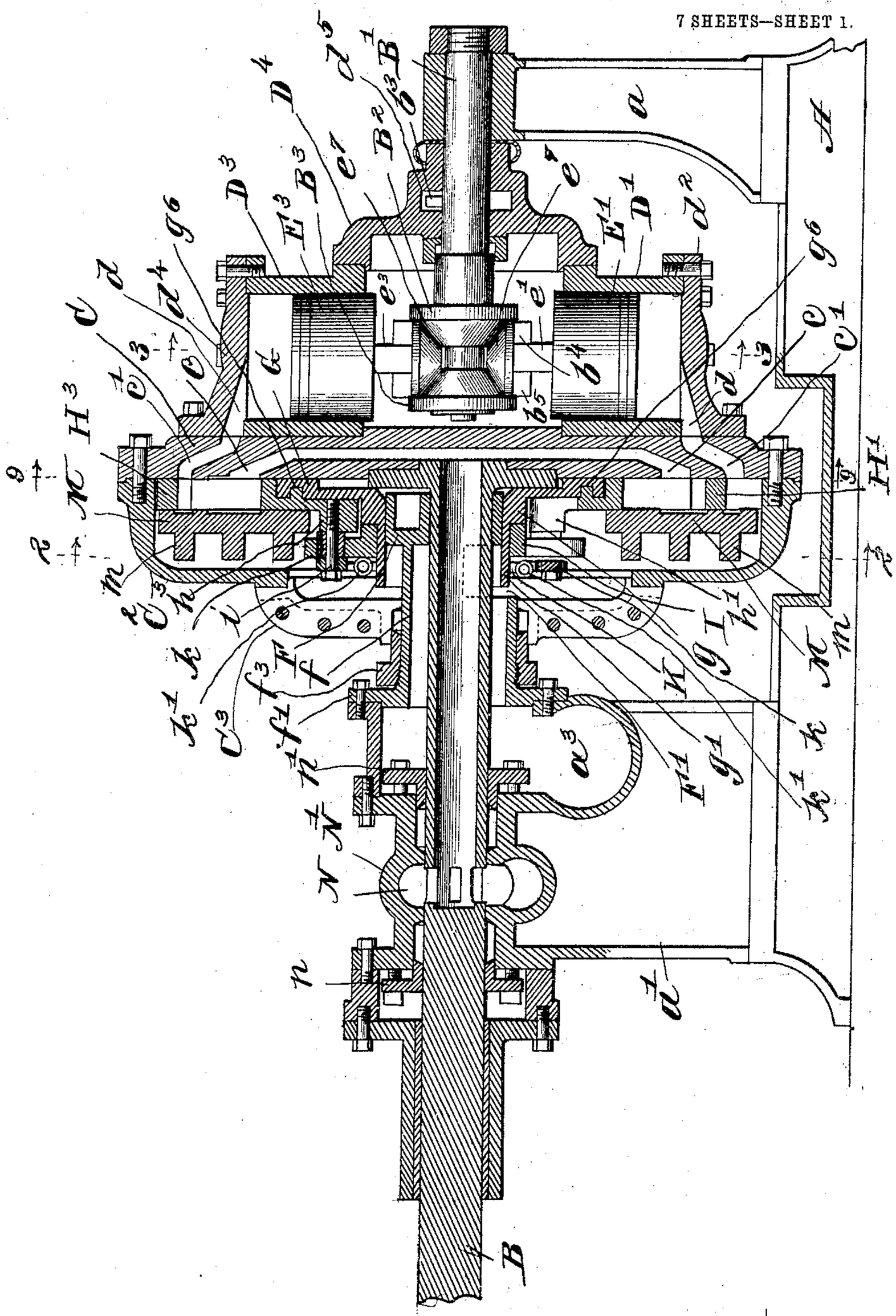
No. 822,001. PATENTED MAY 29, 1906.

C. A. HOLCOMB.

STEAM ENGINE.

APPLICATION FILED OCT. 12, 1903. RENEWED NOV. 2, 1905.

7 SHEETS—SHEET 1.



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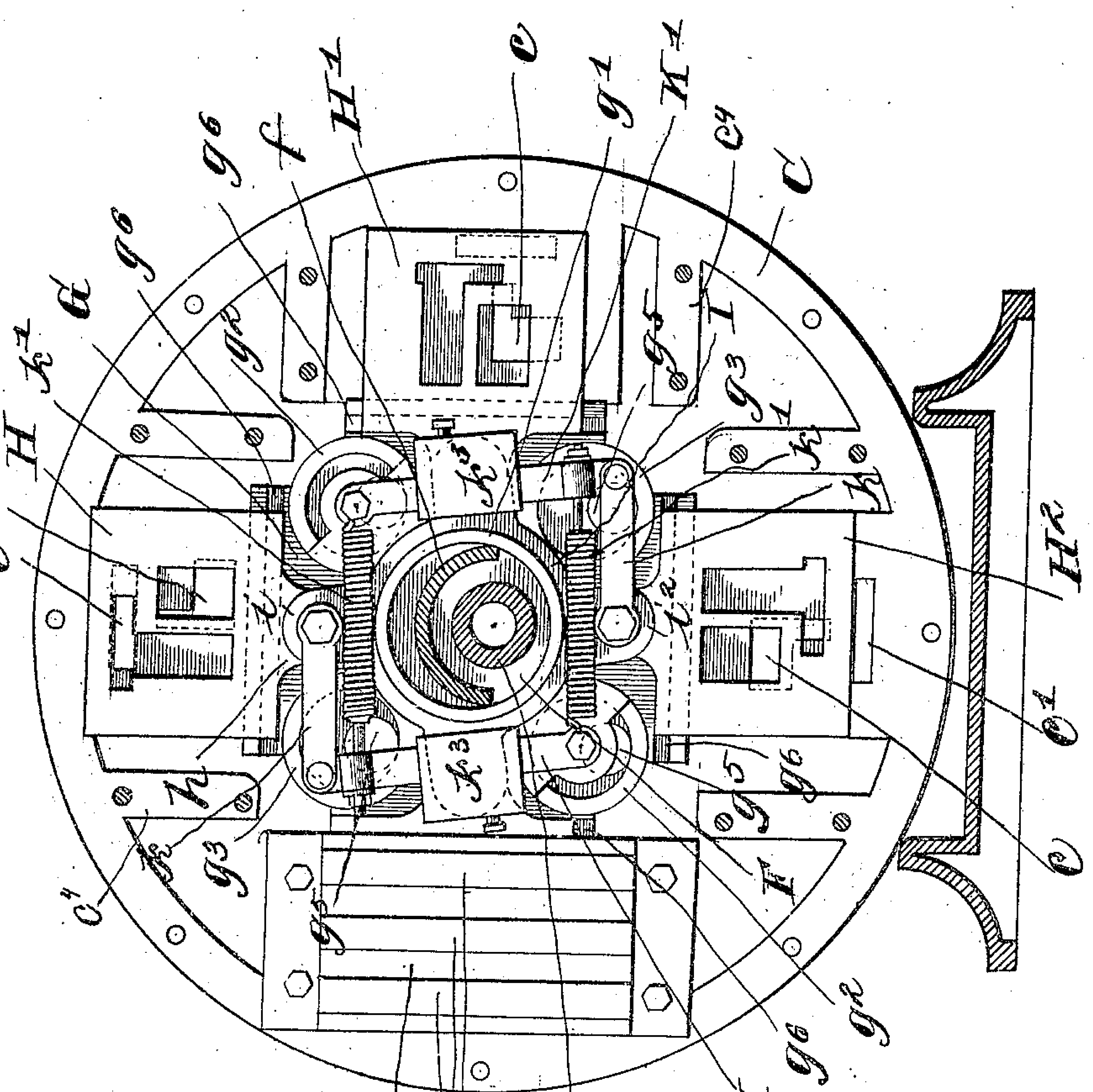

Fig. 2.

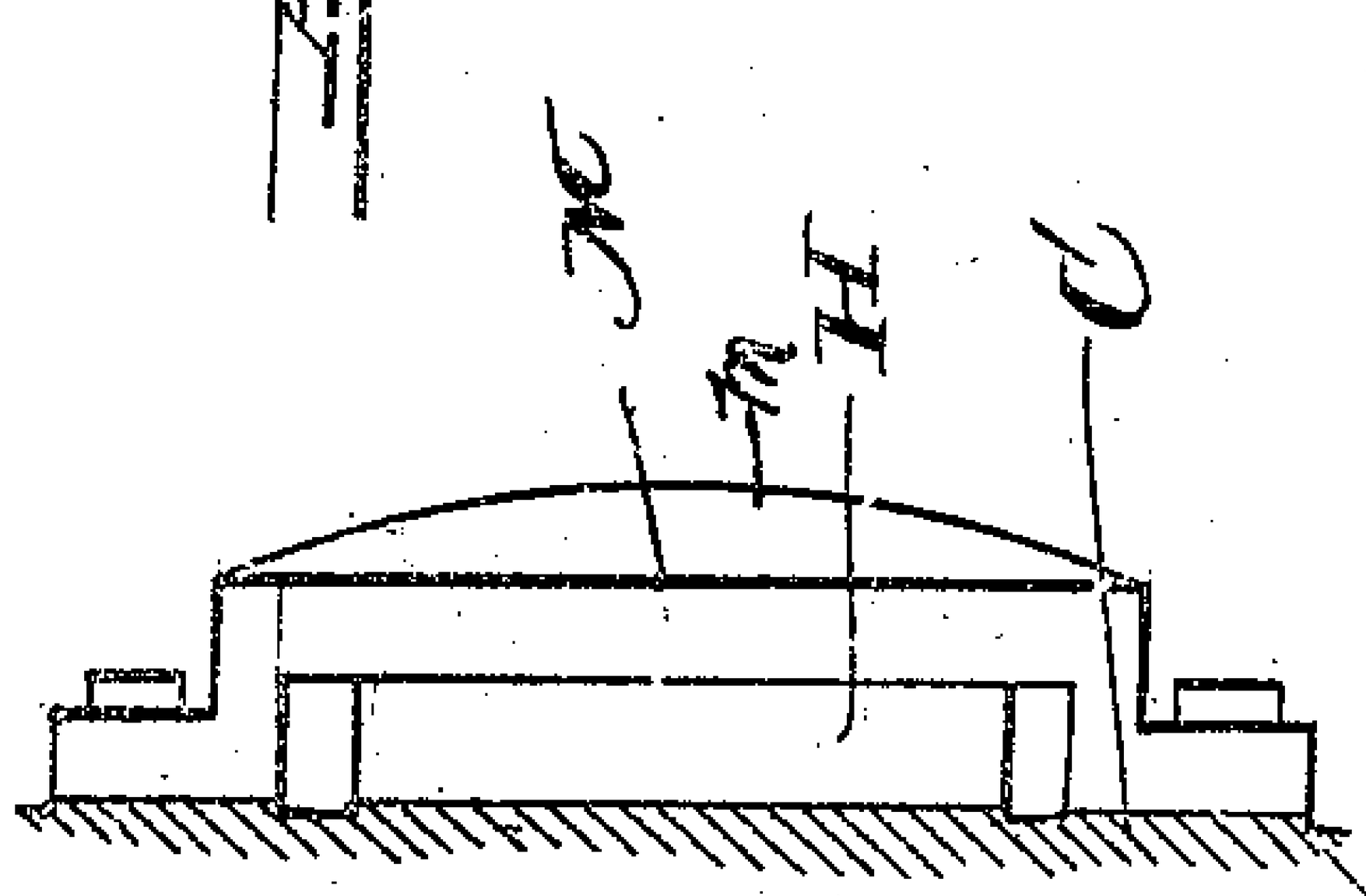

Fig. 11.

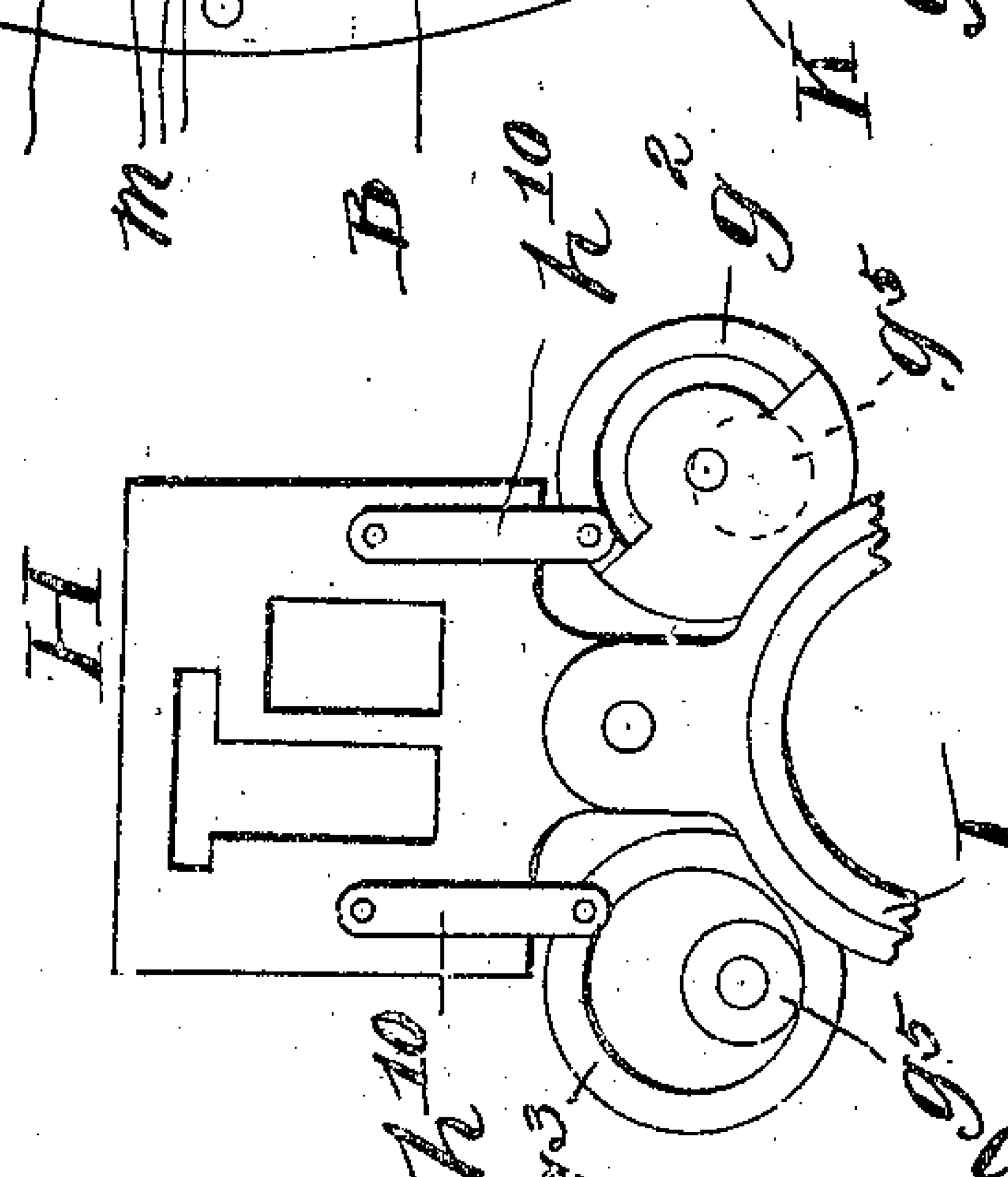

Fig. 10.

Witnesses.

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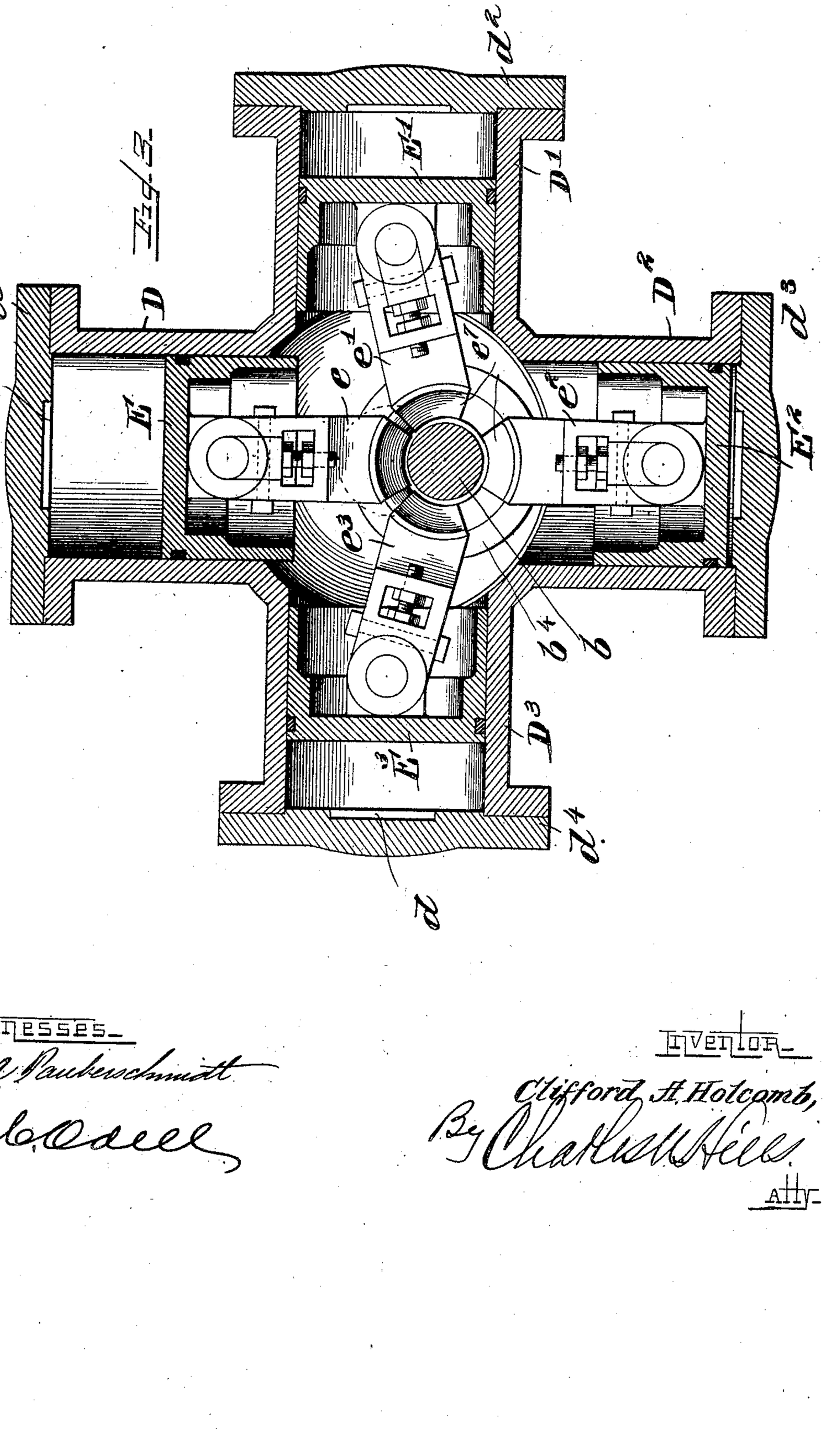
7 SHEETS—SHEET 3.



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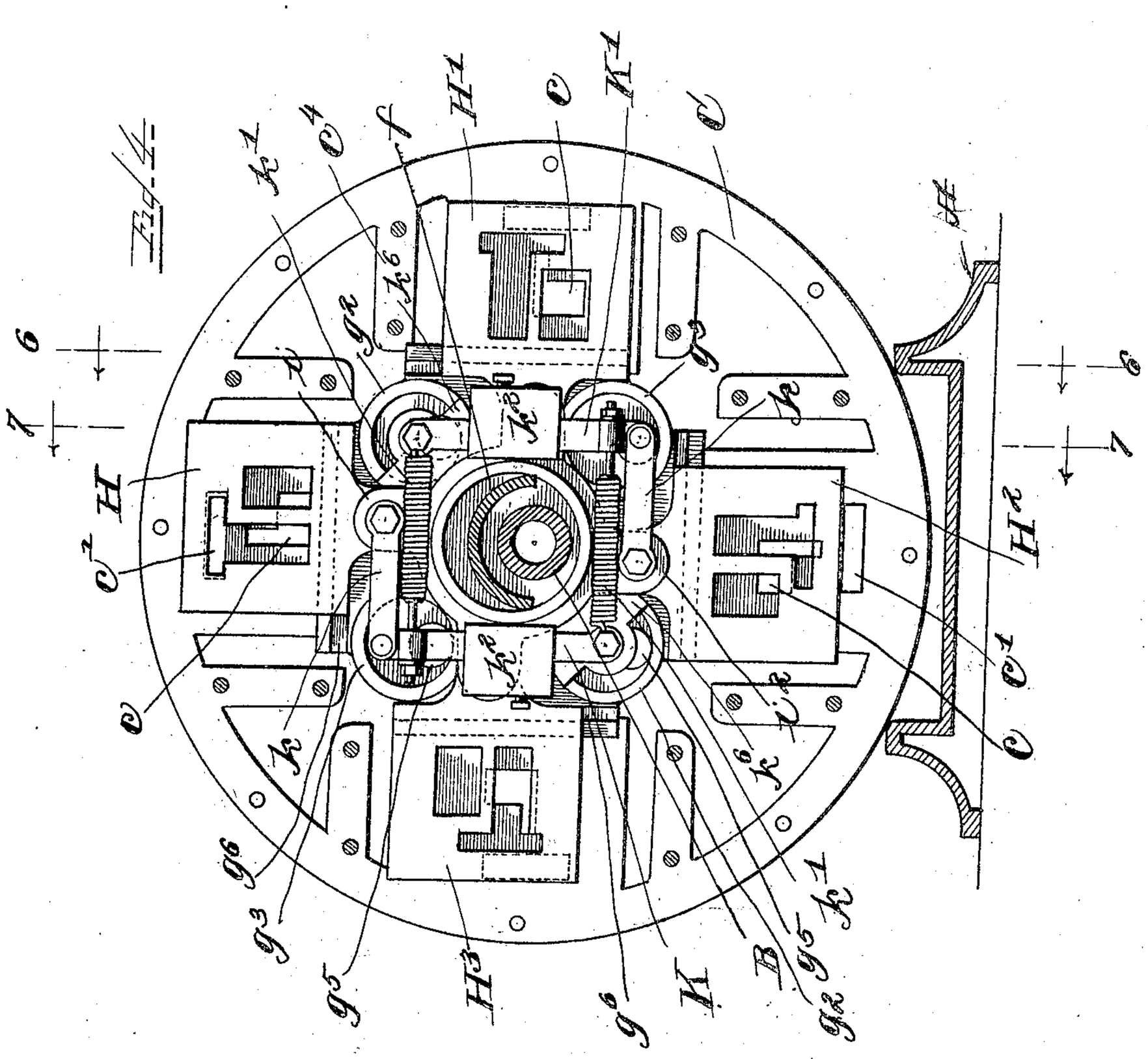

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7 SHEETS—SHEET 5.

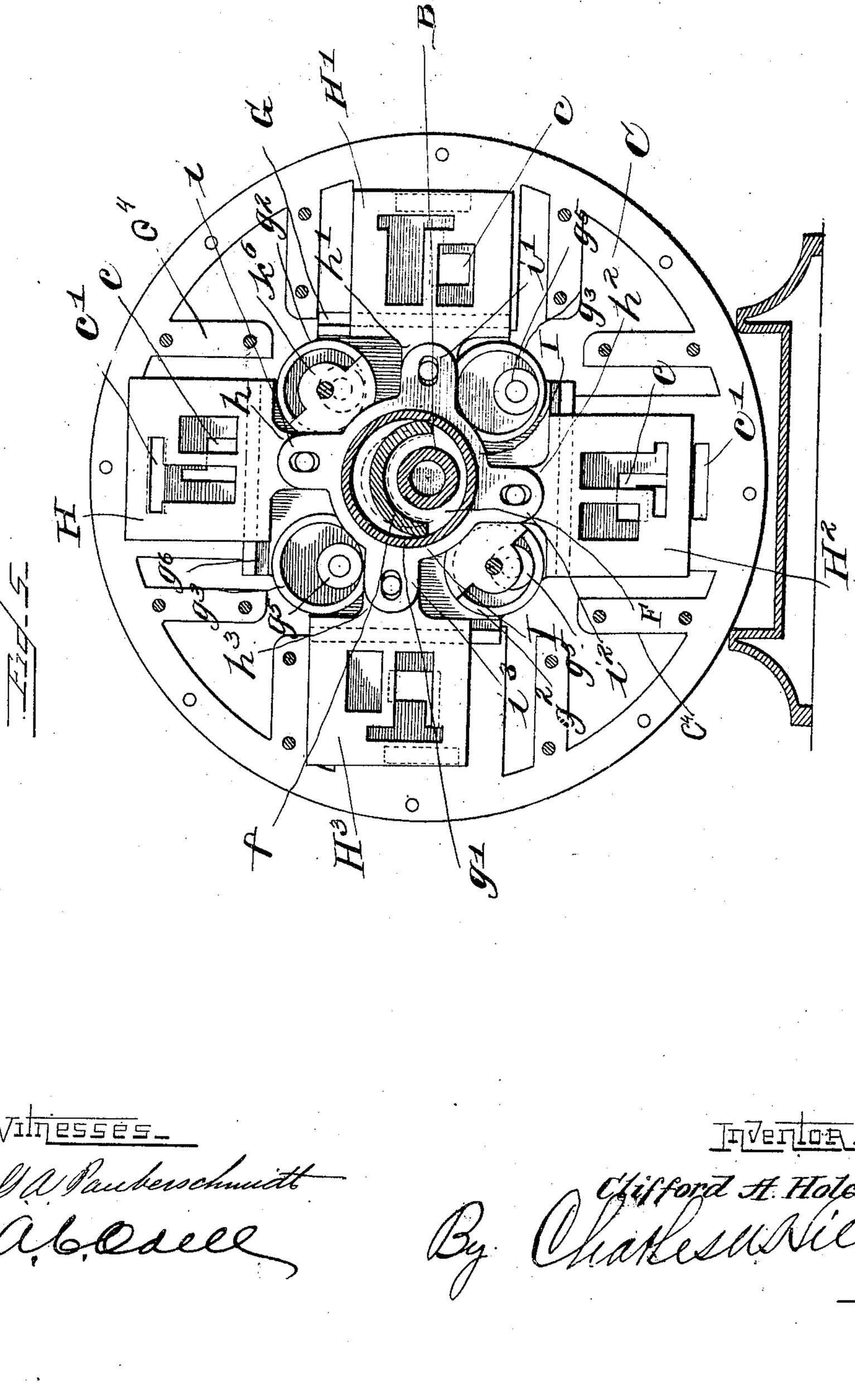

Fig. 5.

Witnesses—

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7 SHEETS—SHEET 6.

Fig. 6.

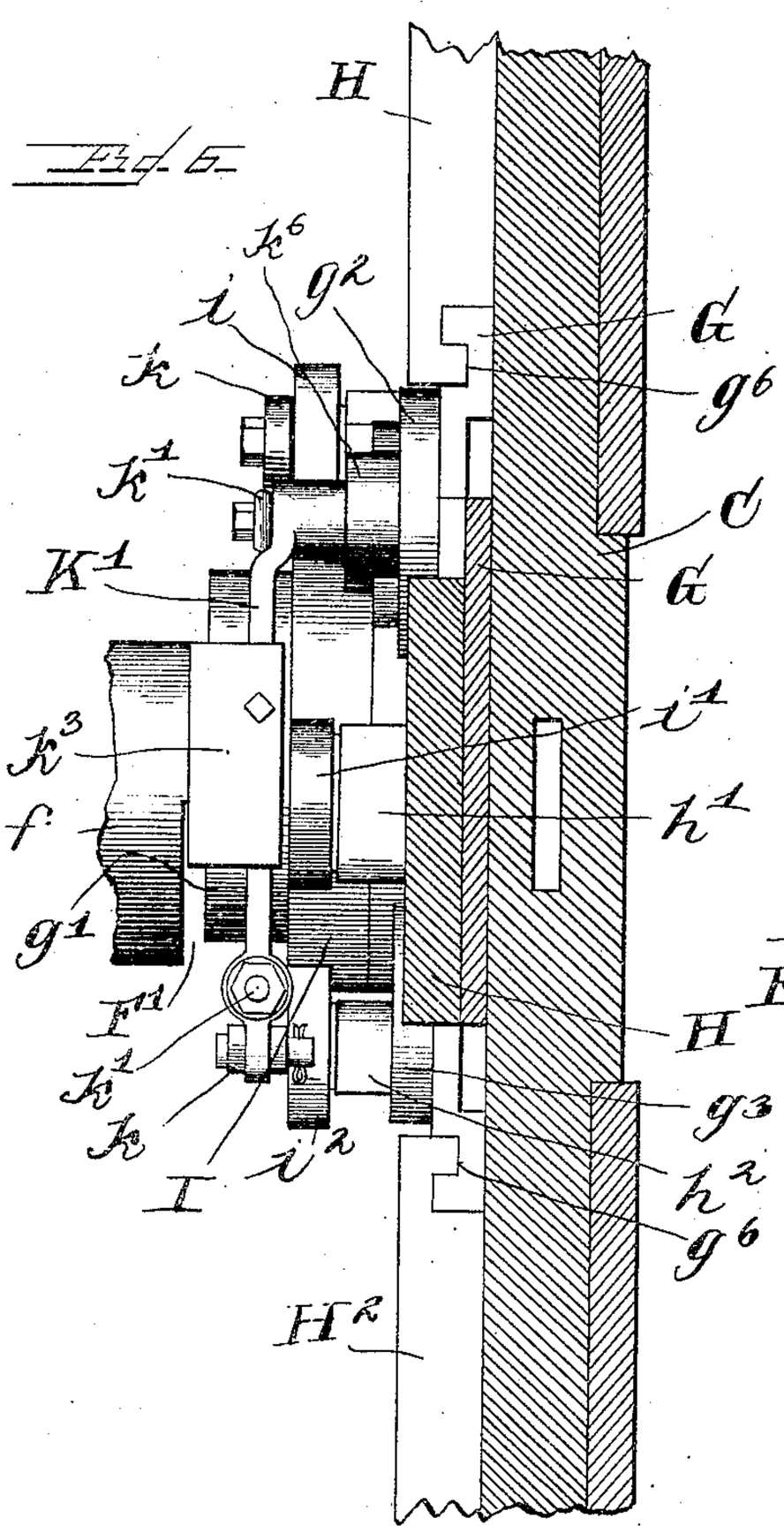
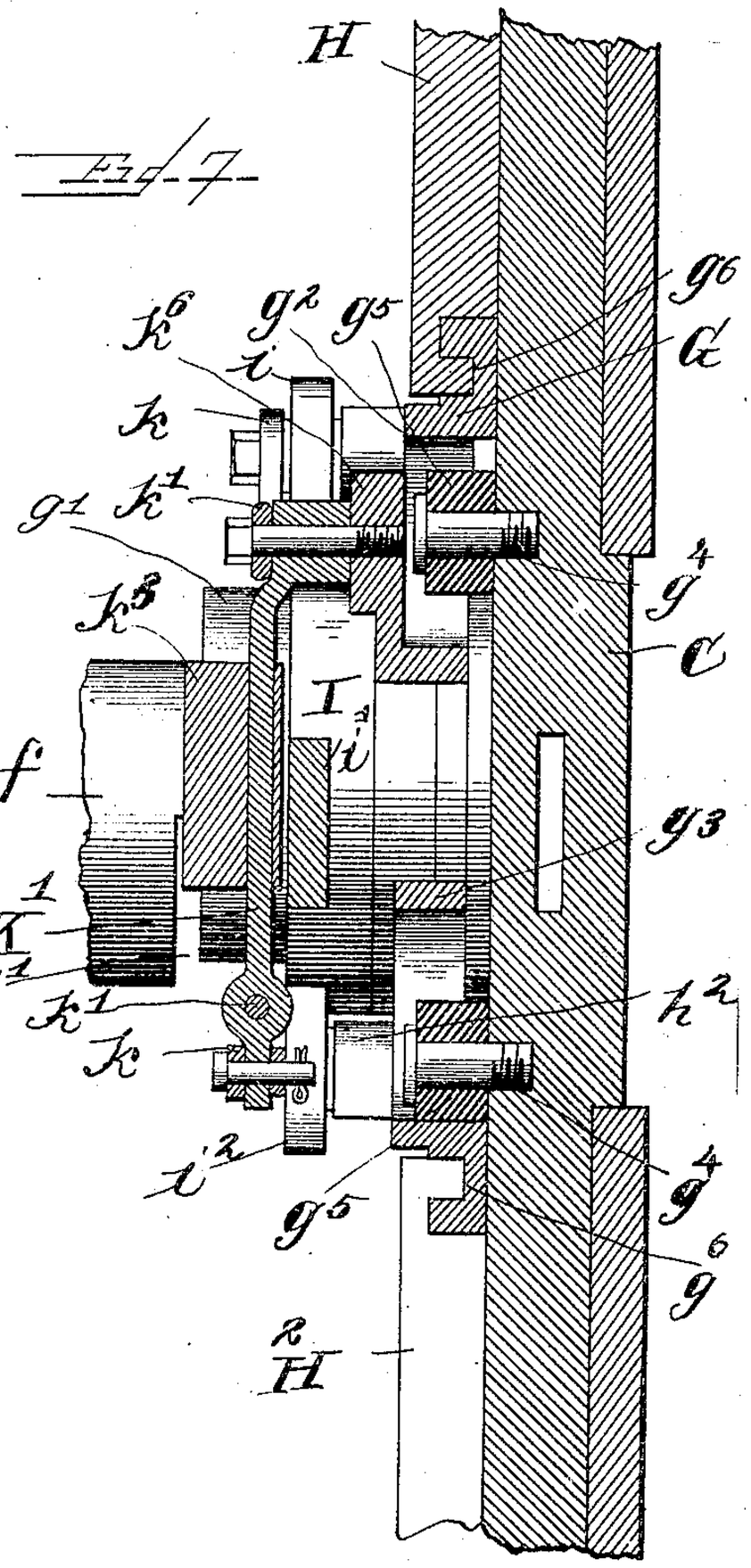


Fig. 7.



Witnesses—

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APPLICATION FILED OCT. 12, 1903. RENEWED NOV. 2, 1905.

7 SHEETS—SHEET 7.

Fig. 8.

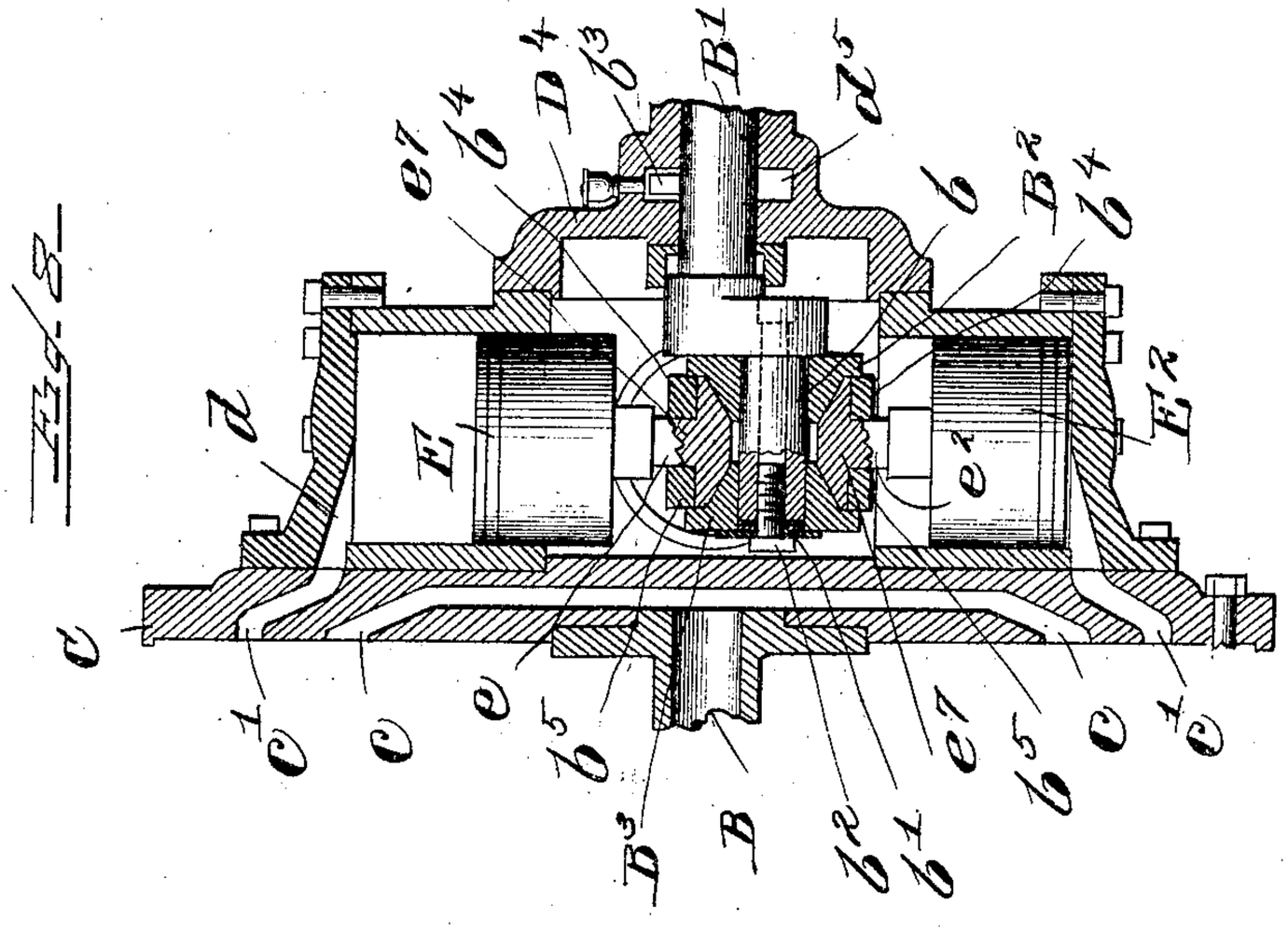
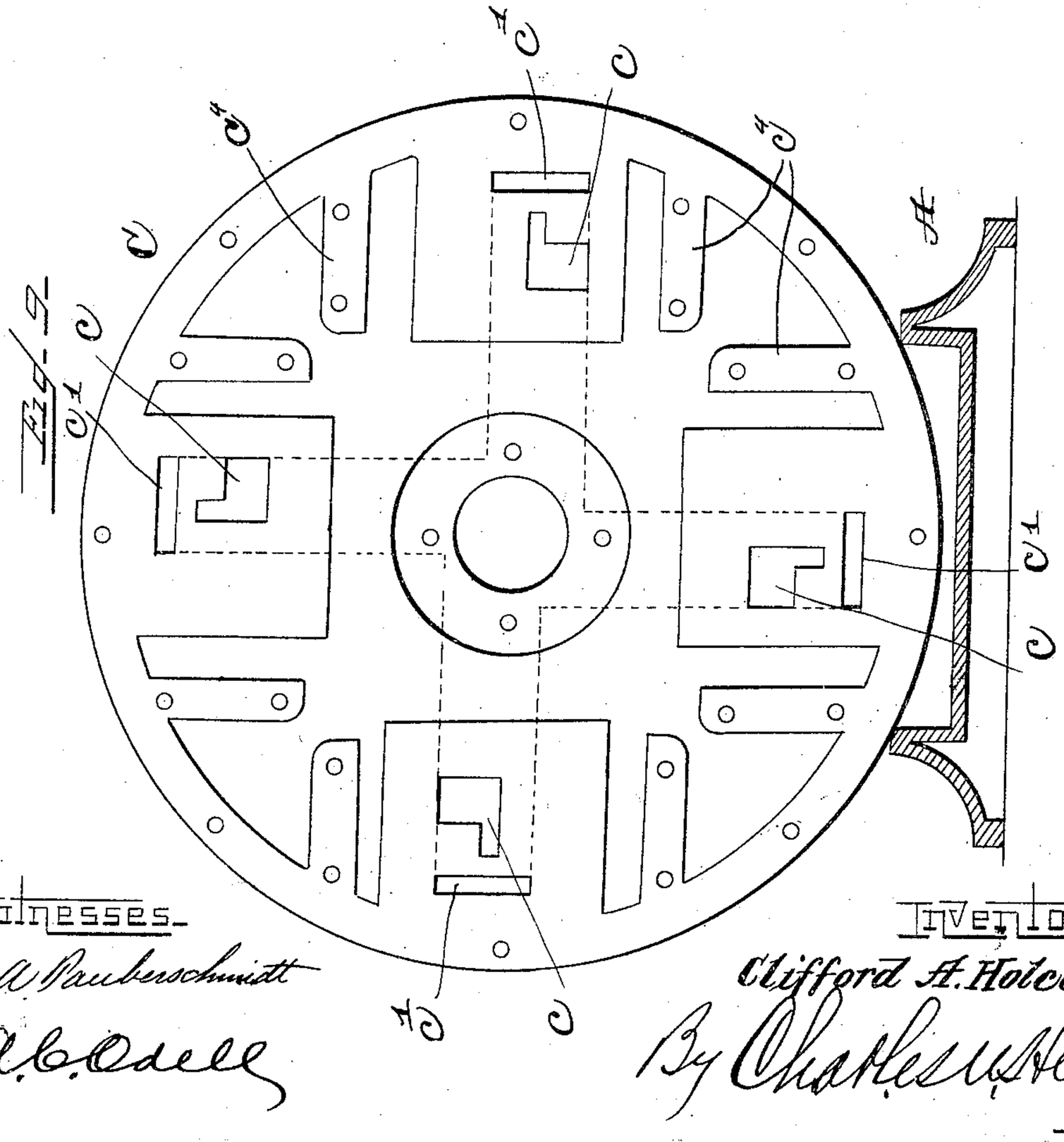


Fig. 9.



Witnesses.

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UNITED STATES PATENT OFFICE.

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STEAM-ENGINE.

No. 822,001. Specification of Letters Patent. Patented May 29, 1906.

Application filed October 12, 1903. Renewed November 2, 1905. Serial No. 285,589.

To all whom it may concern:

Be it known that I, CLIFFORD A. HOLCOMB, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Steam-Engines; and I do hereby declare that the following is a full, clear, and exact description of the same, reference being had to the accompanying drawings, and to the letters of reference marked thereon, which form a part of this specification.

This invention relates more particularly to a steam-engine provided with a plurality of reciprocating pistons in which the cylinders, with the pistons, rotate about a fixed shaft.

Heretofore many different types of rotary and reciprocating engines have been devised, in all of which the vibration caused by the operation of the engine has been considerable, and this, taken in connection with the forms of valve-gear used, has tended to decrease the efficiency.

The object of this invention is to provide a perfectly-balanced engine rotated upon its center by oppositely-acting balanced pistons operating upon a non-rotative crank-shaft.

It is also an object of the invention to provide a simple and easily-governed valve mechanism whereby the ports of the respective cylinders are controlled with slight relative movements of the valves, operated by a single governor affording the effect of a double valve in ordinary engines.

The invention consists in the matters hereinafter described, and more fully pointed out and defined in the appended claims.

In the drawings, Figure 1 is a central vertical section taken longitudinally of the driving shaft of a device embodying my invention and showing the non-rotative shaft and crank in elevation. Fig. 2 is a section taken on line 2 2 of Fig. 1 and illustrates the operation of the governor. Fig. 3 is a section taken on line 3 3 of Fig. 1. Fig. 4 is a section similar to Fig. 2, but illustrates a different position of the valve. Fig. 5 is a similar section taken closer to the disk and with the springs and governing-bars removed. Fig. 6 is an enlarged detail section taken on line 6 6 of Fig. 4. Fig. 7 is an enlarged detail section taken on line 7 7 of Fig. 4. Fig. 8 is a fragmentary detail illustrating the operation of the pistons. Fig. 9 is a section taken on line 9 9 of Fig. 1. Fig. 10 is a detail of a modified construction of the valve-gear. Fig. 11 illustrates a detail of construction.

As shown in said drawings, said engine comprises a base or bed A, having secured at each end thereof uprights or standards a a'. A longitudinal hollow shaft B is journaled on the standard a', which is chambered to provide inlet and exhaust chambers, and said shaft is slotted longitudinally in said inlet-passage to admit steam into said shaft. In alinement with said shaft B and rigidly secured on the standard a is a non-rotative shaft B′, provided at its end adjacent to the inner end of the shaft B with a crank b.

Rigidly secured on the inner end of the shaft B is a circular plate or disk C, provided with passages therein which communicate with the bore of the shaft B and extend from the center of said disk to near the periphery and opening therethrough on the side adjacent said shaft, the apertures or ports being indicated by c. In the drawings four of said passages or ports are shown, one for each of the cylinders of the engine, though obviously the number of such passages corresponds with the number and arrangement of the cylinders with which the engine is provided. Each of said openings c, while approximately rectangular in form, extends upwardly on one side radially of the disk, thus providing a somewhat L-shaped orifice having its greatest length radially of the disk. Between said orifice c and the periphery of said disk a port or opening c' is provided therethrough, which is also rectangular, having its greatest length at a right angle with the radius passing through the extension of the orifice c. Each of said ports c' registers with a corresponding port d in the outer ends of cylinders D, D′, D^2, or D^3, in the present construction shown as four in number and which are rigidly bolted at right angles with each other to the face of said disk C with the ports d therein registering with the ports c', as before described. In the construction shown said cylinders are integrally connected at their inner ends and are provided with cylinder-heads d' d^2 d^3 d^4, rigidly bolted thereto.

Journaled upon the non-rotative shaft B′ is a casing D^4, which fits closely against and is bolted to the inner ends of said cylinders, forming together therewith and the disk or plate C a closed chamber at the inner ends of

said cylinders, into which extends the crank b of the shaft B′. Means are provided for lubricating the bearing of the casing on the shaft B′, comprising a channel d^5, extending around the interior of the hub of said casing and provided with an aperture for admitting a lubricant thereinto, and a pin b^3 is secured in said shaft and extends into said channel and acts to deflect the oil onto the shaft as the engine revolves. Within each of said cylinders is provided a reciprocating piston E E′ E² E³, provided with piston-rings in the usual manner. Piston-rods e e' e^2 e^3 are pivotally connected at one end with the inner end of each piston thereof and at the other end are journaled on said crank b. Said crank b is cylindric, and a washer b', having a greater diameter than the crank, is secured on the end thereof by means of a bolt b^2, which extends through the crank and is provided with a nut at its end, which acts to draw the washer inwardly to the crank. Journaled on said crank are inwardly-facing flanged cones B² B³, which engage, respectively, against the crank-arm and against said washer and afford a bearing for the inner ends of the piston-rods, which, as shown, is extended laterally, forming a head affording shoulders e^7 at right angles with the piston-rods on the inner side and on the outer shaped to engage against said cones.

Continuous rings b^4 b^5 engage over the laterally-directed shoulders e^7 of the piston-rods and within the flanges of the cones and serve to engage the piston-rods to the crank, permitting considerable freedom of movement as the cylinders revolve around said crank, as shown in Fig. 3, and permitting wear on the parts to be taken up by the adjustment of said bolt b^2. Surrounding the inner end of said tubular shafts B and closely adjacent to the disk C is an eccentric F, which actuates the valve-frame G and is provided with an integral sleeve f, open on its under side and extending outwardly therefrom. Said sleeve is provided with a peripheral flange f' at its outer end, which is rigidly bolted to the walls of the exhaust-chamber and acts to hold said sleeve and eccentric from rotation. A tight casing C², having a diameter equal to the diameter of the disk C, is rigidly bolted at its periphery to said disk, as shown in Fig. 1, and a casing comprising the two similar sections C³ is bolted thereto and engages closely around said sleeve and provided with an outwardly-opening seat adapted to receive the inner end of a sleeved follower-nut f^3, threaded on said sleeve adjacent to said flange f' and which acts, together with the seat in said casing, to afford a stuffing-box or gland. Mounted on said eccentric F is a valve-carrying frame G, comprising, as shown, a plate provided with a central apertured hub g, provided with a sleeve g' extending therefrom of less outer and of substantially the same inner diameter as the hub. Said hub fits closely upon the eccentric F, and the valve-frame integral therewith is substantially rectangular in form and is provided at the corners with circular apertures g^2 g^3 opening therethrough and each surrounded by a raised flange. Within each of said circular apertures and rigidly secured in the disk C are the stud-bolts g^4, on each of which is journaled a roller g^5, which tracks on the inner wall of said apertures, thereby forming at each corner of the valve-frame G an eccentric guide which acts to limit the movement of said valve-frame to a gyratory motion about the center of the disk and in the direction of the successive ports opening into the cylinders. Along each side of said valve-frame G, as shown, a slot g^6 is provided, which at all times is maintained at a right angle with the respective inlet-passages of the disk by means of the eccentric guides located at the corners of said valve-frame. Engaged in each of said slots in position to control the respective ports opening through said disk C are the valve-plates H H′ H² H³. Each of said valve-plates is provided with two apertures or ports therethrough, one of which, h^5, is rectangular in form and positioned to the right of the center of the valve and acts to equalize the pressure on the valve-plate, and the other, h^6, located at the left of the center, is elongated radially of the disk and at its top is extended laterally to correspond with the length of the port c' in said disk and acts to convey steam from the ports c to the ports c'. Said valve-plates are each at the inner end on the under surface shaped complementally with the adjacent sides of the valve-frame G and interfit therewith and are adapted to slide thereon laterally. The said valve-plates are also each provided with an inwardly-directed arm h h' h^2 h^3.

A governor-ring I is seated on the sleeve g' of the valve-frame and provided with integral arms i i' i^2 i^3, the arrangement of which corresponds with the passages in the disk C and which are connected with the corresponding arms of the valve-plates by means of stud-bolts, one of which extends downwardly through a radially-slotted aperture in each of the arms of said ring and is provided with a sliding block therein to take the wear and is rigidly secured to the inner end of the arm on the valve-plate. This construction acts to slide all the valve-plates laterally of the valve-frame when said governor-ring I is slightly rotated thereon and affords means for governing the engine by restricting or varying the inlet-ports thereof by such movement. To enable this to be automatically accomplished, governor-bars K and K′ are pivoted on the valve-frame, as shown, near the center of a plate k^6, integral with said frame and positioned above the apertures g^2, as shown in Fig. 4. Said bars are of a length

to extend somewhat past the middle of the adjacent recesses g^3 at their other end and at said ends are each pivotally connected with the outer end of a rod or link k, the other end of which extends at a right angle therefrom and is pivoted on the adjacent arm by means of the pivot-bolt connecting the valve therewith of the governor-ring I. Adjustably engaged with and connecting the oppositely-disposed extremities of said governor-bars are strong coiled springs k', which act normally to hold the free ends of said governor-bars inwardly, as shown in Fig. 4, at which position the valves afford a maximum opening of the various ports during the operation of the engine. Adjustably secured on each of the governor-bars K and K' are the weights k^3, each provided with a set-screw adapted to positively fix the same upon the bar.

At each side of the valve-plate H H' H^2 H^3, respectively, are provided the raised ribs c^4, integral with the disk C and in height approximately equal to the bearing-face of said disk. Said ribs serve as supports for valve-pressure plates M, one of which is rigidly bolted on said ribs c^4 above each valve and is provided with recesses m' m^2 on the under side to correspond with the apertures h^5 h^6 through the valve-plates, affording means for equalizing the pressure, as is usual in such devices. As shown, a plurality of ribs m are provided on each pressure-plate, extending from each end thereof, and thereby increasing strength without materially increasing weight. The steam-supply pipe is connected in any desired manner with the passage N in the top of the standard or pedestal a' and communicates wth the shaft B through the slotted apertures opening thereinto, as shown in Fig. 1. A cap N', cored to afford a part of the steam-inlet passage, is secured above said inlet-apertures and rigidly bolted to the pedestal or standard and recessed at each side of the inlet-passage to afford, together with the follower-nuts n n', glands to prevent the escape of steam therefrom.

The operation is as follows: The engine, assembled and mounted as described, is perfectly balanced, and the oppositely-disposed pistons operating simultaneously upon a stationary crank act to rotate the engine as a whole. When steam is admitted through the shaft B, it passes through the passages in the disk C, through the valve-plate, and from thence to the cylinder of which the inlet-port is open, acting to reciprocate the piston, and thereby rotating the engine, as before described. Inasmuch as the eccentric F, which actuates the valve-frame, is stationary, the rotation of the engine around the same causes gyratory movement of the said valve-frame, carrying the valves therewith and providing maximum opening and complete closure of the valves at dead-centers and permitting the steam to pass through the valves successively to the cylinders. The governor-ring I, with its integral arms, being carried on and movable with and also independently of the valve-frame and having the arms thereof pivotally connected with the respective valve-plates causes all the valves to be simultaneously shifted laterally of the ports when said ring is partly rotated on the frame, restricting or cutting off the inlet-ports, and thereby governing the engine. This is accomplished in part by the peculiar form of the port and openings and the apertures in the valves, as clearly shown in Fig. 2, in which the valves are shown shifted to afford a positive cut-off for the steam through the valves. This movement is caused by the centrifugal action of the governor-bars K K', pivoted on diametrically opposite sides of the valve-frame G and each connected at its free end with oppositely-disposed arms of said governing-ring and held normally at their inward adjustment by strong spiral springs k', which, as shown, are adjustably engaged on the free end of each governor-bar and are attached at the other end to the pivoted end of the opposite governor-bar. The adjustable weights k^3 obviously permit the governor to be set to cut off centrifugally at any required rate of rotation, centrifugal force acting to throw the governor-bars outwardly, shifting the governor-ring and the valves connected therewith laterally with respect to the valve-frame, as shown in Fig. 2. The steam from said cylinders exhausts through the ports d and c' into the casing C^2 with the return stroke of the piston and from thence passes through the sleeve f of the eccentric into the exhaust-chamber a^3, as shown in Fig. 1. The connection of the piston-rods with the crank affords great strength, slight friction, and ease of adjustment, inasmuch as the cones, which do not meet each other on the crank, may be drawn inwardly by the bolt b^2, affording any desired adjustment of the bearing of the rings and the ends of the piston-rods against the same.

Obviously instead of the grooves in the sides of the valve-frame the valve-plates may, if preferred, be connected therewith by means of links h^{10}, one of which connects each side of the valve with the valve-frame, as shown in Fig. 10. Said links permit the valve-plates to be drawn laterally of the valve-frame by the governor and to afford a cut-off, as before described.

Obviously many modifications and variations of details of construction may be made in embodying my invention and the number and arrangement of cylinders and many other features of construction may be varied without departing from the principles of my invention.

I claim as my invention—

1. In an engine the combination with a plurality of cylinders and the pistons therein, of a valve-frame, means actuating the same

and a valve for each cylinder slidably engaged on and operated by said valve-frame.

2. In a rotating engine the combination with a plurality of cylinders and the pistons therein, of a gyratory valve-frame, means actuating the same and a valve for each cylinder slidably engaged on and operated by said valve-frame and affording maximum port-opening and complete closure at dead-centers.

3. In an engine the combination with a plurality of cylinders and pistons therein, of a valve-frame, means imparting gyratory motion thereto, and a valve for each cylinder slidably engaged by and carried on said valve-frame and a governor acting to move said valves laterally of their normal movement.

4. In a rotating engine the combination with a plurality of cylinders and the pistons therein, of a valve-frame, means imparting gyratory motion thereto, and a valve for each cylinder slidably engaged by and carried on said valve-frame and a governor acting to move said valves laterally of their normal movement.

5. In an engine the combination with a plurality of cylinders and the pistons therein, of a valve-frame centrally disposed with respect to the cylinders, means actuating said valve-frame, a valve for each cylinder positively connected with and actuated by said valve-frame and means acting to move said valves laterally of the normal movement of the valves comprising a governor.

6. In a rotating engine the combination with a plurality of cylinders and the pistons therein, of a gyratory valve-frame centrally disposed with respect to the cylinders, means actuating said valve-frame, a valve for each cylinder positively connected with and actuated by said valve-frame and centrifugally-operated means acting to move said valves laterally of the normal movement of the valves comprising a governor.

7. In an engine the combination with a plurality of cylinders and pistons therein, of a valve-frame disposed centrally of the cylinders, means for actuating said valve-frame, a valve for each cylinder slidably carried thereon and means carried on the valve-frame and movable independently thereof acting to slide the valves on the valve-frame comprising a centrifugal governor.

8. In a rotating engine the combination with a plurality of radially-disposed cylinders and pistons therein, of a valve-frame disposed centrally of the cylinders, means for actuating said valve-frame, a valve for each cylinder slidably carried thereon and means carried on the valve-frame and movable independently thereof acting to slide the valves on the valve-frame comprising a centrifugal governor.

9. In an engine the combination with a cylinder and its piston, of a valve-frame, means actuating the valve-frame, a valve slidably carried on said frame and a centrifugal governor also carried on the valve-frame, positive connections between the governor and the valve acting to slide the same on the valve-frame and affording the cut-off.

10. In a rotating engine the combination with a cylinder and its piston, of a valve-frame, means actuating the valve-frame, a valve slidably carried on said frame and a centrifugal governor also carried on the valve-frame, positive connections between the governor and the valve acting to slide the same on the valve-frame and affording the cut-off.

11. In an engine the combination with a valve-frame located centrally, of one or more valves carried thereby and movable therewith and independently thereof and a centrifugal governor mounted on the valve-frame and acting to vary the position of the valves with respect to the valve-frame and port-openings.

12. In a rotating engine comprising a plurality of radially-disposed cylinders the combination with a valve-frame located centrally, of one or more valves carried thereby and movable with and independently thereof and a centrifugal governor mounted on the valve-frame and acting to vary the position of the valves with respect to the valve-frame and port-openings.

13. In a rotating engine comprising a plurality of radially-disposed cylinders the combination with a valve-frame located centrally, of one or more valves carried thereby and movable with and independently thereof and a centrifugal governor mounted on the valve-frame and acting to vary the position of the valves tangentially with respect to the valve-frame and port-openings.

14. In a rotating engine the combination with a non-rotative eccentric, of a valve-frame revoluble thereon, one or more steam-valves adjustably carried on said valve-frame and movable therewith and independently thereof, and a centrifugal governor carried on the valve-frame and positively connected with the valve or valves and acting to shift the same on the frame to cut off admission of steam to the port.

15. In a rotating engine the combination with a non-rotative eccentric of a valve-frame revoluble thereon, of steam-valves adjustably carried thereby and movable with and independently thereof and provided with apertures normally registering with an inlet-passage and a port respectively and normally acting to admit steam therethrough to the port at dead-centers and a centrifugal governor on the valve-frame and acting to shift the valves laterally cutting off the steam from passage through the valves.

16. In an engine the combination with a plurality of oppositely-disposed cylinders, their pistons and crank-shaft, of a valve-

frame positioned centrally of the cylinders, means imparting gyratory motion thereto, a valve for each cylinder carried thereon and movable therewith and a weighted lever pivoted on the valve-frame and positively connected with the valves and acting centrifugally to vary the adjustment thereof with the frame.

17. In a rotative engine the combination with a plurality of oppositely-disposed cylinders and their pistons, of a non-rotative crank with which the pistons are connected, a valve-frame positioned centrally of and eccentrically connected with the cylinders, means imparting gyratory motion thereto, a valve for each cylinder carried thereon and movable therewith and normally at dead-centers affording full port-opening and complete closure respectively, and a weighted lever pivoted on the valve-frame and positively connected with the valves and acting centrifugally to vary the adjustment thereof with the valve-frame varying the cut-off.

18. In a rotative engine the combination with a plurality of oppositely-disposed cylinders and their pistons, of a non-rotative crank with which the inner ends of the pistons are connected, a valve-frame positioned centrally of the cylinders and rotating therewith, means imparting gyratory motion thereto, a chambered valve for each cylinder carried on said valve-frame and movable therewith and through which the steam is conveyed to the ports and a weighted lever pivoted on the valve-frame and positively connected with the valves and acting centrifugally to vary the adjustment thereof with the frame and limiting the passage of steam through said valves.

19. In a rotative engine the combination with a plurality of radially-disposed cylinders and their pistons and piston-rods, of a non-rotative crank with which the inner ends of the piston-rods are connected, a non-rotative eccentric positioned centrally of the cylinders, a valve-frame journaled thereon and eccentrically connected with the cylinders and revoluble therewith, a valve for each cylinder carried thereon and movable therewith and a weighted lever pivoted on the valve-frame and positively connected with the valves and acting centrifugally to vary the adjustment thereof with the frame.

20. In a rotative engine the combination with a plurality of radially-disposed cylinders, their pistons and piston-rods, of a non-rotative crank operatively connected with the piston-rods and about which the engine rotates, a valve-frame positioned centrally of the cylinders, means imparting gyratory motion thereto, a valve for each cylinder carried thereon and movable therewith to afford full port-openings and complete closure thereof at dead-centers and a centrifugally-operating governor movable with the valve-frame and independently thereof and acting to move the valves laterally to afford a cut-off.

21. In a rotative engine the combination with a plurality of radially-disposed cylinders and the pistons therein, of a non-rotative crank connected with said pistons, a centrally-disposed eccentric, a valve-frame thereon afforded gyratory motion thereby, a valve for each cylinder adjustably connected with said valve-frame and a plurality of weighted and mutually counterbalancing levers pivoted on said valve-frame and operatively connected with said valves and acting centrifugally to move the valves laterally with respect to the valve-frame.

22. In a rotating engine the combination with a plurality of radially-disposed cylinders and their pistons, of a fixed crank with which each piston is connected, a port at the outer end of each cylinder, a tubular shaft rigidly secured at the axis of rotation of the cylinders, means admitting steam therethrough, passages leading therefrom and opening adjacent said ports, a non-rotative eccentric through which said shaft passes, a valve-frame mounted thereon, an eccentric-guide connecting the same with the cylinders, a valve for each cylinder carried on the valve-frame and positioned to normally afford full opening and closure of said ports and a centrifugal governor carried on said valve-frame and acting to shift the valves laterally to vary the port-openings.

23. In a rotating engine the combination with a plurality of radially-disposed cylinders and their pistons, of a fixed crank with which each piston is operatively connected and about which the engine rotates, of a port at the outer end of each cylinder, a tubular rotative shaft rigidly secured at the axis of rotation of the cylinders and adapted to admit steam therethrough, passages leading therefrom and opening adjacent said ports, a non-rotative eccentric through which the shaft passes, a valve-frame mounted thereon, an eccentric-guide connecting the same with the cylinders, a valve for each cylinder carried on the valve-frame and provided with a plurality of apertures therethrough which normally register with the open end of the passage and with the ports respectively, thereby normally affording full opening and closure of the ports at dead-centers and a centrifugal governor carried on the frame and acting to shift the valves laterally to restrict or prevent the passage of steam through said valves and ports.

24. In a rotative engine the combination with a plurality of radially-disposed cylinders, their pistons and piston-rods, of a non-rotative crank positioned centrally of the cylinders and means affording a connection thereof with the piston-rods comprising an adjusting-bolt passing axially through the crank, inwardly-facing cones journaled on

the crank one of which is movable by the bolt, a laterally-extended head on each piston-rod shaped to engage said cones and rings engaging around said heads and cones within the flanges of the latter and acting to hold the ends of said piston-rods in operative engagement therewith.

25. In a rotative engine the combination with a plurality of radially-disposed cylinders, their pistons and piston-rods, of a non-rotative crank positioned centrally of the cylinders and means affording a connection thereof with the piston-rods comprising an adjusting-bolt passing axially through the crank, inwardly-facing cones journaled on the crank one of which is movable by the bolt, a laterally-extended head on each piston-rod shaped to engage said cones and rings engaging around said heads and cones within the flanges of the latter and acting to hold the ends of said piston-rods in operative engagement therewith, and a washer having a greater diameter than the crank carried on said bolt and engaging against the larger base of one of said cones and acting to draw the cones inwardly toward each other.

26. The combination with a non-rotative shaft provided with a fixed crank thereon, of a rotative tubular shaft in alinement therewith, a disk comprising an engine-frame secured thereon and provided with substantially radial passages extending therethrough and registering with the bore of the shaft, radial cylinders secured on said frame, pistons therein, operative connections between the pistons thereof and said fixed crank, a non-rotative eccentric on the tubular shaft, a valve-frame mounted thereon and eccentrically connected with the engine-frame, and revoluble therewith, valves movable thereby and connected therewith to afford normally full opening and complete closure of the ports at centers and a governor movable with the valve-frame and independently thereof and acting to shift the valves laterally of their normal movement to afford a cut-off.

27. In an engine the combination with integrally-connected radially-disposed revoluble cylinders and the pistons therein, of a fixed crank connected with said pistons and about which the engine revolves, ports at the outer ends of the cylinders, a central non-rotative eccentric, a valve-frame operated thereby and revoluble with the cylinders, valves carried by said valve-frame and movable normally to afford full opening and closure of the ports and a governor mounted on said valve-frame and comprising a governor-ring, integral arms thereon, positive connections between said arms and said valves and weighted levers pivoted on said valve-frame and connected with said arms and acting centrifugally to partly revolve said governor-ring on the valve-frame thereby moving said valves to limit the opening of the ports.

28. In a rotating engine provided with a plurality of ports disposed near the periphery thereof, a non-rotative eccentric positioned at the axis of rotation, a valve-frame mounted thereon, eccentric-guides affording connection thereof with the engine, valves carried on and operated by said valve-frame to open and close said ports, and a governor comprising a plurality of integrally-connected arms pivoted on said valve-frame and each connected with one of said valves, levers also pivoted on the valve-frame and connected at their ends with said arms and springs acting normally to hold said valves in position to permit maximum opening of the ports.

29. In a rotating engine the combination with a rotative shaft of a plurality of cylinders rigidly engaged thereon, a stationary crank-pin eccentric with said shaft, a plurality of inwardly-facing cones adjustably engaged thereon, pistons operatively connected with said cones, ports opening into said cylinders, slide-valves controlling said ports and centrifugally-operated means acting to regulate said valves.

30. In a rotary engine the combination with a plurality of oppositely-disposed cylinders, of a chambered disk rigidly engaged thereon, a shaft rigidly engaged on said disk, a non-rotative eccentric on said shaft, an apertured valve-frame thereon, a plurality of stud-shafts in said disk, antifriction-rollers thereon adapted to engage in the apertures in said frame and a plurality of laterally-movable valve-plates carried on said frame.

In testimony whereof I have hereunto subscribed my name in the presence of two subscribing witnesses.

CLIFFORD A. HOLCOMB.

Witnesses:

CHARLES N. HILLS,

ALFRED C. ODELL.