

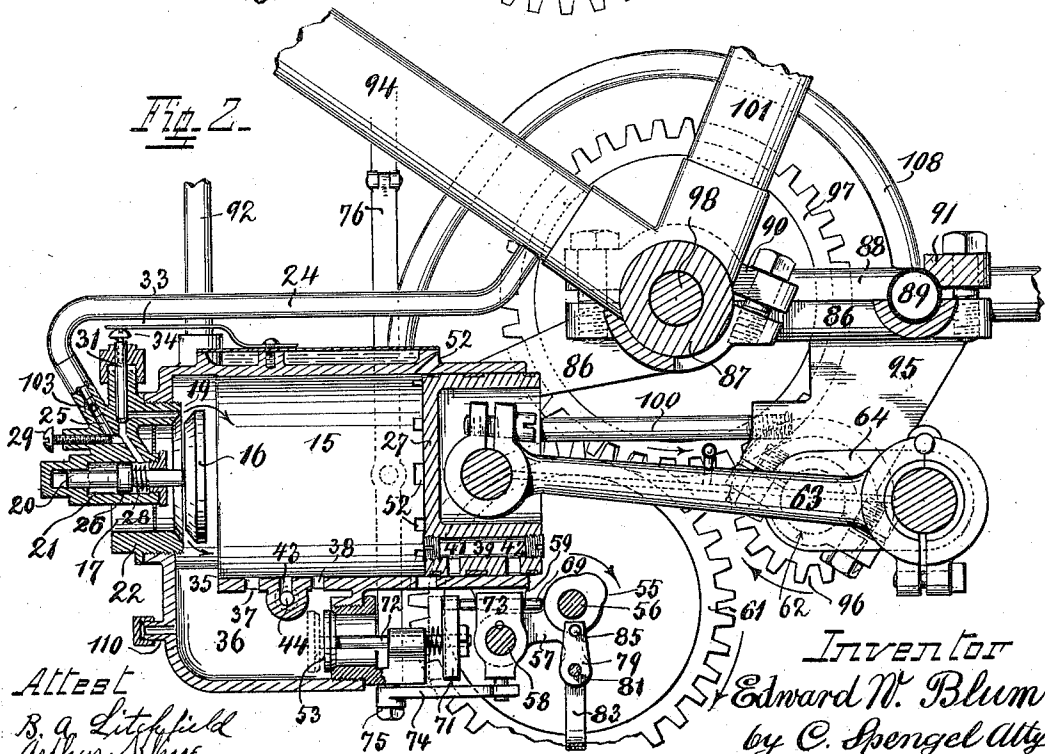
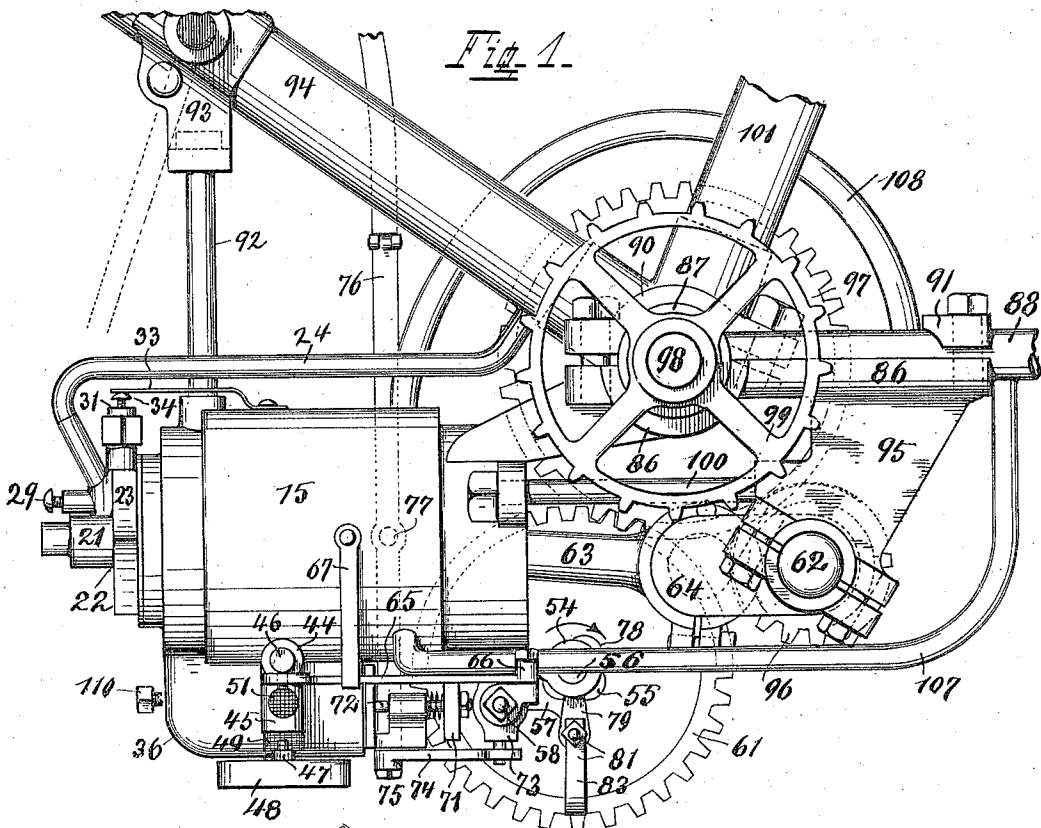
(No Model.)

3 Sheets—Sheet 1.

E. W. BLUM.
GAS MOTOR.

No. 579,554.

Patented Mar. 23, 1897.

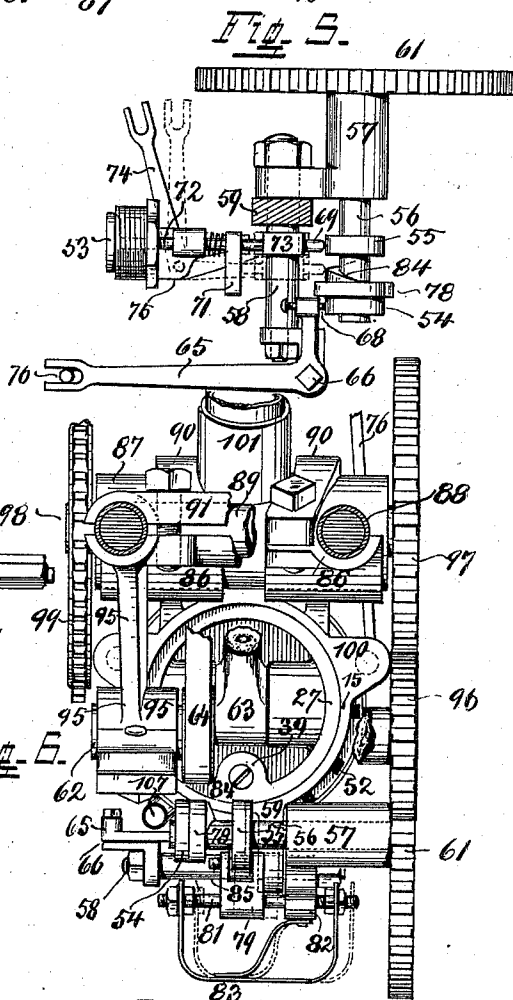
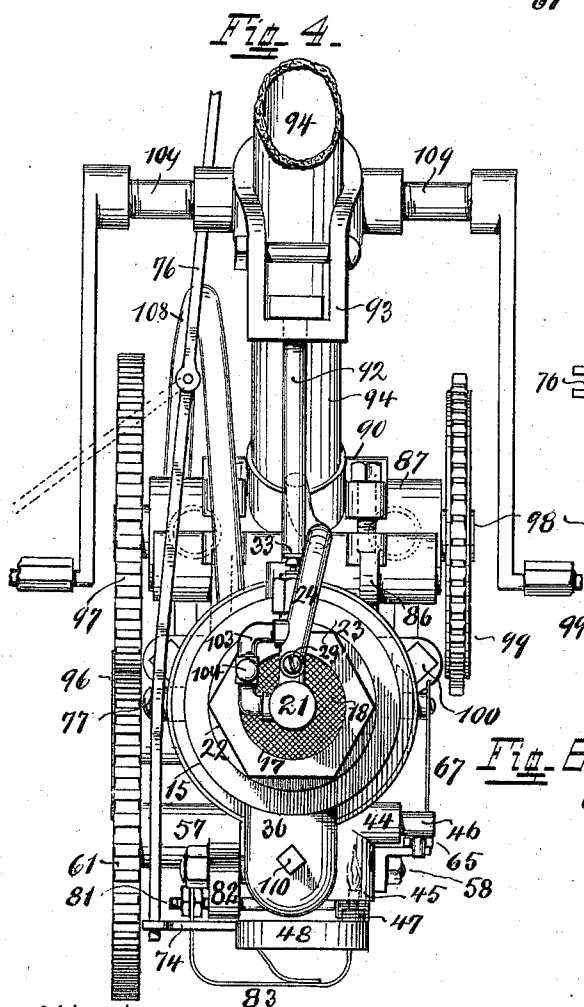
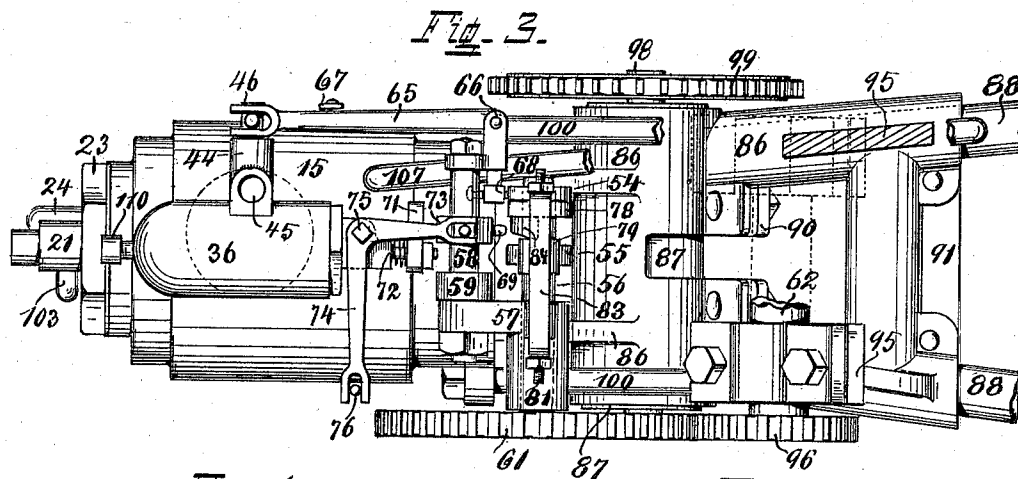


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3 Sheets—Sheet 3.

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Fig. 7.

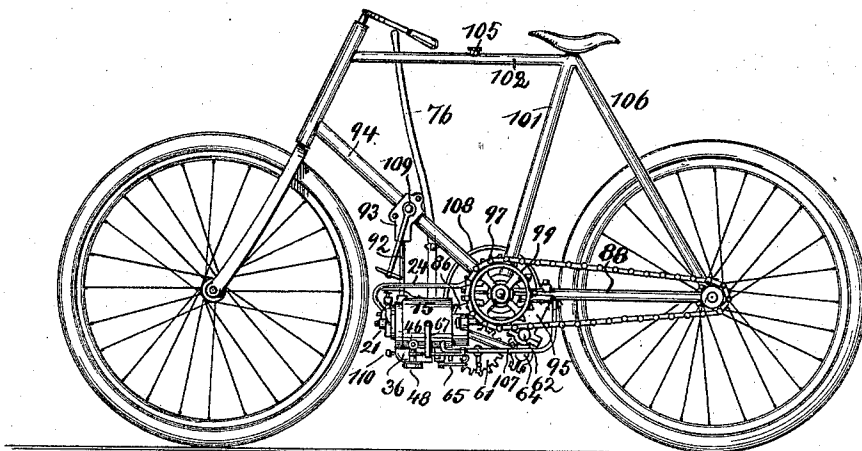


Fig. 8.

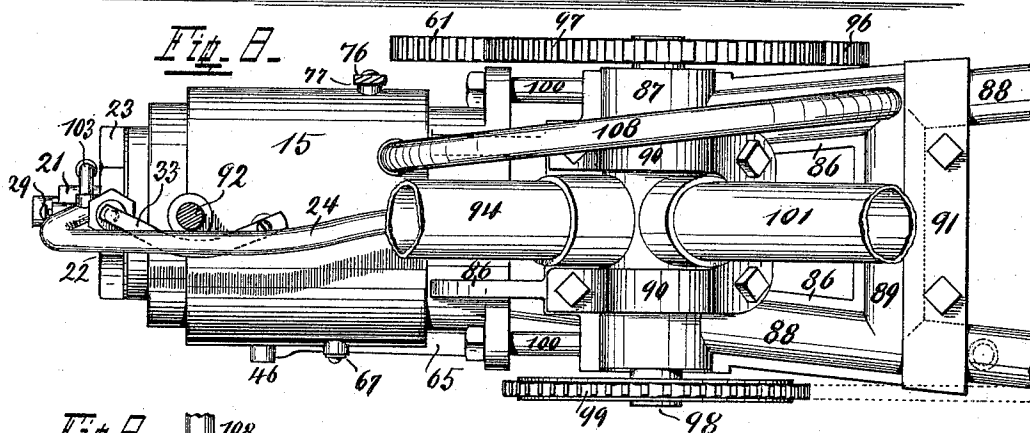


Fig. 9.

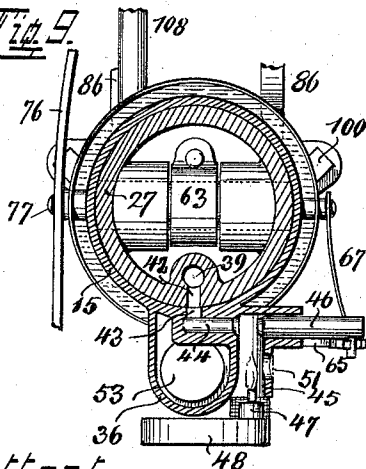


Fig. 10.

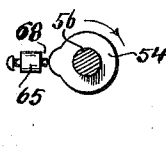


Fig. 11.

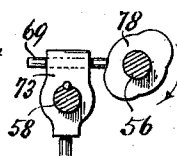


Fig. 12.

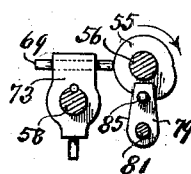
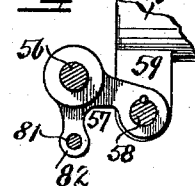


Fig. 13.



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UNITED STATES PATENT OFFICE.

EDWARD W. BLUM, OF CINCINNATI, OHIO, ASSIGNOR OF ONE-HALF TO
JOHN H. STRIEKER, OF ANDERSON, INDIANA.

GAS-MOTOR.

SPECIFICATION forming part of Letters Patent No. 579,554, dated March 23, 1897.

Application filed December 26, 1895. Serial No. 573,306. (No model.)

To all whom it may concern:

Be it known that I, EDWARD W. BLUM, a citizen of the United States, and a resident of Cincinnati, Hamilton county, State of Ohio, have invented certain new and useful Improvements in Gas-Motors; and I do declare the following to be a clear, full, 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, attention being called to the accompanying drawings, with the reference-numerals marked thereon, which form a part of this specification.

This invention relates to improvements in gas-motors or engines of the kind where the motive force is created by gas or a mixture of the same with atmospheric air. It relates more especially to such engines where the gas is derived from the vaporization of a suitable volatile hydrocarbon liquid, preferably some product of petroleum—like gasolene, for instance—and the construction is furthermore adapted for attachment to a bicycle in particular to form the moving motor for the same in substitution of the usual pedal-movement thereof.

The novel features consist, therefore, of parts adapted for use on gas-engines in general—that is, such using manufactured gas—of such parts which are only adapted for engines where vaporized gas is used, and finally of parts whereby an engine of the latter class becomes adapted for use as a bicycle-motor in particular or other vehicle in general.

Of the first class of parts the improvements relate to the admission and exhaust valves, to the means of operating them, to the means whereby the ignition of the gas is brought about, to a speed-governor and the manner of operating it, and to features of construction in general and in detail.

Of the second class of parts the improvements relate to the means for admitting and regulating such admission of the gas-producing liquid and to the features of construction in general and in detail of these parts and others connected therewith.

Of the third class of parts the improvements relate to the means and construction whereby the motor becomes adapted for attachment to and use on a bicycle, to the means

for carrying a gas-producing liquid and water used for cooling the cylinder, and to features of construction in general and in detail involved in this connection.

In the following specification, and particularly pointed out in the claims, is found a full description of my invention, its parts and construction, which latter is also illustrated in the accompanying drawings, in which—

Figure 1 shows in side view a gas-motor constructed after the plan of my invention and adapted for attachment to a bicycle. Fig. 2 is a longitudinal section of the same, showing the piston in position to start upon the compression-stroke. Fig. 3 is an under side view of the same with parts broken away. Fig. 4 is a front view thereof. Fig. 5 is a top view of the valve-gear as it appears on a plane immediately below the cylinder. Fig. 6 is a rear view of the motor with parts broken away. Fig. 7 shows in side elevation a bicycle provided with my motor, illustrating its location relatively to the parts of the bicycle. Fig. 8 is a top view of the motor with parts of the bicycle-frame broken away. Fig. 9 is a vertical section through the cylinder, piston, and ignition-chamber, showing position of all these parts at the time when the ignition occurs. Figs. 10, 11, and 12 show in side views the cams controlling ignition, speed, and exhaust in their relative positions to each other at the time when the ignition takes place. Fig. 13 shows in a detail view construction for supporting the cam-shaft.

In general this engine, which is single acting, belongs to that class of gas-motors where a cycle of four succeeding piston-strokes comprises and accomplishes one complete operation of the engine in the following manner: At the outgoing or suction stroke gas or the gas-producing liquid as well as air are drawn into the cylinder, which mixture is compressed at the following second or compression stroke, at the end of which stroke with the compressed gas and air at its greatest density the ignition and explosion takes place. This latter throws the piston out again, constituting the third or working stroke, being followed by the fourth stroke, which, going inwardly, forms the exhaust-stroke by driving the decomposed gases before it out of the cyl-

inder. This completes the cycle of four strokes, followed again by a suction-stroke.

In stationary motors the engine is carried over from one working stroke to the next one by a fly-wheel, while in a bicycle the momentum of the moving vehicle combined with the weight of the rider takes the place of the fly-wheel. In this case 15 is the cylinder, permanently open at one end and carrying at its other end the admission-valve 16, which controls the inlet of air and gas or the gas-producing liquid. The former enters on the suction-stroke of the main piston through an opening 17, preferably guarded by a screen 18, and the latter through a port 19. Valve 16 is carried by a stem 20, which latter is supported and guided in the ends on a cylindrical chamber 21, which may be a part of the casting which forms the valve-seat 22, and is screwed in the otherwise open end of the cylinder, its outer end being shaped to form a nut 23. The gas or fluid producing it enters from a supply-pipe 24 through a passage 25 into chamber 21, the tube or pipe forming such passage being the means whereby chamber-casting 21 is centrally supported within the inlet-opening 17 and whereby it is connected to the casting forming the valve-seat.

From cylinder 21 the gasolene is expelled by means of a piston 26, connected to valve-stem 20, and moving with the latter forces on the suction-stroke of the big piston 27 the gasolene up through passage 25 and out through the inlet-port 19, which at the same time is uncovered by valve 16. A spring 28, confined within chamber 21 and bearing against the piston therein, serves at the end of the suction-stroke to immediately return valve 16 to its seat. In the meantime—that is, until the next suction-stroke occurs—chamber 21 is filling again through passage 25 to be supplied for the next ejection.

The quantity of oil entering through passage 25 may be regulated by a valve 29. Another valve 31 is provided at the turn where a short branch from passage 25 connects with the outer end of port 19. This valve normally closes the latter, but yields to the pressure when the gasolene is raised up in passage 25 by piston 26. It is held closed by a spring 33, and the quantity of gasolene it admits may also be regulated by regulating the pressure of said spring. For such purpose the latter instead of bearing against the upper end of this valve direct bears against a screw 34 thereat. The change of gas or gasolene which has at once changed into vapor and has become thoroughly mixed with air is now compressed by the returning piston, which moves inwardly or toward valve 16, which latter closes at once at the beginning of the instroke. The larger part of this compressed charge enters through a port 35 into a pocket 36, from whence, through ports 37 and 38, a part of this charge passes into a pocket 39 in the main piston, entering through ports 41 and

42 thereat, as these latter ports register simultaneously with ports 37 and 38 in the passage of the piston over the same. At the turning-point of the piston port 42 of the latter comes over a port 43 in the cylinder-wall, which communicates with ignition-chamber 44, the latter in turn communicating with the lighter-chamber 45, but is normally closed against the latter by a valve 46.

The lighter-chamber surrounds the flame and part of the burner of a suitable lamp 47, the fount 48 of which is supported in any convenient way on the outside of the cylinder. The lower part of the burner is surrounded by wire-gauze at 49, and a necessary ventilation-opening at 51 is protected and closed in the same way. Now at the time above mentioned, that is, at the turning-point of the piston, when port 42 registers with port 43, lighter-valve 46 opens communication between ignition-chamber 44 and lighter-chamber 45, whereby an uninterrupted connection is established between the lamp in the lighter-chamber and pocket 39 in the piston by way of ignition-chamber 44. This position of the parts is shown in Fig. 9, and the result of which is an ignition of the gas in pocket 39. As will be seen, there is no communication at this moment between the latter pocket and the main cylinder or pocket 36 thereof, so that no reaction or puff occurs which might extinguish the lamp or cause the flame of it to flicker and leap through opening 51. This latter contingency, if it should occur, is prevented, however, by the gauze covering said opening. A moment later, as the piston starts on its outstroke, lighter-valve 46 having meanwhile closed, ports 41 and 42 pass over and register simultaneously for an instant with ports 37 and 38, whereby the ignition is carried to the gas in pocket 36, and from there through port 35 to the main cylinder, whereupon the whole charge explodes, driving the piston out toward the open end of the cylinder, thereby producing the effective or working stroke of the piston. At the end of this stroke the latter partly uncovers relief-ports 52, which permit at once a partial escape of the burned gases at the turning-point of the piston when the same starts inwardly on the exhaust-stroke. At this time exhaust-valve 53, seated in one end of the pocket 36, is opened to permit complete escape of all the burned gases which are expelled by the inwardly-moving piston. The end of this, the exhaust-stroke, at which time the exhaust-valve closes, marks also the beginning of another suction-stroke, when valve 16 opens again to admit another charge of air and gas, as has been explained before.

The means for operating the lighter and exhaust valves are cams 54 and 55, rotated by a shaft 56, supported in a bracket 57. This latter may be secured in any suitable manner. In this case it is supported on a rod 58, which, being needed for other purposes, has been utilized. This rod is secured to a lug

59, depending from the cylinder-casting. Shaft 56 is rotated by means of a gear-wheel 61, which receives its motion from the crank-shaft 62, which latter is rotated by the main piston, being connected therewith by connecting-rod 63 and cranks 64.

The proportion of speed between shafts 62 and 56 should be two to one—that is, two revolutions of the former to one revolution of shaft 56, which operates the valves. Differently expressed, this means four piston-strokes to one revolution of shaft 56, which complete the cycle of operations required for one action of the valves from one ignition to the next.

The lighter-valve is acted upon by cam 54 by means of an angle-lever 65, pivoted at 66 and connected to this valve. The operation is clear. The projecting part of the cam acting upon one end of this lever causes the valve 46 to be drawn outwardly to open communication between lighter-chamber 45 and ignition-chamber 44. A spring 67 closes this valve again as soon as the action of the cam on lever 65 ceases. The point of contact between these two latter consists, as to the angle-lever, of a screw 68, which may be adjusted to or from the cam, and by the resulting longer or shorter contact between the two the extent and time of opening of valve 46 may be determined. The exhaust-valve is acted on by cam 55 in this manner, that the projecting part of the latter acts against a loosely-supported pin 69, which in turn acts against a heel 71, secured to the stem 72 of the exhaust-valve. This latter is suitably guided by this stem, as shown in the drawings, and kept seated by the action of a spring. Pin 69 is supported by a shifter 73, which is laterally adjustable on rod 58, before mentioned, by means of an angle-lever 74, pivoted at 75, and operated by a hand-lever 76, pivoted at 77. Lever 76 reaches upwardly to within reach of the rider, and its object in connection with the laterally-shiftable pin 69 is to provide means to control the action—that is, start and stoppage—of the engine. By these means pin 69 may be shifted so as to be outside of the path of the cam 55, in which case the latter cannot act upon the heel of the exhaust-valve, and therefore the operation of the engine is stopped. The same means may also be used for purposes of controlling and reducing speed. For such purpose pin 69 is shifted still further, so as to come opposite the face of cam 78, which also revolves with shaft 56. This cam has two projections, whereby the exhaust-valve is not only operated twice as often, but also at times different from its normal operation. These times are coincident with the receiving and ignition or power-strokes, during which strokes the exhaust-valve is held open and the inlet-valve rendered inoperative. The result of this action is a suspension of the supply of the means which generate the power. Heel 71 on stem 72 remaining always in contact with pin 69

maintains the operative connection between stem 72 and pin 69 during all lateral adjustments of the latter.

There is, further, a speed-governor, which acts automatically at all times for the purpose of reducing excessive speed. It consists, substantially, of a shifter 79, which embraces cam 55 in a manner which does not interfere with its rotation. While this cam 55 is fixedly secured by a key to shaft 56 as far as rotation is concerned, it is free to lateral adjustment and capable to follow shifter 79. This latter is carried by a rod 81, adjustably supported in a bearing 82, and by means of a three-branched spring 83 it is held normally in a position which brings shifter 79, and with it cam 55, in proper position to act upon pin 69 for the purpose of opening the exhaust-valve at the proper time. There is an additional laterally-acting cam 84, which may preferably form a part of cam 78, which at every revolution of shaft 56 acts once either direct or by means of a pin 85 against the governor-shifter 79, which action is of an extent to move cam 55 to a position where it cannot act upon pin 69, which opens the exhaust-valve. This cam 84 is, however, so set that by ordinary speed its action upon shifter 79 ceases in time to enable spring 83 to carry the latter, and with it cam 55, to its normal position, where it may act upon pin 69 and open the exhaust-valve at the proper time. Under normal conditions, therefore, this lateral movement of cam 55 out of reach of pin 69 is of no consequence or effect, because it takes place at a time when said cam is not intended to act upon pin 69, while whenever its action is required to open the exhaust-valve it is in proper place. This arrangement of motions and proportion of time will be disturbed, however, on an excessive increase of speed, when the rotary velocity of shaft 56 will be larger in proportion to the constant action of spring 83, by which it returns the shifter, with cam 55, to its normal position. The result of this disturbance is that pin 69 and cam 55 will not come together any more at the proper time, and the projecting part of the latter may have passed entirely beyond the end of the pin by the time the cam has been shifted back where it would come opposite the pin. Inasmuch as the operation of the exhaust-valve is dependent on the proper operation and coaction of these parts it is plain that whenever these parts fail to act by missing each other no operation of the former takes place. The engine not having exhausted does not receive and therefore loses the effect of a working stroke. One or more of these strokes may be missed at a time, according to the circumstances and excess of speed, whereby this latter is at once reduced to its normal condition, in which cam 55 meets pin 69 at the proper time to open the exhaust-valve. Two parts of spring 83 engage with sliding rod 81, one at each end thereof, whereby a more even and reliable action is attained, which by means of nuts at

each end may be properly regulated. This motor as described may be used as a stationary engine, if mounted on a suitable frame. Inasmuch as it is, however, intended for a bicycle-motor special provision for attachment in a practical manner as well as for the transfer of power becomes necessary. As to position I have selected the space between the two wheels as being the best suited for all purposes in general and in particular as to the proper balance and distribution of the load as well as for reasons of appearance.

Two frames 86 extend rearwardly from the cylinder and are formed to fit from the under side against bearing 87, which supports the pedal-shaft against the frame-braces 88, which extend rearwardly therefrom, and against a short brace 89, connecting these braces.

Caps 90 and 91, applied from above, the first over and around bearing 87, the other over braces 88 and 89, are connected to the frame-sections 86 below, whereby the whole is secured in position. The front end of the cylinder is supported by a tie-rod 92, secured to a hanger 93, which is clamped around frame part 94.

From the rear end of each frame-section 86 depends a hanger 95, forming at its lower end, in combination with a cap, the bearings for the crank-shaft 62. The derived motion of this latter is transferred by means of a gear-wheel 96, mounted thereon, which meshes into another gear-wheel 97, mounted on a driving-shaft 98, which is supported in bearing 87 and takes the place of the ordinary pedal-shaft. At the other end of this shaft the usual sprocket-wheel 99 is mounted, which by means of a chain transfers the motion to the drive-wheel of the bicycle. Brace-rods 100, passing from hangers 95 to the cylinder, add stability to the engine and its frame. Gear-wheel 97 connects with gear-wheel 61 on shaft 56 and rotates the same for the purpose of operating the valves, as has been explained. The proportion of speed between gear-wheels 96 and 61 is like two to one, for reasons which are now fully understood.

As will be seen, the center of the crank-shaft is not in line with the center of the cylinder, whereby I am enabled to use a shorter connecting-rod and shorten the engine, all of which tends to reduce weight. This position is also a very favorable one as regards the transmission of power from the piston to the crank by bringing these two more nearly in a direct line during the effective or working stroke. These same two parts are of course that much out of line on the other stroke, but this is at a time when no power is transmitted from the piston to the crank.

Means to lubricate all working parts are provided in a suitable way, as is customary in such cases. The bearings at the ends of the connecting-rod where the same connects to crank and piston I lubricate by oil carried in the connecting-rod, which is longitudinally

perforated for such purpose and the ends of which perforation terminate in said bearings.

Oil or gasolene being the gas-producing agent, provision has to be made to carry the same in a practical manner, and for which purpose parts of the bicycle-frame are utilized, and particularly parts 101, 102, and 94, from the lower end of which latter supply-pipe 24 starts to and connects with passage 25 and leads to pump-cylinder 21. To obviate the friction which a tightly-fitting piston would cause in the cylinder, no packing is used around the latter, and any possible leakage which has passed to the other side of the piston is pushed back again by the latter through a return-passage 103, which connects the outer end of cylinder 21 with supply-pipe 24. A check-valve 104 may be inserted within this passage.

The gasolene may be supplied to its storage place through a fill-opening 105, properly located in the highest point of the bicycle-frame.

The main cylinder is surrounded by a jacket with a space between, which is filled with water for cooling the cylinder. This water is carried in the two horizontal braces 88 and upright braces 106 of the bicycle-frame, and a circulation is obtained by causing the water to enter the lower part of the jacket by a pipe 107 at one side from one of the frames 88 and leaving the jacket at the top through a pipe 108, which connects with the frame 88 at the other side.

There is no communication between frames 88 and 106 of either side until the rear upper part of frames 106 is reached, so that the water has to pass up on one side through one of the frames 88 and 106 and down on the other side in reverse order before it reenters the jacket through pipe 107. This circulation through the pipes maintains the water at a low temperature.

The pedals are disconnected from their usual position and attached to pins 109, secured in sockets formed in hanger 93, and in which position they form foot-rests for the occupant. They may be attached at any time to the driving-shaft 98, whereby the vehicle may be used again as a pedal-machine.

Hand-lever 76 is in two parts connected by a hinge above its fulcrum and which permits such upper part to be turned down to form a brace and third supporting-point to aid the machine in standing upright while not in use. (See dotted lines in Fig. 4.) This motor may also be used as an air-pump for the purpose of inflating the pneumatic tires of the wheels, the drive-chain mechanism having first been rendered inoperative in a suitable manner. For such purpose a nipple 110 is provided, ordinarily closed, for attachment of a rubber hose.

The operation of all the parts may be shortly described to be as follows: Pin 69, carried by shifter 73, having by means of handle-lever

76 been so adjusted as to be able to receive the action of the exhaust-cam 55, the motor is ready to be started. On the suction or first out stroke inlet-valve 16 opens, admitting air through opening 17, as well as oil through port 19. The oil which had accumulated before in pump-cylinder 21 is forced out by piston 26, operated by the stem of valve 16, and rises in passage 25, lifting valve 31 to enter port 19. The ejected oil quickly changes into vapor, or may, after the parts have become warmed, issue already partly in form of vapor, which becomes thoroughly mixed with air. This mixed charge is now compressed, most of it in chamber 36, by the second or in stroke of the piston, valve 16 having meanwhile closed at the beginning of this stroke. Ports in the cylinder-wall as well as in the piston admit a part of the charge to enter a pocket in the piston as the latter approaches the end of this stroke. At the end of this stroke, cam 54, by acting on angle-lever 65, opens the lighter-valve 46, thereby igniting first the charge in the pocket of the piston, which from here, through the ports mentioned, spreads first into chamber 36 and from there into the main cylinder. The lighter-valve 46 closes immediately after starting the ignition. The resulting explosion throws the piston out again, which stroke constitutes the effective power or working stroke. At the end of it the piston partly uncovers relief-ports 52, whereby an immediate reduction of pressure is attained, which prevents back action, and whereby also fresh air is admitted to pocket 39 in the piston. Meanwhile cam 55, by acting against pin 69 and heel 71, has also opened the exhaust-valve 53, through which the burned gases escape, being expelled by the inwardly-moving piston. Spring action closes the exhaust-valve at the end of this stroke, which completes the fourth of a cycle required for one complete operation of all parts of the engine, and after which the cylinder receives a fresh charge. The regulation of the speed takes place in two ways, as has been explained: first, positively by shifting pin 69, by means of hand-lever 76, opposite cam 78, whereby by an increased operation of the exhaust-valve the pressure is reduced, and, second, automatically by a governing device which by interrupting the normal action of the escape-valve prevents the cylinder from receiving.

Where used as a stationary motor, the described igniting mechanism may be substituted by one operating electrically without departing from the plan of my invention. This motor, although it has been described with reference to a bicycle, is, with suitable modifications, especially as to size, equally well applicable to tricycles, carriages, wagons, street-cars, or other vehicles as a source of power for the purpose of their locomotion, as well as a source of resistance for the purpose of their retardation after they are in motion. By this last-named use is meant its applica-

tion as or in conjunction with a brake system. The manner in which this machine acts so as to retard the motion of the bicycle is as follows: By means of the operating-lever 76 shifter 73 is placed so that pin 69 is in line with and is acted upon by speed-cam 78. When the operating-lever is in this position during the forward strokes of piston 27, the exhaust-valve 53 is held open by the mediate action of cam 78, causing the valve 16 to remain closed, there being no reduction of pressure within the cylinder 15 sufficient to open it against spring 28 in the chamber 21, which keeps it closed. It will be seen that air will now enter the cylinder through valve 53, and no gasoline would accompany this air, as is the case when in the normal operation of the engine air enters the cylinder through valve 16. From what has been said it is plain that the machine is then no longer a source of motive power. Moreover, all the valves remaining closed on the instrokes of the piston 27, the work done in compressing the air within the cylinder would reduce the kinetic energy or speed of the moving bicycle and rider. The potential energy of the compressed air would be lost, because valve 53 would be opened at the beginning of the forward stroke of piston 27 and none of the potential energy would be again converted into the kinetic energy or speed before mentioned. The amount or extent of this reduction of motion would be arbitrary, since by means of the operating-lever the position of the shifter 73 could be again changed at any time to the position in which cam 55 acts on pin 69 or to the position in which pin 69 is not acted upon by either cam 78 or cam 55. When the pin 69 is acted upon by cam 55, the whole mechanism becomes a source of motive power, as has been described in general and in detail; and, finally, when the pin 69 is not acted upon by either cam 78 or cam 55 neither the valve 53 nor valve 16 operates. In this case potential energy is stored up in compressing the burned gas or air which is within the cylinder at this time. The potential energy is not lost, but is immediately converted into kinetic energy by its action on the piston 27 during the outstrokes. This conversion of energy of one kind into energy of a different kind goes on without loss of power except that due to the inherent friction of the mechanism and loss of pressure due to mechanical inaccuracies in valves 53 and 16 and piston 27. This action may be continued for as long as desired, that is, till the position of the shifter 73 is again changed by means of the operating-lever 76 to one of the other positions mentioned.

When it is desired to inflate the tires of the bicycle, the valve 16 is rendered inoperative. This may be done by placing the shifter 73 so that pin 69 will be in line with and acted upon by speed-cam 78 or out of line with both speed-cam 78 and exhaust-cam 55. The machine is now an air-pump, connection having been made from the nipple 110 to the nipple

on the tire of either bicycle-wheel, as before stated. The piston 27 would now be caused to reciprocate by hand-power. The power may be applied by taking one of the pedals 5 off of pin 109 and engaging it to one end of shaft 98, so that it can be used as a hand-crank. When the bicycle is in motion, operating-lever 76 is confined to move only in the plane in which it changes the position of 10 shifter 73. This can be accomplished by any suitable means, and when the bicycle is at rest it may be disengaged from the device and take the position as shown in dotted lines in Fig. 4 for the purpose already stated.

15 The working parts of the machine may be inclosed by a covering of some suitable material.

Having described my invention, I claim as new—

20 1. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17, an admission-valve 16 adapted to close and open it, an admission-port 19 in 25 the valve-seat of the latter, a valve-stem on valve 16, a piston 26 permanently connected to said stem, a receiving-chamber 21 occupied by piston 26, an oil-supply pipe, a passage 25 connecting the latter with chamber 21, as well 30 as port 19, thereby serving at once as an inlet as well as a discharge opening for chamber 21, means to ignite the charge in the cylinder and an exhaust-valve with means to operate it.

35 2. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17, an admission-valve 16 adapted to close and open it, an admission-port 19 in 40 the valve-seat of the latter, a valve-stem on valve 16, a piston 26 permanently connected to said stem, a receiving-chamber 21 occupied by piston 26, an oil-supply pipe, a passage 25 connecting the latter with chamber 21 as well 45 as port 19, thereby serving at once as an inlet as well as a discharge opening for chamber 21, a spring-actuated valve 31 which controls communication between passage 25 and port 19 irrespective of the quantity ejected 50 by the piston, means to ignite the charge in the cylinder and an exhaust-valve with means to operate it.

55 3. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17 and an admission-port 19 in the cylinder, an admission-valve 16 adapted to close or open the two, a valve-stem on the latter, a piston 26 thereon, a receiving-chamber 21 occupied by piston 26, a passage 25 60 connecting chamber 21 with port 19, a supply-pipe connecting with passage 25, a return-pipe 103 connecting chamber 21 with supply-pipe 24, means to ignite the charge in the 65 cylinder and an exhaust-valve with means to operate it.

4. In a gas-motor the combination of a cyl-

inder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an opening in the end of the cylinder adapted to receive and containing a casting 22 which forms 70 at its inside a valve-seat and at its outside a nut 23, containing further a port 19 in the part forming the valve-seat, a central chamber 21, with an air-inlet opening 17 around it, 75 a passage 25 connecting chamber 21 with port 19 and also extended outwardly for connection to a supply-pipe, an admission-valve 16, means to ignite the charge in the cylinder and an exhaust-valve with means to operate it. 80

5. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, air and gas inlets to the cylinder and an admission-valve controlling these inlets, a charge-receiving pocket 36 open to the cylinder and 85 connected to it by ports, an ignition-chamber 44, also connecting with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through 90 them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an exhaust-valve and means to operate the lighter and exhaust valves. 95

6. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17 and an admission-port 19 in the cylinder, an admission-valve 16 adapted to close or open the two, a valve-stem on the latter, a piston 26 thereon, a receiving-chamber 21 occupied by piston 26, a passage 25 connecting chamber 21 with port 19, a supply-pipe connecting with passage 25, a charge-receiving pocket 36 open to the cylinder and 100 connected to it by ports, an ignition-chamber 44 also communicating with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through 105 them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an exhaust-valve and mechanism to operate the lighter and exhaust valves. 110 115

7. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, air and gas 120 inlets to the cylinder, an admission-valve controlling these inlets, a charge-receiving pocket 36 open to the cylinder and connected to it by ports, an ignition-chamber 44, also connecting with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 125 130 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit tempo-

rary communication through them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an angle-lever 65 connected to lighter-valve 46, a spring to hold it normally closed, a rotating cam 54 to operate lever 65 and an exhaust-valve and mechanism to operate it.

8. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17 and an admission-port 19 in the cylinder, an admission-valve 16 adapted to close or open the two, a valve-stem on the latter, a piston 26 thereon, a receiving-chamber 21 occupied by piston 26, a passage 25 connecting chamber 21 with port 19, a supply-pipe connecting with passage 25, a charge-receiving pocket 36 open to the cylinder and connected to it by ports, an ignition-chamber 44, also connecting with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an angle-lever 65 connected to lighter-valve 46, a spring to hold it normally closed, a rotating cam 54 to operate lever 65 and an exhaust-valve and mechanism to operate it.

9. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, air and gas inlets to the cylinder, an admission-valve controlling these inlets, a charge-receiving pocket 36 open to the cylinder and connected to it by ports, an ignition-chamber 44, also communicating with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an exhaust-valve having an outwardly-extended stem, a spring to keep it normally closed and a rotary cam 55 to open it.

10. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17 and an admission-port 19 in the cylinder, an admission-valve 16 adapted to close or open the two, a valve-stem on the latter, a piston 26 thereon, a receiving-chamber 21 occupied by piston 26, a passage 25 connecting chamber 21 with port 19, a supply-pipe connecting with passage 25, a charge-receiving pocket 36 open to the cylinder and connected to it by ports, an ignition-chamber 44 also communicating with the cylinder by a

port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an exhaust-valve having an outwardly-extended stem, a spring to keep it normally closed and a rotary cam 55 to open it.

11. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, air and gas inlets to the cylinder, an admission-valve controlling these inlets, an opening to permit contact of the charge in the cylinder with a live flame, a lighter-valve 46 controlling this opening, an angle-lever 65 connected to valve 46, an exhaust-opening and exhaust-valve 53 therefor, a spring to keep it normally closed, an outwardly-extending stem 72 on valve 53, a heel 71 thereon, a rotary cam-shaft 56, a cam 54 thereon revolving in the path of one end of angle-lever 65 to operate the lighter-valve, a cam 55 thereon to operate the exhaust-valve, a cam 78 for purposes of controlling speed, also mounted on shaft 56, a rod 58, a shifter 73 mounted on it, a pin 69 carried in the latter and in contact with heel 71 and an operating-lever whereby the shifter may be adjusted to bring pin 69 within the path of either cam 55 or 78 or without reach of either.

12. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, an air-inlet opening 17, an admission-port 19 in the cylinder, an admission-valve 16 adapted to close or open the two, a valve-stem on the latter, a piston 26 thereon, a receiving-chamber 21, occupied by piston 26, a passage 25 connecting chamber 21 with port 19, a supply-pipe connecting with passage 25, an opening to permit contact of the charge in the cylinder with a live flame, a lighter-valve 46 controlling this opening, an angle-lever 65 connected to valve 46, an exhaust-opening and exhaust-valve 53 therefor, a spring to keep it normally closed, an outwardly-extending stem 72 on valve 53, a heel 71 on it, a rotary cam-shaft 56, a cam 54 thereon revolving in the path of one end of angle-lever 65 to operate the lighter-valve, a cam 55 thereon to operate the exhaust-valve, a cam 78 for purposes of controlling speed, also mounted on shaft 56, a rod 58, a shifter 73 mounted on it, a pin 69 carried in the latter and in contact with heel 71 and an operating-lever whereby the shifter may be adjusted to bring pin 69 within the path of either cam 55 or 78 or without reach of either.

13. In a gas-motor the combination of a cylinder 15, a piston, connecting-rod, crank and crank-shaft to transfer the power, air and gas inlets to the cylinder and an admission-valve

controlling these inlets, a charge-receiving pocket 36 open to the cylinder and connected to it by ports, an ignition-chamber 44, also connecting with the cylinder by a port 43, an ignition-pocket 39 in the piston and ports 41 and 42 opening outwardly therefrom, all ports so located that the ports in the piston pass over the ports in the cylinder and permit temporary communication through them during the time the piston passes over them, a lighter-chamber 45 connecting with ignition-chamber 44, a lighter-valve 46 controlling this connection, an angle-lever 65 connected to valve 46, an exhaust-opening and exhaust-valve 53 therefor, a spring to keep it normally closed, an outwardly-extending stem 72 on valve 53, a heel 71 on it, a rotary cam-shaft 56, a cam 54 thereon revolving in the path of one end of angle-lever 65 to operate the lighter-valve, a cam 55 thereon to operate the exhaust-valve, a cam 78 for purposes of controlling speed also mounted on shaft 56, a rod 58, a shifter 73 mounted on it, a pin 69 carried in the latter and in contact with heel 71 and an operating-lever whereby the shifter may be adjusted to bring pin 69 within the path of either cam 55 or 78 or without reach of either.

14. In combination with the constituent parts of a gas-motor, having valve-controlled gas and air inlets, an ignition mechanism and an exhaust-valve, a cam 55 adapted to operate the latter, mounted on shaft 56 and receiving a positive rotatory motion from the motor, being also capable of an independent lateral motion of fixed limit on said shaft which brings it to a position in which it is incapable of acting on the exhaust-valve, a spring-controlled shifter 79 supported adjacent to cam 55 and connected therewith in a manner to enable it to determine the position of said cam on shaft 56 without interfering however with the rotation thereof, a cam 84 on shaft 56 receiving also a positive rotatory motion from the latter and having a lateral action upon shifter 79 in a manner to move by it cam 55 to a position in which the latter is incapable of acting upon the exhaust-valve, releasing also said shifter and with it cam 55 at the limit of their lateral motion and subjecting then these parts to the action of the spring which controls shifter 79 and whereby they are returned to a position in which cam 55 is again capable of acting upon the exhaust-valve, the number of such actions of shifter 79 being dependent on the speed of shaft 56 and the motor.

15. In combination with the constituent parts of a gas-motor, having a cylinder with a reciprocating piston and valve-controlled gas and air inlets and exhaust-outlet, an ignition mechanism, an ignition-pocket in the main piston, ports whereby the latter communicates in certain positions with the ignition mechanism and means to operate the latter and the valves.

16. In combination with the constituent parts of a gas-motor, having a cylinder with

valve-controlled gas and air inlets and exhaust-outlet, a valve-controlled ignition mechanism, cams to operate the latter and the exhaust-valve, a rotating cam-shaft 56 on which the cams are mounted, a bracket 57 which supports shaft 56, a lug 59 depending from the cylinder, a rod 58 passing through it and the bracket for connecting the latter, the connection being such as to bring shaft 56 below the cylinder.

17. In combination with the constituent parts of a gas-motor, having a cylinder with valve-controlled gas and air inlets, an ignition mechanism, an exhaust-outlet, a valve controlling it, a laterally-movable, rotating cam 55 to operate it, a shifter 73 carrying a pin 69 through which cam 55 acts upon the exhaust-valve, a lever whereby shifter 73 may be adjusted to bring pin 69 either within or outside of operative connection with cam 55, a rod 58 upon which shifter 73 is mounted and a lug 59 to which rod 58 connects.

18. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, said bearing being supported on the frame between the two wheels of the bicycle, a gas-motor consisting of a cylinder piston, connecting-rod, crank and crank-shaft 62 and other necessary parts, of a frame connected to the cylinder and fitted from the under side against bearing 87 and rearwardly-extending parts 88 of the bicycle-frame, caps 90 and 91 fitted over these parts from above and adapted to be connected to the parts below to complete the attachment of the motor to the bicycle between the wheels thereof and a gear-train connecting shafts 62 and 98.

19. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, said bearing being located on the bicycle-frame between the wheels of the bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank and crank-shaft 62 and other necessary parts, of a frame connected to the cylinder and adapted for attachment to bearing 87, hangers 95 depending therefrom and forming supports for shaft 62 below shaft 98 and between the bicycle-wheels and a gear-train connecting shafts 62 and 98.

20. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank, crank-shaft 62 and other necessary parts, of a frame connected to the cylinder and adapted for attachment to bearing 87, hangers 95 depending therefrom and forming supports for shaft 62, brace-rods 100 connecting them with the cylinder and a gear-train connecting shafts 62 and 98.

21. In combination with the drive-shaft 98, its bearing 87 and supporting-frame 94, 101, 102, 106 of a bicycle, a gas-motor consisting of a cylinder, piston connecting-rod, crank and crank-shaft 62 and other necessary parts, of a frame connected to the cylinder and adapted for attachment to bearing 87, a tie-

rod 92 connecting the front end of the cylinder to part 94 of the frame and a gear-train connecting shafts 62 and 98.

22. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank, crank-shaft 62 and other necessary parts, of a frame connected to the cylinder and adapted for attachment to bearing 87, hangers 95 depending therefrom and forming supports for shaft 62, such hangers depending to a depth which brings the center of the crank-shaft below the center of the cylinder for the purpose described and a gear-train connecting shafts 62 and 98.

23. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank, crank-shaft 62 and other necessary parts, of a frame connecting to the cylinder and adapted for attachment to the bicycle, receiving-sockets on frame part 94 thereof and pins 109 projecting on each side therefrom adapted to receive foot-supports.

24. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston connecting-rod, crank, crank-shaft 62, valves and other necessary parts, operating-cams and a shaft 56 on which they are mounted, a frame for connecting the motor to the cylinder, supports for shafts 56 and 62, a pinion 96 on the latter, a gear-wheel 97 on shaft 98 driven by pinion 96 and a gear-wheel 61 on shaft 56 receiving motion from gear-wheel 97 for the purpose of operating the cam-shaft 56.

25. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank, crank-shaft 62 and other necessary parts, of a frame connecting to the cylinder and adapted for attachment to a bicycle, a gear-train for connecting shafts 62 and 98 and an operating-lever 76 for the purpose of controlling the operation of the

motor, such lever being in two parts hinged together and whereof one part may be turned down and out to be used as a supporting-brace to sustain the bicycle in an upright position.

26. In combination with the drive-shaft 98, its bearing 87 and supporting-frame of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank and crank-shaft 62 and other necessary parts, of a frame connecting to the cylinder and adapted for attachment to a bicycle, a gear-train for connecting shafts 62 and 98 and a nipple 110 open to the cylinder and intended for purposes described.

27. In combination with the drive-shaft 98, its bearing 87 and supporting-frame 88, 94, 101, 102 and 106 of a bicycle, a gas-motor consisting of a cylinder, piston, connecting-rod, crank, crank-shaft 62 and other necessary parts, of a frame connecting to the cylinder and adapted for attachment to a bicycle, a gear-train for connecting shafts 62 and 98, a cooling-jacket surrounding the cylinder and pipes 107 and 108 connecting it with parts 88 and 106 of the bicycle-frame, which latter parts are adapted to carry water and form with said pipe a circulating system.

28. In combination with the drive-shaft 98, its bearing 87 and supporting-frame 88, 94, 101, 102, 106 of a bicycle, a gas-motor adapted to use vaporized gas consisting of a cylinder, piston, connecting-rod, crank and crank-shaft 62, all carried by the bicycle-frame, of which latter parts are adapted to contain the gas-producing liquid or oil, an inlet-port for the latter to the cylinder, a supply-pipe 24 connecting this port with the oil-carrying parts of the bicycle-frame, a valve controlling the oil-admission to the cylinder and mechanism to operate this valve.

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

EDWARD W. BLUM.

Witnesses:

C. SPENGLER,
ARTHUR KLINE.