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THERMAL HYDRAULIC POWER ASSEMBLY

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2 Sheets-Sheet 1

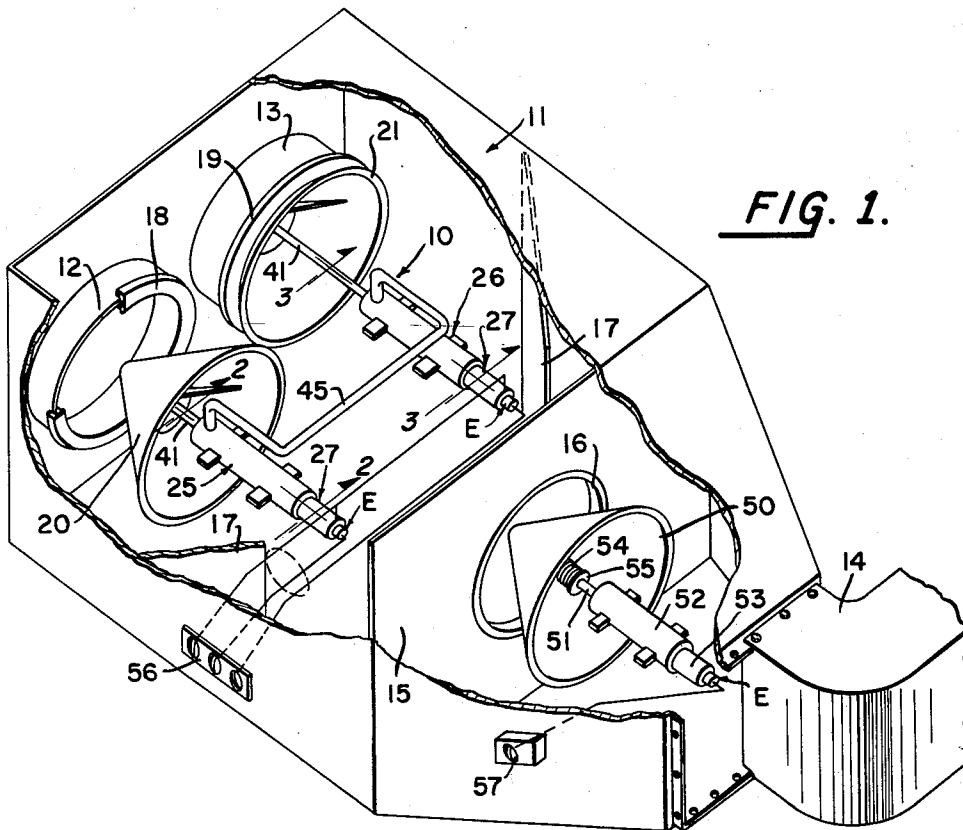


FIG. 1.

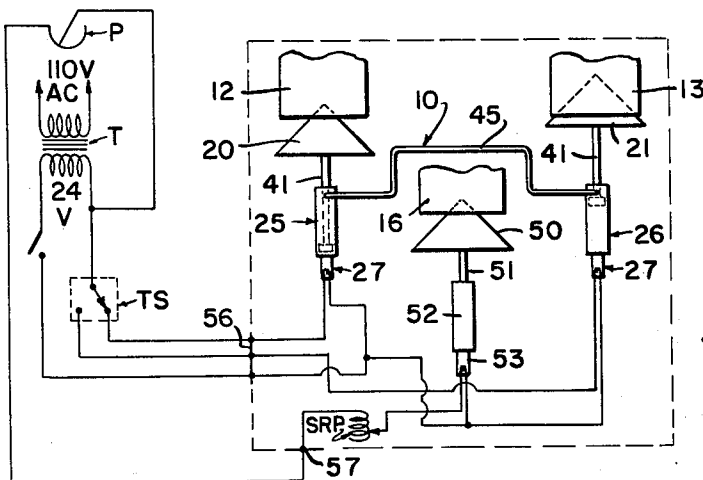


FIG. 5.

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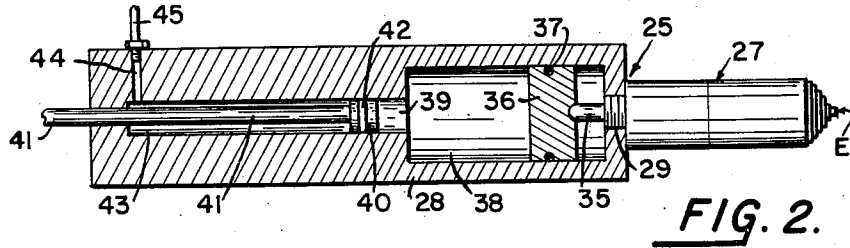
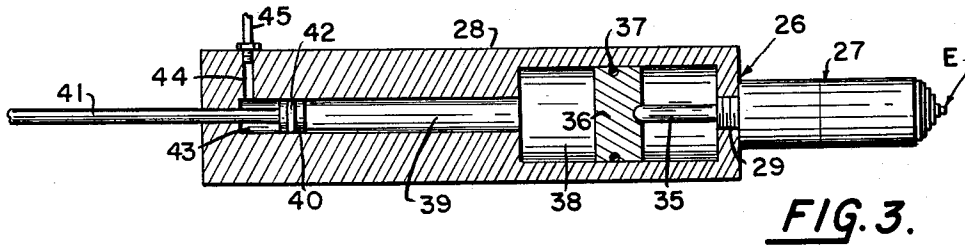
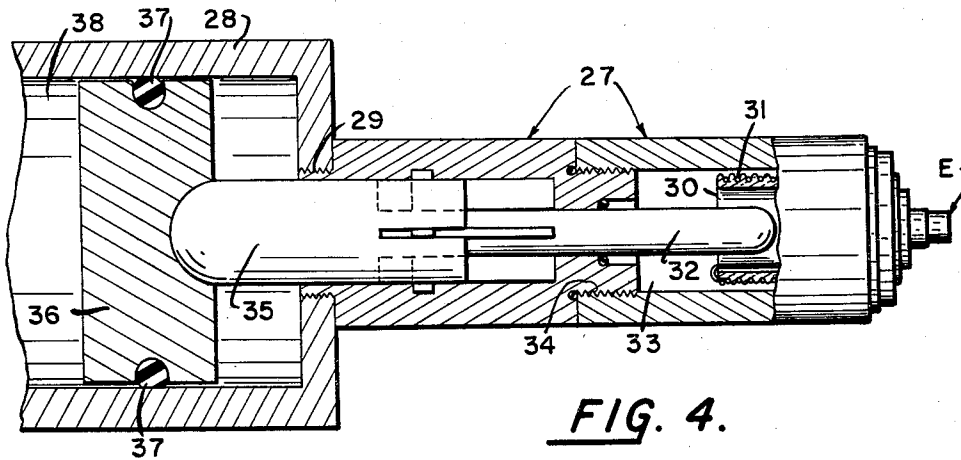
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2 Sheets-Sheet 2



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THERMAL HYDRAULIC POWER ASSEMBLY

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3 Claims. (Cl. 60—23)

This invention relates to a thermal hydraulic power assembly which is compact, self-contained and adapted for imparting reciprocal motion to a plurality of separate hydraulically actuated shafts each of which is operatively connected to mechanism to be reciprocated.

The assembly comprises a plurality of power units each including a thermal motor, hydraulic cylinder and a piston and shaft mounted for reciprocal movement in the cylinder. The plurality of hydraulic cylinders are hydraulically connected together for reciprocal movement of the hydraulic fluid. The arrangement is such that the power units are mechanically independent of each other though connected hydraulically and therefore each unit may be positioned and located as desired relatively to the mechanism to be reciprocated without regard to the other parts of the assembly as a whole.

Thermal motors have been employed heretofore for imparting reciprocal motion to a shaft located between two axially aligned motors and having its ends mounted in the motor housings in contact with expansible material therein. Heating of the material in the thermal motors alternately thus produces reciprocal movement of the shaft which may be mechanically or hydraulically connected to the mechanism to be reciprocated. The use of a single shaft reciprocated by two thermal motors requires that the mechanisms to be operated by the shaft be in direct relationship to the shaft, usually necessitating complicated operative connections or complicated hydraulic systems, and limiting the choice of position and location of parts.

The independent power units of my invention, each including a thermal motor, hydraulic cylinder and hydraulically actuated piston and shaft, provide a wide choice of position and location of parts, and allow for operation of a variety of mechanisms, even an odd number such as three, which could not be possible with a common shaft.

Another feature of the invention is the construction of the hydraulic cylinders and the reciprocal parts mounted therein, whereby limited movement imparted to the thermal motor shaft and piston is transmitted in greatly increased degree through hydraulic pressure to the hydraulically actuated shaft and piston in the hydraulic cylinder. For example, a one-half inch travel of the motor shaft causes the hydraulic shaft to travel two inches. This enables me to use very small, compact power units in my assembly.

The construction herein shown and described may be adapted for imparting reciprocal movement to a wide variety of mechanisms, such for example, as means controlling the flow of cold and hot air into a dual duct box, one embodiment of which is shown in the drawings. By utilizing my invention, prior art air valves, hydraulic valves, solenoid valves, and devices employing high voltage electrical systems to operate pumps, motors or compressors have been eliminated. Low voltage, such as 24 volts, may be used to activate my thermal motors.

The combination of the thermal motors and sealed hydraulic system of my invention eliminates the need for other equipment such as a reservoir of oil or air to be pumped into a hydraulic line in order to create the pressure necessary to produce motion. Constant, uniform pressure is exerted by the hydraulically actuated piston associated with my thermal motor.

Another advantage of the invention is that remote control may be employed for operating two or more mecha-

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nisms which would not be possible if thermal motors and a common shaft were used.

Other objects and advantages of the invention will be apparent from the following specification and drawings in which is shown one embodiment of the power assembly as applied to a dual duct air box.

In the drawings:

FIG. 1 is a perspective view showing my thermal hydraulic power assembly installed in a dual duct air box for actuating hot and cold air inlet dampers.

FIG. 2 is a sectional view, on an enlarged scale, in the plane of the line 2—2 of FIG. 1, showing the hydraulic cylinder and the hydraulically actuated shaft and piston of one of the power units of the assembly in the position they occupy to open one of the air inlets, the thermal motor portion of the power unit being shown in elevation.

FIG. 3 is a sectional view, on an enlarged scale, in the plane of the line 3—3 of FIG. 1, showing the hydraulic cylinder and the hydraulically actuated shaft and piston of the other of the two power units of the assembly in the position they occupy to close one of the air inlets, the thermal motor portion of the power unit being shown in elevation.

FIG. 4 is a longitudinal sectional view, enlarged, of the thermal motor and part of the hydraulic cylinder and contents, in the position shown in FIG. 2.

FIG. 5 is a diagrammatic view of the mechanism shown in FIG. 1 and of an electrical circuit for controlling the operation of the assembly.

In that embodiment of the invention shown in the drawings, the thermal hydraulic power assembly indicated as a whole at 10 is installed in a dual duct air box 11 provided with a hot air inlet through collar 12, a cold air inlet through collar 13, air outlet duct 14, static pressure regulator bulkhead 15 having an outlet 16, and baffles 17 extending at an angle from the side walls of the box 10 to the bulkhead 15. The inlet collars 12, 13 are provided with resilient ring-form gaskets 18, 19, respectively, and are adapted to engage the outer surfaces of cone shaped dampers 20, 21, respectively, when the dampers are in closed positions.

The power assembly embodying my invention comprises two or more power units, two being shown herein and indicated as a whole at 25, 26. The units are structurally identical. In FIGS. 2 and 3 the unit parts are shown in different positions, the unit 25 having actuated the damper 20 to open position and the unit 26 having actuated the damper 21 to closed position. Each of the power units 25, 26 comprises a thermal motor housing 27 rigidly connected at one end to the hydraulic cylinder 28 by screw threaded parts 29 as shown in FIG. 4. The thermal motor housing 27 has mounted therein an electrical thermal element including a holder 30 and wiring 31 thereon, and a reciprocal shaft 32. The chamber 33 is completely filled with a highly expansible compound such as paraffin wax. For convenience of assembly, the motor housing 27 is made in two parts connected together as indicated at 34. The shaft 32 has a forward end 35 which preferably is greater in diameter than the portion 32 and extends into the hydraulic cylinder 28.

A piston 36 provided with an O-ring 37 is fixed on the end of the shaft 35. The diameter of the piston 36 is such that it fits snugly in the hydraulic cylinder 28 for movement axially of the cylinder. The construction of the differential diameter shaft 32, 35 is the subject of my co-pending application U.S. Serial No. 51,201, filed August 22, 1960, now Patent No. 2,999,724, issued September 12, 1961, and need not be described in detail herein. Suffice to say that expansion of the wax in chamber 33, under influence of heat, actuates the shaft and causes it

to move from the position shown in FIG. 2 to that shown in FIG. 3.

The hydraulic cylinder housing 28 has different internal diameters whereby are formed a larger diameter chamber 38 and a small diameter chamber 39 which communicate with each other and contain hydraulic fluid sealed therein between the motor actuated piston 36 and a hydraulic piston 40 fixed on shaft 41. The hydraulic piston 40 is small in diameter as compared to the piston 36. It is provided with an O-ring 42 and fits snugly in the chamber 39 for axial movement therein. The parts of the hydraulic chambers 39 located to the left of the pistons 40, indicated at 43, in each of the two power units, are hydraulically connected together by the bores 44 in cylinders 28 and hydraulic conduit 45 which has its ends fitted into the bores 44. Hydraulic fluid fills the conduit 45, bores 44, and chambers 43 between the two pistons 40 of the respective power units 25, 26 and is sealed therein. Preferably the conduit 45 is flexible so that the power units may be positioned and located as desired for any particular installation and need not be parallel to each other as shown herein.

The shaft 41 of the power unit 25, FIG. 2, is connected to the hot air damper 20, and the shaft 41 of the power unit 26, FIG. 3, is connected to the cold air damper 21, as shown in FIG. 1. When the thermal motor 27 of power unit 26 has been activated and expansion of the material in chamber 33 has caused the shaft 32, 35 and piston 36 to move to the left as shown in FIG. 3, the hydraulic fluid in chambers 38, 39 between pistons 36, 40, forces the piston 40 to move to the left and thus shaft 41 forces damper 21 into the closed position shown in FIG. 1. The effect of this movement of piston 40 of unit 26 also forces the hydraulic fluid in chamber 43 of that unit and in conduit 45 to flow under pressure toward chamber 43 of unit 25, thus forcing the hydraulic piston 40 and motor piston 36 of that unit to move to the right. This retracts shaft 41 of unit 25 to open the damper 20 and it also returns the motor shaft 32, 35 to the position shown in FIG. 2, in readiness for the next cycle of operation.

It will be understood that the assembly as shown herein includes three separate sealed hydraulic chambers, one in each of the units 25, 26, between pistons 36 and 40, and another including the conduit 45 between the pistons 40 of the two units 25, 26. The hydraulic fluid is reciprocated in each of the chambers by alternate movement of the thermal motor shafts.

For the particular embodiment of the invention shown herein, it is desirable also to employ an air pressure regulator which may comprise a damper 50 for regulating the flow of air through the opening 16 in bulkhead 15. The damper 50 is connected by shaft 51 to a hydraulic piston located in the hydraulic cylinder 52 connected to a thermal motor 53. The construction of the cylinder 52, motor 53 and parts mounted therein is similar to the parts of the units 25, 26 heretofore described, excepting that the hydraulic fluid is sealed within the cylinder 52, and a coiled spring 54 on shaft 51 between the damper 50 and an abutment 55 fixed on the shaft 51 causes the damper to move to open position after the expansible material in the thermal motor has been allowed to cool and contract.

The power units 25, 26 may be mounted by any suitable means within the air conditioning box 10 and in any desired position and location. If the dampers 20, 21 are used to open and close openings in walls at an angle to each other, the power units such as 25, 26 can be located at an angle to each other instead of parallel to each other without any change in structure except the shape of the conduit 45.

The cone shaped dampers shown are particularly adapted for air conditioning systems. They diffuse the air streams as they enter the box 10 and provide for efficient mixture of hot and cold air, aided by the baffles 17.

The electrical control system will be understood by reference to the diagrammatic view, FIG. 5, in which the letter T indicates a transformer, SRP a static regulator potentiometer, P a potentiometer, and TS a thermostat switch. An electrical connection strip is indicated at 56 and a connection strip for the static regulator potentiometer is indicated at 57. When the thermostat calls for more hot air to come through inlet 16, the power unit 26 on the cold inlet side is energized by electrical current passing through electrode E to the thermal motor, causing the expansible material to expand and move the shaft 32, 35, and piston 36 to the left, and through the hydraulic fluid in chambers 38, 39, move the piston 40 and shaft 41 to move damper 21 and close the cold air inlet. This movement also causes the piston 36 in unit 25 to be retracted as heretofore explained to open the hot air inlet.

In the particular embodiment shown, hydraulic chambers 38, 39 are proportioned relatively to each other so that a one-half inch axial movement of the shaft 32, 35, and piston 36 thereon causes the hydraulic piston 40 and shaft 41 to travel two inches. These proportions of course can be varied, but in any case very limited movement of the thermal motor shaft by expansion of the material in chamber 33 is required to produce relatively greater movement of the shaft 41 which operates a damper or the like to be reciprocated.

Changes may be made in details of construction and in the form and arrangement of parts without departing from the scope of the invention as defined by the appended claims.

I claim:

1. A valveless thermal hydraulic power assembly for imparting reciprocal motion to a plurality of separate mechanisms which comprises

- (a) a plurality of separate self-contained power units located and positioned in variable relationship to each other, each power unit comprising
- (b) a thermal motor housing,
- (c) expansible and contractible material in the housing,
- (d) means for heating the material,
- (e) a reciprocable power shaft in the thermal motor housing actuated by expansion of the material,
- (f) a hydraulic cylinder connected to the thermal motor housing,
- (g) a hydraulic chamber in the cylinder,
- (h) the reciprocable power shaft having an end extending into the hydraulic chamber,
- (i) a power piston on said end portion slidably engaging the hydraulic cylinder,
- (j) a hydraulic shaft in the chamber having an end projecting from the chamber,
- (k) a hydraulic piston on the hydraulic shaft reciprocably movable in the hydraulic chamber,
- (l) proximate surfaces of the power and hydraulic pistons being spaced apart in said hydraulic chamber, and
- (m) hydraulic fluid in the chamber sealed therein between the power and hydraulic pistons,
- (n) a conduit between the hydraulic cylinders of said plurality of power units communicating with the hydraulic chambers of said units at the sides of the hydraulic pistons removed from the power pistons, and
- (o) hydraulic fluid sealed in said conduit and hydraulic chambers for reciprocal movement of the fluid between the hydraulic pistons of the plurality of power units in response to expansion of the thermally expansible material in one unit and contraction of said material in another unit of the plurality of power units.

2. A valveless thermal hydraulic power assembly for

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imparting reciprocal motion to a plurality of separate mechanisms which comprises

- (a) a plurality of separate self-contained power units located and positioned in variable relationship to each other, each power unit comprising 5
- (b) a thermal motor housing,
- (c) expansible and contractible material in the housing,
- (d) means for heating the material,
- (e) a reciprocable power shaft in the thermal motor housing actuated by expansion of the material, 10
- (f) a hydraulic cylinder connected to the thermal motor housing,
- (g) a hydraulic chamber having different internal diameters in the cylinder, 15
- (h) the reciprocable power shaft having an end extending into the hydraulic chamber,
- (i) a power piston on said end portion slidably engaging the hydraulic cylinder,
- (j) a hydraulic shaft in the chamber having an end projecting from the chamber, 20
- (k) a hydraulic piston on the hydraulic shaft reciprocably movable in the hydraulic chamber,
- (l) the hydraulic piston being smaller in diameter than the power piston, 25
- (m) proximate surfaces of the power and hydraulic pistons being spaced apart in said hydraulic chamber, and

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- (n) hydraulic fluid in the chamber sealed therein between the power and hydraulic pistons,
- (o) a conduit between the hydraulic cylinders of said plurality of power units communicating with the hydraulic chambers of said units at the sides of the hydraulic pistons removed from the power pistons, and
- (p) hydraulic fluid sealed in said conduit and hydraulic chambers for reciprocal movement of the fluid between the hydraulic pistons of the plurality of power units in response to expansion of the thermally expansible material in one unit and contraction of said material in another unit of the plurality of power units.

3. The power assembly defined by claim 1 in which the conduit between the hydraulic cylinder and hydraulic chambers of the plurality of power units is flexible and the power units are movable relatively to each other.

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