No. 815,833. PATENTED MAR. 20, 1906.

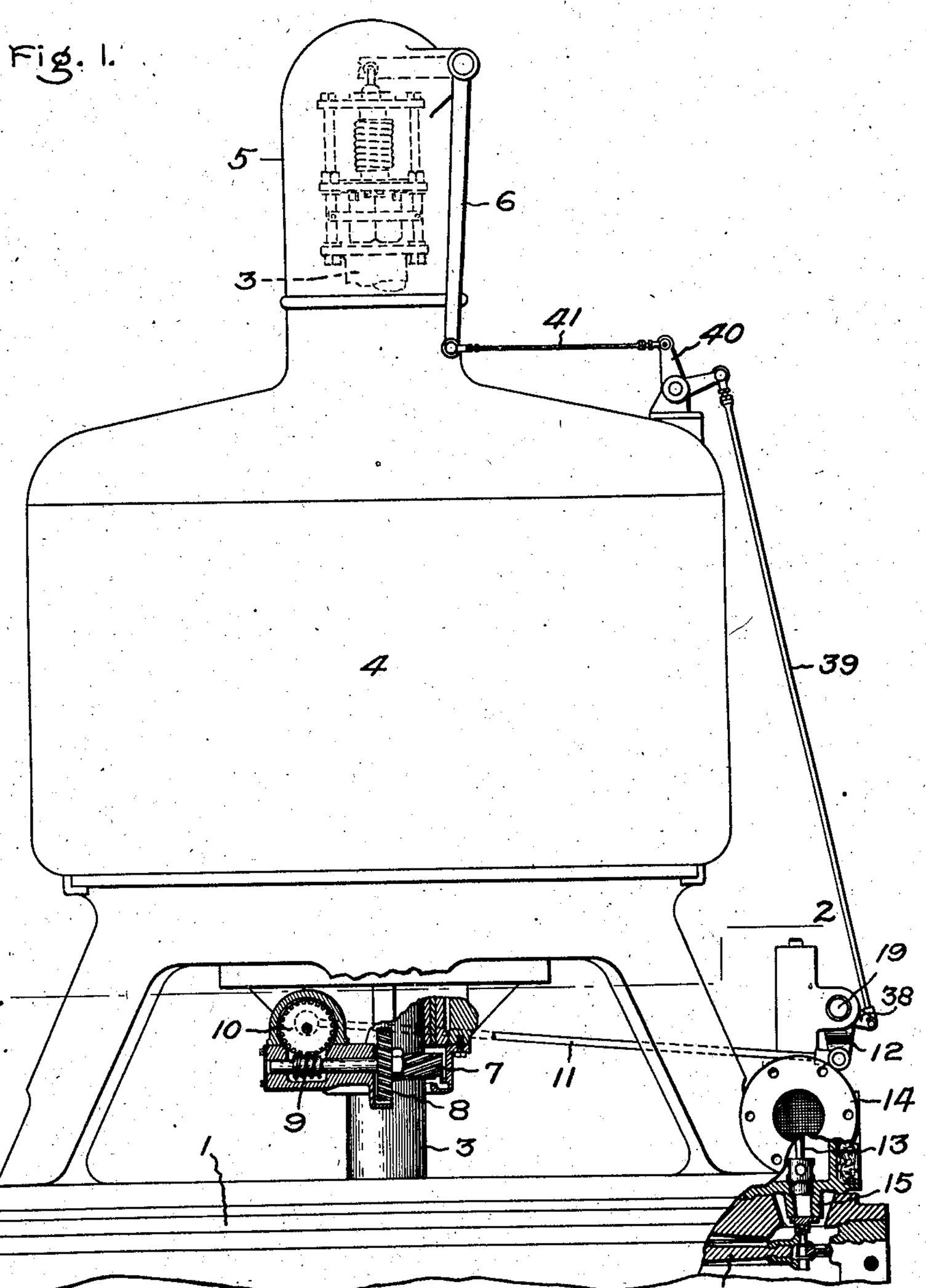
D. HURLEY.

# GOVERNING MECHANISM FOR TURBINES.

APPLICATION FILED SEPT. 1, 1905.

6 SHEETS—SHEET 1.

Fig. 1.

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6 SHEETS—SHEET 2.

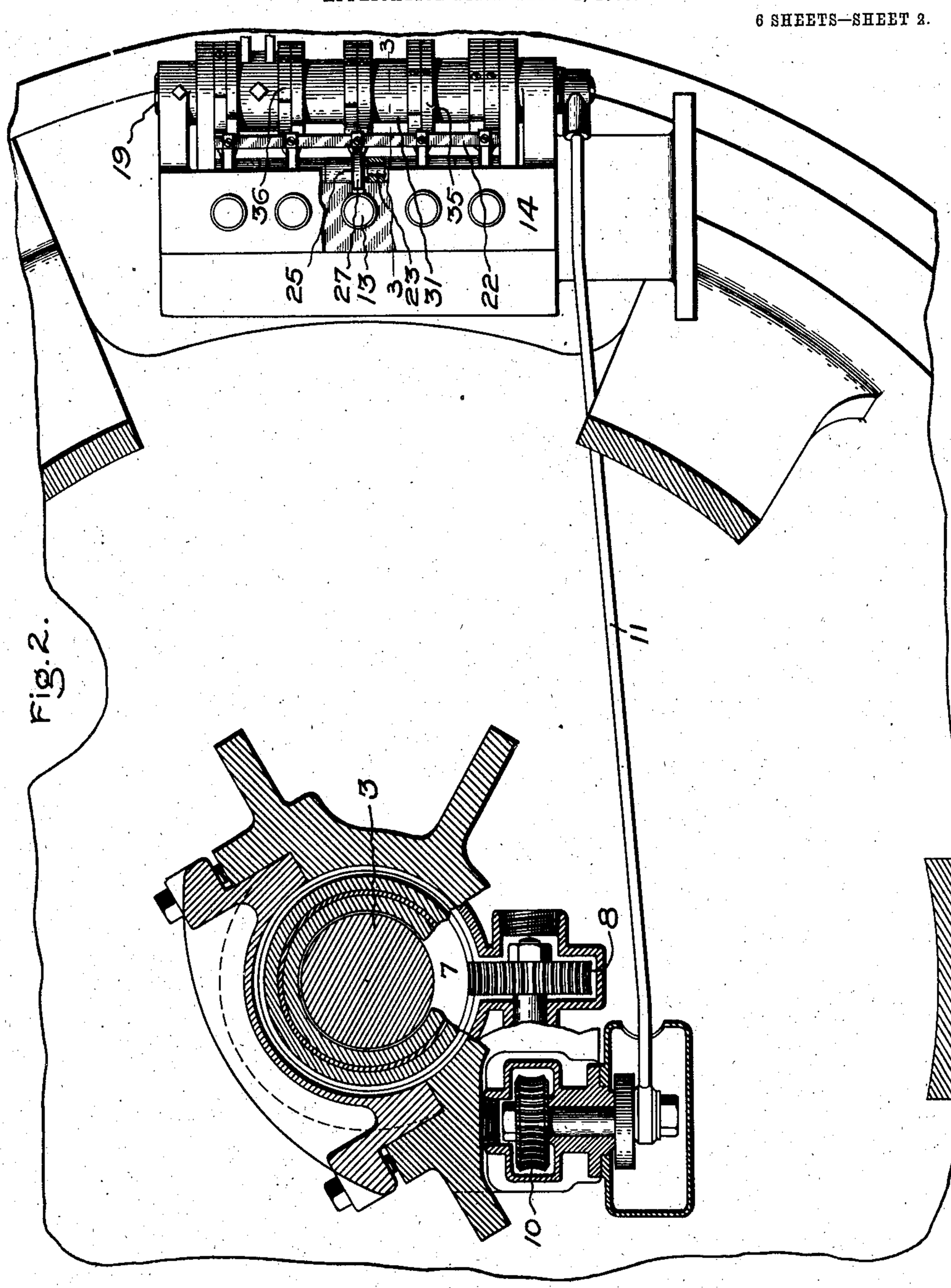


Fig. 2.

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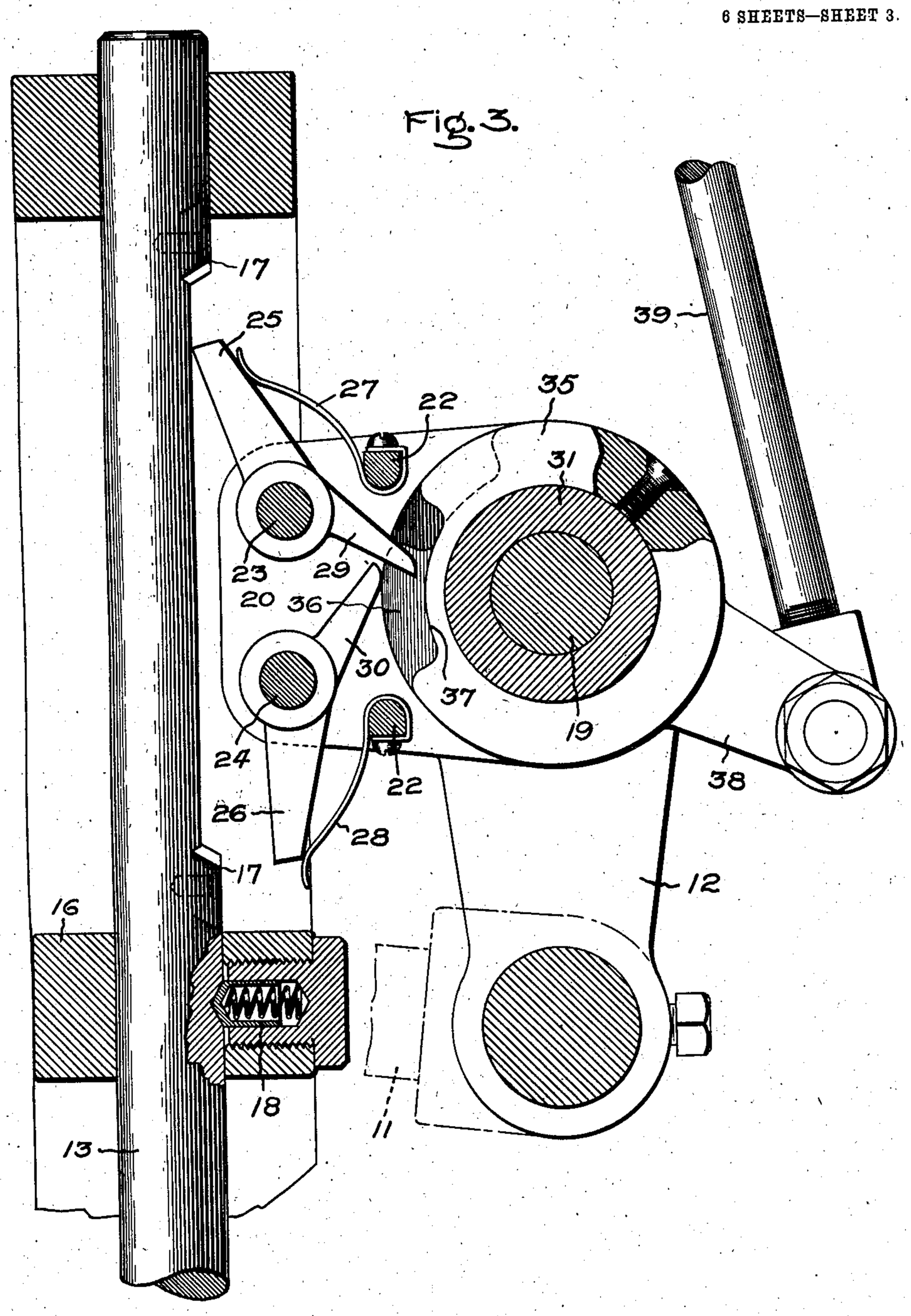
6 SHEETS—SHEET 3.

Fig. 3.

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6 SHEETS—SHEET 4.

Fig. 4.

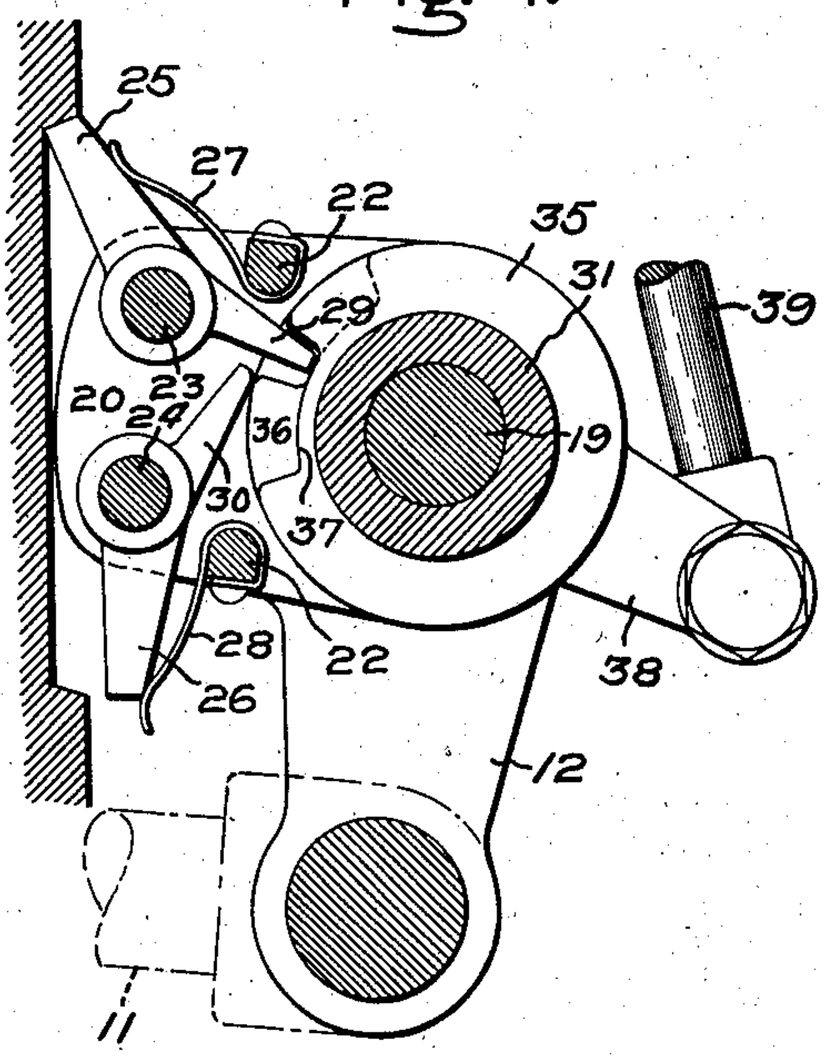



Fig. 5.

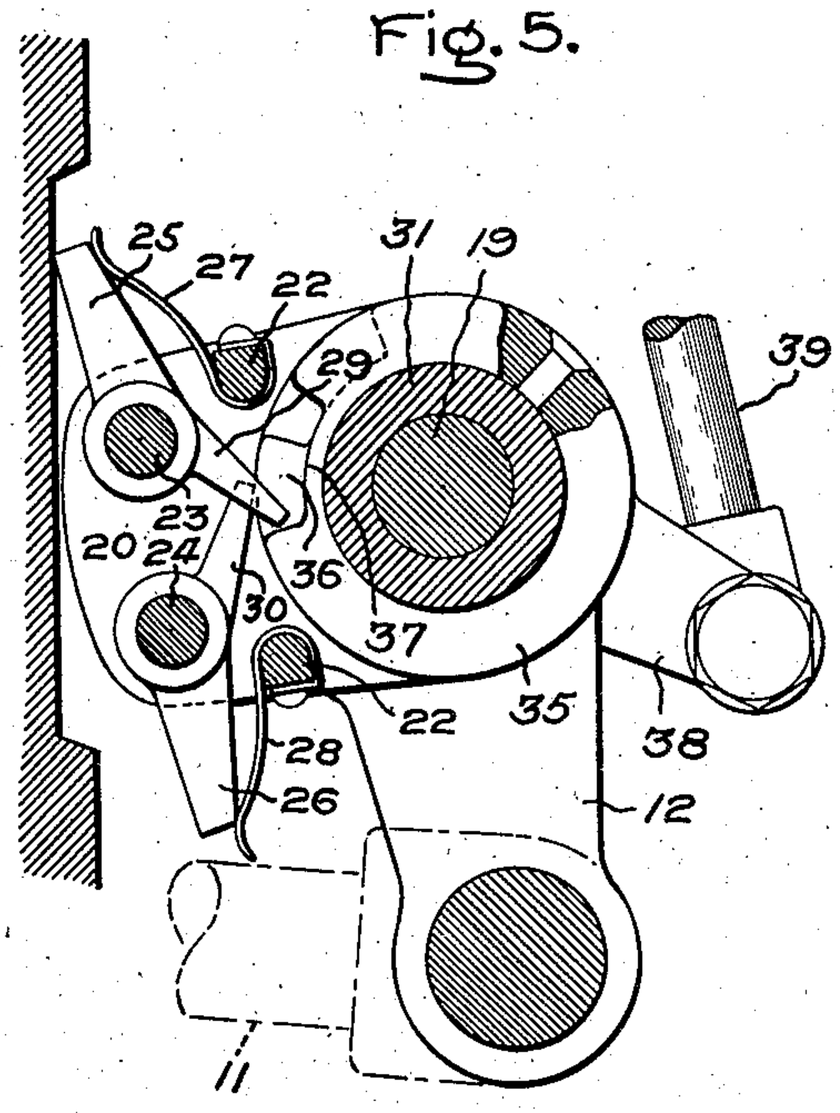



Fig. 6.

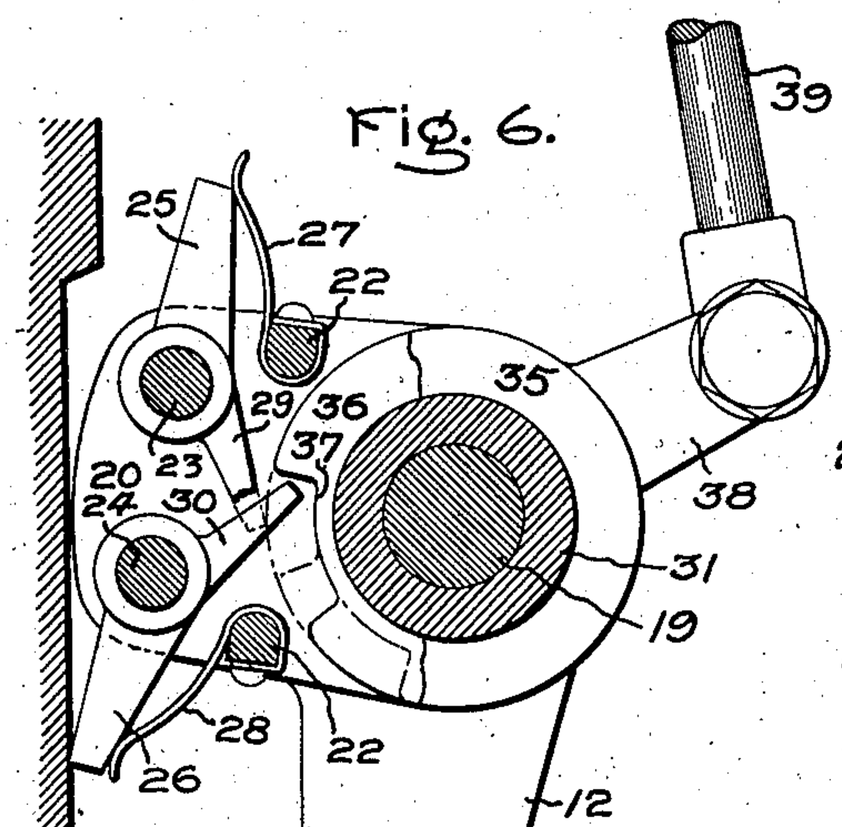
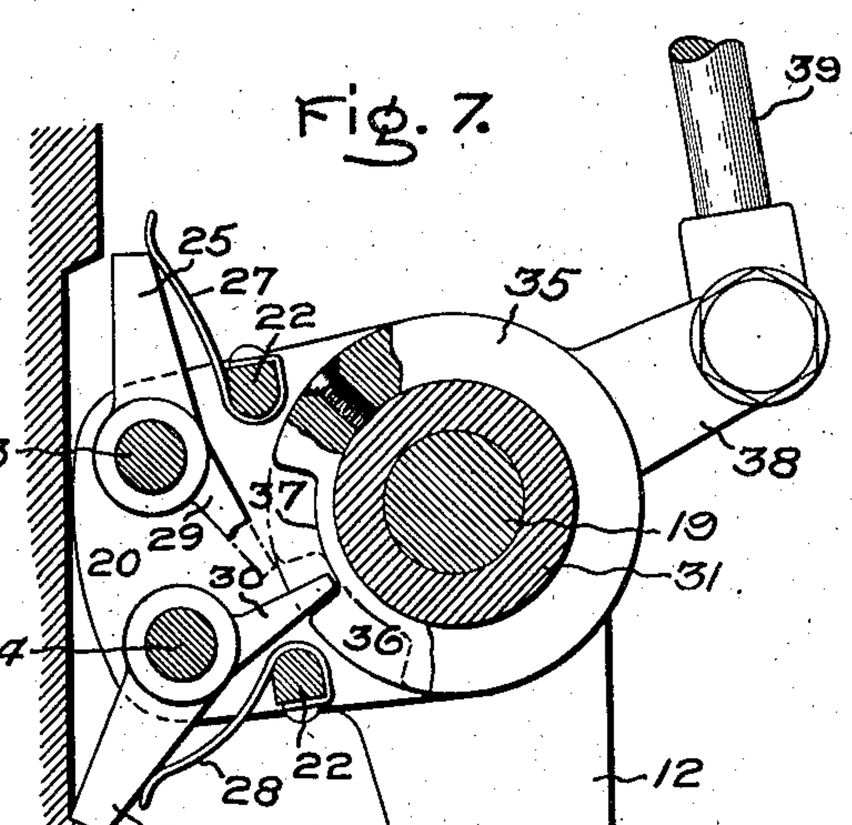



Fig. 7.

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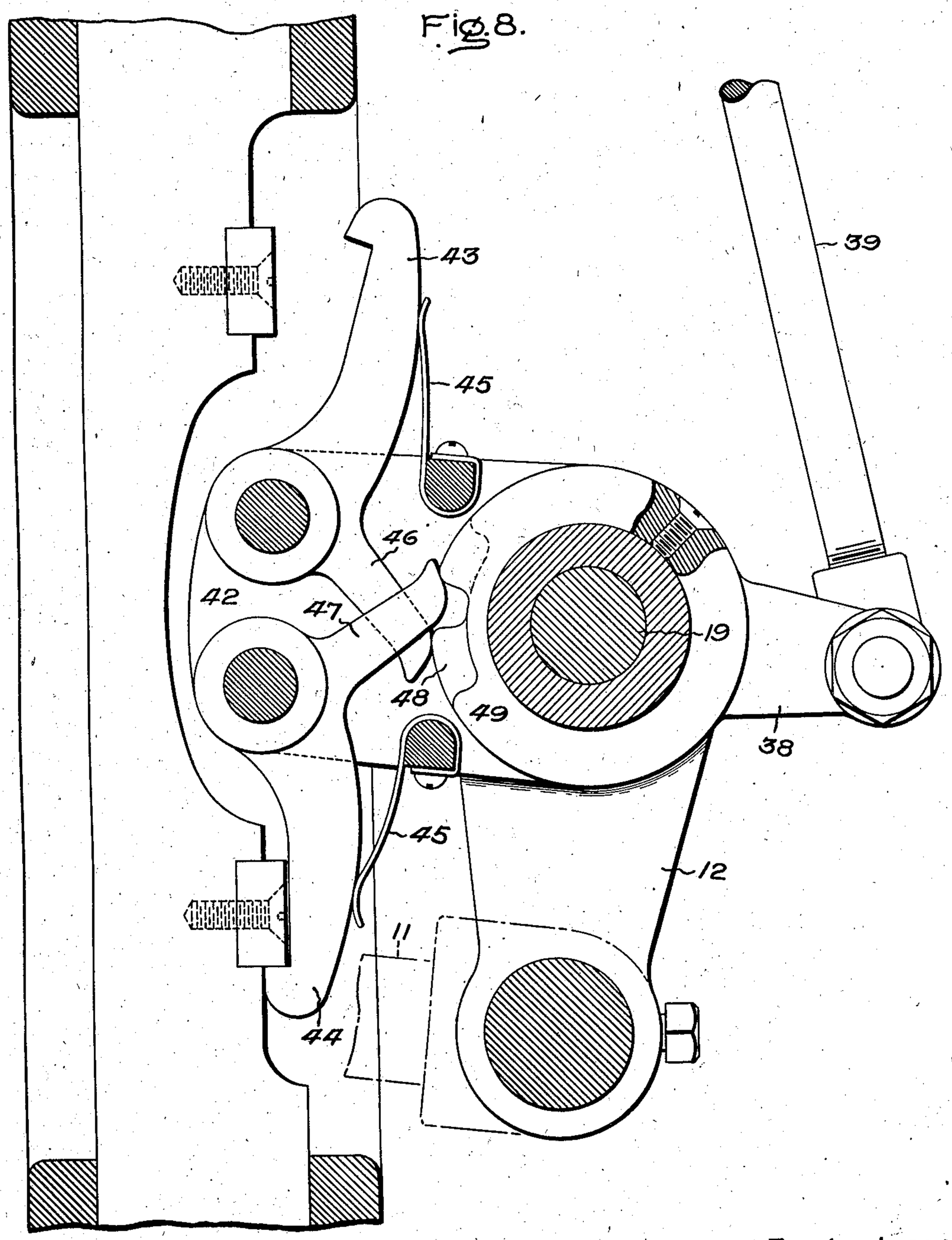
6 SHEETS—SHEET 5.

Fig. 8.

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6 SHEETS—SHEET 6.

Fig. 9.

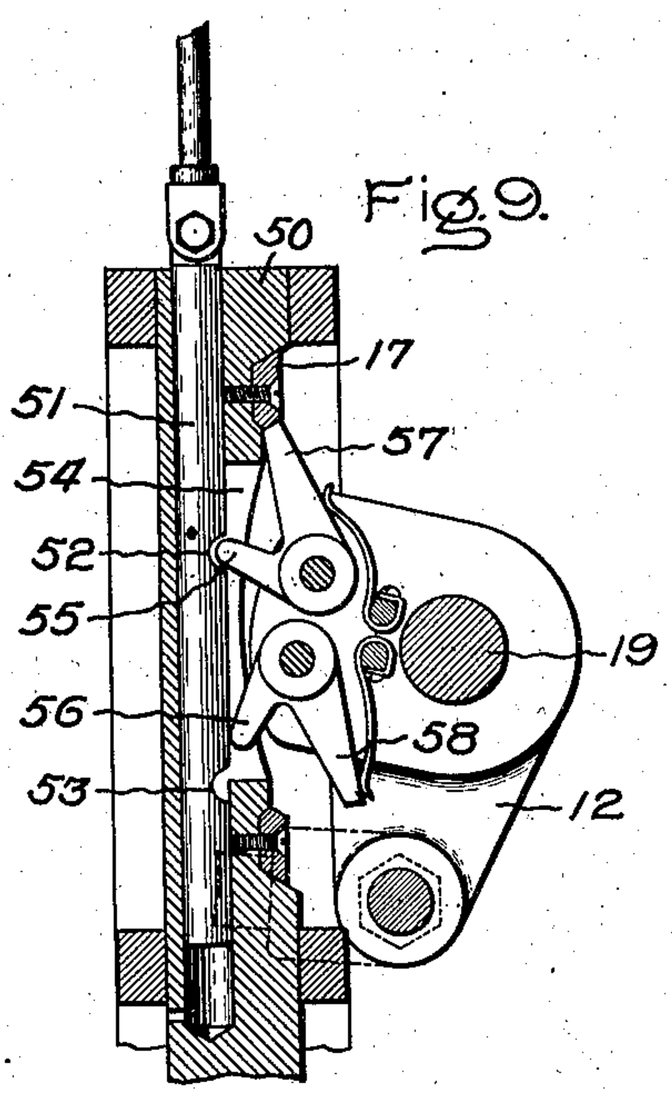



Fig. 10.

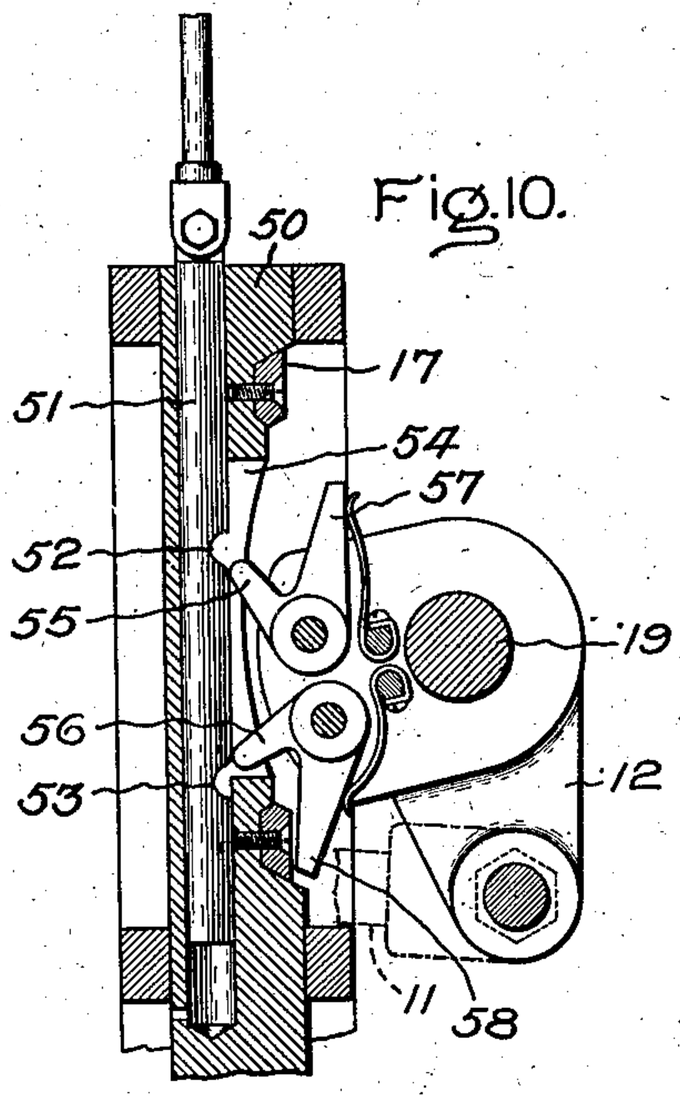



Fig. 11.

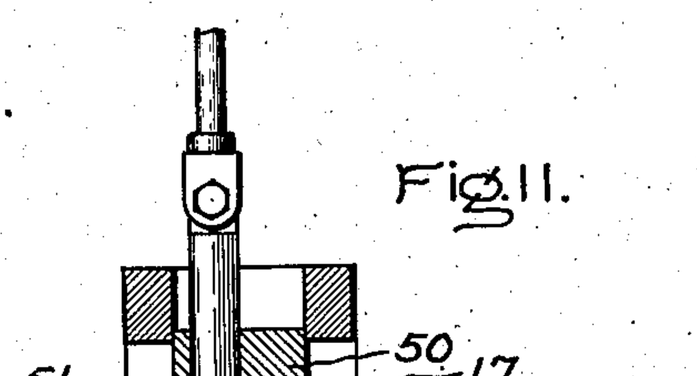
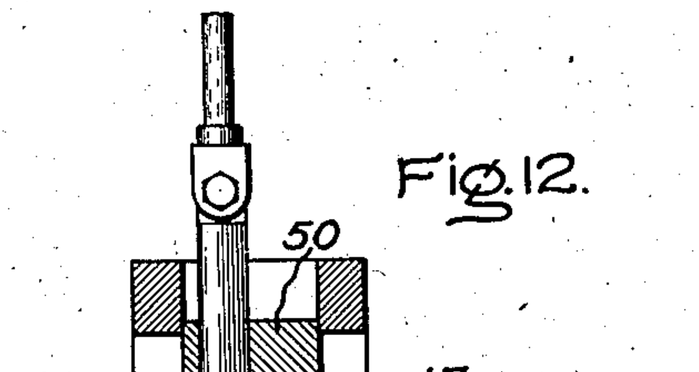



Fig. 12.

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# UNITED STATES PATENT OFFICE.

DANIEL HURLEY, OF PROVIDENCE, RHODE ISLAND, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

## GOVERNING MECHANISM FOR TURBINES.

No. 815,833. Specification of Letters Patent. Patented March 20, 1906.

Application filed September 1, 1905. Serial No. 276,669.

*To all whom it may concern:*

Be it known that I, DANIEL HURLEY, a citizen of the United States, residing at Providence, county of Providence, and State of Rhode Island, have invented certain new and useful Improvements in Governing Mechanism for Elastic-Fluid Turbines, of which the following is a specification.

The present invention relates to governing mechanism for elastic-fluid turbines, and has for its object to provide an effective governing mechanism wherein the valves are positively actuated by mechanical means which is simple, compact, and of a rugged character.

In the accompanying drawings, which illustrate embodiments of my invention, Figure 1 is a side elevation, partly in section, of the upper portion of a turbine of the Curtis type together with a generator driven thereby. Fig. 2 is a sectional and partial plan view of the same, taken on line 2 2 of Fig. 1. Fig. 3 is a sectional view, partly in elevation, of the valve-operating mechanism, the section being taken on line 3 3 of Fig. 2. Figs. 4 to 7, inclusive, show the four principal positions of the valve-actuating mechanism. Fig. 8 is a view in side elevation with certain of the parts and sections of a slight modification, wherein the valves are opened by a pulling action of the dogs instead of by a pushing action, as in the previous figures; and Figs. 9 to 12, inclusive, show a further modification wherein the device for controlling the actuating-dogs is located within the stem of the valve.

1 represents the casing of a turbine containing bucket-wheels 2, mounted on the upright shaft 3. Situated above the turbine and driven thereby is an electric generator 4. The main shaft 3 is common to the rotating elements of the turbine and the generator. The upper end of the shaft is provided with a speed-responsive device which is surrounded by the dome 5. Motion from the device to the valve mechanism is imparted by means of the bell-crank lever 6 and other parts, as will hereinafter appear.

The present valve-gear depends for its action upon a motive device which is constantly moving to and fro either in a straight line or in the arc of a circle. In order to transmit motion from the main shaft of the turbine to said device, which may for the purposes of this description be called a "steam-lever," the following mechanism is employed: Mounted on the main shaft at a point below the middle bearing is a gear 7, meshing with a pinion 8, the latter being mounted on a horizontal shaft carrying a worm 9 for transmitting its motion to the worm-wheel 10. The worm-wheel 10 is mounted on a suitable shaft, that carries a disk 11 at its outer end. On the disk is mounted a crank-pin, which is connected by the connecting-rod 11 with the arm 12, the latter being keyed or otherwise connected to the steam-levers which actuate the valves.

As many valves may be provided as are desired. These valves may regulate the admission of steam or other elastic fluid to the turbine, or they may regulate the passage of steam from one stage to the next in a multistage machine. I may provide each valve with a separate stem, or two or more valves may be provided with the same stem and so located that one valve will control the admission of steam to the turbine, another valve the passage of steam from one stage to another of lower pressure, and so on. The number of admission-valves can be increased or decreased from that shown in the drawings. They are designed to operate successively both in opening and in closing, under normal conditions; but under abnormal conditions the governor may so shift the parts that two or more of the valves in the same stage will open or close simultaneously, or practically so, to satisfy any sudden change in load. Since all of the valves and their actuating mechanisms are alike, a detail description of one of them will be sufficient.

13 represents the stem of an unbalanced admission-valve located in the chest 14, Figs. 1 and 2, and controlling the passage of the motive fluid to the nozzle or nozzle-sections 15 of the turbine. The stem is provided with one or more guides 16 for directing its vertical movements. I prefer to have a guide above as well as below the actuating mechanism. In the present embodiment of the invention the valve is attached to the lower end of the stem. At one side of the center of the valve-stem it is slightly flattened, and the ends of the flattened portion are provided with shoulders formed of detachable hardened steel blocks 17. Mounted in one of the guides is a spring-pressed plunger 18, that is adapted to enter a beveled depression in the

valve-stem, and thus serve to hold the valve in a definite open position with respect to its seat. In Fig. 3 the valve is assumed to be wide open. When the valve is seated, it is unbalanced, and hence the pressure of the steam in the chest serves to keep it closed.

Situated at one side of the valve-stem and extending at right angles thereto is a fixed spindle 19, upon which the steam-levers 20 are loosely mounted. To one of the levers is attached the downwardly-extending arm 12, which in turn is connected by the connecting-rod 11 with the main driving-shaft, and as the connecting-rod moves to and fro a rocking or to-and-fro motion is imparted to the steam-lever. In order that all of the steam-levers may be driven from the same crank-shaft, they are united by the horizontally-extending bars 22. They may also be united by rods 23 and 24, acting as pivots for the actuating-dogs 25 and 26. The dogs are normally pressed into engagement with the valve-stem by flat springs 27 and 28, mounted on the frame-pieces 22. The toe of each of the pivoted dogs is adapted to engage one of the shoulders 17 on the valve-stem, and by a pushing action open or close the valve. The dog 25 is provided with a tail portion 29, that is adapted to govern its action on the valve. The dog 26 is provided with a tail portion 30 for the same purpose. Surrounding the spindle 19 and loosely mounted thereon is a sleeve 31, upon which the two-part shields 35 36 for governing the action of each pair of dogs are mounted. Each part of these shields is provided with a cut-away portion, as indicated at 37, and another portion which presents an unbroken cylindrical surface to the tail of the dog. One part of the shield controls the action of the upper dog and the other the action of the lower dog. In order that these dogs shall not interfere with each other in their action, they are slightly offset and under certain conditions overlap. It will be noted in Fig. 3 that the tail portion of the upper dog is situated in the cut-away portion 37, which means that the spring 27 is holding the dog in a position to engage the upper shoulder on the valve-stem. It will also be seen that the tail portion of the lower dog is riding on the peripheral surface of the shield and that the dog is held in an inoperative position against the stress of the flat spring 28. Assuming now that the steam-lever is rocked about the axis of the spindle 19, the upper dog 25 will move until it just touches the shoulder 17, when its motion will be reversed by reason of the reversal of motion of the connecting-rod 11, and the dogs will move downward. So long as the lower dog 26 is held in the position shown the rocking or to-and-fro movements of the steam-lever will have no effect; but just as soon as the shield is shifted. so that the upper dog is thrown out of engagement and the lower dog into engagement with the valve-stem, the next stroke of the steam-lever will close the valve, it being understood that a single stroke of the steam-lever closes the valve and a single stroke opens it. It is evident from the foregoing that as the load changes it will become necessary to cause this dog or that to engage the valve-stem and actuate the valve. To accomplish this, the parts 35 and 36 of each shield are mounted upon the sleeve 31 and fastened by screws or other devices. These shields are set one behind the other by such amount as will cause the valves to normally open one after the other and close in like order. To the sleeve 31 is attached an arm 38, the latter being connected by the rod 39, bell-crank lever 40, Fig. 1, adjustable connecting-rod 41 with the bell-crank lever 6, which responds to changes in position of the shaft-governor. As the shaft-governor changes its position it shifts the shields of the different valves to such positions that the proper relation between the motive fluid admitted and the load is established. Under normal conditions some of the valves are opened, some of the valves are closed, and at least one valve is opening and closing more or less frequently for regulating purposes. When the load on the turbine is at a maximum, all of the valves will be open except the last, which will open and close rather slowly to compensate for minor load changes. For a definite load the shields for the different valves will remain stationary, while all of the steam-levers are constantly moving to and fro at any predetermined rate—for example, one hundred strokes per minute. The upper dogs work by a push action to open the valves, and the lower dogs by a push action to close the valves. It is preferable to locate the axes of the dogs as near as possible to the stem, so that the push will be nearly in a straight line, and hence not force the stems over against the opposing surfaces of the guides 16.

Referring to Fig. 4, the steam-lever 20 is shown in its extreme upper position, and the dog 25 is in engagement with the shoulder on the valve-stem. The position of the part 35 of the shield is such that the dog is permitted to assume the position shown. The position of the part 36 of the shield is, however, so disposed as to hold the lower dog 26 out of action.

In Fig. 5 the steam-lever 20 is shown at the end of its downward stroke, the dog 25 having moved downward over the flattened face of the valve-stem, the relative position of the dog 26 with respect to the steam-lever remaining unchanged. The next stroke of the steam-lever 20 in the upward direction will merely raise the dog 25 until it touches the

upper shoulder of the valve-stem. In other words, the dogs do no work except when it is necessary to move a valve.

In Fig. 6 the valve is shown in the closed position, with the steam-lever 20 in its extreme upper position. In this case the part 35 of the shield is moved to a position where it engages the tailpiece of and holds the dog 25 out of action. The part 36 of the shield has, however, been moved by the governor to a point where the tailpiece of the dog 26 registers therewith and the dog is in the operative position.

In Fig. 7 a similar relation of parts is shown to that in Fig. 6, except that the steam-lever is at its lower position.

In Fig. 8 is shown a slight modification of the invention, wherein the valves are opened and closed by a pulling action of the dogs instead of a push action. In this figure 42 represents the steam-lever, which is supported and actuated in the manner previously described. 43 and 44 are dogs loosely pivoted on the steam-lever and normally pressed into engagement with the valve-stem by the flat springs 45. The upper dog is provided with a tailpiece 46 and the lower one with a tailpiece 47. The former coöperates with the part 48 of the shield and the latter with the part 49 of the shield. Owing to the fact that the dogs act by a pulling action instead of a pushing action, the connection between the governor and the arm 38 has to be reversed. This construction has the advantage that the axes of the dogs can be arranged directly in line with the points of engagement of the dogs, and in this way eliminate any side thrust upon the parts.

Referring to Figs. 9 to 12, inclusive, I have shown a modification of my invention, wherein the shields for controlling the dogs are placed inside of the valve-stems, thus simplifying the parts, reducing the size of the apparatus as a whole, and eliminating some of the structural difficulties involved in mounting a number of individually-moving parts on the same spindle 19, as in the previous figure. 50 represents the valve-stem, which is bored longitudinally to receive the shield 51. The shield in the present instance takes the form of a cylindrical rod containing the transverse notches 52 and 53. These notches correspond in function to the depression in the cylindrical shields previously referred to. The steam-lever for each valve is mounted on the spindle 19 and receives its motion therefrom. The spindle is keyed to and moved by the arm 12, the latter receiving motion from the connecting-rod 11. In addition to the cylindrical opening in the shield the valve-stem is cut away at 54 to receive the tails 55 and 56 of the dogs 57 and 58. With the parts as shown in Fig. 9 the upper dog 57 is active and the lower dog 58 inactive. As the steam-lever moves downward about its axis the wall of the depression 52 gradually moves the dog 57 to the position shown in Fig. 10, while the tail portion 56 of the lower dog merely rides downward on the surface of the shield. In Fig. 11 the valve is shown in the closed position, while the steam-lever is in the raised position. The position of the shield 51 has been so changed by the governor, which is attached to the upper end, that the upper notch or depression 52 no longer affects the movements of the upper dog 57, while the lower depression 53, which was formerly inactive, is now active and controlling the in-and-out movements of the dog 58. In Fig. 12 the valve is shown in the closed position, as before, the shield keeping the same position; but the steam-lever is now at its lowest position, and the depression 53 coöperating with the flat spring has permitted the lower dog to drop into its normal operative position. Instead of using dogs that operate by a pushing action to move the valves I may employ dogs which operate by a pulling action, as typified by those in Fig. 8, as will be readily understood.

As stated in connection with the previous figures, only one stroke of the steam-lever is necessary to open or close a valve, and subsequent movements of the steam-lever after the valve has been opened or closed have no effect thereon until such time as the governor makes a change in the position of the shield due to a change in load. Where a number of valves are employed in governing the same machine, the shields for the different valves are connected together in such a manner that they will cause the valves to open and close one after the other for normal load changes and to permit two or more valves to open or close simultaneously for abnormal load changes. A satisfactory means for accomplishing this is to connect all of the shields together and set the notches or depressions 52 and 53 of the several shields one behind the other in point of operation.

The invention has been described in connection with a steam-turbine having a plurality of valves; but it is within the scope of my invention to provide the turbine with only one regulating-valve and to open and close it in accordance to the demand for motive fluid. I may utilize this feature in connection with an admission-valve or with a stage-valve, or with a single admission-valve and a stage-valve either mounted on the same or separate stems. The several constructions, as shown and described, possess the advantage that all of the actuating mechanism can be located on one side of the valve-stem, where it can readily be seen by the operator, and, further, the arrangement described reduces the over-all dimensions of the mechanism to the minimum.

In accordance with the provisions of the patent statutes I have described the principles of operation of my invention, together with the apparatus which I now consider to represent the best embodiment thereof; but I desire to have it understood that the apparatus shown is only illustrative and that the invention can be carried out by other means.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a governing mechanism, the combination of a valve, a stem for the valve, a lever situated at one side of the stem, dogs mounted thereon which engage the stem, and actuate the valve, a pivot for the lever situated on the same side of the stem as the dogs, and a shield responsive to load changes for controlling the effective action of the dogs.

2. In a governing mechanism, the combination of a valve, a stem for the valve, a lever situated wholly on one side of the stem, dogs mounted thereon which engage the stem and actuate the valve, tailpieces for the dogs, a shield which coöperates with the tailpieces to control the effective action of the dogs, and a load-responsive device for moving the shield.

3. In a governing mechanism, the combination of a valve, a stem for the valve, a lever having a constant to-and-fro motion, dogs mounted thereon which engage the stem and actuate the valve, tailpieces for the dogs, a shield, depressions in the shield the walls of which act on the tails of the dogs and control their action, and a shaft-governor for changing the relative positions of the tails and depressions.

4. In a governing mechanism, the combination of a valve, a stem for the valve, a steam-lever situated wholly on one side of the stem, a pivot for the lever also situated on the same side of the stem and extending at right angles thereto, a valve-opening and a valve-closing dog mounted on the lever, tailpieces for the dogs, a shield for governing the effective action of the dogs on the valve, depressions into which the tails of the dogs enter as the lever is moved from one position to the other, and a speed-responsive device for moving the shield.

5. In a governing mechanism, the combination of a plurality of regulating-valves, steam-levers for the valves situated wholly on one side thereof, a pivot common to the levers and situated on the same side of the valves, dogs mounted on the end of the levers adjacent to the stems, shields for controlling the action of the dogs which are also mounted on the same side of the valves, the said shields being set to give successive action of the dogs on the valves, and a shaft-governor for shifting the position of the dogs as the load changes.

6. In a governing mechanism, the combination of a valve, a pivoted steam-lever, dogs mounted on the lever for opening and closing the valve by a pulling action, and a speed-responsive device that determines which dog shall act on the valve.

7. In a governing mechanism, the combination of a plurality of valves, pivoted steam-levers which open and close the valves by a pulling action, shields that determine which dog or dogs shall act on the valve or valves, and a load-responsive device that moves the shields.

8. In a governing mechanism, the combination of an unbalanced valve which is held against its seat by fluid-pressure, a lever for opening and closing it, a motor for constantly keeping the lever moving to and fro, a governor for controlling the action of the lever on the valve, and a spring-pressed plunger which engages the valve-stem and holds the valve open when released by the lever.

9. In a governing mechanism, the combination of a regulating-valve, a stem therefor, a lever which has a constant to-and-fro motion, a dog carried by the lever for moving the valve, a shield located in the valve-stem for determining the effective action of the dog on the valve, and a load-responsive device for actuating the shield.

10. In a governing mechanism, the combination of a regulating-valve, a stem therefor having shoulders thereon and containing a longitudinal opening, a steam-lever which has a constant to-and-fro motion, dogs carried by the lever and arranged for engagement with the shoulders, a shield for controlling the effective action of the dogs, which is located in the longitudinal opening in the valve-stem, and a speed-responsive device which actuates the shields.

11. In a governing mechanism, the combination of a plurality of regulating-valves, perforated stems therefor, steam-levers which have a constant to-and-fro motion for opening and closing the valves, shields that are located in the stems for controlling the effective action of the levers on the valves, and a speed-responsive device that causes the shields to act on the dogs in a manner to produce successive movements of the valves.

In witness whereof I have hereunto set my hand this 19th day of August, 1905.

DANIEL HURLEY.

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