PATENT SPECIFICATION

416,669

Application Date: March 11, 1933. No. 7449/33.

Complete Left: July 13, 1933.

Complete Accepted: Sept. 11, 1934.

PROVISIONAL SPECIFICATION.

Improvements in or relating to Steam Power Systems Embodying Compound or Multi-expansion Steam Engines.

We, THE "SENTINEL" WAGGON WORKS LIMITED, a British Company, of 20, Iddlesleigh House, Caxton Street, Westminster, London, S.W. 1, and ABNER DOBLE, a Citizen of the United States of America, of "Alta Vista", Ridgebourne Road, Shrewsbury, do hereby declare the nature of this invention to be as follows:—

This invention is for improvements in or relating to steam power systems embodying compound or multi-expansion steam engines and has for one of its objects to improve the efficiency of such systems when working under variable load conditions.

According to the present invention there is provided a steam power system comprising the combination with a compound or multi-expansion steam engine, a steam generator for supplying the primary-steam to the engine and means for employing the primary-steam before it reaches the engine for reheating the receiver-steam passing from one expansion stage to another in the engine, of a thermostat for controlling the temperature of the primary-steam by regulating the feed-water supply to the generator and means for maintaining under the control of the said thermostat the temperature of the reheated receiver-steam by passing to the thermostat primary-steam after it has reheated the receiver-steam. It will be found that this arrangement will enable the temperature of the receiver-steam to be maintained always near to the maximum desired for efficient working of the engine in spite of variations in the load on the engine.

Preferably there is provided a throttle-valve for controlling the supply of primary-steam to the engine, which throttle-valve is disposed in that part of the primary-steam circuit through which the primary-steam passes to the thermostate after heating the receiver-steam. This will be found to cause an increase in the temperature of the primary-steam which is used to reheat the receiver-steam when the engine is running under a light load, thus compensating for the greater difficulty of transferring the heat of the primary-steam to the receiver-steam under such conditions.

In a convenient construction there is provided a pipe through which the receiver-steam is passed to be reheated, which pipe extends along side a primary-steam tube in the generator. The receiver-steam pipe and primary-steam tube just mentioned may be formed respectively as the two coils of a double-wound helix.

In an alternative construction there may be a casing through which the receiver-steam is passed to be reheated, and a coiled tube contained within the casing through which tube the primary-steam is passed.

The invention will be found to be particularly useful in steam power systems for driving road vehicles and a preferred embodiment of the invention for use in this connection will now be described.

The preferred steam power system for driving a road vehicle comprises a steam generator of the "flash" or series tube type. The generator has a plurality of spiral water tubes connected in series and disposed one above the other and contained within the lower part of a vertical cylindrical casing. The uppermost water-tube is connected to a helical steam-tube disposed within the upper part of the casing and constituting a wall of the combustion chamber. The burner or furnace is disposed within the upper part of the helical steam-tube and the combustion gases pass downwardly past the steam-tube and the water-tubes and escape through a flue at the bottom of the casing. Feed-water is supplied to the lowermost water-tube.

In carrying out the invention the helical steam-tube forms one coil of a double-wound or multiple-wound helix, the other or another coil of which is arranged to have receiver steam passed through it, and will be referred to as the receiver-steam helical. The coils or tube-portions of the helix are similar to one another and are disposed side by side along their length, and the helix is close wound so that adjacent turns are in contact with one another.

The generator is arranged to supply

primary-steam to a compound steam engine having two expansion stages, and the primary-steam from the generator passes from the upper end of the steam-tube therein through a main throttle-valve which may be disposed outside the casing of the generator, and then to a thermostat which controls the supply of feed-water to the generator, and which may be constructed as described in co-pending Application No. 7450/33. From the thermostat the primary-steam passes to the high-pressure cylinder of the engine.

The receiver-steam discharged by the high-pressure cylinder of the engine is passed through the receiver-steam helical of the generator before being supplied to the low-pressure cylinder of the engine. Thus it will be appreciated that the receiver-steam will receive heat from the primary-steam in the steam-tube of the generator during the passage of the receiver-steam from one expansion stage to the other of the engine.

When the power system just described is operating under light or partial load conditions (which frequently exist when driving road vehicles) the receiver-steam will be cooler than when heavy load conditions prevail. Thus the receiver-steam will abstract from the primary steam in the steam-tube of the generator a comparatively large amount of heat. However, since the thus cooled primary-steam controls the thermostat the latter will operate so as to reduce the supply of feed-water to the generator. The temperature of the primary-steam used for reheating will thereby be raised above the normal value in order to compensate for the greater amount of heat abstracted from the primary-steam. When water is present in the receiver-steam a still greater amount of heat will be abstracted by it from the primary-steam and the thermostat will be operated so as to cause the temperature of the primary-steam used for reheating to be raised still further to compensate for the greater amount of heat required under these conditions by the receiver-steam. It will be noted that under light load conditions less steam is required to drive the engine and a reduction in the supply of feed-water to the generator is desirable.

By passing the primary-steam through the throttle-valve before the thermostat is reached an additional advantage is secured. Under light load conditions the throttle-valve will be partially closed and there will be a drop in the temperature of the primary-steam across the throttle valve. The thermostat will consequently operate so as further to increase the temperature of the primary-steam used for reheating and this is desirable because the lower steam velocities of the primary and receiver-steam and the lower density of the receiver-steam at light loads render the transference of heat to the receiver-steam more difficult.

The construction just described may be modified by the employment of a multi-expansion engine having three or more cylinders. In this case there will be two or more receiver-steam helicals disposed side by side with the steam-tube in the generator. Thus say in a triple expansion engine the receiver-steam from the high-pressure cylinder will be led through one receiver-steam helical before passing through the middle pressure cylinder, and the receiver-steam discharged by the latter will be led through a second receiver-steam helical before passing to the low-pressure cylinder. Also if desired a further helical-tube forming part of the multiple-wound helix may serve to conduct the primary-steam from the throttle-valve to the thermostat, for the purpose of reheating the primary-steam after it has passed through the throttle-valve. In certain circumstances the thermostat may be disposed immediately before the throttle-valve and in such cases the reheater helical for the primary-steam will deliver the steam direct to the engine.

In the construction above described the helical tubes of which the double-wound or multiple-wound helix is composed may be welded together with the welds serving to fill up the helical crevices between adjacent turns of the helix on the interior of the latter.

It has been found convenient to arrange that the direction of flow of the receiver-steam through its portion of the helix shall be opposite to the direction of flow of the primary-steam through the steam-tube, but the direction of flow of reheated primary steam or of the receiver-steam may be reversed if desired.

Instead of leading the receiver-steam from the engine to the generator as in the construction described above, primary-steam from the generator may be led to the engine for the purpose of reheating the receiver-steam. A convenient way of doing this is to have a casing through which is led the receiver-steam passing from one expansion stage to another in the engine and to pass primary-steam through a tube, preferably a coiled tube, contained within the casing. In the case of a triple expansion engine two such casings will be provided and through them will be passed respectively the receiver-steam between the first two and the second two stages of expansion in the engine. The tubes for

the primary-steam in such casings will be connected in series. Obviously instead of two casings a single divided casing could be used.

The steam passed through the tube or tubes contained within the casing or casings just mentioned will be the whole of the primary-steam produced in the generator, and the latter may be controlled by the thermostat control apparatus described in Specification of Application No. 110/32. In this case the primary-steam for reheating the receiver-steam will be withdrawn from the generator immediately before the point is reached at which, when the feed-water supply means are energised, the controlling fluid (water or steam) re-enters the circulatory path of the generator after leaving it at a point slightly below normal water level. The primary-steam after reheating the receiver-steam will be returned to the generator at the point where the said controlling fluid re-enters the said circulatory path.

When the steam power system just described is operating under light load the receiver-steam will be cool and will serve to cool the primary-steam so that less controlling fluid is needed to maintain the primary-steam delivered by the generator at the required temperature. Hence the thermostat will operate so that less feed-water is supplied to the generator. When heavy load conditions prevail, the receiver-steam will abstract very little heat from the primary-steam and more controlling fluid than under light load conditions will be needed to maintain the primary-steam delivered at the required temperature. The thermostat will thus be operated to supply more feed-water to the generator than under light load conditions.

Instead of employing a thermostat as described in the Specification of Application No. 110/32, a thermostat of ordinary type may be used, and the generator may be of the horizontal type. In this case it is preferred to pass the primary-steam from the steam-tube of the generator to the primary-steam tube or tubes in the reheater casing or casings, and to pass the primary-steam subsequently through the main throttle-valve before it passes through a tube in the generator containing the thermostat. In this case the primary-steam is passed directly from the thermostat to the engine. Apart from the fact that the throttle-valve is disposed in that part of the primary-seam circuit through which the primary-steam passes to the thermostat after heating the receiver-steam, this arrangement will operate in substantially the same manner as the arrangement just described, except that no controlling fluid is passed to the primary-steam before it reaches the thermostat.

In all of the constructions described above the thermostat may be so arranged as partially or wholly to shut down the burner or furnace if the steam temperature rises beyond a safe level.

It is to be understood that the invention is not restricted to the precise constructional details set forth.

Dated this 11th day of March, 1933.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London,
E.C. 1,
Chartered Patent Agents.

COMPLETE SPECIFICATION.

Improvements in or relating to Steam Power Systems Embodying Compound or Multi-expansion Steam Engines.

We, THE "SENTINEL" WAGGON WORKS LIMITED, a British Company, of 20, Iddlesleigh House, Caxton Street, Westminster, London, S.W. 1, and ABNER DOBLE, a Citizen of the United States of America, of "Alta Vista", Ridgebourne Road, Shrewsbury, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention is for improvements in or relating to steam power systems embodying compound or multi-expansion steam engines and has for one of its objects to improve the efficiency of such systems when working under variable load conditions.

According to the present invention there is provided a steam power system comprising the combination with a compound or multi-expansion steam engine, a steam generator for supplying the primary-steam to the engine and means for employing the primary-steam before it reaches the engine for reheating the receiver-steam passing from one expansion stage to another in the engine, of a thermostat for controlling the temperature of the

primary-steam by regulating the feed-water supply to the generator and means for maintaining under the control of the said thermostat the temperature of the re-heated receiver-steam by passing to the thermostat primary-steam after it has re-heated the receiver-steam. It will be found that this arrangement will enable the temperature of the receiver-steam to be maintained always near to the maximum desired for efficient working of the engine in spite of variations in the load on the engine.

Preferably there is provided a throttle-valve for controlling the supply of primary-steam to the engine, which throttle-valve is disposed in that part of the primary-steam circuit through which the primary-steam passes to the thermostat after heating the receiver-steam. This will tend to increase the temperature of the primary-steam which is used to reheat the receiver-steam when the engine is running under a light load, thus compensating for the greater difficultv of transferring the heat of the primary-steam to the receiver-steam under such conditions.

In a convenient construction there is provided a conduit through which the receiver-steam is passed to be reheated, which conduit extends alongside a primary-steam tube in the generator. The receiver-steam conduit and primary-steam tube just mentioned may be formed respectively as two coils of a plural-wound helix.

In an alternative construction there may be a casing through which the receiver-steam is passed to be reheated, and a coiled tube contained within the casing through which tube the primary-steam is passed.

The invention will be found to be particularly useful in steam power systems for driving road vehicles, and certain preferred embodiments of the invention for use in this connection will now be described, by way of example only and with reference to the accompanying drawings. It is to be understood however that the invention is not restricted to the precise constructional details set forth.

In the drawings,

Figure 1 is a diagrammatic view of a steam power system comprising a vertical steam generator of the series tube type the casing of which is shown partly in central cross-section,

Figure 2 is an enlarged detail view in cross-section of a portion of the tubing of the generator shown in Figure 1 and illustrates a constructional modification, and

Figures 3 and 4 are diagrammatic views of modified forms of steam power systems in accordance with the invention.

Like reference numerals indicate like parts throughout the drawings.

The steam power system shown in Figure 1 comprises a steam generator of the " flash " or series tube type indicated generally at 10. The generator 10 is supplied with feed-water through a pipe 11 and steam produced in the generator is delivered through a pipe 12 to the high-pressure cylinder 13 of a compound steam engine whereof the low-pressure cylinder is indicated at 14. Pistons which reciprocate in the cylinders 13 and 14 serve to rotate the engine crank-shaft which is indicated at 15. The receiver-steam passing from the high-pressure cylinder 13 to the low-pressure cylinder 14 is conducted by a pipe 16 to a conduit 17 in the form of a helical steam-tube disposed within the generator 10 and extending alongside a primary steam-tube therein. The receiver-steam is reheated during its passage through the helical-tube 17, and on leaving the latter it is conducted by a pipe 18 to the steam-inlet of the low-pressure cylinder 14. The exhaust steam from the engine is discharged from the low-pressure cylinder 14 through an outlet 19 to a suitable condenser or to the atmosphere.

The generator 10 comprises a vertical cylindrical casing 20 which contains the generator tubing and is preferably lined with heat insulating material indicated at 21. The generator tubing comprises a set of spiral water-tubes 22 and 23 disposed one above another within the lower part of the casing and connected in series, and helical steam-tubes 24 and 25. The latter extend alongside one another and constitute two portions of a triple wound helix whereof the third portion is constituted by the helical reheater-tube 17 through which the receiver-steam is passed. The lower end of the steam-tube 24 is connected to the outlet from the uppermost water-tube 23, and the upper end of the tube 24 reaches through the casing 20 to a throttle valve 26 disposed outside the latter. The outlet from the throttle valve 26 communicates with the upper end of the steam-tube 25 and the lower end of the latter is connected to the inlet of a thermostat tube 27 whereof the outlet is connected to the pipe 12. The thermostat tube 27 is associated with a thermostat rod which operates suitable devices contained in a control box 28 for controlling the supply of feed-water to the generator and also if desired for controlling the burner or furnace. The thermostat which comprises the tube 27 and the thermostat rod may conveniently be constructed as described in the specifica-

tion of copending application No. 7450/33, although not shown specifically thus herein.

The fuel for combustion is supplied to the generator through a burner 29 which projects through the upper wall of the casing 20. Combustion of the fuel takes place within the helical tubes 17, 24, and 25, and the combustion gases flow downwardly past these tubes and also past the water-tubes 23 and 22 and escape through a flue 30 at the bottom of the casing.

During operation of the generator feed-water will be supplied through the pipe 11 to the lowermost spiral water-tube 22 and in passing through the tubes 22 and 23 the water will be converted into steam. The steam so produced will be further heated in passing through the steam-tube 24, and after passing through the throttle valve 26 the steam will be reheated during its passage through the steam-tube 25 to compensate for any drop in temperature which may occur due to throttling the steam. The steam will then pass through the thermostat-tube 27 and leave the generator to be delivered to the engine.

It will be appreciated from the foregoing that when the steam power system just described is in operation the receiver-steam passing from the high-pressure cylinder 13 to the low-pressure cylinder 14 of the engine will receive heat from the primary-steam in the steam-tube 24 and also from the primary-steam in the steam-tube 25 of the generator, and that the temperature of the reheated receiver-steam will be maintained under the control of the thermostat by reason of the fact that the primary-steam is passed to the thermostat after it has reheated the receiver steam.

In most cases it will be found that the tubes 17, 24 and 25 of the triple wound helix need only be disposed in contact with one another in order to ensure the required amount of transference of heat between them. However, in order to ensure greater transference of heat between these tubes they may be welded together internally of the helix as shown in Figure 2, with welds 31 serving to fill up the helical crevices between the tubes along that surface of the tubes which is exposed to the combustion gases.

The modified construction shown diagrammatically in Figure 3 differs from that of Figure 1 in several respects. In the first place, a generator 32 embodying thermostat control apparatus as described in Specification No. 110/32, Serial No. 394,713, is employed and instead of leading the receiver-steam from the engine to the generator, primary steam from the generator is led to the engine for the purpose of reheating the receiver-steam. A triple-expansion engine is shown having cylinders 33, 34 and 35, the crank shaft of the engine being indicated at 36.

Steam produced by the generator 32 passes through a pipe 37 and throttle valve 38 to the high-pressure cylinder 33 of the engine. The steam leaves the cylinder 33 by a pipe 39 by which it is conducted to a casing 40 in which it circulates and the steam leaves the casing 40 by a pipe 41 which conducts it to the cylinder 34. Similarly the steam on leaving the cylinder 34 is conducted by a pipe 42 to another similar casing 43 and leaves the latter by a pipe 44 through which it passes to the low-pressure cylinder 35. Exhaust-steam from the cylinder 35 escapes through a pipe 45 to a suitable condenser or to the atmosphere. The receiver-steam is heated during its passage through the casings 40 and 43 by primary-steam from the generator 32, such primary-steam being conducted by a pipe 46 to coiled steam pipes 47 and 48 disposed respectively in the casings 43 and 40 and connected in series. After leaving the coiled pipe 48 the primary-steam returns to the generator 32 through a pipe 49.

The pipes 46, 47, 48 and 49 are connected in series with the generator tubing being interposed in the main circulatory path thereof immediately before the thermostat is reached. That is to say the pipe 46 is a continuation of that part of the generator tubing which in the construction of specification No. 394,713 conducts the steam to the location of the thermostat, and the pipe 49 has its outlet connected to the inlet of that part of the generator tubing at which the thermostat is located. The fluid (water or steam) which, in accordance with the invention described in specification No. 394,713, is abstracted from a location 51 in the generator immediately below the water level and caused to re-enter the circulatory path of the generator immediately before the thermostat is reached, is conducted from the point 51 by a pipe 50 so as to join the steam in the pipe 49 immediately before such steam returns to the generator to influence the thermostat. It will be appreciated that all of the primary-steam passing through the whole circulatory path of the generator is conducted through the coiled pipes 47 and 48, and affects the thermostat after being cooled by receiver-steam in the casing 43 and 40.

The construction illustrated diagrammatically in Figure 4 is in many respects similar to that shown in Figure 3. In Figure 4, however, a generator 52 of a

horizontal type is shown embodying thermostatic control of a different kind from that shown in Figure 3. The generator tubing is indicated diagrammatically at 53 and is supplied with water through a feed-water inlet 54. A burner 62 projects through an opening at one end of the generator casing to supply the fuel for combustion. Primary-steam produced in the generator tubing 53 is passed through a pipe 55 reaching into both compartments of a divided casing 56, 57, a partition 58 serving to separate the compartments 56, 57 from one another. On leaving the pipe 55 the primary-steam passes through a throttle valve 59 and then reenters the generator casing to pass through a tube 60 containing a thermostat of any ordinary construction. The thermostat is arranged to operate suitable mechanism in a control box 61 so as to regulate the supply of feed-water to the generator and also if desired to control the operation of the burner 62. After passing in contact with the thermostat the primary-steam leaves the generator to be conducted by a pipe 63 to the high-pressure cylinder 33 of the engine. The pipes 39 and 41 serve to conduct to and from the compartment 56 of the casing the receiver-steam passing from the cylinder 33 to the cylinder 34. Similarly the pipes 42 and 44 conduct to and from the compartment 57 the receiver-steam passing from the cylinder 34 to the cylinder 35.

When the steam power systems above described are operating under light or partial load conditions (which frequently exist when driving road vehicles) the receiver-steam will be cooler than when heavy loads prevail. Thus the receiver-steam will abstract from the primary-steam in the steam tubes 24 and 25 shown in Figure 1, or in the coiled pipes 47 and 48 shown in Figure 3 or in the pipe 55 shown in Figure 4, a comparatively large amount of heat. However, since the thus cooled primary-steam in each case controls the thermostat the latter will operate so as to reduce the supply of feed water to the generator. The temperature of the primary-steam used for reheating the receiver-steam will thereby be raised above the normal value in order to compensate for the greater amount of heat abstracted from the primary-steam by the receiver-steam. When water is present in the receiver-steam a still greater amount of heat will be abstracted by it from the primary-steam and the thermostat will in this case be operated so as to cause the temperature of the primary-steam used for reheating the receiver-steam to be raised still further to compensate for the greater amount of heat required under these conditions by the receiver-steam. It will be noted that under light load conditions less steam is required to drive the engine and a reduction in the supply of feed-water to the generator is desirable.

In the case also of the construction shown in Figure 3 the cooling of the primary-steam by the receiver-steam under light load conditions will tend to lower the temperature of the primary-steam passing to the thermostat to a greater extent than under heavy or medium loads. Less controlling (cooling) fluid will therefore be required to be supplied through the pipe 50 in order to maintain the primary-steam delivered by the generator at the desired temperature. The thermostat (which serves to maintain the temperature of the delivered steam at the desired level) will therefore operate in such manner as to reduce the supply of controlling fluid through the pipe 50. Since the supplies of controlling fluid and feed-water are both controlled simultaneously by the thermostat, there will accordingly be less feed-water supplied to the generator. Conversely, more controlling fluid will be required to be supplied through the pipe 50 under heavy than under medium or light load conditions and this will result in the thermostat being operated to supply more feed-water to the generator.

By passing the primary-steam through the throttle valve 26 or 59 as shown in Figures 1 and 4 before the thermostat is reached an additional advantage is secured. Under light load conditions the throttle valve 26 or 59 will be partially closed and there will be a drop in the temperature of the primary-steam across the throttle valve. The thermostat will consequently operate so as further to increase the temperature of the primary-steam used for reheating the receiver-steam and this is desirable because lower steam velocities of the primary and receiver-steam and the lower density of the latter at light loads render the transference of heat to the receiver-steam more difficult.

The construction shown in Figure 1 may be modified by the employment of a multi-expansion engine having three or more cylinders. In this case there will be two or more helical tubes similar to the tube 17 for the receiver-steam, such tubes being disposed side by side with the remaining helical tubes in the generator. Thus say in a triple-expansion engine the receiver-steam from the high-pressure cylinder will be led through the receiver-steam reheating tube 17 before passing through the middle pressure cylinder, and the receiver-steam discharged by the

latter will be led through a second similar receiver-steam reheating tube of helical form before passing to the low-pressure cylinder.

In certain circumstances in the construction of Figure 1 the thermostat tube 27 may be interposed in the primary-steam circuit immediately before the throttle valve 26 is reached, and in such cases the helical tube 25 in which the primary-steam is reheated will deliver the steam directly to the pipe 12.

In the construction of Figure 1 it has been found convenient to arrange that the direction of flow of the receiver-steam through the helical tube 17 shall be opposite to the direction of flow of primary-steam through the tube 24, but in the same direction as the flow of the primary-steam through the tube 25. If desired, however, the direction of flow of the receiver-steam through the tube 17 or of the primary-steam through the tube 25 may be reversed.

In all of the constructions described above the thermostat may be so arranged as partially or wholly to shut down the burner or furnace if the steam temperature rises above a safe level.

It is to be understood that the invention is not restricted to the precise constructional details set forth and that although the constructions described above are particularly applicable for use on road vehicles, they may be employed in other cases where a compound or multi-expansion engine is required to operate under variable load conditions.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A steam power system comprising the combination with a compound or multi-expansion steam engine, a steam generator for supplying the primary-steam to the engine, and means for employing the primary-steam before it reaches the engine for reheating the receiver-steam passing from one expansion stage to another in the engine, of a thermostat for controlling the temperature of the primary-steam by regulating the feed-water supply to the generator and means for maintaining under the control of the said thermostat the temperature of the reheated receiver-steam by passing to the thermostat primary-steam after it has reheated the receiver-steam.

2. A system according to claim 1, comprising a throttle-valve for controlling the supply of primary-steam to the engine, which throttle-valve is disposed in that part of the primary-steam circuit through which the primary-steam passes to the thermostat after heating the receiver-steam.

3. A system according to claim 1 or claim 2, comprising a conduit through which the receiver-steam is passed to be reheated, which conduit extends alongside of a primary steam-tube in the generator.

4. A system according to claim 3, wherein the said receiver-steam conduit and primary steam-tube are formed respectively as two coils of a plural-wound helix.

5. A system according to claims 2 and 3 or claims 2 and 4, comprising a primary steam-conduit disposed alongside the said primary steam-tube and receiver-steam conduit, and serving to conduct primary-steam from the outlet of the said throttle-valve to the thermostat.

6. A system according to claim 1 or claim 2, comprising a casing through which the receiver-steam is passed to be reheated, and a coiled tube contained within the casing through which tube the primary steam is passed.

7. In a steam power system, the combination and arrangement of parts substantially as shown in Figure 1, or in Figure 3, or in Figure 4, or as modified in Figure 2, of the accompanying drawings or substantially as hereinbefore described.

Dated this 13th day of July, 1933.
BOULT, WADE & TENNANT,
111 & 112, Hatton Garden, London,
E.C. 1,
Chartered Patent Agents.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1934.

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

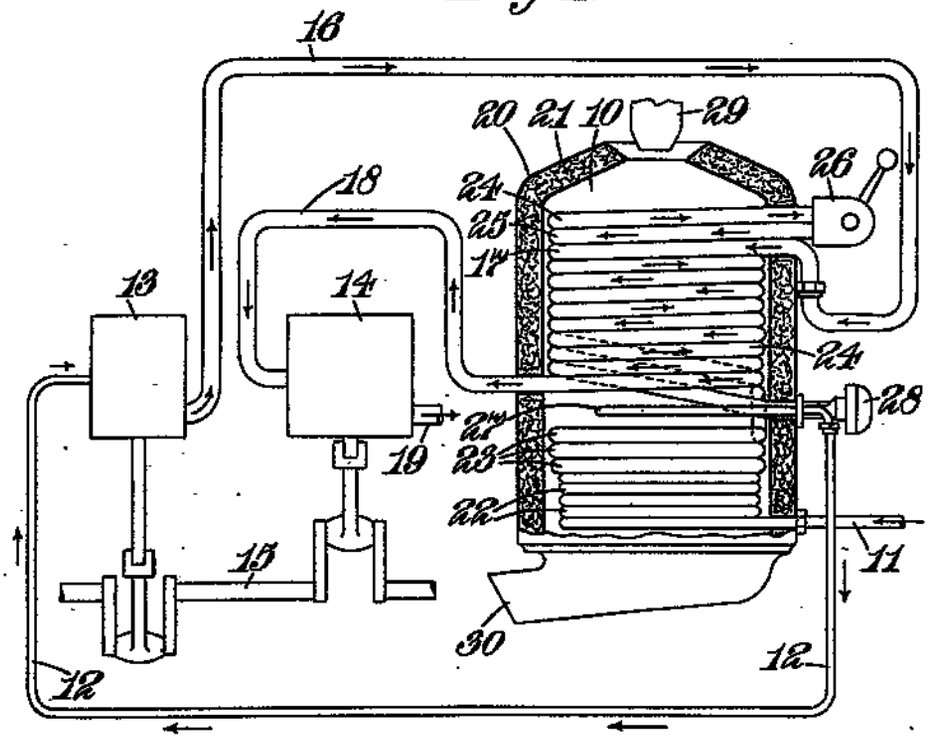

Fig. 2.

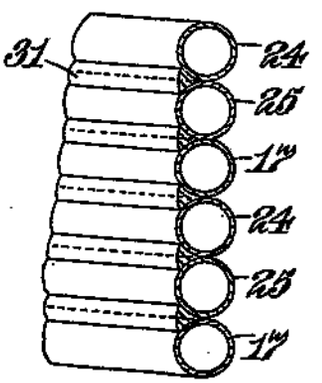

Fig. 3.

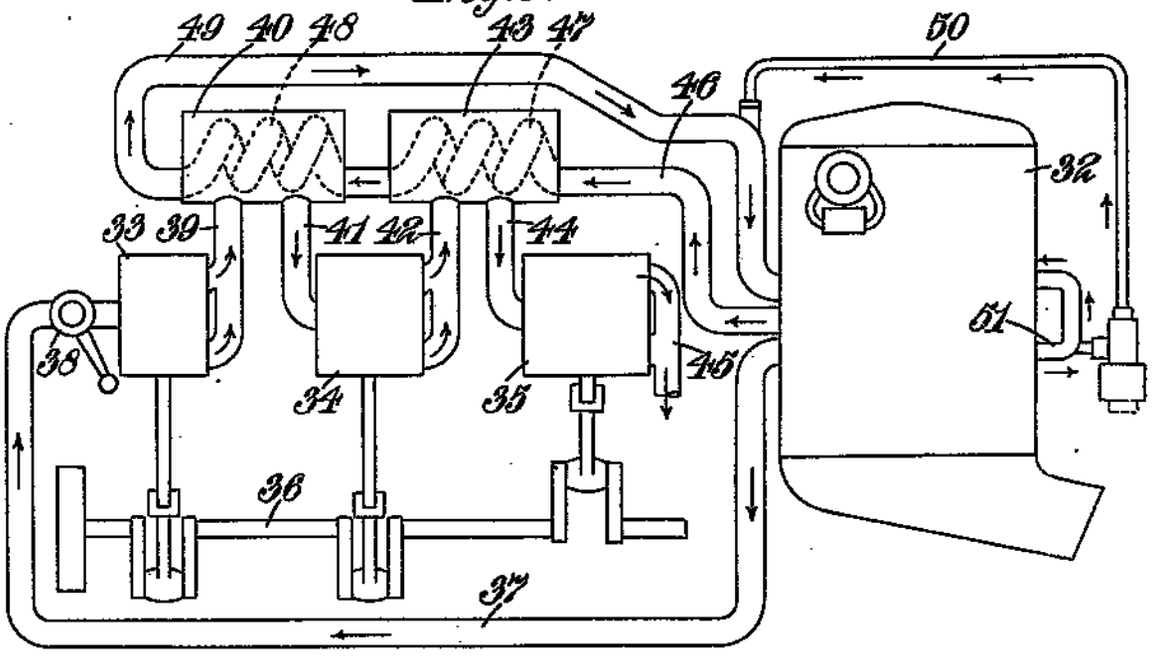

Fig. 4.

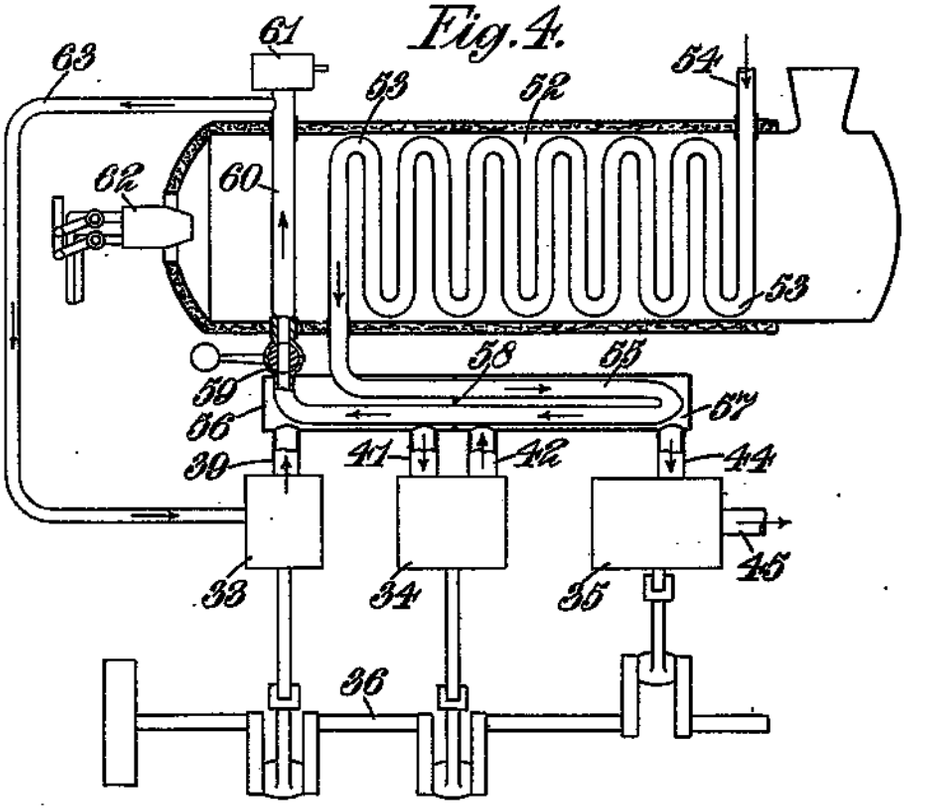

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Fig.1.

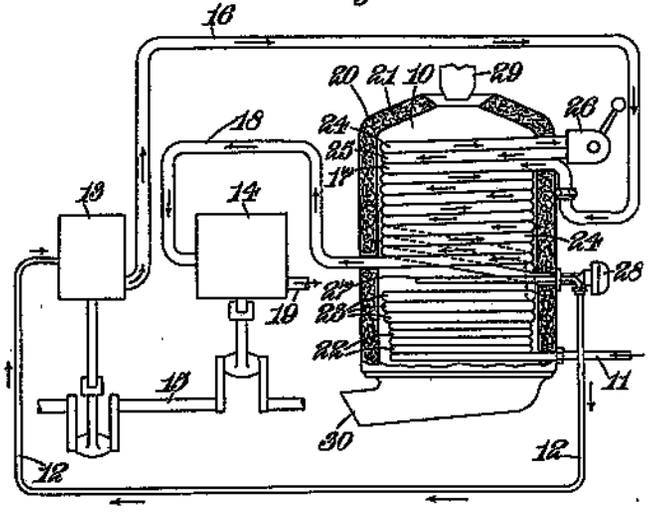


Fig.2.

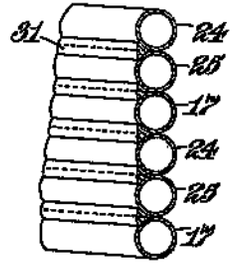


Fig.3.

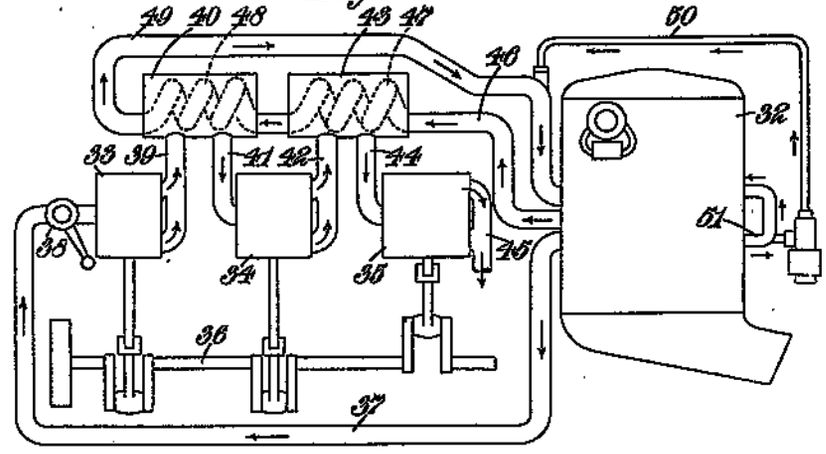
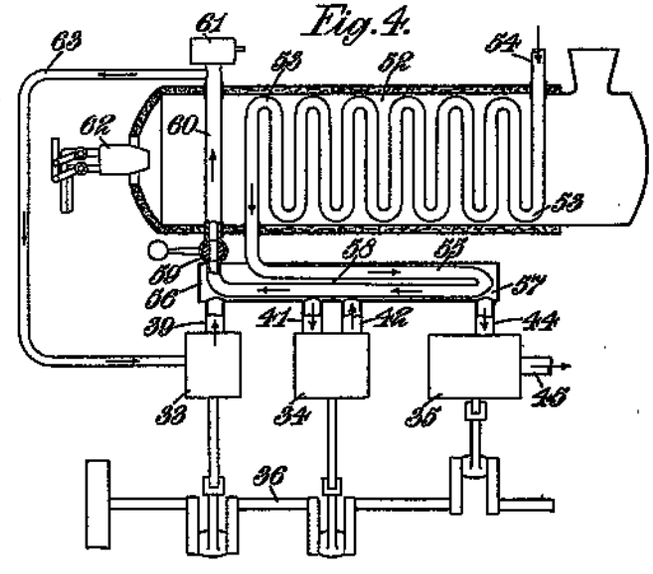


Fig.4.



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