Sept. 14, 1965 M. E. ANDERSON ETAL 3,206,117

MOTOR-OPERATED VALVE

Filed Sept. 5, 1961 2 Sheets-Sheet 1

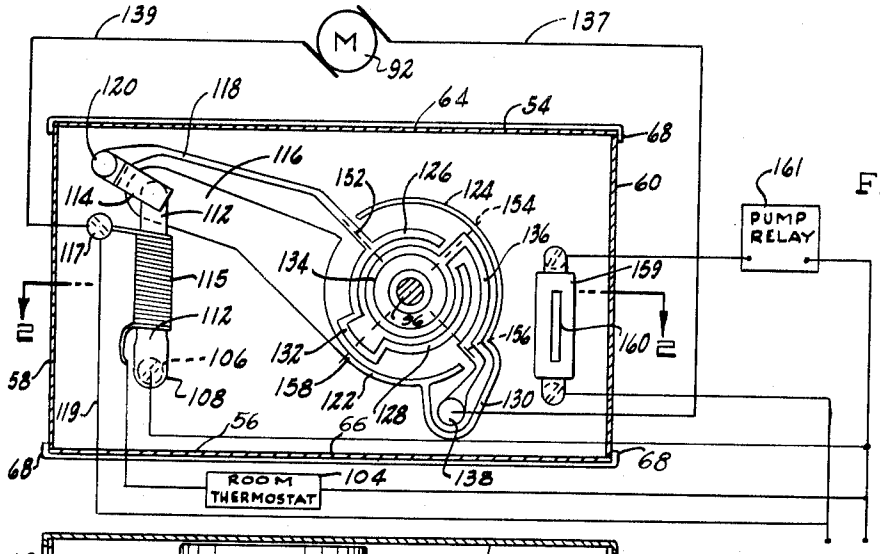


FIG_1

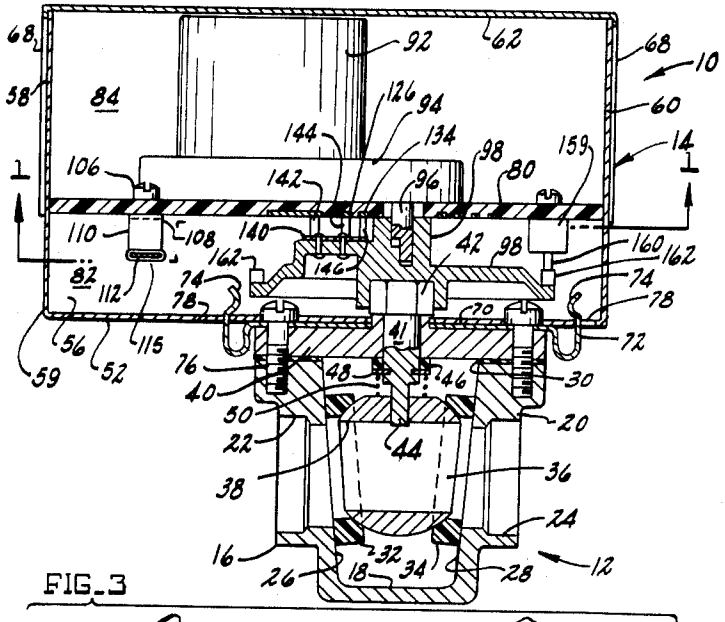
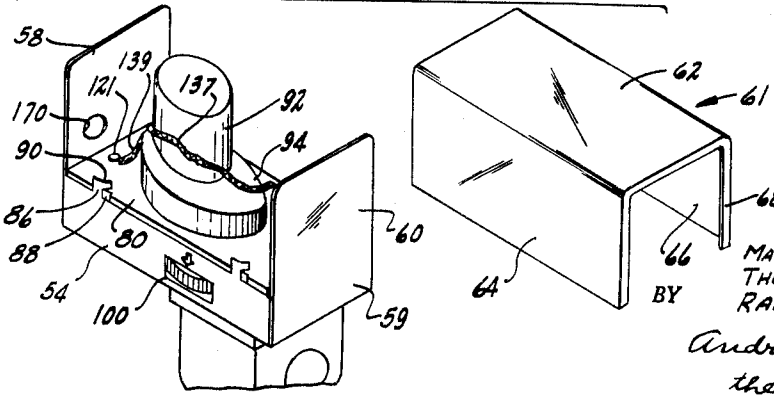


FIG_2

FIG_3



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MOTOR-OPERATED VALVE

Filed Sept. 5, 1961 2 Sheets-Sheet 2

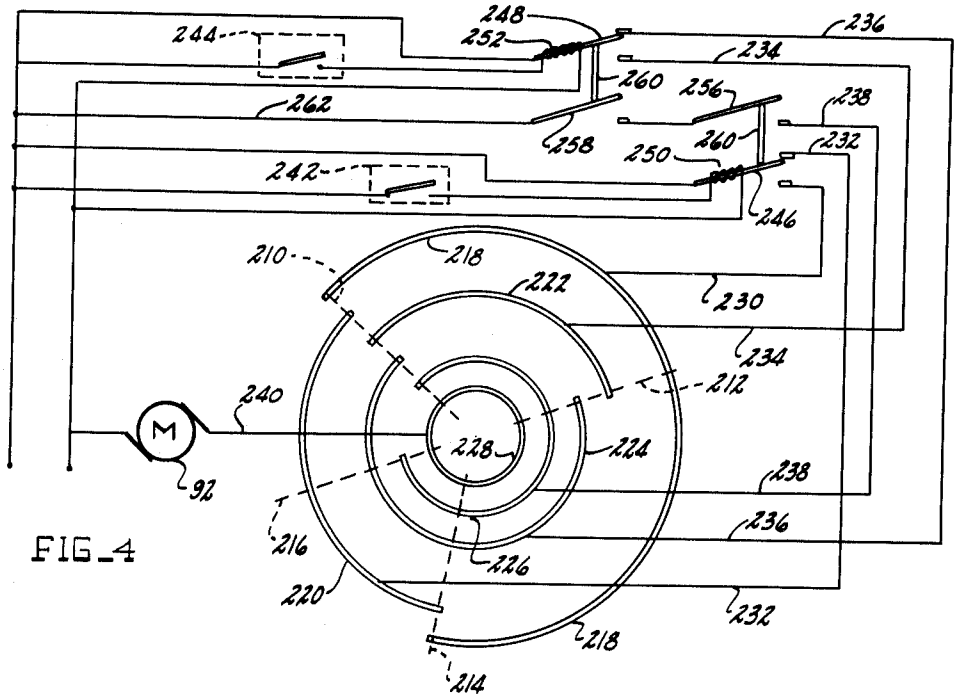


FIG_4

FIG_5

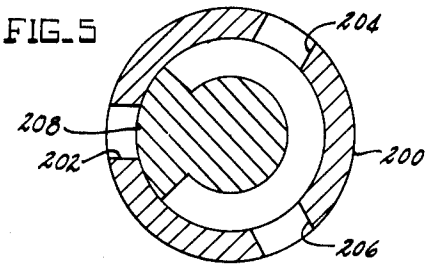


FIG_6

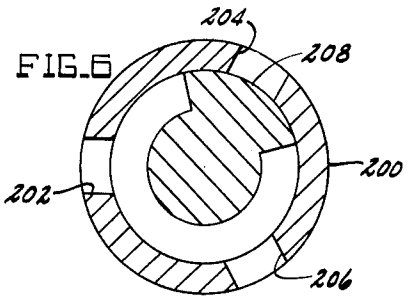


FIG_7

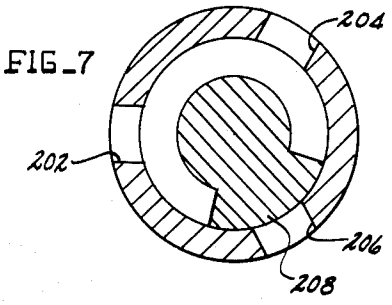
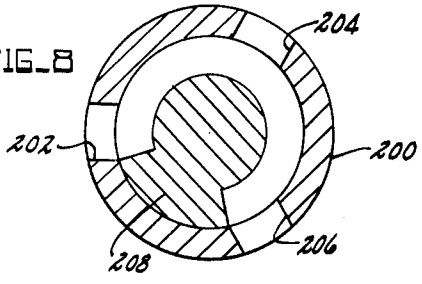


FIG_8



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1

3,206,117

MOTOR-OPERATED VALVE

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9 Claims. (Cl. 236—1)

This invention relates to motor-operated valves, as for example valves which are utilized to control the flow of heat exchange fluid to the room heat exchangers in domestic heating systems.

One object of the invention is to provide a motor-operated valve which can be manufactured as a relatively small size device, thereby permitting it to be installed adjacent the fin-type heat exchange units utilized behind baseboards in the so-called baseboard-type heating system.

A further object of the invention is to provide a motor-operated valve having a stand-by manual operator for the valve element, thereby permitting the valve to be operated in the event of power failure.

A further object of the invention is to provide a motor-operated valve having a printed circuit type control system arranged within the motor housing structure to thus simplify the electrical wiring.

A further object of the invention is to provide a motor-operated valve and printed circuit control therefor, wherein the electrical terminals are located in easily accessible positions, thereby facilitating initial hook-up of the electrical controls and subsequent repair as needed.

A further object of the invention is to provide a motor-operated valve having a printed control circuit which includes a large number of circuits, thereby minimizing circuit assembly time and eliminating errors commonly involved in the manual hooking up of conventional switching harness.

An additional object of the invention is to provide a motor-operated valve wherein the motor portion is easily removed from the valve portion, thereby among other things permitting the two portions to be shipped separately if desired and permitting relative freedom in parts stock on the supplier shelves.

Another object of the invention is to provide a motor-operated valve wherein the motor portion and movable flow-throttling portion can be readily separated from the valve casing which is installed in the fluid line, whereby to permit ready repair or replacement of the motor, movable valve element and/or valve seats.

Another object of the invention is to provide a motor-operated valve wherein the valve casing is provided with two internal convergent surfaces for mounting a pair of valve seats and an interposed valve element, the arrangement being such that the valve element is automatically wedged into a position wherein it readily seals against the valve seats.

A further object of the invention is to provide a motor-operated valve wherein the flow is substantially a straight-through flow, and wherein the pressure drop through the valve is relatively small, thereby enabling the valve to be operated by a relatively low strength motor.

A further object of the invention is to provide a motor-operated valve wherein the operating time for moving the valve element between its opened and closed positions is relatively short.

2

Another object is to provide a motor-operated valve which can control the flow through a plurality of outlets, thereby adapting the valve to use as a device for supplying heat exchange fluid to each of a plurality of zones to be conditioned.

A still further object of the invention is to provide a motor-operated valve having an improved arrangement of electrical controls disposed in a compact relation within a housing structure carried atop the valve casing, said control arrangement including a thermally-operated time delay structure and an auxiliary switch structure designed to control the operation of a fluid pumping mechanism in conjunction with the operation of the valve.

Other objects of this invention will appear from the following description and appended claims, reference being had to the accompanying drawings forming a part of this specification wherein like reference characters designate corresponding parts in the several views.

In the drawings:

FIGURE 1 is a sectional view of one embodiment of the invention taken on the line **1—1** in FIG. 2;

FIG. 2 is a sectional view of the FIG. 1 embodiment taken on line **2—2** in FIG. 1;

FIG. 3 is a reduced scale perspective view of the FIG. 1 embodiment, showing parts of the mechanism disassembled to illustrate interior details;

FIG. 4 is a diagrammatic view of an electric circuit which can be utilized with a second embodiment of the invention;

FIG. 5 is a sectional view through the above-mentioned second embodiment, showing same in a fully closed position;

FIG. 6 is another view of the FIG. 5 embodiment, showing same in a partially open position;

FIG. 7 is a further view of the FIG. 5 embodiment, showing same in a second partially open position; and

FIG. 8 is a view of the FIG. 5 embodiment, showing same in a fully open position.

Before explaining the present invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and arrangement of parts illustrated in the accompanying drawings, since the invention is capable of other embodiments and of being practiced or carried out in various ways. Also, it is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation.

Referring to the drawings, there is shown therein a motor-operated valve structure **10** including a fluid valve portion **12**, and a motor operator portion **14**. Valve portion **12** includes a rotary valve element **36** having an upwardly extending stem **41** which is adapted to be drivingly connected to an electric motor **92** disposed within the motor portion **14**. The motor portion **14** also includes an electrical switch structure having a series of contacts **142** and **144** arranged to be opened and closed during rotation of the electric motor, to thus control the distance through which the motor is operated and the position of the valve element, either in its closed or opened position. As shown in FIG. 1, the illustrated valve is utilized in conjunction with a room thermostat in a conventional domestic room heating system, the general arrangement being such that when the thermostat calls for heat the electric motor moves the valve to an open position to admit heat exchange fluid to the room heat exchanger, and when

the room thermostat is satisfied the motor moves the valve to a closed position cutting off the flow of heat exchange fluid to the heat exchanger.

Referring to FIG. 2, valve portion **12** comprises a generally cup-shaped valve casing **16** having a bottom wall **18** and an upstanding peripheral side wall **20**. Suitable inlet and outlet openings are provided in the casing side wall, as at **22** and **24**. Internally the casing is constructed to provide two relatively flat opposed side wall surfaces **26** and **28**, said surfaces proceeding from the mouth portion **30** of the casing in a generally tapering or convergent relationship to thus form mounting surfaces for the two annular valve seat elements **32** and **34**, preferably formed of polytetrafluoroethylene or other material having desired characteristics of good sealing action and long service life.

Interposed between the two valve seat elements **32** and **34** is a valve element **36** configured to have a generally spherical outer surface engagable with the surface of the valve seats and having a generally straight duct or passage **38** for conducting fluid between the inlet **22** and the outlet **24** when the valve element is rotated to the open position, as shown.

The mouth of casing **16** is closed by a cover element **40** which is provided with a suitable central opening to receive the operating stem **42** for valve element **36**, said stem having a non-circular lower end portion **44** disposed within a non-circular bore in the valve element so that rotation of the stem is effective to rotate the valve element. In order to seal the joint between the stem and cover **40** there may be provided a compressible annular seal element **46**, E ring **48**, and compression spring **50** arranged to place member **46** in compression for providing a relatively tight seal against the cover element. Spring **50** also urges valve element **36** downwardly so as to wedge the members **32** and **34** tightly relative to the ball and to their mounting surfaces **26** and **28**. The general arrangement is such as to provide a generally leakproof construction which can be readily assembled and removed through mouth **30** as desired.

Referring now to the motor-operator portion of the assembly, said portion includes a housing structure **59** having a flat base wall **52**, a relatively short upstanding front wall **54**, a relatively short upstanding rear wall **56**, and two relatively high side walls **58** and **60**. The housing is closed by a removable U-shaped cap **61** which comprises a top wall **62**, a front wall section **64** and a rear wall section **66**, said front and rear wall sections being of sufficient vertical dimension to reach the upper edge of the corresponding front wall sections **54** and **56** to thus provide a closed housing structure when the two sections are telescoped together. As shown best in FIG. 3, the walls of the cap section **61** are provided with inturned flanges, as at **68**, to thus permit the cap section to be telescoped onto the lower housing section and removed therefrom as desired.

Connection of the housing structure with the valve portion **12** is readily accomplished by means of the snap-on structure best shown in FIG. 2, said clip structure preferably being formed of spring steel and comprising a flat portion **70** and two spring arm portions **72** having upstanding detent portions **74** formed thereon. The clip structure can be readily secured to valve casing element **40** by means of the screws **76** which are utilized to secure the two casing elements **16** and **40** together. The base wall **52** is of course provided with suitable openings to permit stem **41** and the heads of screws **76** to project therethrough without in any way striking or preventing the base wall from correctly seating on the upper face of cover element **40**. Base wall **52** is also provided with openings **78** located to register with detent portions **74** so that installation of motor portion **14** may be accomplished by downward movement of the housing structure, with a consequent initial snapping apart of the detent portions **74** and and subsequent snapping of these detent portions toward one another to their locked positions.

Mounted within the housing structure is a flat terminal board **80** of generally rectangular construction, said board constituting a partition for subdivinding the housing into a lower switch chamber **82** and an upper motor chamber **84**. Securement of the terminal board may be conveniently effected through the use of tabs **86** formed as integral extensions of the front and rear walls **54** and **56**, said terminal board having suitable notches or recesses **88** formed in its front and rear edges to permit the board to be installed on the upper edges of the walls **54** and **56** without strking tabs **86** or without shifting about in the installed condition. When the board is in place the lateral extensions **90** of the tabs can be turned inwardly to lock the terminal board against vertical displacement. The board may be separated from the housing structure at any time by merely bending the tab extensions **90** back to their positions in the plane of the tabs.

The motor for operating the valve is shown at **92**, and preferably comprises a uni-directional motor having a series of cooperating speed reducing gears located in the general portion designated by numeral **94**. As shown in FIG. 2, the motor is provided with an output shaft **96** which preferably moves at a relatively low speed, as for example one or two r.p.m., said motor shaft projecting through an opening in the terminal board and having a non-circular lower end portion seated in a non-circular recess in a connector member **98**. This connector member has its lower surface configured as a non-circular socket and is fitted over the non-circular upper end portion **42** of the aforementioned valve stem so that during energization of motor **92** members **98** and **42** are rotated together to thus transmit rotation to the spherical valve element **36**.

Member **98** is of generally circular outline in top plan, and the diameter thereof is just slightly less than the spacing between walls **54** and **56**. Also, the axis of shaft **96** is located centrally between walls **54** and **56** so that during rotation of shaft **96** the peripheral edge of member **98** is at all times closely adjacent wall **54**. As best shown in FIG. 3, wall **54** is provided with a slot **100**, and the peripheral edge surface of member **98** is serrated at least for a portion of its length, so that in the event of electrical power failure the serviceman or householder may apply thumb pressure to the serrated surface to rotate member **98** for thereby moving valve element **36** to its open or closed position as desired. Suitable indicia may be printed on walls **54** and the peripheral edge of member **98** to indicate when the valve element is in its open and closed positions.

The operation of motor **92** may be readily controlled by the circuitary best shown in FIG. 1. As there shown, the circuitry includes a conventional room thermostat **104** suitably connected to screw-type terminal **106** located on the upper surface of board **80**. The terminal is electrically connected with a bracket **108** which has a downwardly extending leg portion **110** for mounting an elongated bimetal leaf **112**. A suitable heater in the form of an electric resistance wire **115** is wrapped around the bimetal with one end thereof connected with thermostat **104** whereby to be energized when thermostat **104** calls for heat. The other end of the resistance heater wire connects with a rivet **117** which extends from a terminal **121** located on the upper face of board **80**. A conventional line **119** leads back to the power source (as for example a twenty-four volt transformer). The free end of leaf **112** is arranged to move between a lower contact carried on a bracket portion **114** and an upper contact carried on or formed integrally with printed portion **116** of a printed circuit located on the underside of terminal **80**. Bracket **114** includes an upper portion which is electrically connected to printed portion **118** of the printed circuit, as by means of a rivet **120**. In its low temperature position leaf **112** engages the lower contact on bracket **114**. When the room thermostat calls for heat an electric signal is sent through bracket **108**, resistance heater **115**, and line **119** so that bimetal leaf **112** after a predetermined time delay

bends upwardly to engage the contact carried on printed circuit portion **116**. This printed portion is connected with a first "valve opening" track comprised of the two arcuate track sections **122** and **124**, and printed circuit portion **118** is connected with a "valve closing" track comprised of the two track sections **126** and **128**. It will be noted that sections **122** and **124** are connected by a printed non-track portion **130**, and that track sections **126** and **128** are connected together by a printed non-track portion **132**.

To connect the above-described tracks with the operating motor **92** there is provided an endless electrically conductive track **134**, preferably equipped with a non-track lead wire connection portion **136**, the actual connection with the lead wire being made by a rivet **138** which extends though the terminal board to a terminal in the motor compartment **84**. A lead wire **137** extends from this terminal to the motor, and another lead wire **139** extends from the motor to terminal **121**.

Cooperating with the printed arcuate track section is an electrical brush mechanism having a flat plate-like base portion **140** and three upstanding leaf-like brush elements **142, 144** and **146**; the base portion electrically interconnects the brush elements. These brush elements are arranged on the rotary member **98** so that brush **146** registers with track **134**, brush **144** registers with track sections **126** and **128**, and brush **142** registers with track sections **122** and **124**. The brushes preferably have thin line contact with the various tracks, and the position of the various brushes in different rotated locations of member **98** is diagrammatically designated in FIG. 1 by the dotted lines **152, 154, 156** and **158**. Lines **152** and **156** represent open positions of the valve element, and lines **154** and **158** represent closed positions of the valve element. The direction of brush rotation in FIG. 1 is clockwise.

In operation, assume the brushes are in position **154** and thermostat **104** calls for heat; after bimetal **115** is heated, current flows through printed lead **116**, track section **122**, lead **130**, track section **124**, brushes **142** and **146**, track **134**, printed lead **136**, flexible lead **137**, motor **92**, and back to the source via leads **139** and **119**. Thus the motor is energized to rotate the valve element **38** until brush position **156** is reached, whereupon the connection between track section **124** and brush **142** is broken to halt the motor in the valve open position.

When the flow of heat exchange fluid through the valve is sufficient to satisfy thermostat **104** heater **115** is de-energized to allow bimetal **112** to engage the contact on bracket **114**. Thereupon the motor is supplied with current via printed lead **118**, track **128**, brushes **144** and **146**, track **134**, printed lead **136**, and flexible lead **137**. The motor thus moves the valve element until the brushes reach the "valve closed" position **158**. The sequence is repeated on each call for heat, it being noted that the motor never reverses its rotation; thus a low cost uni-directional motor can be used. Further, the printed circuit board is such that a random direction motor could also be used. Such an arrangement would permit the valve to automatically reverse its direction if an obstacle should become lodged on the valve seat during the valve-closing period. The valve element would then move to the closed position in the reverse direction and dislodge the obstacle.

As thus far described, the construction provides only for the automatic opening and closing of the valve element in accordance with temperature sensing by the room thermostat. In present-day heating systems the call for heat from the thermostat brings into operation a pump for circulating the heat exchange fluid through the room heat exchangers. The present construction as shown in the drawing therefore also includes an electric switch **159** which is arranged to be suitably connected to the electrical circuit for energizing the circulator pump relay **161** when the thermostat calls for heat.

As shown in the drawing, switch **159** may be a conventional snap switch or other leaf type switch having a lever type actuator **160** arranged above the perpiheral surface portion of member **98**. This member is provided at spaced points around its periphery with raised cam-forming portions **162**, the peripheral extent of these portions being such that during the opening and closing movements of valve element **36** switch **159** will be energized to control the current supplied to the pump motor (not shown). In this way the opening of valve **36** is correlated with the operation of the heat exchange fluid circulating pump to thus time the flow of heat exchange fluid strictly in accordance with the call for heat from the thermostat, and to thus preclude any flow of heat exchange fluid at other than the desired time periods.

If desired, instead of the switch **159** and cams **162**, a printed circuit-brush arrangement similar to the previously described arrangement could be provided for controlling the heat exchange fluid circulator. Whichever arrangement is utilized, it is preferred that the terminals for the electrical leads all be on the motor compartment face of the terminal board **80** so that the electrical leads may be connected after the terminal board is in place, and so that any repair of the electrical leads or replacement of the terminal board may be easily accomplished without unnecessary removal of parts or destruction of any connections. In this regard the use of printed circuitry is advantageous because of its long service life, relatively short construction time, freedom from assembly errors, and elemination of bulky electrical lead wires in the switch chamber, with their consequent tendency to become entangled with the operating components.

It will be noted from FIG. 3 that the electrical lead wires may be connected to the exposed screw type terminals by extending same through an opening **170** formed in either or both of the side walls **58** and **60**. When both walls are provided with lead openings, one of the openings preferably accommodates the lead wires for 110 volt circuitry, and the other opening accommodates the lead wires for 24 volt circuitry. The general arrangement enables the top cap or cover section **61** to be readily removed from housing section **59** without disturbing the electrical wiring.

The drawings show an arrangement wherein the printed circuit tracks are formed on the underside of terminal board **80**, and wherein the cooperating brushes are carried on the rotary member **98**. This is the preferred arrangement, but it is possible to achieve some advantages of the invention by disposing the printed circuit on rotary member **98** and the cooperating brushes on fixed member **80**. Whichever arrangement is employed, the terminals are preferably located in exposed conveniently accessible positions. It will be noted that generally speaking, the illustrated device lends itself to ready repair and replacement of parts, while being relatively compact and simple in structure. Thus, the motor portion **14** may be readily removed and/or shipped separately from valve portion **12**. Similarly, the top cap section **61** of the motor housing may be readily removed from the lower housing section **59** to permit ready access to the terminals of the control system.

With reference to the construction of valve portion **12**, it will be noted that by using a ball type valve the flow passage **36** is substantially the same size as the inlet and outlet passages for the valve body. This provides a full flow, low pressure drop characteristic in a construction having a relatively small over-all dimension, i.e., the valve body can be a relatively small device in relation to its flow capacity. The ball-type valve is further advantageous in that it provides very tight shut-off without leakage while preventing any accumulation of stream matter which might damage or corrode the valve. A further advantage of the valve is the fact that it requires only a quarter turn to move from full on to full off; thus, with a given speed of motor shaft **96** there is a relatively quick actuation of the valve, quicker than in other type valves. Since the ball valve does not require a reciprocating type actuation a relatively low cost uni-directional motor can be used.

Referring to the FIG. 5 embodiment, there is diagrammatically shown a valve for controlling the flow of heat exchange fluid to two separate zones of use, said valve including a housing 200 having an inlet 202, a first outlet 204 and a second outlet 206. It will be understood that outlet 204 is connected with piping which leads to one zone to be conditioned by the heat exchange fluid, and outlet 206 connects with other piping which leads to a second zone to be conditioned by the heat exchange fluid. The rotary valve element for controlling the flow through the valve is designated by numeral 208, and it will be seen that in the FIG. 5 position the rotary valve element closes both of the outlets 204 and 206.

Clockwise rotation of valve element 208 unseals the inlet 202 so that outlet 206 is open to fluid flow; outlet 204 is at this time closed by the valve element. Further clockwise rotation of the valve element to the FIG. 7 position closes outlet 206 and opens outlet 204. Still further clockwise rotation of the valve element to the FIG. 8 position opens both of the outlets 206 and 204.

It will be seen that with the illustrated arrangement heat exchange fluid can be supplied to either or both of two zones to be conditioned by the fluid. To move the rotary valve element between its various positions there may be provided an electric motor 92 arranged on a terminal board as shown in FIG. 2. To control the motor the terminal board may have a series of six printed electrical tracks on its underside configured as shown in FIG. 4. These tracks cooperate with six brushes arranged in a radial row and constructed similarly to the three brushes shown in FIG. 2; the brush positions for the various valve element positions are designated in FIG. 4 by the four dotted lines 210, 212, 214 and 216. It will be understood that brush position 210 corresponds with the FIG. 5 valve element position, brush position 212 corresponds with the FIG. 6 valve element position, brush position 214 corresponds with the FIG. 7 valve element position, and brush position 216 corresponds with the FIG. 8 valve element position.

As shown in FIG. 4 there are six arcuate track sections numbered respectively 218, 220, 222, 224, 226 and 228. The leads for the various track sections are designated by numerals 230, 232, 234, 236, 238 and 240. Lead 240 conducts current to the rotary valve element motor 92. Track sections 218, 222 and 226 are utilized to energize the motor during movement from the closed position to respective ones of the one positions. Track sections 224 and 220 are utilized to energize the motor during movement from the respective open positions to the closed position.

The zone conditioned by flow of heat exchange fluid through outlet 206 is provided with a room thermostat 242, and the zone which is conditioned by the flow of heat exchange fluid through outlet 204 is provided with a room thermostat 244. Thermally-operated relay switches, preferably in the form of bimetal switch arms, are provided at 246 and 248, each of said switch arms being adapted to supply current to a respective one of tracks 218 and 222 when its resistance heater 250 or 252 is energized by closing of the switch in its respective room thermostat. When the respective thermostats are satisfied the respective switch arms 246 and 248 take the illustrated positions for supplying current to the valve element-closing tracks 220 and 224.

Each of the switch arms 246 and 248 is mechanically connected with a switch arm 256 and 258, as by means of a pushpin 260. The arrangement is such that when both of the thermostats 242 and 244 are calling for heat line 262 is closed by the switch arms 256 and 258 so that current is supplied to the arcuate track 226.

As previously noted, brush position 210 occurs when the valve element in in the fully closed condition of FIG. 5. Assume the valve is in this position and both of the room thermostats 242 and 244 are de-energized; none of the tracks 218, 222 and 226 is live. Therefore there is no energization of motor 92. If we assume that thermostat 242 now calls for heat, the heater 250 is energized so that current flows through line 230, track 218, the brush means, track 228, line 240 and motor 92. The motor rotation is then continuous until the brush means reaches position 214, whereupon the connection between track 248 and the brush means is broken to de-energize the motor. In position 214 fluid can flow through outlet 204 as shown in FIG. 7; in this position one of the brushes is engaged with track 220. When thermostat 242 is satisfied switch arm 246 moves back to its illustrated position whereupon current flows through line 232, track 220, the brush means, track 228, line 240, and motor 92. The motor thereupon rotates clockwise until the brush position 210 is reached. The valve element is fully closed in this position.

Assume now that thermostat 244 calls for room conditioning; switch arm 248 is operated by heater 252 to supply current to line 234; track 222, the brush means, track 228, line 240 and motor 92. The motor thereupon operates until the brush position 212 is reached, this position serving to place the valve element in the FIG. 6 position for supplying heat exchange fluid to the outlet 206. When room thermostat 244 is satisfied, switch arm 248 moves to its illustrated position for supplying current to line 236, track 224, the brush means, track 228, line 240 and motor 92. The motor thereupon rotates the valve element clockwise to brush position 210 which corresponds with the fully closed position of the valve element as shown in FIG. 5.

Assume now that both of the room thermostats 242 and 244 call for heat, both of the switch arms 246 and 248 move down so that switch arms 256 and 258 are each closed against its respective contact, thereby causing current from line 262 to flow through line 238, track 226, the brush means, track 228, line 240, and motor 92. The motor thereby rotates the valve element until brush position 216 is reached, said position corresponding to the FIG. 8 valve element position wherein both of the outlets 204 and 206 are supplied with heat exchange fluid. When thermostat 242 becomes satisfied, switch arm 256 will open, and current will flow through switch arm 246, line 232, track 220, the brush means, track 228, line 240, and the motor 92. The motor will thereupon move the valve element until brush position 210 is reached. When brush position 210 is reached, one of the brushes will be engaged with track 222, so that current will flow through line 234, track 222, the brush means, track 228, line 240 and motor 92. Thus the motor will not stop when it reaches position 210 but will continue until position 212 is reached. In this position outlet 206 is supplied with heat exchange fluid so that the zone served by thermostat 244 continues to receive heat exchange fluid until its room thermostat is satisfied. When thermostat 244 is satisfied the current flows through line 236, track 224, the brush means, track 228, line 240, and motor 92 so that the motor moves the valve element clockwise to the fully closed position.

It will be seen that the general arrangement is such that motor 92 is automatically directed by the zone thermostats 242 and 244 to supply heat exchange fluid to respective zones until each zone is satisfied. The arrangement is advantageous in that it permits a single motor-operated valve to supply fluid to a plurality of zones, with resultant saving in over-all cost of the valves and system. The plural outlet valve as diagrammatically shown in FIG. 5 may in practice have many of the structural features of the FIG. 2 device, including the ball type valve, top access for the valve element, removable mounting of the motor housing, manual positioner for the valve element, printed circuit on the underside of the terminal board, and top access to the terminals.

While the above description has necessarily proceeded on the basis of concrete embodiments of the invention, yet it will be understood that modifications and rearrange-

ments can be resorted to without departing from the spirit of the invention as set forth in the appended claims.

We claim:

1. In association with a valve casing; a rotary valve element disposed within said casing for controlling fluid flow therethrough; and said casing including a removable cover element disposed to permit access to the valve element for installation and repair thereof; the combination comprising a housing structure adapted to be removably secured on said cover element; a terminal board removably disposed within said housing structure and subdividing same into a switch chamber and a motor chamber; an electrical motor disposed on the motor chamber face of said board and having an output shaft extending through the board into the switch chamber; a drive connection disposed in said switch chamber for operatively connecting the motor shaft with the aforementioned valve element so that the motor rotation is effective to operate the valve element between open and closed positions; a printed motor control circuit on the switch chamber face of said board, including a series of spaced arcurate electrical track portions centered around the axis of the motor output shaft; and electrical contact brushes disposed in said switch chamber and movable during motor rotation to traverse the tracks for controlling the motor operation.

2. The combination of claim 1 wherein the aforementioned drive connection includes a manually rotatable hand wheel having its periphery disposed adjacent an outer surface of the housing structure; said housing structure having an opening in said outer surface to enable the hand wheel to be manually rotated independently of the motor.

3. In association with a valve casing; and a stem-equipped valve element arranged within said casing with its stem projecting therefrom so that rotary movement of the stem is effective to operate the valve element between open and closed positions; the combination comprising a housing structure adapted to be removably disposed atop said valve casing; said housing structure including a bottom wall, a front wall, a rear wall, and two side walls; the front and rear walls terminating relatively short distances above the bottom wall, and the two side walls terminating relatively far distances above the bottom wall; a terminal board extending within and across the housing at the upper edges of the front and rear walls to be supported thereon; cooperating means carried by the terminal board and front and rear walls for detachably mounting the terminal board in place; electric motor means disposed on the upper face of said terminal board and having an output shaft extending through said board into the space adjacent the bottom wall; a driving connection interposable between the motor means output shaft and the aforementioned valve element stem including a rotary wall element disposed adjacent the underface of the terminal board; a motor control circuit, including printed electrical tracks located on the terminal board underface and track-engaging electrical brushes located on the rotary wall element; and a U-shaped cap element removably disposed on the housing structure with the two flanges thereof in general vertical alignment with the housing structure front and rear walls; one of the aforementioned side walls having an opening therethrough for extension of lead wires to the terminal board.

4. In association with a valve casing; and a rotary valve element disposed within said casing for controlling flow of fluid therethrough; the combination comprising an electric motor arranged to be operatively coupled to said valve element for moving same between its open and closed positions; and means for controlling the operation of the motor, including at least three connected electrical brushes and at least three arcuate electrical printed tracks; said tracks and brushes being mounted for cooperative relative movement during rotation of the motor to thereby limit the motor travel during each period of track energization; one of said tracks being continuous and being at all times engaged with one of the brushes to thereby serve as a current source for the other two brushes, a second one of the tracks including a plurality of arcuate discontinuous track sections arranged to engage a second one of the brushes to control movement of the motor in the valve opening period; and a third one of the tracks including a plurality of discontinuous track sections located to engage the third brush to control movement of the motor in the valve closing period.

5. The combination of claim 4 and further comprising a thermally-operated time delay relay for alternately energizing the second and third tracks to initiate the valve opening and valve closing movements.

6. In association with a valve casing; and a valve element disposed within said casing for controlling flow therethrough; the combination comprising a housing structure positionable adjacent said valve casing; a terminal board disposed within the housing structure and subdividing same into a terminal chamber and a switch chamber; a valve element-operating motor disposed within said terminal chamber and having leads connected to certain of the terminals therein; and electrical control mechanism for the motor including a series of printed circuit tracks on the switch chamber face of the terminal board and cooperating electrical brush means disposed to traverse said tracks during motor movement; the aforementioned switch chamber being substantially devoid of terminals or electrical harness.

7. In association with a valve casing; and a valve element disposed with said casing for controlling flow therethrough; the combination comprising a housing structure positionable adjacent said casing; a terminal board disposed within the housing structure and subdividing same into a switch chamber adjacent the valve casing and a motor chamber remote from the valve casing; an electric motor disposed in the motor chamber and operatively connectable with the valve element for controlling its position within the valve casing; switch means within the switch chamber, including printed circuit tracks located on the switch chamber face of the terminal board and cooperating electrical brush means arranged for traversing movements thereacross during operation of the motor; terminals located on the terminal chamber face of the board; and electrical connections extending through the board from certain of the terminals to certain of the tracks.

8. In combination, a valve mechanism having an inlet and two separate outlets for supplying heat exchange fluid to two separate zones to be conditioned; a movable valve element located between said inlet and outlets so that fluid may be supplied only to one outlet, only to the other outlet, to both outlets, or neither outlet, depending on the valve element position; an electric motor operatively connected with said valve element to move same between its various positions; and means for controlling the operation of said motor, including thermostats adapted to be located in each zone which is supplied with fluid from the valve mechanism, and five motor-energizer circuits arranged so that two of the circuits are controlled exclusively by one thermostat, two of the circuits are controlled exclusively by the other thermostat, and the other circuit is controlled jointly by the two thermostats; each of said circuits comprising a switch automatically operable by the motor to supply current thereto until the valve element reaches the position dictated by the respective thermostat.

9. In combination, a valve mechanism having an inlet and two separate outlets; a rotary valve element located between said inlet and outlets so that fluid may be supplied only to one outlet, only to the other outlet, to both outlets, or neither outlet, depending on the valve element position; an electric motor operatively connected with said valve element to rotate same between its various positions; and means including condition-sensing means and printed circuit means energized thereby for controlling operation of said motor, said printed circuit means comprising a circuit board having a series of arcuate electrical tracks and cooperating brush means movable along the tracks

during the motor-operating periods; said condition sensing means comprising a separate condition sensing mechanism responsive to the flow through each outlet; said separate condition sensing mechanisms being arranged to independently control the current supplied to the printed circuit means, whereby flow can continue through each outlet until its respective condition sensing mechanism is satisfied.

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