mechanism to follow and

be absolutely controlled by the motions of the arm D. In Fig. 1 this is accomplished in the following manner: At J is shown a steam-engine driving the two armatures *g* and *h* of two generators G and H. An electric motor or other motor may of course replace the steam-engine J, as will be apparent from the other figures of the drawings. The field-magnet windings of the generator G are included in the balance-circuit F, and the windings are so proportioned that the small current passing through the circuit F will strongly energize these magnets. This generator H is merely the exciter of the generator G. *h'* is the exciter-circuit. At Z may be included a rheostat or other current-controller. The generator G supplies current to the armature *k* of the motor K by means of the circuit *k'*. Field-magnets of the motor K are constantly energized from the mains by the circuit *k''*. This motor K supplies the power which adjusts the steering or other mechanism by any desired connection—such, for instance, as the worm and sector L. For convenience of illustration I have shown the rudder in dotted lines at M and the rudder-post *m*, the worm and sector L directly turning the rudder-post *m* and the switch-arm being mounted directly upon the rudder-post. Of course these mechanical connections are diagrammatic and do not represent the more complicated mechanism necessary to multiply and apply the power in the most satisfactory manner to the rudder or to the gun, signal device, or other mechanism or apparatus to be controlled and adjusted. It will now be seen from this figure of the drawings that if the circuits are properly arranged, so that the currents will flow in the right direction, the movement of the arm D will cause a proportionate movement of the rudder-post or shaft *m*, which will bring the switch-arm E to the position at which current through the balance-circuit F will cease. When a small current flows through the balance-circuit F, it energizes the field-magnets of the exciter H sufficiently to strongly excite or saturate the field-magnets of the power-generator G. The current developed by the generator G drives motor K and adjusts the rudder, gun, or other adjustable mechanism until the movement of arm E stops the current flowing through the balance-circuit F and thereby instantly deënergizes the generators. In the remaining figures of the drawings no exciter H is used, but the circuit F includes field-windings of a small generator H, which generates sufficient current to move the valves of a steam-engine, the steam providing the necessary energy for moving the rudder or other mechanism to be adjusted and restoring the switch-arm E to the position of equilibrium or balance in the balance-circuit F. Throughout all these figures J' indicates an electric motor energized from the mains C. This motor J' takes the place of the steam-engine J of Fig. 1, and drives the generator H. In all these figures also the field-magnets of this generator H are energized directly by the current flowing in the balance-circuit F.

In Fig. 2 the current produced by the generator H is led through the circuit *p* to an electrodynamic device P. The field-magnet of this electrodynamic device may be supplied from the mains through the windings and connections *p*, and the armature or movable member may be supplied with the current flowing in the circuit *p*. Of course these relations may be reversed, and circuit *p* connected to the stationary part, while *p'* energizes the movable part of the electrodynamic device. This electrodynamic device P may be directly connected with and thereby move the valve mechanism Q for the steam, hydraulic, pneumatic, or other power employed to do the work of adjusting the steering-gear, gun, or other adjustable mechanism at *m*.

In Fig. 3 the motor J', the generator H driven thereby, and the balance wire or circuit F and its connections are identical with Fig. 2, but the shaft of the motor J' is mechanically connected to and turns the gearing *j*, which drives at a substantially constant speed the spur wheel or pinion R. In showing this feature diagrammatically I have had to show the pinion R both in side and in face view, so as to indicate in what manner the pinion R is utilized. The current from the generator H, instead of directly actuating the valves Q, drives the electrodynamic device P', taking current in the same manner as the electrodynamic device P already described in connection with Fig. 2. This electrodynamic device P is connected mechanically with the rotating pinion R in such a manner that it can shift the position of the rotating pinion R and force it into engagement with either of the opposing racks S S'. These racks S S' are mounted upon the valve-stem *q*, so that the engagement of the pinion R with the rack S will cause the valve-stem to move in one direction while the engagement of the pinion with the opposite rack S' will cause an opposite motion. The details of the valves Q are of course immaterial, but they should preferably be arranged to shut off steam and stop the engine as soon as the pinion R leaves the racks.

I have shown at T in Figs. 2, 3, 4, 5, and 6 an arrangement of springs by which the valve is automatically returned to its central position to stop the steam-engine, ram, or other motor used to move the rudder, gun, or other adjustable mechanism. The details of these opposing and balance springs will be apparent from these figures, especially Fig. 4, without further description. Of course any other equivalent device may be used instead. At *r* in Fig. 3 I have shown a universal connection for the pinion R, whereby it may be continuously rotated and at the same time be laterally adjustable, as described, by means of the electrodynamic device P'.

In Fig. 4 I have shown a pinion R' some-

what similar in function to pinion R, but in this case acting directly upon a segmental rack U, which turns upon the center *u* and carries the projection *u'*, provided with a friction-roller, as shown. This projection *u'* moves the valve-stem *q* of the valve Q by means of the two opposing plates U'. When the segmental rack U is turned to the right, it is clear that the projection *u'* is forced to the left, carrying with it the valve-stem *q* and moving the valve accordingly. The spring mechanism T will restore the valve-stem *q* and valve to a central position as soon as the rack U is free to return to its central or normal position, as shown in the figure. The pinion R' is rotated and caused to turn the rack U by means of the motor or electrodynamic device P''. One member of this motor or electrodynamic device is energized from the mains and the other receives current from the generator H. In other respects than those mentioned the apparatus and connections of Fig. 4 are the same as those of Figs. 2 and 3.

In Fig. 5 an electro dynamic device P', supplied with current from the generator H, as in the other figures, is caused to turn a switch V, and thereby short-circuit one or the other of the two electromagnets or solenoids W W' which are supplied by current from the mains C C'. These two magnets or solenoids W W' are connected in series and are wound and placed to balance each other in their action upon the pivoted lever-arm *w*, which may be connected directly to the valve-stem *q*, as shown. When the switch V is in its central position, as shown in the drawings, the two magnets or solenoids W W' receive a certain amount of current in series, but being substantially balanced the springs T keep the valve or valves Q central. When, however, the movement of the switch V short-circuits one or the other of the windings of the solenoids W W', and thereby cuts out half the resistance in the solenoid circuit between the mains C, one solenoid becomes deënergized, and the other receives twice the energizing-current, causing it to throw the lever-arm *w* and actuate the valve Q in the proper direction to admit steam, water, or other pressure to the engine, ram, or other motor which moves the rudder, gun, or other adjustable mechanism at *m*. When the switch-arm E is again brought to a position to balance the electromotive forces in the balance wire or circuit F, the motor H being deënergized, as already described in connection with Figs. 1, 2, 3, and 4, allows the switch-arm V to return to its central position under the action of its spring *v*, thereby again balancing the magnets or solenoids W W' and permitting the springs T to restore the valves to their central position and shut off steam, water, or other motive power.

In Fig. 6 a slight modification of Fig. 4 is shown, the difference being that the field-magnets of the motor J', which drives the generator H, and the field-magnets of the electrodynamic device or motor P'', which drives the pinion R', are combined into a single magnet energized by a single circuit across the mains C.

There are many other combinations which may be made, greatly simplifying the parts of my system; but I have not attempted to set these forth at length, because the great number of arrangements which are possible without in any way departing from the principles and mode of operation of my system are innumerable, and they would obscure rather than make clear the more essential features of the invention. As an instance, however, it will be seen that the motor J' and the generator H, connected by a common shaft, are in reality a motor generator, but that the field magnetism of the generator H is reversed by the movement of the switch-arm D, and normally when the stearing-gear, gun, or other mechanism is not being adjusted no current whatever flows through the balance-circuit F, which energizes the field-magnets of the generator H.

I have not attempted to show the details of the steam-engine, hydraulic ram, or other motive power used to adjust the rudder, aim the gun, set the signal device, or operate the other adjustable mechanism to which my electrical controlling system is applied, save in one instance, (shown in Fig. 1;) nor have I attempted in diagrammatically illustrating the valve or valves Q of the steam, hydraulic, pneumatic, or other fluid power to show the practical working details of such valves, for it is clear that these valves will be variously modified for different uses and the details are not pertinent to the present invention. I will, however, briefly describe the operation of the complete apparatus as illustrated in Fig. 1, and from this and the description of the other figures the differences in details and operation will be apparent.

In Fig. 1, let M be the rudder of a ship, which is attached and turned by the shaft or rudder-post *m*. As shown, the rudder is intended to be amidships. If the controlling-handle D is moved to the left onto the adjacent contact *d'*, it is clear that a current will flow from the switch-arm D through the balance wire or circuit F to the switch-arm E. The passage of this current energizes the field-magnets of the exciter H, and thereby excites the field-magnet of the power dynamo G, which provides electric energy for the rudder-operating motor K, causing it to turn in a direction to shift the arm E to the left. This action continues until the switch-arm E comes onto a contact *e* corresponding with the contact D upon which the switch-arm D rests, thereby restoring the electrical balance in the balance-circuit F and bringing the adjusting action to an end. It will be seen that the power is derived from the steam-engine J. The controlling-current which flows through the balance-wire or balance-circuit F does none of the work. It merely energizes the

field-magnets of the exciter H, the exciter H producing the stronger current, which energizes the field-magnets of the power dynamo G. The energy developed in the exciter-circuit h' comes from the steam-engine J, and the energy developed by the power dynamo G comes from the same source and operates the motor K. In this respect all the forms of the invention shown in the various figures of the drawings are similar. In no instance is the balance-circuit F relied upon to do work or provide the motive power.

In Figs. 2, 3, 4, 5, and 6 the energy required to adjust the rudder, gun, signal, or other adjustable mechanism is provided by the steam, hydraulic, or other motor, and even the energy required to shift the valve Q is derived either directly from the mains, as in the case of the solenoids W W′ in Fig. 5, or directly from the constant-speed motor J′, which turns the armature and thereby generates the current of the dynamo H, and which also in Fig. 3 supplies the mechanical power through the mechanical connections j r and the pinion R. In Figs. 4 and 6 the generator H, driven by the motor J′, drives in turn the motor P″, which gives the mechanical power for shifting the valves, while in Fig. 2 the current from the generator H operates an electrodynamic device, which directly shifts the valves. In Fig. 3 the electrodynamic device P′ merely applies the mechanical power of the motor J′ to shift the valve, and in Fig. 5 the electrodynamic device P′ shifts a switch, which applies electric energy derived from the mains C to one or the other of the two solenoids W W′, and thereby indirectly shifts the valves.

By employing the current which flows through the balance-circuit F as a magnetizing-current for a suitably-driven constant-speed dynamo or generator H, I produce a controlling-current, which may be fifty or one hundred times greater than the current which flows in the balance wire or circuit F. Moreover, as it is clear that the current produced by a dynamo, other things being equal, depends upon the strength of the field, and as the strength of the field is varied but little by an increase of the field-magnet current after the field-magnet becomes saturated I am enabled by my system to generate maximum current by means of the generator H, even when the controlling switch-arm V has been moved but slightly from the position of balance—that is to say, if the movement of the switch-arm D through a quarter of the length of the resistance d' is sufficient to nearly saturate the field-magnets of the generator H the current produced by this generator H will be very nearly as great as if the arm D had been moved a much greater distance. It will also be clear that if the number of turns and resistance of the field-windings of generator H which are included in the balance-circuit F are large as compared with the resistances d' and e' a greater effect will be produced in the circuit F with less waste of current, for the passage of a large current through the circuit F tends to alter the relative potentials of the successive contacts d and e of the two resistances d' and e'. All these matters will, however, be apparent to any one versed in the art and are mere details rather than essential principles of my invention. So also the various forms of electrodynamic devices which may be employed may be greatly varied without in any way departing from the principle of my system, and by "electrodynamic" I mean to include all forms of electric motors.

In the more generic aspect of my invention the switches and subdivided resistances D d' E e' are to be regarded as two sources of variable electromotive force included in a balance-circuit F and normally balanced, one of the said sources being manually controlled, as at D, and the other turning with and actuated by the rudder, gun, signal, or other adjustable mechanism to which my controlling system is applied. Generator H, receiving its power from any suitable source—such as those which I have described—is excited by the current flowing in the balance-circuit F, and thereby caused to send a current corresponding to the direction in which the switch-arm D has been moved, but deriving the energy from an entirely different source. The power which adjusts the rudder, gun, signal, or other adjustable mechanism is derived from any suitable electric, hydraulic, pneumatic, steam, or other source, and the controlling-current generated by means of the dynamo H serves to control and direct the application of such motive power.

Having now fully set forth my invention in some of its preferred forms, I claim as my own, and desire to secure by these Letters Patent of the United States, together with such modifications and variations as may be made by mere skill in the art, the following:

1. The method of electrically controlling and adjusting from a distance, a ship's rudder, gun, signal apparatus, or other adjustable mechanism, by introducing into the field-magnet circuit of an electric generator, a current corresponding in direction to the deviation of the controlling handle or device; causing the current thereby generated to control and apply the motive power for adjusting the said adjustable mechanism; and causing such adjustment to introduce an opposing and equal electromotive force or current into the said balance-circuit and thereby stop the said adjustment, substantially as set forth.

2. In combination in a system for controlling the position of a rudder, gun, signal apparatus, or other adjustable mechanism (as at m) from a distance, and with suitable motive power for adjusting the said mechanism, two or more sources of variable electromotive force, a balance wire or circuit F extending between the said sources, one of the said

sources being manually controlled (as at D) and the other being controlled (as at E) by the position of the said rudder, gun, signal apparatus, or other adjustable mechanism, a suitably-driven generator H having its field-current supplied or controlled by the said balance-circuit F, and an electrodynamic device receiving current from the said generator and controlling the said motive power, substantially as set forth.

3. In combination in a system for controlling the position of a rudder, gun, signal apparatus, or other adjustable mechanism (as at *m*) from a distance, and with suitable motive power for adjusting the said mechanism, an electrical controlling device for the said motor, a suitably-driven generator H supplying current to the said electrical controlling device, a source of variable electromotive force included in the field-circuit of the said generator H and manually adjustable as at D, a second source of variable electromotive force also included in the field-circuit of the said generator H, and mechanical connections between the said rudder, gun, signal apparatus, or other adjustable mechanism and the said second variable electromotive force, for controlling it; whereby upon the adjustment of the first said variable electromotive force the said rudder, gun, signal apparatus, or other adjustable mechanism, will be adjusted by the said motive power to follow the adjustment of the variable electromotive force, substantially as set forth.

4. In combination in a system for controlling the position of a rudder, gun, signal apparatus, or other adjustable mechanism (as at *m*) from a distance, and with suitable motive power for adjusting the said mechanism, one or more sources of electric energy, the balance-circuit F, a manually-controlled switch (as at D) and connections for introducing more or less electromotive force at will into the said balance-circuit F, the switch E and connections for introducing more or less opposing electromotive force into the said balance-circuit, the said switch E coöperating with and being moved by the said rudder, gun, signal apparatus, or other adjustable mechanism, a suitably-driven generator H, the field-windings of which are included in the said balance-circuit F, and electrically-actuated controlling devices for the said motive power, receiving current directly or indirectly from the said generator H, substantially as set forth.

5. In combination with steering or other adjustable mechanism and motive power therefor, an electrically-actuated controlling device for the said motive power, a suitably-driven generator H supplying a controlling or actuating current for the said electrically-actuated controlling device, a source or sources of electric current (as C) a balance-circuit F, the current in which determines the field-magnetism of the said generator H, means for introducing at will into the said balance-circuit more or less electromotive force, and other means for introducing into the said circuit an opposing or balancing electromotive force mechanically connected with and adjusted by the said adjustable mechanism, substantially as set forth.

6. With the steering or other adjustable mechanism, and with electric mains or other source of electric power, a motor supplied from the said mains, a generator H driven thereby, an electrodynamic device (as P, P′, P″) receiving current from the said generator H, a balance-circuit F including, or connected with, the field-windings of the said generator H, a switch D adjustable at will to introduce more or less electromotive force into one end of the said balance-circuit F, a second switch E mechanically connected with the said steering or other adjustable mechanism and adjustable therewith to introduce more or less opposing or balancing electromotive force into one end of the said balance-circuit F, motive power for the said steering or other adjustable mechanism, and controlling mechanism for the said motive power mechanically connected with the said electrodynamic device, substantially as set forth.

In testimony whereof I have hereunto set my hand, at Philadelphia, Pennsylvania, this 24th day of December, A. D. 1895.

MATHIAS PFATISCHER.

In presence of—
HAROLD BINNEY,
GEO. ECKHARD.