

Jan. 6, 1925.

1,521,842

W. D. SPRAGUE ET AL.

INTERNAL COMBUSTION MOTOR

Filed Sept. 24, 1921.

4 Sheets-Sheet 1

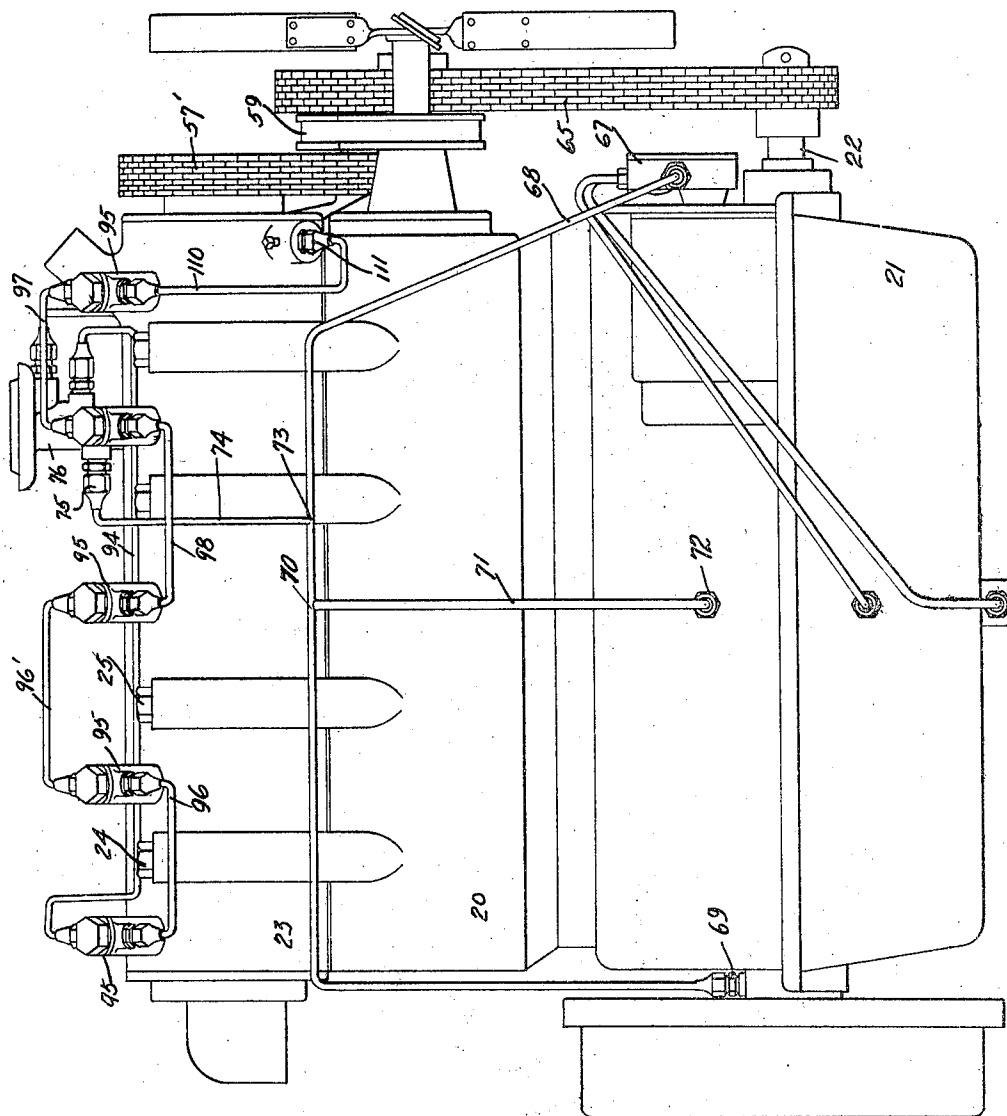


Fig. 1.

WITNESSES

William P. Goebel,
P. H. Pattison,

INVENTORS

W. D. SPRAGUE
J. G. ELKIN
BY *Mumford*
ATTORNEYS

Jan. 6, 1925.

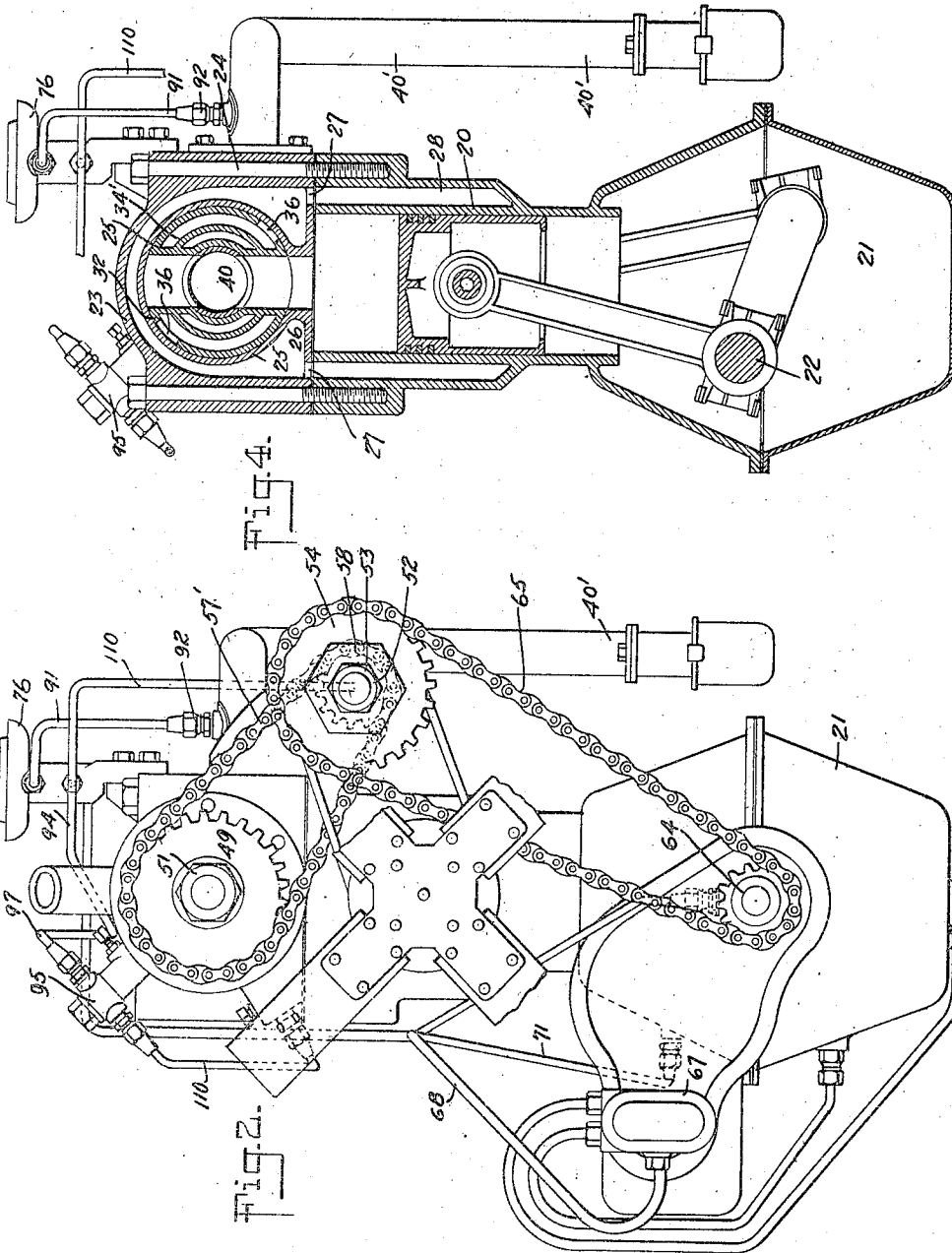
W. D. SPRAGUE ET AL

1,521,842

INTERNAL COMBUSTION MOTOR

Filed Sept. 24, 1921

4 Sheets-Sheet 2



WITNESSES
William A. Hoebel.
R. H. Patterson.

INVENTORS
W. D. SPRAGUE
J. G. ELKIN
BY *Mum & Co*
ATTORNEYS

Jan. 6. 1925

1,521,842

W. D. SPRAGUE ET AL

INTERNAL COMBUSTION MOTOR

Filed Sept. 24, 1921

4 Sheets-Sheet 3

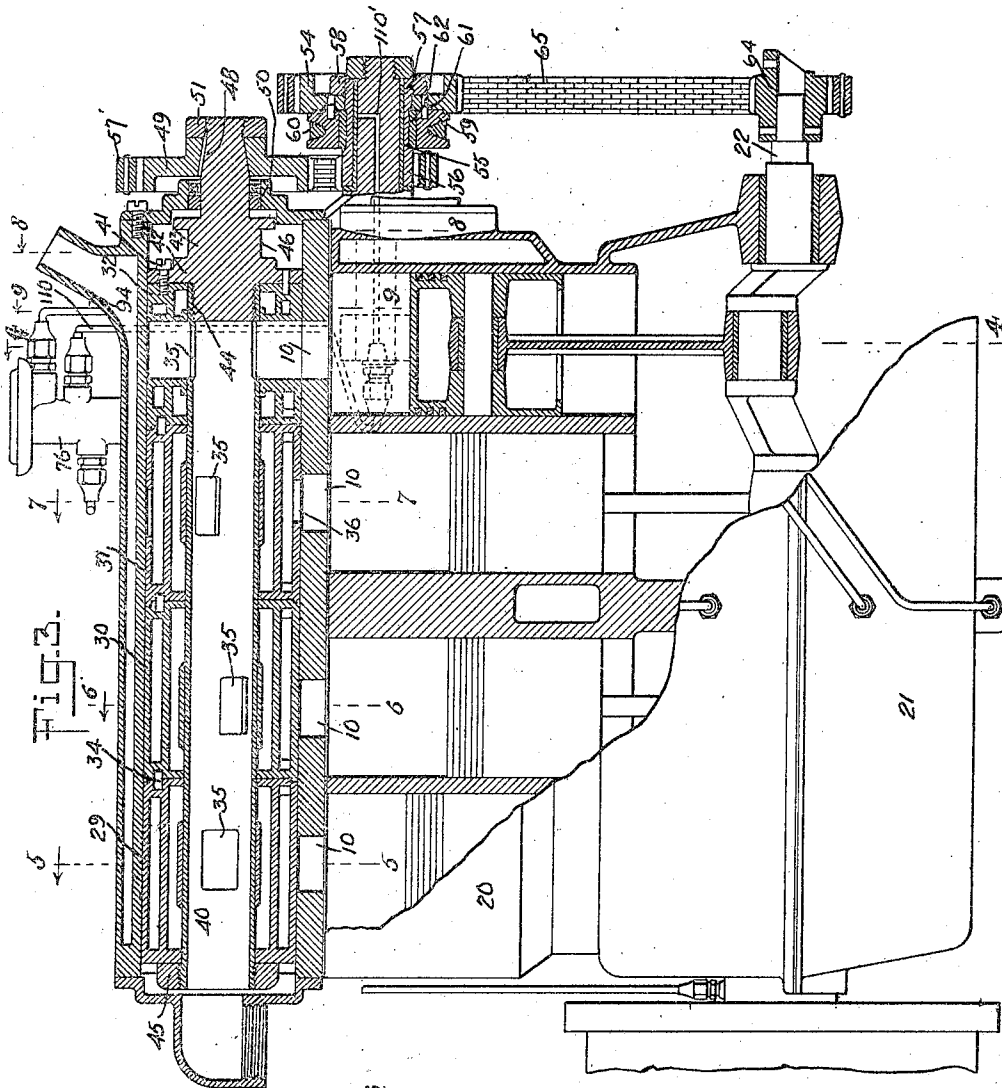
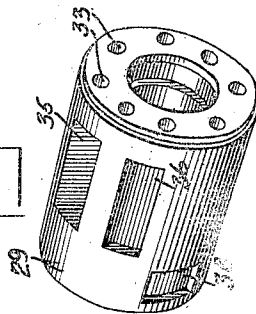


Fig. 2.

Fig. 13.



WITNESSES
William P. Goebel.
P. H. Patterson.

INVENTORS
W. D. SPRAGUE
J. G. ELKIN
BY *Munn & Co.*
ATTORNEYS

Jan. 6. 1925.

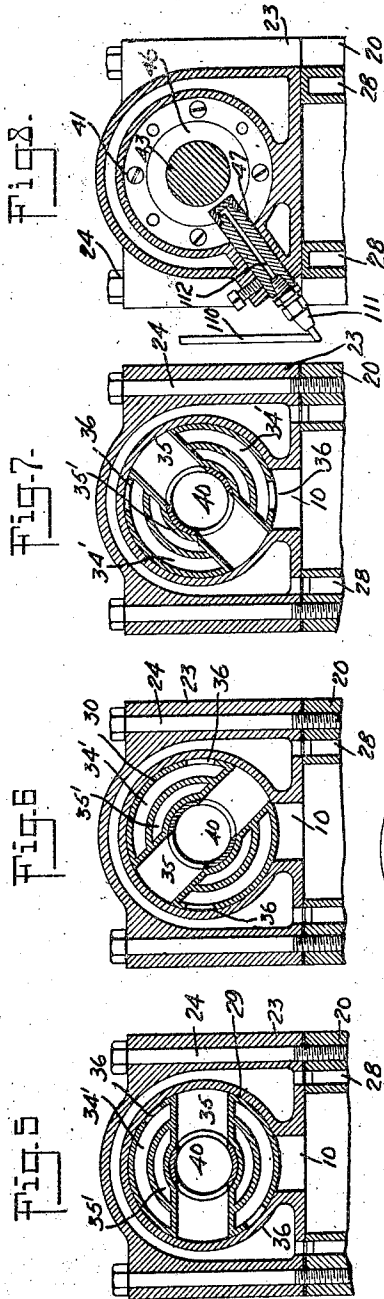
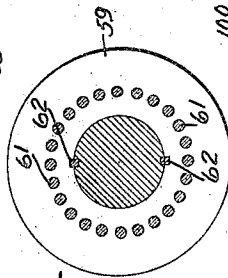
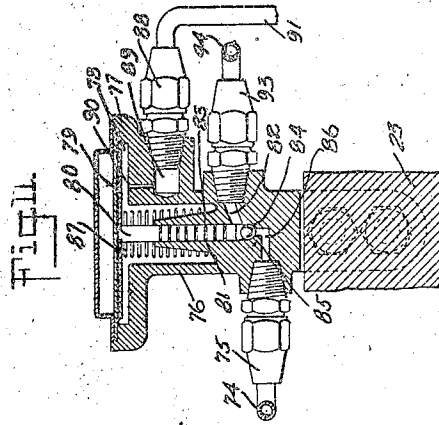
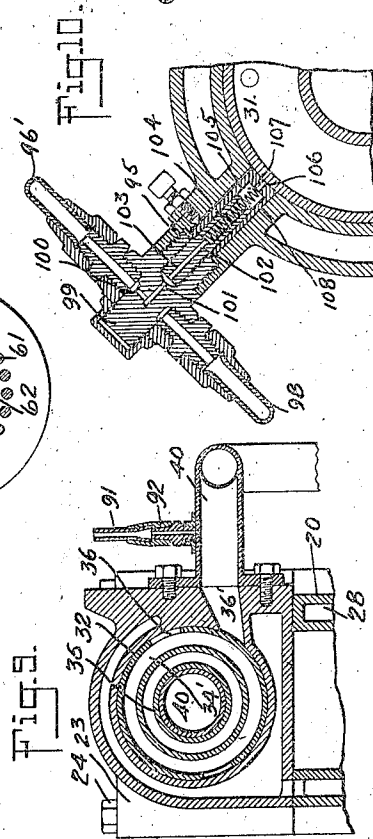
1,521,842

W. D. SPRAGUE ET AL

INTERNAL COMBUSTION MOTOR

Filed Sept. 24, 1921

4 Sheets-Sheet 4



WITNESSES

William P. Goebel.
P. H. Patterson.

INVENTORS

W. D. SPRAGUE
J. G. ELKIN

Mum & Co.
ATTORNEYS

Patented Jan. 6, 1925.

1,521,842

UNITED STATES PATENT OFFICE.

WILLIS DOUGLASS SPRAGUE AND JACOB G. ELKIN, OF NEW YORK, N. Y.; SAID ELKIN
ASSIGNOR TO SAID SPRAGUE.

INTERNAL-COMBUSTION MOTOR.

Application filed September 24, 1921. Serial No. 502,892.

To all whom it may concern:

Be it known that we, WILLIS DOUGLASS SPRAGUE and JACOB G. ELKIN, both citizens of the United States, and both residents of the city of New York, borough of Manhattan, in the county and State of New York, have invented a new and Improved Internal-Combustion Motor, of which the following is a full, clear, and exact description.

The present invention relates to new and useful improvements in internal combustion motors, and it pertains more particularly to a rotary valve mechanism therefor.

It is one of the objects of the invention to construct a cylinder head capable of use with internal combustion motors, which head carries a rotary valve, said head being interchangeable with heads of motors of any type.

It is another object of the invention to construct an internal combustion motor in such a manner that poppet valves and the like are dispensed with, thus increasing both the efficiency and quietness of operation of the motor.

It is a further object of the invention to construct a rotary valve in such a manner that smoking of the motor particularly at low speeds, is practically eliminated.

It is a further object of the invention to provide a lubricating system for rotary valves, the use of which insures absolute lubrication of all moving parts thereof.

It is a further object of the invention to provide means for automatically controlling the operation of the lubricating system.

It is a further object of the invention to construct a rotary valve for internal combustion motors in such a manner that the several moving parts thereof will be prevented from developing wear in defined paths, which construction insures tight joints between the several working parts at all times and the elimination of compression leaks.

It is a further object of the invention to construct the motor so that the power required for operating the valve mechanism will be materially reduced.

It is a further object of the invention to construct the rotary valve so that the fuel is introduced longitudinally of the cylinder

producing excessive turbulences of the gases and greatly promoting flame propagation.

It is a further object of the invention to mount the bearings so that the same may be subjected to the cooling action of a suitable cooling medium thereby greatly increasing the efficiency of the valve.

It is a still further object of the invention to provide an adjusting means whereby the timing of the valve relative to the position of the crank shaft may be varied in order that the valve may be timed either "late" or "early" as desired.

With the above and other objects in view, which will appear as the nature of the invention is better understood, reference is had to the accompanying drawings, in which

Figure 1 is a side elevation of an internal combustion motor equipped with a rotary valve and valve mechanism;

Figure 2 is a front end elevation thereof;

Figure 3 is a side elevation partly in longitudinal section showing the specific construction of the valve, the lubricating means and driving means;

Figure 4 is a vertical sectional view taken on the line 4—4 of Figure 3;

Figure 5 is a detail transverse sectional view showing the position of the rotary valve during the compression stroke of the motor, said view being taken on the line 5—5 of Figure 3;

Figure 6 is a similar view showing the position of the rotary valve at the time of firing of the explosive charge in the cylinder of the motor, said view being taken on the line 6—6 of Figure 3;

Figure 7 is a similar view showing the position of the rotary valve during the intake stroke of the motor, said view being taken on the line 7—7 of Figure 3;

Figure 8 is a detail sectional view taken on the line 8—8 of Figure 3 and showing a portion of the lubricating system and the mechanism by which the rotary valve is given reciprocating movement during its operation;

Figure 9 is a detail sectional view taken on the line 9—9 of Figure 3, and showing the relative position of the valves and the intake manifold of the motor;

Figure 10 is a detail sectional view show-

ing the manner in which the lubricant is applied to the rotating valves together with the mechanism employed for introducing the lubricant to the valves;

5 Figure 11 is a detail sectional view of the automatic controlling means of the lubricating system;

Figure 12 is a detail sectional view of the valve-timing mechanism, and

10 Figure 13 is a perspective view of one of the valve elements.

Referring again to the drawings and more particularly to Figure 1, the reference character 20 designates the cylinder block. 21 the oil pan, and 22 the crank shaft of an internal combustion motor, which elements form no part of the present invention and may be of any preferred type or form.

The reference character 23 designates the 20 head of the motor and said head 23 is secured to the block 20 by suitable fastening means in the form of bolts 24 or the like. The head 23 is constructed in such a manner as to provide an internal passage 25, which 25 passage is circular in cross sectional form and extends throughout the length of the said head 23. The head 23 is provided with a water space 26 and said water space 26 communicates by means of openings or the 30 like 27 with the water jacket 28 of the cylinder block 20, and it is by this means that a circulation of cooling medium is maintained throughout the head 23.

As more clearly shown in Figure 3 the 35 valve comprises a plurality of individual valve sections 29, 30, 31 and 32, there being one of these valve sections for each cylinder of the motor. The specific construction of these valve sections 29, 30, 31 and 32 is more 40 clearly shown in Figure 13, and referring to said figure, it will be noted that each of the valve members is provided in its opposite ends with a circular series of spaced recesses 33. These recesses 33 are adapted 45 to receive pins 34 by means of which a driving connection between the several valve elements is had. These valve elements are each cast to provide an inner chamber 34' and a transverse or radial passage 35, and an inner 50 dead-air space 35'. The radial passage 35 forms the axial passage of the valve and extends interiorly through each of the valve members as more clearly shown in Figures 5 to 8. Extending through the side wall of 55 each of the valve members at diametrically opposite points are passages 36, and said passages 36 form the intake ports of the valve and establish communication between the chamber 34' thereof and the interior of 60 the adjacent cylinder. Each of the valves is also provided at diametrically opposite points with openings or ports 38 which pass through the outer wall of the valve members. These ports 38 are offset with respect 65 to the ports 36. Communication between the

intake manifold 40' and the passages 38 is established by means of a port or the like 36' in the head 23, more clearly shown in Figure 9.

Each of these valve members 29, 30, 31 and 70 32 is mounted upon a tubular member 40. The forward valve member 32 is secured to the tubular member 40 by means of bolts or the like 41, which passes through a flange 42 formed on a plug or the like 43 which 75 has threaded engagement with the tubular member as at 44. The remaining valve members are caused to rotate one with the other by means of the pins 34 in the spaced openings 33 as heretofore described. The 80 pins 34 are maintained in engagement with their respective recesses or openings 33 by means of a nut 45 having threaded engagement with the tubular member 40 at the 85 end opposite to the valve member 32. By this construction it is apparent that as the tubular member 40 is rotated the several valve members will likewise be rotated within the circular passage 25 of the head 23. 90

The plug 43 heretofore mentioned is provided with a cam groove 46 and said cam 95 groove is adapted to receive a rigid member 47 more clearly shown in Figure 8 for a purpose to be hereinafter more fully described. The forward end of the plug 43 is preferably tapered as indicated by the reference character 48 and keyed to said tapered portion is a sprocket 49. The reference character 50 designates a bearing in 100 which the plug 43 is mounted for rotation and the reference character 51 designates a nut for securing the sprocket 49 on the tapered portion 48 of said plug 43.

Projecting from the forward end of the 105 cylinder block 20 is a stub shaft 52 and secured upon the outer end of said stub shaft 52 by means of a nut 53, is a sprocket 54. Between this sprocket 54 and the stub shaft 52 is a bushing 55 and mounted upon the 110 inner end of said sleeve and in alignment with the sprocket 49 is a sprocket 56. Passing around the sprockets 49 and 56, is a chain 57', preferably of the so-called silent type. The sprocket 56 is formed with a 115 hub extension 57 and the sprocket 54 is loosely mounted on said hub extension and is secured thereon by means of a nut 58. Interposed between the sprockets 54 and 56 is a fan belt pulley 59 and said fan belt 120 pulley 59 is provided upon its outer or forward face with a circular series of spaced openings or recesses 60.

Carried by the sprocket 54 and adapted 125 to engage with the spaced openings or recesses 60, is a plurality of pins 61, and said pins form the means for driving the fan belt pulley 59 as well as a timing adjustment for the driving mechanism of the valve, said timing adjustment being more 130 specifically referred to hereinafter. The fan

belt pulley 59 is keyed to the hub extension 57 of the sprocket 56 by means of keys 62, thus insuring a positive drive of the hub extension 57 and the sprocket 56 upon operation of the sprocket 54, the power being transmitted to the fan belt pulley 59 by means of the pins 61.

Mounted upon the outer end of the motor crank shaft 22, is a sprocket 64. Passing around the sprocket 64 and the sprocket 54 is a chain 65, preferably of the silent type, and this chain 65 forms the driving medium of the sprocket 54 from the crank shaft 22.

The operation of the invention so far as described is as follows: Upon operation of the motor the rotation of the crank shaft 22 causes a rotation of the sprocket 54 through the medium of the sprocket 64 and the chain 65. As the sprocket 54 is rotated, through the medium of the pins 61 the fan belt pulley 59 will be likewise rotated, and through the medium of the keys 62 and the hub extension 57 of the sprocket 56 it is apparent that said sprocket 56 will be driven. The sprocket 56 drives the several valves 29, 30, 31 and 32 through the medium of the plug 43, the sprocket 49 and the chain 57, and said valves will be rotated within the circular passage 25 of the head 23 of the motor and the several intake and exhaust ports thereof will be moved to proper position to supply each cylinder in its turn with an explosive charge and exhaust the products of combustion therefrom.

The sprocket 54 is so constructed as to have twice the number of teeth as the sprocket 64 and the sprocket 49 is so constructed as to have twice the number of teeth as the sprocket 56 by which arrangement of parts the crank shaft 22 will move four complete revolutions to each revolution of the several valves 29.

Assuming now that it is desired to change the timing relation of the several valves 29, 30, 31 and 32 with respect to the crank shaft 22. To obtain this the nut 58 is disengaged from the hub extension 57 of the sprocket 56 and the sprocket 54 is moved along said hub extension until the pins 61 disengage from their respective recesses or openings 60, in which position the several valves are free to rotate within the head 23. If, now, said valves are rotated by hand, until different openings 60 are positioned opposite the pins 61 than were previously used, it will be seen that the timing of the valves relative to the crank shaft will be changed as the several valves are rotated. Owing to the engagement of the rigid member 47 heretofore mentioned with the cam groove 46 of the plug 43, it will be noted that the several valves are reciprocated longitudinally of the head 23 of the motor during operation, and thus prevent a wearing of the several parts in defined paths which latter would result

were the several valves rotated without the aforementioned reciprocating movement.

The cycle of operation of the valve is as follows:

With the parts in the position shown in Figure 3, No. 1 cylinder is exhausting, No. 2 cylinder is taking in a charge of fuel, No. 3 is firing, and No. 4 is compressing a charge. With the parts in this position, it will be seen that the exhaust port 35 of the valve 32 is in register with the port 10 in the head 23 and these two ports when in register establish communication between the No. 1 cylinder and the tubular member 40, which extends centrally through the valves. As the motor continues to operate the intake port 36 of the valve 31 passes out of registration with the port 10 of the No. 2 cylinder and the exhaust port 36 of the valve 30 will pass into register with the port 10 of the No. 3 cylinder, permitting the products of combustion to escape from said No. 3 cylinder. Simultaneously with this operation the intake port 36 of the No. 1 cylinder will pass into register with the hereinbefore mentioned port 10 to permit of a charge entering No. 1 cylinder as the piston therein travels downwardly. Upon further operation of the motor, the charge in No. 4 cylinder is fired and the exhaust port 35 of the valve member 29 passes into register with the port 10 in order to permit of a discharge of the products of combustion from said cylinder. Upon further operation of the motor, the charge taken into the second cylinder is fired, it being understood that during the operation heretofore described the said charge has been compressed. As the motor continues to operate the several intake and exhaust ports establish communication between the intake manifold 40' and the cylinders and the exhaust manifold or tubular member 40 and the cylinders in order that they may receive their charges and exhaust their products of combustion in proper sequence.

The several moving parts of the motor are lubricated by a force feed system and said force feed system is operated by a pump 67. Leading from the pump 67 is an oil line 68 and said oil line extends upwardly and rearwardly of the motor to a nipple 69 adapted to feed lubricant to the rear main bearing of the motor. Branching off from the line 68 as at 70, is an oil line 71, leading to a nipple 72, which lubricates the center main bearing of the motor. Connected to the line 68 as at 73, is a branch 74, and said branch 74 terminates in a nipple 75 secured in an automatic controlling element 76. This automatic controlling element 76 is shown in detail in Figure 11, and comprises a body having a flattened upper portion 77 hollowed out to form a chamber 78. Bridging this chamber 78 is a diaphragm 79 of

any suitable material, and extending therefrom is a stem or the like 80. This stem 80 is slidably mounted in a tubular extension 81 within the body portion of the device, and the bottom of this passage terminates in a seat 84 with which a ball valve 85 is adapted to engage, the ball valve being employed to close a transverse and angularly extending passage 86. Surrounding the stem 86 is a coil spring 87 which tends to force the diaphragm upwardly. Leading into the controlling device 76, is a nipple 88 and the end of said nipple lies within a chamber 89. Establishing communication between this last mentioned chamber 89 and the chamber 78 heretofore mentioned, is a passage 90. Leading from the nipple 88 is a pipe 91, and said pipe is connected by means of a nipple 92 to the intake manifold 40'. The purpose of this connection between the chamber 78 and the intake manifold 40' will be hereinafter more specifically set forth.

The passage 86 heretofore mentioned is the means by which communication is established between the nipple 75 and the nipple 93 from which nipple 93 leads a pipe or line 94. This pipe or line 94 extends longitudinally of the cylinder as more clearly shown in Figure 1 and extends to a lubricating device 95 at the rear of the motor. There are five of these lubricating devices 95 as shown in Figure 1, and the specific construction of all of these devices is the same, which construction is shown in detail in Figure 10. The two rear lubricating devices 95 are connected by means of a pipe or the like 96, the two forward ones by means of a pipe 97, and the second and third ones from the forward end of the motor by means of a pipe 98.

Referring to Figure 10, it will be seen that each of these lubricating devices comprises an inner plug 99 provided with an annular passage 100. The annular passage 100 connects with a right-angular passage 101, and said right-angular passage 101 communicates with a passage 102 in a plug 103. This plug 103 has one of its ends recessed as at 104 and slidable about said plug 103 is a hollow member 105, which latter has a discharge opening 106. Interposed between the plug 103 and the sliding member 105 and seated in the recess 104 is a coil spring 107, by means of which the sliding member is projected in the recess 108 in the head 23 in which it is mounted. The outer end of the sliding member 105 is curved to conform to the surface with which it contacts in order that friction and wear may be reduced between these members. These members are formed in the same manner and it will be seen that as lubricant is introduced to the passage 101, the same will be discharged through the plug 103 and the discharge open-

ing 106 of the sliding member 105, to the several valves to be lubricated. From this construction it will be apparent that as the lubricant is forced through the line 94, the same will be introduced to the rear lubricating device 95 and to its next adjacent lubricating device 95 by means of the pipe 96, to the next lubricating device 95 by means of the pipe 96', to the next lubricating device 95 by means of the pipe 98, and to the forward lubricating device 95 by means of the pipe 97, it being understood that the lubricant in its forced circulation through the course just described will be discharged to the several parts to be lubricated.

Leading from the forward lubricating device 95 is a pipe 110 and said pipe 110 communicates with a nipple 111 which in turn discharges directly into a passage 112 in the rigid member 47 heretofore mentioned in order that the engaging surface of the rigid member 47 and the cam groove 46 heretofore mentioned will be lubricated during the operation of the motor. This pipe also serves to supply lubricant to a passage 110' in the stub shaft 52 to lubricate the bushing 55. Each of the several passages 102, 110' and 112 is packed with felt or other suitable absorbent material in order that a too free flow of lubricant therethrough will not be had.

The lubricating system is automatically controlled in the following manner: Experience and tests have proven that when a motor of the internal combustion type is throttled down by a reduction of the volume of charge admitted to the several cylinders, owing to the reduced volume of charge in the intake manifold being insufficient to supply the "pull" of the pistons, a partial vacuum is created in the intake manifold, the extent of which vacuum is determined by the degree of reduction of fuel in the intake manifold.

Referring to Figure 11 and assuming that the motor has been throttled down to a point where as above mentioned the partial vacuum will be produced in the intake manifold,—owing to the communication between the intake manifold and the chamber 78 in the automatic controlling valve the vacuum in the intake manifold will have a tendency to depress the diaphragm 79 and through the medium of the stem 80, a pressure will be exerted upon the ball valve 84, and, consequently the volume of lubricant passing through the right angular passage 86 from the nipple 75 to the nipple 93, will be correspondingly reduced. The degree of reduction of lubricant passing from the nipple 75 to the nipple 93 will correspond to the vacuum produced in the intake manifold and consequently the several moving parts of the motor will be supplied with a smaller amount of lubricant when the motor is throt-

tled than when the motor is operating at high speeds. Inasmuch as the smoking of rotary valve motors is due primarily to superfluous lubrication at low speeds, the automatic control of lubrication in the present device serves by a reduction of volume of lubricant to eliminate smoking of the motor at low speeds or when the same is throttled down. By this construction it is apparent that a controlling mechanism such as described in the present application tends to automatically control the lubrication of the motor in such a manner that smoking of the motor at low speeds is eliminated and all of the several parts of the motor are sure to obtain lubrication in a quantity commensurate with the speed at which they operate, thus providing the necessary lubrication without waste of the lubricant employed.

From the foregoing it will be readily understood that a head constructed in accordance with the present invention produces a quiet running of the motor in which smoking at low speeds is eliminated.

The automatic controlling element described in this specification and shown in Figure 11 of the drawings is the sole invention of J. G. Elkin and its specific construction is made the subject matter of a separate application filed September 24, 1921, Serial No. 503,075, and this mechanism is shown and described in the present application to make a complete operating device and is claimed broadly in the present application for the reason that in its broadest conception, it is the joint invention of W. D. Sprague and J. G. Elkin.

We claim:

1. A combined intake and exhaust valve element for internal combustion motors, said valve element comprising a housing adapted to be removably attached to the motor block, a sleeve of smaller diameter than said housing and mounted axially thereof, a plurality of interconnected valve elements mounted on said sleeve, means for securing the valve elements together to cause their operation in unison, and means for securing said valve

element to said sleeve, said means comprising a nut having threaded engagement with one end of said sleeve and a driving plug having threaded engagement with the other end of said sleeve.

2. A combined intake and exhaust valve element for internal combustion motors, said valve element comprising a housing adapted to be removably attached to the motor block, a sleeve of smaller diameter than said housing and mounted axially thereof, a plurality of interconnected valve elements mounted on said sleeve, means for securing the valve elements together to cause their operation in unison, and means for securing said valve element to said sleeve, said means comprising a nut having threaded engagement with one end of said sleeve, a driving plug having threaded engagement with the other end of said sleeve, a flange carried by said driving plug and engaging one of the valve members, and means passing through said flange and secured to the valve member which said flange engages to permit a driving connection between the driving plug, the sleeve, and the valve members.

3. A combined intake and exhaust valve element of the rotary type for internal combustion motors, comprising a valve housing adapted for removable attachment to an internal combustion motor block, a sleeve mounted axially of said housing and forming the exhaust port, a plurality of valve elements carried by said sleeve, each of said valve elements having circumferential passages forming the intake passages of the valves and having ports coinciding with ports in the valve housing, and means for securing said valve elements to said sleeve, said means comprising a nut having threaded engagement with one end of the sleeve and a driving plug having threaded engagement with the opposite end of the sleeve and positively connected with one of the inter-engaged valve elements.

WILLIS DOUGLASS SPRAGUE.
JACOB G. ELKIN.