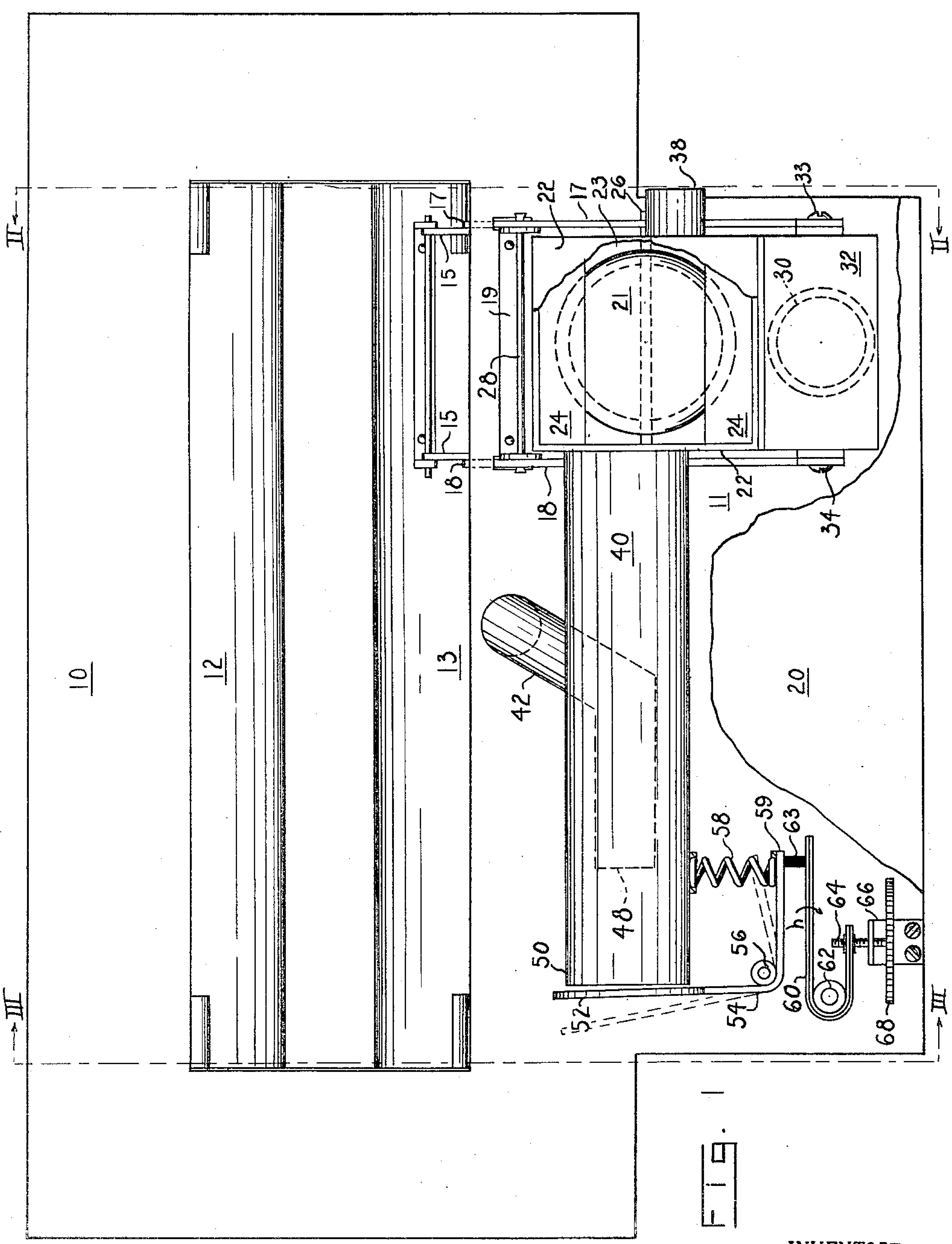
Nov. 17, 1953 C. HOTCHKISS ET AL 2,659,535

AIR VOLUME CONTROL SYSTEM AND APPARATUS

Filed July 28, 1950 2 Sheets-Sheet 1



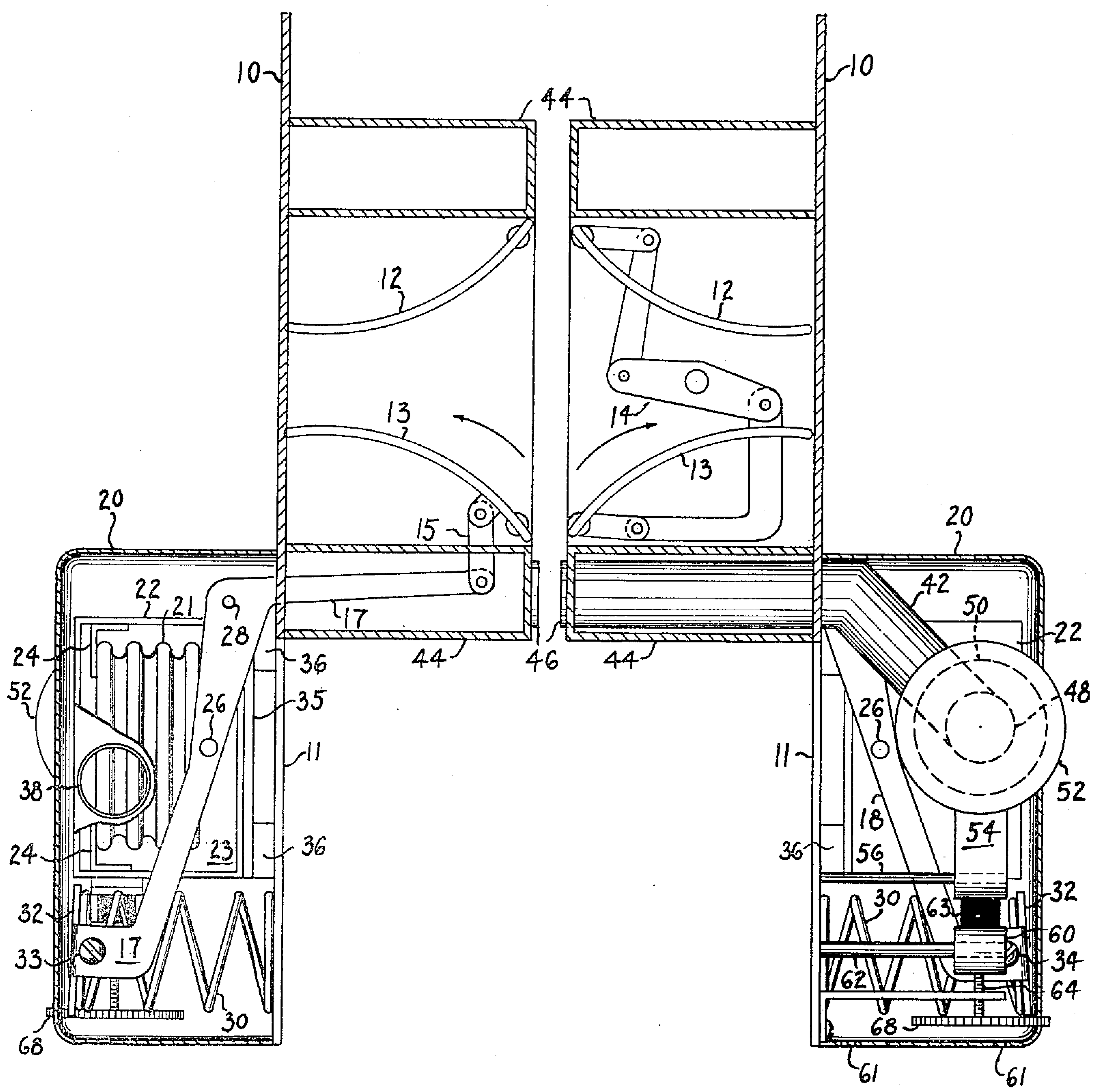
INVENTORS
CLIFFORD HOTCHKISS
JUSTIN A. DEUBEL
BY
Tate & Weikart
ATTORNEYS

Nov. 17, 1953 C. HOTCHKISS ET AL 2,659,535

AIR VOLUME CONTROL SYSTEM AND APPARATUS

Filed July 28, 1950 2 Sheets-Sheet 2

Fig. 2 Fig. 3



INVENTORS
CLIFFORD HOTCHKISS
JUSTIN A DEUBEL
BY
Tate & Weikart
ATTORNEYS

Patented Nov. 17, 1953 2,659,535

UNITED STATES PATENT OFFICE

2,659,535

AIR VOLUME CONTROL SYSTEM AND APPARATUS

Clifford Hotchkiss and Justin A. Deubel, Milwaukee, Wis., assignors to Perfex Corporation, Milwaukee, Wis., a corporation of Wisconsin

Application July 28, 1950, Serial No. 176,358

8 Claims. (Cl. 236—49)

1

This invention relates generally to actuators and in particular to actuators for air volume control dampers. It concerns a unitary assembly for regulating the flow of conditioned air to a room or other enclosure and utilizes the thermal energy of the conditioned air for moving the damper blades thus making unnecessary any wiring or external electric power.

In controlling the comfort conditions of a room or other enclosure it has in the past been proposed to control the volume of conditioned air admitted into the room. Under such systems of control the temperature of the conditioned air and the velocity of the conditioned air entering the room is maintained constant, the heating requirements for the room being met by variations in the volume of conditioned air admitted to the room, such volume being determined by the position of the conditioned air inlet damper blades. One such apparatus is disclosed in U. S. Reissue Patent 22,870 issued to G. A. Peple, Jr. The present invention comprises an actuator, suitable for use with an air volume damper, which utilizes the thermal energy of the conditioned air. An actuator of this type is disclosed in U. S. Patent No. 1,181,443 issued to W. M. Fulton. The present invention is an improvement in such actuators and provides certain advantages, including accuracy in positioning the conditioned air inlet dampers, as will subsequently be pointed out.

An object of the present invention is to provide a unitary assembly for regulating the flow of conditioned air into a room or other enclosure which utilizes the thermal energy available because of the temperature gradient between the conditioned air and the room air.

A further object is to provide an actuator for an air volume damper which, under certain conditions, positively draws room air over the actuating element, this aspiration of room air being independent of normal room convection currents and of the volume of conditioned air being admitted into the room.

In order that the invention may be more readily understood, reference is had to the accompanying drawings, in which—

Fig. 1 is a front view of the apparatus with the control cover broken away;

Fig. 2 is a right side view of the apparatus taken along the lines II—II of Fig. 1;

Fig. 3 is a left side view of the apparatus taken along the lines III—III of Fig. 1.

Referring now to Fig. 1 in which is shown a fabricated frame or panel 10 which may be fastened on a wall adjacent an outlet aperture of a conditioned air duct. An extension plate 11 of frame 10 constitutes a mounting for the actuator or control unit shown. A damper unit, consisting of two curved damper blades, upper blade 12 and lower blade 13, mounted within the frame 10, controls the admission of conditioned air (indicated by arrows in Figs. 2 and 3) into the room, the temperature of which is to be controlled.

2

A pivotal linkage 14, shown generally in Fig. 3, provides unitary and synchronous action between the damper blades so that they rotate in unison but in opposite directions. A link 15 pivotally attached to the lower damper blade 13, is pivotally connected to levers 17 and 18. The levers 17 and 18 extend along the sides of a casing 22 and are pivotally mounted on a bracket 19, fastened to the frame 10 by means of a pivot pin 28. Casing 22 is secured to the plate 11 by any suitable means and, as illustrated, is spaced from plate 11 by member 35, formed of thermal insulating material, and spacer blocks 36. A cover member 20 is provided to encompass the actuator unit and is detachably secured to the extension plate 11. The casing 22 provides an enclosure or chamber 23 in which is located a thermal responsive member which is the operating element, here shown as a bellows 21, which contains a volatile fluid causing the bellows 21 to expand upon being heated. The bellows 21 is secured by brackets 24 to the casing 22 and overlies a shaft 26 journaled in the levers 17 and 18. Thus, movement of the bellows 21 results in a corresponding movement of the shaft 26 to pivot the levers 17 and 18 about the stationary pivot 28, journaled in the bracket 19. A compression spring 30, bearing against the extension plate 11, engages a metal plate 32, secured to the lever 17 by screw 33 and secured to lever 18 by screw 34. The spring 30 biases the levers 17 and 18 against expansion movement of the bellows 21. As has been pointed out, the casing 22 is secured to the plate 11 but spaced therefrom by a piece of thermal insulating material 35 and metal blocks 36. This mounting for bellows 21 effectively insulates it from thermal conduction from the frame 10 and plate 11.

A room air inlet pipe 38 is secured to one side of the casing 22 and protrudes through the cover 20, thus providing a conduit from the bellows chamber 23 to the room. A tube 40 is secured to the opposite side of casing 22 and extends along a line parallel to the damper blades. The tube 40 provides an outlet conduit from the bellows chamber to the room and also serves as an inlet conduit for the duct air. A conduit, here shown as pipe **42**, is connected, as shown in Figs. 1 and 3, to the damper housing **44** and projects through an opening in tube **40** to lie concentrically therein. The pipe **42** has an inlet opening **46** exposed to the duct air behind the damper assembly and an outlet opening **48** within the tube **40**.

The tube **40** terminates in an opening **50** which is provided with a closure means here shown as a flat valve member **52**. The valve member **52** is secured to an L-shaped lever **54** which is pivoted on a pin **56** fastened to the base plate **11**. A compression type spring **58** is interposed between the lever end **59** and the tube **40** to bias the valve member **52** to closed position. A temperature sensing element, here shown as a bimetal strip **60**, is mounted on a pivot pin **62** secured to the base plate **11**. A block of insulation material **63** is riveted to one end of strip **60** and abuts the lever end **59**. An adjusting screw **64**, threaded through a bracket **66**, permits adjustment of the position of member **52** with relation to the outlet **50** thereby providing a control point adjustment. A serrated knob **68** on the end of adjusting screw **64** extends beyond the cover **20** to allow external adjustments to be made. Note that the cover **20** is open at the end adjacent the bimetal **60** and that the bottom of cover **20** has openings **61** therein which permit the circulation of room air over the bimetal **60**.

Operation

Referring to Figure 1, when the member **52** is in full open position (shown in broken lines in Figure 1), heated air from the duct flows through the pipe **42**, out its open end **48** and out of the end **50** in the tube **40**. This flow of heated air aspirates room air through the pipe **38** into the casing **22** past the bellows **21**. Under these conditions the bellows **21** will be maintained at room temperature and will be in a relatively contracted position with damper blades **12** and **13** wide open. As the member **52** is moved toward the opening **50**, it will reach a position with reference to the opening **50** such that the resistance to the flow of air through the opening **50** will prevent room air from being aspirated through the pipe **38**.

When the member **52** moves further toward the open end **50**, increasing the resistance to the flow of air therethrough, a portion of the heated air will flow slowly back through the tube **40** into the casing **22**. This slow moving heated air will be cooled somewhat as it moves through the tube **40** but will raise the temperature of bellows **21** above room temperature. A still further closure of open end **50** by the member **52** will cause heated air to flow more rapidly through the tube **40** and into the casing **22**. Since the velocity of the flow of this heated air through the tube **40** increases as the member **52** approaches the open end **50**, the loss of thermal energy to the walls of tube **40** by the air flowing through the tube **40** will decrease and the temperature of bellows **21** will be increased.

With the apparatus in the position shown in Figures 1, 2, and 3, the bellows **21** is partially expanded and damper blades **12** and **13** are consequently in an intermediate position. The member **52** is positioned by the bimetal strip **60** at a point with reference to the open end **50** such that a portion of the heated air flowing from the pipe **42** flows through the tube **40** establishing the bellows **21** at a temperature somewhat above room temperature. Bellows **21** has assumed an expansive position such that the damper blades **12** and **13** are separated to admit into the room a sufficient volume of heated air so as to just balance the heat losses from the room.

Should this position of equilibrium be disturbed by increased heat losses from the room, because of decreasing outdoor temperature or for other reasons, the consequent slight upward movement of the free end of strip **60** will move the member **52** slowly away from the opening **50**, decreasing the resistance to the flow of heated air out of the open end **50**. With such movement less and less heated air will flow into the casing **22** and eventually no heated air will flow thereto and room air will be aspirated into the casing **22**. As this takes place, the temperature of bellows **21** will consequently be slowly decreased and will approach room temperature. Consequently damper blades **12** and **13** will be slowly moved in opening direction as bellows **21** contracts. The resulting increased volume of heated air flowing past the damper blades **12** and **13** will eventually again balance the heat losses from the room and the bellows **21** and damper blades **12** and **13** will come to rest at a new position of equilibrium.

Should the heat losses from the room thereafter decrease, because of increasing outdoor temperature or for other reasons, member **52** will be moved toward the open end **50** and heated air will eventually begin to flow through the tube **40** into the casing **22**. As member **52** approaches the open end **50** the velocity and consequently the thermal energy of the heated air passing to casing **22** will increase and the temperature of the bellows **21** will therefore slowly increase. The resulting expansion of bellows **21** will move damper blades **12** and **13** in closing direction. The decreasing volume of heated air flowing past the damper blades **12** and **13** into the room will eventually be such that the heat losses from the room will again be balanced and bellows **21** and damper blades **12** and **13** will assume a new position of equilibrium.

It will be noted that the flow of room air through the pipe **38** into the casing **22** is, under certain conditions, positively induced and aspirated through the casing **22** by the flow of heated air out of the open end **50**. The flow of room air past the bellows **21** does not depend on convection currents in the room and is independent of the position of damper blades **12** and **13**. As a result there is no loss of control of the temperature of, and consequently the position of, the bellows **21** as the damper blades **12** and **13** approach their closed position.

It will be understood that by reversing the direction of movement of the room temperature sensing element **60** and reversing the direction of movement of damper blade-moving linkage, the actuator might be utilized for controlling the admission of cooled, rather than heated air into a room or other enclosure the temperature of which is to be controlled. Additionally bimetal strip **60** might be arranged so that its free end moves upwardly when heated and the linkage between the damper blades **12** and **13** and bellows **21** reversed so that upon an increase in room temperature the member **52** would move away from the open end **50** and the bellows **21** would move in a contracting direction to close damper blades **12** and **13**.

From the foregoing description it will be apparent that many modifications of this invention are possible; however, the invention is to be limited only by the scope of the appended claims.

What is claimed is:

1. In an apparatus for controlling the flow of heated air from a source thereof into a room the temperature of which is to be maintained at a selected value: a thermal sensing element responsive to the temperature of the room, a thermal responsive member operable to vary the flow of heated air into the room, an enclosure for said thermal responsive member having inlet and outlet openings, a conduit for the transmission of heated air from said source into said enclosure, closure means for said outlet opening operable by said thermal sensing element for selectively directing heated air from said conduit to said thermal responsive member and for utilizing the kinetic energy of the heated air transmitted through said conduit to draw air from the room through said inlet opening to said thermal responsive member dependant upon the deviation of the room temperature from said selected value.

2. In an apparatus for controlling the flow of heated air from a source thereof into a room the temperature of which is to be maintained at a selected value: a thermal sensing element responsive to the temperature of the room, a thermal responsive member operable to vary the flow of heated air into the room, an enclosure for said thermal responsive member having inlet and outlet openings, a conduit extending from said source of heated air into said enclosure and having its outlet directed toward the outlet opening in said enclosure, closure means for the outlet opening in said enclosure operable by said thermal sensing element for selectively directing heated air from said conduit to said thermal responsive member and for utilizing the kinetic energy of the heated air discharged from said conduit outlet to aspirate air from the room through the enclosure inlet opening to said thermal responsive member dependant upon the deviation of the room temperature from said selected value.

3. An apparatus for controlling the flow of heated air from a source thereof into a room the temperature of which is to be maintained at a selected value comprising: a thermal sensing element responsive to the temperature of the room, a thermal responsive member, a damper controlling the flow of heated air into the room, linkage means connecting said thermal responsive member and said damper, said damper being moveable by said member in response to variations in the temperature thereof, an enclosure for said thermal responsive member having inlet and outlet openings, a conduit extending from said source of heated air into said enclosure and having its outlet directed toward the outlet opening in the enclosure, closure means for the outlet opening in said enclosure operable by said thermal sensing element for selectively directing heated air from the conduit to the thermal responsive member and for utilizing the kinetic energy of the heated air discharged from said conduit outlet to aspirate air from the room through the enclosure inlet opening to said thermal responsive member dependant upon the deviation of the room temperature from said selected value.

4. In a conditioned air regulating system, the combination of a damper controlling the flow of conditioned air to an enclosure, a first temperature responsive element controlling the position of said damper, a chamber for said element, a first conduit connecting said chamber with said enclosure, a second conduit connecting said chamber with a variably obstructed opening, a valve member adjacent said opening and moveable between a first position wherein said opening has a maximum obstruction and a second position wherein said opening has a minimum obstruction, a third conduit connecting said second conduit with the conditioned air supply and adapted to discharge conditioned air through said second conduit and out said opening as said valve member approaches its second position and to direct conditioned air through said second conduit to said first temperature responsive element as said valve member approaches its first position, a second temperature responsive element controlling the position of said valve member, whereby the position of said damper is controlled by the differential in temperature existing between the conditioned air temperature and the enclosure air temperature through the operation of the air affecting said first temperature responsive element, said last mentioned air comprising enclosure air aspirated through said first conduit when said valve member approaches its second position and comprising conditioned air directed through said second conduit when said valved member approaches its first position.

5. In an apparatus for controlling the flow of conditioned fluid from a source thereof into an enclosure the condition of which is to be maintained at a selected value: a first condition responsive member responsive to the condition of said enclosure, a second condition responsive member operable to vary the flow of conditioned fluid into said enclosure and means for changing the condition of the fluid ambient to said second condition responsive member, said means including a chamber having openings and housing said second condition responsive member, one of said openings connecting said chamber with said enclosure at a position opposite from the other of said openings, a conduit extending from said source of conditioned fluid to said chamber, and closure means for said other opening and operable by said first condition responsive member to selectively direct conditioned air to said second condition responsive member and to aspirate enclosure air through said inlet opening to said second condition responsive member.

6. In an apparatus for controlling the flow of conditioned fluid from a source thereof into an enclosure the condition of which is to be maintained at a selected value: a first condition responsive member responsive to the condition of said enclosure, a second condition responsive member operable to vary the flow of conditioned fluid into said enclosure, a conduit connecting said second condition responsive member with said enclosure, and means controlled by said first member utilizing the kinetic energy of the conditioned fluid for drawing fluid from said enclosure to said second member through said conduit and for directing conditioned fluid from the source to said second member, dependant upon the deviation of the enclosure condition from said selected value.

7. In an apparatus for controlling the flow of heated air from a source thereof into a room the temperature of which is to be maintained at a selected value: a first thermal responsive member responsive to the temperature of the room, a second thermal responsive member operable to vary the flow of heated air into the room, a

conduit connecting said second thermal responsive member with the room, and means controlled by said first member utilizing the kinetic energy of the heated air for drawing air from the room to said second member through said conduit and for directing heated air from the source to said second member dependant upon the deviation of the room temperature from said selected value.

8. In a conditioned air regulating system, the combination of a conditioned air conduit forming a source of conditioned air and leading to an enclosure, a damper controlling the admission of conditioned air to said enclosure, a first temperature responsive element controlling said damper in accordance with temperature changes affecting said element, a system of conduits connecting said conditioned air conduit with said first temperature responsive element, connecting said enclosure with said first temperature responsive element and connecting said conditioned air conduit with a valved opening, a second temperature responsive element controlling said valved opening whereby enclosure temperature changes affecting said second temperature responsive element vary the size of said valved opening to change the direction of flow of air affecting said first temperature responsive element to selectively provide conditioned air and enclosure air and thereby change said damper position.

CLIFFORD HOTCHKISS.
JUSTIN A. DEUBEL.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
Re. 22,870	Peple	Apr. 15, 1947
1,181,443	Fulton	May 2, 1916
1,875,851	Carson	Sept. 6, 1932
1,917,880	Frantz et al.	July 11, 1933
2,241,108	Ackers	May 6, 1941
2,440,052	Lingen et al.	Apr. 20, 1948
2,487,367	Peple	Nov. 8, 1949
2,523,497	Copping	Sept. 26, 1950