No. 741,976. PATENTED OCT. 20, 1903.

F. M. RITES.

GOVERNING VALVE GEAR FOR EXPLOSIVE AND INTERNAL COMBUSTION ENGINES.

APPLICATION FILED JAN. 24, 1902. RENEWED OCT. 15, 1902.

NO MODEL. 3 SHEETS—SHEET 1.

Fig. 1.

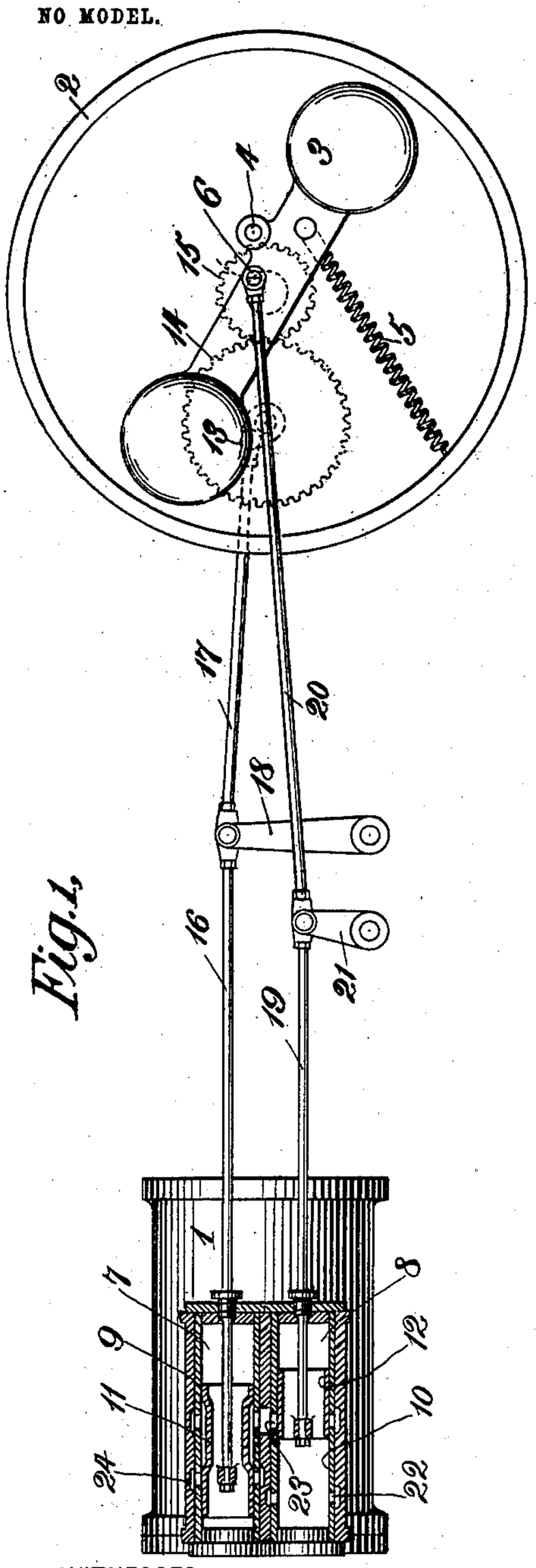
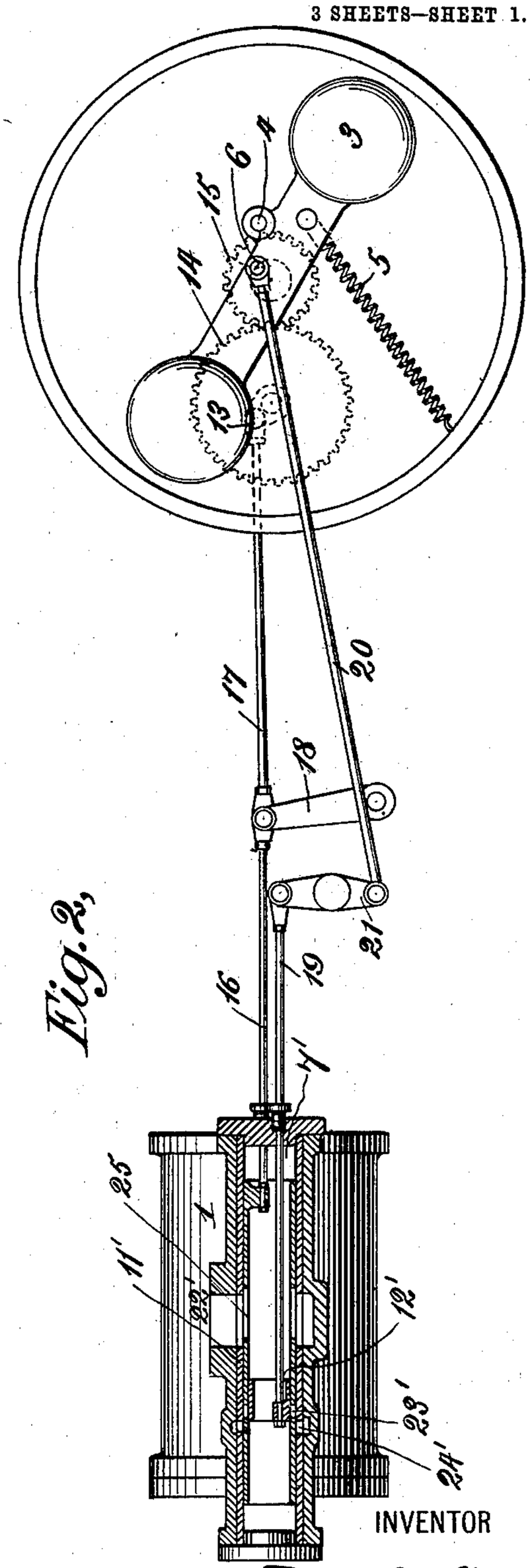


Fig. 2.



WITNESSES:
C. F. Carrington
W. H. Grover.

INVENTOR
Francis M. Rites
BY
Chapin Hayward & Mann
ATTORNEYS

No. 741,976. PATENTED OCT. 20, 1903.

F. M. RITES.

GOVERNING VALVE GEAR FOR EXPLOSIVE AND INTERNAL COMBUSTION ENGINES.

APPLICATION FILED JAN. 24, 1902. RENEWED OCT. 15, 1902.

NO MODEL. 3 SHEETS—SHEET 2.

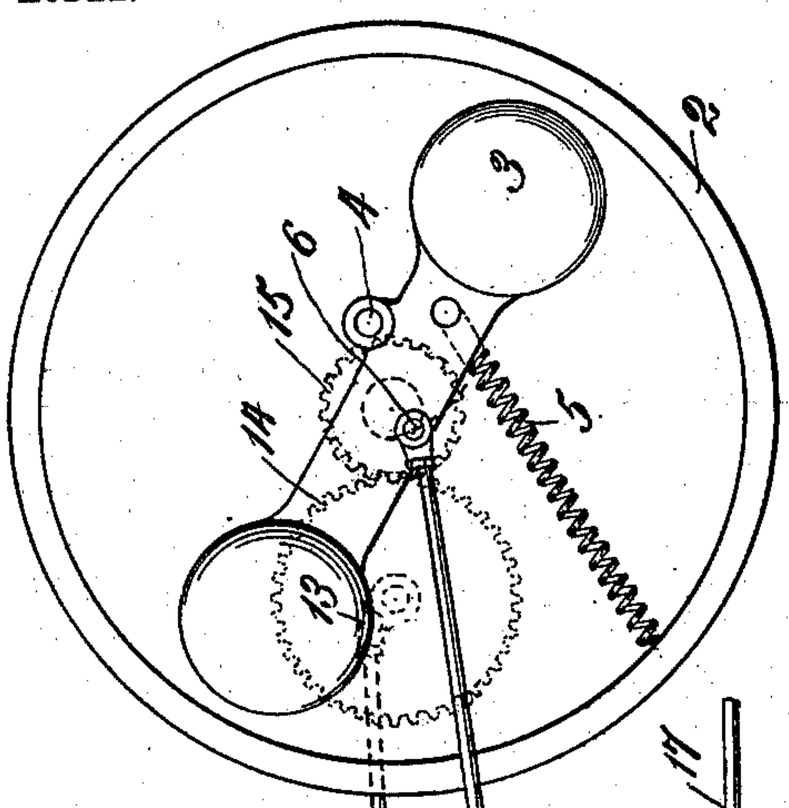


Fig. 3.

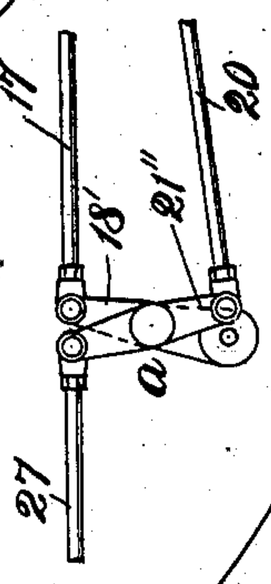


Fig. 4.

Fig. 7.

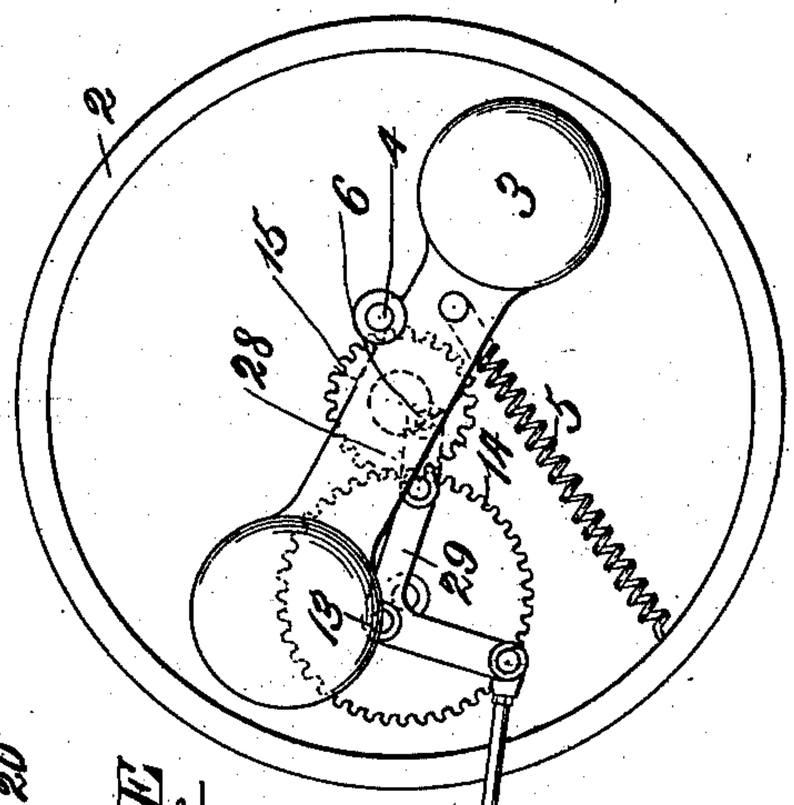


Fig. 5.

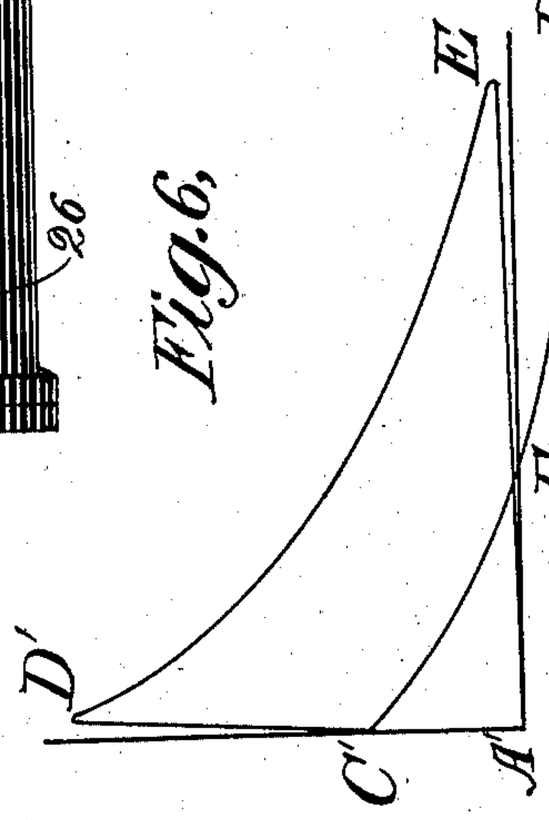


Fig. 6.

WITNESSES:
C. F. Carrington
W. W. Conover.

INVENTOR
Francis M. Rites
BY
Chapin Hayward & Mabie
ATTORNEYS

No. 741,976. PATENTED OCT. 20, 1903.

F. M. RITES.

GOVERNING VALVE GEAR FOR EXPLOSIVE AND INTERNAL COMBUSTION ENGINES.

APPLICATION FILED JAN. 24, 1902. RENEWED OCT. 15, 1902.

NO MODEL. 3 SHEETS—SHEET 3.

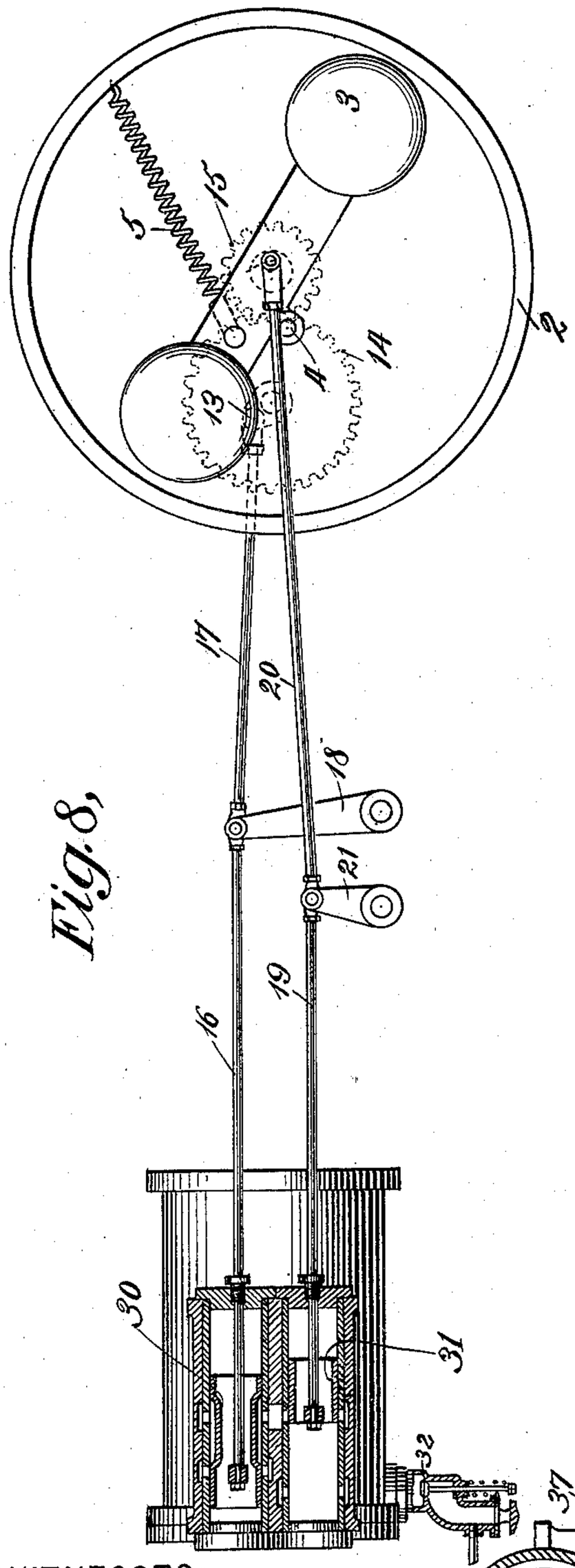


Fig. 8.

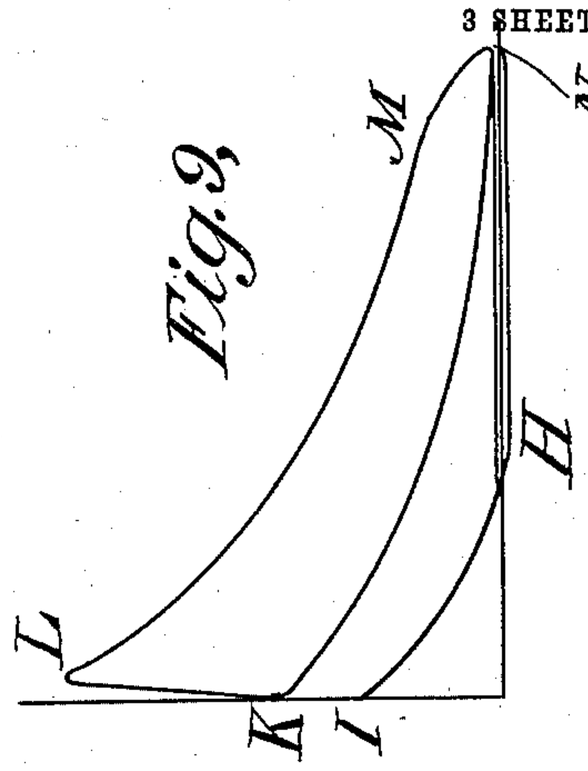


Fig. 9.

Fig. 10

WITNESSES:

C. F. Cunningham

W. M. Conover

INVENTOR

Francis M. Rites

BY

Chapin Hayward & Mauk

ATTORNEYS

No. 741,976. Patented October 20, 1903.

UNITED STATES PATENT OFFICE.

FRANCIS M. RITES, OF ITHACA, NEW YORK.

GOVERNING-VALVE GEAR FOR EXPLOSIVE AND INTERNAL-COMBUSTION ENGINES.

SPECIFICATION forming part of Letters Patent No. 741,976, dated October 20, 1903.

Application filed January 24, 1902. Renewed October 15, 1902. Serial No. 127,389. (No model.)

To all whom it may concern:

Be it known that I, FRANCIS M. RITES, a citizen of the United States, residing at Ithaca, in the county of Tompkins and State of New York, have invented certain new and useful Improvements in Governing-Valve Gear for Explosive and Internal-Combustion Engines; and I do hereby 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.

My invention relates to improvements in governing-valve gear for explosive and other internal-combustion motors, and more particularly for engines of the four-cycle and six-cycle types in which combustion takes place in the working cylinder or in each working cylinder of multiple-cylinder engines during every second or third revolution, as the case may be.

My invention consists in the novel means employed whereby the charge of the engine may be regulated by regulating either admission or exhaust, so that uniform speed of the engine may be maintained without the necessity of throttling, with its attendant waste of power, and without missing explosions.

My invention also consists in the novel construction of the valve-gear, in the novel manner of operating the valve or valves of the engine by the governor, and in the many features of combination, construction, and arrangement, as will be pointed out hereinafter in the claims.

Heretofore the regulation of the speed of internal-combustion engines, and more especially of explosive-engines, has usually been effected either by the employment of a hit-and-miss governor, which causes the engine to miss impulses when the speed rises too high, or by throttling the supply of fuel before mixture thereof with air, which leads to uncertainty of ignition, or by throttling the air-supply or the supply of mixed air and fuel, both of which methods are wasteful of power, since they involve the exertion of a considerable amount of power by the engine in drawing in the charge. In order to avoid these objections, attempts have been made to accomplish regulation of such engines by varying the point of cut-off of the explosive mixture; but the mechanisms for this purpose heretofore devised have involved the use of sliding cams, difficult of adjustment by a governor and requiring the use of governors of inefficient and slow-acting types, and the use of connecting devices containing an objectionable number of parts and joints. In the valve-gears herein illustrated and described, however, the valve mechanism is directly connected with and operated by a governor, which may be of a very efficient, powerful, and quick-acting type—such as a fly-wheel governor—and the use of sliding cams or the like adjusted by the governor is avoided. The governor is arranged to vary the point of cut-off of the explosive mixture or alternatively of exhaust-closure and accomplishes this by shifting the eccentric or other valve-actuating device employed in accordance with change in position of the governor-weight.

The objects of my invention are to improve the governing mechanism of explosive and internal-combustion engines of the class described, to render the same more rapid in action, more sensitive, and capable of effecting closer regulation of speed with greater economy, to decrease the number of parts and joints of such governing mechanism, to adapt the same for operation by fly-wheel governors, and generally to make the governing mechanism as simple, effective, and reliable as possible.

I will now proceed to describe my invention with reference to the accompanying drawings, in which certain forms of valve-gear embodying my invention are illustrated, and will then point out the novel features in claims.

In the said drawings, Figure 1 shows one form of valve-gear controlling admission in which separate admission and cut-off valves are employed, the said valves being located in separate valve-chambers, the valves and valve-chambers being shown in section. Fig. 2 is a similar view illustrating a form of valve-gear in which separate admission and cut-off valves are employed, the latter being a riding cut-off valve located within the admission-valve. Fig. 3 is a similar view illustrating another form of valve-gear in which one valve performs the functions both of the ad-

mission-valve and of the cut-off valve of either of the preceding figures, being given a compound motion, as hereinafter described. Fig. 4 is a detail view of the rocker-arms of the valve-gear of Fig. 3 shown in a different position. Fig. 5 is a view similar to Figs. 1, 2, and 3, illustrating another form of valve-gear in which a single valve performs the functions both of an admission-valve and of a cut-off valve. Figs. 6 and 7 are views showing indicator-cards such as are characteristic of engines governed by varying the cut-off and by throttling the admission, respectively. Fig. 8 is a view similar to Fig. 1, the valve-gear illustrated being arranged to vary the point of exhaust-closure. Fig. 9 is a view showing an indicator-card such as is characteristic of an engine governed by varying the point of exhaust-closure. Fig. 10 shows a transverse section of an engine-cylinder through the exhaust-valve chamber and shows mechanism for operating an exhaust-valve which may be used in connection with the mechanism for operating admission-valves illustrated in Figs. 1, 2, 3, and 5.

In the several figures of the drawings illustrating valve-gears the engine-bed and other portions of the engine not required for the purposes of this description are omitted.

In Fig. 1 an engine-cylinder 1, fly-wheel 2, and a governor-weight 3, pivoted to the fly-wheel at 4, are shown.

The particular governor shown is of my invention and is covered by Letters Patent No. 534,579, dated February 19, 1895, and is in common use and requires no specific description.

Numeral 5 designates the governor-spring. The governor-weight carries a valve-actuating device, which in this instance is an eccentric 6 of the pin type, so mounted on the weight that as the latter swings about its pivot the eccentric swings across the end of the crank-shaft on which the fly-wheel is mounted, being always to one side of the center of the fly-wheel, however. The throw and angular advance of the eccentric are thereby varied, and so the point of cut-off of the valve operated thereby. Instead of a pin eccentric a disk eccentric may be used without the exercise of invention, disk eccentrics being employed frequently in governors of this type. The cylinder is provided with two valve-chambers 7 and 8 for admission and cut-off valves, respectively, and in these valve-chambers are liner-bushings 9 and 10, in which the ports are cut accurately; but the use of such bushings is optional. The admission-valve 11 is of the piston type and the cut-off valve 12 is a hollow sleeve.

The engine shown is of the four-cycle type, in which an impulse is received every second revolution, and therefore the valve 11 is operated by a crank-pin 13, (shown in dotted lines,) driven by reducing-gears 14 and 15 having a ratio of two to one, gear 15 being mounted on the main crank-shaft of the engine. If the engine were a six-cycle engine, the ratio of these gears would be three to one. The mechanism shown for imparting motion from crank-pin 13 to valve 11 comprises a valve-stem 16, a valve-rod 17, and a rocker-arm 18; but the particular mechanism employed for this purpose is immaterial. Any suitable means may be employed for transmitting motion from the eccentric 6 to the cut-off valve 12. I have shown for the purpose a valve-stem 19, an eccentric-rod 20, and a rocker-arm 21.

The cut-off-valve chamber 8 is provided with an admission-port 22 and with a port 23, connecting said valve-chamber with the admission-valve chamber 7. A port 24 connects the latter valve-chamber with the engine-cylinder. The parts of the valve-gear are shown in a position of early cut-off, the throw of the eccentric being little greater than the lap of the valve. At low speeds or when the engine is at rest the eccentric will occupy another position, such that the throw of the valve 12 is much greater. The relative positions of the eccentric and valve-crank pin 13 are such that at the beginning of the admission-stroke when port 24 is open port 23 is likewise open and the incoming charge has free entrance to the cylinder, the admission of the charge being cut off through the closing of port 23 by valve 12 at a point in the stroke determined by the position of the governor-weight 3, cut-off being as rapid as in an automatic cut-off steam-engine. The governor-weight 3 shifts its position according to variations in load on the engine in the well-known manner, so that the admission of the charge is cut off at the proper time to insure uniformity of speed of the engine, and the governor being of a powerful and sensitive type will maintain the speed of the engine within narrow limits.

Although valve 12 will open port 23 at the beginning of the working stroke of the engine as well as at the beginning of the admission-stroke, valve 11 will keep port 24 closed during the working stroke, since it reciprocates at half the speed of the cut-off valve.

Any suitable exhaust-valve and operating mechanism therefor may be employed.

It will be noted that valve 12 is substantially the same as what is known as a "riding cut-off valve," although located in a different valve-chamber from that in which the main valve is located. In Fig. 2 I have illustrated valve mechanism in which a similar riding cut-off valve 12′ is located in the same chamber with and within the admission-valve 11′, the constructions in other respects being substantially the same. The incoming charge enters the valve-chamber 7′ through a port 22′ and a corresponding port 25 in valve 11′, passing out into port 24′ through a port 23′ in valve 11′ when said port 23′ is uncovered by valve 12′ and when port 23′ is in registry with said port 24′. The valve-stem 19 and

valve-rod 20 are connected by a rocker-arm 21, pivoted at an intermediate point, since in this form of valve-gear the direction of motion of the cut-off valve must be opposite to the direction of motion of the valve 12 of Fig. 1 in corresponding portions of the stroke of the two engines.

In the form of valve-gear shown in Fig. 3 a single valve performs the functions both of an admission-valve and of a cut-off valve. This valve is designated by reference-numeral 26. Numeral 22″ designates the admission-port to the valve-chamber 7″, and numeral 24″ the port leading from said chamber to the engine-cylinder. As in the forms of valve-gear described above the crank-pin 13 is connected by a valve-rod 17 to a rocker-arm, (designated in Fig. 3 by numeral 18′;) but in this form of valve-gear the rocker-arm 21″, which is connected by the valve-rod 20 to the eccentric 6 of the governor-weight, is pivotally mounted upon the rocker-arm 18′, as shown more particularly in Fig. 4, and is connected by a valve-stem 27 to the valve 26. The valve 26 therefore has motion imparted to it both by the crank-pin 13 and by the eccentric 6, and this motion is such as to give prompt admission of working fluid to the cylinder at proper times with cut-off determined by the position of the governor-weight 3, while during the working stroke of the engine, although a retrograde motion is imparted through the valve by the eccentric-pin 6, the valve will be lapped over port 24″ to such an extent that the port will be closed.

In Fig. 5 I have illustrated another form of valve-gear, in which the same effect is obtained as in Fig. 3, the eccentric-pin 6 in this case being connected by a link 23 to a bell-crank 29, mounted upon the crank-pin 13, the other arm of said bell-crank being connected by a valve-rod 17 to a rocker-arm 18, itself connected by a valve-stem 27 to the valve 26.

In Figs. 6 and 7 I have shown the difference between the indicator-card of an engine provided on its admission side with my valve-gear and such a card as is characteristic of an engine governed by throttling the admission. Referring first to Fig. 7, the line A B represents the admission-line and the line B C the compression-line, the line D E being the expansion-line and the line E A the exhaust-line. The drop in the admission-line A B represents the effect of throttling the admission, and the area between the line A B and the line B C represents negative or wasted work. In an engine the speed of which is governed by varying the point of cut-off of working fluid the admission-line A′ B′, Fig. 6, will be horizontal up to the point of cut-off F, at which point rarefaction below admission-pressure will begin and the compression-line B′ C′ will return over the line F B′, there being no loss of work during the admission, since all power which is expended in expanding the charge during admission is returned to the cycle during the compression-stroke. It is obvious, therefore, that my invention will result in important economy over the method of governing by throttling the admission, while it makes it possible to maintain uniformity of speed to an extent not possible of attainment by the hit-and-miss method of governing.

The speed of an explosive or internal-combustion engine may also be regulated by regulating the duration of the exhaust period, the governor being arranged to shorten the exhaust period if the normal speed is exceeded. Fig. 8 illustrates such an engine, the exhaust-valve mechanism of which is substantially the same as the admission-valve mechanism of Fig. 1. Valve 30 is the main exhaust-valve and reciprocates at a speed relative to that of the piston corresponding to the cycle of the engine, and valve 31 is a riding exhaust-valve, which when it covers its ports prevents exhaust whatever may be the position of the valve 30. The admission-valve 32 opens by suction. Such a valve-gear governs the speed of an engine just as truly as does a valve-gear governing admission. This may be seen by reference to Fig. 9, in which line N H represents the exhaust-line of an indicator-card and line H I the compression-line. The point H is variable, depending upon the position of the governor-weight and the eccentric carried thereby. At the beginning of the exhaust period both exhaust-valves open their ports and the exhaust continues at substantially uniform back pressure until valve 31 closes, when compression, as represented by line H I, begins. On the next forward stroke expansion takes place along the line I H until inlet-valve 32 opens by suction. Such valve continues open until the end of the stroke, line H N being the admission-line, and on the next back stroke compression of the fresh charge takes place, as indicated by the line N K. Ignition is represented by the line K L and expansion after ignition by the line L M, release taking place at M. The point H being variable, the point at which suction sufficient to open valve 32 is produced, and therefore the amount of combustible gas taken into the cylinder, is varied accordingly.

It is obvious that the valve-gears shown in Figs. 2, 3, and 5 may be employed for regulating exhaust just as that shown in Fig. 1 is employed, as described above.

In Figs. 1, 2, 3, and 5 I have not shown exhaust-valves or mechanism for operating the same. Fig. 10 shows exhaust-valve mechanism which may be used with the admission-valve mechanism of any of these figures and which is a well-known mechanism for the purpose in common use. It consists of a cam-shaft 33, which may be driven from the crank-shaft of the engine by gears having a speed ratio of two to one, so that shaft 33 revolves at half the speed of the crank-shaft, a cam 37 on said shaft, and a follower-lever 38, en-

gaging said cam and also the stem of a puppet exhaust-valve 36 of ordinary type.

It is obvious that my invention is susceptible of many modifications and variations in form, construction, and arrangement of the parts without departing from the basic principles thereof. I do not limit myself to any particular method of accomplishing the variation in the point of cut-off. I do not limit myself to the use of any particular type of fly-wheel governor or to the use of a fly-wheel governor, since obviously the same variation could be effected by hand. Neither do I limit myself to the particular types of valve shown nor to the application of my invention to four-cycle engines, since obviously it is clearly applicable to engines in which an impulse occurs every third stroke or even to engines in which an impulse occurs at greater intervals, the ratio of the gears driving the low-speeded valve-actuating device being proportional to the cycle of the engine.

In my Patent No. 542,424, dated July 9, 1895, I have illustrated and described a valve-gear for steam-engines wherein one distribution-valve of the engine is operated by two eccentrics, one fast to the shaft and the other a shifting eccentric adjustable by a speed-governor. The valve-gear shown in Figs. 3 and 4 of the accompanying drawings embody the application of the valve-gear of said patent to internal-combustion engines of the four-cycle type.

In the following claims I employ the term "eccentric" to include both a pin eccentric, such as shown in the drawings, and a disk eccentric. It is well recognized that such a pin is as truly an eccentric as is a disk eccentric and that such pin and disk are the exact equivalents of each other, their only difference being a difference in diameter.

What I claim is—

1. In a valve-gear for explosive and internal-combustion engines, the combination with admission-valve gear comprising two coöperating valve-actuating devices and valve means operated thereby and controlling admission to the engine, one of said valve-actuating devices driven at the speed of the engine, determining the point of valve-closure, and adjustable to that end, the other driven at less speed, of an exhaust-valve separate from said admission-valve means, and means for positively operating the same.

2. In a valve-gear for explosive and internal-combustion engines, the combination of two coöperating valve-actuating devices controlling the same portion of the engine cycle, one, driven at the speed of the engine, determining the point of valve-closure, the other driven at less speed, valve means, and intermediate mechanism positively connected to and driven by said valve-actuating devices and having positive driving connection with the valve means for moving the same in both directions of motion thereof.

3. In a valve-gear for explosive and internal-combustion engines, the combination of two coöperating valve-actuating devices, controlling the same portion of the engine cycle, one, a shifting eccentric driven at the speed of the engine, determining the point of valve-closure, and adjustable to that end, the other driven at less speed, valve means, and intermediate mechanism positively connected to and driven by said valve-actuating devices and having positive driving connection with the valve means for moving the same in both directions of motion thereof.

4. In a valve-gear for explosive and internal-combustion engines, the combination of two coöperating valve-actuating devices, controlling the same portion of the engine cycle, one, a shifting eccentric driven at the speed of the engine, and movable in a path which is to one side of the center of rotation, determining the point of valve-closure, the other driven at less speed, and valve means operated thereby.

5. In a valve-gear for explosive and internal-combustion engines, the combination of two valves controlling admission and operating mechanism therefor positively operating the same, one valve being driven at a speed, less than the engine speed, proportionate to the cycle of the engine, the other driven at the speed of the engine and variable as to the point of closure, means for varying the point of closure of said last-named valve, a separate exhaust-valve, and means for positively operating the same.

6. In a valve-gear for explosive and internal-combustion engines, the combination with main and riding valves, of a valve-actuating device connected with the main valve and driven at less than the speed of the engine, and another valve-actuating device connected with the riding valve and driven at the speed of the engine.

7. In a valve-gear for explosive and internal-combustion engines, the combination with main and riding valves, of a valve-actuating device connected with the main valve and driven at less than the speed of the engine, an automatic fly-wheel governor, and a second valve-actuating device carried and adjusted thereby, and connected with the riding valve.

8. In a valve-gear for explosive and internal-combustion engines, the combination with main and riding valves, one located within the other, of a valve-actuating device connected with the main valve and driven at less than the speed of the engine, and another valve-actuating device connected with the riding valve and driven at the speed of the engine.

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

FRANCIS M. RITES.

Witnesses:
E. BAUMANN,
J. E. DEAKIN.