June 5, 1934. G. H. IRWIN 1,961,933

GAS COMBUSTION SYSTEM AND CONTROL

Filed May 20, 1931 3 Sheets-Sheet 1

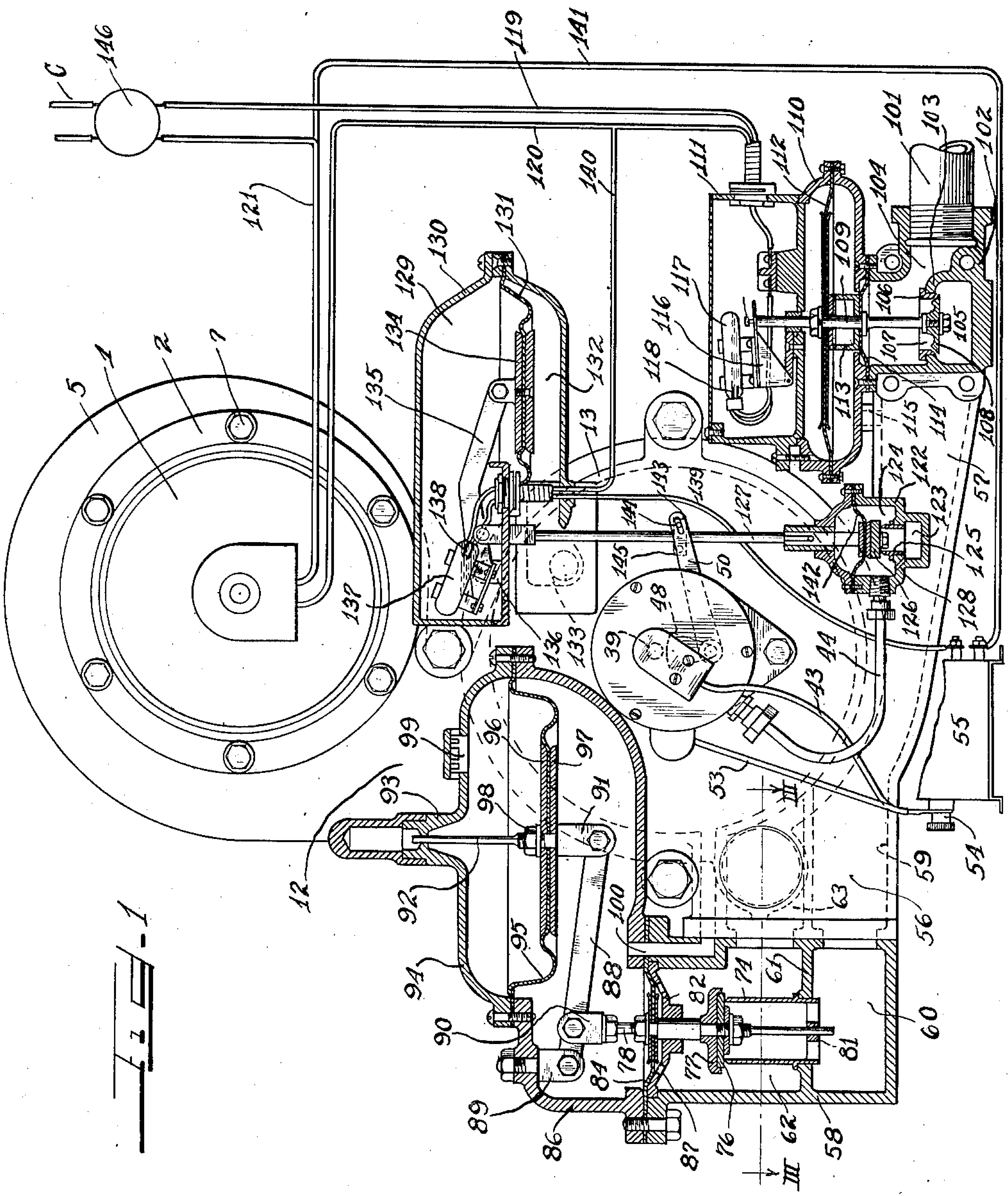

Fig-1

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GAS COMBUSTION SYSTEM AND CONTROL

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Fig. 2

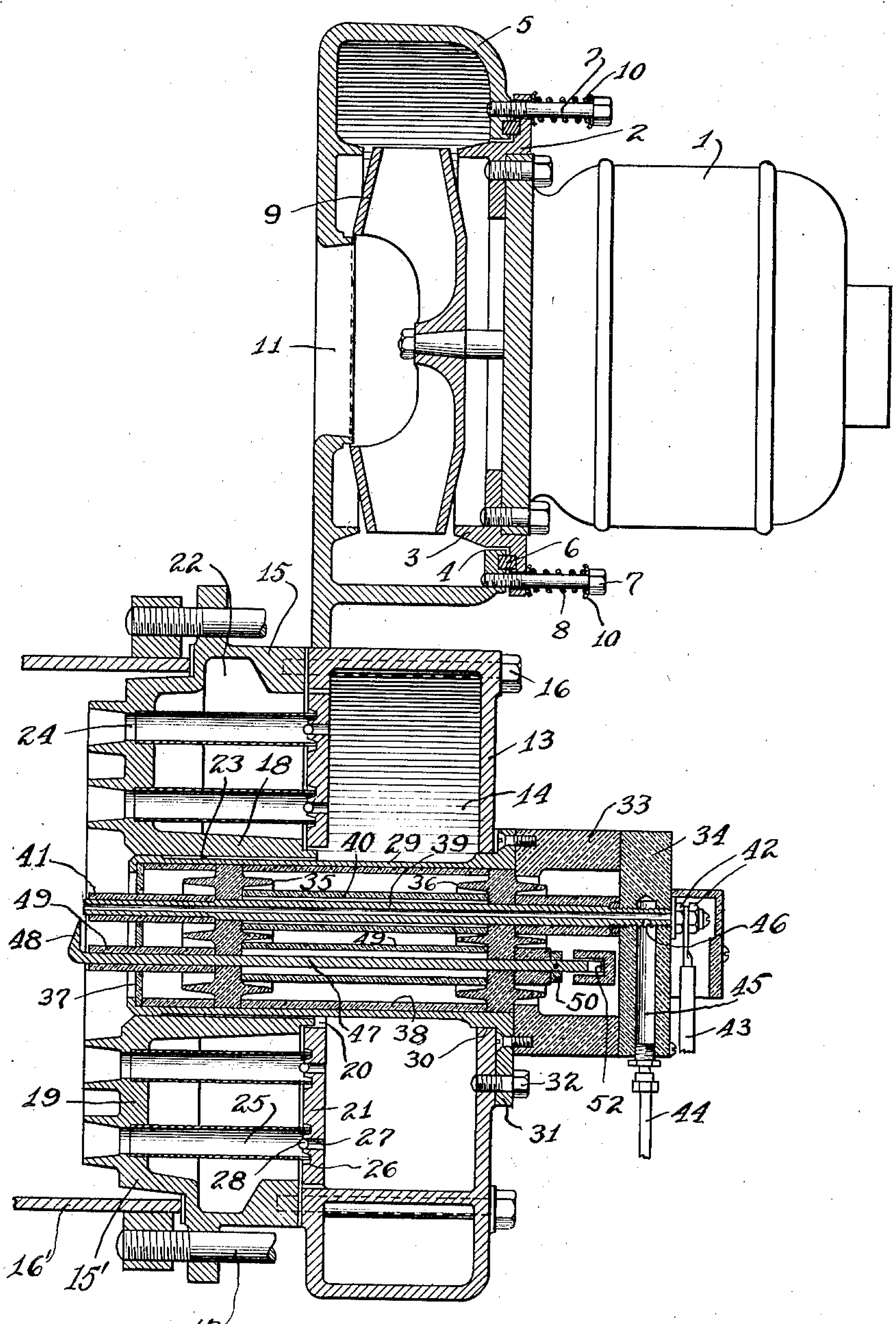

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FIG. 3

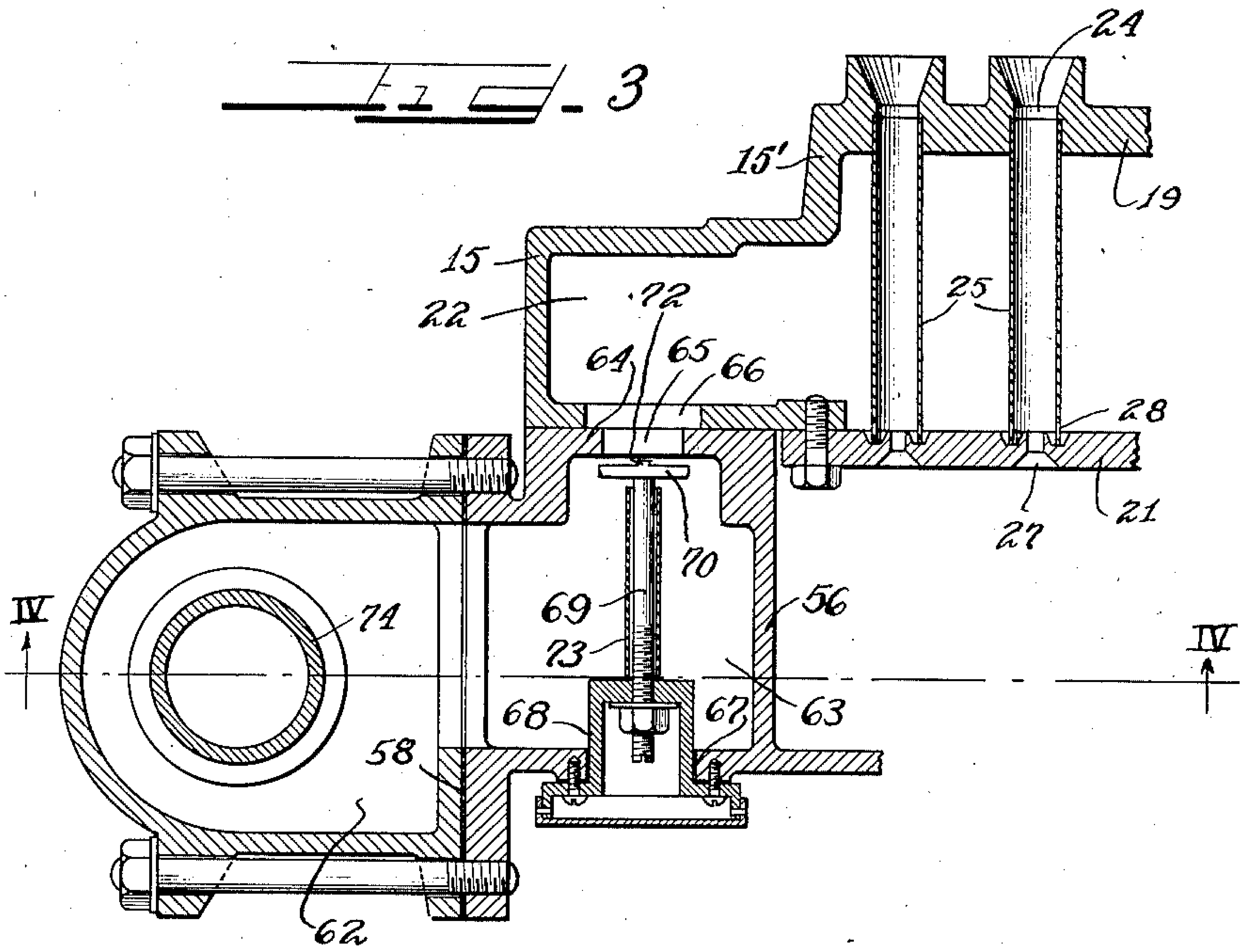
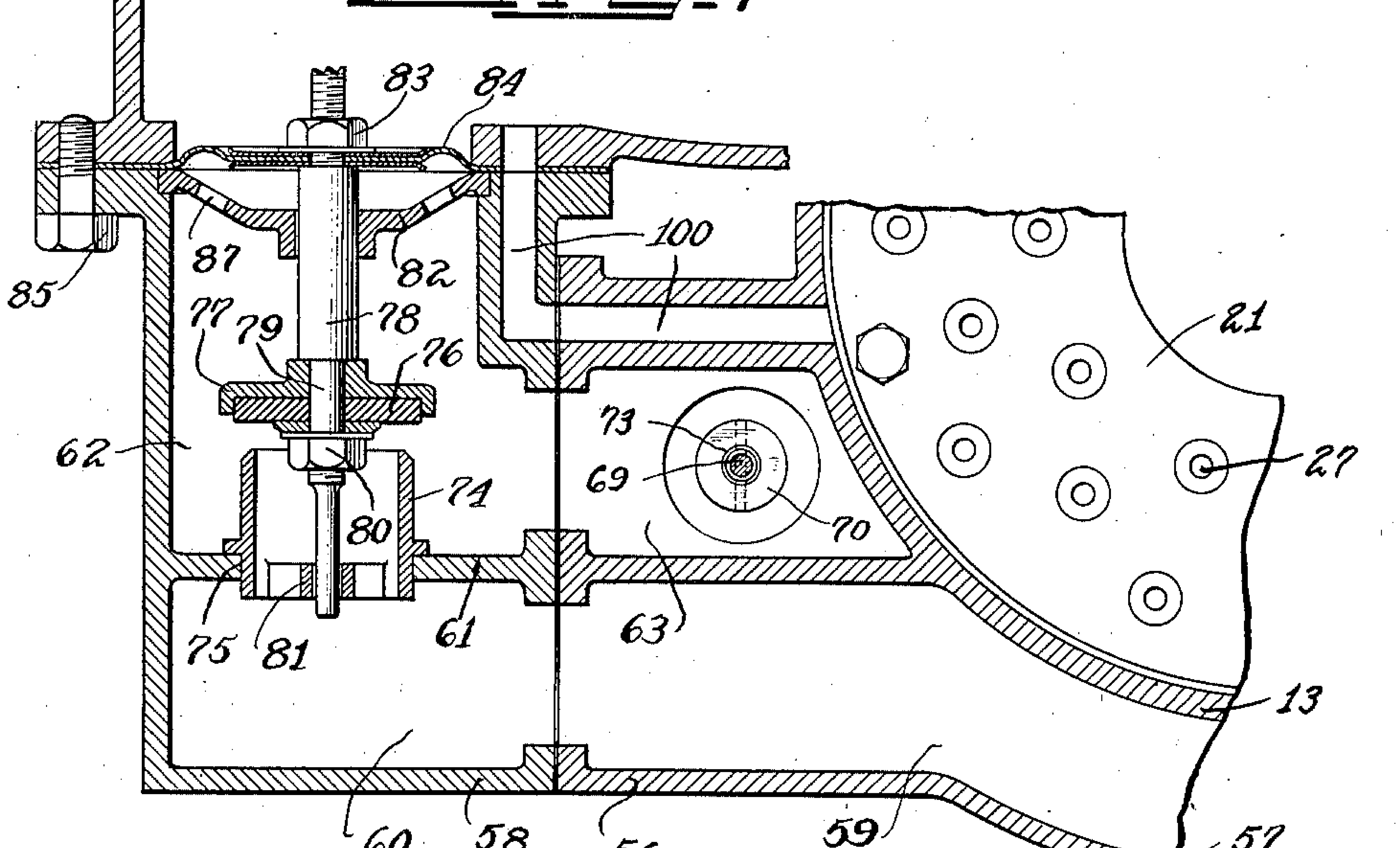


FIG. 4



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UNITED STATES PATENT OFFICE

1,961,933

GAS COMBUSTION SYSTEM AND CONTROL

George H. Irwin, Chicago, Ill.

Application May 20, 1931, Serial No. 538,782

5 Claims. (Cl. 158—99)

My invention relates to gas combustion systems particularly applicable for supplying heat for heat distributing furnaces or for heating or power generating boilers, and improved automatic controlling and regulating means therefor.

The invention concerns particularly the type of combustion system in which gas is entrained into and mixed with air forced under pressure through the burner structure and where a gas pilot flame and electric ignition means are provided for igniting the combustion mixture driven from the burner.

An important object is to provide a combination and arrangement of controlling elements in which the functioning and operation of the gas supply controlling means for the burner and the ignition element is in accordance with and dependent solely upon the volume and pressure of the air delivered to the burner from the fan or blower element, so that, upon failure of adequate air supply to the burner, the gas supply to the burner will be automatically terminated and the ignition element adjusted accordingly for re-ignition upon resumption of adequate air supply and corresponding gas supply to the burner.

A further object is to provide a gas combustion system comprising a blower or fan, a driving motor therefor, a pneumatically operated gas supply valve for the burner, a pneumatically operated pilot flame valve, and a pneumatically operated ignition circuit control, the operation of such elements depending upon the pressure of the air delivered by the blower or fan to the burner.

A further object is to provide a gas pilot flame ignition and also an electrical ignition device for the burner automatically pneumatically controlled by the pressure of the blower air so that upon starting of the system the electrical ignition will be in operation to ignite the pilot flame for ignition by said flame of the burner and disconnection then of the electrical ignition means, and so that, upon failure of the blower and resulting cut off of the gas supply to the burner, the electrical ignition will be reconnected for service to assure reignition of the pilot flame when the blower delivery again becomes normal.

Another object is to provide a control in which, when the system is first started, the pilot burner receives an initial gas supply for a short time, a pneumatically operated switch and a pneumatically operated valve becoming effective after the air pressure comes to normal to increase the gas supply to the pilot burner for an extended flame and to disconnect electrical ignition means which initially function to ignite the pilot burner.

A further object is to provide pneumatically controlled means for automatically establishing the electrical ignition upon failure of gas supply to the pilot burner for a suitable pilot flame.

Another object is to provide controlling means for regulating the pressure of the gas supplied to the burner and functioning also to control the circuit for the fan driving motor in accordance with the gas pressure so that when the gas pressure is adequate the motor will be kept in circuit, but, in the event of low or insufficient gas pressure or of total failure of the gas supply, the motor circuit will be broken.

Still another object is to provide pneumatically operated controlling means involving the use of flexible diaphragms, and with provision for movement of the control parts to a safety position upon rupture or breakage of any of the diaphragms.

A still further object is to provide a compact and efficient arrangement and combination of the various operating and controlling elements.

The above specifically referred to and other features of construction, arrangement and operation are incorporated in the structure shown on the drawings, in which drawings

Figure 1 is a side elevation of the motor fan burner and control assembly with the various controlling elements more or less in vertical section;

Figure 2 is an enlarged vertical section through the blower and burner element;

Figure 3 is an enlarged section on plane III—III of Figure 1; and

Figure 4 is a section on plane IV—IV of Figure 3.

A conventional type of electric motor 1 is shown mounted on an annular base 2 which has a cylindrical flange 3 extending through the opening 4 in one side of the fan housing 5, a resilient gasket 6 being interposed between the base and the blower housing, this gasket preventing direct contact of the base with the fan housing. Screws 7 extend through holes in the base 2 and thread into the adjacent wall of the blower housing and compression springs 8 encircle the screws between their heads and the base and exert yielding pressure against the base to securely clamp the gasket 6 but without permitting contact of the base with the housing wall. The holes in the motor base through which the screws extend are of sufficient diameter to prevent direct contact of the screws with the base so that the only connection between the motor structure and the fan housing is through the gasket 6 and the springs 8 so as to prevent transmission to the fan housing 5 of vibration or vibratory noises from the motor or the fan rotor 9 mounted on the motor shaft. Preferably, cup washers 10 are interposed at the ends of the springs 8 so as to keep the springs centered relative to the screws and preferably out of direct contact therewith.

The fan structure has the axial air inlet 11 and the tangential outlet 12 which has tangential connection with the cylindrical frame 13 of the burner structure, this frame defining the air chamber 14. The gas burner structure and the operation thereof is substantially like that disclosed in my co-pending application, Serial No. 422,745, filed January 23, 1930 which has resulted in Patent No. 1,948,663 issued February 27, 1934. The air chamber frame 13 is secured to and concentric with the annular burner body or frame 15 by means of screws 16, the inner or nozzle end of the body 15' extending into the opening 16' of the furnace or boiler (not shown) to be heated, the burner structure being held in place by suitable bolts 17.

The frame 15 has the cylindrical inner wall 18 extending from its wall 19 and terminating in the opening 20 of the inner wall 21 of the air chamber frame 13. The wall 18 of the burner head is concentric with the outer wall thereof to form the annular gas chamber 22 and the axial passageway 23. The end wall 19 of the burner head has the outlet ports 24 receiving the outer ends of the mixing tubes 25 which at their inner ends engage annular pockets 26 in the wall 21 of the air chamber frame 13, this wall having an air supply orifice 27 for each of the tubes 25, and adjacent the end of each orifice the interior of the corresponding tube communicates with the gas chamber 22 by a port 28. The air delivered to the air chamber 14 under pressure is forced through the orifices 27 and through the mixing tubes 25, the passage of the air streams past the gas orifices 28 causing gas to be inducted into the tubes to mix with the air before delivery into the furnace for combustion.

The ignition apparatus shown has a construction and operation substantially like that fully disclosed in my co-pending application Serial No. 384,442, filed August 8, 1929, which has resulted in Patent No. 1,928,428 issued September 26, 1933. The structure is in the form of a plug having the cylindrical metal body shell 29 which extends through the opening 30 in the outer wall of the air frame 13 and then extends through the axial passageway 23 of the burner head. The shell has the outer flange 31 by which it is fastened by screws 32 to the air frame 13. A head 33 of insulating material is secured to the outer end of the shell 29 and has the closure cap 34.

Within the shell 29 are cross wall structures 35 and 36 of insulating material, the wall 36 being at the outer end of the shell, and a disc 37 closes the inner end of the shell, the shell being lined by insulating bushings 38.

Extending through the head 33 and the shell 29 and supported by the insulating cross walls in the shell is the pilot gas tube 39 which may be surrounded by insulating bushings 40. At its inner end this gas tube projects a distance beyond the end of the disc 37 for presenting a pilot gas flame to the outlets of the mixing tubes 25. To resist the intense heat of the furnace, the insulating sleeve 41 on the inner section of the gas tube may be of heat refractory material, and the disc 37 may also be of such material.

The outer end of the gas pilot tube is threaded and extends through the cap 34 to receive nuts 42 for connecting the electrical conductor 43 with the tube, the tube forming one terminal of the electric ignition means. The gas supply for the pilot tube is received from the pipe 44 communicating with the passageway 45 through the cap 34, which passageway connects with the bore of the tube through a port 46.

Below the pilot tube 39 the electrode rod 47 extends through the walls 35 and 36 and through the end wall 37 and terminates in a segmental deflection or wing 48 whose edge is adjacent to the outlet of the pilot tube to form a spark gap. Insulating bushings 49 surround this rod and at its outer end it projects into the head 33 and is there connected to an arm 50 which extends laterally to the exterior of the head 33 for connection with controlling apparatus which will be described later. The rod is rotatable in its support and a brush 52 serves to connect it with an electric conductor or wire 53. (Figure 1.) The conductor 53 connecting with the electrode rod and the conductor 43 connecting with the pilot tube extend from the terminals 54 of the secondary winding of a transformer 55 as shown in Figure 1. When the ignition circuit is closed, the high voltage current flow between the electrode wing 48 and the end of the pilot tube will ignite the gas issuing from the pilot tube and, as will be described more in detail later, the oscillation of the electrode rod and the wing 48 will serve to loosen and dislodge any soot, dirt, or other foreign matter which may have lodged in the air gap between the wing and the pilot tube.

The lateral extension 56 and a bottom extension 57 on the air chamber frame 13 are preferably cast integral therewith, the extension 56 forming at its outer end a seat to which the frame 58 is secured, this frame housing the valve structure for controlling the flow of gas into the gas burner chamber 22. The extensions 56—57 form a gas manifold having the passageway 59 communicating with the lower part 60 of the valve structure frame 58 below the partition 61 therein. Above this partition the valve chamber 62 communicates with the inlet chamber 63 in the extension 56, the inner wall 64 of the extension having the valve port 65 therethrough communicating by way of a registering opening 66 in the burner head with the gas chamber 22 as clearly shown in Figure 3.

In the front wall of the extension 56 and in axial alignment with the valve port 65 is the opening 67 which is closed by a detachable cup-shaped plug 68 whose inner wall receives the threaded end of the valve stem 69 which terminates in the valve disc 70 for cooperating with the port 65 to control the gas flow into the burner chamber. The valve acts as a baffle to limit the supply of gas to the burner to be in proportion with the volume of air delivered by the blower so as to form an efficient and economical combustion mixture during normal operation of the system. By means of the threaded engagement of the valve stem in the plug 68 the valve may be adjusted relative to the port 65 and a stop extension 72 on the valve abuts against the wall 64 to prevent complete closure of the port and to prevent the gas supply from being too limited and preventing a mixture which would be too lean to ignite or burn in the furnace. An abutment sleeve 73 around the valve stem may be provided for limiting the opening adjustment of the valve.

Describing now the main gas flow controlling valve, a valve seat in the form of a cylindrical tubular frame 74 is mounted on the partition wall 61 to extend through the opening 75 therethrough, the frame at its upper end being beveled to form an edge seat for the valve plate 76 supported by the valve disc 77, the valve plate being of a suitable material which will intimately engage with the edge seat. The valve stem 78 has the reduced end 79 receiving the valve disc and plate which are clamped in position by a nut 80 threading on the valve stem. The valve stem at its lower end extends through and is guided by the cross wall 81 at the lower end of the frame 74. At its upper end the valve stem extends through and is guided by the dished partition 82 seated at the upper end of the housing 58, and above this partition the stems are secured by a nut 83 to a diaphragm 84. Mounted on the housing 58 and detachably secured thereto by means of bolts 85 is the housing body 86 for the pneumatic controlling mechanism for the valve which will be described later. The partition 82 and the diaphragm 84 are secured at their peripheries and clamped between the housings 58 and 86. To relieve the pressure below the diaphragm 84 when the valve moves downwardly, the partition 82 may have one or more relief passageways 87.

Within the control mechanism housing 86 is a lever 88 pivoted at its outer end to a depending bracket 89, the valve stem 78, by means of a clevis 90 at its upper end, being pivoted to the lever adjacent to the lever fulcrum. At its inner end the lever is pivoted to a bracket 91 at the lower end of a guide stem 92 which is guided at its upper end by the guide lug 93 on the cover 94 detachably secured to the body frame 86. Clamped at its periphery between the body 86 and the cover 94 is a flexible diaphragm 95 through whose center the guide stem 92 passes. Upper and lower weights or discs 96 and 97, concentric with the guide stem, are clamped between the bracket 91 and the nut 98 on the stem and in turn clamp the central portion of the diaphragm. The cover 94 is provided with a vent 99 for relieving the space above the diaphragm of pressure.

The space below the diaphragm communicates with the air chamber 14 of the burner structure through a passageway 100 extending through the wall of the housing 58 and the extension 56. When the blower is not in operation the weighted diaphragm exerts pressure on the lever 88 and the lever multiplies the pressure so that the valve plate 76 is held securely against the edge seat of the frame 74, any gas flow from the manifold 59 to the burner being then shut off. Any air in the chamber below the diaphragm 95 will flow out through the passageway 100 and through the burner. However as soon as the blower is started air will flow from the burner air chamber 14 through the passageway 100 into the space below the diaphragm 95 and as the air pressure overcomes the weight of the diaphragm and the parts connected therewith, the diaphragm will be elevated and through the lever connection the valve will be raised from the seat frame 74 for the admission of gas into chamber 62 and from there into the chamber 63 and through valve port 65 into the burner gas chamber where it is inducted into the mixing tubes by the air streams therethrough and mixed with the air for delivery into the furnace. The properly adjusted baffle valve 70 regulates the gas supply and stabilizes the gas flow into the furnace.

When the fan is stopped, the pressure below the diaphragm 95 is relieved through the passageway 100 and the diaphragm moves rapidly downwardly on account of the weighted discs thereon and the valve 76 is moved to its closing position. The pivot connections of the lever 88 with the diaphragm and valve stem are preferably sufficiently loose so that when the diaphragm falls to its lower position it will give a blow to the end of the lever which blow, through the leverage arrangement will rapidly and with considerable pressure force the valve 76 to its seat to fully shut off the gas flow. To assist in such rapid closing, the diaphragm 84 may be of elastic material so that when it moves through its neutral line from the upper position (Figure 4) to its lower position (Figure 1) it will exert more or less of a snap action on the valve stem. Such snap action may precede the final blow of the diphragm 95 against the lever so that such blow will exert the final pressure to insure accurate and secure seating of the valve. The weights on the diaphragm 95 acting through the lever will then hold the valve firmly closed. Such weights will also resist initially opening of the valve until the air from the blower is brought up to the proper pressure and then the diaphragm is gradually raised and the valve opened so that by the time the air pressure becomes normal the valve will be opened for the required supply of gas.

The diaphragm 84 serves also to segregate the air under diaphragm 95 from the gas in chamber 62, and even though this diaphragm should become ruptured no harm can result as the air pressure below the diaphragm 95 is always higher than the gas pressure in chamber 62 and a small amount of air which would escape into the gas would do no harm.

The sharp edge seat on frame 74 for the valve 76 prevents the accumulation of any scales, impurities or foreign matters from lodging on the seat, and the frame 74 is comparatively high so that during passage of gas therethrough scales, impurities or foreign matters may have a chance to drop down and settle in the chamber 60. Any foreign particles which might pass the valve seat would settle at the bottom of the chamber 62 before the gas travels to the furnace.

The gas supply comes from a gas main 101 which connects with the end of the manifold passageway 59 in frame extension 57. A valve frame 102 connects the gas main with the manifold frame 57. A partition 103 separates the inlet chamber 104 from the outlet chamber 105 in the valve frame and an annular valve seat ring 106 mounted on the partition provides the port 107 connecting the chambers and a valve 108 for controlling the port. The valve seats against the lower edge of the seat ring and its stem 109 extends upwardly through a diaphragm frame 110 mounted on the valve frame and through a switch box 111 mounted on the diaphragm frame. The diaphragm frame supports the diaphragm 112, the stem extending centrally through the diaphragm and supporting a weight 113 below the diaphragm. A flexible partition 114 is interposed between the valve frame 102 and the diaphragm frame 110 so as to separate the inlet gas chamber 104 from the chamber below the diaphragm 112, which chamber connects with the manifold passageway 59 through a port

115 so that when gas flows from the inlet pipe 101 past the valve 108 and into the manifold passage 59 the diaphragm 112 will be subjected to the pressure in the manifold.

In the switch box 111 is a rocker frame 116 connected with the upper end of the valve stem 109 and carrying a mercury switch bulb 117 whose switch terminals 118 are connected with conductors 119 and 120, the conductor 119 extending from a suitable current supply source (not shown) and the conductor 120 connected with one terminal of the fan driving motor whose other terminal is connected by conductor 121 with the current supply source so that as the mercury switch is tilted the motor circuit will be either opened or closed.

The weight on the diaphragm 112 and the gas pressure against the underside of the diaphragm cooperate to position the valve 108 for the flow of gas into the manifold 59 for the required gas pressure therein. Should the pressure of the gas delivered from the main be insufficient for adequate gas supply in the manifold 59, the weighted diaphragm will immediately lower and tilt the mercury switch to cause opening of the motor circuit and the circuit would not be reestablished until the gas pressure again becomes sufficient for safe operation of the system.

Describing now the ignition control, the pilot flame controlling valve structure 122 has the inlet and outlet chambers 123 and 124 connected by a port tube 125 which affords a seat for the valve 126 whose stem 127 extends upwardly. The inlet chamber 123 of the valve structure communicates with the manifold passage 59 and is connected through a restricted port 128 directly with the outlet chamber 124, which chamber is connected by the pipe 44 with the ignition plug structure, Figure 2, for delivery of gas to the pilot tube 39. When the valve 126 is raised from its seat the supply of gas to the pilot tube will be increased.

At its upper end the valve stem 127 extends into the upper chamber 129 of a diaphragm housing 130, the diaphragm 131 separating this upper chamber from the lower chamber 132, this lower chamber being connected through the passageway 133 with the air chamber 14 of the burner structure.

The diaphragm 131 is weighted by disc 134 and is pivoted to one end of a lever 135 which is fulcrumed at its other end on a bracket 136, the valve stem 127 being pivoted at its upper end to the lever adjacent to its fulcrum axis. When the air pressure under the diaphragm 131 becomes sufficient the diaphragm is raised and the lever 135 swung upwardly, and the valve 126 will be raised from its seat for the increased flow of gas to the pilot tube. When the blower is not operating and the diaphragm 131 is down, the valve 126 is held on its seat and only a limited supply of gas can flow through the restricted port 128 for the pilot tube and the pilot flame is therefore short. When the motor and blower are started and air is driven into the burner structure air chamber 14 the pressure of the air in diaphragm chamber 132 will gradually raise the diaphragm 131 and the pilot valve will open for increased flow of gas and the pilot flame will be extended ready for efficient ignition of the combustion mixture which issues from the burner structure.

The lever 135 carries a mercury switch 137 having contacts 138 which cooperate with the mercury in the switch to control the primary circuit for the transformer 55. As shown in Figure 1 one of the contacts is connected by conductors 139 with one terminal of the transformer primary and the other terminal of the switch is connected by conductor 140 with the conductor 120 of the motor circuit, the other terminal of the transformer primary being connected by a conductor 141 with the conductor 121 of the motor circuit. The transformer primary and the switch 137 are thus serially included in a circuit which is in shunt of the motor 1, with both the motor circuit and the shunt circuit controlled by the mercury switch 117 connected with the pressure regulator valve 108.

When the motor is at rest and the diaphragm 131 down to close the pilot valve 126, the mercury switch 137 is in position to close the transformer primary circuit and the secondary circuit will be effective to cause flow of ignition current between the electrode wing 48 and the end of the pilot tube 39 and both the electrical ignition and the short pilot flame are operated. When the motor is started and the blower builds up the pressure in the burner air chamber and in the chamber below the diaphragm 131, the pilot valve 126 is raised off its seat and the pilot flame extended and when the diaphragm is fully raised the mercury switch 137 will be in position to disconnect the contacts 138 for opening of the transformer primary circuit and cessation of the electrical ignition flow. This is very desirable as the high tension ignition current flow might interfere with the proper operation of radios in the vicinity.

Upon failure of adequate air supply, for any reason, or when the motor is shut off, the diaphragm 131 recloses the pilot valve and the transformer circuit is reclosed to provide electrical ignition for the burner in case the pilot flame should fail, thus eliminating any danger of explosion. A flexible diaphragm 142 may be applied to the pilot valve so as to prevent leakage of gas from the chamber 124 to the atmosphere past the valve stem 127.

Referring to Figure 1, the arm 50 which extends from the electrode rod 47 of the ignition structure, has a slot 143 in its outer end receiving a pin 144 extending from a bracket 145 which is adjustable on the valve stem 127. With this arrangement, whenever the valve stem is shifted by operation of the diaphragm 131, the electrode rod will be rotated and its terminal wing 48 swung relative to the end of the pilot tube so that any soot or other foreign matter which may have collected at the spark jet will be loosened and dislodged, and short circuiting prevented. It will thus be seen that the adjustment of the pilot flame for burner operation, the primary circuit of the electrical ignition transformer, and the oscillation of the electrode to prevent short circuiting, are automatically accomplished pneumatically by the pressure in the burner supply air acting on the diaphragm 151.

The diaphragms for the main gas flow regulating valve 76, the pilot valve 126 and the pressure regulating valve 108 are of flexible material and designed with the idea that should any one of them fail or break, the mechanism controlled thereby would fall on the safe side. For example should the diaphragm 95 for the main gas flow regulating valve 76 rupture or burst, the air pressure would be neutralized on the opposite sides thereof and the diaphragm would drop and close the valve. Should the diaphragm 131 for the pilot valve rupture or burst it would drop and close the pilot valve and close the transformer circuit for the electrical ignition. Should the diaphragm 112 for the gas pressure regulating valve 108 break or rupture it would drop and cause opening of the motor circuit and although the valve 108 would then be opened wide, this would be only momentarily for as soon as the motor stops the air supply would stop and the valve 76 would be closed to shut off gas flow from the burner, and liability of an explosion would be prevented. Failure of the air supply would also then result in closing of the pilot valve and reclosing of the transformer circuit.

Briefly repeating the operation of the system, suppose that gas flow from the main 101 is entirely shut off as by a suitable valve (not shown), and that the manually operable or thermostatically operable main switch 146 between the supply conductor C and the motor circuit, is opened. The valve in the supply main 101 being closed there will be no pressure in the system and the valve 108 will be opened and the circuit will be opened by the mercury switch 117. If it is now desired to start the system, the valve in the main 101 is opened and gas flows through the open port 107 into the manifold passageway 59 and as the gas pressure builds up in the manifold it will be communicated through the port 115 to the chamber below the diaphragm 112 and the valve stem will be raised sufficiently to cause the mercury switch 117 to close the circuit and then if the switch 146 is closed the motor will start to run and drive the blower. As the air pressure builds up in the burner structure the diaphragms 95 and 131 will be raised so that the valve 76 is opened for admission of gas into the burner air stream and the pilot valve 126 is opened for a lengthened pilot flame. As the air flow through the burner draws in the gas from the manifold passageway 59 the pressure below the diaphragm 112 will tend to decrease and the valve 108 will open a little wider for increased flow of gas into the manifold to restore the pressure, such opening movement of the valve 108 being insufficient to effect the mercury switch 117 which will remain in circuit closing position to keep the motor circuit closed, the valve floating adjacent to its seat to control the degree of opening of the port 107 for the flow of gas from the main to the manifold for maintenance of the uniform desired pressure in the manifold.

While the pilot valve 126 is opening for extension of the pilot flame the transformer remains in circuit until the diaphragm 131 has been moved upwardly far enough to cause tilting of the mercury switch 137 to open the transformer circuit and then, during normal operation of the system, the extended pilot flame will keep the burner ignited. Also during movement of the pilot valve the electrode rod 47 is oscillated to clear the spark gap for proper ignition current flow so that ignition of the pilot flame will be assured.

When the switch 146 is opened either manually or thermostatically the motor stops and with it the air pressure and as the pressure is relieved from underneath the diaphragms 95 and 131 the main gas flow controlling valve 76 is closed, the transformer circuit is reclosed, the pilot valve is closed to retract the pilot flame, and the electrode rod 47 is given a slight turn to clear the spark gap, and the system is ready for further operation as soon as the switch 146 is reclosed. While the switch 146 is opened and the valve 76 is closed the gas pressure built up in the manifold 59 and communicated to the diaphragm 112 through the port 115 will tend to raise or hold the diaphragm up with the valve 108 wholly or partly closed but with the mercury switch 117 in circuit closing position so that when the switch 146 is again closed the motor may immediately start operating to drive the blower.

The operation of the main gas flow control valve 76, the operation of the pilot flame, and electrical ignition, are thus automatically pneumatically controlled by the pressure of the air delivered by the fan to the burning structure, and the operation of the gas pressure controlling valve 108 and the safety switch 117 for the motor circuit are automatically controlled by the pressure of the gas delivered from the gas main 101. Should the air flow become inadequate or fail entirely at any time, the pneumatically controlled devices will immediately be moved to safety position, and upon failure of adequate gas pressure in the main, or total failure of gas supply, the safety switch 117 will be moved to open the motor circuit and upon stopping of the motor the fan stops and the pneumatically controlled devices will be shifted to their safety positions.

I have shown a practical and efficient embodiment of the various features of my invention but I do not desire to be limited to the exact details shown as changes and modifications in the construction and arrangement and operation may be made without departing from the scope and principles of the invention as defined by the appended claims.

I claim as my invention:

1. In a gas combustion system, the combination of a burner structure adapted to receive gas and air, an air supply element for delivering air under pressure to the burner structure, a pilot burner for igniting the combustion mixture delivered by said burner structure, electrical ignition means for igniting the gas from said pilot burner, a valve for controlling the supply of gas to said pilot burner, a switch for controlling the circuit for said electrical ignition means, pressure operated means connected with said valve and said switch and controlled by the pressure of the air delivered to said burner structure, said pressure operated means holding said valve and switch closed when said air supply element is not operating and becoming effective upon delivery of air to said burner structure to open said valve for flow of gas to said pilot burner for ignition by said electrical ignition means and for then causing said switch to open said circuit whereby during normal operation of said burner structure the combustion mixture delivered thereby will be ignited by said pilot burner flame, one of the electrodes of said electrical ignition means being movable, and means under control of said pressure operated means for causing said movable electrode to be moved to clean the gap between said electrodes.

2. In a gas combustion system, the combination of a burner, a valve for controlling the supply of gas to said burner, a blower for delivering air to said burner, an electric motor for driving said blower and a circuit therefor, ignition means for the combustion mixture and a circuit therefor, a switch controlled by the pressure of the gas supply to simultaneously open said motor circuit and said ignition circuit when the gas supply is insufficient, and an independent switch for said ignition circuit controlled solely by the pressure of the air delivered to said burner to hold said ignition circuit open when the air pressure is normal.

3. In a gas combustion system, the combination

of a burner, a blower for delivering air to said burner, a valve for controlling the supply of gas to said burner to be mixed with the delivered air to form a combustion mixture, an electric motor for driving said blower and a circuit therefor, ignition means for the combustion mixture and a circuit therefor, means responsive to the pressure of the gas supply to regulate said valve and a switch controlled by said means to simultaneously close said motor circuit and said ignition circuit when the gas pressure is normal, and an independent switch for said ignition circuit controlled solely by the pressure of the air delivered to said burner for opening said circuit when the air pressure is normal.

4. In a gas combustion system, the combination of a burner, a blower for blowing air to said burner, a valve for controlling the supply of gas to be mixed with the air to form a combustion mixture, an electric motor for driving said blower and a circuit therefor, electric ignition terminals for ignition of the combustion mixture and a circuit therefor, a switch controlled by the pressure of the gas supply through said valve to close said motor circuit and said ignition circuit when the gas pressure is normal, an independent switch for said ignition circuit controlled solely by the pressure of the air delivered to said burner to be opened when the air pressure is normal, and means controlled by the opening and closing of said independent switch for causing relative movement of said ignition terminals.

5. In a gas combustion system, the combination of a main burner, a blower for delivering air thereto under pressure, an electric motor for driving said blower, a pressure regulating valve for regulating the pressure of air delivered to said burner, a circuit for said motor and a switch therefor, means controlled by the pressure of the gas delivered to the burner for controlling said valve and for opening said motor circuit in the event of low or insufficient gas pressure or upon total failure of the gas supply, a pilot burner for igniting said main burner, electrical ignition means for said pilot burner and a circuit therefor, means whereby said ignition circuit is primarily under control of said motor circuit switch to be closed when said motor is operating, and an independent switch controlled solely by the pressure of the air delivered to said main burner to be opened when the air pressure is normal.

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