

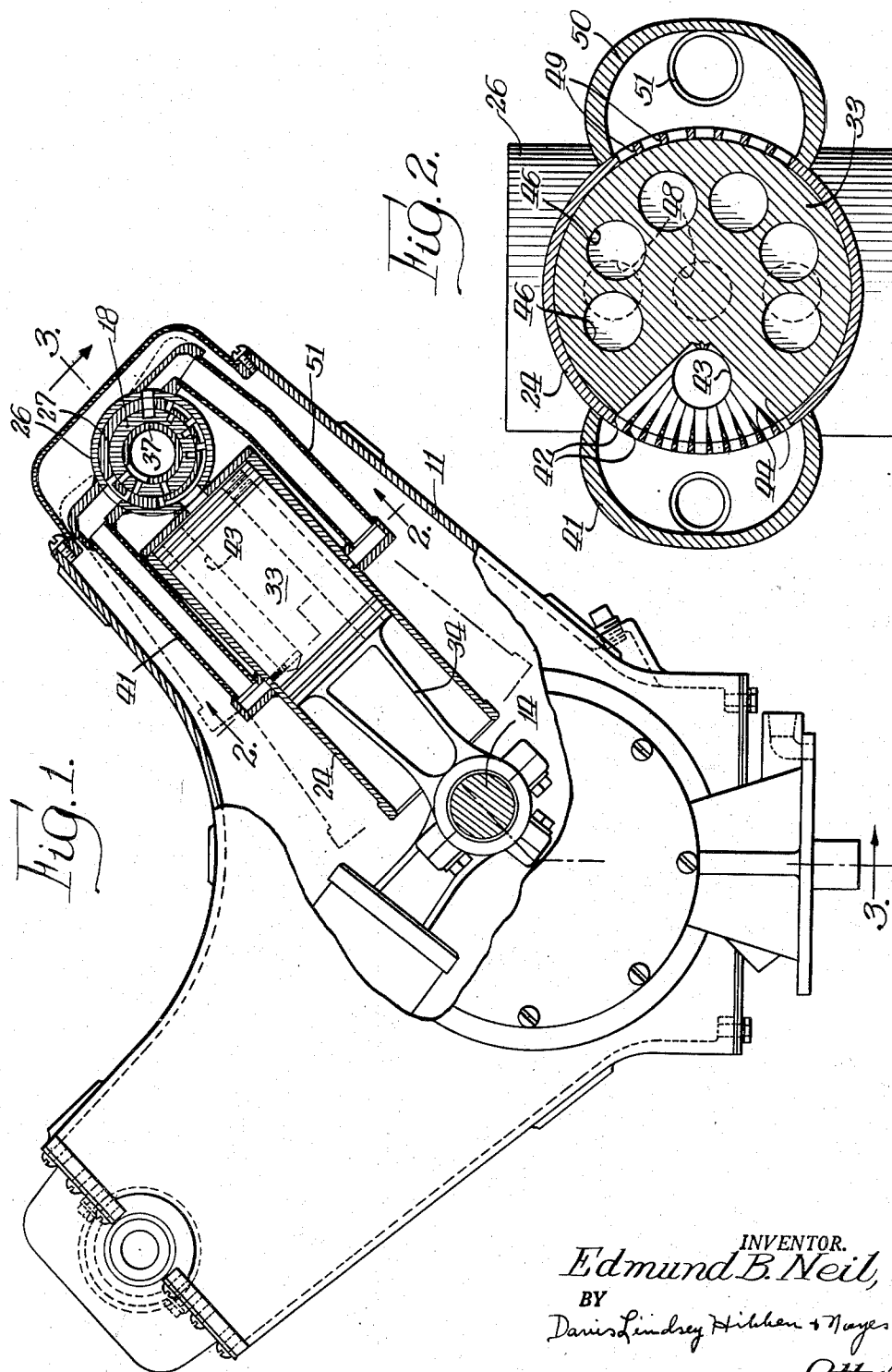
Nov. 30, 1954

E. B. NEIL
VAPOR ENGINE

2,695,596

Filed Aug. 18, 1952

3 Sheets-Sheet 1



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3 Sheets-Sheet 2

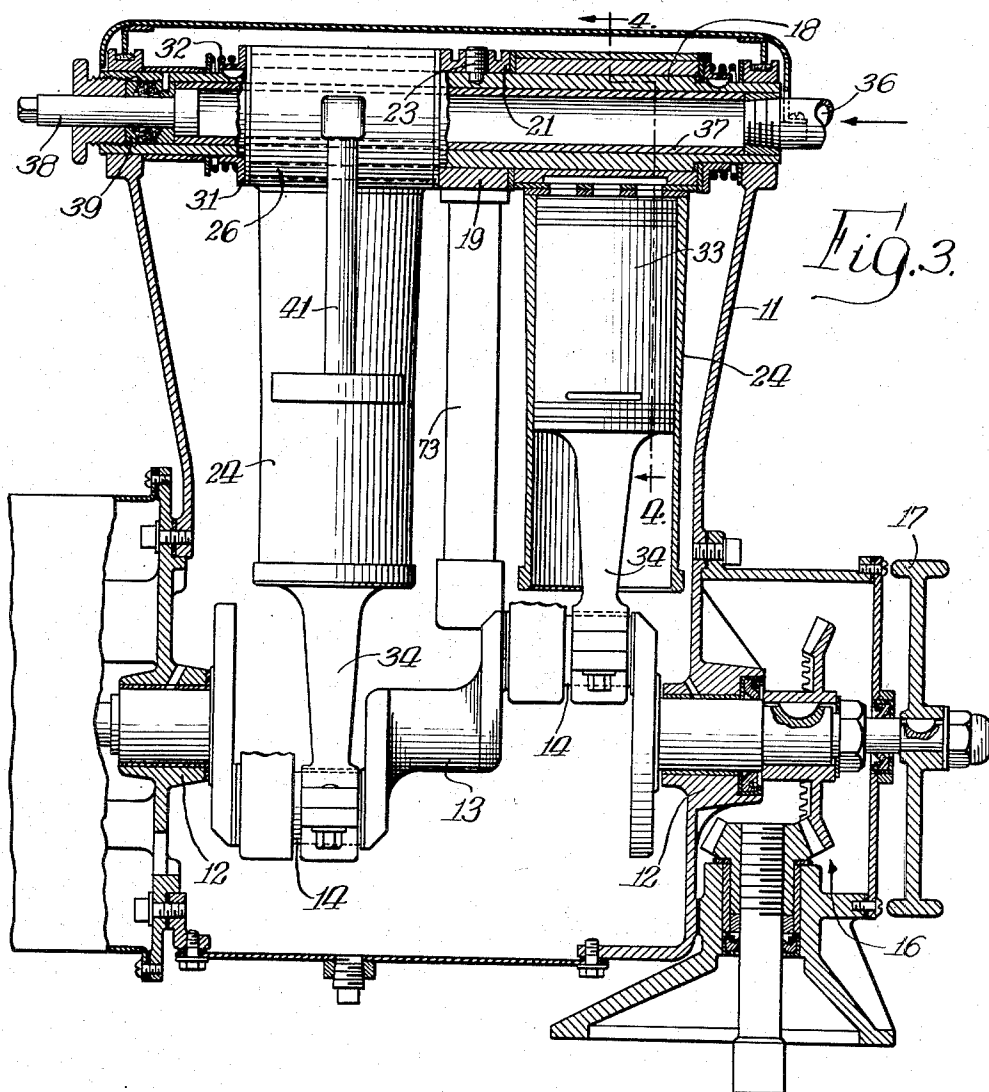


Fig. 3.

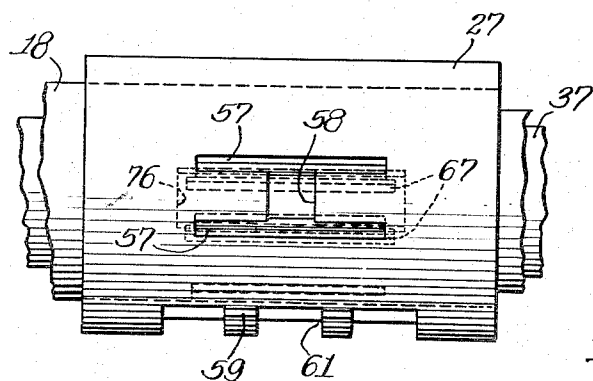


Fig. 7.

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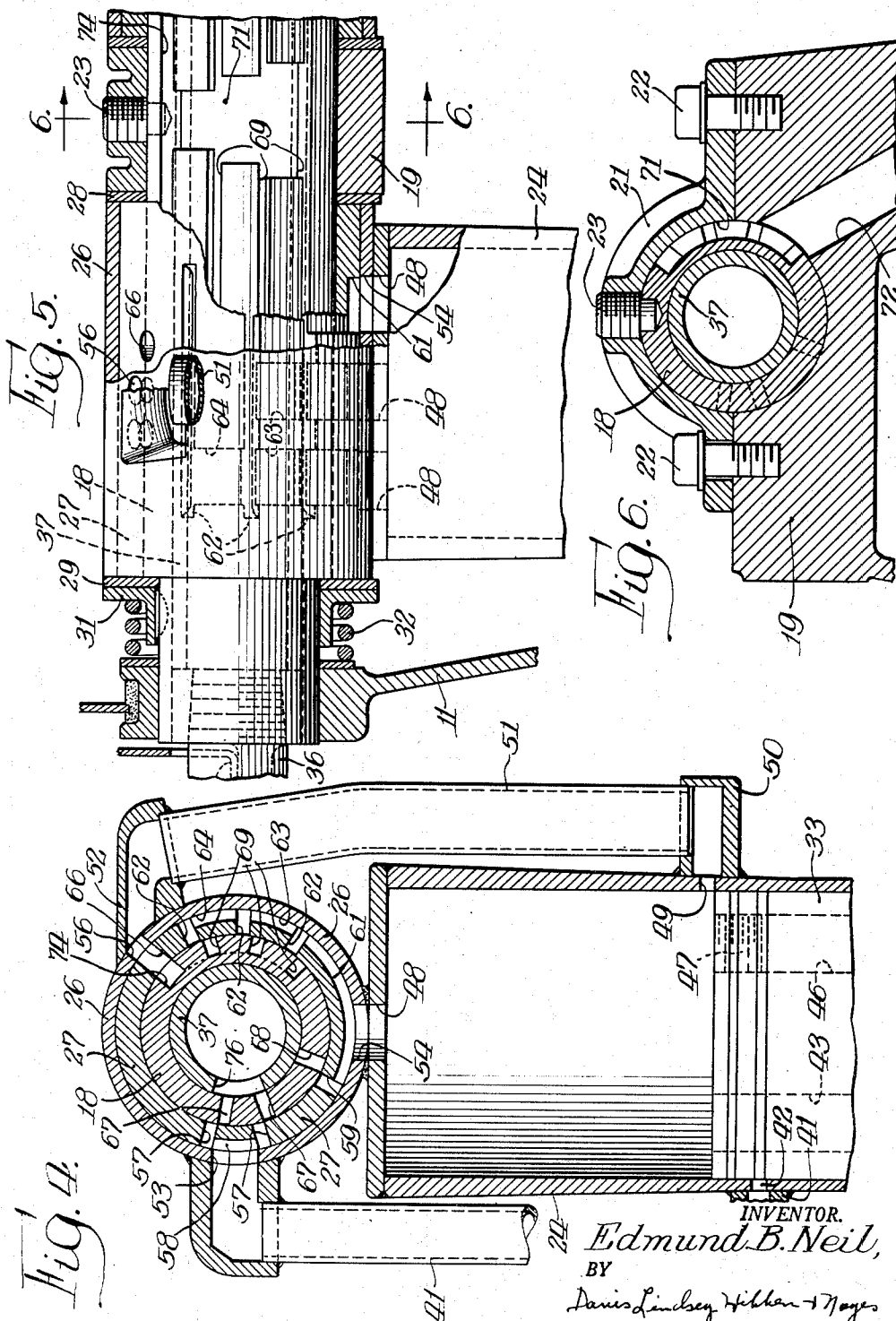
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2,695,596

Filed Aug. 18, 1952

3 Sheets-Sheet 3



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2,695,596

VAPOR ENGINE

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Application August 18, 1952, Serial No. 304,862

14 Claims. (Cl. 121-65)

This invention relates to vapor engines of a novel type and more particularly to a novel porting means for controlling the flow of vapor to and from such engines.

In my copending application S. N. 39,735, filed July 20, 1948, I have described and claimed a novel vapor engine of the oscillating cylinder type in which the combined effects of the oscillation of the cylinder and the reciprocation of the piston are relied upon to control the flow of vapor to the engine. The present invention utilizes the same combined effects but in conjunction with a novel porting arrangement which has special advantages in large size engines for operation at higher pressures and higher speeds. In the specific embodiment illustrated in my application S. N. 39,735 inlet ports for admitting vapor to the engine are provided in coacting flat plates or surfaces forming adjacent parts of the oscillating cylinders and the fixed support for the cylinders. In my present invention I employ a generally cylindrical porting arrangement which is concentric with the cylinder pivot means so as to eliminate the opportunity for leakage of vapor into the engine crankcase, as hereinafter described in detail.

Accordingly, a primary object of the invention is to provide a novel vapor engine of the oscillating cylinder type in which the flow of vapor is controlled both by the oscillation of the cylinder and by the reciprocation of the piston.

A further object of the invention is to provide an improved porting means for controlling the flow of vapor in an engine of the foregoing type.

Another object of the invention is to provide an improved porting means for a vapor engine of the oscillating cylinder type which avoids leakage of vapor from the porting means into the engine crankcase.

Still another object of the invention is to provide in a vapor engine of the oscillating cylinder type a novel combination of a cylinder pivot and a generally cylindrical porting structure for controlling the flow of vapor to and from the engine.

Other objects and advantages of the invention will become apparent from the subsequent detailed description taken in connection with the accompanying drawings, wherein:

Fig. 1 is an end view of an engine embodying the features of the invention with one of the cylinders thereof shown in axial section;

Fig. 2 is a transverse sectional view taken along the line 2-2 of Fig. 1;

Fig. 3 is a sectional view taken substantially along the line 3-3 of Fig. 1 with portions thereof in elevation;

Fig. 4 is a fragmentary sectional view on an enlarged scale taken substantially on the line 4-4 of Fig. 3 and showing the piston in its lower position;

Fig. 5 is an enlarged fragmentary elevational view with portions thereof in section showing the exhaust porting arrangement at the rear of the right-hand cylinder as seen in Fig. 3;

Fig. 6 is a sectional view taken along the line 6-6 of Fig. 5; and

Fig. 7 is an enlarged fragmentary elevational view showing the inlet porting arrangement as seen from the left in Fig. 4.

The operation of an engine of the character herein disclosed is dependent upon the pressure exerted by a vapor, and the term "vapor" as used herein refers to

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any gas or vapor such as air, carbon dioxide, steam, various refrigerants, etc.

In the drawings the invention is shown as embodied in a multi-cylinder engine of the V-type, the particular engine illustrated having four cylinders with two arranged on each side of the V. The structure comprises a crankcase 11 provided with suitable line bearings 12 for supporting a two-throw crankshaft 13. The crankshaft 13 has a pair of crank bearings 14 and to each of the bearings a pair of pistons is connected with one piston extending to one side of the V and the other piston to the other side of the V, as clearly seen in Figs. 1 and 3. A power take-off designated generally at 16 is provided at one end of the crankshaft 13 as well as a flywheel 17.

Mounted in the upper part of the crankcase 11 on each of the opposite sides of the V is a pivot or trunnion in the form of an elongated fixed sleeve 18. The opposite ends of the sleeve 18 are supported in the walls of the crankcase 11 and the central portion of the sleeve 18 is received within a support 19 (Fig. 6) which is rigidly mounted on the crankcase 11. A clamp member or cap 21 is fitted over the sleeve 18 and is secured to the support 19 by means of a plurality of screws 22. A set screw 23 extends through the cap 21 into the sleeve 18 for holding the latter in fixed non-rotatable relation. Similar caps are also provided at the ends of the sleeve 18.

The fixed sleeve 18 provides a pivot for a pair of oscillatable cylinders 24 which are mounted on opposite sides of the support 19. As best seen in Figs. 4 and 5, a cylindrical supporting sleeve 26 is rigidly secured, as by welding, to the top or head of each of the cylinders 24. Within the sleeve portion 26 a cylindrical valve or timing sleeve 27 is press-fitted for rotary oscillating movement with the supporting sleeve 26. The elongated fixed pivot sleeve 18 extends concentrically through the timing sleeves 27 of each pair of cylinders 24 so that the cylinders are operatively suspended for oscillating movement about the fixed sleeve 18. It will be understood that the sleeve portion 26 and the timing sleeve of each cylinder oscillate as a unit relative to the fixed sleeve 18. A sealing washer 28 is disposed between the support 19 and the adjacent ends of each of the sleeve portions 26 and 27, and a similar sealing washer 29 is provided at the opposite or outer ends of the cylinder portions 26 and 27. A thrust member 31 actuated by spring 32 at each end of the pivot 18 serves to compress the washers 28 and 29 in sealed relation against the opposite ends of the sleeves 26 and 27 and around the fixed sleeve 18 so that leakage of vapor into the interior of the crankcase 11 is effectively prevented during oscillation of the cylinders 24.

Mounted within each cylinder 24 is a piston 33 which is of elongated form and has integrally formed therewith a connecting rod portion 34 connected in the usual manner to one of the crank pins 14. Thus, as the crankshaft 13 rotates, each piston is reciprocated within its cylinder and the cylinder is caused to oscillate about the pivot sleeve 18.

Vapor from a suitable generator or source of supply is admitted to the engine through an inlet pipe 36 (Fig. 3) which communicates with the interior of the fixed or pivot sleeve 18 at one end thereof. As will hereinafter appear, the fixed sleeve 18 and the oscillatable sleeves 26 and 27 are provided with a plurality of ports and passageways for admitting vapor to and exhausting vapor from the cylinders 24. For use in starting the engine, an elongated control tube 37 is mounted for limited rotation within the fixed pivot sleeve 18 so as to control the admission of vapor into the porting system provided in the sleeves 18, 26, and 27. Thus, the vapor inlet pipe 36 communicates with one end of the control tube 37 and the opposite end of the control tube 37 is sealed and is provided with an operating portion 38 which projects from the crankcase through a suitable stuffing box 39 (Fig. 3). By rotary manipulation of the operating portion 38, the admission of vapor to the cylinders 24 is controlled according to any predetermined rotary position of the control tube 37.

As heretofore mentioned, my invention utilizes both

the oscillation of the cylinder and the reciprocation of its associated piston in order to regulate the admission of vapor to the cylinder during operation of the engine. By this mean the desired degree of cut-off is obtained, i. e. the vapor is admitted to the cylinder only during the initial portion of the power stroke of the piston. Thus, in Figs. 1 and 2 the piston 33 is shown in its uppermost position at the beginning of the power stroke. The control tube 37 is shown in position for normal running operation of the engine and, by appropriate communication between the various ports and passageways in the porting system as hereinafter described in detail, vapor is admitted into an inlet pipe 41 which is affixed at its upper end to the sleeve portion 26 of the cylinder and communicates at its lower end with a plurality of holes 42 provided in the wall of the cylinder 24. Thus, vapor communication is established between the pipe 41 and the interior of the cylinder 24. In order to admit vapor to the interior of the cylinder 24 during the desired portion of the piston stroke, the piston 33 is provided with a longitudinal or axially extending bore 43 which is open at the head end of the piston for communication with the interior of the cylinder. At the opposite end of the bore 43, the piston 33 is provided with a plurality of angularly disposed openings or bores 44 which extend inwardly from the periphery of the piston and converge to open into the lower end of the axial bore 43. As will be clearly seen from Figs. 1 and 2, these bores 44 are adapted to register with the openings 42 in the cylinder wall during a portion of the piston stroke. In the arrangement shown in the drawings, it will be seen that the passages 44 are in register with the openings 42 in the cylinder wall when the piston 33 is at the uppermost end of its stroke (Fig. 1). As the piston 33 moves downwardly, the lateral passageways 44 pass downwardly beyond the openings 42 whereby to cut off or disrupt the vapor communication from the conduit 41 to the axial bore 43 in the piston.

From the foregoing, it will be apparent that during the normal running position of the control tube 37, vapor will be admitted to the interior of the cylinder only during the relatively brief period of time when the lateral passageways 44 and the cylinder wall openings 42 are in register. Thus, cut-off is obtained shortly after the piston 33 starts its downward stroke and full advantage is thereby taken of the vapor expansion in the cylinder. It will also be apparent that cut-off is obtained without the use of complicated external mechanisms such as a link movement or cam system.

The piston 33 is also shown as being provided with a plurality of axially extending circumferentially arranged bores 46 in addition to the bore 43. However, the bores 46 are optional and are provided solely for the purpose of reducing the weight of the unit. These bores 46 are fitted with suitable plugs 47 (Fig. 4) at their upper ends, and vapor is admitted to the cylinder only through the bore 43.

The vapor within the cylinder 24 is exhausted therefrom on the upstroke of the piston through a plurality of openings 48 provided in the cylinder head and communicating with the exhaust porting system, as hereinafter described in detail. However, an important feature of my invention is the provision of exhaust lead when desired. For this purpose, the cylinder 24 is provided with a plurality of openings 49 (Fig. 2) in the wall thereof substantially opposite to the vapor inlet openings 42. An exhaust vapor conduit 51 is secured at its lower end to a manifold 50 attached to the cylinder adjacent the openings 49 and extends upwardly to a manifold 52 secured around suitable ports in the outer sleeve portion 26 of the cylinder assembly. Thus, the exhaust lead openings 49 are connected to the exhaust porting system at the top of the cylinder. The area of the openings 49 and the relative location thereof with respect to the bottom of the piston stroke determines the time at which the exhaust vapor is released through the conduit 51.

The exhaust lead arrangement as described above permits rapid venting or release of exhaust vapor from the cylinder 24 just before the piston 33 reaches its bottom dead center position at the end of the power stroke and ahead of the opening of the main exhaust ports at the top of the cylinder as determined by the angular position of the cylinder relative to its pivot. As the piston 33 moves upwardly in its exhaust stroke, the main ex-

haust ports are gradually opened in response to oscillation of the cylinder 24 and the lead exhaust openings 49 are closed. However, the main exhaust ports are closed thereafter when the piston reaches its top dead center position at the end of the exhaust stroke. Thus, I can obtain preliminary exhaust of vapor any desired number of degrees ahead of the bottom dead center piston position while not affecting the time of closing of the exhaust porting at the top dead center piston position. Consequently, the opening and closing functions of both the main exhaust ports and the lead exhaust ports are independently adjustable rather than being tied together as an inherent characteristic of the oscillating cylinder construction. It will also be understood, of course, that the provision of the external exhaust tube 51 may be omitted in those circumstances where exhaust lead is found to be unnecessary or undesirable.

Referring now particularly to Figs. 4 to 6, the structure and operation of the porting system for regulating the admission and exhaust of vapor in response to oscillation of the cylinder will now be described. The oscillating cylindrical sleeve portion 26 which is rigidly affixed to the top of the cylinder 24 is provided with an enlarged aperture 53 for communication with the cut-off vapor inlet conduit 41. Direct exhaust vapor from the cylinder 24 enters the porting system through a plurality of openings 54 provided in the sleeve portion 26 in register with openings 48 in the cylinder head. In this instance three pairs of aligned openings 48 and 54 are shown. The lead exhaust enters the porting system from the manifold 52 through a plurality of openings 56 also provided in the sleeve portion 26, three such openings 56 being shown.

The timing sleeve or cylinder 27 which is press-fitted in the sleeve portion 26 for oscillation in unison with the latter is provided with a set of inlet ports and a set of oppositely disposed exhaust ports. In this instance the inlet ports comprise a pair of elongated slots 57 interconnected at their central portions by a transverse groove 58 extending therebetween and in register with the aperture 53 in the sleeve portions 26 (Figs. 4 and 7). In addition, another elongated slot 59 is also provided in the sleeve 27 and communicates through a circumferentially extending arcuate groove 61 with the openings 54 and 48 for full stroke admission of vapor to the cylinder 24. The exhaust port means for the sleeve 27 comprises a plurality of elongated slots 62 (Fig. 5), three being shown in this instance, which are interconnected by means of a pair of transversely extending grooves 63 and a similar groove 64. The lowermost slot 62, as viewed in Fig. 4, is also connected to the full stroke vapor inlet slot 59 by means of the groove 61. As will be seen from Fig. 5, the slots 62 are substantially the same in length and the interconnecting grooves 61, 63 and 64 are arranged so that the groove 61 communicates with all three of the cylinder head exhaust ports 48 and the registering ports 54, the grooves 63 interconnect the bottom slot 62 with the center slot 62, and the groove 64 interconnects the center slot 62 with the upper slot 62. The sleeve 27 is also provided with three exhaust lead openings 66 in register with the openings 56 in the outermost sleeve portion 26.

The fixed sleeve 18 is likewise provided with complementary sets of inlet and exhaust ports adapted to be disposed in and out of register with the corresponding ports in the oscillatable sleeve 27. It will be understood that the fixed sleeve 18 is formed with two such sets of inlet and exhaust ports, one for each of the cylinders 24 which pivot about the sleeve 18. The cut-off admission slots in the sleeve 18 are designated at 67 for cooperation with the corresponding slots 57 in the sleeve 27. The full stroke admission slot is indicated at 68 and cooperates with the corresponding slot 59 in the sleeve 27. On the exhaust side, three elongated slots 69 are provided in the sleeve 18 for cooperation with the slots 62 in the sleeve 27. It will be seen from Fig. 5 that the slots 69 have progressively increasing lengths and communicate at their inner ends with a central manifold passage 71 provided in the support 19 and having a gradually increasing width. It will also be understood from Fig. 5 that the exhaust slots 69 from each of the cylinders 24 feed into the common central passage 71.

A lateral passageway 72 (Fig. 6) extends downwardly from the passage 71 through the support 19, and a vapor exhaust line 73 (Fig. 3) is connected thereto for dis-

charging exhaust vapor through the wall of the crankcase 11. The lead exhaust from the conduit 51 and the manifold 52 passes through the aligned apertures 56 and 66 in the sleeves 26 and 27, respectively, for discharge into an elongated slot 74 also provided in the fixed sleeve 18. As seen in Fig. 5, the slot 74 extends substantially the full length of the sleeve 18 and discharges lead exhaust from both cylinders 24 into the passage 71. It will be understood that the varying lengths of the slots 69 and the stepped interconnection of the slots 62 is for the purpose of providing the proper exhaust port areas in order to accommodate the increasing and decreasing amounts of exhaust vapor during oscillation of the cylinders.

The control tube 37 at the center of the porting system is used primarily for starting purposes in order to provide full stroke or cut-off vapor admission or any desired combination thereof. For this purpose, the tube 37 has a slot 76 which upon rotary manipulation of the tube 37 is adapted to register with either the cut-off slots 67 or the full stroke slot 68 in the fixed sleeve 18. Inasmuch as the control tube 37, like the fixed sleeve 18, cooperates with both of the cylinders 24, it will be understood that two such slots 76 are provided in suitable locations above the respective cylinders. The control tube 37 is manipulated by means of the operating extension 38 and is preferably arranged for limited rotary movement, e. g. about 100°. Inasmuch as a separate control tube 37 is provided for each bank of cylinders 24, I may also provide suitable connections for manipulating the two control tubes in unison if desired.

In the operation of the engine, the port 76 of the control tube will be in closed position beyond or to the right of the port 68, as viewed in Fig. 4, when the engine is at a standstill. However, as the control sleeve is rotated in a clockwise direction, port 76 will open into the full stroke admission port 68 of the fixed sleeve 18 and at the beginning of the power stroke when the port 59 is brought into register with the port 68 by appropriate rocking movement of the cylinder 24, high pressure vapor is admitted through the ports 68, 59, 54 and 48 into the upper end of the cylinder 24 for exerting pressure on the head of the piston 33. At this point in the operation vapor flow is continuous during the power stroke without cut-off. As the control sleeve is rotated further, port 76 opens into the lowermost port 67 and when the cylinder 24 has oscillated into proper position to align the ports 57 with the ports 67, high pressure vapor is then admitted through the cut-off admission system as hereinbefore described. As the control sleeve 37 is rotated still further, the port 76 opens into both ports 67 for increasing the vapor flow to the cut-off admission tube 41. Because the slot 76 is wide enough to overlie slightly both the full stroke admission port 68 and the lowermost cut-off port 67 in the fixed sleeve 18, it will be seen that the device permits of any combination of full stroke and cut-off admission during starting of the engine. As hereinbefore explained in connection with Fig. 2, the cut-off ports 42 in the cylinder wall are in register with the passages 44 in the piston 33 for only a small portion of the power stroke so that the desired vapor expansion is realized in the cylinders. It will also be understood that when the oscillating cylinder 24 is in position to permit admission of the high pressure vapor to the engine by alignment of the ports 67 and 57, the oppositely disposed cooperating exhaust ports in the sleeves 18 and 27 are out of register so that the vapor does not escape through the exhaust system.

As the piston approaches the end of the power stroke, as seen in Fig. 4, the lead exhaust ports 49 in the cylinder wall are uncovered allowing exhaust vapor to escape through the conduit 51, as hereinbefore described, and thence from the manifold 52 through the aligned ports 56 and 66 into the exhaust slot 74 which is in register with the latter before the other exhaust slots 69 are in position to discharge vapor from the engine. The lead exhaust vapor thus passes from the slot 74 through the circumferentially grooved passageway 71 into the vapor exhaust outlets 72 and 73. When the piston reaches lower dead center upon completion of the lower stroke, the normal exhaust slots 62 begin to open into the slots 69 of the fixed sleeve 18. The slots 69 also lead into the peripherally connecting groove 71 so that the direct exhaust from the slots 69 is also discharged through the vapor exhaust outlets 72 and 73. At approximately the midpoint of the exhaust stroke of the piston, the ports 62 are in complete register with the ports 69. It will be understood that

during this portion of the cycle, i. e. during the exhaust stroke of the piston, the oscillation of the cylinder 24 has caused the ports 57 to be shifted out of register with the ports 67 so that no high pressure vapor is admitted to the cylinder. As hereinbefore described, the lead exhaust is cut off as soon as the piston moves above the cylinder wall openings 49.

By the foregoing cylindrical porting system, it will be seen that the sealing of high pressure vapor is readily accomplished by means of the washers 28 and 29 so that leakage of high pressure vapor from the porting system into the crankcase 11 is substantially eliminated or kept to a tolerable minimum. Any leakage which occurs within the porting system per se is not detrimental since it involves merely leakage of high pressure vapor to the exhaust system. By reason of the pivotal suspension of the cylinders on the fixed sleeve 18, the thrust of the cylinders is always parallel to the axis of the cylinder regardless of the cylinder angle. Consequently, the clearance between the fixed sleeve 18 and the oscillating sleeves 27 in the region of the vapor inlet ports is constant as determined by manufacturing tolerances. In the zone below the horizontal center line of the cylindrical porting system, the upward pressure or thrust of the cylinders seals the various slots and openings against the leakage of high pressure vapor into the exhaust system. In other words, the areas in the porting system below the horizontal center line are always in contact due to the vertical thrust of the cylinders, whereas the areas above the horizontal center line have a slight predetermined clearance which can be controlled by the manufacturing technique.

By reason of the above described advantages, the porting system and cylinder suspension arrangement herein described will be seen to be particularly useful in connection with larger size engines adapted to operate at high pressures and higher speeds and wherein leakage of vapor must be held to a minimum.

Another important advantage of the invention for many purposes resides in the fact that the engine as described above is non-reversible so that the correct direction of rotation is insured during starting. This is true for either full stroke or cut-off admission of vapor to the cylinders because of the correlated arrangement of the cylindrical ports with respect to the cut-off and full stroke vapor inlets. For example, it will be evident from the drawings that the cylindrical ports 68 and 59 begin to register for full stroke admission of vapor only when the cylinder is in its oscillatory position corresponding to top dead center position of the piston. With a multiple cylinder arrangement as herein described, at least one cylinder will always be in proper position for the desired uni-directional starting. Similarly in the case of cut-off admission, the registry of the cut-off ports 42 and 44 is ineffective unless the cylindrical ports 57 and 67 are likewise aligned, and the latter condition begins to occur only at the oscillatory position of the cylinder corresponding to top dead center position of the piston. Thus, by my combination of cut-off vapor inlet means with a porting system responsive to oscillation of the cylinder, I obtain consistent uni-directional starting together with the thermodynamic advantages of cut-off vapor admission.

Although the invention has been described in connection with certain specific structural embodiments, it will be understood that various modifications and equivalent structures may be resorted to without departing from the scope of the invention as defined in the appended claims.

I claim:

1. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having vapor passages therethrough, sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotally supporting the cylinder, said sleeve means having vapor passages adapted to register with the vapor passages in said fixed sleeve, and manually operable control means within said fixed sleeve for controlling the admission of vapor thereto.
2. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having vapor passages therethrough, sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for rocking movement relative thereto, said sleeve means having vapor passages

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adapted to register with the vapor passages in said fixed sleeve, and a manually operable control tube movably mounted within said fixed sleeve for controlling the admission of vapor thereto.

3. In a vapor engine having a crankcase, an oscillating cylinder in said crankcase, and a reciprocating piston in said cylinder, the combination of a fixed sleeve rigidly mounted on said crankcase and having vapor passages therethrough, oscillatable sleeve means surrounding said fixed sleeve and rigidly secured to the cylinder for pivotally supporting the latter on said fixed sleeve, said sleeve means having vapor passages adapted to register with the vapor passages in said fixed sleeve upon oscillation of the cylinder for admitting and exhausting vapor to and from the engine, and a manually movable control tube rotatably mounted within said fixed sleeve for controlling the admission of vapor to the latter.

4. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having vapor supply and vapor exhaust passages therein, sleeve means rigidly secured to the head of the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotally supporting the cylinder, said sleeve means having an arcuate vapor passage therein communicating with the cylinder through the head thereof and adapted to register alternately with said vapor supply and said vapor exhaust passages in the fixed sleeve in response to oscillation of the cylinder, and manual control means within said fixed sleeve for controlling the admission of vapor thereto.

5. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having vapor passages therethrough, oscillatable sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotal support of the cylinder, cut-off vapor inlet means for admitting cut-off vapor to the cylinder through the piston, direct vapor inlet means for admitting vapor directly to the cylinder, said oscillatable sleeve means being provided with a plurality of vapor passages adapted to register with the vapor passages in said fixed sleeve and including separate port means communicating with said cut-off vapor inlet means and said direct vapor inlet means, and a control tube movably mounted within said fixed sleeve and having port means for controlling the admission of vapor through the passages in said fixed sleeve to said separate port means in said oscillatable sleeve means.

6. In a vapor engine having an oscillating cylinder and reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder, sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotally supporting the cylinder, said fixed sleeve and said sleeve means having direct vapor inlet passages and cut-off vapor inlet passages adapted to register in response to oscillation of the cylinder, conduit means connecting said cut-off vapor inlet passages with the cylinder for admitting vapor to the latter through the piston, and a control tube movably mounted within said fixed sleeve for controlling the introduction of vapor to the latter, said control tube having a slot adapted to be moved manually into register with one or both of said vapor inlet passages.

7. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having vapor passages therethrough, oscillatable sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotal support of the cylinder, lead exhaust means for discharging vapor from the cylinder, direct exhaust means for discharging vapor from the cylinder, said oscillatable sleeve means being provided with a plurality of vapor passages adapted to register with the vapor passages in said fixed sleeve and including separate port means communicating with said lead exhaust means and said direct exhaust means, and a control tube movably mounted within said fixed sleeve for controlling the admission of vapor thereto.

8. In a vapor engine, the combination of an oscillating cylinder having direct exhaust port means in the head thereof and lead exhaust port means in the side wall thereof, a reciprocating piston in said cylinder, a fixed sleeve providing a pivot for the cylinder, oscillatable

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sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotal support of the cylinder, said fixed sleeve and said sleeve means each having vapor passages therethrough including exhaust openings adapted to register in response to oscillation of the cylinder for discharging exhaust vapor from the direct exhaust port means of the cylinder, and conduit means communicating between the lead exhaust port means in the cylinder and said exhaust openings for discharging exhaust vapor from the cylinder upon movement of the piston to uncover said lead exhaust port means whereby exhaust lead is provided to permit quick release of exhaust vapor from the cylinder before said exhaust openings are in complete register.

9. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and having a plurality of inlet and exhaust vapor passages therethrough, oscillatable sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotal support of the cylinder, separate means for admitting cut-off inlet vapor through the piston to the cylinder and for discharging lead exhaust vapor from the cylinder, means for admitting direct inlet vapor to the cylinder and for discharging direct exhaust vapor from the cylinder, said oscillatable sleeve means being provided with a plurality of vapor passages adapted to register with the inlet and exhaust vapor passages in said fixed sleeve and including separate port means communicating with each of said inlet vapor means and exhaust vapor means, and a movable control tube mounted in said fixed sleeve for controlling the introduction of vapor thereto.

10. In a vapor engine having a crankcase, an oscillating cylinder in said crankcase, and a reciprocating piston in said cylinder, the combination of a pivot sleeve mounted in said crankcase, a support for said pivot sleeve rigid with said crankcase and holding the pivot sleeve in fixed non-rotatable position, said pivot sleeve having inlet and exhaust vapor passages therethrough and said support having an exhaust vapor outlet communicating with the exhaust vapor passages in said pivot sleeve and adapted to be connected to an exhaust pipe, oscillatable sleeve means rigidly connected to the cylinder and surrounding said pivot sleeve for pivotal support of the cylinder, said sleeve means being provided with inlet and exhaust vapor passages adapted to register with the passages in said pivot sleeve, and manual control means within said pivot sleeve for controlling the admission of vapor thereto.

11. In a vapor engine having a crankcase, a pair of oscillating cylinders arranged side-by-side in said crankcase, and reciprocating pistons in said cylinders, the combination of a pivot sleeve mounted in said crankcase, a central support for said pivot sleeve rigid with said crankcase and holding the pivot sleeve in fixed non-rotatable position, oscillatable sleeve means rigidly connected to each of the cylinders and surrounding said pivot sleeve on opposite sides of said central support for pivotally supporting the cylinders, said pivot sleeve having inlet and exhaust vapor passages therethrough adjacent each of the cylinders, said sleeve means each being provided with cooperating inlet and exhaust vapor passages adapted to register with the corresponding passages in said pivot sleeve, and said support having a common exhaust vapor outlet communicating with the exhaust vapor passages in said pivot sleeve for both cylinders, and manual control means within said pivot sleeve for controlling the admission of vapor thereto.

12. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve having vapor passages therethrough, oscillatable sleeve means surrounding said fixed sleeve and rigidly secured to the cylinder for pivotally supporting the latter on said fixed sleeve, said sleeve means having vapor passages adapted to register with the vapor passages in said fixed sleeve upon oscillation of the cylinder for admitting and exhausting vapor to and from the engine, annular sealing means surrounding said fixed sleeve and engaging the opposite axial ends of said sleeve means for preventing leakage of vapor, and manual control means within said fixed sleeve for controlling the admission of vapor thereto.

13. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed sleeve providing a pivot for the cylinder and

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having vapor passages therethrough, oscillatable sleeve means rigidly secured to the cylinder for oscillation therewith and surrounding said fixed sleeve for pivotal support of the cylinder, and conduit means communicating between the side of the cylinder and said sleeve means for discharging lead exhaust vapor from the cylinder, the head of said cylinder also having port means for discharging direct exhaust vapor, said sleeve means being provided with a plurality of vapor passages adapted to register with the vapor passages in said fixed sleeve including lead exhaust port means communicating with said conduit means and separate port means communicating with the direct exhaust port means in the cylinder head, and said lead exhaust port means being adapted to be opened before the piston reaches its bottom dead center position with said separate port means being adapted to close substantially at the top dead center position of the piston.

14. In a vapor engine having an oscillating cylinder and a reciprocating piston in said cylinder, the combination of a fixed pivot sleeve having vapor passages therethrough, sleeve means rigidly secured to the head end of the cylinder and concentrically surrounding said fixed sleeve for pivotally supporting the cylinder in downward-

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ly extending relation from said fixed sleeve, said sleeve means having cooperating vapor passages adapted to register with the vapor passages in said fixed sleeve, and a manually movable control tube concentrically mounted within said fixed sleeve for controlling the admission of vapor thereto, the thrust of the cylinder being parallel to the axis thereof and in the direction of said pivot sleeve, and the vertical component of said thrust serving to maintain the contiguous surfaces of the concentric fixed sleeve, sleeve means, and control tube in sealing contact whereby to prevent leakage along said surfaces adjacent said vapor passages.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
822,367	Hanscom	June 5, 1906
856,651	Murphy	June 11, 1907

FOREIGN PATENTS

Number	Country	Date
19,995	Great Britain	Dec. 12, 1889