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METHOD OF OPERATING MULTISTAGE PRIME MOTORS.

APPLICATION FILED MAY 11, 1908.

930,564. Patented Aug. 10, 1909.

2 SHEETS—SHEET 1.

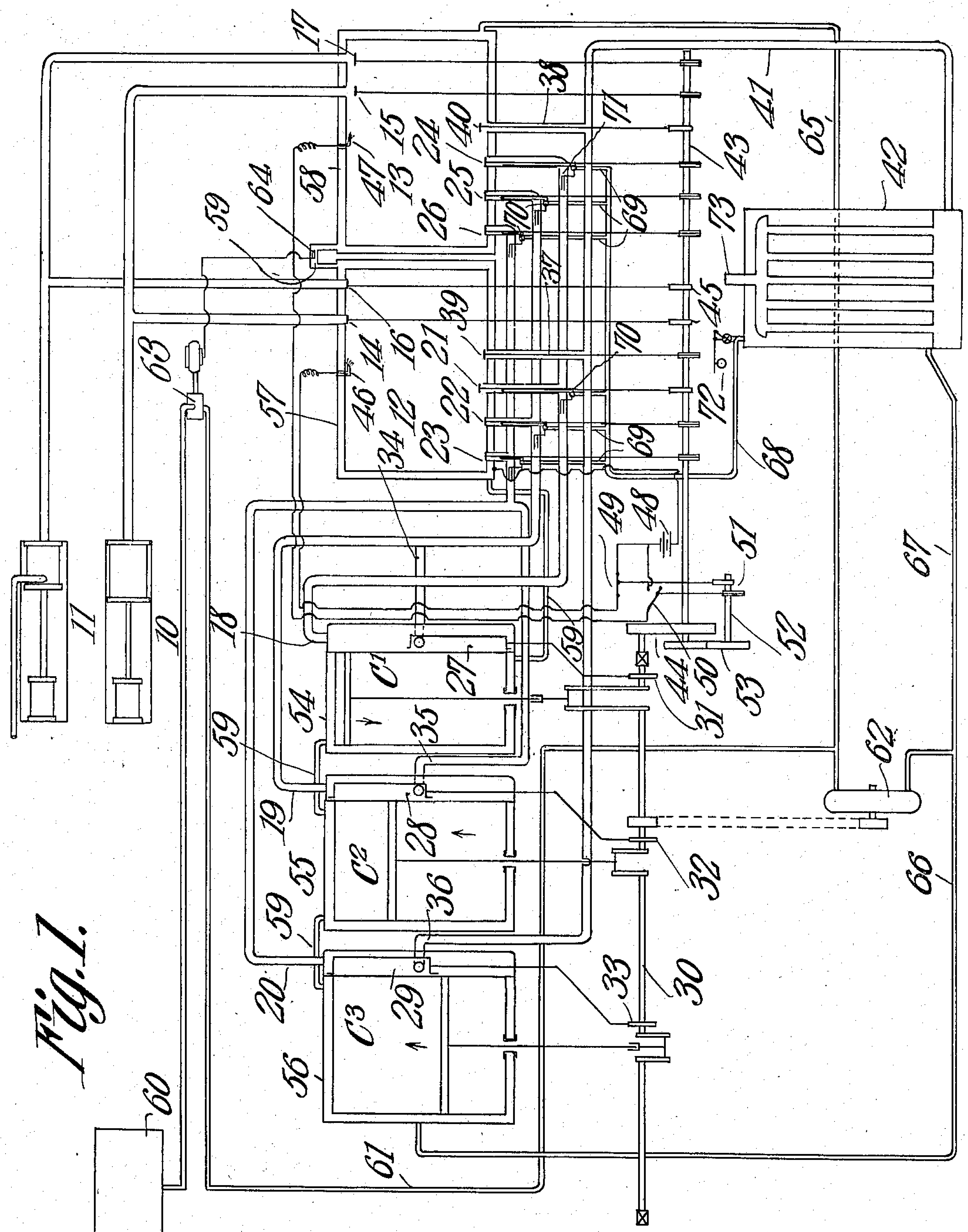

Fig. 1.

Witnesses

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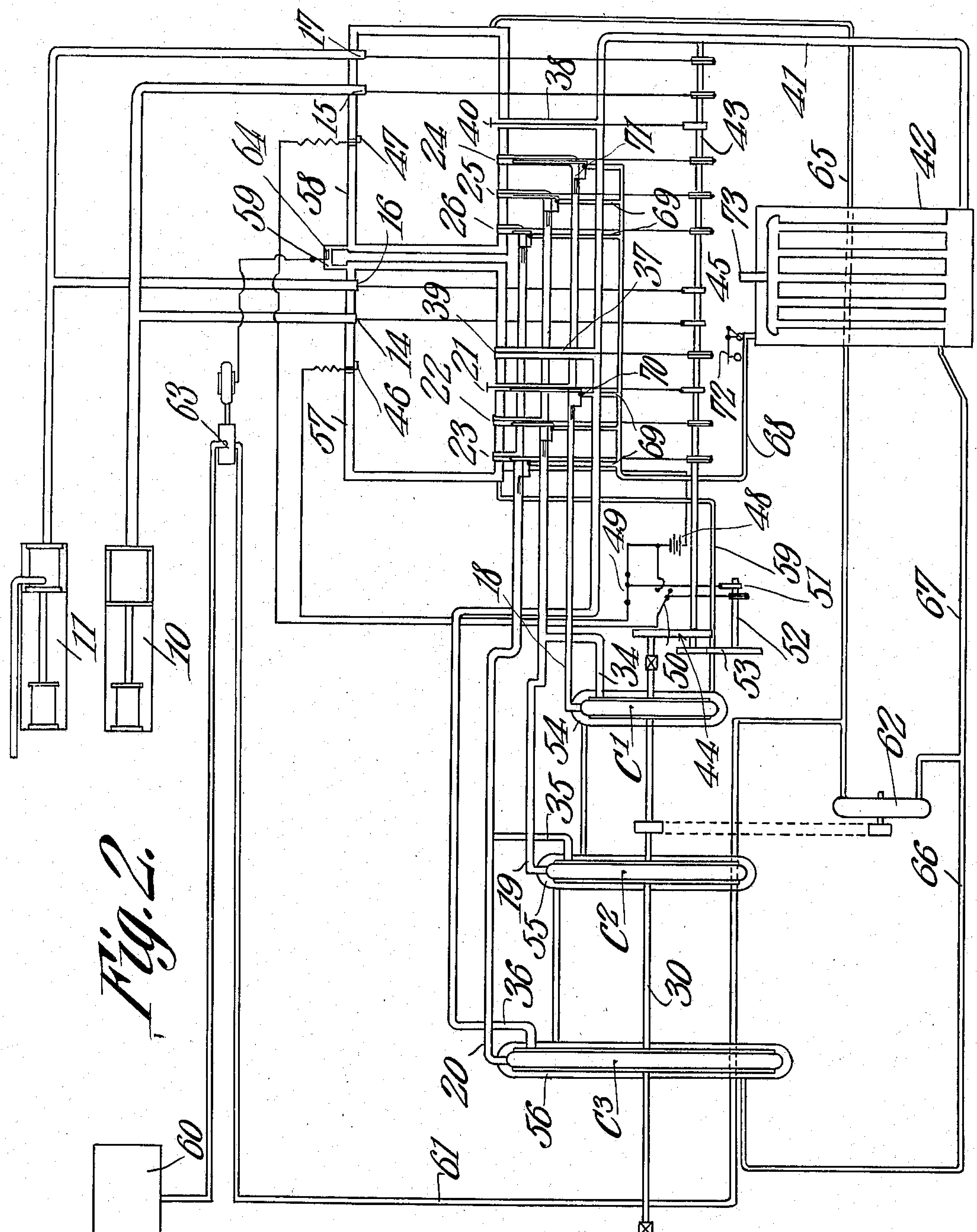

Fig. 2.

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UNITED STATES PATENT OFFICE

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METHOD OF OPERATING MULTISTAGE PRIME MOTORS.

No. 930,564. Specification of Letters Patent. Patented Aug. 10, 1909.

Application filed May 11, 1908. Serial No. 432,143.

To all whom it may concern:

Be it known that I, PETER G. SCHMIDT, a citizen of the United States, residing at Tumwater, in the county of Thurston and State of Washington, have invented a new and useful Method of Operating Multistage Prime Motors, of which the following is a specification.

The present invention relates to the operation of multi-stage prime motors.

One object of the invention is to provide an improved method of utilizing fluid pressures, however produced, to actuate the motor elements of a multi-stage prime motor.

Another object of the invention is to provide apparatus to be actuated by such improved method.

A third object of the invention is to provide a cooling means for the fluid medium which will operate with the minimum efficiency loss.

In the operation of multi-stage prime motors heretofore, it has been proposed to produce a series of different pressures, each adapted to operate one of the motor elements of a multi-stage motor, as in those explosion engines where each of the motor elements is actuated by an explosion of different intensity produced by either varying the quantity or quality of the explosive medium, or by varying the degree of compression before explosion; or a certain substantially constant fluid pressure has been produced and a single portion of the fluid used successively in the different motor elements in the manner common in compound steam engines.

This invention consists in first producing a single fluid pressure of the requisite degree and subtracting successive decrements of the pressure and actuating the successive motor elements of a multi-stage prime motor, each successive decrement being employed first to actuate a separate one of the successive motor elements, although the energy of such decrement may be utilized not only in the motor element to which the decrement is first conducted, but in other motor elements of lower stage.

The invention further consists in the method of cooling the fluid under pressure by the introduction of a suitable fluid into the pressure decrement at a temperature approximating that at which the latent heat of vaporization disappears, or, in other words, at a temperature at which there is no loss of energy due to the change in condition of the fluid (as, for instance, by the introduction of water at a temperature approximating 790° C. absolute or 516° C. thermometric). It is to be understood, however, that in the specific instance of using water the temperature will only be approximated as in that case the pressure developed would approach 3400 pounds per square inch, an obviously inconvenient one to handle. If, however, water at about 450° C. be used for cooling, the resultant pressure is found to be within practical limits.

The invention still further consists in apparatus for the production of such results, here shown as a form of multi-stage prime motor provided with certain elements adapted to operate in the foregoing manner.

In the drawings, like characters of reference are used to indicate the same part in the several views, and Figure 1 is a diagrammatic view of one form of apparatus adapted to be used in this connection, this being a multi-stage double acting reciprocatory motor. Fig. 2 is a similar diagram of another form of apparatus, there being indicated a multi-stage rotary motor or turbine.

It is to be understood that the devices thus represented are typical of a variety of devices which may be used in connection with this invention, as, for instance, the air and gas compressors may be replaced by a steam generator, and the igniters, jackets and jet coolers omitted. The motor would then run as a steam engine, the cooling water after passing through the heater would be utilized in the boilers, and the heater would in that case act as a condenser.

In that embodiment of the apparatus to be used in connection with this method of utilizing fluid pressures here illustrated, there are shown types of multi-stage prime motors having successive motor elements which are, in Fig. 1, reciprocatory and, in Fig. 2, rotary. There is, however, no difference in the mode of operation whether all the elements be reciprocatory, all rotary, or part reciprocatory and part rotary. This being the case, the motor elements have the same reference character in all views, the successive elements being designated by the characters C′ C^2, and C^3, the types shown being three stage in character.

At 10 in the drawings is indicated an air compressor and at 11 a gas compressor supplied with gas from any suitable source, and these are connected by suitable pipes to pressure chambers 12 and 13. Valves 14 and 15 control the admission of air to these chambers and valves 16 and 17 the admission of gas. Connecting these chambers and the motor elements are pressure pipes 18, 19 and 20 leading, respectively, to the elements C′, C^2, and C^3. Valves 21, 22 and 23 in the chamber 12 and valves 24, 25 and 26 in the chamber 13 control the flow of fluid pressure through these pipes, valves 21 and 24 controlling pipe 18, valves 22 and 25 controlling pipe 19, and valves 23 and 26 controlling pipe 20. The admission to and exhaust from the motor elements may be further controlled by means of suitable valves located in valve chests on the motor elements or by other arrangements such as piston controlled ports. In Fig. 1 of the present arrangement, there is shown a method of control for double acting reciprocatory motors, the same being the common D-valve and the valves for the successive elements are indicated at 27, 28 and 29, being intended to typify any form of valve control at the motor elements.

Actuated by the motor elements is shown a power shaft 30 whereon is mounted, in Fig. 1, suitable valve operating means, such as eccentrics 31, 32 and 33 arranged to operate, respectively, the valves 27, 28 and 29. These eccentrics are so arranged as to operate the valves in succession in the manner common to this class of devices.

Leading from the motor elements are exhaust pipes 34, 35, and 36, the exhaust pipe 34 communicating preferably with the pressure pipe 19, 35 in like manner being connected to the pressure pipe 20. The exhaust pipe 36 has connected thereto exhaust pipes 37 and 38 from the chambers 12 and 13, respectively, the exhaust from these chambers being controlled by valves 39 and 40, respectively. The exhaust pipe 36 is then continued, as shown at 41, to a water heater 42.

The numeral 43 indicates a shaft actuated preferably from the main shaft by means of any suitable driving or motion communicating mechanism, as at 44, by which the speed of rotation of the shaft 43 is timed to accord with that of the main shaft. The shaft 43 is preferably termed a cam shaft, and is provided with valve operating cams, or the like as indicated at 45, there being in the present instance twelve of these cams so arranged as to actuate the valves in the manner hereinafter described.

In the chambers 12 and 13, there are spark plugs 46 and 47, the same being intended as typical of any form of igniter. These are connected in the usual manner with a battery, or the like, as indicated at 48, and in their respective circuits are shown switches 49 and 50 actuated by cams 51 on a shaft 52 driven by gearing 53 from the cam shaft. The shaft 52 is arranged to rotate at a suitable speed so that the cams held thereon may move in proper timed relation to the engine cycle. It is obvious that a variety of mechanisms may be used to accomplish this purpose and the gearing 53 of the diagram is intended to represent any such mechanism.

The motor elements are jacketed, as shown respectively at 54, 55 and 56, and the pressure chambers as at 57 and 58. Suitable pipes 59 connect these various jackets.

At 60 is indicated a source of cold water supply and a pipe 61 extends therefrom to a circulating pump 62. In the line of the pipe 61 is a force pump 63 controlled by a thermostat preferably located in the jacket of the explosion chambers as indicated at 64. From the water jacket 58 a pipe 65 is carried to the intake of the pump 62 and the outlet of said pump is connected by a pipe 66 with the water jacket 56. The pipe 66 is provided with a branch 67 running to the inlet of the heater 42.

From the heater 42 extends a pipe 68 provided with a series of injection nozzles 69 extending into the pressure supply pipes adjacent the valves of the pressure chambers. Each of these supply pipes is provided with a valve 70 controlled by a thermostat 71 located in the pressure supply pipe wherein the respective nozzle is held.

On the heater at 72 is provided a safety valve and the final exhaust is indicated at 73.

In describing the method of operation, it is assumed that the pressure chamber 12 has been charged and the charge just exploded. There is thus produced in that chamber a fluid pressure, the mixture and degree of compression of the charge being arranged so that the produced pressure is somewhat greater than that required in the high pressure element. As it is possible under some conditions to operate without the use of the injection water, the method of operation will first be described as using only the fluid pressure produced in the chamber. Things being in the state above mentioned, the high pressure motor element C′ will be at the beginning of its cycle, the element C^3 will have passed through two thirds of its cycle and the element C^2 through five sixths of its cycle. The valves 14 and 16 leading to the compressors will be closed, as will the valves 22 and 23 leading to the motor elements C^2 and C^3, and the valve 39 leading to the exhaust. The valve 21 leading to the high pressure motor element C′ is opened by the action of its cam and a decrement of the fluid under pressure is allowed to pass therethrough to the pipe 18 and from thence to the motor element C′, the valve at this element being arranged to permit the fluid to actuate the motor element. The motor element C′ is thus caused to begin movement. When the motor element C′ has completed one sixth of its cycle, the other motor elements will have also progressed one sixth, so that the element C^2 is now at the start of its cycle. By the action of the cams, the valve 21 is closed and the valve 22 opened. A second decrement of the fluid under pressure will now pass from the pressure chamber and begin to develop kinetic-energy in the element C^2. In like manner, upon the element C' accomplishing one third of its cycle, the valve 22 will be closed and the valve 23 opened. A third decrement of the fluid will now begin to actuate the element C^3. In the meantime, in the pressure chamber 13 the valve actions have been as follows. Throughout the operations just described, the valves 24, 25 and 26 have remained closed. At the start the valve 40 has been open. This valve has closed at an early period, the timing of which will be understood when it is explained what follows the closing of valve 23 in chamber 12. The valves 15 and 17 have both remained open from the start, and the chamber 13 is now filled with a compressed explosive mixture. As the element C' finishes one half of its cycle, valve 23 is closed and valves 14, 16 and 39 in chamber 12 are opened. At the same time, valves 15 and 17 are closed in chamber 13. As this is accomplished, the switch 50 is closed and the charge exploded, producing a body of fluid under pressure in chamber 13. It should be noted that the cams 51 are so arranged as to close the switches and immediately thereafter open them. By the continued action of the cams valve 24 is now opened and the motor element C' supplied with a second decrement of fluid under pressure. When this element has completed two thirds of its cycle, the valve 24 is closed and the valve 25 is opened to supply motor element C^2 with its second portion. Meanwhile, the exhaust from C' passes through pipe 34 to mingle with the second decrement from the pressure chamber and assists the action of such decrement in the motor element C^2. In like manner, a third decrement is next supplied to C^3, being mixed with the exhaust from C^2. As the motor element C' completes its cycle, valve 26 is closed, the exhaust from C^3 passing out by the pipe 36. While this has been in progress, the entering fresh air and gas in chamber 12 have swept the remainder of the exploded charge out of that chamber, and upon the completion of the passage of this remainder, the valve 39 has closed. The cycle is then completed by the closing of the valves 14 and 16 and the switch 49.

While the foregoing has been described as operating without the use of injection water, it is usually preferable to employ steam to assist in the actuation of the motor elements and to keep down the temperature, and to this end the method now to be referred to is employed.

The motor being in motion and the pump in operation, circulation will be set up through the pipe 66, jackets 56, 55, 54, 57 and 58, and the pipes 59 connecting said jackets, back through the pipe 65. The effect of this will naturally be to heat the water of circulation and, owing to the great heat produced in explosion motors, the water will soon be heated to a point where removal of the pressure will convert it into steam and the water will no longer have the proper cooling effect. The thermostat 64 will then open the valve of the force pump 63 so as to permit the influx of cooling water. Further, the explosions in the chambers 12 and 13 produce a high temperature in the contents and as the gases rush out through the various valves, the valves and pipes become intensely heated unless means are provided to reduce the temperature. To do this without the usual loss of efficiency in explosive engine jacketing it becomes necessary to employ a cooling liquid previously heated to such a degree that the loss of energy will not be abnormally large as would be the case were cold water employed. As the cold water is introduced, a portion of the heated water is passed through the heater 42 and thence to the nozzles 69. Now, as the gases pass out through one of the various valves, the thermostat in the pipe leading from that valve will operate, under the influence of the heat, to open its valve and will remain operative until the gases have been cooled to the required temperature. As the valve opens, the hot water is forced through the nozzle and is at once converted into steam. Now, if this be done at a point where the pressure is, say, 500 pounds per square inch and the water about 470° C., the resultant loss of energy will be negligible. Further, if water at this temperature be introduced where the pressure is lower there will still be less loss of efficiency, and the water expanding into steam will do useful work.

It will be noted that, by the peculiar method of heating the water and utilizing the same, the greater portion of the heat energy lost by the gases in cooling throughout the system is absorbed by the cooling fluid and again utilized in the system by the expansion of the cooling fluid.

What is claimed is:—

1. That method of utilizing a fluid under pressure in the operation of a multi-stage prime motor which consists in subtracting separate portions of such fluid pressure and conducting the same to the successive elements of the motor, each successive portion having a decremental pressure, and renewing the initial pressure supply at intervals determined by the cycle of operation of the motor.

2. That method of operating multi-stage

prime motors which consists in the successive productions of pressure in a closed chamber at predetermined intervals with relation to the cycle of operation of the motor, and the utilization of such pressure by subtracting successive portions of the contents of said chamber and actuating thereby the successive motor elements of the prime motor, each successive portion having a decremental pressure.

3. The method of operating prime motors which consists in the periodical ignition of a combustible medium to produce successive pressures in a closed chamber and the utilization of each pressure by subtracting successive portions of the contents of said chamber and actuating thereby the successive motor elements of a multi-stage motor, each successive portion having a decremental pressure.

4. The method of operating prime motors which consists in the compression of a combustible medium, the ignition of such medium in a closed chamber at predetermined intervals with relation to and timed by the motor, and the utilization of fluid pressure thus produced by subtracting successive portions of the contents of said chamber and actuating thereby the successive motor elements of a multi-stage prime motor, each successive portion having a decremental pressure.

5. The method of operating prime motors which consists in the compression of a combustible medium, the ignition of such medium in a closed chamber, the utilization of the fluid pressure thus produced by subtracting successive portions of the contents of said chamber, each successive portion having a decremental pressure cooling said portions, and actuating thereby the successive motor elements of a multi-stage prime motor.

6. The method of operating prime motors which consists in the compression of a combustible medium, the ignition of such medium in a closed chamber, the utilization of the fluid pressure thus produced by subtracting successive portions of the contents of said chamber, each successive portion having a decremental pressure cooling said portions by the introduction of water at a temperature above that required to produce the pressure to be utilized, and actuating thereby the successive motor elements of a multi-stage prime motor.

In testimony that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

PETER G. SCHMIDT.

Witnesses:
I. N. GILLIS,
J. M. WALKER.