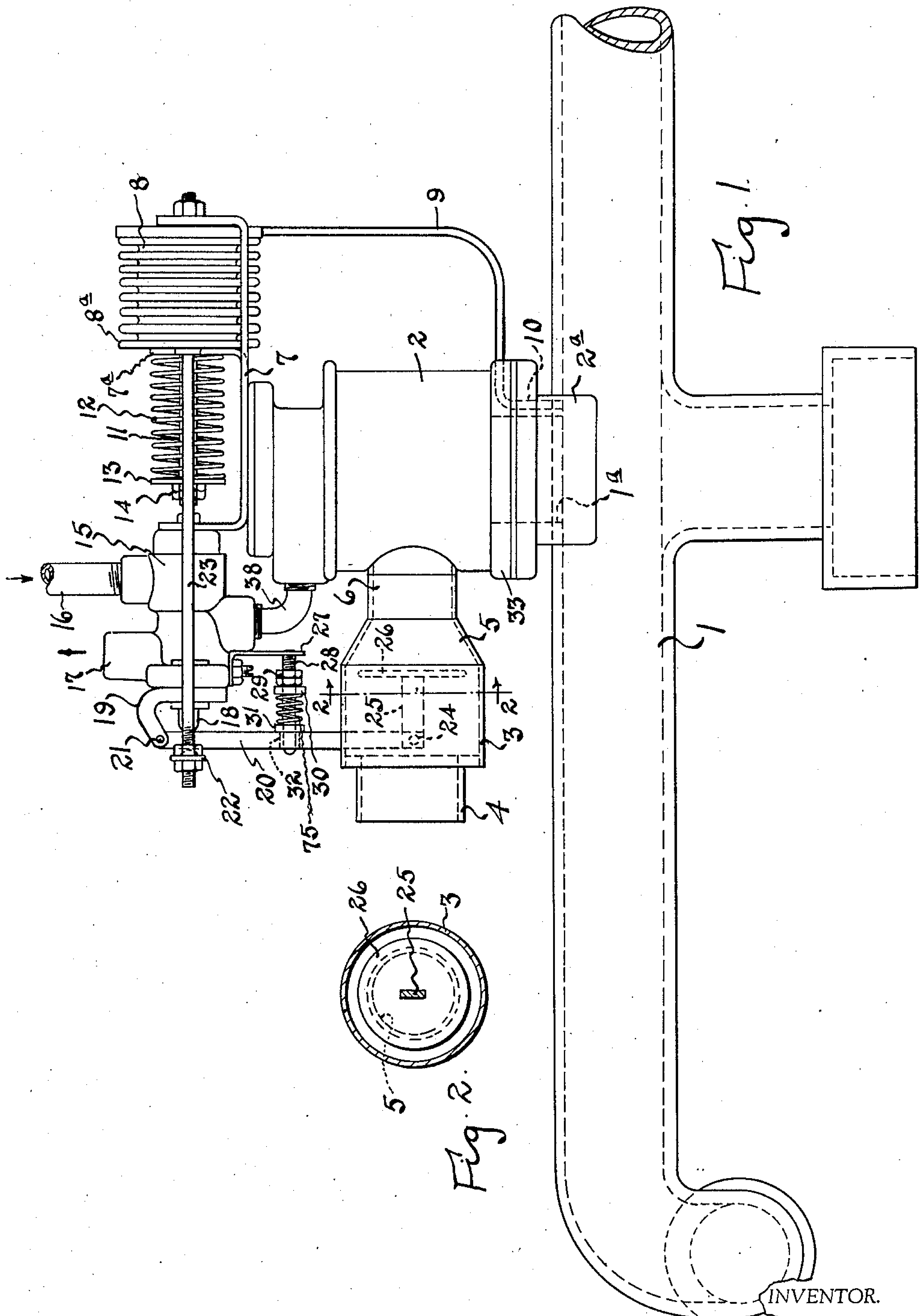
Feb. 28, 1939. E. G. PARVIN 2,148,709

FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 22, 1938 5 Sheets-Sheet 1



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FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 22, 1938 5 Sheets-Sheet 2

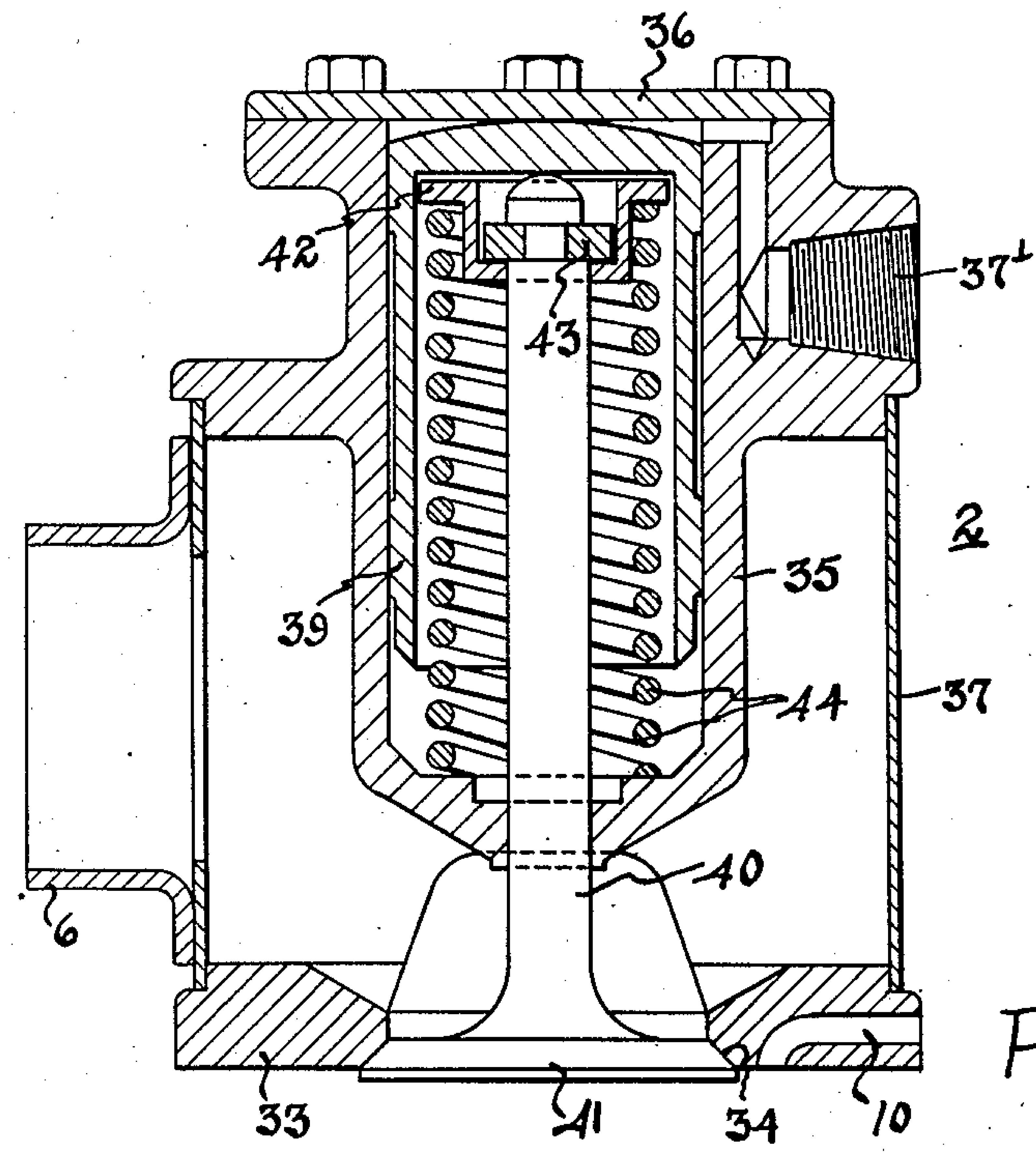

Fig. 3.

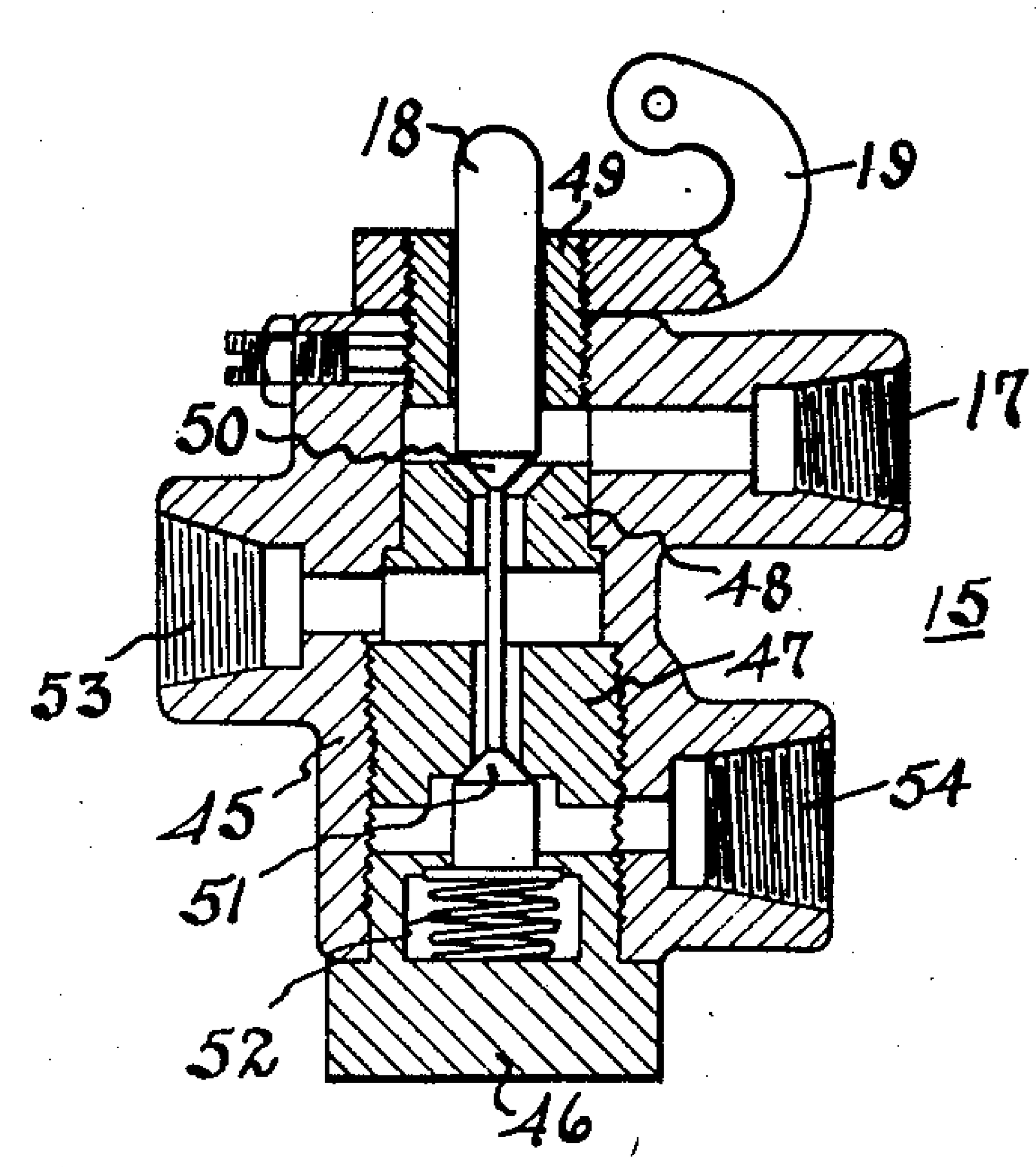

Fig. 4.

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FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

Filed Jan. 22, 1938 5 Sheets-Sheet 3

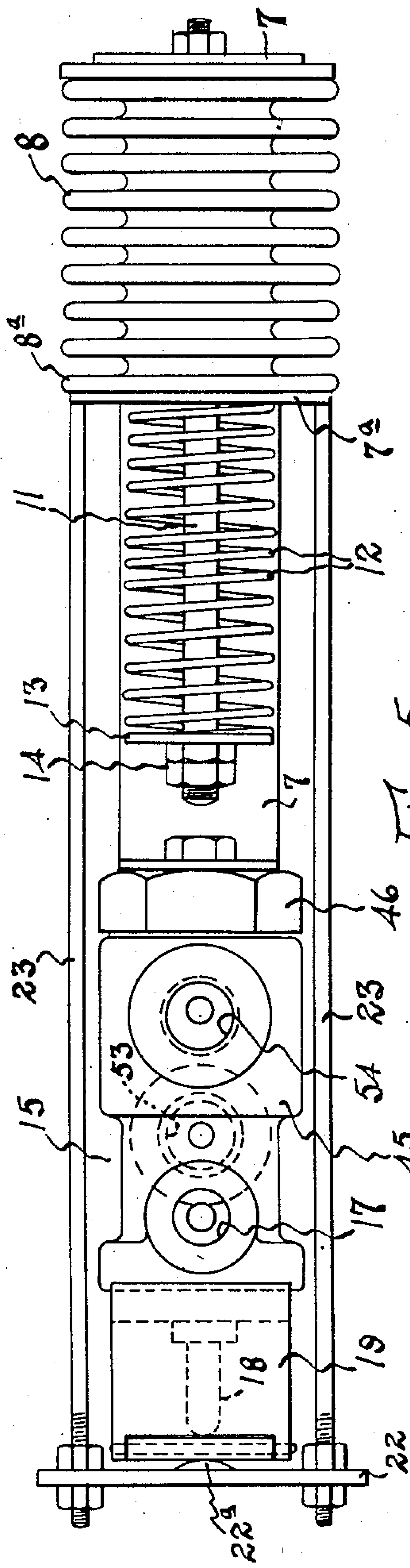

Fig. 5

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FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

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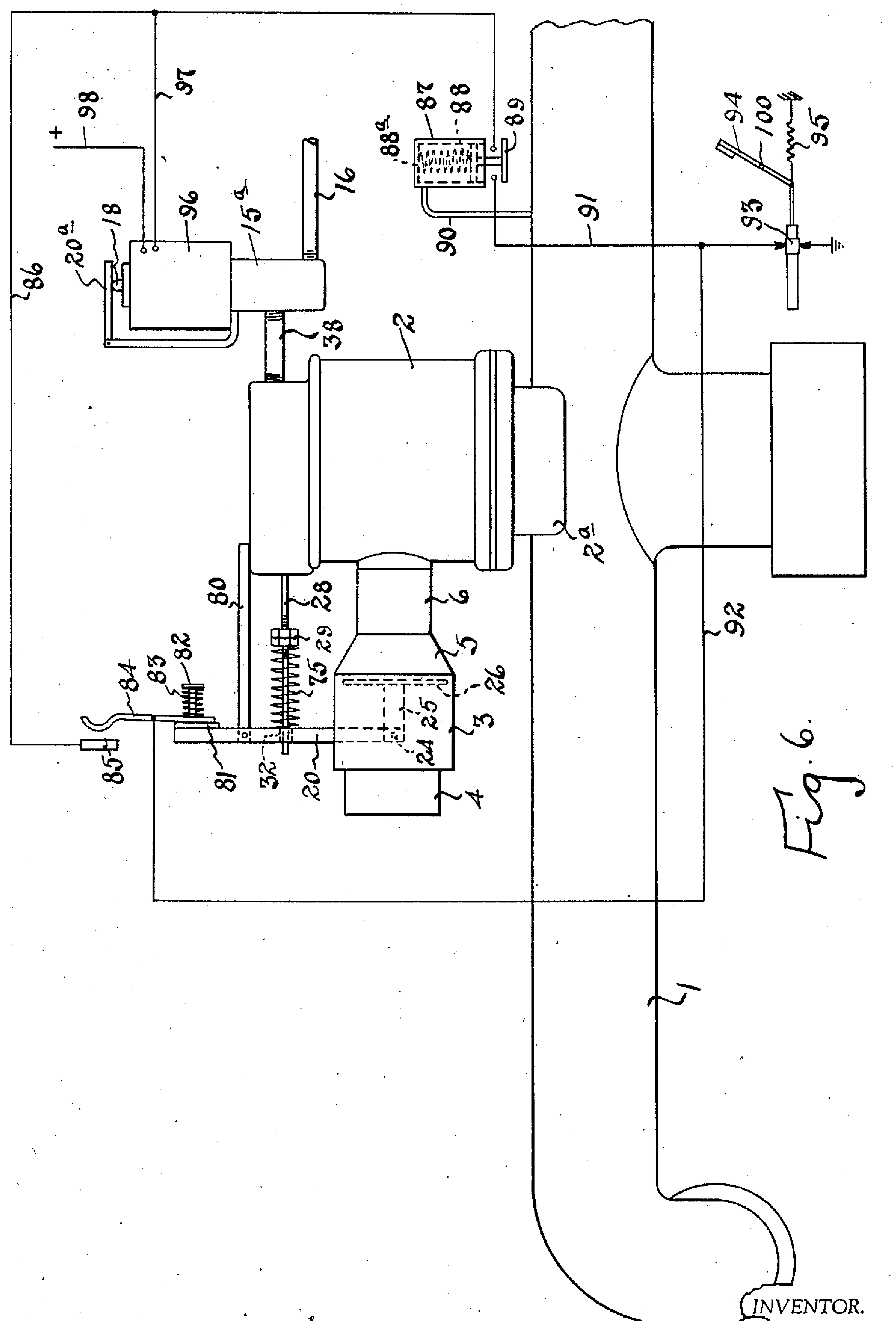

Fig. 6

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FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

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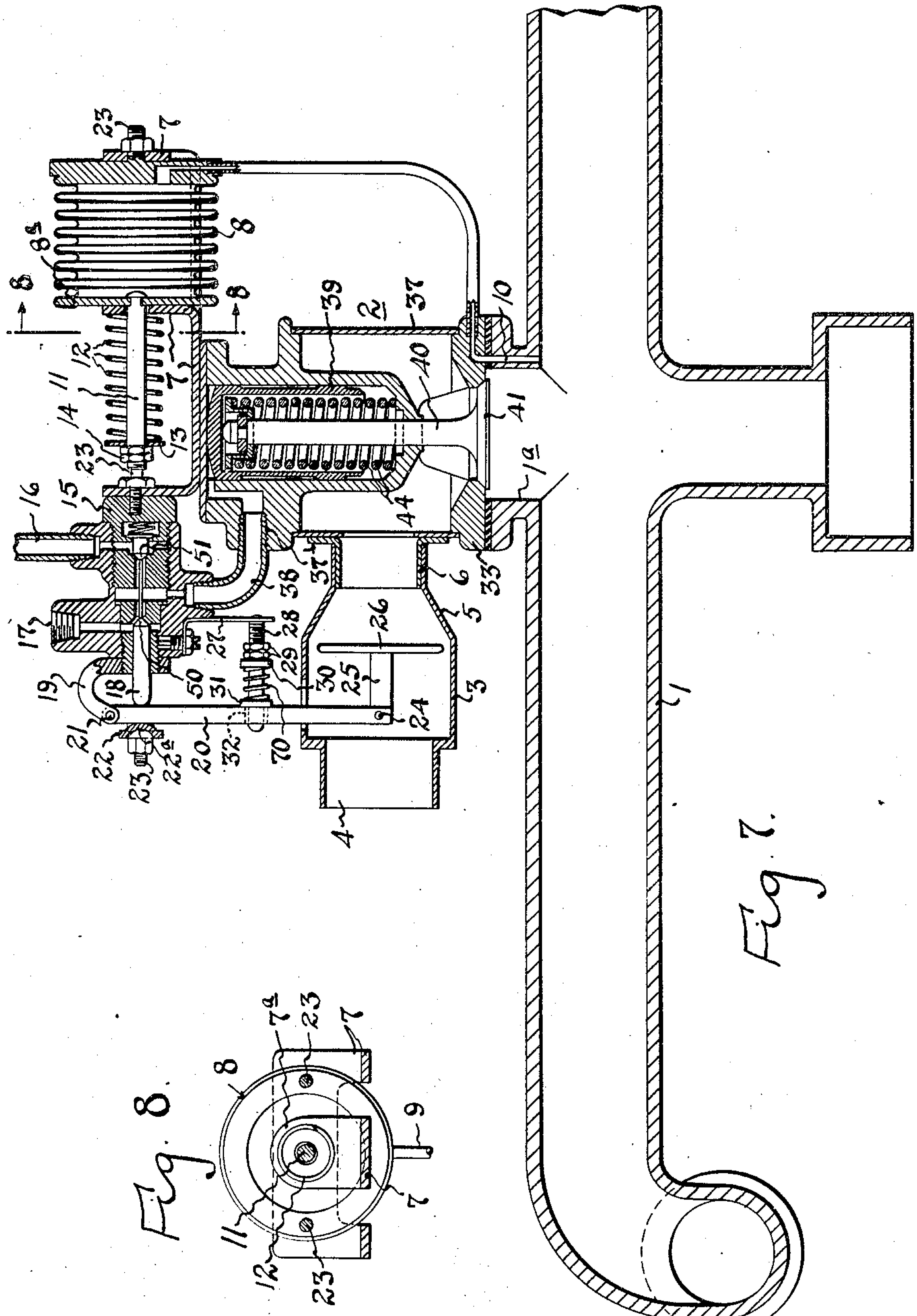

Fig. 7.

Fig. 8.

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Patented Feb. 28, 1939

2,148,709

UNITED STATES PATENT OFFICE

2,148,709

FUME ELIMINATOR FOR INTERNAL COMBUSTION ENGINES

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Application January 22, 1938, Serial No. 186,280

15 Claims. (Cl. 123—124)

This invention relates to mechanism by means of which the fuming of internal combustion engines, particularly when employed on vehicles such as buses, trucks and the like, is automatically eliminated.

An object of this invention is to provide an automatically acting mechanism for introducing air directly into the intake manifold of an internal combustion engine, the action of which is subject to the atmospheric pressure conditions within the manifold and the flow of air thereinto.

A more general object of the invention is to provide a mechanism of this type acting to introduce air directly into the intake manifold when the engine is operating at greater than idling speed and the supply of fuel thereto is substantially that equivalent to idling speed.

These and other objects successfully secured by means of the invention disclosed herein are obtained in accordance with the structure and the manner of operating it herein disclosed.

This invention resides substantially in the combination, construction, arrangement and relative location of parts, all as will be described in greater detail in the following specification.

In the accompanying drawings,

Figure 1 is an elevational view of a mechanism in accordance with this invention showing a portion of the intake manifold of an internal combustion engine;

Figure 2 is a cross-sectional view taken on the line 2—2 of Figure 1;

Figure 3 is a vertical, central, longitudinal, cross-sectional view of the fluid pressure operated air inlet valve employed;

Figure 4 is a longitudinal, central, cross-sectional view through the air valve employed to control the air inlet valve;

Figure 5 is a top plan view of the mechanism of Figure 2 omitting particularly the intake manifold and the fluid pressure operated air inlet valve for sake of clarity; and

Figure 6 is a combined elevational and diagrammatic view of a modified form of the invention herein disclosed;

Figure 7 is a longitudinal, vertical, central cross-sectional view through the mechanism shown in Figure 1;

Figure 8 is a cross-sectional view taken on the line 8—8 of Figure 7.

There are now known a number of systems which, as far as I am aware, are unduly complicated and are not dependably employed with the object in view of eliminating the fuming of internal combustion engines, particularly those used on buses, trucks and the like. As is well known, an internal combustion engine operated vehicle throws off large quantities of obnoxious gases when the engine being driven by the momentum of the vehicle is operating at greater than idling speed and the accelerator and hence the fuel supply are at idling position.

The present invention has for its general object the elimination of fuming of this type by a mechanism which is relatively simple with respect to those heretofore known and which is also stable and dependable in operation.

In Figure 1 there is illustrated diagrammatically at 1 a portion of the intake manifold of an internal combustion engine provided with a depending central branch to which the carburetor is connected in the usual manner. On the top of the manifold at any suitable point is an opening or port 1a in the wall thereof to which the mechanism of this invention is connected. To accomplish this connection there is provided a suitable form of fitting or saddle 2a which is secured to the manifold in any air-tight manner and is provided with a central passage therethrough. Upon this saddle is mounted the fluid pressure operated air inlet valve which is generally indicated at 2 in Figure 1. The casing of this valve is provided with a sleeve 6 to which is connected an air inlet fitting comprising a conical portion 5, a cylindrical portion 3, and a sleeve 4, to which when desired an air strainer may be connected so that the air entering the manifold through the mechanism is cleaned.

Supported on top of the air inlet valve 2 is a bracket 7 of any suitable form on which is mounted a bellows or sylphon 8. As is well known in the art, a bellows device of this type is made up of a thin corrugated wall which is flexible so that the device is expansible and contractible in a longitudinal direction. This bellows forms a closed chamber and is shown mounted on the bracket 7 so that the right hand end thereof is fixed thereto so that it cannot move. The left hand end 8a of the bellows is free so that it may move to the right when sub-atmospheric pressure conditions are created therein. The space in the bellows is connected by pipe 9 to a passage 10 formed in the base 33 of the valve 2 and in the fitting 2a which in turn connects with the interior of the intake manifold through an aligned port in the wall of the manifold as shown.

The bracket 7 is provided with an intermediate arm 7a against which the end 8a of the bellows is held by means of a spring 12. Secured to the end of the bellows and freely passing through the arm 7a is a rod or stud 11 having a washer 13 thereon held in place by locknuts 14. The spring 12 is interposed between the washer 13 and the arm 7a so that the end 8a of the bellows is held against the arm 7a with a force depending upon the adjusted tension of spring 12.

Supported from the bracket 7 is the arm valve 15 which controls the supply and exhaust of operating air to the inlet valve 2. The valve 15 is provided with the exhaust port 17 and the constant fluid pressure supply connection 16. The stem of the valve is shown at 18 projecting from the casing and engaging a depending arm 20 which is pivotally supported at 21 from an arm 19 mounted on the valve 15. The side of the air inlet tube 3 is slotted so that the arm 20 may project thereinto, as is clear from Figure 1. Secured to the end 8a of the bellows are a pair of rods 23, see Figures 1 and 5, which are united at their free ends by a cross-bar 22 held thereon by locknuts as shown. This bar is provided with a contact piece 22a which engages the lever 20. Extending at right angles to the lever 20 from the end thereof is a short arm 25 on which is mounted a disc 26 of less external diameter than the internal diameter of the air inlet tube 3. The disc 26 is placed adjacent the large end of the conical tubular portion 5 and arranged so that the air must travel around the disc in going to the air inlet valve 2.

Supported in any suitable manner from the valve 15 is an arm 27 on which a threaded rod 28 is mounted. This rod extends through an opening 32 in the lever 20 and is encircled by a spring 75 which lies between a washer engaging the lever 20 and a washer 30 engaging a pair of locknuts 29 adjustably mounted on the rod 28. At 38 is shown a connection between the valve 15 and the valve 2.

The fluid pressure operated inlet valve 2 is shown in detail in Figure 3. It consists of a casting 33 having a cylinder 35 integral therewith. The lower part of the casting is provided with a central opening having a seat 34 thereon. This opening is in alignment with the passage in the fitting 2a when the parts are assembled. The upper end of the cylinder 35 is closed by means of a removable plate 36. The casting is so formed as to provide a chamber around the lower end of the cylinder which is closed by means of a cylindrical wall 37 mounted on the casting and provided with a port in alignment with the sleeve 6. The upper part of the casting is provided with a passage opening into the cylinder 35, as indicated at 37′, to which the pipe 38 connects. The passage 10 is shown in the bottom part of the casting. Within the cylinder 35 is a longitudinally reciprocable piston 39 constructed in the form of a hollow shell and having a convex upper end so as not to seal off the passage 37′ when in its retracted position as shown in Figure 3. Extending into the cylinder is a valve stem 40, on the lower end of which is the valve 41 which cooperates with the seat 34. Mounted on the upper end of the valve stem is a saddle 42 between which and the lower end of the cylinder 35 is a spring 44. The upper end of the valve stem is provided with a washer 43 engaging the saddle so that the spring may hold the valve 41 seated when the cylinder is open to exhaust.

The valve for controlling the supply of compressed air to the air inlet valve is shown in Figure 4. It consists of a casing 45 of any suitable construction having a chamber therein which is closed at one end by the cap screw 46. Within the chamber are the two plugs 47 and 48 which are spaced from each other and from the cap screw 46 and which have central passages therethrough and seats thereon. The upper end of the chamber is closed by means of a bushing 49 which serves to support the lever 19 on the valve casing. The valve stem 18 is so formed as to have the valves 50 and 51 thereon and arranged to cooperate with the seats in the plugs 47 and 48. At 52 is a spring bearing against the valve stem and normally holding it in a position so that valve 51 is seated and valve 50 is unseated. The small chamber between the cap screw 46 and plug 47 communicates with a threaded passage 54 in the casing to which the air supply pipe 16 connects. The small chamber between the plugs 47 and 48 are in communication with a threaded passage 53 in the valve casing to which the pipe 38 connects. The small chamber between the plug 48 and the bushing 49 is connected to the exhaust port 17 in the valve casing which is shown threaded so that an exhaust pipe connection may be made thereto if desired.

The operation of the device will now be described. When the engine of which the intake manifold is a part is running at idling speed and the accelerator and hence the carburetor are at idling position the vacuum in the intake manifold, that is the actual pressure therein, is of the order of sixteen to eighteen inches of vacuum, varying somewhat, of course, with the particular engine, its adjustment, etc. At this time, of course, the same vacuum condition exists in pipe 9 and bellows 8. However, the tension on spring 12 is so adjusted that the end 8a of the bellows is held against the arm 7a. At this time all of the other parts are in the position shown in Figure 1 and, of course, valve 41 of the air inlet valve 2 is closed. As the engine is speeded up by operating the accelerator, which of course is connected to the carburetor, the vacuum condition in the intake manifold does not change materially, the tendency of the vacuum to increase in the intake manifold because of the increased speed of the engine being, of course, substantially counteracted by the fact that a corresponding increase in the fuel and air mixture going therethrough to the engine occurs.

However, in the event that the accelerator is retarded towards idling position or released so that it returns back to idling position, the fuel mixture being supplied is reduced. The engine, however, does not immediately fall to idling position particularly when it is on a vehicle such as a bus or truck because of the momentum of the bus or truck which tends to maintain the speed of the engine. Thus, assuming that the engine remains clutched to the wheels, the speed of the engine will fall off to idling speed very gradually. In the event that the vehicle is descending a hill it, of course, may not fall off but actually increase. As those familiar with the operation of such vehicles know, the normal operation of vehicles of this type requires repeated retardation of the accelerator when de-clutching the engine, especially in traffic and hilly country. Thus a large part of the time the engine is operating at greater than idling speed with the accelerator and hence the carburetor at idling speed or at a position within the position which it would have for the corresponding speed of the engine. Under all of these conditions the vacuum within the intake manifold increases, that is the pressure decreases, and depending upon the adjustment of the mechanism comprising this invention it will be at a value where the left hand end 8a of the bellows moves over to the right compressing the spring 12. For example, under a common operating condition with the average bus or truck engine, the adjustments would be such that upon the attainment of a vacuum of twenty inches in the intake manifold the bellows would thus contract.

This contraction of the bellows causes a movement of the rods 23 to the right as well as the cross-bar 22 which bearing on the lever 20 causes it to pivot in a counter-clockwise direction about the pivot point 21. This movement of the lever 20 since this lever engages the valve stem 18 causes valve 50 to seat and valve 51 to unseat. The result is that the exhaust port 17 is closed off and air is supplied from the source through pipe 16, port 54, through the passage in plug 47, to port 53, and from there through the connection 38 into the cylinder 35 of the air inlet valve. The pressure created by the air on the upper end of the piston 39 causes it to move downwardly, compressing spring 44 and unseating valve 41. The unseating of valve 41 opens the intake manifold 1 to the atmosphere through the air inlet tube comprising the portions 4—3—5—6, to port 1a in the manifold through the port defined by the seat 34. This resulting passage is of substantial size so that, in effect, the intake manifold is in substantially free communication with the atmosphere with the result that the pressure in the intake manifold falls pretty close to atmospheric pressure. It immediately follows that the pressure falls to a like value in the bellows 8. Spring 12, therefore, returns the bellows to the position shown in Figure 1 and moves the cross-bar away from lever 20 leaving it free. This lever, however, does not return back to the position shown in Figure 1 at this time because the air moving through the tube 4—3—5—6 builds up a pressure on the disc 26 which is partially blocking this passageway and causing the air to travel around the edges thereof. Hence the valve 50 remains seated and the valve 51 remains unseated, maintaining the supply of air from pipe 16 on the top of piston 35 and holding the valve 41 unseated. Under these conditions, the engine is acting as a pump and drawing large quantities of fresh air through it. The volume of this air compared to the fuel in the mixture coming from the carburetor is large so that a substantially non-explosive mixture is formed. The movement of this large volume of clean, fresh air through the engine cools it, but more importantly the obnoxious and malodorous fuming which would otherwise occur is eliminated.

As the engine gradually falls to idling speed, the amount of air being drawn past the disc 26 correspondingly decreases, and depending upon the initial adjustment of spring 75 as the engine approaches close to or reaches idling speed the pressure of the moving air on the disc 26 falls to the point where spring 75 takes control and moves disc 26 and lever 25 back to the position shown in Figure 1. As soon as this occurs spring 52 in the valve 15 re-seats valve 51 and unseats valve 50, opening the cylinder 35 to exhaust through the port 17. The spring 44 in the air inlet valve thereupon seats the valve 40, cutting off the supply of air through the port 1a to the intake manifold. The engine is now only getting a fuel mixture corresponding to idling speed and then begins to operate normally. It will be apparent that a similar set of operations occurs under all of the varying road conditions that are encountered in the operation of vehicles equipped with internal combustion engines and the device of this invention. For example, if the accelerator is moved up from idling position before the engine speed has fallen to idling position it will be apparent that the air inlet valve will close because the increased supply of fuel mixture through the carburetor will proportionately cut down the supply of clean air through the inlet valve to the extent that spring 75 will move the lever back to the position shown in Figure 1.

An important practical feature of the construction illustrated is that found in the fact that the lever 20 is relatively free of the rod 28 and the spring structure thereon to move in a counter-clockwise direction from an operated position, at which time, it will be recalled, the cross-bar 22 has moved back out of engagement with the lever 20. The purpose of this arrangement is to accommodate the structure to backfiring. In the case of a backfire, the valve 41 being open, the back pressure which occurs may kick the disc 26 back without danger of damaging it and its connected structure because it may move freely on the pin 28. To further project it in the event that this back pressure is excessive, the sections 3 and 4 of the air inlet tube are arranged so that the lever 20 may move back against it as a stop which takes some of the strain off of the cross-bar 22 and the other connected parts.

The practical value of this invention will be apparent when it is considered that attempts have been made to develop other systems in which the control of the air inlet valve is either directly subjected to variations in the pressure conditions in the intake manifold or through intermediate devices. There is no difficulty in initially actuating devices of this type from the pressure in the intake manifold when the accelerator is retarded towards or to idling position and the engine is operating above idling position. However, immediately the air inlet valve opens the pressure in the intake manifold falls substantially to but does not quite reach atmospheric pressure and, therefore, the pressure differential available to maintain the apparatus in operated condition is quite small and in fact is a fraction of an inch.

Furthermore, as the engine speed drops off towards idling position the vacuum in the intake manifold approaches nearer and nearer to atmospheric pressure so that this pressure differential becomes increasingly smaller. It becomes at once apparent, therefore, that any apparatus directly operated by the pressure in the intake manifold and variations therein is relatively unstable and insensitive. Actual experience has demonstrated this to be so much so as to render the devices of very doubtful practicability. On the other hand, applicant's invention involves a system in which the air inlet valve is only opened through the action of intermediate devices controlled by the pressure in the intake manifold. This valve is held open, however, by mechanism as explained above which is subjected to the air being supplied through the air inlet valve, the quantity and velocity of which is proportional to the speed of the engine, other factors being constant, and in absolute values is substantial.

In the system of Figure 6 the invention is embodied in a system which is electrically controlled. As before, the intake manifold is shown in part at 1 with the air inlet valve 2 mounted thereon by means of a coupling member 2^a. The inlet for the valve is shown in the form of a tube comprising the sections 4—3—5—6. Supported from the valve body by means of an arm 80 is the vertical lever 20 similar to that of the previous arrangement, having secured on its lower end by means of the rivet or the like 24 an arm 25 and a disc 26 at the large end of the conical portion 5 of the inlet 2. The lever 20, as shown, is pivotally mounted intermediate its ends on the arm 80. Secured to the upper end of the lever 20 is a plate 81 of insulating material on which is supported a contact finger 84 by means of a headed pin 82 and a spring 83. This arrangement permits a relative movement between the spring finger 84 of the lever 20 so as not to interfere with the action of the flowing air on the disc 26. The pin 28 now mounted on the valve 2 extends through a hole 32 in the lever 20 and is provided with lock-nuts 29 to adjust the tension on the spring 75 which acts to hold the lever 20 in the position shown. The supply and exhaust of air to the cylinder of valve 2 is controlled by a valve 15ª similar to the valve 15 of the previous arrangement but in this case electromagnetically operated by means of a solenoid 96. The valve 15ª is of the same construction as the valve 15 and as clearly illustrated in Figure 4. However, the valve 15ª instead of being operated by a sylphon is operated with an electro-magnet as illustrated in Figure 6. The air supply pipe 16 is connected to the cylinder of valve 2 through the valve 15ª and the coupling 38, as before. The valve stem 18 of the valve 15ª is operated by means of an armature 20ª pivotally supported in any suitable manner and in the field of the solenoid 96. Valve 15ª is normally seated to cut off the supply of air from pipe 16 to pipe 38 so that the pipe 38 is open to exhaust at which time the solenoid 96 is not energized.

A fluid pressure operated switch is provided comprising a cylinder 87 connected by a pipe 90 to the intake manifold 1. The lower end of the cylinder is open and in it is a piston 88 controlled by a spring 88ª. Connected to the piston is a movable contact 89 arranged to cooperate with a pair of fixed contacts when the vacuum in the intake manifold acting through the pipe 90 is sufficiently high so that the piston 88 moves up and compresses spring 88ª. At 94 is diagrammatically shown the accelerator pedal pivotally mounted at 100 and held in the position shown by a spring 95 when the operator's foot is removed therefrom. Connected to the accelerator pedal is a switch 93 which is closed, as shown, when the accelerator pedal is free. One contact of the switch is grounded and the other is connected by wire 91 to one of the pairs of contacts controlled by the movable contact 89. Wire 91 is connected by wire 92 to contact finger 84. The fixed contact 85 cooperating with this finger is connected by wire 86 to the other contact of the air switch and by wire 97 to one terminal of the solenoid 96. The other terminal of the solenoid is connected by wire 98 to the positive side of the current source, the negative terminal of which is grounded.

In the operation of this mechanism, as the vehicle proceeds under the motive power of the engine the accelerator pedal 94 is depressed, tensioning spring 95 and moving the contact of switch 93 to the left out of engagement with the fixed contacts. At this time, of course, valve 2 is closed and lever 20 is in the position shown so that contact finger 84 is out of engagement with fixed contact 85. Solenoid 96 is deenergized and valve 15ª is closed. Air switch 89 is open. These conditions exist and continue until the operator removes his foot from the accelerator pedal whereupon switch 93 closes. The momentum of the vehicle, whether it is on the level or running down-hill, now drives the engine from the rear wheel, the clutch being engaged so that the vacuum in the intake manifold increases to the point where the air switch closes. Current then flows from the source through wire 98, solenoid 96, wire 97, wire 86, air switch 89, wire 91 and accelerator switch 93 to ground. The energization of solenoid 96 causes valve 15ª to open cutting connection 38 off from the atmosphere and connecting it to pipe 16 and hence the air pressure source. The supply of air to the cylinder and valve 2 causes valve 41 to unseat, opening the intake manifold to the atmosphere through the inlet 4—3—5—6. The inrush of air moves disc 26 to the right, moving lever 20 in a counter-clockwise direction, compressing spring 75 and engaging contact finger 84 with contact 85. Thus the engine pumps air for the objects explained above. Of course as soon as valve 41 opens the pressure intake manifold builds up so that spring 88ª opens the air switch 89. However, the solenoid 96 remains energized since current flows from wire 96 now through switch 85—84 and wire 92 through switch 93 to ground. Thus the air valve remains open until the engine speed falls substantially to idling speed when the movement of air around the disc 26 will have fallen so that spring 75 is able to return lever 20 back to normal position, breaking the circuit to solenoid 96 at switch 85—84. Thus valve 15ª closes, cutting off the supply of air to the cylinder of the air inlet valve and opening that cylinder to atmosphere. Spring 44 then closes valve 41 and the engine then receives an explosive mixture and begins to operate normally.

From the above description it will be apparent to those skilled in the art that the particular form of structure which applicant has elected to employ for purposes of disclosure herein may be easily varied as to details and arrangement without departing from the novel scope of the subject matter thereof. I do not, therefore, desire to be limited strictly by the disclosure but rather by the scope of the claims granted.

What I seek to secure by Letters Patent is:

1. The combination with the intake manifold of an internal combustion engine and a valve for supplying air directly thereto, of means controlled by the pressure conditions in the intake manifold for operating said valve, and means controlled by the flow of air to the intake manifold for modifying the operation of said air inlet valve by the last previously mentioned means.

2. The combination with the intake manifold of an internal combustion engine and a valve for supplying air directly thereto, of means controlled by the pressure conditions in the intake manifold for operating said valve, and means in the air stream to the air inlet valve for holding said last previously mentioned means actuated until the engine speed approaches idling speed.

3. The combination with the intake manifold of an internal combustion engine, an air intake conduit for supplying air directly thereto and a valve in said conduit, of means actuated by the pressure in the intake manifold for operating said valve, and means mounted in said conduit for maintaining said last previously mentioned means actuated until the engine approaches idling speed.

4. The combination with the intake manifold of an internal combustion engine and a valve for supplying air directly thereto, of fluid pressure actuated means connected to the intake manifold for operating said air inlet valve, and means controlled by the movement of air to the intake manifold for maintaining said last previously mentioned means actuated until the engine speed approaches idling speed.

5. In an apparatus of the type described, the combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air to the manifold, of pressure fluid actuated means controlled by the pressure in the intake manifold for supplying fluid under pressure to and exhausting it from said inlet valve to actuate it, of means in the stream of air supplied to the intake manifold by the inlet valve for holding said last previously mentioned means actuated after initial actuation until the engine speed falls to approximately idling speed.

6. The combination with the intake manifold of an internal combustion engine and a valve for supplying air directly thereto, of means controlled by the pressure conditions in the intake manifold for operating said valve, and means controlled by the movement of air to the air inlet valve for holding said last previously mentioned means actuated until the engine speed approaches idling speed while the carburetor is at idling speed.

7. The combination with the intake manifold of an internal combustion engine and an air inlet valve for supplying air directly into the manifold, of means actuated by the pressure in the intake manifold for opening said valve, and means in the air stream supplied to the manifold through said valve for holding said last mentioned means actuated until the engine speed falls to that corresponding to a retarded position of the carburetor throttle valve.

8. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air directly to said manifold, of pressure fluid operated means connected to the intake manifold for controlling the supply of fluid under pressure to and exhaust from said inlet valve to operate it, and means controlled by the air supplied through the inlet valve to the manifold for maintaining the valve operated until the engine speed falls to a position corresponding to a retarded position of the carburetor throttle valve.

9. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air directly to said manifold, of pressure fluid operated means connected to the intake manifold for controlling the supply of fluid under pressure to and exhaust from said inlet valve to operate it, and means in the air stream to the manifold through the inlet valve for holding said last mentioned means actuated until the engine speed falls from a higher speed to one corresponding to a retarded position of the carburetor throttle valve.

10. In an apparatus of the type described, the combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air to the manifold, of pressure fluid actuated means controlled by the pressure in the intake manifold for supplying fluid under pressure to and exhausting it from said inlet valve to actuate it, of means in the stream of air supplied to the intake manifold by the inlet valve for holding said last previously mentioned means actuated after initial actuation until the engine speed falls to approximately idling speed and the carburetor is at idling speed.

11. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated inlet valve for supplying air directly to the manifold, of a valve for controlling the supply of fluid under pressure to and exhaust from said inlet valve, pressure fluid operated means connected to the intake manifold for operating said valve, and means in the stream of air supplied to the manifold through the inlet valve for holding said air valve operated until the engine speed falls to idling speed or a speed corresponding to a retarded position of the carburetor throttle valve.

12. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated inlet valve for supplying air directly to the manifold of a valve for controlling the supply of fluid under pressure to and exhaust from said inlet valve, pressure fluid operated means connected to the intake manifold for operating said valve to open it, and means in the stream of air supplied to the manifold through the inlet valve for holding said air valve operated until the engine speed falls to idling speed or a speed corresponding to a retarded position of the carburetor throttle valve.

13. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air directly into the manifold, of an air valve for controlling the supply of fluid under pressure to and exhaust from said inlet valve, pressure fluid operated means connected to the intake manifold for operating said air valve to supply air to said inlet valve, said air inlet valve having a conduit with a restriction, and means mounted in said conduit adjacent said restriction for maintaining said air valve operated until the engine speed falls to idling speed.

14. The combination with the intake manifold of an internal combustion engine and a pressure fluid operated valve for supplying air directly into the manifold, of an air valve for controlling the supply of fluid under pressure to and exhaust from said inlet valve, pressure fluid operated means connected to the intake manifold for operating said air valve to supply air to said inlet valve, said air inlet valve having a conduit with a restriction, and means mounted in said conduit adjacent said restriction for maintaining said air valve operated until the engine speed falls to a speed corresponding to a retarded position of the carburetor.

15. The combination with the intake manifold of an internal combustion engine and a valve for supplying air thereto, of means controlled conjointly by the pressure conditions in the intake manifold and the accelerator for operating said valve, and means controlled by the flow of air to the intake manifold for maintaining the air inlet valve operated until the engine speed falls substantially to idling speed.

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