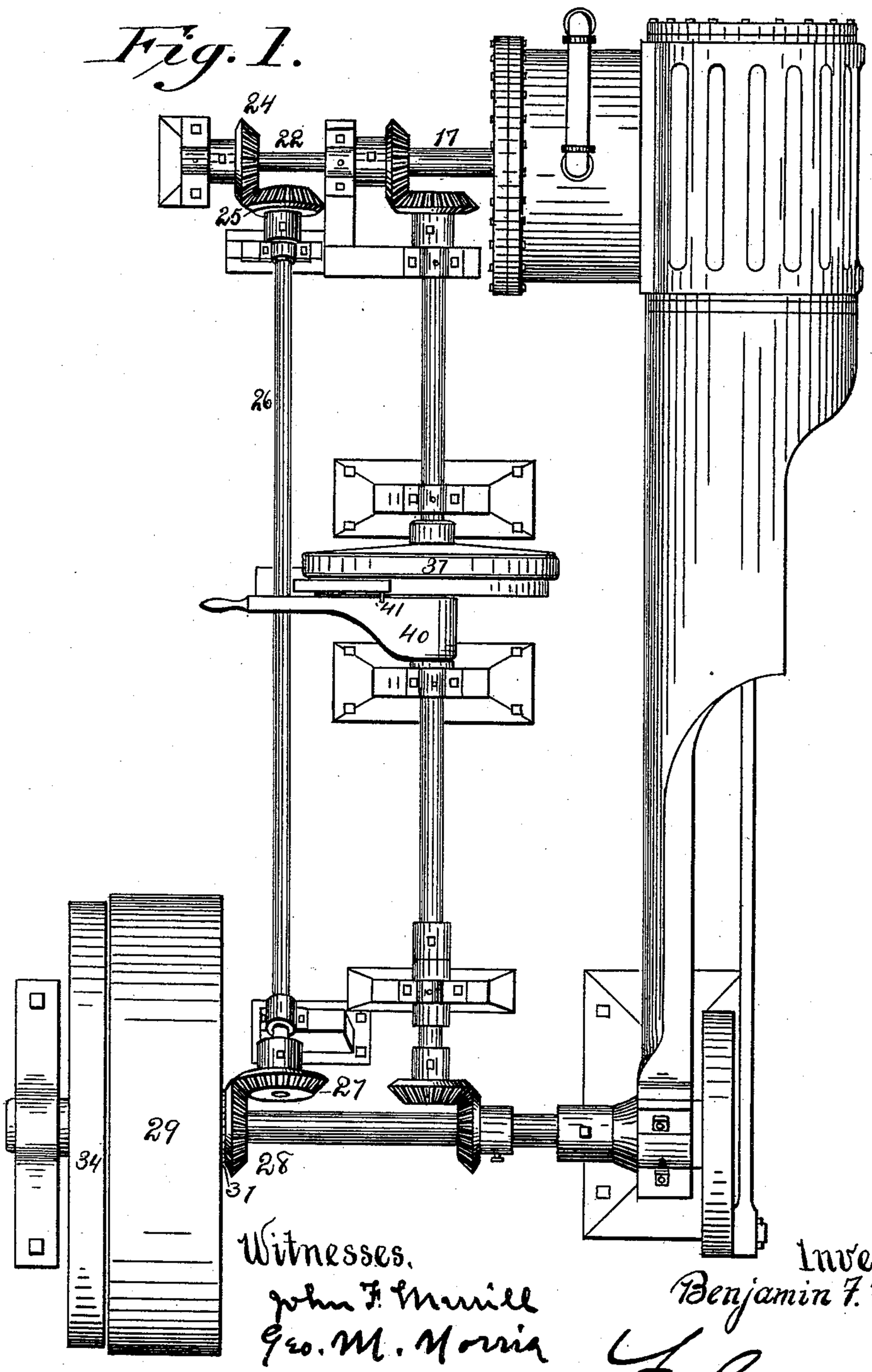
(No Model.) 5 Sheets—Sheet 1.

B. F. FITCH.

CUT-OFF VAVLE AND GEAR.

No. 453,173. Patented May 26, 1891.

Fig. 1.



Witnesses.
John F. Merrill
Geo. M. Morris

Inventor.
Benjamin F. Fitch.
By F. F. Fitch Attorney.

(No Model.) 5 Sheets—Sheet 2.

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CUT-OFF VAVLE AND GEAR.

No. 453,173. Patented May 26, 1891.

Fig. 2.

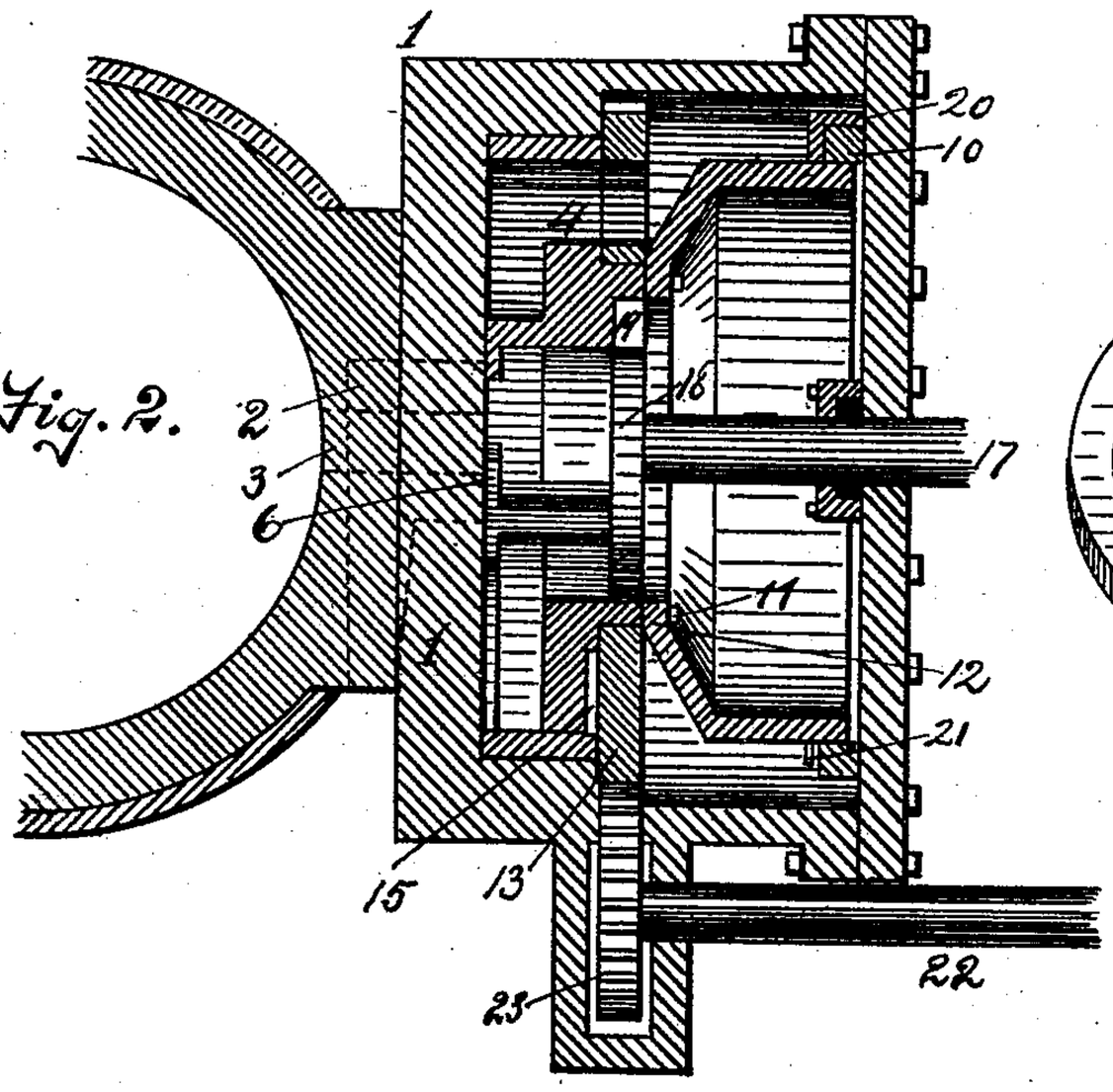


Fig. 7.

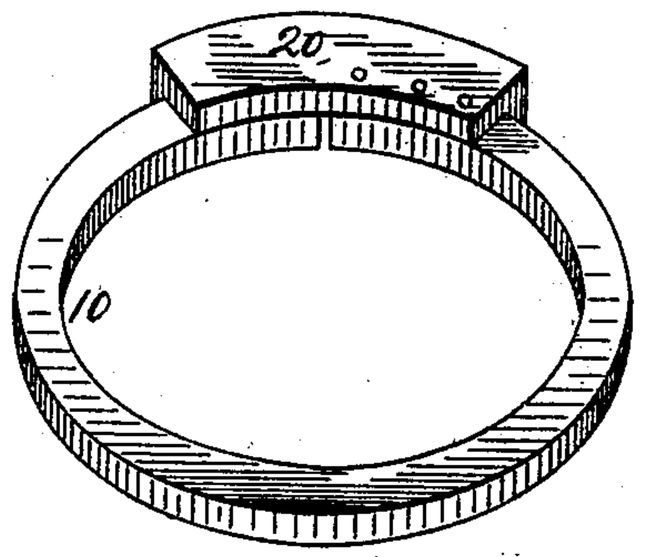


Fig. 3.

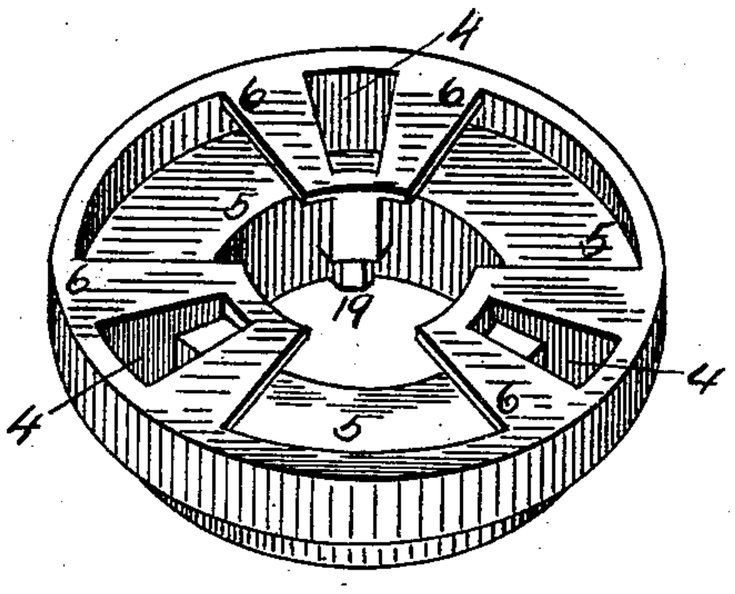
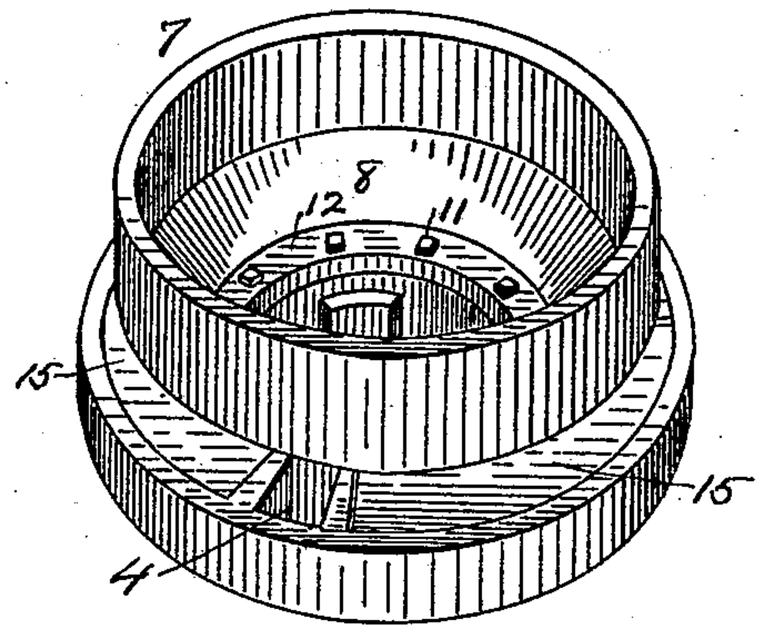


Fig. 4



Witnesses.
John F. Merrill
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(No Model.) 5 Sheets—Sheet 3.

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CUT-OFF VAVLE AND GEAR.

No. 453,173. Patented May 26, 1891.

Fig. 5.

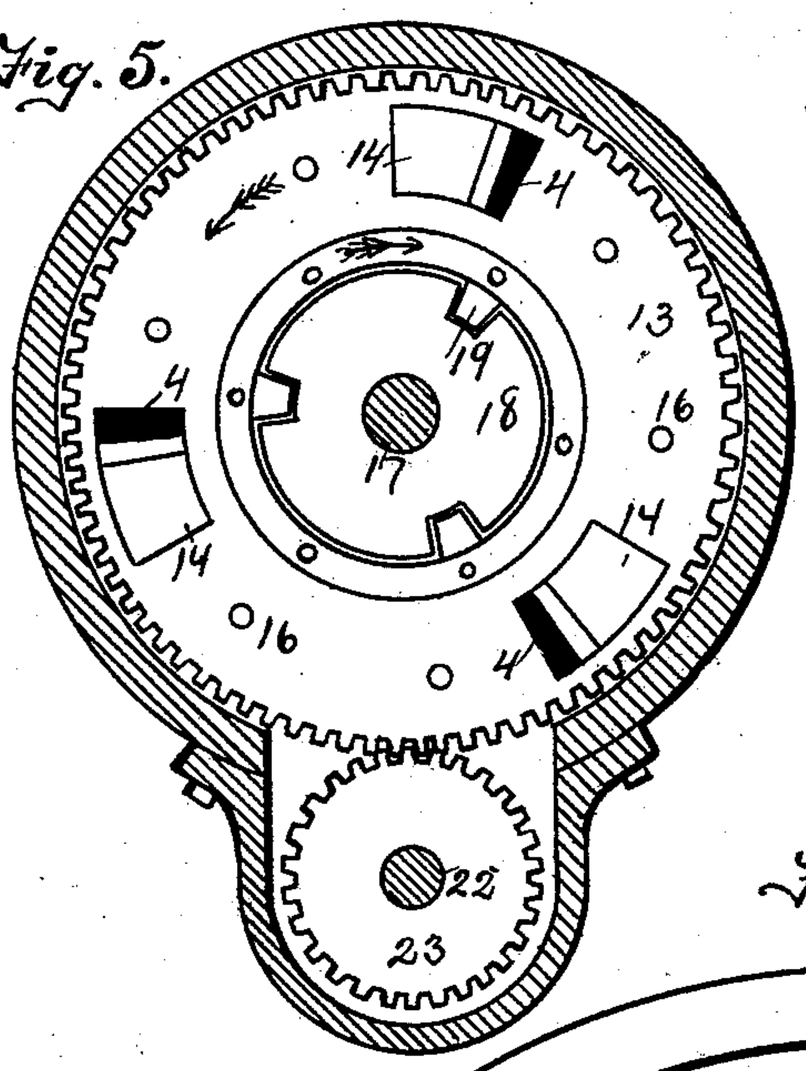


Fig. 6.

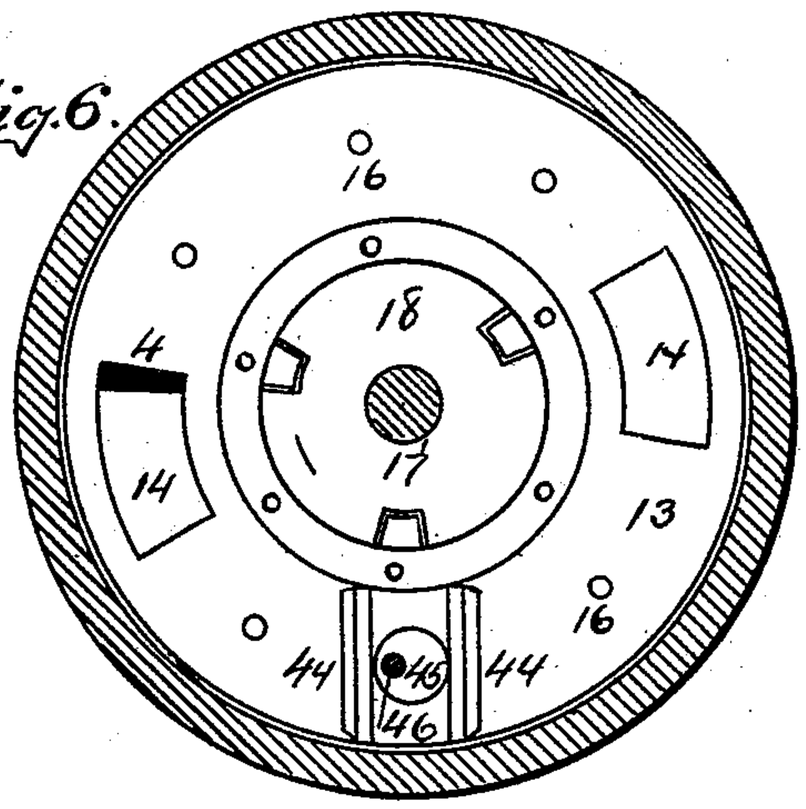
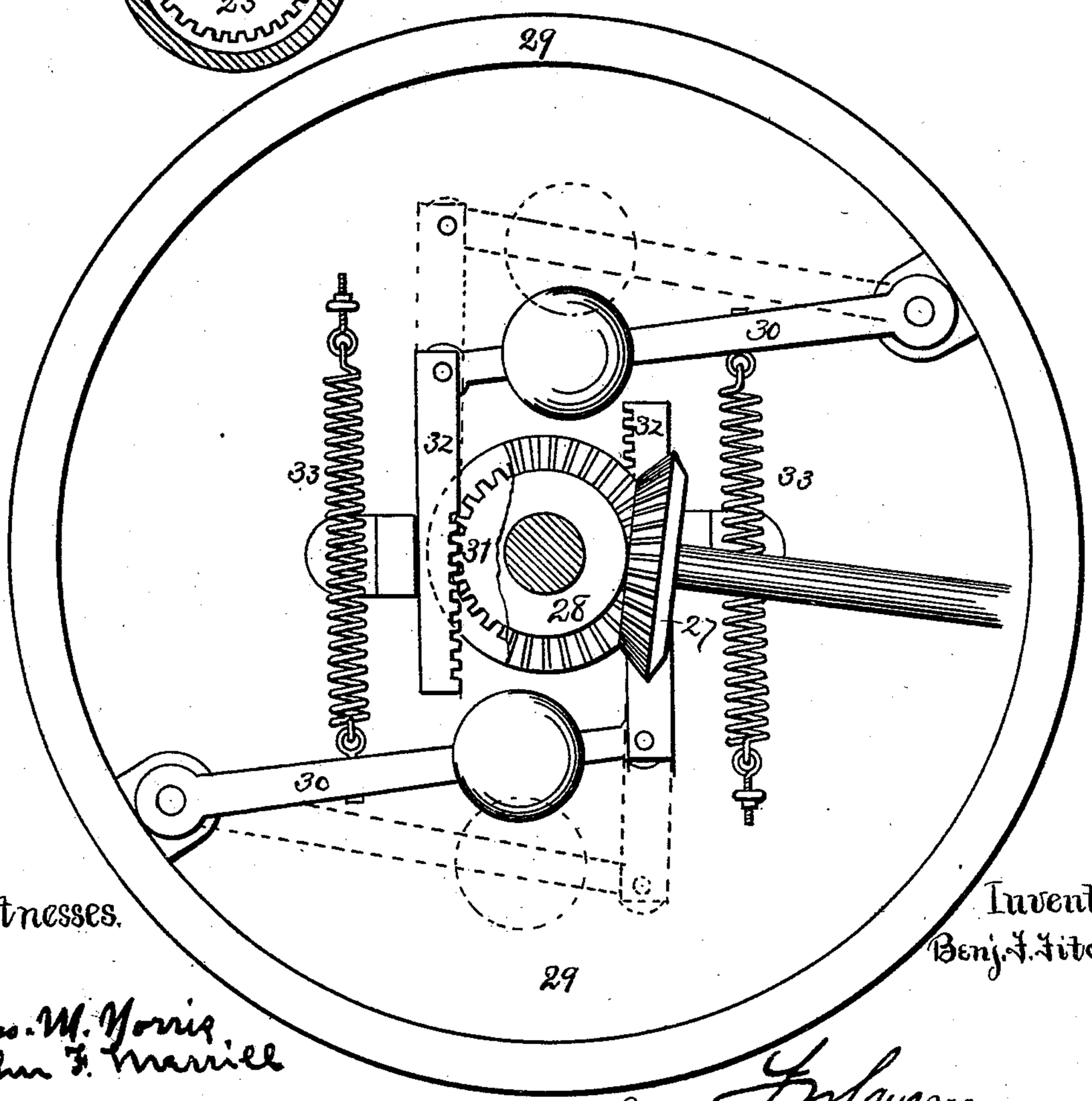


Fig. 8.



Witnesses.

Geo. M. Morris
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(No Model.) 5 Sheets—Sheet 4.

B. F. FITCH.

CUT-OFF VAVLE AND GEAR.

No. 453,173. Patented May 26, 1891.

Fig. 9.

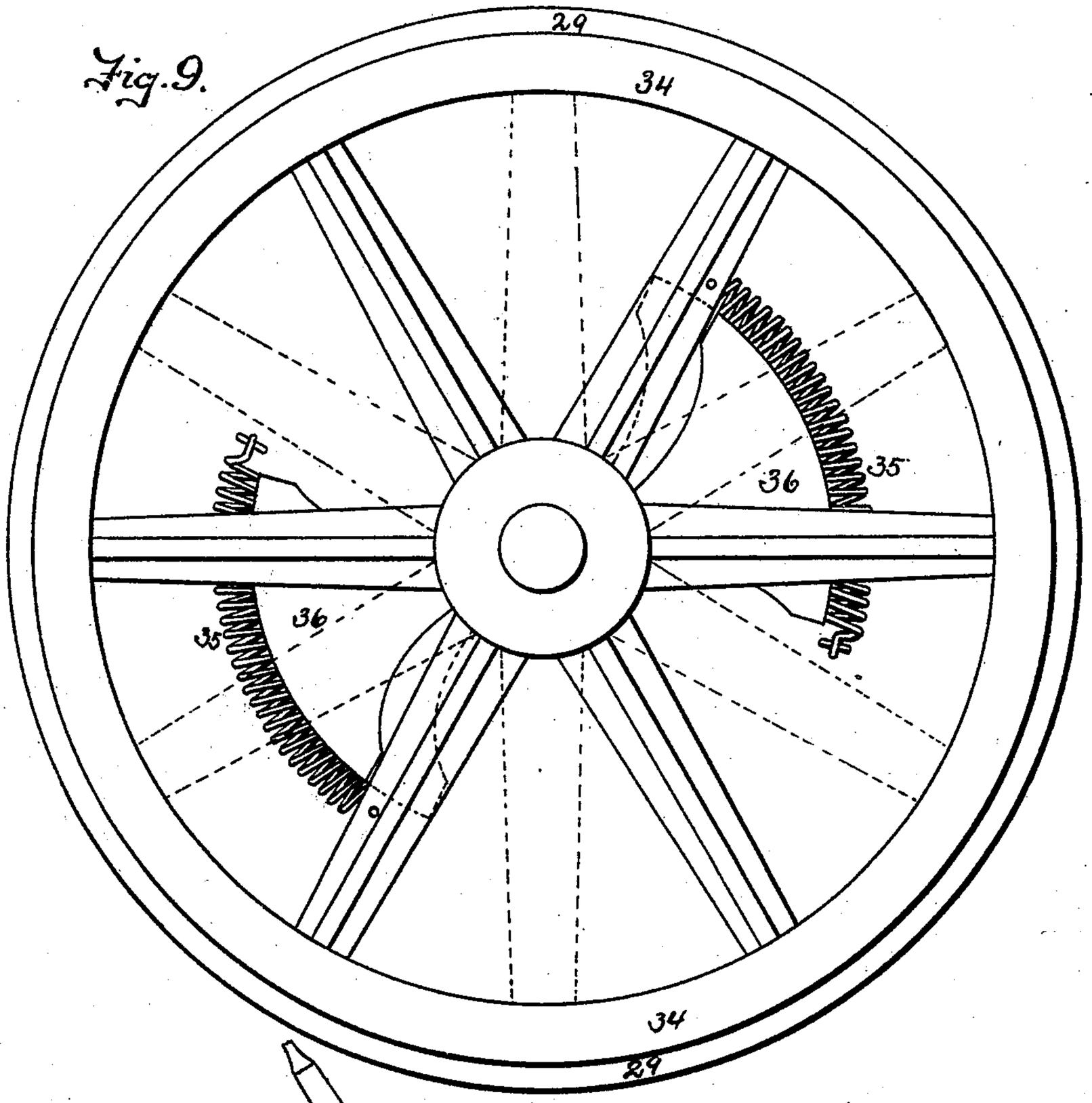

Fig. 10.

Witnesses.

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(No Model.) 5 Sheets—Sheet 5.

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CUT-OFF VAVLE AND GEAR.

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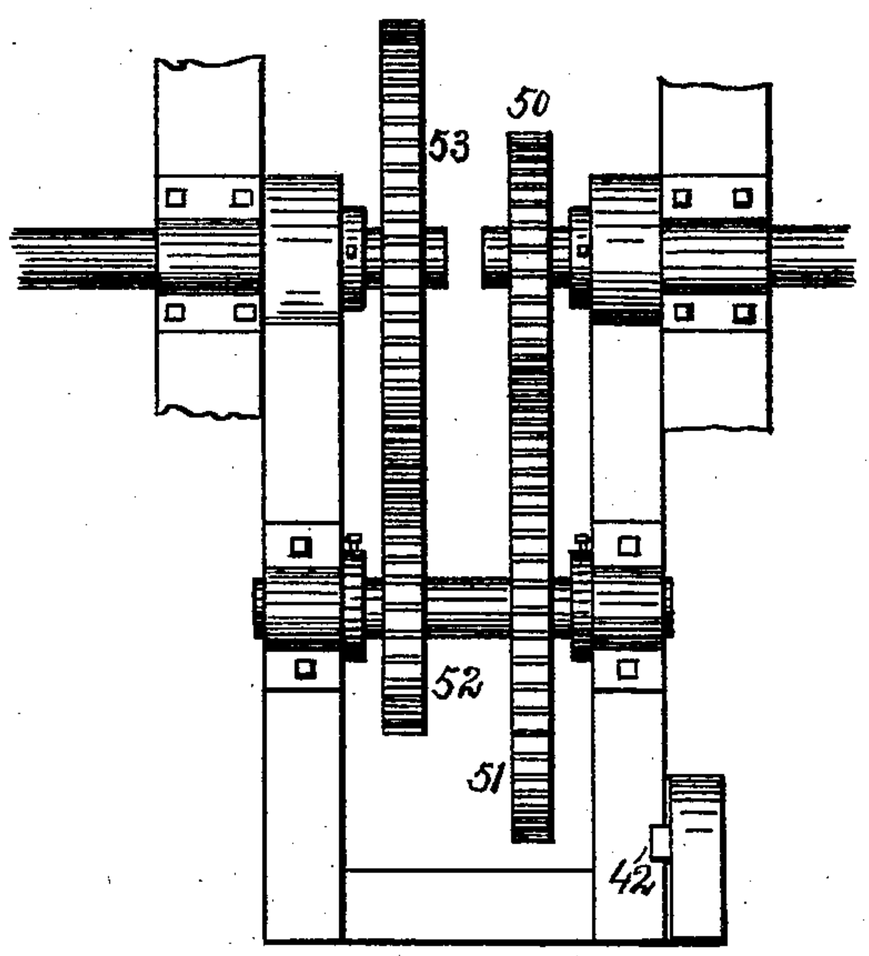

Fig. 11.

Witnesses.
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Inventor.
Benjamin F. Fitch.

By F. F. Lauer Attorney.

UNITED STATES PATENT OFFICE.

BENJAMIN F. FITCH, OF LA CROSSE, WISCONSIN.

CUT-OFF VALVE AND GEAR.

SPECIFICATION forming part of Letters Patent No. 453,173, dated May 26, 1891.

Application filed December 31, 1889. Serial No. 335,559. (No model.)

To all whom it may concern:

Be it known that I, BENJAMIN F. FITCH, a citizen of the United States, residing at La Crosse, in the county of La Crosse and State of Wisconsin, have invented certain new and useful Improvements in Valves and Valve-Gear for Steam-Engines; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same, reference being had to the accompanying drawings, and to the figures of reference marked thereon, which form a part of this specification.

This invention relates to improvements in the construction and operation of cut-off valves and valve-gear for steam-engines; and it consists, generally, in the construction and arrangement of the valve and cut-off and the means employed for operating the same, in the reversing-gear, and in the means employed for producing and maintaining a constant equilibrium between load and steam-pressure, and for maintaining a uniform exhaust, regardless of the point of cut-off. The various points of invention will be hereinafter more specifically set forth.

The invention is especially adapted for working steam expansively on high rotative speed engines, and the objects to be attained are a greater economy in the use of steam by obviating back-pressure, by obtaining complete expansion up to the end of the stroke, and the instant relief of the steam when its work is completed, relieving the engine from the losses occasioned by early lead, compression, and back-pressure.

Other objects of the invention are to obtain a continuously-rotating automatic cut-off, which is so connected with and operated by a centrifugal governor upon the band-wheel as to produce and maintain a constant equilibrium between load and steam-pressure by varying the point of cut-off according to the work to be accomplished.

The invention is illustrated in the accompanying drawings, in which—

Figure 1 represents a general plan view of the operative parts of an engine, showing the relation thereto of the several features constituting my improvement; Fig. 2, a central longitudinal section of the valves and valve-chest; Fig. 3, a perspective view of the face of the valve; Fig. 4, a similar view of the back of the same; Fig. 5, a cross-section of the valve-chest, showing the construction of the cut-off slide and the mode of operation of the same and the valve; Fig. 6, a modification of the cut-off slide; Fig. 7, a detail of the packing-ring closing the joint between the balance-column of the valve and the valve-chest cover; Fig. 8, a cross-sectional view through the crank-shaft, showing the mode of operating the variable automatic cut-off by means of the centrifugal governor upon the band-wheel; Fig 9, a similar view in the opposite direction, showing the arrangement of the spring connection between the band and fly-wheel; Fig. 10, a detail of the reversing-gear, and Fig. 11 a modification of the same.

Like characters designate corresponding parts in all of the figures.

The valve is of rotary class, and its construction and its operation are as follows:

1 represents the valve-seat of circular form, having a central exhaust-port and two opposite steam-ports 3 3.

The valve, a face view of which is shown in Fig. 3, is provided with three segmental steam-ports 4 4 and the same number of segmental exhaust-spaces 5 5, separated from the steam-ports by means of radial diaphragms or port-coverings 6 6. The ports and exhaust-spaces alternate, and are so located that the centers of port and exhaust are diametrically opposite. In order to give as great an exhaust-space as possible, and thus to permit the instant release of the steam at the completion of the stroke of the piston, the port-coverings are brought closely up to the edge of the ports, are of sufficient width to close the ports in the valve-seat, and the remaining space is left for the exhaust-steam. To afford still further relief, and especially for the purpose of increasing the area of the smallest part of the exhaust-space—that is, the point nearest the central exhaust-opening in the valve—the port-coverings are cored or chambered underneath their faces, as shown in Fig. 3, thereby greatly increasing the exhaust-space and permitting instant relief of the steam at the completion of the stroke. Back-pressure is by this means wholly obviated.

From the back of the valve extends the steam balance-column 7, which is of as great a circumference as possible within the limits of the steam-ports 4. In order to give a still greater circumference to the outer edge of the column and to provide a more perfect balance, the outer portion of the column is flared or extended in any convenient manner, as shown at 8, so as not to interfere with the free passage of the steam through the ports. The outer end of the column extends nearly to the valve-chest cover, and the joint at this point is closed by means of an expansion packing-ring 10, hereinafter to be described. The column, for convenience in mechanical construction, may be formed separately from the body of the valve and united thereto by means of bolts 11, passing through a flange 12, formed at the base thereof, and thence into the body of the valve.

I have provided for the use of a variable cut-off, adjustable either automatically or by use of a hand-lever. The form of the slide employed is different in the two cases.

The construction of the automatically-adjustable cut-off is as follows: The circular cut-off slide is located in the channel formed between the rear of the valve and the extended portion of the column. This consists of an annular plate 13, fitting closely around the column and seated against the back of the valve. The enlargement of the balance-column has the further use, in addition to that mentioned, of forming a guard against the unseating of the cut-off, as shown. The cut-off is provided with three segmental steam-openings 14, corresponding in relative position with the valve-ports and of a width suited to the point in the stroke at which the cut-off is to take place to allow the admission of steam from zero up to any point within a half inch of the completion of the stroke. The periphery of the slide is provided with cogs, by means of which it is continuously rotated, as hereinafter stated.

In place of the automatic cut-off described a variable cut-off adjustable by hand may be used. This consists of an annular plate differing from the one heretofore described in having two steam-openings located diametrically opposite each other. For the purpose of adjustment there are formed at any convenient point upon the rear of the slide two parallel lips or bosses 44, having upright inner shoulders, between which is adapted to move an eccentric or crank-arm 45, mounted upon a spindle 46, passing through the head of the valve-chest and attached to an adjustable hand-lever outside. The movement of the spindle by means of the lever causes the crank-arm or eccentric to bear against one or the other of the two bosses, and thus rotates the slide a short distance in either direction, allowing steam to be admitted through the valve for a longer or shorter period, as may be desired. This form of cut-off slide is provided for use with a throttling-governor and with the reversing-gear herein described. It is readily adjustable at all times, whether under steam-pressure or not.

The rear of the valve against which the cut-off slide is seated is chambered between the ports, as shown at 15, leaving sufficient of the body of the valve around its inner and outer circumference and the edges of the ports to form a steam-tight seat for the cut-off slide. The object of this space is to afford a relief for the steam carried along within the ports of the slide to prevent the forcing apart of the slide and valve, and for the same purpose the slide is provided with perforations 16 between the ports.

The valve is operated by means of a spindle or stem 17 in operative connection with the crank-shaft, the stem being provided at its inner extremity with a notched flange 18, with which notch engages a lug 19, formed upon the interior circumference of the valve-column; or the flange may be provided with lugs adapted to fit corresponding notches formed in the interior of the column. It will thus be seen that the valve is not rigid upon its stem, but is allowed to have a vibratory motion thereupon to allow for any irregularities caused by wear or the imperfect setting of the spindle with reference to the valve-seat. The pressure of the steam within the chest causes the valve to remain always perfectly seated, and the stem affords no hinderance thereto. At the same time this arrangement allows a telescoping movement of the valve with reference to the spindle to take up any decrease of thickness in the body of the valve occasioned by wear.

A steam-tight joint is effected between the balance-column and the cover of the steam-chest by means of the expansion packing-ring 10 before mentioned. This consists of a ring having an inner circumference to fit the outer edge of the balance-column, and is divided at one point in its circumference, which division is protected by an angular covering 20, secured to the ring at one side of the division and overlapping the other extremity for some distance. Suitable pins 21 prevent the slipping of the same longitudinally upon the column, but allow the latter and the ring to turn freely with reference to each other, except for a portion of the circumference covered by the angular covering 20, the position of the pins being such as to engage with the ends of the same to prevent a complete revolution. This arrangement permits a telescoping movement of the ring and column with reference to each other to take up the wear upon the face of the valve and the outer surface of the ring. The face of the ring is seated against the valve-chest cover and is kept in place against the same by the pressure of the steam. It will be seen that there is no wear upon the outer or inner circumference of the ring, but only upon its flat face, and therefore the wear to which it is subjected does not in any manner impair its efficiency, as in the case of rings

for a similar purpose, in which the wear is upon the outer or inner circumference, changing the size of the same without at the same time wearing or changing the curve of the section-covering against which the ring rests, whereby a space is left between the two parts of the ring, causing leakage. It is to be understood that the division of the ring is not for the purpose of taking up wear, but solely for the purpose of allowing for the expansion and contraction of the metal occasioned by changes of temperature.

The valve is rotated by means of its spindle having miter-gear connection with the crank-shaft. Means are provided in connection with the reversing-gear hereinafter described, whereby the valve is caused to rotate at one-third the speed of the crank-shaft, in order to bring the ports of the valve to register with the steam-openings at the proper intervals. This may be accomplished by means of reducing-gears in case the reversing-gear of the form described is not employed.

The cut-off slide is rotated in the opposite direction from the valve by means of a pinion in mesh with the cogs formed upon the periphery thereof, as previously described. The means employed for forming the connection between the cut-off slide and the band-wheel upon the crank-shaft are such that the closing of the steam-passage through the valve takes place earlier or later in the stroke, according to the load upon the band-wheel. From the shaft 22, carrying the gear 23 in mesh with the cut-off slide and connected therewith by suitable miter-gears 24 and 25, is a shaft 26, running to the crank-shaft, with which it is also connected by a bevel-gear 27 on the line-shaft and a similar gear 28 upon the crank-shaft. The gear 28 is loose upon the crank-shaft and is connected with the band-wheel 29 by means of a centrifugal governor of the class known as the "fly-wheel governor," the weighted arms 30 of which are connected with a pinion 31, integral with the miter-gear 28 by means of racks 32, pivotally connected with the free end of said arms. The centrifugal force generated by the revolution of the band-wheel, acting through the weighted arms of the governor in the ordinary manner, causes the miter-gear 28 to turn earlier in the stroke than the band-wheel, and by means of the connection heretofore described between the said gear and the cut-off slide, the latter is caused to act earlier in the stroke, thereby decreasing the quantity of steam admitted to the cylinder and diminishing the average pressure. In the same manner by a decrease of the centrifugal force caused by a slower movement of the band-wheel the springs 33 act upon the weighted arms of the governor, and by the same connection with the cut-off cause the latter to operate later in the stroke, giving a corresponding average increase of pressure. The cut-off valve is thus seen to be entirely automatic and variable according to the strain upon the band-wheel. A further improvement consists in the means employed for controlling the action of the cut-off in such a manner as to produce a constant equilibrium between the load upon the band-wheel and the pressure of the steam. The band-wheel heretofore described is also loose upon the crank-shaft, but is moved substantially in unison therewith by means of spring connection between the same and the fly-wheel 34, which is fixed to the shaft. To opposite arms of the fly-wheel 34 are secured at one extremity heavy coiled springs 35, the other end of each of which is secured to the band-wheel at substantially the same radial distance from the axis of revolution. Suitable supports 36, having a curved surface whose center of curvature is the axis, retain the springs in such a position that the line of strain is always substantially perpendicular to the radii of the two wheels.

The action of the spring connection just described is to allow the band-wheel to travel earlier or later in the stroke than the fly-wheel, according to the load, an excess of load causing it to travel later than the fly-wheel, while a lightening of the load allows it to travel earlier than the fly-wheel. The spring connection, moreover, and the governor negative each other, and the result is that as the load increases steam is admitted to the cylinder through a greater portion of the stroke, thereby increasing the average pressure, and as the load diminishes steam is admitted during a shorter portion of the stroke, decreasing the average pressure. A constant equilibrium is thus preserved between load and pressure, thereby greatly increasing the economy and efficiency of the engine.

Another feature of invention consists in the construction and arrangement of the reversing-gear, which may be either operated by hand or arranged to work automatically. This is located upon the shaft by which the valve is rotated. This shaft is divided at any convenient point, and upon the driven shaft or the section toward the valve is mounted an internal gear 37, and upon the end of the other shaft or drive section an external spur-gear 38 of smaller diameter, and between the two and meshing with both a third gear 39, mounted in bearings upon a hand-lever 40, pivotally mounted upon the shaft carrying the gear 38, so as to turn freely thereon. By means of the gear 38 motion is transmitted from one section of the shaft to the other at a reduced rate of speed. The relative size of the gears is such that the movement of the driven section is reduced to one-third the speed of the drive-section. By moving the hand-lever 40 through a certain arc the gear 39 mounted thereon travels part way around the gear 38 and also the internal gear 37, but at the same time moves the latter through a somewhat greater arc than that traversed by the lever, as clearly shown in Fig. 10, thereby moving the valve. By moving the valve through such an arc that the relative position

of its ports and exhaust-spaces is reversed, which is, in the construction shown, about one-sixth of a circle, it is evident that the steam will be introduced into the opposite port of the cylinder, thus reversing the motion of the engine. The action of the reversed movement of the shaft is to retain the hand-lever against the stop 41, by which its movement is limited at the proper point.

For rendering the reversing-gear automatic it is only necessary to provide spring-stops 42 to retain the hand-lever at its extreme position at the opposite extremity of the arc from that which it would naturally assume from the movement of the drive-shaft upon which it is mounted. In this method of use the setting of the valve with reference to the spindle is reversed. By releasing the spring-stop the lever is moved by the motion of its shaft to the opposite extremity of the arc, thereby reversing the valve automatically.

As a modification of the reversing-gear I may use the arrangement shown in Fig. 11, consisting of differential gearing, a small gear 50 on the drive-shaft being in mesh with a large gear on an independent swing-shaft 51, moving in bearings upon arms mounted pivotally upon the same axis as the drive and the driven shafts. Upon the said swing-shaft is mounted a small gear 52 of the same size as the one upon the drive-shaft and in mesh with a larger gear 53 upon the driven shaft of the same size as that upon the swing-shaft. The relative proportions of the several gears are such that the driven shaft rotates at one-third the speed of the drive-shaft. By swinging the arms carrying the independent shaft upon their pivotal points the same result is obtained as in the device previously described—that is to say, the valve moving with the driven shaft is so rotated as to reverse the relative positions of the steam-ports and exhaust-spaces, thereby reversing the engine. This device may be arranged to work automatically in the same manner as heretofore described in connection with the other device.

The action of the governor in connection with the cut-off slide may be indefinitely compounded, if desired. One wheel carrying a centrifugal governor may be fixed to a shaft in operative connection with the crank-shaft, said governor operating a spur-gear mounted upon a loose sleeve upon the shaft, and a second wheel carrying a similar governor, mounted upon the sleeve, the second governor being in operative connection with a spur-gear in mesh with a gear upon the shaft operating the cut-off. This compound movement will be readily understood from the description of the operation of the single governor heretofore described, and therefore it is not set out in detail or illustrated in the drawings.

I claim as my invention—

1. A rotary valve for steam-engines, having a series of segmental inlet-ports and exhaust-spaces alternating therewith and so arranged that a port and an exhaust-space are diametrically opposite, cylinder-port coverings close up to the edges of the port and of slightly greater width than the ports, the angular dimensions of ports, port-coverings, and exhaust-spaces having such relation to each other that a cylinder-port is opened to an exhaust-space slightly in advance of the opening of the opposite live-steam port, whereby exhaust takes place slightly in advance of taking steam and one exhaust opens simultaneously with the closing of the other, substantially as specified.

2. A rotary valve for steam-engines, having a series of steam-inlet ports and exhaust-spaces alternating therewith, so arranged that a port and an exhaust-space are diametrically opposite, the relative angular dimension of ports and exhaust-spaces being such that the distance between the corresponding edges of a port and the opposite exhaust-space is slightly less than one hundred and eighty degrees, substantially as specified, whereby the exhaust takes place slightly in advance of taking steam.

3. A rotary valve for steam-engines, having a series of segmental steam-inlet ports and exhaust-spaces alternating therewith, and so arranged that the outer line of a port and an exhaust-space are diametrically opposite, and the relative angular dimensions of port and exhaust space being such that the distance between the corresponding edges of a port and the opposite exhaust-space is slightly less than one hundred and eighty degrees, substantially as specified, whereby the exhaust-space is opened slightly in advance of the closing of the opposite port.

4. A rotary valve for steam-engines, having a series of segmental steam-inlet ports and exhaust-spaces alternating therewith, and so arranged that the outer line of a port and an exhaust-space are diametrically opposite, cylinder-port coverings between said valve-ports and exhaust-spaces of slightly greater width than said ports, and the angular distance between the corresponding edges of a port and the opposite exhaust-space being slightly less than one hundred and eighty degrees, whereby one port is closed slightly in advance of the opening of the opposite port, while the exhaust continues up to the end of the stroke, substantially as specified.

5. A rotary valve for steam-engines, having a series of segmental steam-inlet ports and exhaust-spaces alternating therewith and leading to a central exhaust-passage, the portion of the body of the valve separating each two adjacent ports, and exhaust-spaces being chambered underneath the port-covering upon the exhaust side, leaving only a thin wall for the inlet-ports continuous with the port-coverings, substantially as described, whereby the entire space upon the face of the valve, except that necessary for the ports, walls thereof, and port-coverings, is included in the exhaust-space.

6. A rotary valve for steam-engines, having segmental steam-inlet ports and a balance-column arising from the back of the valve inside the inner edges of said ports, the said column having its outer part of larger diameter than the said inner part and secured thereto by means of an inwardly-projecting annular flange, substantially as specified, whereby a seat for the cut-off slide is formed between the extended portion of said column and the back of the valve.

7. A rotary valve for steam-engines, having segmental steam-inlet ports and exhaust-spaces, steam balance-column integral with or secured to the back of the valve, a spindle adapted to rotate by means of suitable connection with the crank-shaft, a flange formed upon or secured to the end of said spindle and loosely fitting the interior of said column, and lugs formed upon said column or flange and adapted to engage with a corresponding notch upon the other of said parts, the said lugs and notches being so disposed as to lie out of diametrically-opposite positions, substantially as and for the purpose herein specified.

8. In combination with a rotary valve having steam balance-column integral with or secured to the back of the same, a single expansion packing-ring surrounding the outer edge of said column, adapted to seat against the valve-chest cover and to rotate with said column and valve, whereby a steam-tight joint is formed by the pressure of the steam between the column and cover, and the wear upon the ring is confined to its plane face and in the direction of its length, equal wear being thus secured upon all parts of the ring, substantially as specified.

9. A rotary valve for steam-engines, having segmental steam-ports, and a cut-off slide seated against the back of the valve, having segmental steam-passages adapted to register with said ports, the back of the valve between said ports being chambered or hollowed out, substantially as and for the purpose specified.

10. In combination with a rotary valve for steam-engines, having a series of segmental steam-ports, a cut-off disk having ports adapted to register with said valve-ports and seated against the back of the valve, cogs upon the periphery of said cut-off disk, a pinion in mesh therewith, and operative connection between said pinion and the crank-shaft, substantially as described, for continuously rotating said cut-off in a direction contrary to that of the valve.

11. In combination with a rotary valve having a series of segmental steam-ports, a cut-off disk having segmental openings adapted to register with said valve-ports, and provided with cogs upon its periphery, a pinion in mesh therewith, a wheel upon the crank-shaft loose with reference thereto within certain limits, but rotating substantially in unison therewith, operative connection between said loose wheel and said pinion, and a centrifugal governor controlling the rotation of said loose wheel with reference to the rotation of the crank-shaft, substantially as and for the purpose herein specified.

12. In combination with a rotary valve and cut-off slide and a loose cogged wheel upon the crank-shaft in operative connection with the said cut-off slide, a band-wheel mounted upon the crank-shaft, carrying a centrifugal governor connected with said cog-wheel and adapted to control the rotation of the latter relatively to the band-wheel, a fly-wheel fixed upon the crank-shaft, and a spring connection between said fly and band wheels, substantially as and for the purpose specified.

13. In combination with a rotary valve and cut-off slide and a loose cog-wheel upon the crank-shaft in operative connection with said cut-off slide, a band-wheel mounted upon the crank-shaft, carrying a centrifugal governor connected with said cog-wheel and adapted to control the rotation of the same relatively to the band-wheel, a fly-wheel fixed upon the crank-shaft, springs having their opposite extremities attached to the fly and band wheels, respectively, at substantially the same distance from the axis, and curved supports for said springs attached to said fly-wheel, substantially as specified, and for the purpose herein set forth.

14. In combination with a rotary valve for steam-engines, having segmental steam-ports and exhaust-spaces, a spindle for operating said valve, a divided shaft, one section of which is in operative connection with the crank-shaft and the other with the valve, an external gear upon the drive-section, an internal gear upon the driven section, a pinion in mesh with said internal and external gears, and a lever upon which said pinion is mounted, the said lever being pivoted in the axis of said shafts, substantially as specified, whereby by the swinging movement of said lever and pinion the driven shaft is rotated and the relative position of the valve-ports and exhaust-openings is reversed.

15. In combination with a rotary valve for steam-engines, having segmental steam-ports and exhaust-openings, a spindle for operating said valve, a divided shaft, one section of which is in operative connection with the crank-shaft and the other with the valve-spindle, an external gear upon the extremity of the drive-section, an internal gear upon the extremity of the driven section, a pinion in mesh with said internal and external gears, a lever upon which said pinion is mounted, the said lever being pivoted in the axis of said shafts, and spring-stops for retaining the said lever at the proper limits for reversing against the motion of the reversed movement of the drive-shaft, whereby by the release of the stops the operation of reversing is automatically effected.

16. In combination with a rotary valve having segmental steam-ports and exhaust-openings, a circular cut-off slide having segmental steam-openings adapted to register with said

ports, and connections between said cut-off slide and the crank-shaft of the engine, whereby the same is caused to rotate continuously in a contrary direction to that of the valve, substantially as and for the purpose herein specified.

17. In combination with a rotary valve having steam balance-column integral with or secured to the back of the same, an expansion packing-ring surrounding the outer edge of said column and adapted to seat against the back of the valve-chest cover and rotate with said column and valve, the said packing-ring consisting of a single metallic ring divided at one point and having an annular flange secured to one of the ends thus formed and overlapping the joint upon the two outer sides of the ring, substantially as specified, whereby expansion and contraction of the body of the ring are allowed, while a steam-tight joint is maintained.

In testimony whereof I affix my signature in presence of two witnesses.

BENJAMIN F. FITCH.

Witnesses:
W. L. CROSBY,
C. H. MILLER.