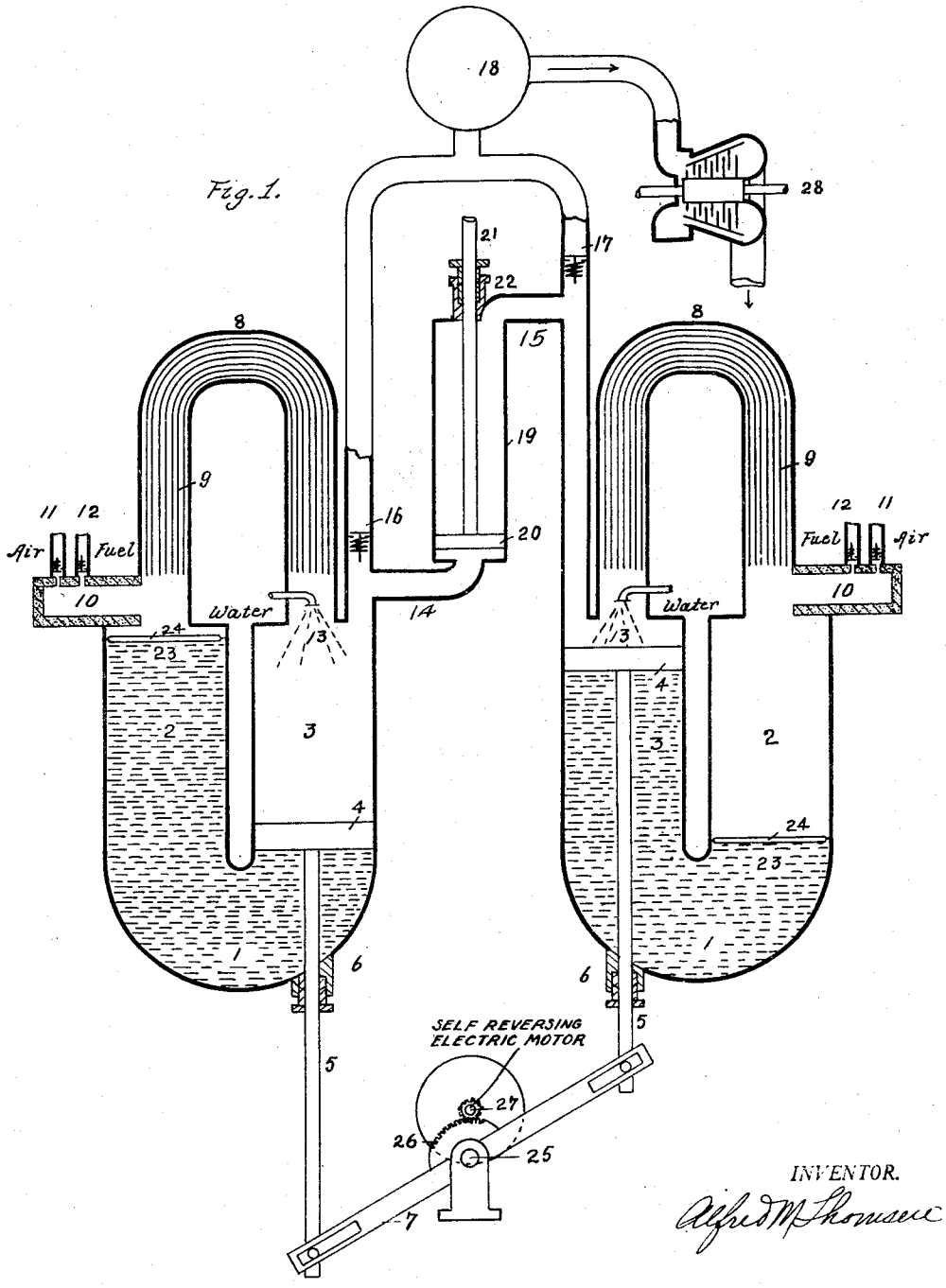
Dec. 18, 1945. A. M. THOMSEN 2,391,078

APPARATUS FOR POWER DEVELOPMENT

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Fig. 1.



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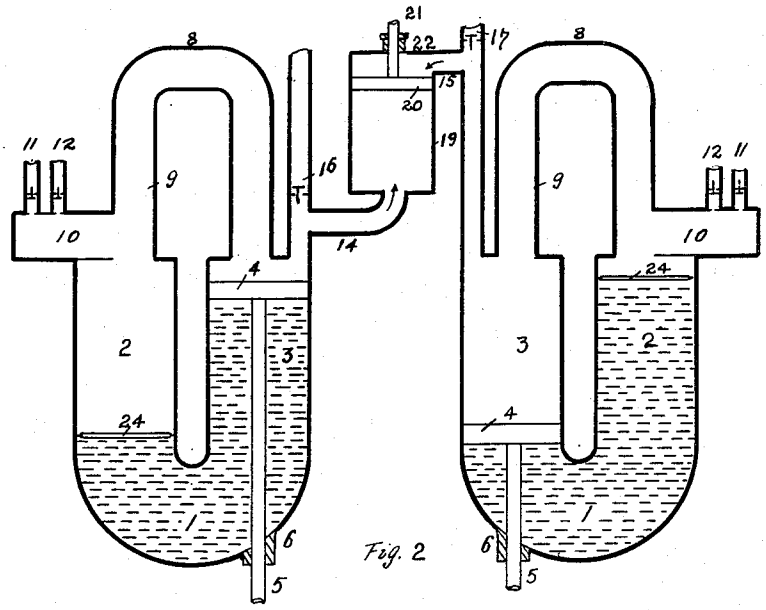


Fig. 2

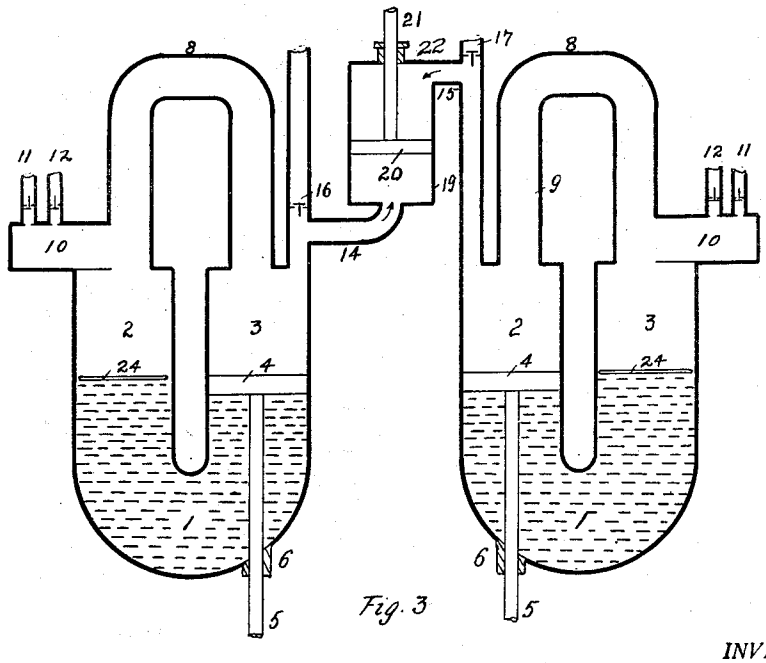


Fig. 3

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APPARATUS FOR POWER DEVELOPMENT

Alfred M. Thomsen, San Francisco, Calif.

Application June 16, 1942, Serial No. 447,293

5 Claims. (Cl. 60—45)

This invention deals in general with means whereby a substantially greater conversion of the heat energy of a fuel into mechanical energy can be achieved than is considered standard in modern steam engineering or in internal combustion. For this reason it is rather difficult to classify my invention for it partakes of the nature of both and also involves certain features that were a part of the "hot air" or "caloric" engines of last century, even including in this category some of the thermodynamic abstractions that were never built.

For this reason I shall commence at once with a description of the thermodynamic functions involved. I believe that this object will be best attained by the use of the diagrammatic drawings attached hereto. It should be borne in mind that this diagram does not represent any actual engine but consists solely of conventional figures used in any discussion of thermodynamics.

Referring, therefore, to the drawings, Fig. 1, same will be seen to consist of two identical structures, subsequently referred to as the right and left divisions, and between them and interconnected with them a third structure, diverse from the former structures. Throughout the drawings the same number has been placed upon identical parts save where interconnected with the third structure. Fig. 2 and Fig. 3 illustrate in a schematic manner the approximate position of certain parts, the pistons, at two different positions in the cycle.

Commencing, therefore, with the left hand structure, this is seen to consist of two doubly interconnected vessels **2** and **3**, the interconnections being numbered respectively, **1** and **8**. The lower interconnection, numbered **1**, is sealed by a body of liquid, hereafter referred to as water, but not limited to this appellation. This water fills the space between the piston **4** and the natural surface of said water. To prevent wave action in said body of water a float **24** rests upon said surface.

This body of water is kept in a state of oscillation, constant in amplitude, by means of the movements of the piston **4**. In the drawings this piston is represented as close-fitting, but this is not essential, for, as will be seen later on, the vapor pressure above **24** and above **4** is equal and the piston in question performs no work save that of overcoming friction and of maintaining the water in motion.

By each oscillation, the gaseous fluid which fills the space not occupied by water in the vessels **2** and **3** is thus seen to be alternately transferred from one vessel to the other through the upper interconnection **8**. This upper interconnection functions as a "regenerator" and is filled with a packing **9** exposing a very large surface to the contact of the gaseous fluid when it is being transferred from **2** to **3**, or from **3** to **2**. It is the object of the invention to maintain a differential in temperature between the gaseous fluid when it occupies either one or the other of these two vessels and, hence, in the transfer in one direction or the other, heat is either abstracted from or conveyed to said gas in its passage through the regenerator. In the drawings, the packing **9** is represented as plates but actual construction is optional. The material used for such packing is likewise optional and may vary from plain iron through the entire gamut of ferrous and non-ferrous alloys, some type of stainless steel being most appropriate.

Heat is supplied to said gaseous fluid by the injection of both air and fuel. These are seen as entering by the valved ducts **11** and **12**, into the combustion chamber **10**, which is represented as having insulated walls to set it apart from the rest of the structure. Parenthetically it may be noted that such an insulated combustion chamber will require no means for ignition of the charge save the stored heat in its walls. As the continuous injection of both air and fuel would soon raise the pressure to a prohibitive degree, the surplus is vented at the valve **16**, thus keeping conditions at each oscillation constant. In the drawings, this valve and all other valves are represented as actuated by the variations in pressure of the working fluids and as loaded by springs to ensure closing.

Inasmuch as the constant addition of heat is more positive than the losses of heat sustained by conversion of a part of said heat into mechanical energy, the gradual effect upon the regenerator would be to have the temperature steadily increase so that the differential between the two vessels **2** and **3** would gradually become impaired. To prevent this effect a cooler **13** is introduced. It consists as indicated of a spray pipe whereby the gaseous working fluid on each transfer is subjected to intimate contact with the body of water previously described. It is obvious that such a spray may be either constant or intermittent as long as it is adequate in volume to remove the residual heat to a constant factor. In the drawings it is represented as constant. Unless the piston **4** were of a loose type this would demand that some means be also used to equalize the volume of water on either side of said piston,

but as such matters pertain to engine design and not to the thermodynamics of the cycle they have been omitted from the drawings, which as already said is but a diagrammatic representation of the thermodynamics involved. Similarly, the means employed to introduce the moving body of water, or rather a part thereof, into intimate contact with the gaseous fluid, i. e., pumps and pipes, have been deliberately omitted so as not to clutter up the diagram.

Having thus described the first part of the drawings, the heat cycle pertaining thereto will next be explained in full detail before proceeding with the balance of the presentation. It is suggested, meanwhile, that the opening and duct 14 be disregarded as if it were not present, but that the wall of the vessel 3 at this point be considered as closed.

To follow the cycle through one complete oscillation let the start be made with the piston in the position indicated in the drawings. As said piston now rises to the other extreme position the gaseous fluid in 3 will become gradually transferred into 2 and passing through the regenerator 8 it will pick up heat on the way, hence the pressure of the gaseous fluid will be increased in accordance with the well known laws of expansion of gases by heat.

On the return stroke of the piston the gaseous fluid will part with a portion of its heat to the regenerator and any surplus will become abstracted by the spray 13. The conditions of temperature and pressure will thus have been restored, provided that the increase of pressure during the upstroke was not sufficiently great to cause the relief valve 16 to function and equalize the pressure.

To get the effect of the heating addition, to wit, 10, 11 and 12, let it now be supposed that as the piston approaches its lowest position and is say, 30° of an arc before the dead center, when the pressure within the enclosed space filled with the gaseous fluid is almost at its extreme low, then the valves 11 and 12, being pressure actuated, will open and discharge both fuel and air into the combustion chamber 10 which will burn, so that very hot combustion products stream out of 10 and commingle with the last portion of the gaseous fluid being transferred. It will be evident that the heat thus added will be absorbed almost in its entirety by the regenerator and there will be but a small rise in pressure due to the additional volume of the air added. Timing in the admission of air and fuel is, of course, immaterial so long as the supply is adequate to furnish the necessary amount of heat.

On the return stroke, however, this heat will be given off to the gas on its passage through the regenerator and in addition will be augmented by the additional hot gases leaving 10 until the air and fuel are again cut off due to the increase in pressure in chamber 10, say when the piston has passed another 30° of an arc on the other side of the dead center. The result will be a great rise in pressure when the piston reaches the top of its stroke.

This excess of pressure will then cause the valve 16 to function until equilibrium is again restored. It will thus be seen that the air injected at 11, at the low pressure point of the cycle, is rejected by the engine at the high point of pressure. The assembly, as thus far described, therefore, constitutes in effect a thermo-compressor which takes in relatively cold air at 11, and discharges air, commingled with combustion products, likewise relatively cool, at 16. The increase in pressure thus obtained is evidently by a purely thermic method and not by impressing mechanical energy thereupon, for as already explained, the piston 4 performs no function save the transfer of the gaseous fluid from one vessel to the other.

The oscillating body of water is seen to serve two purposes. It acts as a displacing piston in the transfer of the working fluid from one vessel to another and at the same time it provides the essential cooling function. When the water level sinks in the vessel 2, its walls become exposed to the hot gas fire gases. As there is no moving part in contact with such walls they might conceivably be lined with firebrick on the inside, or otherwise insulated, but in any event even such lining would be exposed to the hot fire gases during a part of the cycle.

Now on the second half of the cycle these walls become covered with water and the heat which said walls have abstracted from the gases is in turn conveyed to the moving water which consequently becomes heated. The same effect is produced by the use of the same medium as the cooling agent in the spray pipe 13, so in due time this body of water will be raised to boiling temperature and the absorbed sensible heat will be once more liberated as heat of vaporization of steam, said steam commingling with and forming a part of the working fluid. In time, therefore, the "gaseous fluid" which is the working fluid of the engine becomes a mixture of the products of combustion of the fuel injected at 12 commingled with the steam arising from the cooling function performed by the oscillating body of water. However, if it be at times desirable to keep said oscillating body of water below the boiling point, then the walls of the containing vessel, numbered 1, 2 and 3 in the drawings, or any part thereof, being necessarily of metal and hence good conductors of heat, can manifestly be made the means for such abstraction of heat, reducing the temperature of the contained water to any extent desired.

At each stroke of the piston 4, when it reaches the top of its stroke, or shortly before and after that point, the valve 16 will open and permit the excess volume of "gaseous working fluid" to escape into the receiver 18. The composition will, of course, be identical with that already cited as the temperature of emission must be well above that of the boiling point of water. Such a spasmodic release of highly compressed gases requires equalization before it be used in a prime mover, hence the representation of the receiver 18 to perform this function. Manifestly, the difference in pressure on either side of the valve 16, will be kept as low as possible.

So far the explanation of the drawings has been confined to the left hand structure, with the exception of the air receiver. The right hand structure will now be considered. It will be seen to be identical throughout with the one already described. The motions of the two pistons 4 are synchronized; the piston rods 5 passing out from the vessels 3 through the stuffing box 6 to connect with the rocker arm 7 which has its fulcrum at 25, by which said pistons are moved. In the drawings, said motion is imparted through the instrumentality of a toothed quadrant 26 attached to the rocker arm and a pinion 27 which in turn is actuated by an electric motor equipped with a self-reversing device. As such motion controls the entire operation within the component parts it need not be connected to the prime mover, which in the drawing is a turbine 28 in which

the compressed working fluid is finally expanded and converted into mechanical energy.

The function of the assembly as so far explained is, therefore, to take in compressed air and fuel at 11 and 12, respectively, and to produce a smooth flow of a mixture of nitrogen, surplus oxygen, carbon dioxide, and steam issuing from the receiver 18 in the direction of the arrow, to a prime mover which may be of any design or type selected. Manifestly, this mixture of gases and steam is at a far higher pressure than the incoming compressed air, and the fuel burned has in part been converted into energy represented by this increase of pressure and by the steam simultaneously generated.

The central structure will now be explained. It is seen to consist of a cylinder 19 within which moves a piston 20, the piston rod 21 passing out through the stuffing box 22. 14 and 15 are ducts leading from the spaces below and above the piston 20 to the cool gas spaces of the right and left structures formerly described.

Inasmuch as these structures are synchronized it follows that when the pressure within one of these structures is at its highest point it is at its lowest within the other structure. The piston 20 will thus be actuated by this change and will rise and fall in harmony with the pressures alternating within the right and left hand structures. It follows that if the piston rod 21 be connected in any suitable manner with the mechanism it is proposed to move then energy will be obtained from the expansion of the gases alternately functioning on either side of said piston.

Such expansion will represent a corresponding drop in temperature of the expanding gas and will, therefore, require less use of the cooling sprays 13 within the primary structures. This in turn means less steam generation, and steam generation is the poorest utilization made of the fuel consumed as it is unavoidably accompanied by the loss of heat when such steam condenses.

Contrariwise, the energy obtained within the third structure represents an almost theoretical conversion of heat into mechanical energy, the only losses being in friction and in radiation losses. In as much as the entire assembly will, of course, be most carefully insulated against such heat losses, it follows that radiation losses will be very small. It is not too much to say that the main reason for obtaining the compressed fluid which is vented to the prime mover is so as to make available the maximum use of the third structure indicated on the drawings. This portion is actually the most important part of the invention and the complex structures to both right and left function chiefly to make its operation possible.

A great many conventional modifications can, of course, be made without departing from the spirit of the invention herein disclosed, such for instance as substituting valves moved by the mechanism instead of the "clack" valves operated by the fluid indicated in the drawings. All such modifications I regard as within the scope of this disclosure.

Having thus fully described my invention, I claim:

1. In an apparatus for converting the major part of the heat energy of fuel into mechanical energy the combination of; two doubly interconnected vessels, one interconnection containing a regenerator and the other interconnection being sealed by a liquid displacer; means for keeping the liquid displacer in oscillation; means for injecting fuel and air for combustion of same into one vessel and means for periodically releasing an equivalent volume of the products of said combustion from the other vessel; a suitable prime mover for converting the energy resident in said vented gases into mechanical energy and means for conveying said vented gases to said prime mover.

2. In an apparatus for converting the major part of the heat energy of fuel into mechanical energy as set forth in claim 1; the addition of means for bringing the products of combustion that have passed through the heat regenerator and have not yet been vented into intimate contact with a portion of the liquid displacer thus reducing their temperature approximately to that of the displacer.

3. In an apparatus for converting the major part of the heat energy of fuel into mechanical energy the combination of; two vessels, doubly interconnected at different levels, the upper interconnection containing a heat-regenerator, the lower interconnection being sealed with an oscillating body of water; means for maintaining said water in a state of oscillation; means for injecting fuel and air for combustion of same into one vessel and means for periodically releasing an equivalent volume of the products of said combustion from the other vessel; means for bringing said products of combustion into intimate contact with a portion of the oscillating body of water thus correspondingly reducing their temperature; a suitable prime mover and means for connecting same to the herein described vessel so that the vented fluid may pass through said prime mover and have the energy stored therein converted into mechanical energy.

4. In an apparatus for converting the major part of the heat energy of fuel into mechanical energy as set forth in claim 3; the addition of means for abstracting heat from the oscillating body of water, thus controlling the relative percentage of water vapor in the vented gases.

5. In an apparatus for converting the major part of the heat energy of fuel into mechanical energy as set forth in claim 3; the addition of means for utilizing the expansion of a portion of the working fluid in doing mechanical work while it yet remains a portion of the confined working fluid.

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