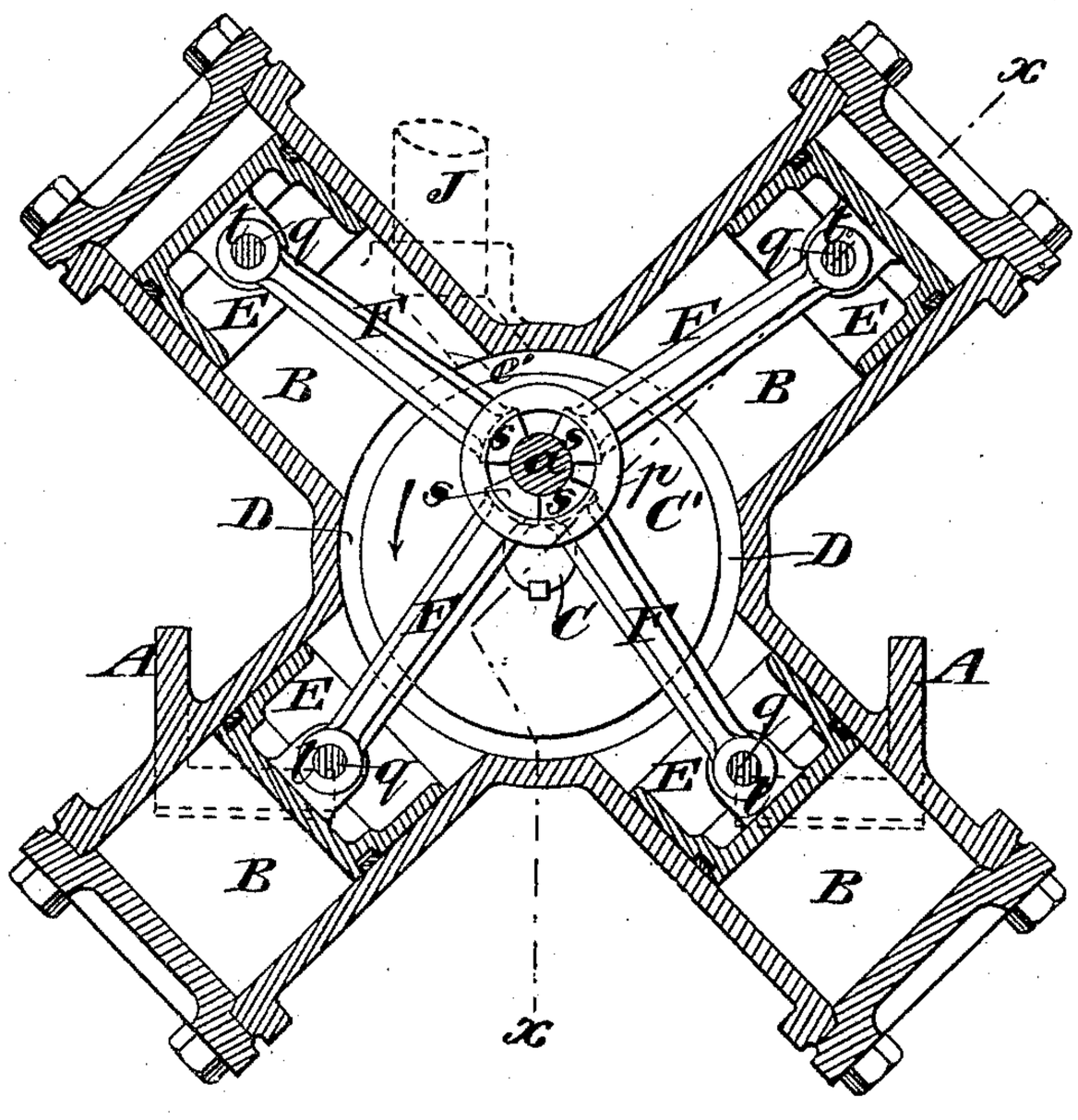
(No Model.) 4 Sheets—Sheet 1.

G. A. BRONDER.

STEAM ENGINE.

No. 452,964. Patented May 26, 1891.

Fig. 1.



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(No Model.) 4 Sheets—Sheet 2.

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STEAM ENGINE.

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Fig. 2.

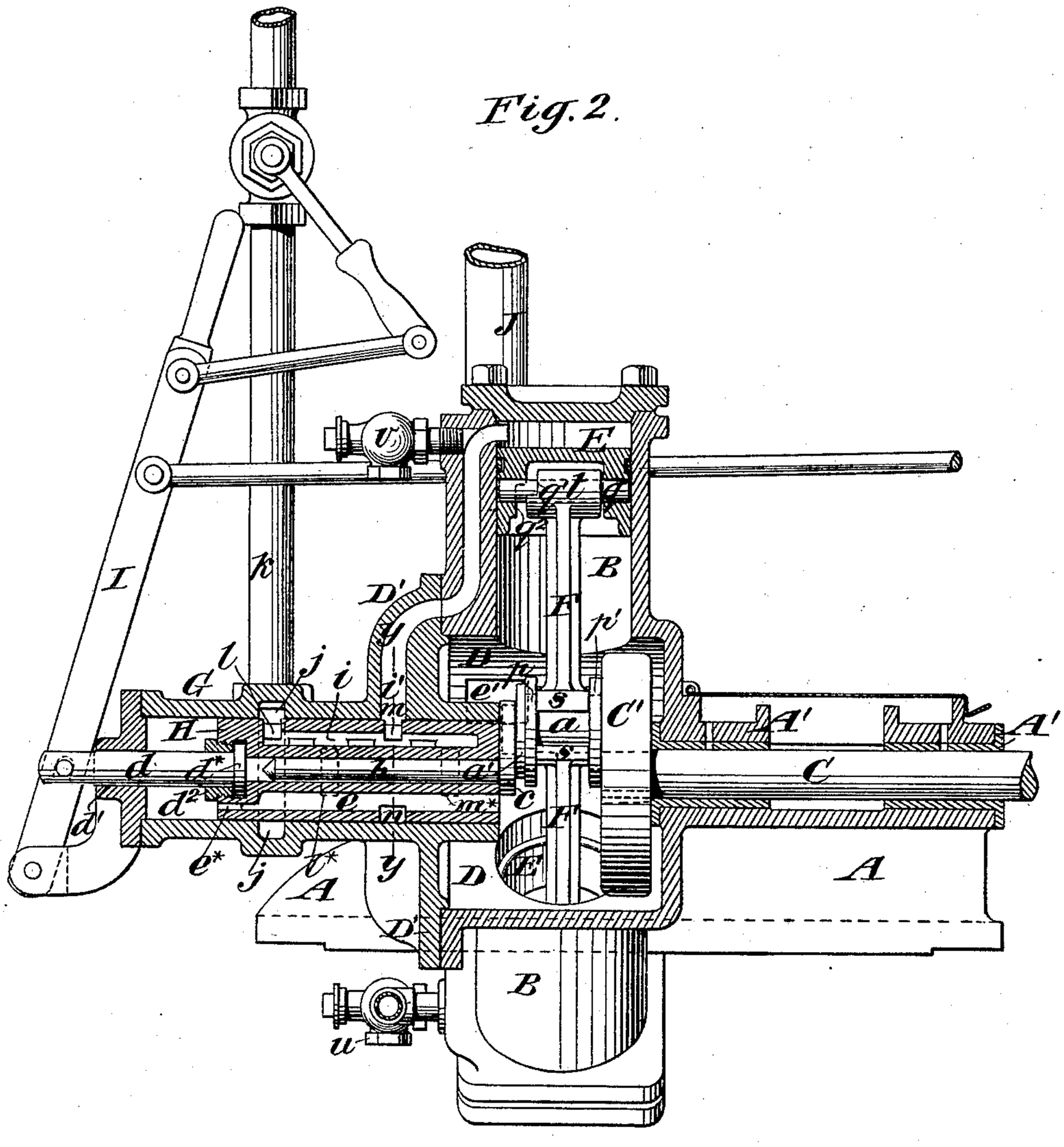

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Fig. 3.

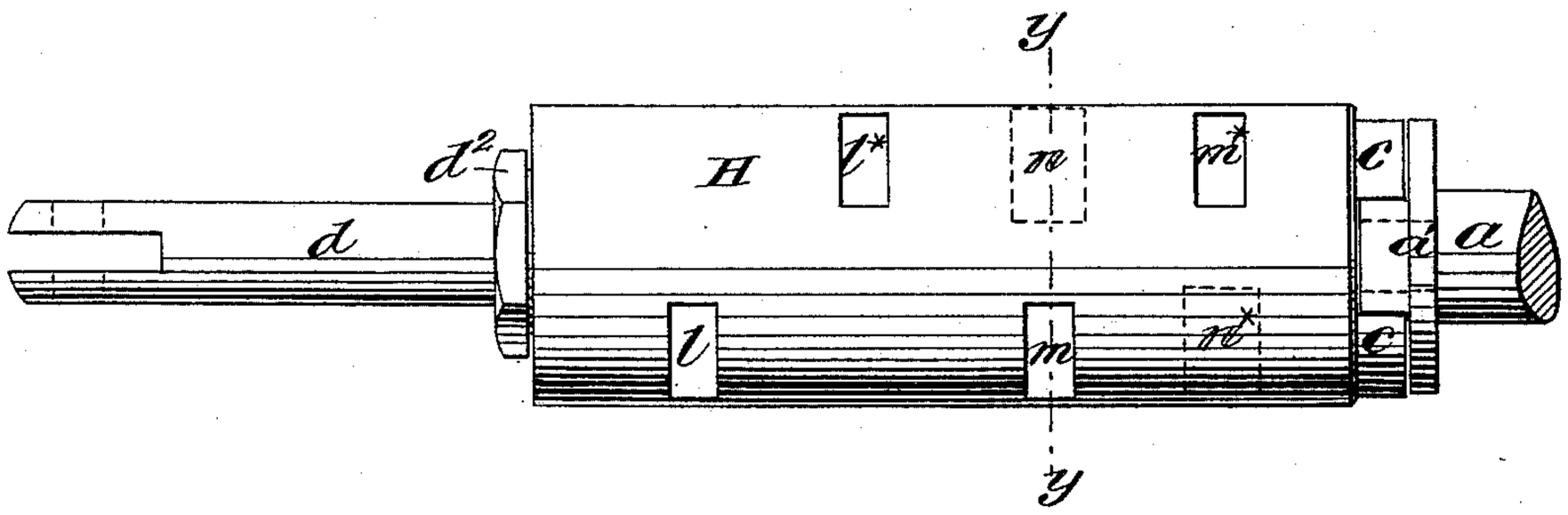


Fig. 4.

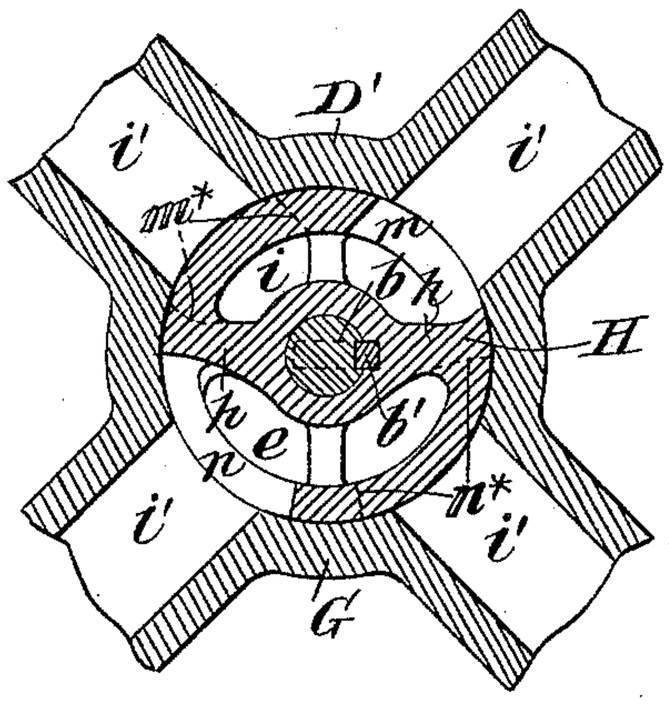
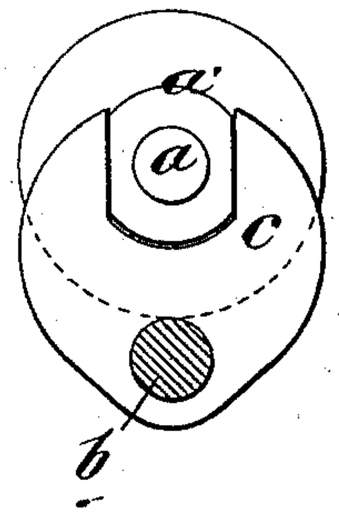


Fig. 5.



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(No Model.) 4 Sheets—Sheet 4.

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STEAM ENGINE.

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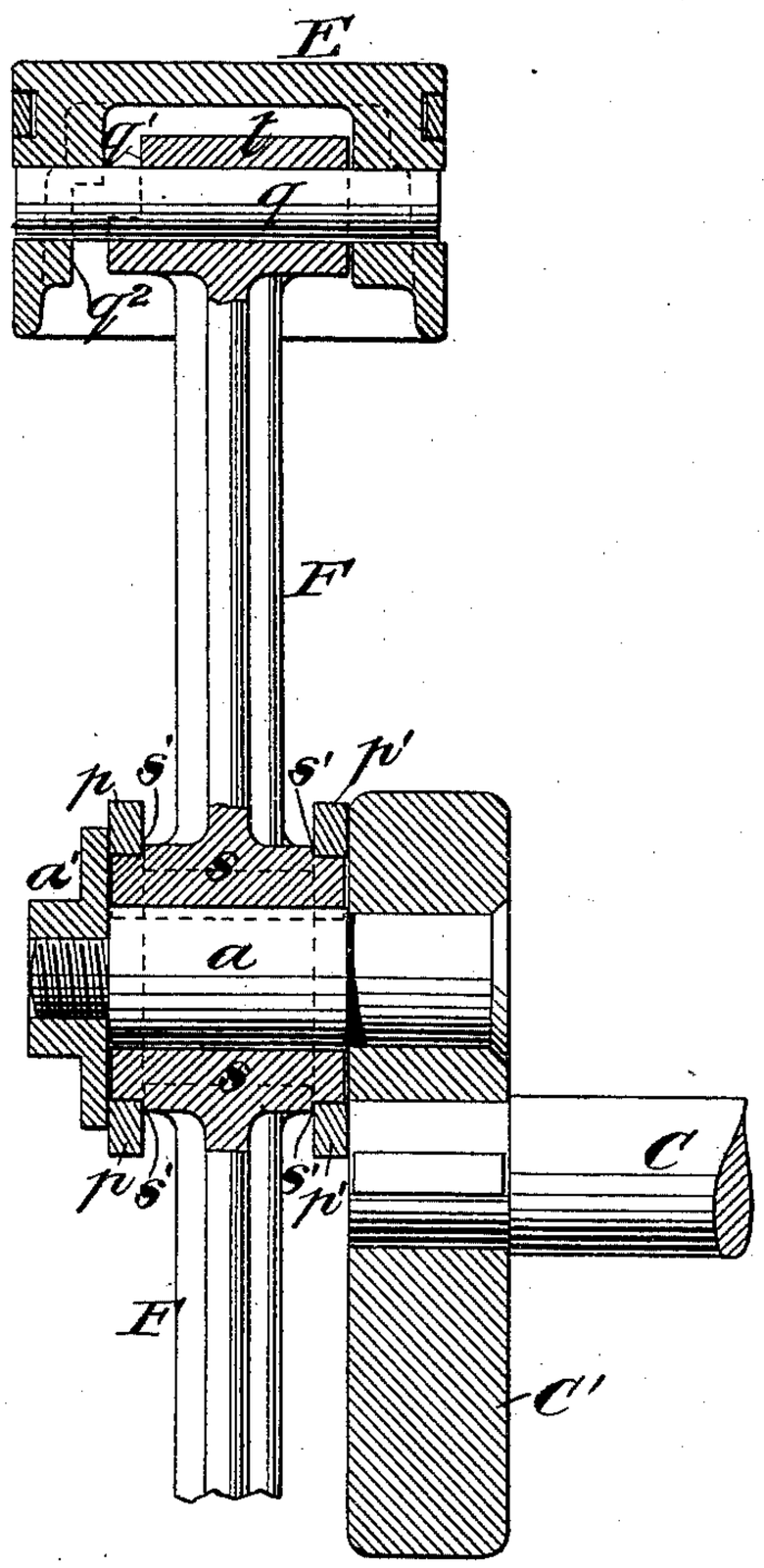
Fig. 6.



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UNITED STATES PATENT OFFICE.

GASTON A. BRONDER, OF NEW YORK, N. Y.

STEAM-ENGINE.

SPECIFICATION forming part of Letters Patent No. 452,964, dated May 26, 1891.

Application filed March 17, 1890. Serial No. 344,153. (No model.)

To all whom it may concern:

Be it known that I, GASTON A. BRONDER, of the city and county of New York, in the State of New York, have invented a new and useful Improvement in Steam-Engines, of which the following is a specification, reference being had to the accompanying drawings.

This invention relates to that class of steam-engines in which several cylinders are arranged radially around a crank-shaft, to the crank of which rotary motion is imparted by the reciprocating movement of pistons within the said cylinders.

I will first describe my invention with reference to the drawings, and afterward point out its novelty in claims.

Figure 1 represents a central vertical section of an engine embodying my invention, taken centrally through the cylinders and pistons. Fig. 2 represents a vertical section taken at right angles to Fig. 1 about in the line *x x* of Fig. 1. Fig. 3 is an outside view of the rotary valve of the engine. Fig. 4 represents a transverse section of the valve and valve-chest in the line *y y* of Figs. 2 and 3. Fig. 5 represents a transverse section of the driving-spindle of the valve and a face view of the connection between the said spindle and the crank-pin of the engine. Fig. 6 represents a sectional view of one of the pistons, the crank, and their connections.

Similar letters of reference designate corresponding parts in all the figures.

The engine represented has four cylinders.

A designates the bed-plate, B B B B the cylinders, and C the crank-shaft working in bearings A′ on the bed-plate. The cylinders are arranged radially around the line of the axis of the crank-shaft at equal distances apart and closed at their outer ends only. They may be secured to the bed-plate in any suitable manner, but are represented as being in one casting with the bed-plate, the said casting also containing a central chamber D, to which the inner ends of the cylinders B are always open, steam being used in the outer sides of the pistons only, and the cylinders and pistons being therefore single-acting. The chamber D contains the crank C′. It is closed at the side farthest from the crank-shaft by a head D′, on which is centrally arranged the cylindrical valve-box G.

E E E E are pistons, and F the rods through which the said pistons transmit power to the wrist or pin *a* of the crank. The connections of these rods with the pistons and with the crank-pin *a* will be hereinafter more fully explained.

The cylindrical valve-box and the rotary cylindrical induction and eduction valve H contained therein have their axes in line with the axis of the crank-shaft C. This shaft terminates within the chamber D. The valve H is fitted to a central driving-spindle *b* (see Figs. 2, 4, and 5) with a spline *b′* (shown in Fig. 4) in such manner that it may be moved longitudinally upon the said spindle, but compelled to turn therewith. This driving-spindle *b* is centered and supported by the valve itself, the valve being centered by fitting the stationary box G. One end of said spindle projects through the inner end of the valve and valve-box and is furnished with a crank *c*, (see Figs. 2 and 5,) which is connected with the crank-pin *a* of the engine in such manner, as will be hereinafter more fully described, that the valve will rotate with the crank-shaft and crank. The valve is furnished at its outer end with a stem *d*, which passes through a guide or stuffing box *d′* in the outer end of the valve-box G. This stem has a swivel connection with the valve by a collar *d** on the inner end of the stem and a nut d^2, screwed into the end of the valve outside of this collar, and the valve is thereby permitted to turn freely on the stem as it is rotated by the connection of its crank *c* with the crank-pin *a*, the stem not rotating. To the outer end of the stem is connected a hand-lever I for the purpose of moving the valve longitudinally in its seat within the valve-box G to reverse the engine. The valve-box G has provided in it around the valve an annular groove or passage *j*, with which the steam-pipe *k* is in constant communication, and it has in it four ports *i′*, leading to the outer ends of the cylinders E, one for each cylinder, the said ports being equally spaced circumferentially, as shown in Fig. 4, and ranging with each other in a circumferential direction.

The rotary cylindrical valve H is hollow and has its internal cavity divided throughout its whole length by a partition *h* into two chambers *i e*, (see Figs. 2 and 4,) the former of which *i* may be termed the "induction-chamber," as it receives the steam to be delivered to the engine, and the latter of which *e* may be termed the "eduction-chamber," as the steam from the cylinders passes through it on its way to the exhaust-pipe. The induction-chamber *i* is closed at both ends, as shown in Fig. 2, and the eduction-chamber *e* is open at the inner end and in free communication with the central chamber D, before described, which receives all the exhaust-steam from the cylinders and from which an opening *e'* leads to the exhaust-pipe J. The induction-chamber *i* has in it two ports *l m*, opening to the periphery of the valve and ranging with each other lengthwise of the valve, as shown in Fig. 3, the said ports being spaced at such distances apart that when *l* ranges circumferentially with the annular steam-channel *j* of the valve *m* ranges circumferentially with the ports *i'*, leading to the cylinders, as shown in Fig. 2. The said chamber *i* has also in it two ports *l* m**, arranged and spaced relatively to each other like those *l m;* but as to the circumference of the valve the said ports *l* m** are at a distance of ninety degrees from those *l m*, as shown in Fig. 4, in which *m* is shown in full outline and the port *m** in dotted outline, and as to the length of the valve the said ports *l* m** are at such distance from those *l m*, as shown in Fig. 3, that when the two ports *l m* range, respectively, with the annular channel *j* and ports *i'*, as shown in Fig. 1, the ports *l* m** are closed by the walls of the valve-box. The eduction-chamber *e* has in it two ports *n n**, opening to the periphery of the valve, the port *n* being exactly opposite to *m* and the port *n** being similarly opposite to *m**, as may be understood by reference to Fig. 4, so that when either cylinder is taking steam through the ports *l m* or *l* m** the opposite one is exhausting through the port *n* or *n**. The eduction-chamber *e* has a small opening *e** in its inner end for the purpose of allowing the escape through the said chamber to the exhaust-chamber D of any steam that may leak around the valve into the space which is left within the valve-box G at the outer end of the valve. In order, however, to prevent leakage as far as possible the valve may be provided with ring packing of any suitable kind; but the eduction-chamber E being open at both ends, as described, the valve is balanced lengthwise. The valve is so set circumferentially in relation to the crank-pin *a* and the cylinder-ports *i'* that whichever port *m* or *m** ranges circumferentially with the cylinder-ports *i'* will, in the rotation of the valve with the crank in one direction or the other, begin to open to the port *i'* of either cylinder at the time or just before the crank-pin passes the center of said cylinder. As the valve rotates with the crank-shaft the valve-port *m* or *m**, whichever is in range with the cylinder-ports *i'*, gives steam to and cuts it off from the several cylinders in succession, while the exhaust always takes place from the opposite cylinder through the valve-port *n* or *n**. By placing the valve lengthwise by the means provided for the purpose, as the lever I, to bring either the valve-ports *l* m** or those *l m* into range with the channel *j* and ports *i'* the engine may be made to run in either direction, and hence by shifting the valve lengthwise a proper distance the engine is reversed, or by bringing it to an intermediate position its ports are all closed by the walls of the seat and the engine is stopped.

As the steam only acts on the outer sides of the pistons, the piston-rods F act upon the crank-pin *a* only with a thrust, and in order that said rods may be opposite each other and each act upon the whole length of the crank-pin and the oscillations of the said rods be provided for, their inner ends, which bear upon the crank-pin, are made in the form of saddles, as shown at *s* in Figs. 1, 2, and 6, the bearing-surfaces of which are arcs of considerable less than ninety degrees, and in order to confine these saddles to the crank-pin they are surrounded on opposite sides of the rod F with rings *p p'*. The parts of the said saddles which receive the said rings are shouldered, as shown at *s'*, and the said rings are held to these shoulders between the crank *c* and a nut *a'*, (see Figs. 4 and 5,) which is screwed onto the end of the crank-pin outside of the ring *p*. This nut is represented in Figs. 3 and 5 as embraced within a fork on the crank *c* of the valve-spindle, and it is through this engagement of the said nut with the said crank *c* that the rotation of the valve-spindle is produced by the rotation of the main crank C', while the nut is locked positively against unscrewing by the said engagement with the said crank *c*. The said crank *c*, being between the flange of the said nut and the inner end of the valve-box G, as shown in Fig. 2, holds the valve-spindle *b* against any longitudinal movement.

The connection between the outer ends of the rods F and the pistons E are made by strong pins *q*, which pass through the pistons and through transverse sockets *t* in the ends of said rods, the said pins being firmly secured in the pistons and the rods being capable of swinging freely upon them. In order to facilitate the connection and disconnection of the rods with the crank-pin by means of the rings *p'*, room is left within the pistons, as shown at *q' q²* in Fig. 6, for a movement of the sockets *t* lengthwise of the pin *q* and the consequent lateral movement of the rod F a distance equal to the thickness of the ring *p'*, which comes next the crank. This permits the connection and disconnection to be made while the pistons are in the cylinders, when the head D', the valve-box, valve, and valve-spindle are removed. To effect the connec-

tion, the rings p' are first placed over the crank-pin and the rods F having been moved back on the pins q until their sockets t occupy the spaces q' q^2 in the pistons, the saddles s are applied to the crank-pin and then pushed forward into the ring p', the sockets t of the rods being permitted to slide on the pins q. The ring p is then put on over the saddles, and on the nut being screwed onto the crank-pin up to the latter ring the rods F are securely and properly confined to the crank-pin. The disconnection is permitted, after the removal of the head D', valve-box, valve, and valve-spindle, by taking off the nut a' and the ring p and sliding back the rods on the pins q until the saddles s are free of the ring p. In order to insure a proper support for the pins q in the pistons and in the sockets of the piston-rods, the spaces q' q^2 are divided on the inner and outer halves of the said pin, as shown in Fig. 2, the outer portion q' of the space being formed by recessing the end of the socket and the inner portion q^2 by recessing the interior of the piston. This division of the space prevents any bending of the pin in the said space.

The lower cylinders may be furnished with draining cocks or valves, as shown at u in Fig. 2, which valves may also serve for the escape of any accidental excessive pressure due to compression in the cylinders, and the upper cylinder may also be furnished with escape cocks or valves v for the purposes last mentioned.

The term "steam" as used in this specification is intended to comprehend all fluid bodies capable of use for motive power, and by the term "steam-engine," I intend to include all engines in which such fluids may be used for motive power.

What I claim as my invention, and desire to secure by Letters Patent, is—

1. The combination, in an engine, with a crank-shaft and several cylinders arranged radially to the axis of the said shaft and pistons in said cylinders connected with the crank, of a rotary and longitudinally-movable cylindric valve and a seat therefor having their axes in line with the crank-shaft, the said seat having a single port for each cylinder and the said valve being divided longitudinally into two chambers, one for induction and the other for eduction, and both chambers having duplicate ports, all substantially as and for the purpose herein set forth.

2. The combination, in a multiple-cylinder engine, with a cylindrical valve-chest common to the several cylinders and open at its inner end, of a cylindrical valve longitudinally divided into two chambers, one for induction and another for eduction, and having ports in said chambers for the reception, induction, and eduction of steam, the said induction-chamber being closed at both ends of the valve and said eduction-chamber being open at both ends of the valve, substantially as and for the purpose herein set forth.

3. The combination, in an engine, with a main crank and crank-shaft and screw-threaded crank-pin a, several cylinders arranged radially to the axis of said shaft, pistons in said cylinders, and connecting-rods between said pistons and the main crank, of a central rotary valve, a crank c, attached to said valve, a nut a' on the screw-threaded crank-pin for confining the connecting-rods thereon, the said crank c engaging with said nut a' to produce the rotary motion of the valve and to prevent the turning of the said nut on the screw-thread of the crank-pin, all substantially as herein set forth.

4. The combination, with the crank-shaft and the cylinders and pistons arranged radially thereto, of a crank-pin screw-threaded at its end, connecting-rods between said pistons and the crank-pin, rings p p' for connecting the inner ends of said rods with said crank-pin, a nut on said crank-pin for securing said rings and the connecting-rods in place, and pins q, which connect the outer ends of said rods with the pistons and lengthwise on which the said rods are capable of lateral movement when said nut is removed, substantially as and for the purpose herein set forth.

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D. H. HAYWOOD.