June 16, 1964 R. GRINNELL, JR 3,137,211

COMPOUND UNIFLOW STEAM ENGINE

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Fig. 3

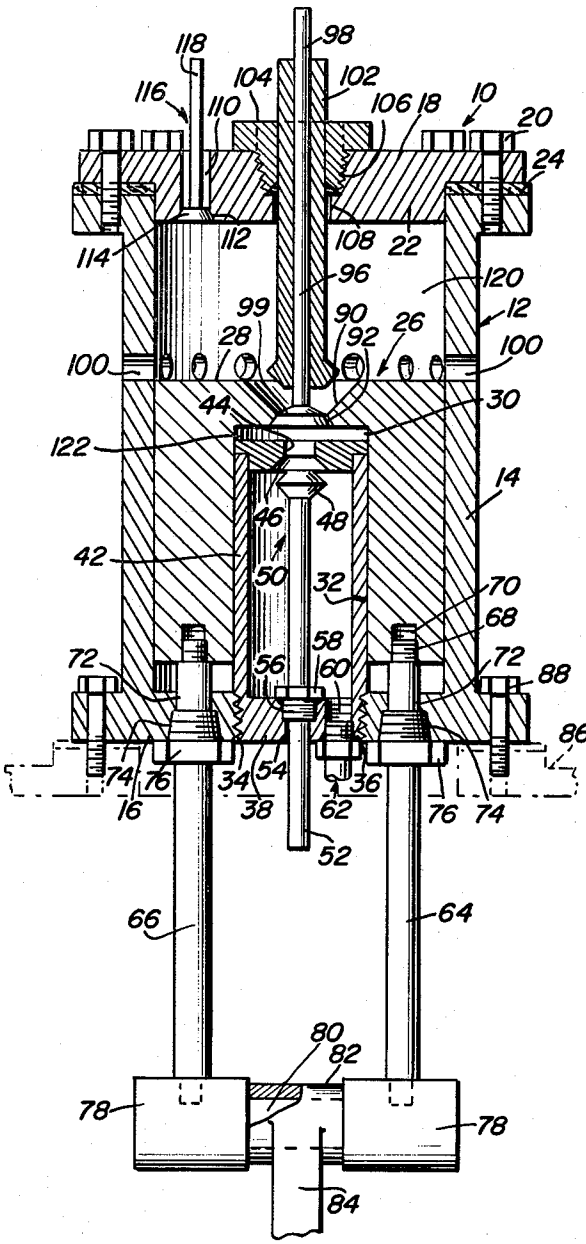


Fig. 1

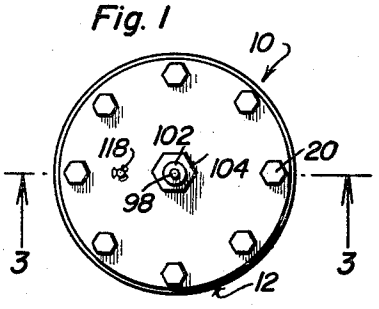
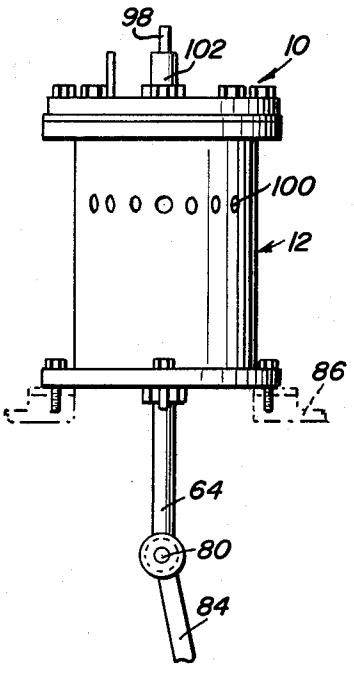


Fig. 2



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Fig. 7

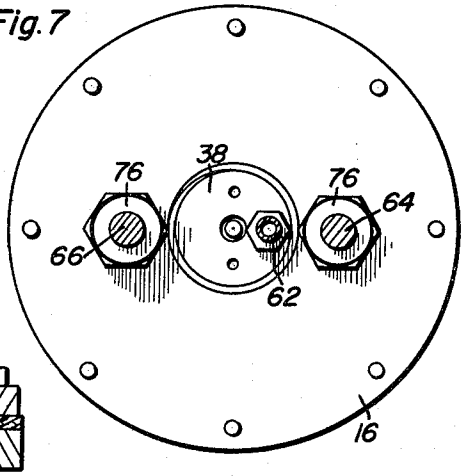


Fig. 4

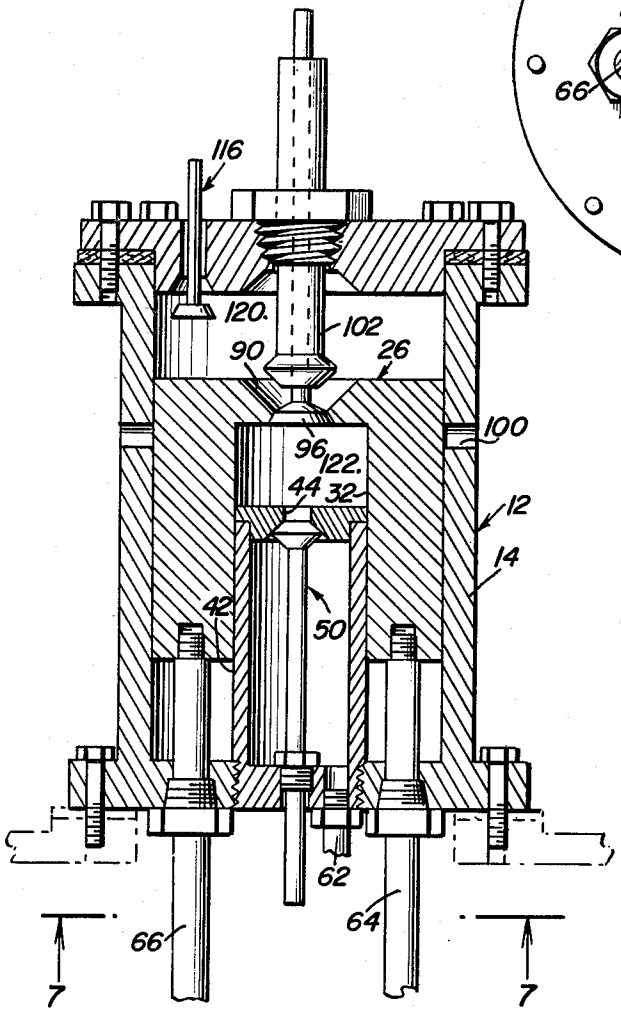
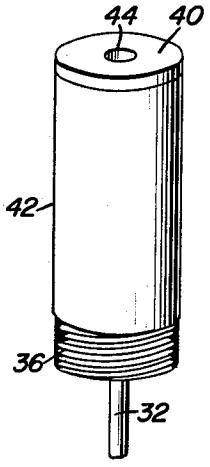


Fig. 8



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Fig. 5

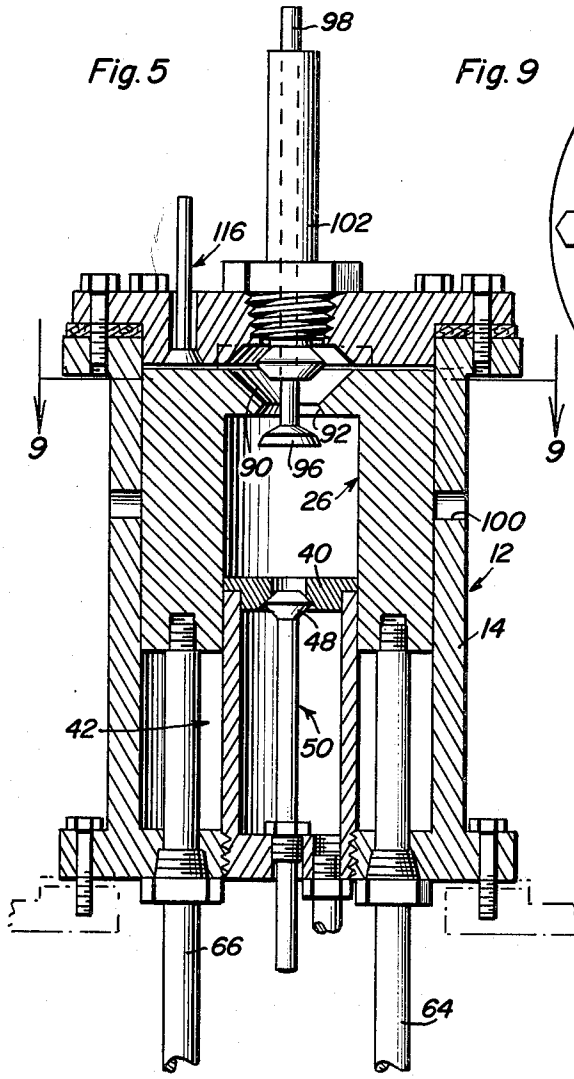


Fig. 9

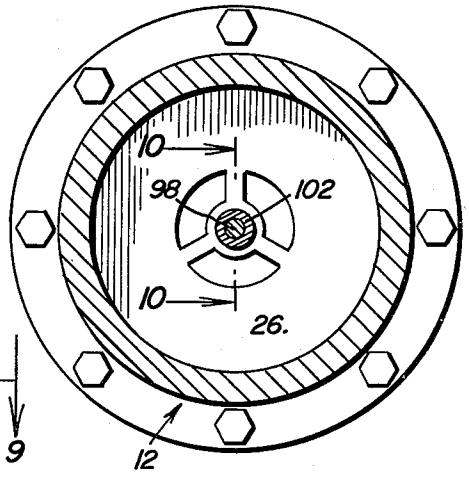
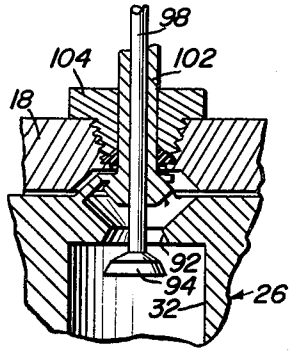


Fig. 10



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Fig. 6

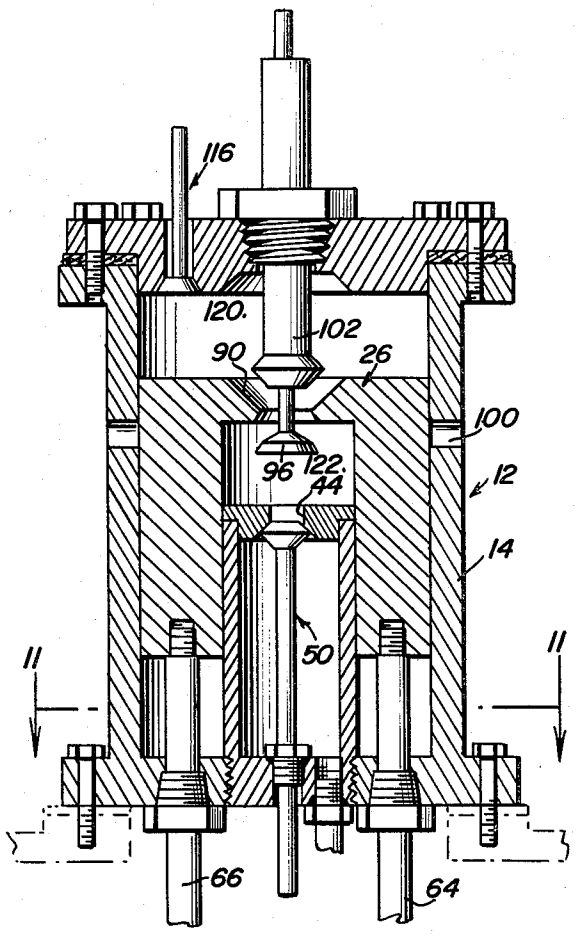


Fig. 12

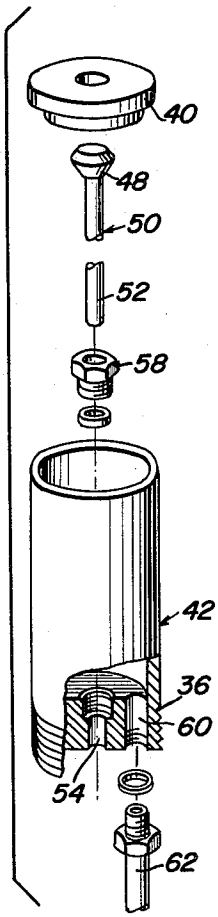
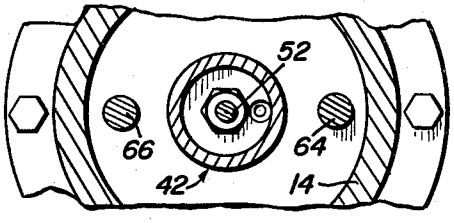


Fig. 11



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United States Patent Office 3,137,211 Patented June 16, 1964

3,137,211

COMPOUND UNIFLOW STEAM ENGINE

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Filed May 1, 1961, Ser. No. 106,811
9 Claims. (Cl. 91—163)

This invention relates to a novel and useful compound uniflow steam engine and more particularly to a steam engine specifically adapted to appreciably reduce heat loss and also to provide an extremely simple means for transferring once expanded steam from the high pressure chamber to the low pressure chamber for further expansion.

Because of the unique construction of the steam engine of the instant invention it may be conveniently constructed of any desired number of cylinders and with the cylinders arranged relative to each other in substantially any conventional arrangement.

The steam engine of the instant invention is further unique in that from the time the steam enters the cylinder of the steam engine to the time it is exhausted from the cylinder of the steam engine the steam is moving continually in the same general direction throughout the first expansion of the steam, the transfer of the steam from the high pressure chamber to the low pressure chamber, throughout the second expansion of the steam and as the steam is being exhausted from the cylinder. By movement of the steam continually in one direction far less heat loss occurs and thus condensation of the steam is maintained at a minimum.

The steam engine of the instant invention utilizes the provision of a cylinder having closure end walls at opposite ends thereof and a piston slidably disposed in the cylinder. A stationary piston extends longitudinally of the cylinder and therewithin from one end wall of the cylinder and the piston is provided with a longitudinally extending blind bore opening toward the stationary piston and slidably receives the latter. The stationary piston is hollow and a steam inlet opening is formed in the end wall of the cylinder from which the stationary piston projects and is in registry with the interior of the stationary piston. The free end of the stationary piston is provided with an outlet opening communicating the interior of the stationary piston with the blind bore formed in the piston member slidably disposed in the cylinder and passage means is formed in the piston member which communicates the blind bore with the head of the piston member remote from the end of the piston member in which the blind bore is formed. First and second valve means are disposed in the outlet opening formed in the stationary piston and the passage means formed in the piston member respectively. The end wall of the cylinder remote from the end wall from which the stationary piston projects is provided with valved vent means for venting that end of the cylinder to the ambient atmosphere and the cylinder is provided with radially opening exhaust passages normally covered by the piston member but which are uncovered by the latter upon movement of the piston member to its limit position adjacent the end wall of the cylinder from which the stationary piston projects. As the piston member is positioned adjacent the end wall from which the stationary piston projects, the first valve means controlling the outlet opening in the stationary piston is opened which communicates the area between the free end of the stationary piston and the blind end of the bore formed in the piston member with the steam supply. As the piston member moves toward the other end of the cylinder, the first valve means closes whereupon further expansion of the steam in the high pressure chamber will continue to move the piston member toward the other end of the cylinder. During the movement of the piston member toward the other end of the cylinder, the vent means is opened thus enabling the low pressure chamber disposed between the other end wall of the cylinder and the piston member to be exhausted. As the piston member reaches the other end of the cylinder the second valve means controlling the passage means between the high pressure chamber and the low pressure chamber is opened and the steam is thus allowed to further expand in the low pressure chamber between the piston member and the other end wall of the cylinder during subsequent movement of the piston member toward the end wall of the cylinder from which the stationary piston projects. As the piston member approaches the one end wall the exhaust port means are uncovered and the low pressure chamber is communicated with the ambient atmosphere. Then, subsequent opening of the first valve means and the vent means in the other end wall of the cylinder will result in a new charge of steam being expanded in the high pressure chamber and movement of the piston member toward the other end wall of the cylinder.

The main object of this invention is to provide a compound uniflow steam engine which will efficiently enable each charge of steam to be twice expanded without appreciable heat loss occurring.

A further object of this invention, in accordance with the preceding object, is to provide a steam engine which may be operated in a highly efficient manner and which may have a plurality of cylinders arranged in any one of a plurality of conventional methods in order that a steam engine constructed in accordance with the present invention may be readily constructed for operation in close and irregularly shaped quarters.

A further object of this invention, in accordance with the preceding objects, is to provide a compound steam engine which may be more compactly constructed.

A final object to be specifically enumerated herein is to provide a compound uniflow steam engine which will conform to conventional forms of manufacture, be of simple construction and easy to operate so as to provide a device that will be economically feasible, long lasting and relatively trouble free in operation.

These together with other objects and advantages which will become subsequently apparent reside in the details of construction and operation as more fully hereinafter described and claimed, reference being had to the accompanying drawings forming a part hereof, wherein like numerals refer to like parts throughout, and in which:

FIGURE 1 is a top plan view of a steam engine cylinder constructed in accordance with the present invention;

FIGURE 2 is a side elevational view of the steam engine cylinder illustrated in FIGURE 1;

FIGURE 3 is a vertical longitudinal sectional view on somewhat of an enlarged scale taken substantially upon the plane indicated by the section line 3—3 of FIGURE 1;

FIGURES 4, 5 and 6 are longitudinal vertical sectional views similar to that of FIGURE 3 but showing the component parts of the engine in different positions;

FIGURE 7 is a horizontal sectional view taken substantially upon the plane indicated by the section line 7—7 of FIGURE 4;

FIGURE 8 is an enlarged perspective view of the stationary piston utilized in the construction of the steam engine;

FIGURE 9 is a horizontal sectional view taken substantially upon the plane indicated by the section line 9—9 of FIGURE 5;

FIGURE 10 is a fragmentary vertical sectional view taken substantially upon the plane indicated by the section line 10—10 of FIGURE 9;

FIGURE 11 is a horizontal sectional view taken substantially upon the plane indicated by the section line 11—11 of FIGURE 6; and

FIGURE 12 is an exploded perspective view of the stationary piston and valve means therefor, parts thereof being broken away and shown in section.

Referring now more specifically to the drawings the numeral 10 generally designates the steam engine of the instant invention which includes a cylinder assembly generally referred to by the reference numeral 12.

The cylinder assembly 12 includes a cylinder 14 having opposite end walls 16 and 18. The end wall 18 is removably secured to the corresponding end of the cylinder 14 by means of suitable fasteners 20 and includes a cylindrical projection 22 snugly received within the corresponding end of the cylinder 14. A gasket 24 is disposed between the cylinder 14 and the end wall 18.

Piston means in the form of a piston member generally referred to by the reference numeral 26 is slidably disposed in the cylinder 14 and it will be observed that the piston member 26 includes a large cross sectional area head end 28 and a small cross sectional head end 30 which comprises the end wall of a blind bore 32 formed in the end of the piston member 26 remote from the large head end 28. The end wall 16 is provided with a centrally disposed threaded bore 34 and a hollow cylindrical stationary piston has a threaded neck portion 36 on one end threadedly engaged in the threaded bore 34. The stationary piston includes a unitary outer end wall 38 and a removable end wall 40.

The end wall 40 may be secured to the free end of the stationary piston 42 in any convenient manner and it will be noted that an outlet opening 44 is formed in the end wall 40 and is provided with a valve seat 46 with which the head 48 of the valve generally referred to by the reference numeral 50 may be engaged. The valve 50 comprises first valve means for the steam engine 10 and includes an operating rod 52 which is slidably received through a bore 54 formed in the end wall 38 of the stationary piston 42. The bore 54 is provided with a threaded counterbore 56 in which a packing gland assembly 58 is threadedly engaged. The end wall 38 also includes a steam inlet opening 60 in which the outlet end of a steam line 62 is engaged.

A pair of piston rods 64 and 66 are provided and each includes a threaded shank end portion 68 threadedly engaged in a blind bore 70 formed in the end of the piston member 26 remote from the large head end 28. Each of the piston rods 64 and 66 is slidably received through a bore 72 formed in the end wall 16 and each of the bores 72 is provided with a threaded counterbore 74 in which there is secured a packing gland assembly 76.

Each of the piston rods 64 and 66 is provided with a journal 78 on its end remote from the threaded shank 68 and the journals 78 are aligned and rotatably journal the opposite end portions of a wristpin 80 carried by the journal 82 of a connecting rod 84 whose other end may be operatively connected to the crankshaft of the steam engine 10. It will be noted that the cylinder assembly 12 is secured to the crankcase 86 of the steam engine 10 by means of suitable fasteners 88. Additionally, it is to be understood that the operating rod 52 of the valve 50 may be operatively connected in any convenient manner to the crankshaft (not shown) of the steam engine 10 in order that the valve 50 may be operated in timed sequence relative to the reciprocating movement of the piston member 26 in the cylinder 14.

The piston member 26 includes steam transfer passage means 90 which communicates the blind end of the bore 32 with the large head end 28 of the piston member 26 and is provided with a seat 92 with which the valve head 94 of the valve 96 may be engaged. The valve 96 includes an operating rod 98 which also may be operatively connected to the crankshaft of the steam engine 10 in any convenient manner so as to operate the valve 96 in timed

sequence with the reciprocating movement of the piston member 26. The cylinder 14 includes a plurality of circumferentially spaced and radially extending exhaust ports 100 which are normally covered by the piston member 26 but which may be uncovered upon movement of the piston member 26 to the bottom dead center position illustrated in FIGURE 3 of the drawings. The transfer valve 96 has its operating rod 98 slidably disposed in a transfer valve sleeve 102 which extends longitudinally of the cylinder 14 and is formed integrally with the piston member 26. It will be noted that the transfer valve sleeve 102 is slidably received through a packing gland assembly 104 which is threadedly engaged in the counterbore 106 formed in the bore 108 in the end wall 18. The end wall 18 also includes a vent passage 110 including a valve seat 112 with which the head 114 of a vent valve generally referred to by the reference numeral 116 may be engaged. The vent valve 116 includes an operating shaft 118 which also may be operatively connected to the crankshaft of the steam engine 10 for operation in timed relation with reciprocation of the piston member 26.

In operation, as the piston member 26 is moved to the bottom dead center position illustrated in FIGURE 3 of the drawings the exhaust ports 100 of the low pressure or second work chamber 120 are uncovered and the twice expanded steam in the second work chamber 120 may be exhausted. At the same time, the valve 50 is opened which communicates the steam line 62 with the high pressure or first work chamber 122. The pressure of steam in the first work chamber 122 will then begin to move the piston member 26 toward the end wall 18. Before the exhaust ports 100 are covered, the valve 116 is opened thus venting the second or low pressure work chamber 120 to the ambient atmosphere. As the piston member 26 reaches approximately the half way point toward the end wall 18, the valve 50 is closed. Then, as the piston member 26 reaches the top dead center position illustrated in FIGURE 5 of the drawings the valve 96 is opened thus communicating the first or high pressure work chamber 122 with the second or low pressure work chamber 120. Inasmuch as the cross sectional area of the piston member 26 disposed in the low pressure work chamber 120 is greater than the small head end 30 of the piston member 26 disposed in the first or high pressure work chamber 122, the piston member 26 will be urged downwardly toward bottom dead center position whereupon substantially all of the steam will be transferred from the high pressure chamber to the low pressure chamber. Just shortly before the valve member 98 is opened, the valve member 116 is closed in order to terminate venting of the low pressure chamber 120 and as soon as the piston member 26 again reaches the bottom dead center position illustrated in FIGURE 3 of the drawings the valve member 98 is moved to the closed position thereby terminating communication of the first and second work chambers whereupon subsequent opening of the valve member 50 will again admit pressure into the first work chamber 122. It will be noted that during the transfer from the first work chamber 122 to the second work chamber 120 that the steam moves an extremely short distance and that the steam during movement through the cylinder assembly 12 moves generally in one direction and in a substantially straight path. By constructing the steam engine 10 in the manner previously set forth in order to provide as short a transfer of steam from the high pressure chamber to the low pressure chamber as possible and by constructing the cylinder assembly 12 in a manner whereby the steam during the process of being twice expanded will move in generally the same direction, the heat loss of the steam is negligible and accordingly, condensation is held to a minimum.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous

modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation shown and described, and accordingly all suitable modifications and equivalents may be resorted to, falling within the scope of the invention as claimed.

What is claimed as new is as follows:

1. A compound uniflow steam engine comprising a cylinder having closure end walls at opposite ends and piston means slidably disposed between said end walls defining first and second work chambers between said end walls and said piston at first and second end portions of said cylinder respectively, said piston means having a larger transverse sectional head area disposed in said second chamber than in said first chamber, first work chamber steam inlet means including first valve means adapted to be operated in response to movement of said piston means to said first end portion of said cylinder and during subsequent movement of said piston means back toward said second end portion of said cylinder for admitting steam under pressure to said first work chamber, passage means formed in and opening through opposite ends of said piston at points spaced inwardly of the adjacent peripheral portions of said piston and communicating said first work chamber with said second work chamber, said passage means including second valve means operable in second work chamber including second valve means operable in response to movement of said piston means to said second end portion of said cylinder and during movement of said piston means to said first end portion of said cylinder for communicating said first and second work chambers.

2. A compound uniflow steam engine comprising a cylinder having closure end walls at opposite ends and piston means slidably disposed between said end walls defining first and second work chambers between said end walls and said piston at first and second end portions of said cylinder respectively, said piston means having a larger transverse sectional head area disposed in said second chamber than in said first chamber, the first work chamber steam inlet means including first valve means adapted to be operated in response to movement of said piston means to said first end portion of said cylinder and during subsequent movement of said piston means back toward said second end portion of said cylinder for admitting steam under pressure to said first work chamber, passage means communicating said first work chamber with said second work chamber including second valve means operable in response to movement of said piston means to said second end portion of said cylinder and during movement of said piston means to said first end portion of said cylinder for communicating said first and second work chambers, said piston means comprising a generally cylindrical piston member having a longitudinally extending blind bore formed in one end thereof opening toward said first end wall, said first end wall of said cylinder having a hollow cylindrical stationary piston projecting outwardly therefrom and longitudinally of said cylinder slidably receivable in said blind bore, an outlet opening in the free end of said stationary piston, said first means being disposed in said outlet opening, said first end wall having a steam inlet formed therein communicated with the interior of said stationary piston.

3. The combination of claim 2 wherein said passage means is formed in said piston member and communicates the blind end of said bore with the end face of said piston member disposed in said second work chamber.

4. The combination of claim 3 wherein said first and second valve means include operating rods extending longitudinally of said cylinder and slidably disposed through said first and second end walls respectively.

5. The combination of claim 4 wherein said outlet opening and said passage means extend longitudinally of said cylinder and are concentric with the longitudinal axis of said cylinder.

6. A compound uniflow steam engine comprising a cylinder having closure end walls at opposite ends and piston means slidably disposed between said end walls defining first and second work chambers between said end walls and said piston at first and second end portions of said cylinder respectively, said piston means having a larger transverse sectional head area disposed in said second chamber than in said first chamber, said work chamber steam inlet means including first valve means adapted to be operated in response to movement of said piston means to said first end portion of said cylinder and during subsequent movement of said piston means back toward said second end portion of said cylinder for admitting steam under pressure to said first work chamber, passage means communicating said first work chamber with said second work chamber including second valve means operable in response to movement of said piston means to said second end portion of said cylinder and during movement of said piston means to said first end portion of said cylinder for communicating said first and second work chambers, said piston means including a pair of parallel longitudinally extending piston rods, means in one end wall slidingly receiving said rods, means carried by the ends of said rods remote from said piston means adapted to be pivotally secured to one end of a connecting rod, said piston means comprising a generally cylindrical piston member having a longitudinally extending blind bore formed in one end thereof opening toward said first end wall, said first end wall of said cylinder having a hollow cylindrical stationary piston projecting outwardly therefrom and longitudinally of said cylinder slidably receivable in said blind bore, an outlet opening in the free end of said stationary piston, said first means being disposed in said outlet opening, said first end wall having a steam inlet formed therein communicated with the interior of said stationary piston.

7. The combination of claim 6 wherein said passage means is formed in said piston member and communicates the blind end of said bore with the end face of said piston member disposed in said second work chamber.

8. The combination of claim 7 wherein said first and second valve means include operating rods extending longitudinally of said cylinder and slidably disposed through said first and second end walls respectively.

9. The combination of claim 8 wherein said outlet opening and said passage means extend longitudinally of said cylinder and are concentric with the longitudinal axis of said cylinder.

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