Aug. 20, 1935. H. A. GEHRES ET AL 2,012,229

INTERNAL COMBUSTION ENGINE

Filed March 10, 1931 2 Sheets-Sheet 1

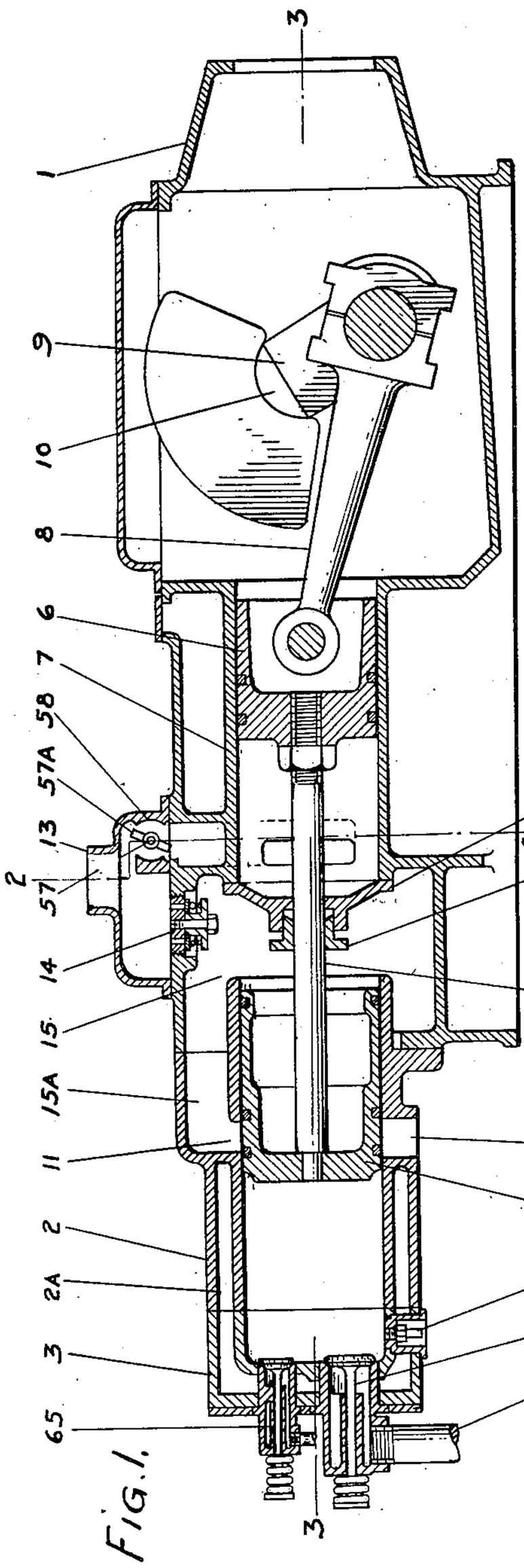

FIG. 1.

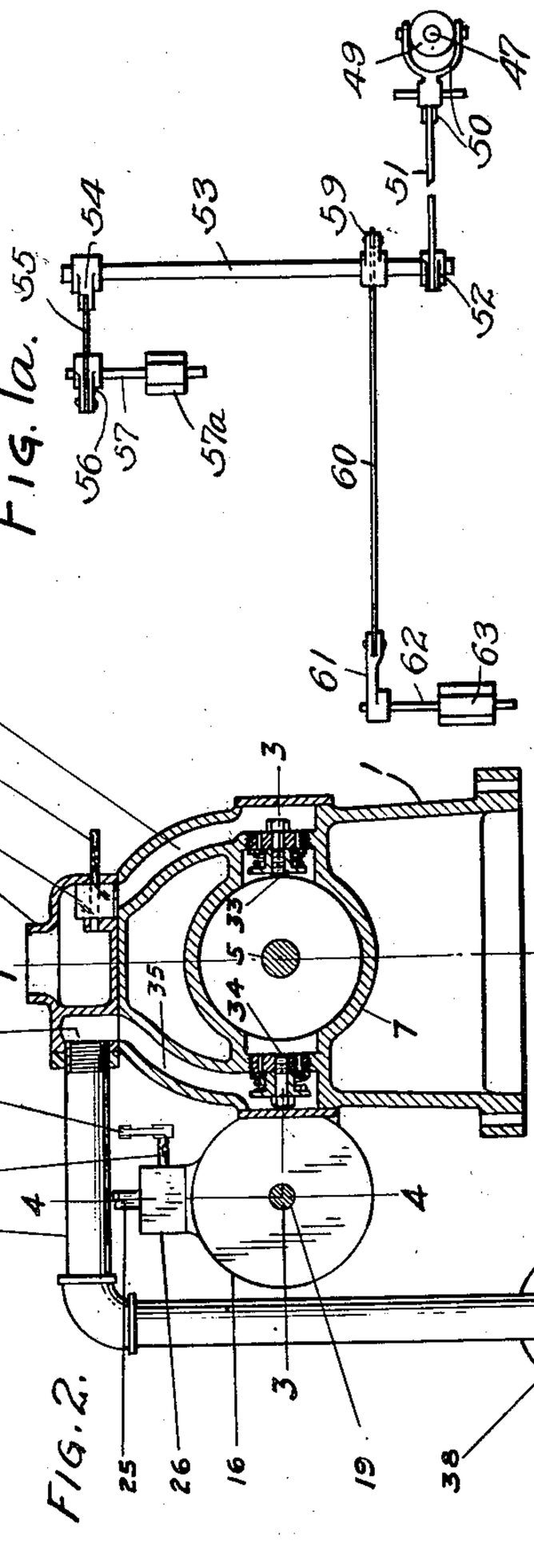

FIG. 1a.

FIG. 2.

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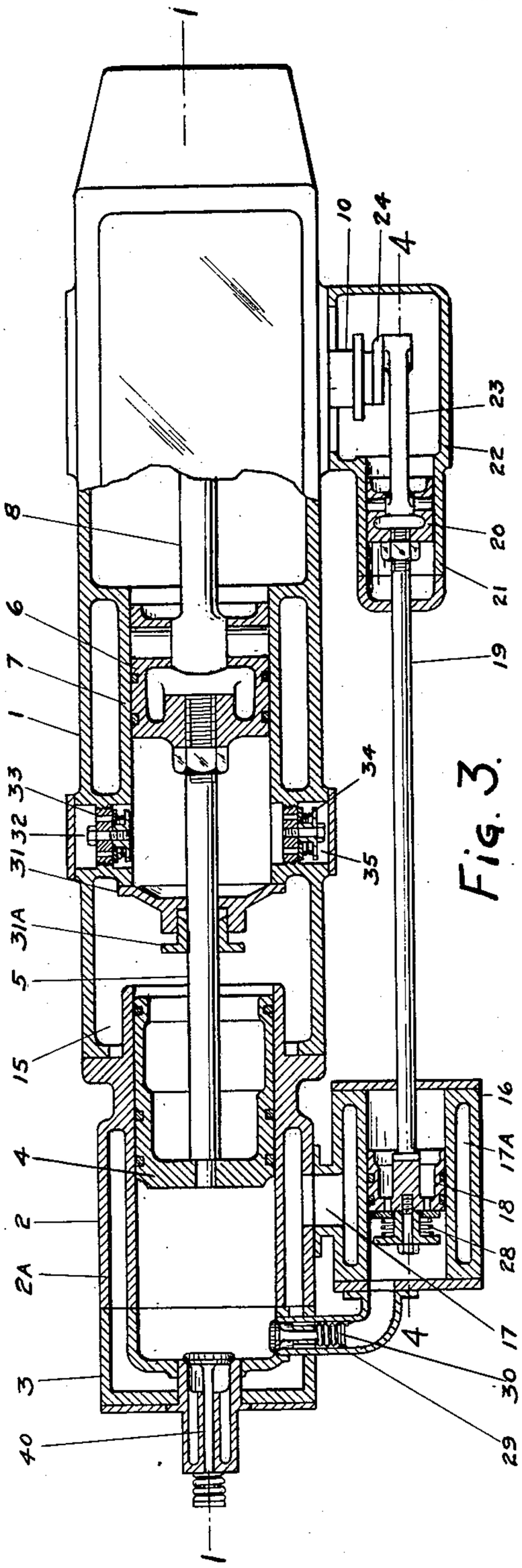

Fig. 3.

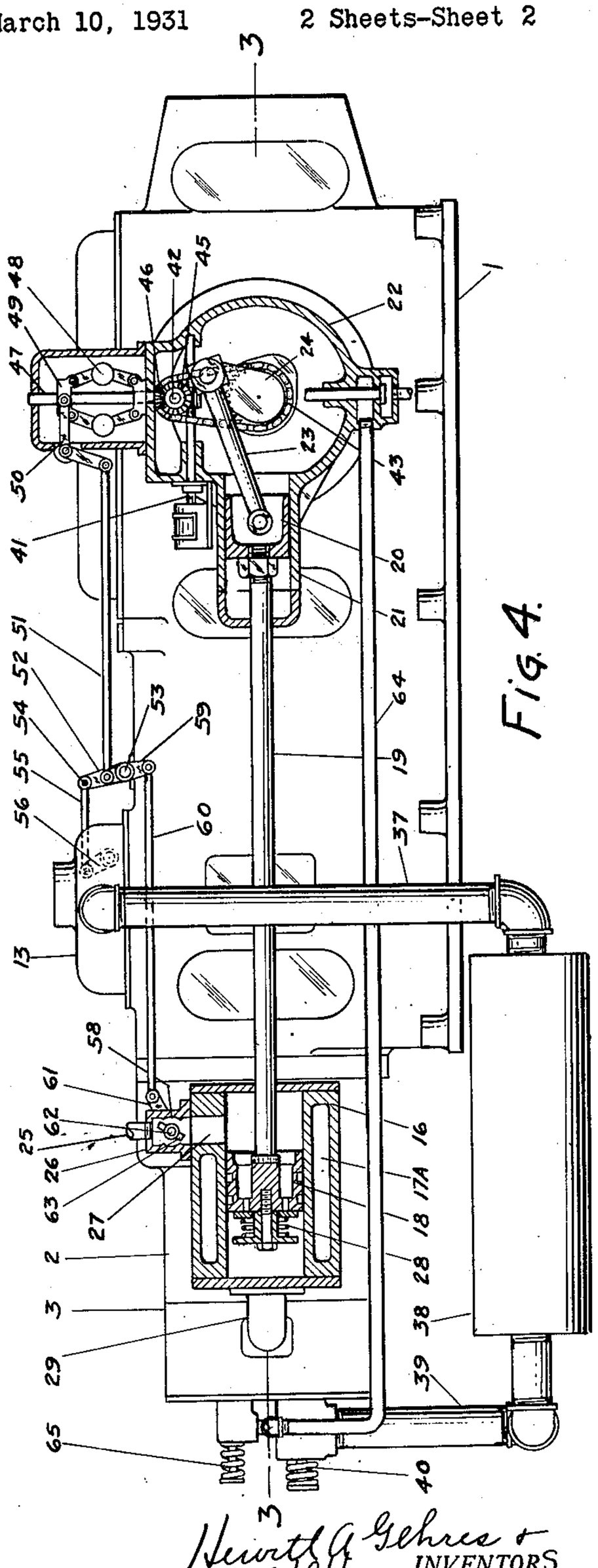

Fig. 4.

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2,012,229

INTERNAL COMBUSTION ENGINE

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Application March 10, 1931, Serial No. 521,460

32 Claims. (Cl. 123—69)

The present invention is designed to increase the efficiency and power of an internal combustion engine. As exemplified it is applied to a two cycle engine having the usual piston-controlled inlet and exhaust ports and a separate gas supply inlet. To this usual construction the present invention contemplates supplying additional sur-charging air after the closing of the piston-controlled inlet and exhaust ports so that the final explosive mixture may be increased and the power and efficiency of the engine correspondingly increased. Under some conditions the introduction of this auxiliary, or sur-charging air may be utilized in assisting in scavenging the cylinder prior to the closure of the exhaust port and also in bringing about a more thorough mixture of the fuel and air in the cylinder prior to the ignition. The present invention also contemplates a simple and convenient method of control of the power of the engine and in accomplishing this a control of the auxiliary, or sur-charging air, in connection with the fuel, may be conveniently utilized for controlling the explosive mixture. The invention also contemplates a simple and convenient means of compressing and delivering the main and auxiliary air supplies to the cylinder and also the fuel thereto. Further features and details of the invention will appear from the specification and claims.

A preferred embodiment of the invention is illustrated in the accompanying drawings as follows:—

Fig. 1 shows a central vertical section of the engine on the line 1—1 in Figs. 2 and 3.

Fig. 1*a* shows a plan view of the control linkage.

Fig. 2 shows a section on the line 2—2 in Fig. 1.

Fig. 3 shows a horizontal section on the line 3—3 in Figs. 1, 2 and 4.

Fig. 4 shows a side elevation, partly in section, on the line 4—4 in Figs. 2 and 3.

1 marks the engine frame. A power cylinder 2 is mounted on this frame. It is provided with the usual water-cooled jacket 2*a* and cylinder head 3. A power piston 4 operates in this cylinder and is connected by a piston rod 5 with a cross head 6, the cross head being of piston form and operating in a guide cylinder 7. A pitman rod 8 extends from the cross head to a crank 9, the crank operating a crank shaft 10 mounted in the usual bearings in the frame. The power cylinder is provided with an air inlet port 11 and exhaust port 12. These are piston-controlled in the common manner of two cycle engines, the air port closing in advance of the exhaust port. Air is delivered through an air inlet housing 13 and passes through an air inlet check valve 14 to a chamber 15. Air is drawn into the chamber 15 on the compression stroke of the power piston and compressed during the power stroke of the piston and transferred from the chamber 15 through a bypass 15*a* to the inlet port 11, scavenging the power cylinder of burnt gases and discharging them through the exhaust port and filling the power cylinder with air for combustion.

A gas delivering pump cylinder 16 is secured on the side of the power cylinder and a passage 17 connects the water jacket of the power cylinder with a water jacket 17*a* on the gas pump. The plunger 18 of the gas pump has an operating rod 19 extending to a cross head 20. The cross head operates in a guide 21 mounted in an auxiliary frame 22 secured on the side of the main frame. A pitman 23 connects the cross head with a crank 24, said crank being on the end of the crank shaft 10. Gas is supplied through a pipe 25 and passes a control valve 26 to the pump cylinder. The piston is provided with a spring-controlled inlet valve 28 through which the gas passes on the outward stroke of the piston and which closes on the compression stroke of the piston, or plunger 18. The gas is delivered from the gas pump by way of a pipe 29 and through a spring-loaded gas inlet valve 30 to the power cylinder. The crank 24 is so positioned relatively to the main crank of the engine as to time the lifting of the spring-loaded valve and the introduction of gas in such a manner as to prevent the loss of gas through the exhaust port but to accomplish the introduction early in the compression stroke of the power cylinder. Preferably this introduction starts prior to the closing of the exhaust port while there is still movement of air in the power cylinder in that such an introduction accomplishes a more thorough mixture of the air and gas.

The guide cylinder 7 is provided with a head 31 and with a stuffing box 31*a* through which the piston rod 5 operates. Thus the cross head and guide of the engine are utilized in forming an auxiliary compressor. Air is delivered to the guide cylinder 7 by way of a passage 32 and inlet valve 33. Air is discharged from the cylinder past the discharge valve 34, passage 35, connection 36 to the pipe 37. The pipe 37 leads to a receiver 38 and a pipe 39 leads from the receiver past the spring-loaded non-return valve 40 to the power cylinder. This auxiliary, or sur-charging air is preferably delivered at the head end of the

cylinder in that this part of the cylinder is apt to be over-rich in fuel and consequently there is accomplished a more thorough mixture of the air and gas in the cylinder. The valve **40** opens directly following the opening of the exhaust port and the introduction of this air assists in scavenging the cylinder, particularly that part of the cylinder in which the burnt gases are apt to be pocketed. After the closing of the exhaust port air is continued to be delivered by way of the valve **40**, thus sur-charging the power cylinder with air and permitting the use of a greater charge of fuel.

A magneto **41** is actuated from a governor shaft **42** which is driven by a chain **43** from the crank shaft **10**. The magneto is connected (connection not shown) with a spark plug **44** timing a spark for ignition at the proper moment.

The governor is driven from a beveled gear **45** on the shaft **42** and this meshes with a beveled pinion **46** on a governor spindle **47**. The governor is the ordinary centrifugal governor type having the centrifugal elements **48** operating on a head **49**. The movement of the head is communicated through a bell crank lever **50** and link **51** to a rock lever **52**. The rock lever is mounted on a shaft **53** carried by the frame of the engine. A second rock lever **54** is also fixed on the shaft **53** and is connected by a link **55** with a rock arm **56**. The rock arm **56** is fixed on a spindle **57** of a butterfly valve **57***a*, the butterfly valve working between shoulders **58** having cylindrically formed surfaces therein operating in relation to the closing edges of the valve. A third rock arm **59** is fixed on the shaft **53** and this is connected by a link **60** with a rock arm **61**. This rock arm is fixed on a spindle **62** carrying the butterfly valve **63** of the fuel control valve **26**.

The control of the engine, therefore, involves a control of the sur-charging air and fuel and these are controlled with relation to each other and through this a mixture may be maintained which is economical at small loads, thus giving a wide range of power for the engine. By making the surface **58** of considerable length the introduction of sur-charging air may be retarded and the control during the very light loads be accomplished through a regulation of the fuel gas alone, the sur-charging air being admitted and gradually increased to take care of the heavier loads.

With this construction it is possible to increase to a very great extent the power output of the engine, thus decreasing the initial cost for a given power output. It also increases the efficiency, flexibility and available power range.

We have herein described a preferred embodiment of the invention, but it will be understood that variations of the engine as exemplified may be made without departing from the invention and this is particularly so with relation to the sur-charging of the power cylinder after the closing of the discharge opening, or the exhaust port of the cylinder.

What we claim as new is:—

1. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; means delivering air to the cylinder during the period the discharge is open for scavenging the cylinder and supplying the cylinder with combustion air; and a mechanism separate from the means delivering air for sur-charging the cylinder after the closure of the discharge.

2. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; and auxiliary means operating separately from the mechanism and delivering sur-charging air to the cylinder during the compression stroke of the piston.

3. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; and auxiliary means operating separately from the mechanism delivering air during the period the discharge is open and sur-charging the cylinder with air during the compression stroke, said mechanism and means operating in step with the piston.

4. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; and auxiliary means operating separately from the mechanism admitting sur-charging air to the cylinder during the compression stroke of the piston, said mechanism and means operating in step with the piston.

5. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; and auxiliary means admitting sur-charging air independently of the fuel to the cylinder during the compression stroke of the piston, the admission of the sur-charging air being adjacent to the point of admission of the fuel, said mechanism and means operating in step with the piston.

6. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; and auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston, the admission of the sur-charging air being adjacent to the point of admission of the fuel, said mechanism and means operating in step with the piston.

7. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder; means delivering air to the cylinder during the period the exhaust port is open for scavenging the cylinder and supplying the cylinder with combustion air; and mechanism operating independently of the means delivering air for sur-charging the cylinder after the closure of the exhaust port.

8. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder; mechanism delivering air to the inlet port; and means operating independently of the mechanism delivering sur-charging air to the cylinder during the compression stroke.

9. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling

said ports; means delivering gaseous fuel to the cylinder; mechanism delivering air to the inlet port; and means operating separately from the mechanism and delivering sur-charging air independently of the fuel to the cylinder after the closure of the exhaust port.

10. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; and means delivering air to the cylinder during the period the discharge is open for scavenging the cylinder and supplying the cylinder with combustion air, said means delivering sur-charging air to the cylinder after the discharge is closed, said gaseous fuel delivering devices comprising a gas pump timed to deliver gas through its compression with relation to the closure of the exhaust to prevent loss of said gas during the discharge.

11. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; and auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston, the gaseous fuel delivering devices comprising a gas pump timed to deliver gas through its compression with relation to the closure of the discharge to prevent loss of said gas through the discharge.

12. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; and auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston, the gaseous fuel delivering devices comprising a gas pump timed to deliver gas through its compression with relation to the closure of the discharge to prevent loss of said gas through the discharge.

13. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the power cylinder comprising a pump timing the delivery of fuel through the compression of the pump; and means delivering air to the cylinder during the period the exhaust port is opened for scavenging the cylinder and supplying the cylinder with combustion air, said means delivering sur-charging air to the cylinder during the compression stroke.

14. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the power cylinder comprising a pump timing the delivery of fuel through the compression of the pump; mechanism delivering air to the inlet port; and means delivering sur-charging air to the cylinder during the compression stroke.

15. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder comprising a pump timing the delivery of fuel through the compression of the pump; mechanism delivering air to the inlet port; and means delivering sur-charging air to the cylinder during the compression stroke, said fuel delivery being timed with relation to the closure of the exhaust port to prevent loss of fuel past the exhaust port.

16. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston, the gaseous fuel delivering devices comprising a gas pump timed to deliver gas through its compression with relation to the closure of the discharge to prevent loss of said gas through the discharge; and means varying the pump charges to vary the power of the engine.

17. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder comprising a pump timing the delivery of fuel through the compression of the pump; mechanism delivering air to the inlet port; means delivering sur-charging air to the cylinder during the compression stroke; and means varying the pump charges to vary the power of the engine.

18. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder comprising a pump timing the delivery of fuel through the compression of the pump; mechanism delivering air to the inlet port; means delivering sur-charging air to the cylinder during the compression stroke, said fuel delivery being timed with relation to the closure of the exhaust port to prevent loss of fuel past the exhaust port; and means varying the pump charges to vary the power of the engine.

19. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston; and means varying the sur-charging air.

20. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston; and means varying the sur-charging air.

21. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston; and means varying the sur-charging air.

22. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the

piston; and means varying the fuel delivery and the sur-charging air.

23. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering combustion air to the cylinder; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston; and means varying the fuel delivery and the sur-charging air.

24. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; auxiliary means admitting sur-charging air to the cylinder during the compression stroke; and means varying the fuel delivery and the sur-charging air.

25. In an internal combustion engine, the combination of a cylinder having a discharge for burnt gases; means controlling said discharge; gaseous fuel delivering devices for the cylinder; mechanism delivering scavenging and combustion air to the cylinder before the closure of the discharge; auxiliary means admitting sur-charging air to the cylinder during the compression stroke of the piston, the gaseous fuel delivering devices comprising a gas pump timed to deliver gas through its compression with relation to the closure of the discharge to prevent loss of said gas through the discharge; and means varying the charge delivered by the pump and the sur-charging air.

26. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder controlling said ports; means delivering gaseous fuel to the cylinder comprising a pump timing the delivery of fuel through the compression of the pump; mechanism delivering air to the inlet port; means delivering sur-charging air to the cylinder during the compression stroke, said delivery being timed with relation to the closure of the exhaust port to prevent loss of fuel past the exhaust port; and means varying the charge delivered by the pump and the sur-charging air.

27. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder; a compression chamber bypassing to the inlet port and responding to the action of the power piston; a piston rod connected with the power piston and a cross head piston; a guide cylinder in which the cross head piston operates; a crank; a pitman between the cross head piston and the crank; a closure and compressor valves for the guide cylinder; and a connection from the guide cylinder to the power cylinder conveying air to the power cylinder during the period the exhaust port is open and delivering air after the closing of the exhaust port for supplying the cylinder with sur-charging air.

28. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder; a compression chamber bypassing to the inlet port and responding to the action of the power piston; a piston rod connected with the power piston and a cross head piston; a guide cylinder in which the cross head piston operates; a crank; a pitman between the cross head piston and the crank; a closure and compressor valves for the guide cylinder; and a connection from the guide cylinder to the power cylinder conveying sur-charging air to the power cylinder.

29. In an internal combustion engine, the combination of a cylinder having inlet and exhaust ports; a power piston in the cylinder; a compression chamber bypassing to the inlet port and responding to the action of the power piston; a piston rod connected with the power piston and a cross head piston; a guide cylinder in which the cross head piston operates; a crank; a pitman between the cross head piston and the crank; a closure and compressor valves for the guide cylinder; a connection from the guide cylinder to the power cylinder conveying sur-charging air to the power cylinder; and a receiver in said connection.

30. In an internal combustion engine, the combination of a power cylinder having inlet and exhaust ports; a power piston in the power cylinder; a chamber responsive to the action of the power piston and having a bypass leading to the inlet port; a pump delivering gaseous fuel to the cylinder; a piston rod extending from the power piston; a cross head guide of piston form connected with the rod; a guide cylinder in which the cross head piston operates; a closure and compressor valves for the guide cylinder; a connection between the guide cylinder and the power cylinder supplying sur-charging air to the power cylinder; a control valve controlling the inlet to the pump; and means responsive to the engine speed controlling the control valve.

31. In an internal combustion engine, the combination of a power cylinder having inlet and exhaust ports; a power piston in the power cylinder; a chamber responsive to the action of the power piston bypassing to the inlet port; a pump delivering gaseous fuel to the cylinder; a piston rod extending from the power piston; a cross head of piston form connected with the rod; a guide cylinder in which the cross head piston operates; a closure and compressor valves for the guide cylinder; a connection between the guide cylinder and the power cylinder supplying sur-charging air to the power cylinder; a control valve controlling the inlet to the gas pump and the guide cylinder; and a control means responsive to the engine speed controlling said control valve.

32. In an internal combustion engine, the combination of a power cylinder having inlet and exhaust ports; a power piston in the power cylinder; a chamber responsive to the action of the power piston bypassing to the inlet port; a pump delivering gaseous fuel to the cylinder; a piston rod extending from the power piston; a guide cylinder in which the cross head piston operates; a closure and compressor valves for the guide cylinder; a connection between the guide cylinder and the power cylinder supplying sur-charging air to the power cylinder; control valves controlling the inlets to the gas pump and the guide cylinder; and a control means responding to variations in the speed of the engine controlling said inlet valves.

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