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GAS ENGINE.

APPLICATION FILED OCT. 1, 1906. RENEWED JULY 27, 1908.

923,594.

Patented June 1, 1909.

3 SHEETS—SHEET 1.

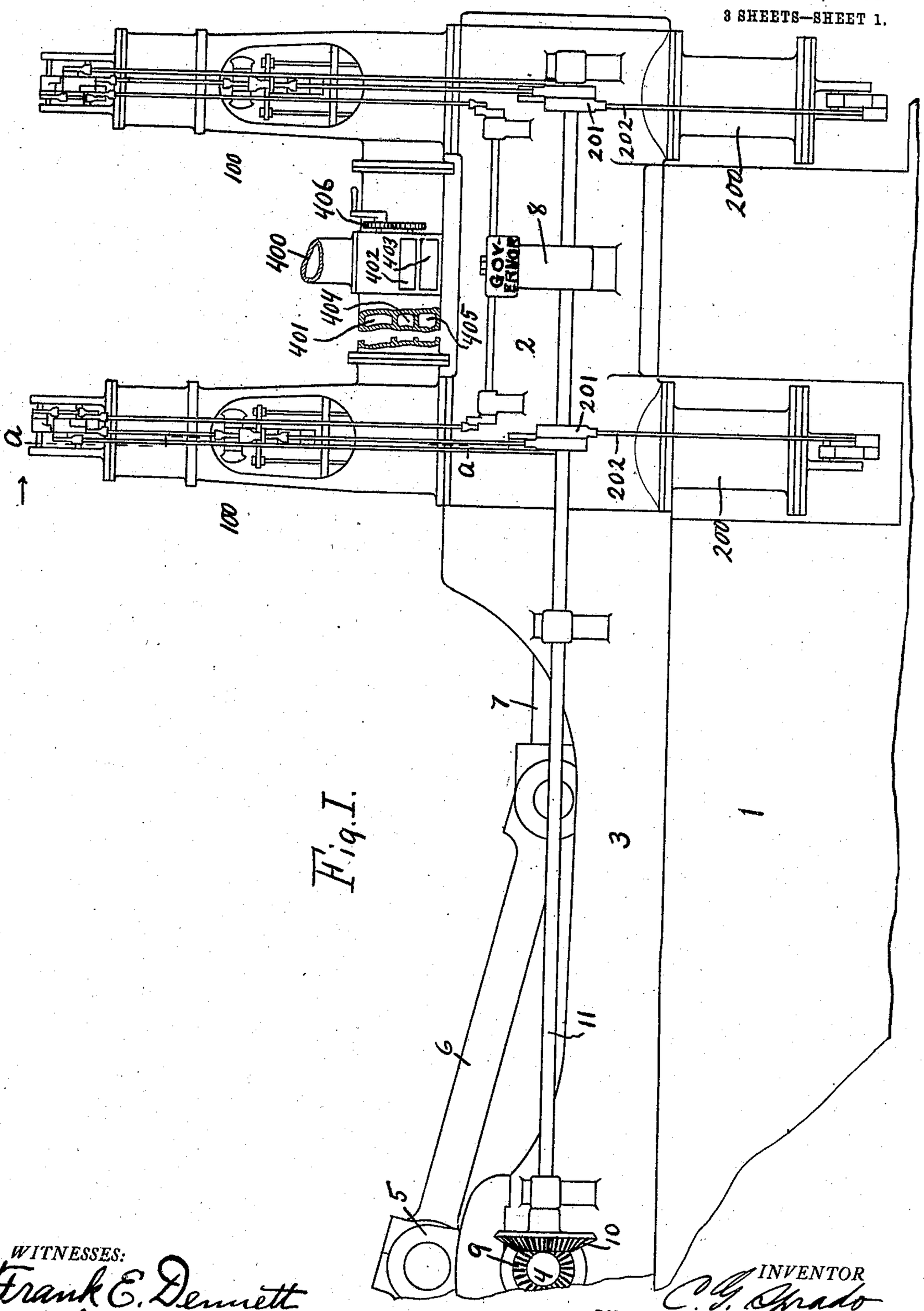

Fig. 1.

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3 SHEETS—SHEET 2.

Fig. II.

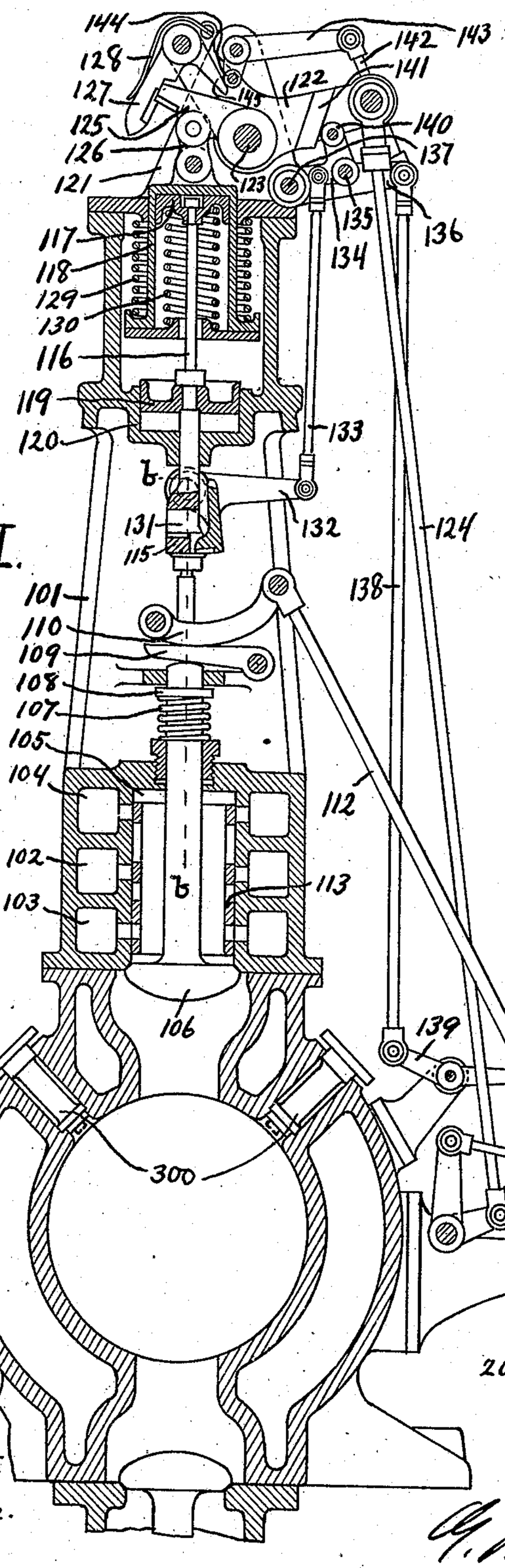
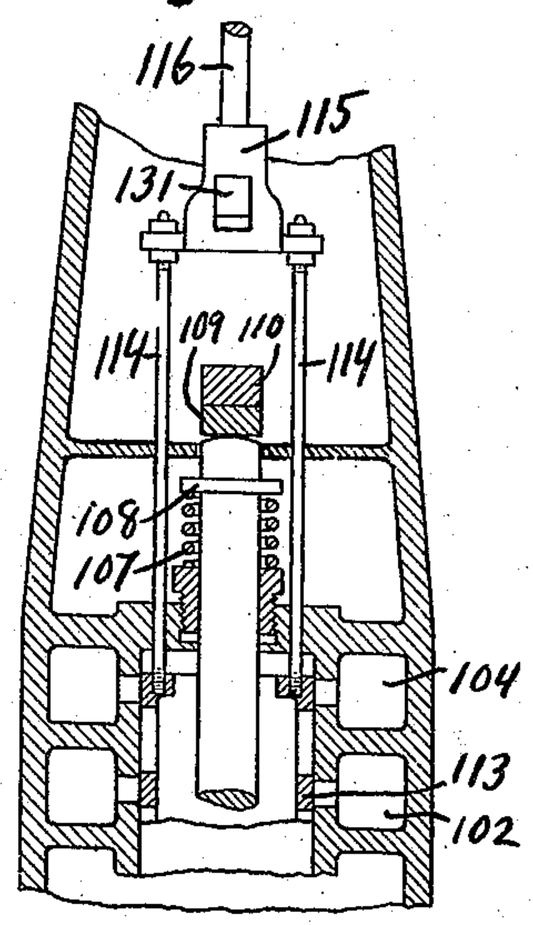


Fig. III.



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3 SHEETS—SHEET 3.

Fig. VI.

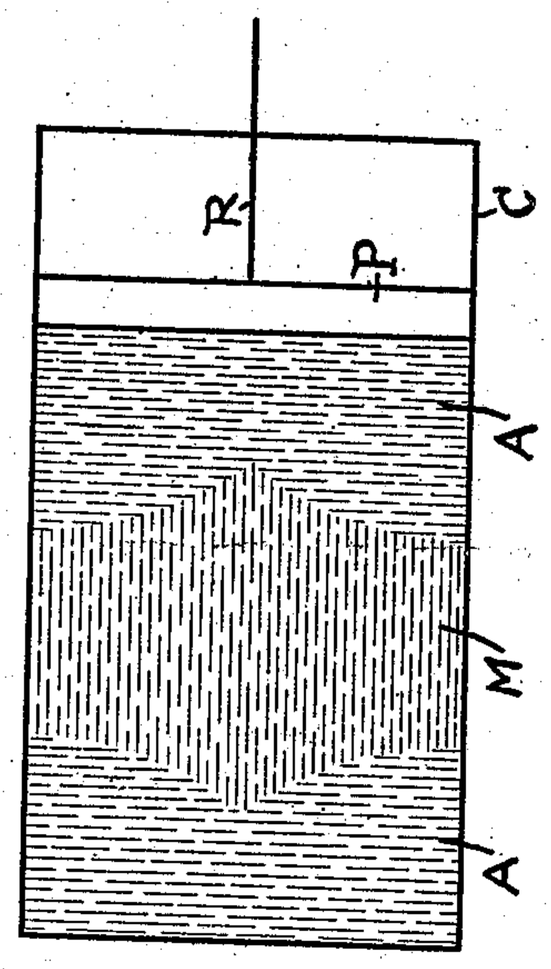


Fig. VII.

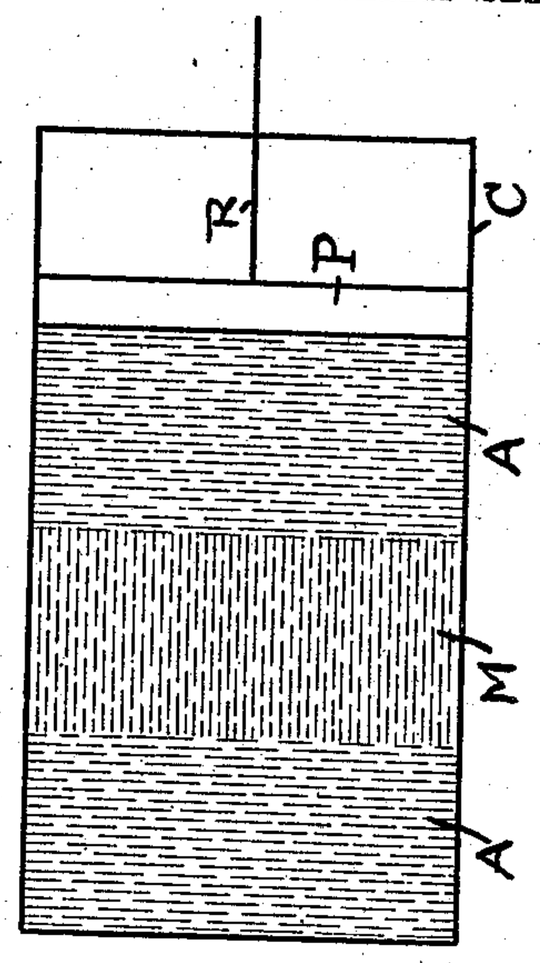


Fig. IV.

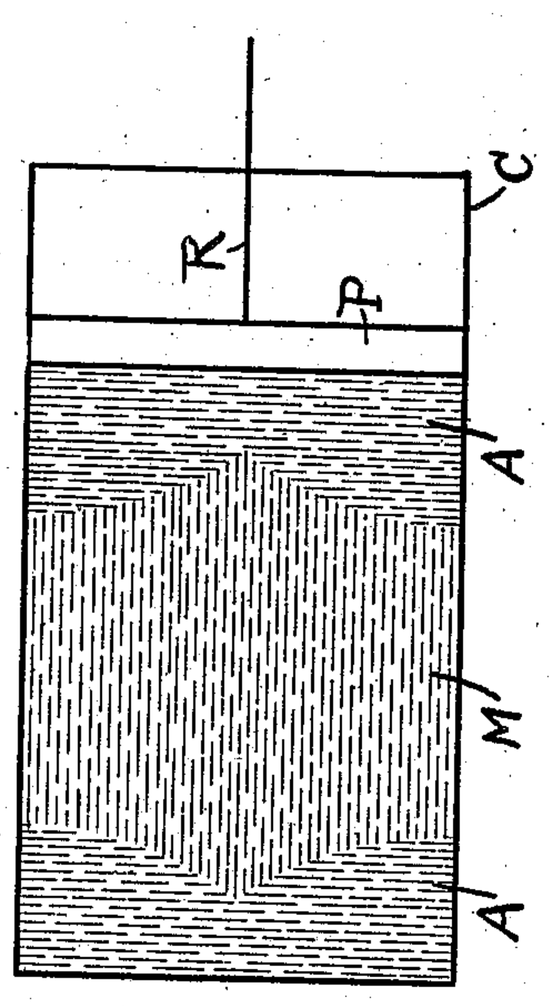
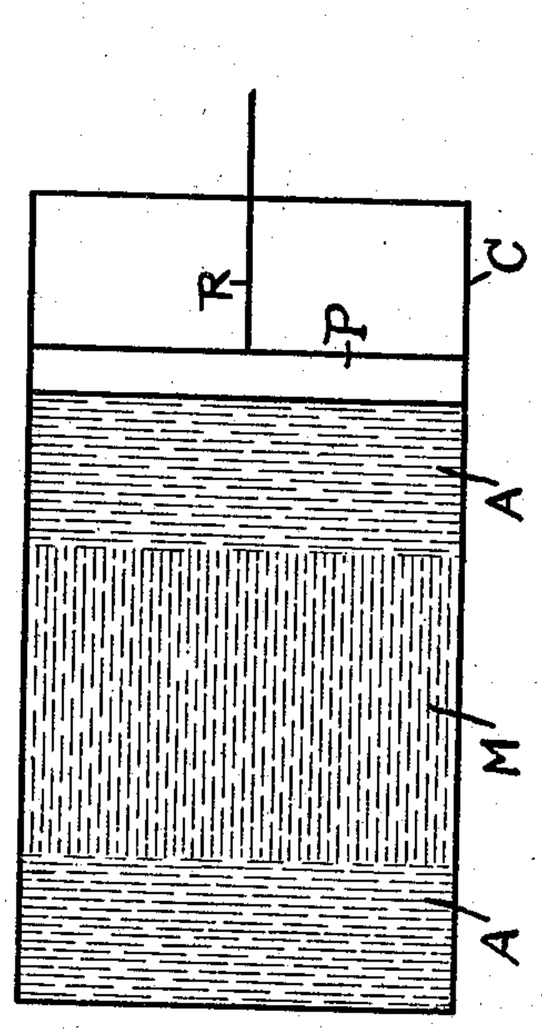


Fig. V.



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UNITED STATES PATENT OFFICE.

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GAS-ENGINE.

No. 923,594. Specification of Letters Patent. Patented June 1, 1909.

Application filed October 1, 1906, Serial No. 336,869. Renewed July 27, 1908. Serial No. 445,523.

To all whom it may concern:

Be it known that I, CARL G. SPRADO, a citizen of the United States, residing at Milwaukee, in the county of Milwaukee and State of Wisconsin, have invented certain new and useful Improvements in Gas-Engines, of which the following is a specification.

This invention relates to gas engines and the combination therewith of a specific type of valve mechanism for controlling the admission of an explosive mixture to the explosion chamber of such engines, and is primarily intended to be made use of in connection with that type of gas engine in which it is customary to use variable charges of an explosive mixture and also to admit into the explosion chamber a filling or displacing medium.

The specific valve mechanism herein disclosed is not necessarily limited in its application to gas engines but may be used wherever similar functions are desirable.

In gas engines where various sized charges of explosive mixture are admitted into the explosion chamber of the engine, while a filling or displacing medium is also admitted to said explosion chamber in order that the pressure conditions existing within said chamber may remain constant notwithstanding the differences that may exist between the sizes of the charges of the explosive mixture admitted at different times, the proper separation of the filling medium from the charge of explosive mixture, or stratification, as it is called, is of great importance in order that the entire charge of explosive mixture may be exploded together and thereby prevent a slow and comparatively useless burning of a part of the charge, thus wasting its energy. Where in an engine it is desired to maintain perfect stratification as between the charge of explosive mixture and a filling medium, it is necessary in order to obtain the most perfect results for the admission valve to open and close as instantaneously as possible.

It is the purpose of this invention to provide a gas engine, in which the principle of stratification is used, with valve gear for controlling the supply of the explosive mixture which operates the valve practically instantaneously, said valve operating mechanism not being dependent upon the speed of the engine for its speed of operation.

While the drawings illustrate a specific practical embodiment of an apparatus for carrying out this invention, it is to be understood that the invention is not limited to the construction shown in which springs are put under compression during a cycle of the engine when the valve is inactive, thus storing power for the instantaneous operation of the valve at the proper times in the cycle of operation. Any other mechanism equivalent to that shown and described by this application could be substituted for that herein shown and described, provided it operated the valve practically instantaneously, the time consumed in the actual opening and closing movement not being dependent upon the speed of the engine, and such a construction would be included within the scope of this invention.

In the drawings which illustrate a practical embodiment of this invention and on which the same reference characters are used to indicate the same parts in each of the several views,—Figure 1 represents an elevation of a gas engine embodying this invention. Fig. 2 represents a vertical section taken on the line *a*—*a* of Fig. 1 looking in the direction indicated by the arrow. Fig. 3 represents a vertical section taken on the line *b*—*b* of Fig. 2. Figs. 4, 5, 6 and 7 represent diagrammatic illustrations of stratifications established between a filling medium and an explosive mixture in the explosion chamber of an engine.

On the drawings, 1 represents the foundation; 2 the cylinder; 3 the main frame; 4 the shaft; 5 the crank; 6 the connecting rod; 7 the piston rod; and 8 the governor of a gas engine, all of which may be of any known or desirable construction.

Secured to the shaft 4 is a bevel wheel 9 which meshes with the bevel wheel 10 secured to a shaft 11 and from which shaft the governor receives its motion as well as the valve gear for the several valves of the engine.

The engine illustrated is of the four cycle double acting type and is provided at each end with an admission valve 100, and an exhaust valve 200, which being of similar construction respectively have been indicated by the same reference characters on the drawings.

Referring to Fig. 2 of the drawings, the admission valve mechanism comprises a bonnet 101 provided with air passages 102, 103, and a gas passage 104, which communi-

cate through ports with an interior chamber 105, which in turn is in communication with the interior of the cylinder. A main admission valve 106 controls the thoroughfare from chamber 105 to the interior of the cylinder. The stem of this valve 106 passes through a stuffing box and the valve is retained upon its seat by the spring 107 which is compressed between said stuffing box and a collar 108 secured to said valve stem. This valve is operated at proper intervals corresponding to the position of the piston, by means of the lever 109 pivotally secured to the bonnet upon which is adapted to rock the rocking lever 110, also pivotally secured to the bonnet at one end and connected with the eccentric 111, fastened to the shaft 11, by means of the connecting rod 112. This valve 106 in the operation of the engine is to be adjusted so as to start to open preferably just before or at the beginning of the suction stroke of the engine and to close at the end of the suction stroke. Reference character 113 represents a valve seated in the chamber 105 and adapted to control the ports leading from each of the passages 102, 103 and 104. This valve is connected by means of the rods 114 with a yoke member 115 which is carried by the rod 116. The rod 116 carries at its upper end an enlarged head or nut 117 between which and the bottom of a movable pot surrounding this head is contained a spiral spring. 118 indicates the movable pot which is adapted to be moved vertically through an aperture provided in the top of the bonnet 101, and this pot is also provided with a projection at its lower edge between which projection and the top of the bonnet 101 is seated a spiral spring. Secured to the rod 116 is a piston 119 which works in a cylinder 120 to cushion the movement of the gas valve, the cylinder being provided with the usual inlet and outlet for air of the common cataract type which it is not deemed necessary to show. Pivoted to an extension 121 on the top of the bonnet 101 is a lever 122 which is adapted to be oscillated about its pivot 123 by the connecting rod 124, which through the motion transmitting mechanism shown receives motion from the eccentric 111. Pivoted upon the same pivot 123 is a lever arm 125 to which is secured the pot 118 by means of a link 126. Secured to the end of the lever 122 is a pivoted catch 127 normally pressed inwardly by the spring 128, as shown. This catch is adapted to engage with the end of the lever 125 and lift said lever as the lever 122 is oscillated, thereby lifting the pot 118 and compressing the spiral spring 129. The valve 113 would also be lifted at the same time because of the spring 130 if means were not provided for retaining it in its closed position. The yoke 115 is provided with an aperture 131 within which a catch upon one arm of the bell crank lever 132 is adapted to enter. When this catch is seated within said aperture and the pot 118 is lifted by the levers 125 and 122, the spring 129 will be compressed between the projection on the pot and the top of the bonnet, while at the same time the spring 130 will be compressed between the head 117 on the rod 116 and the bottom of the pot. Means are provided for so releasing the parts that first one spring will act and restore the movable parts which it controls to their former position, and at a later period the other spring will act and restore the parts which it controls to their former position. This action just mentioned is effected through the following instrumentalities: An arm of the bell crank lever 132 is connected by means of the rod 133 with a second bell crank lever 134 which is pivoted at 135 to a lever 136 which is in turn pivoted at 137 to the projection on the top of the bonnet. Lever 136 is connected at its other end by means of connecting rod 138 with a lever 139, which in turn is connected with the governor 8. As the speed of the engine increases or decreases, the lever 136 will be moved, thereby raising or lowering the bell crank lever 134 which is carried thereby and rocking said bell crank lever on its pivot 135. The catch on the bell crank lever 132 should be heavy enough to maintain it in the position shown in Fig. 2, or a spring should be provided for this purpose, so that said catch will maintain said position except as moved therefrom by contact with the yoke 115 or by the mechanism to be described. One arm of the bell crank lever 134 is provided with an antifriction roller 140 which is adapted to be engaged by an inclined track or cam 141 carried by the lever 122. Connecting rod 138 is also united by means of a connecting rod 142 with a bell crank lever 143 which is pivoted to the extension on top of the bonnet and which is also provided with the antifriction roller 144 on one arm thereof which is adapted to be contacted by the arm 145 of the catch 127.

The action of the apparatus just described is as follows: During a cycle of the engine while the main valve 106 is closed, the lever 122 is rocked downwardly by the connecting rod 124 and cam 111, the catch 127 carried thereby being engaged with the lever 125, raises the pot 118 and the catch on the bell crank lever 132 being engaged in the aperture 131 of the yoke 115, springs 129 and 130 are both compressed. At some point in the downward travel of the lever 122 the track or cam 141 will engage with the antifriction roller 140, such point of contact depending upon the position of the lever 136 as determined by the speed of the engine and indicated by the governor. On further downward movement of the lever 122 the upper part of the bell crank lever 134 will

be forced to the right, as shown in Fig. 2, and the catch on the bell crank lever 132 will thereby be disengaged from the aperture 131 and the spring 130 will force the rod 116, rods 114 and valve 113 upwardly until the head 117 strikes the upper end of the pot. At this time the valve 113 will have uncovered the ports of the gas passage 104 and the air passage 102. The explosive mixture in proper proportions will enter the cylinder during the period that the valve remains in this position. This period is determined by the position of the antifriction roller 144 which is also under the influence of the governor. As the lever 122 in its further downward movement will bring the arm 145 of the catch 127 into engagement with said antifriction roller, and on further movement will swing said catch so as to release lever 125 when the spring 129 will return the pot, valve and associated parts to the position shown in Fig. 2, thus closing the ports leading from the gas supply passage 104 and the air supply passage 102. The full stroke of the engine will then be completed and the ordinary cycles of a four cycle gas engine will continue. The inlet valve at the other end of the cylinder meanwhile will perform similar operations to those just described.

The reference character 201 indicates eccentrics on the shaft 11 which actuate the exhaust valve mechanism by means of connecting rods 202.

300 represents sparking plugs or other ignition devices of any preferred type.

The valve mechanism just described is intended primarily for use with a four cycle gas engine in which a filling or displacing medium is introduced into the explosion chamber during a part of the suction stroke. For this purpose the gas supply main 400 is provided which is in communication with the gas passage 401 which in turn communicates with the passage 104.

402 and 403 indicate respectively air ports which afford open communication with the separate air passages 404, 405, respectively, these latter passages in turn communicating with the passages 102 and 103 respectively formed in the valve bonnet.

406 represents an adjusting mechanism for controlling two valves (not shown) which control the thoroughfares through passages 401 and 404 respectively, in order that the proper proportions of gas and air may be secured to form the maximum explosive mixture.

The port 403 and air passages 405 and 103 are provided for the following purpose: In the normal operation of the engine just before or at the beginning of the suction stroke, the valve 106 is unseated by the mechanism shown. This permits air to flow through port 403 and passages 405 and 103 into the cylinder to act as a filling or displacing agent. If now the gas valve which is controlled by the governor should not open until near the middle of the stroke of the piston when the piston speed is close to its maximum, the rush of air into the cylinder at such a time would be so great that uncertainty would exist as to the exact proportions of the mixture which would result from the admission of the gas. To avoid such uncertainty, the valve 113 is arranged to close the ports leading from the passage 103 and to open the ports leading from the passage 102 at the same time that the ports leading from the gas passage 104 are opened. The gas and air then admitted to the cylinder will flow under equal conditions and the proper proportions will be maintained.

The diagrammatic views, viz., Figs. 4, 5, 6 and 7 show the stratification that exists in a cylinder when the admission of the explosive mixture is governed by a valve which depends upon the speed of the engine for determining its speed of opening and closing and the stratification which results from the use of a valve which acts practically instantaneously both in opening and in closing. These figures show a scheme of stratification in which an explosive mixture is admitted to the cylinder in different volumes according to the work imposed upon the engine, while air or a similar filling or displacing medium is admitted during the first and last parts of the suction stroke in order to maintain the conditions of density within the cylinder the same whether the charge of explosive mixture be large or small as compared with the entire volume of the cylinder. In these figures C represents the cylinder; P the piston; R the piston rod; M the explosive mixture; and A the filling or displacing medium. In Figs. 4 and 6 it will be noticed that on account of the throttling tendency of the valve when it is moved by the engine, there result cone shaped ends to the charge of the explosive mixture. These cone shaped ends of the charge are apt to become diffused and mixed with the adjacent air during the suction and compression strokes and a part of the charge at least has a tendency to become different from the remaining part of the explosive charge. In Figs. 5 and 7 is shown the stratification that results when a valve is used, the opening and closing of which is practically instantaneous, a clean and accurate stratification being the result, the whole of the charge maintaining its general characteristics irrespective of the volume of the charge which is introduced into the cylinder. Figs. 4 and 5 illustrate a condition where the work imposed upon the engine is such as to require a volume of explosive mixture equal to half the volume of the cylinder, while Figs. 6 and 7 illustrate a condition where the work imposed upon the engine is such as to require an

explosive mixture of only one-third the volume of the cylinder.

It will be noticed from Figs. 4 and 6 that in using a throttling valve, as the proportion of the charge grows smaller, the relative proportion of said charge which consists of an uncertain mixture grows larger; while Figs. 5 and 7 show that by using an instantaneous valve the character of the charge remains the same whether the charge be large or small.

Certain features and construction of the valve gear shown but not claimed herein are claimed in my application Serial Number 264,163.

What I claim is:

1. The combination with a gas engine provided with an explosion chamber of a gas valve and mechanism adapted during the suction stroke of said engine to operate said valve to permit the said explosion chamber to be filled by a filling medium, a charge of explosive mixture and additional filling medium stratified in the order enumerated, a governor responsive to the speeds of the engine for controlling the operation of said valve to vary the size of the charge of explosive mixture, and means for opening and closing said valve substantially instantaneously operating through a period of time independent of the speeds of said engine.

2. The combination with a gas engine, of a gas admission valve, a governor responsive to the speeds of the engine, and means to open and close said gas valve substantially instantaneously operating through a period of time independent of the speeds of the engine but the times of beginning the opening and closing of said valve both being determined by the speeds of the engine as indicated by said governor.

3. The combination with a gas engine provided with an explosion chamber of a main admission valve and operating mechanism therefor adapted to retain said valve open during the suction stroke of said engine, a gas valve adapted when in its closed position to permit a filling medium to flow into said explosion chamber and when in its open position to prevent such flow but to permit an explosive mixture to flow into said explosion chamber, means for opening and closing said gas valve substantially instantaneously operating through a period of time independent of the speeds of said engine, a governor responsive to the speeds of said engine, and means controlled by said governor to cause said gas valve to be opened sooner and closed later as the speed of said engine decreases.

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

CARL G. SPRADO.

Witnesses:

G. F. De Wein,

Frank E. Dennett.