No. 724,291. PATENTED MAR. 31, 1903.

# G. HOWARD & G. GIBBS.

## VALVE GEAR.

APPLICATION FILED SEPT. 5, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

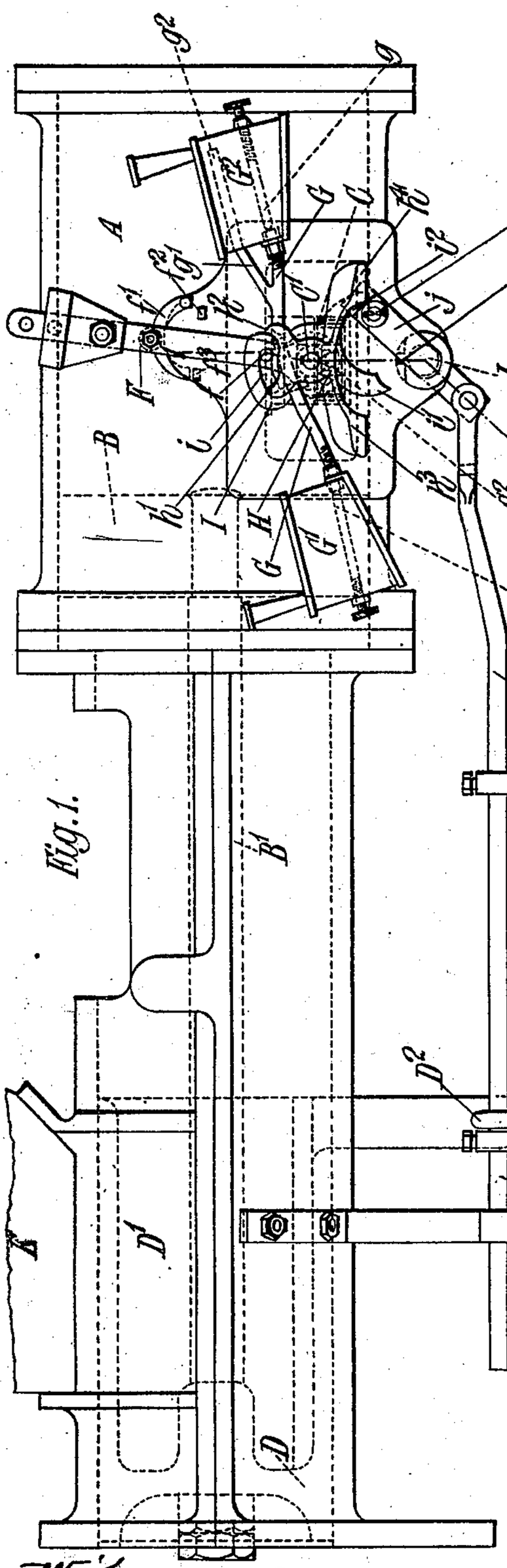

Fig. 1.

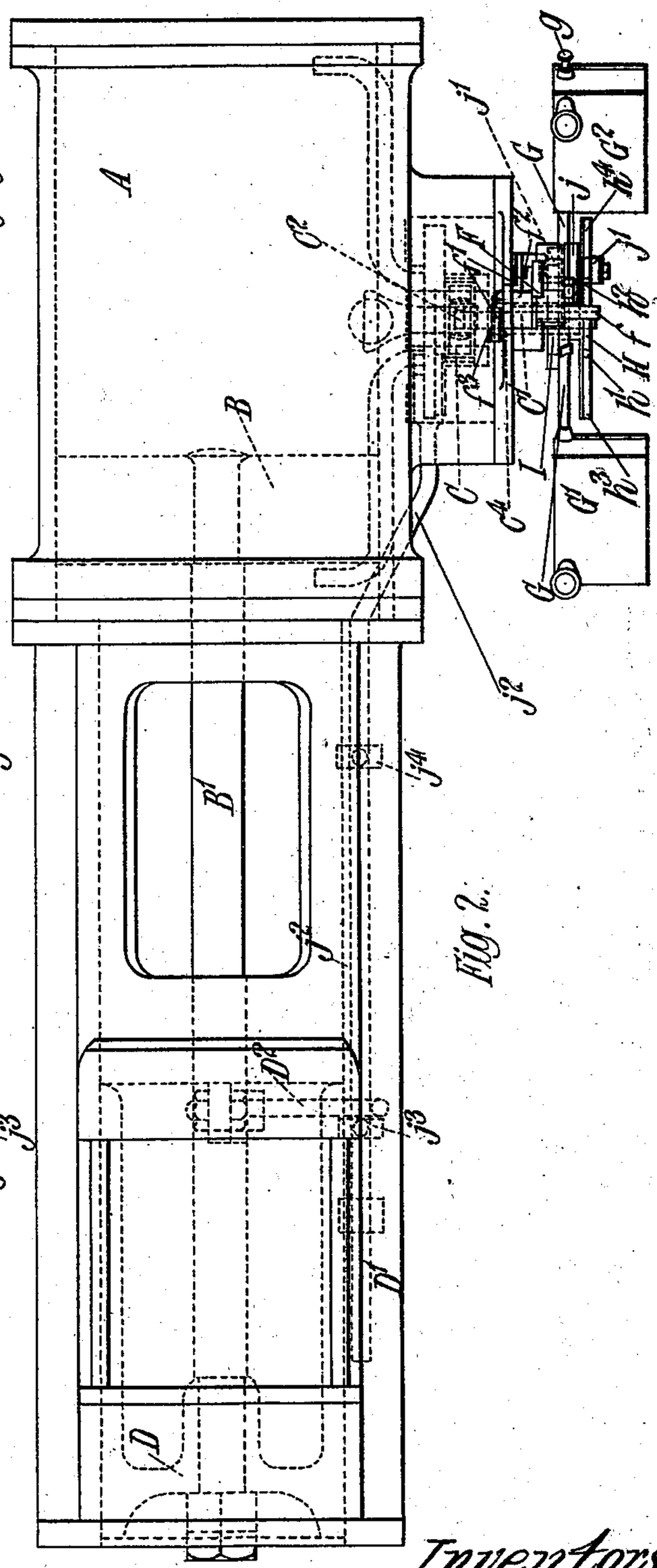

Fig. 2.

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## VALVE GEAR.

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NO MODEL. 3 SHEETS—SHEET 2.

*Fig. 3.*

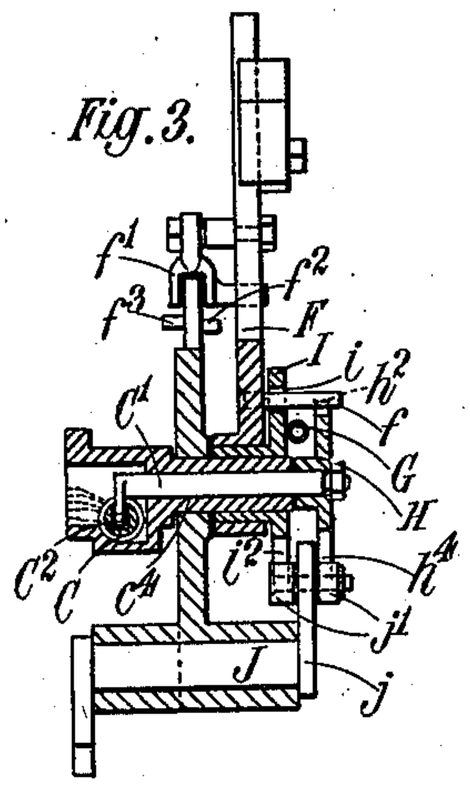
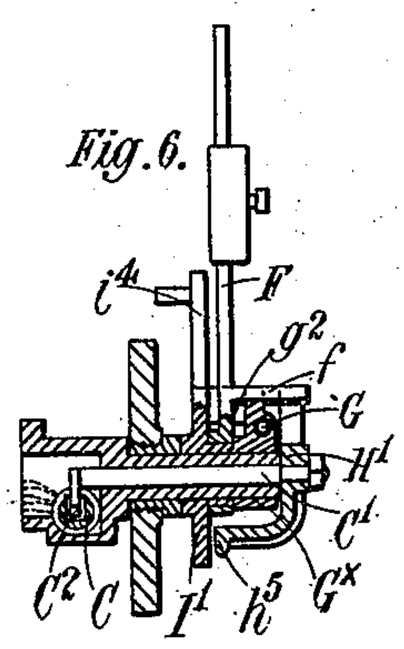



*Fig. 6.*

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## VALVE GEAR.

APPLICATION FILED SEPT. 5, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

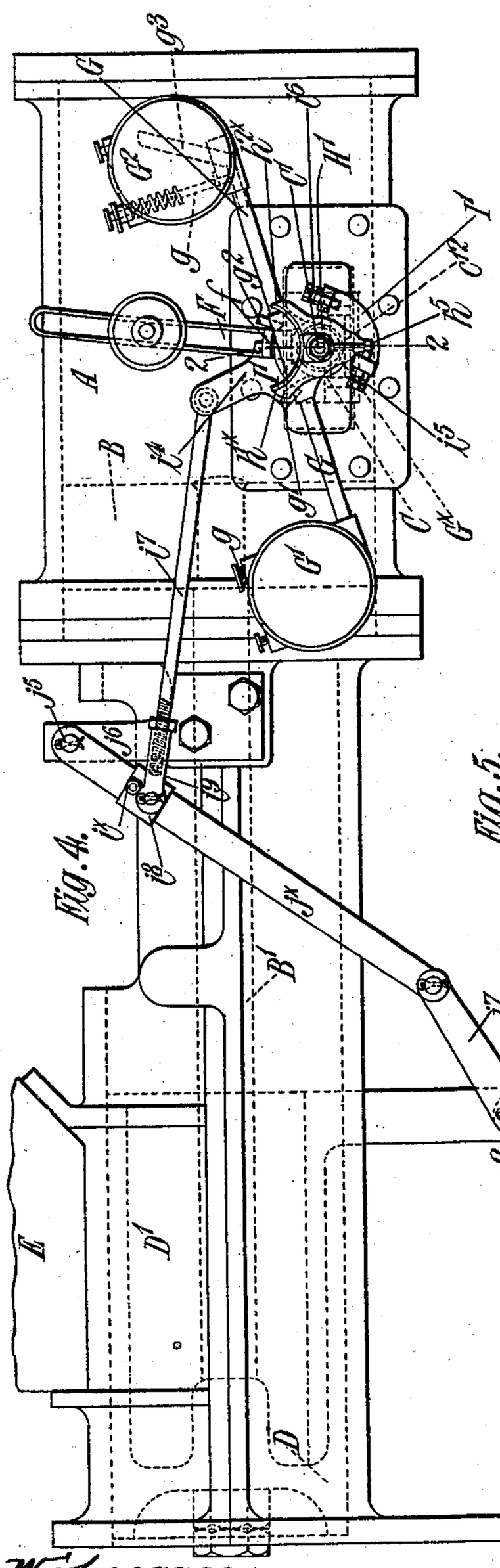

Fig. 4.

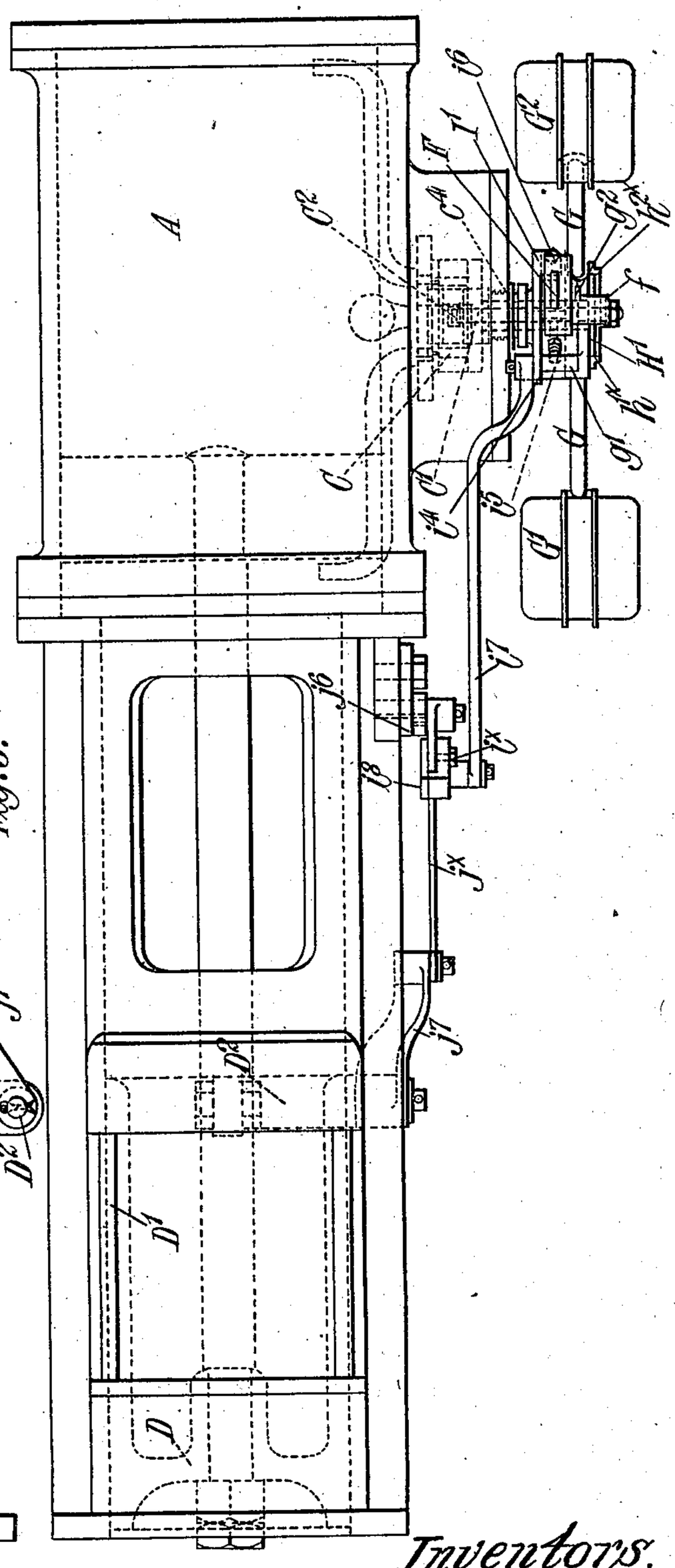

Fig. 5.

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# UNITED STATES PATENT OFFICE.

GEOFFREY HOWARD AND GEORGE GIBBS, OF BEDFORD, ENGLAND.

## VALVE-GEAR.

SPECIFICATION forming part of Letters Patent No. 724,291, dated March 31, 1903.

Application filed September 5, 1902. Serial No. 122,252. (No model.)

*To all whom it may concern:*

Be it known that we, GEOFFREY HOWARD and GEORGE GIBBS, engineers, subjects of the King of Great Britain, residing at Britannia Iron Works, Bedford, in the county of Bedford, England, have invented certain new and useful Improvements in Valve-Gear, of which the following is a specification.

This invention has reference to valve-gear for steam and other fluid pressure engines, and is particularly applicable to the control of the fluid-pressure-distributing valve of a mechanical stoker of the kind wherein the fuel is fed to the furnace by a reciprocating pusher or ram operated by a piston and wherein the fluid-pressure for working said piston is, by an automatically-actuated fluid-pressure-distributing valve, admitted to and exhausted from the working cylinder at periodical intervals which by adjusting the valve-gear are capable of being prolonged or diminished, as required.

According to our invention the movements of said valve are automatically controlled by a weighted arm and a rocking beam or lever having at its opposite ends receptacles for containing liquid or other suitable mobile substance, the said receptacles being in communication with each other. By appropriate mechanism actuated by the reciprocations of the fuel feeder, pusher, or ram each time the piston completes one of its strokes the distributing-valve is set into its intermediate or "cut-off" position, while the rocking beam is caused to assume an inclined position with the receptacle containing the most liquid in a higher position than the other receptacle, the said beam in assuming this position also raising the weighted arm. The flow of the liquid from the higher to the lower receptacle causes the said beam to rock and liberate the weighted arm from its raised position, so that it falls by the action of gravity and in so doing causes the distributing-valve to be shifted into its open position for admitting motive fluid to the cylinder and causing the piston to perform another stroke. The time occupied by the liquid in flowing from the higher to the lower receptacle of the rocking beam regulates the period of rest between the movements of the distributing-valve, and therefore between the strokes of the piston.

In order that our said invention may be clearly understood and readily carried into effect, we will now describe the same more fully with reference to the accompanying drawings.

Figure 1 is a side elevation, and Fig. 2 a plan, of one form of our valve-gear applied to a mechanical stoker of the kind referred to. Fig. 3 is a vertical transverse section of the valve-gear, taken approximately on the line 1 1 of Fig. 1. Fig. 4 is a side elevation, and Fig. 5 a plan, of a modified form of our valve-gear applied to the said mechanical stoker. Fig. 6 is a vertical transverse section of the valve-gear, taken approximately on the line 2 2 of Fig. 4.

Like letters of reference indicate similar parts in all the figures.

A is the steam or other fluid pressure cylinder.

B is the piston, and B′ its piston-rod.

C is the distributing-valve, which is in the form of a piston and receives its reciprocations from a transverse spindle C′ and crank $C^2$ thereon.

D is the ram or pusher, and D′ the chamber in which it works.

E is a hopper, from which the fuel for feeding the furnace is supplied to the chamber D′.

F is the weighted arm, and G the rocking beam.

Referring more particularly to Figs. 1, 2, and 3, H and I are two oscillatory or swinging plates, the former of which has a pair of horns $h'$ $h^2$ at the upper part and a pair of ears $h^3$ $h^4$ at its lower part and is keyed or otherwise secured to the valve-spindle C′. The other oscillatory plate I has at its upper part a segmental slot $i$ and at its lower part a pair of lugs $i'$ $i^2$ and is free to rock upon a sleeve $c^4$ on the said valve-spindle. For sake of distinction we will refer to these two plates, respectively, as the "horned" plate and the "slotted" plate. The said weighted arm F is also free to rock about said sleeve $c^4$ of the valve-spindle C′, and it has a lateral pin or finger $f$, which engages with the slot $i$ in the slotted plate. The slotted plate also carries the rocking beam G, having at its opposite ends the receptacles G′ $G^2$ for containing the liquid or other suitable mobile substance, the said receptacles being in commu-

nication with each other through a pipe or conduit which in the example shown constitutes the aforesaid beam G. Situated beneath the said valve-spindle C′ is a rocking shaft J, carrying an arm *j*, which has two antifriction rollers or pins *j′ j′* near its free end, said rocking shaft receiving its movement from a sliding rod or bar $j^2$, bearing adjustable tappets $j^3$ $j^4$, which are struck by a finger $D^2$ on the ram during the reciprocating movements of the latter. The said antifriction-rollers *j′ j′* are so situated that as said arm *j* rocks they will strike against the ears $h^3$ $h^4$ of the horned plate H and the lugs $i'$ $i^2$ of the slotted plate I, thus imparting oscillatory motion to these plates and to the valve-spindle.

As the ram D reciprocates under the action of the steam admitted by the valve C to the working cylinder and as it completes one or other of its strokes—say its left-hand stroke—its finger $D^2$ strikes the tappet $j^3$ on the sliding bar $j^2$, thereby shifting the latter to the left and causing the rocking shaft J to turn and its arm *j* to rock toward the right. One of the antifriction-rollers on said arm then strikes the ear $h^4$ of the aforesaid horned plate H, thereby actuating said plate and causing the valve-spindle to rock to the extent necessary to bring the slide-valve into its central or cut-off position, Fig. 1, thus closing the steam and exhaust ports of the working cylinder. This movement of the rocking shaft J and its arm *j* also brings the other antifriction-roller against the lug $i^2$ on the aforesaid slotted plate I, whereby the latter is actuated and the beam G it carries is rocked into the position represented in Fig. 1. Thus the receptacle $G^2$ on said beam is raised and the receptacle G′ lowered, so that the fluid in the raised receptacle will flow through the hollow beam into the lower receptacle. This movement of the slotted plate I also causes its slot *i* to act upon the pin *f* of the weighted arm F, whereby the latter is moved into an almost upright position, as represented in Fig. 1. The said weighted arm remains in this position until sufficient liquid from the upper receptacle has flowed into the lower receptacle to overcome the inertia of the weighted arm and cause it, through the intervention of the slotted plate I and the pin *f*, to fall from its upright position toward the left. In falling its pin *f*, by moving in the slot *i* of the slotted plate, strikes the horn *h′* of the horned plate H, whereby the latter is actuated and caused to rock the valve-spindle. The valve C is thus shifted into its open position to admit steam to the working cylinder on the side of the piston opposite to that to which it was previously admitted. The piston is therefore caused to perform a stroke toward the right until, upon approaching the end of its stroke, the finger $D^2$ on the ram actuates the other tappet $j^4$ on the sliding bar $j^2$, whereby the movements of the aforesaid horned and slotted plates H and I and the weighted arm F are again effected, but in the opposite direction.

The aforesaid weighted arm F serves to retard the operation of the beam G, so that said beam will not be overbalanced until the whole, or practically the whole, of the liquid from the upper receptacle has flowed into the lower one. Said weighted arm also serves to increase the force of the impulse imparted to the valve-spindle. The position of the weight on the said arm is preferably made adjustable.

The speed at which the fluid flows from one receptacle to the other is controlled by adjustable valves *g g* or other suitable devices, so that the periods of rest between the strokes of the piston can be regulated at will. It is desirable in some cases to have an unequally-timed period of rest between the strokes, so that the piston will remain stationary at one end of its stroke longer than at the other end. For this purpose we provide at one end of the aforesaid beam G a by-pass, through which the fluid can flow into the adjacent receptacle $G^2$ independently of the valve *g*, and therefore enter said receptacle at a greater speed than it can do when flowing past the said valve. The end $g^2$ of this by-pass is arranged to lie above the level of the fluid in the receptacle $G^2$ when the latter is in its raised position, Fig. 1, so that the fluid in escaping from said receptacle is compelled to flow past the said valve *g*.

In order to limit the extent of movement of the aforesaid slotted plate I, we provide a fixed stop $i^3$, against the opposite sides of which it strikes at the ends of its movements.

The flow of the fluid from one to the other of the receptacles of the beam G regulates the period of rest between the strokes of the piston, and the position of the tappets $j^3$ $j^4$ on the sliding bar $j^2$ regulates the length of the strokes of said piston in either direction.

We may provide means for preventing the aforesaid weighted lever from shifting beyond its approximately upright position to which it is set by the slotted plate I. Said means may comprise a loosely-pivoted T-piece *f′*, carried by the weighted arm and operating in conjunction with fixed stops $f^2$ $f^3$, with which it will engage by its inertia if the said weighted lever should tend to turn beyond its proper position.

Referring now to the modification shown by Figs. 4 to 6, in which the manner of imparting motion to the weighted arm F and rocking beam G is varied, H′ is a plate attached to the outer end of the valve-spindle C′, said plate having at its upper part horns $h'^{\times}$ $h^{2\times}$ and at its lower part a lug $h^5$. Loosely mounted on a sleeve $c^4$, surrounding the valve-spindle, is a plate I′, having at its upper part an arm $i^4$ and at its lower part two adjustable set-screws $i^5$ $i^6$, so arranged that their inner ends are capable of striking the lug $h^5$ of the plate H′. The free end of the said arm $i^4$ is connected by a rod $i^7$ to a stud-

block $i^8$, mounted on a swinging arm $j^\times$ and capable of adjustment thereon by a set-screw $i^\times$. The upper end of this arm is pivotally connected at $j^5$ to a bracket $j^6$ and at its lower end is connected by a link $j^7$ to the finger $D^2$ of the ram D, from which motion is transmitted to said plate I′ by the swinging arm $j^\times$ and connecting-rod $i^7$. $G^\times$ is a boss loosely mounted on the sleeve $c^4$ and carrying the rocking beam G with its receptacles G′ $G^2$. This boss also has projections $g'$ $g^2$, between which the finger $f$ of the weighted arm F works. This finger also works between the horns $h'^\times$ and $h^{2\times}$ of the plate H′. The arm $i^4$ of the plate I′ has shoulders to engage with the projections $g'$ $g^2$ of the boss $G^\times$ of the beam. When the said arm $i^4$ and plate I′ are rocked by the movement of the ram D and the swinging arm $i^\times$, the arm $i^4$ acts upon one or other of the projections $g'$ $g^2$ and rocks the beam G, the other projection that is not acted upon by said arm then turning the weighted arm F into its approximately upright position, as shown in Fig. 4. The liquid in the uppermost receptacle $G^2$ of the beam then flows into the lowermost receptacle G′ until the weight of the latter is sufficient to overbalance the weighted arm F and turn it over its dead-center and permit it to fall, as already explained in connection with the previously-described arrangement. As the said weighted arm falls its finger $f$ strikes the horn $h'^\times$ of the plate H′, thereby actuating said plate and angularly shifting the valve-spindle into a position to cause the valve to uncover the steam-inlet to the working cylinder and permit the steam to drive the piston from left to right. As the piston performs its stroke the swinging arm $j^\times$ and connecting-rod $i^7$ turn the arm $i^4$ and plate I′ toward the right, thereby bringing the set-screw $i^6$ into contact with the lug $h^5$ of the plate H′ and setting this plate into a position to place the valve at its central or cut-off position, thus stopping the supply of steam to the working cylinder. Simultaneously with this movement of the plate H′ the beam G has been rocked into the reverse position to that represented in Fig. 4—*i. e.*, with the receptacle G′ uppermost. Therefore the liquid which has previously flowed into this receptacle from the receptacle $G^2$ now flows back again into the receptacle $G^2$ and in so doing eventually causes the beam to rock and the weighted arm to swing as already described, but in the opposite direction.

The valves $g$ $g$ for regulating the flow of the liquid to and from the receptacles G′ $G^2$ are arranged vertically instead of horizontally, as in the previously-described construction. The by-pass $g^3$ is similar in action to that already described with reference to Figs. 1 to 3.

The aforesaid connecting-rod $i^7$ is adapted to be shortened or lengthened in order to regulate the stroke of the plate I′, for which purpose we have shown the end of said rod screw-threaded to engage with a correspondingly-screw-threaded socket $i^9$ on the stud-block $i^8$.

We wish it to be understood that our invention is not only applicable to the working cylinders of mechanical stokers, but can be applied with advantage to the working cylinders of other engines—such as hydraulic or other pumps, compressed-air motors, and such like. We also wish it to be understood that instead of a slide-valve a rotary valve may be employed.

What we claim is—

1. In distributing-valve gear for fluid-pressure engines, the combination with the working cylinder, its piston, and its distributing-valve; of a rocking beam provided at its ends with receptacles communicating with each other and containing mobile substance, a weighted arm with which said beam coöperates, means controlled by the piston for setting the beam in an inclined position, raising the weighted arm, and placing the valve in its intermediate or "cut-off" position, means for liberating said weighted arm by the movement of the beam due to the flow of the mobile substance from the upper to the lower receptacle, and means for enabling said arm to open the valve substantially as described.

2. In distributing-valve gear for fluid-pressure engines, the combination with the working cylinder, its piston and its distributing-valve; of a rocking beam provided at its ends with receptacles communicating with each other and containing mobile substance, means for controlling the flow of the said mobile substance from one receptacle to the other, a weighted arm with which said beam coöperates, means controlled by the piston for setting the beam in an inclined position, raising the weighted arm, and placing the valve in its intermediate or "cut-off" position, means for liberating said weighted arm by the movement of the beam due to the flow of the mobile substance from the upper to the lower receptacle, and means for enabling said arm to open the valve substantially as described.

3. In distributing-valve gear for fluid-pressure engines, the combination with the working cylinder, its piston, and its distributing-valve; of a rocking beam provided at its ends with receptacles communicating with each other and containing mobile substance, adjustable valves for controlling the flow of the said mobile substance from one receptacle to the other, a weighted arm with which said beam coöperates, means controlled by the piston for setting the beam in an inclined position, raising the weighted arm, and placing the valve in its intermediate or "cut-off" position, means for liberating said weighted arm by the movement of the beam due to the flow of the mobile substance from the upper to the lower receptacle, and means for enabling said arm to open the valve substantially as described.

4. In distributing-valve gear for fluid-pressure engines, the combination with the working cylinder, its piston and its distributing-valve; of a rocking beam provided at its end with receptacles communicating with each other and containing mobile substance, means for controlling the flow of the said mobile substance from one receptacle to the other, a by-pass on one receptacle for the mobile substance to flow into said receptacle independently of the controlling means, a weighted arm with which said beam coöperates, means controlled by the piston for setting the beam in an inclined position, raising the weighted arm, and placing the valve in its intermediate or "cut-off" position, means for liberating said weighted arm by the movement of the beam due to the flow of the mobile substance from the upper to the lower receptacle, and means for enabling said arm to open the valve substantially as described.

5. In distributing-valve gear for fluid-pressure engines, the combination with the working cylinder, its piston, and its distributing-valve; of a rocking beam provided at its ends with receptacles containing mobile substance and communicating with each other through a conduit in the beam, means for controlling the flow of the said mobile substance from one receptacle to the other, a by-pass in one receptacle for the mobile substance to flow into said receptacle independently of the said controlling means, a weighted arm with which said beam coöperates, means controlled by the piston for setting the beam in an inclined position, raising the weighted arm, and placing the valve in its intermediate or "cut-off" position, means for liberating said weighted arm by the movement of the beam due to the flow of the mobile substance from the upper to the lower receptacle, and means for enabling said arm to open the valve substantially as described.

6. In distributing-valve gear for a mechanical stoker operated directly by a fluid-pressure engine; the combination with the working cylinder, its piston, and its distributing-valve, of a rocking beam loosely mounted on the valve-spindle and provided at its ends with receptacles communicating with each other and containing mobile substance, a weighted arm coöperating with said beam and also loosely mounted on the valve-spindle, two oscillatory plates, one loosely mounted on the valve-spindle and the other affixed thereto, means connecting said loose oscillatory plate with the ram of the stoker, means whereby the loose plate causes the beam to assume an inclined position, the weighted arm to assume an approximately vertical position and the other plate to set the valve in its intermediate or "cut-off" position, and means whereby the beam in rocking by the flow of the mobile substance from the upper to the lower receptacle, releases the weighted arm and permits it to operate the plate fixed to the valve-spindle and open the valve substantially as described.

7. In distributing-valve gear for a mechanical stoker operated directly by a fluid-pressure engine; the combination with the working cylinder, its piston, and its distributing-valve, of a rocking beam loosely mounted on the valve-spindle and provided at its ends with liquid-containing receptacles communicating with each other, adjustable valves for controlling the flow of said liquid from one receptacle to the other, a by-pass on one receptacle for the liquid to flow thereinto independently of the adjustable valve, a weighted arm coöperating with the beam and loosely mounted on the valve-spindle, two oscillatory plates, one mounted loosely on the valve-spindle and the other fast thereon, an adjustable rod connecting said loose swinging plate to the ram of the stoker through the intervention of a swinging arm, adjustable block and link, set-screws on the loose plate adapted to coöperate with a projection on the fast plate, projections on the beam coöperating with shoulders on the loose plate, a finger on the weighted arm with which the projections on the beam coöperate, and projections on the fast plate with which said finger of the weighted arm coöperates, all substantially as and for the purposes specified.

8. In distributing-valve gear for a mechanical stoker, operated directly by a fluid-pressure engine; the combination with the working cylinder, its piston and its distributing-valve, of a rocking beam provided at its ends with liquid-containing receptacles communicating with each other, adjustable valves for controlling the flow of said liquid from one receptacle to the other, a by-pass on one receptacle for the liquid to flow thereinto independently of the adjustable valves, an oscillatory plate loosely mounted on the valve-spindle and carrying said beam, a weighted arm coöperating with the beam and loosely mounted on the valve-spindle, another oscillatory plate mounted fast on the said valve-spindle, a rocking arm for actuating both of said plates for setting the valve into its "cut-off" position and the beam into an inclined position, a sliding rod connected with said rocking arm, adjustable tappets on said sliding rod, a finger on the ram of the stoker for acting upon said tappets, and a finger on the weighted arm engaging with a slot in the loose plate and lying in the path of projections on the fast plate, all substantially as and for the purposes specified.

In testimony whereof we have hereunto set our hands, in presence of two subscribing witnesses, this 22d day of August, 1902.

GEOFFREY HOWARD.
GEORGE GIBBS.

Witnesses:
JAMES ROPER,
ERNEST GEORGE BRANDON.