J. STUMPF.

STEAM ENGINE.

APPLICATION FILED APR. 18, 1908.

1,042,168. Patented Oct. 22, 1912.

Fig. 2.

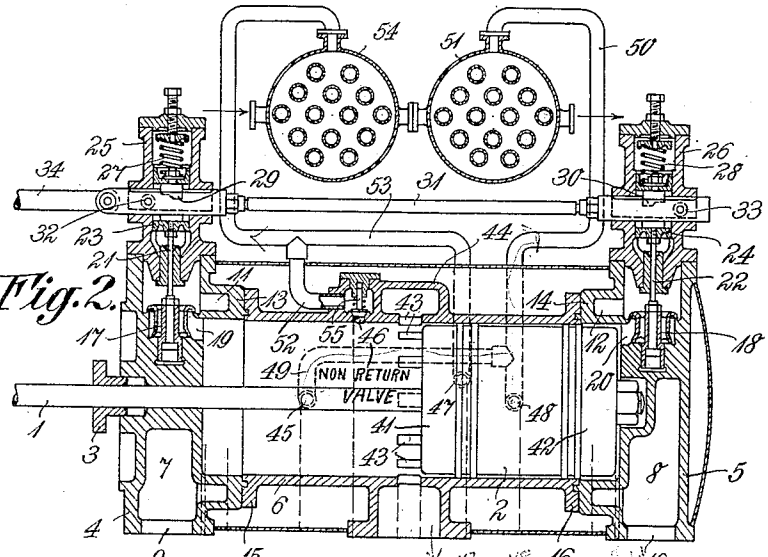


Fig. 1.

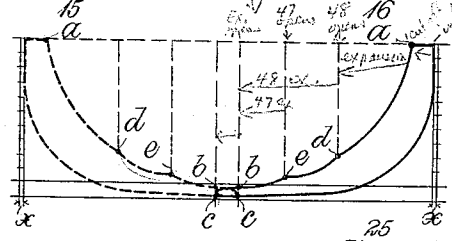


Fig. 3.

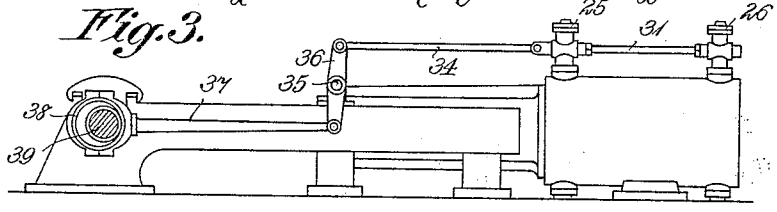
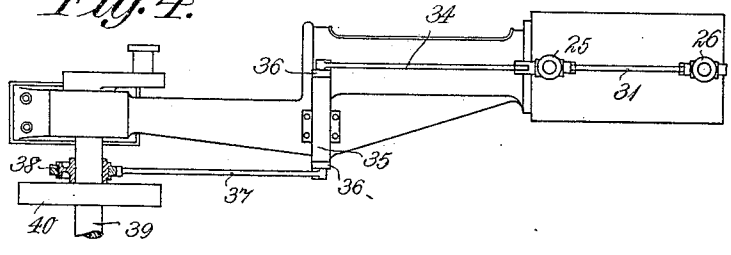


Fig. 4.



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STEAM-ENGINE.

1,042,168. Specification of Letters Patent. Patented Oct. 22, 1912.

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To all whom it may concern:

Be it known that I, JOHANN STUMPF, a citizen of the Empire of Germany, residing at Berlin, Germany, have invented certain new and useful Improvements in Steam-Engines, of which the following is a full, clear, and exact description.

This invention relates to steam engines of that kind in which steam is admitted through an inlet port at the end of the cylinder and is exhausted through separate exhaust ports controlled or uncovered by the piston at and near the end of its working stroke. Such engines have received the name "uni-directional flow" or briefly "una-flow" steam engines for the reason that the steam once admitted into the cylinder does not return on its path.

The object of the present invention is to improve the thermal working conditions in such engines so as to enable a high ratio of expansion to be carried out with maximum efficiency in a single cylinder. This result is obtained primarily by the provision of means for heating the steam near the inlet end during expansion and compression and secondly by using in conjunction therewith means for bring the working steam at the end of expansion into layers of decreasing dryness toward the exhaust while the piston uncovers the exhaust ports to let this wettest steam pass off and then on the reversal of its motion covers the exhaust ports and retains them covered while the cylinder-heated, drier steam is trapped and compressed up to the inlet end. By proceeding in this way, the thermal and temperature conditions of the cylinder are such that a high ratio of expansion may be carried out in a single cylinder without incurring the well known losses which in the past has forced engineers to have recourse to multiple expansion engines.

In the accompanying drawings: Figure 1, is a diagram of the action of the steam in an engine constructed according to this invention, Fig. 2, is a longitudinal vertical section through the cylinder of a double acting steam engine constructed in accordance with this invention showing heat exchange bodies connected to it. Fig. 3 is a diagrammatic side elevation of the improved engine. Fig. 4, is a plan of the same partly in section.

Considering as a whole the cylinder of the double acting engine illustrated in the drawings, this cylinder may be regarded as consisting of three main parts, first the cylinder cover 4, provided with a stuffing box 3, through which passes the rod 1, of the piston 2, secondly the cylinder head 5, and thirdly the main body of the cylinder 6, disposed between the covers 4, and the head 5, and containing the piston 2. The cylinder covers 4 and 5, have formed in them annular chambers 7 and 8, connected by means of openings 9 and 10 with steam supply pipes which are not shown in the drawings. Adjoining the chamber 7 and 8 and communicating therewith are annular chambers 11 and 12, formed in cylindrical projections 13 and 14 from the cylinder covers 4 and 5. The length of these cylindrical projections corresponds to the distance of travel of the piston from the dead center to the point when cut off occurs. The ends of the cylinder 6, are connected to the projections 13, and 14 of the cylinder covers 4 and 5 by means of flanges 15 and 16. Within the cylinder covers 4 and 5, and leading to the cylinder 6, there are provided suitable steam inlet ports 19 and 20 to be controlled by double seat valves 17 and 18. The spindles 21 and 22 of the valves 17 and 18, carry at their upper or outer ends, sleeves or sliding blocks 23 and 24, which can reciprocate in the cylindrical cap or casing 25 or 26, mounted on the end of the cylinder 6, this sleeve being controlled by an adjustable spring 27 or 28. Each slide 23 or 24 is provided with or has formed on it a cam 29 or 30. Rollers 32 and 33 mounted on the valve spindle 31 operate on these cams 29 and 30 as the valve spindle reciprocates so that while the valve 17 is opened the valve 18 is held closed by its spring 28. Conversely during the return stroke of the valve spindle 31 the valve 17, is closed by the action of its spring 27, and the valve 18 is opened by the roller 33, engaging with the cam 30. The valve spindle 31 is connected by a rod 34 to a two armed lever 36 mounted on a rock shaft 35 the other arm of the lever being connected to an eccentric rod 37 (Figs. 3 and 4). The eccentric 38, is preferably of the shifting type controlled or adjusted by a shaft governor 40 which is diagrammatically represented as being mounted on the crank shaft 39, the action of the governor regulating the cut-off from the cylinder. The piston 2, is provided with extensions or projections 41 and 42, each of which corresponds in length to the length of the cylindrical ex-

tensions 13, 14, of the cylinder covers 4 and 5, these extensions of the piston projecting into the extensions of the cylinder formed by the parts 13 and 14 and surrounded by the annular heating jackets 11 and 12.

In the claims the jackets formed by the hollow covers and the annular projections are referred to as partial jackets to distinguish them from the ordinary steam jacket which is arranged over the entire cylinder and heats all parts indiscriminately.

The exhaust ports 43, are disposed midway in the length of the cylinder 6, and communicate with the surrounding annular chamber 44, which is connected to the cylinder in a manner favorable to the conduction of heat therefrom so as to have a cooling effect in the neighborhood of the exhaust. This annular chamber or exhaust belt thus forms a cooling jacket or belt. In addition to the exhaust ports 43 there are also formed in the walls of the cylinder in the construction of the engine illustrated in Fig. 2, ports 45, 46, 47, and 48. Of these ports 45 and 48 are in communication by means of pipes 49 and 50 with a heat exchange body 51, or some accessory apparatus for utilizing the exhaust steam while the ports 46 and 47 communicate by pipes 52 and 53 with another heat exchange body or accessory apparatus 54 of the same type. Between the ports 45, 46, 47 and 48, and the outlet pipes connected thereto are disposed automatic non-return valves 55 shown in section as applied to the port 46 Fig. 2. The valves on the other ports are similarly arranged.

The operation of this uni-directional flow engine is as follows:—Steam enters at the inlets 9 and 10 to the hollow covers and circulates through these covers on its way past the inlet valves 17 and 18, to the inlet ports 19 and 20 at the ends of the cylinder. When the piston moves from the position illustrated to the point *a* (Fig. 1), cut-off takes place and there is a circular disk of steam in the cylinder which by expanding to the left becomes wider and pushes the piston to the left. The steam near the inlet end during expansion receives heat from the hot partial jacket formed in the first place by the hollow cover and in the second place by the short annular extension. This steam which is practically quiescent as regards the layer near the hollow cover, does not therefore give up heat corresponding to the expansion. The layers of steam nearer the moving piston, however, receive little or no heat from the cylinder walls and consequently these layers are composed of wet steam, the dryness of the steam decreasing gradually from the inlet end to the piston end. When the piston uncovers the exhaust ports 43, at and near the end of its working stroke, it is the steam in the wettest zones which passes out first and then the drier steam follows. When the piston on its return stroke closes the exhaust ports 43 it is the hot, dry or slightly superheated steam which was adjacent to the hot jacket which forms the residual steam to be trapped and compressed and this steam during compression rises in temperature under the action of the piston in compressing it and of the hot jacket at the inlet end.

It will be seen that all the heat given up by the end cover to the steam in the cylinder is retained within the cylinder since this steam is itself retained in the cylinder, so that this end cover provides the peculiar phenomenon of a heating jacket with no loss. The bulk of the heat from the annular extensions 11 and 12, is also retained within the cylinder as the steam in expanding gives up some of its heat to the walls of the cylinder which maintains these walls at a highly graduated temperature. In order to further avoid loss of heat from the hot jacket, the end of the piston which is necessarily a comparatively cold part of the steam space, is insulated from the hot surfaces. This is effected by providing the heads 41, 42 on the end of the piston, which heads are out of contact with the hot surfaces.

Hitherto the withdrawal of steam from reciprocating engines has been effected either by mechanically controlled valves or through an outlet at the center of the cylinder. To obviate the necessity of mechanically controlled valves and at the same time to give an option as to the pressure at which the steam is to be withdrawn, I provide a uni-directional flow steam engine cylinder with the intermediate ports 45, 46, 47, 48 which are controlled in the first place by the piston 2, and in the second place by the automatic non-return valves as indicated at 55. The steam passing through the ports 45, 46, 47, 48 is withdrawn through pipes 49, 50, to the accessory apparatus 51, which is shown as the second stage of a heater and by the pipes 52, 53 to the apparatus 54 which is shown as the first stage of a heater. The water or the like to be heated passes through the two stages in the direction indicated by the arrows.

I claim:

1. The combination with a steam engine cylinder having an inlet port and an exhaust port distant therefrom, of means for heating the steam within the cylinder near the inlet port, a relatively cold chamber into which the exhaust port leads, and an elongated piston working in the cylinder and adapted to uncover the exhaust port as the piston nears the end of its working stroke and to keep said port closed and to cover and protect the adjacent interior portion of the cylinder during the remainder of its operating cycle.

2. In combination with a cylinder having

an inlet port at its end and exhaust port intermediate in its length, means for heating the steam near the inlet end during expansion and compression comprising a hot partial jacket at the inlet end of the cylinder, means for bringing the working steam at the end of expansion into layers of decreasing dryness toward the exhaust, comprising a cold exhaust steam belt around the exhaust ports and into which said exhaust ports open directly, said hot jacket and cold belt being spaced apart with an unjacketed portion of the cylinder extending between and means for allowing said wettest steam to pass off unheated at the end of expansion and to trap and compress heated steam comprising an elongated piston working in said cylinder and adapted to uncover said exhaust ports at the end of expansion and retain said ports covered and the interior of the cylinder out of connection with the exhaust belt during compression, substantially as described.

3. In a steam engine, the combination with a working cylinder having an inlet port at its end and separate exhaust ports and a working piston in said cylinder adapted to uncover said exhaust ports at the end of the working stroke and also to retain them covered during expansion and compression of the steam, of means for securing graduation of the steam in zones of driest steam near the inlet end and wettest steam near the exhaust ports consisting of a partial jacket about the inlet end of said cylinder and from which jacket said cylinder inlet port leads, a live steam supply pipe to said jacket and a valve controlling the admission of live steam from said jacket to the cylinder through said inlet port.

4. In a steam engine in combination with a cylinder having exhaust ports therein and a piston working in said cylinder and adapted at and near the end of its working stroke to uncover said exhaust ports and during expansion and compression of the steam to retain said exhaust ports covered, means for securing graduation of the steam in zones of driest steam near the inlet end and wettest steam near the exhaust ports consisting of a hollow cover having a live steam inlet port therein leading to the cylinder, a live steam supply pipe to said hollow cover, and a valve in the live steam port leading from said hollow cover to the cylinder for controlling the admission of steam to said cylinder.

5. In a steam engine in combination with a cylinder having exhaust ports therein and a piston adapted to overrun and control said ports, means for securing graduation of the steam in zones of driest steam near the inlet end and wettest steam near the exhaust ports consisting of a hollow cover for said cylinder having ports leading therefrom to the cylinder, a hollow annular extension on said cover, said extension forming a part of the circular walls of the cylinder, a live steam supply pipe to said hollow cover, and a valve in the port leading from said cover to the cylinder for controlling the admission of live steam to said cylinder.

6. In a steam engine in combination with a cylinder having exhaust ports therein and a piston adapted at and near the end of its working stroke to overrun and control said ports, means for securing graduation of the steam in zones of driest steam near the inlet end and wettest steam near the exhaust ports consisting of a hollow cover having live steam ports leading to the cylinder, an annular hollow extension on said cover, said extension being substantially equal in length to the travel of the piston during normal steam admission to the cylinder, a live steam supply pipe to said hollow cover and a valve in the port leading from said hollow cover to the cylinder and controlling the steam admission to the cylinder from said hollow cover.

7. In a steam engine in combination with a cylinder having exhaust ports therein and a piston adapted at and near the end of its working stroke to overrun and control said ports, means for securing graduation of the steam in zones of driest steam near the inlet end and wettest steam near the exhaust ports consisting of a hollow cover having live steam ports therein leading to the cylinder, an annular hollow extension on said cover, said extension being substantially equal in length to the travel of the piston during normal steam admission to the cylinder, a live steam supply pipe in said hollow cover, and a double seat admission valve for the port leading from said hollow cover to the cylinder.

8. In combination with the cylinder of a uni-directional flow engine, a hot partial jacket on the inlet end of said cylinder and means for insulating said hot jacket from the cold parts of the cylinder steam space.

9. In combination in a steam engine, a cylinder having steam inlet ports at its end and separate exhaust ports therein, a hollow cover on said cylinder having a hollow annular extension thereon, which forms part of the cylinder, a live steam supply pipe to said hollow cover, and means for insulating said piston from the hot surfaces at the inlet end of the cylinder comprising a head on said piston extending at its end for a length substantially equal to the length of the hollow annular extension on the cover and of less diameter than the interior of said annular extension.

10. In combination in a steam engine, a cylinder having steam inlet ports at its end and separate exhaust ports therein, a hollow cover on said cylinder, a hollow annular extension on said cover, said extension form-

ing a part of the cylinder, a live steam supply pipe to said hollow cover, a working piston adapted at and near the end of its working stroke to overrun and control the separate exhaust ports, and means for insulating said piston from the hot surfaces of said hollow cover and annular extension comprising a head on said piston extending for a length substantially equal to the length of the hollow annular extension on the cover within which annular extension said piston head projects at the end of the piston stroke but with the walls of which annular extension the cylindrical part of said piston head is out of contact.

11. In a steam engine, means for withdrawing steam to accessory apparatus and at a pressure between the working pressure and the end pressure consisting of a cylinder having steam inlet ports thereto and separate exhaust ports, a working piston in said cylinder adapted to overrun and control said exhaust ports at and near the end of its working stroke and an outlet passage arranged in the cylinder wall at a point intermediate between the inlet end and the exhaust ports and means for withdrawing steam from said intermediate outlet passage to said accessory apparatus.

12. In a steam engine, means for withdrawing steam to accessory apparatus and at a pressure between the working pressure and the end pressure consisting of a cylinder having steam inlet ports thereto and separate exhaust ports, a working piston in said cylinder adapted to overrun and control said exhaust ports at and near the end of its working stroke and an outlet passage arranged in the cylinder walls at a point intermediate between the inlet end and the exhaust ports, a check valve in said intermediate outlet passage and means for conducting steam from said check valve to said accessory apparatus.

13. In a steam engine, means for withdrawing steam to accessory apparatus and at a pressure between the working pressure and the end pressure consisting of a cylinder having steam inlet ports thereto and separate exhaust ports, a working piston in said cylinder adapted to overrun and control said exhaust ports at and near the end of its working stroke, a steam jacket at the inlet end of said cylinder, and an outlet passage arranged in the cylinder wall at a point intermediate between the inlet end and the exhaust ports and means for withdrawing steam from said intermediate outlet passage to said accessory apparatus.

14. In a steam engine, means for withdrawing steam to accessory apparatus and at a pressure between the working pressure and the end pressure consisting of a cylinder having steam inlet ports thereto and separate exhaust ports, a working piston in said cylinder adapted to overrun and control said exhaust ports at and near the end of its working stroke, a steam jacket at the inlet end of said cylinder, an outlet passage arranged in the cylinder wall at a point intermediate between the inlet end and the exhaust ports, a check valve in said intermediate outlet passage and means for conducting steam from said check valve to said accessory apparatus.

15. In a steam engine, a cylinder having steam inlet and exhaust ports arranged at different points axially in the cylinder, auxiliary ports intermediate said inlet and exhaust ports, and communicating with accessory apparatus, a working piston adapted to uncover said auxiliary and exhaust ports in its travel and means other than the working piston for closing as desired said auxiliary ports.

16. In a steam engine, in combination, a cylinder having steam inlet and exhaust ports arranged at different points axially in the cylinder, auxiliary ports intermediate said inlet and exhaust ports and communicating with accessory apparatus, a working piston adapted to successively uncover said auxiliary and exhaust ports in its travel, and non-return valves in said auxiliary ports.

17. In a steam engine, in combination, a cylinder having steam inlet and exhaust ports arranged at different points axially in the cylinder, auxiliary ports intermediate said inlet and exhaust ports and communicating with accessory apparatus, a working piston adapted to successively uncover said auxiliary and exhaust ports in its travel, non-return valves in said auxiliary ports, a hollow cover on said cylinder, said cover being provided with the inlet ports to the cylinder, a live steam supply pipe to said hollow cover and lift valves in said steam inlet ports for controlling the admission of steam to said cylinders.

18. In a steam engine, a cylinder having steam inlet ports and also exhaust ports arranged at different points axially in the cylinder, a working piston adapted to uncover said exhaust ports in its travel and means other than the working piston for closing as desired all the said exhaust ports except the last ports uncovered by the piston in its stroke.

19. In a steam engine in combination a cylinder having steam inlet and separate exhaust ports therein said exhaust ports being arranged at different points axially in the cylinder, a working piston adapted to successively uncover said exhaust ports in its travel, non-return valves in all exhaust ports except the last ports uncovered by the piston in the succession which last ports act as main exhaust ports.

20. In a steam engine in combination a cylinder having steam inlet and separate ex-

haust ports therein said exhaust ports being arranged at different points axially in the cylinder, a working piston adapted to successively uncover said exhaust ports in its travel, non-return valves in all exhaust ports except the last ports uncovered by the piston in the succession, which last ports act as main exhaust ports, a hollow cover on said cylinder, said cover being provided with the inlet ports to the cylinder, a live steam supply pipe to said hollow cover and lift valves in the steam inlet ports for the cylinder controlling the admission of steam to said cylinder.

In testimony whereof I hereunto affix my signature in the presence of two witnesses.

JOHANN STUMPF.

Witnesses:
HENRY HASPER,
WOLDEMAR HAUPT.