Sept. 15, 1942. W. W. HALLINAN 2,295,841

HEATING SYSTEM

Filed Oct. 26, 1939 2 Sheets-Sheet 1

Fig. 1.

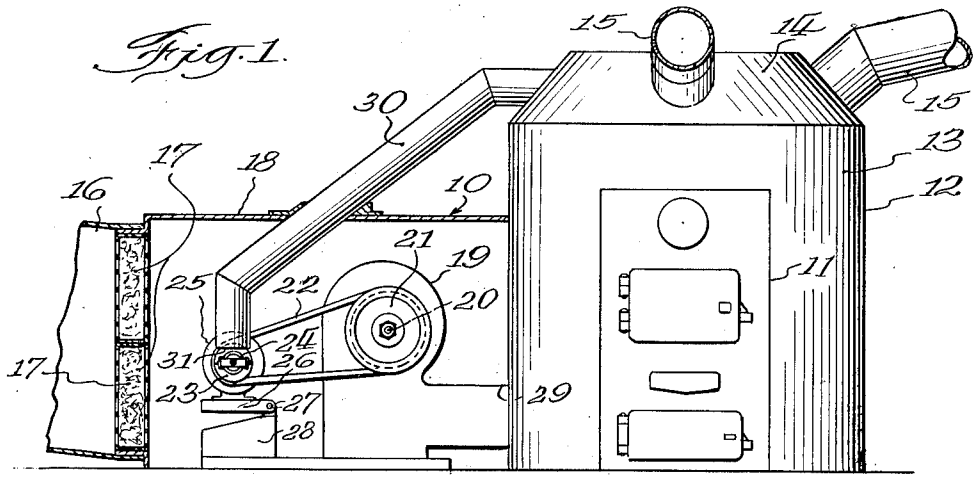

Fig. 2.

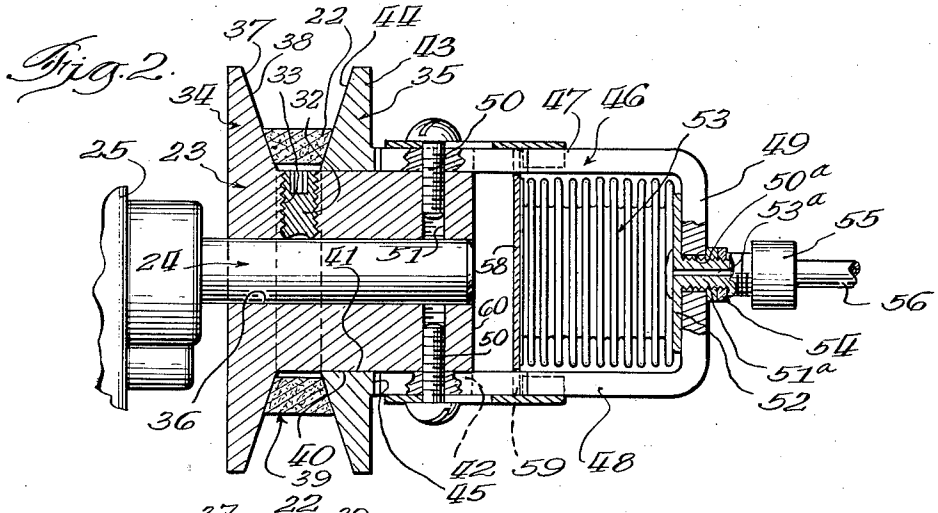

Fig. 3.

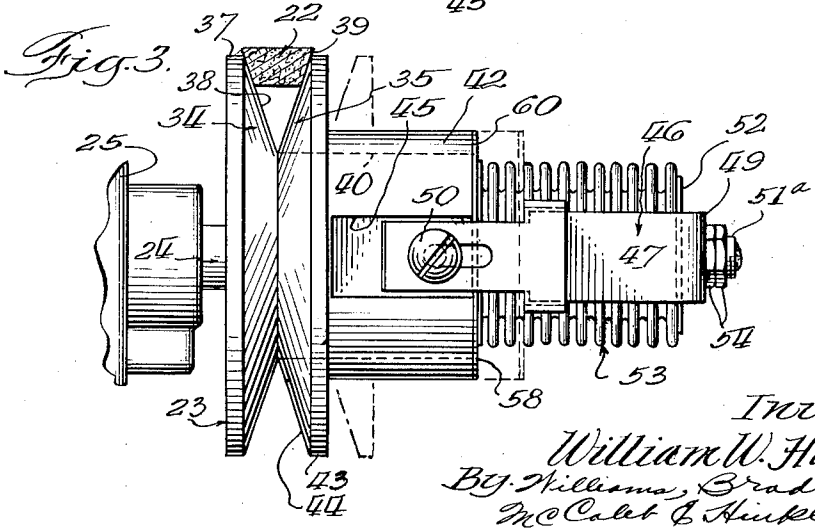

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Fig. 4.

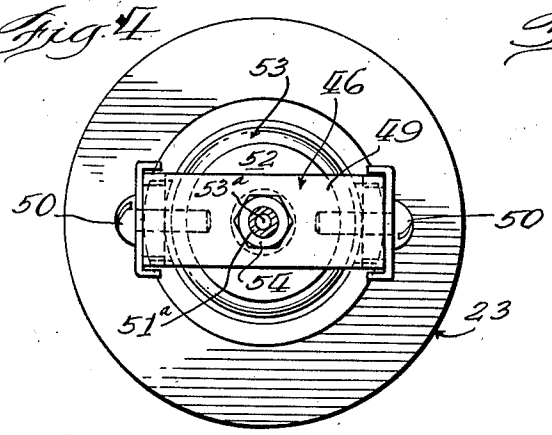


Fig. 6.

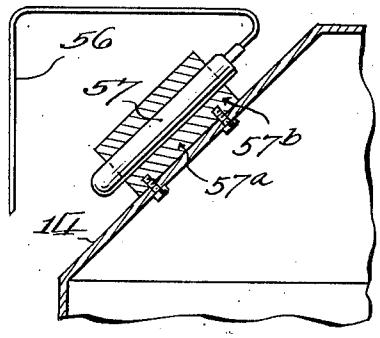
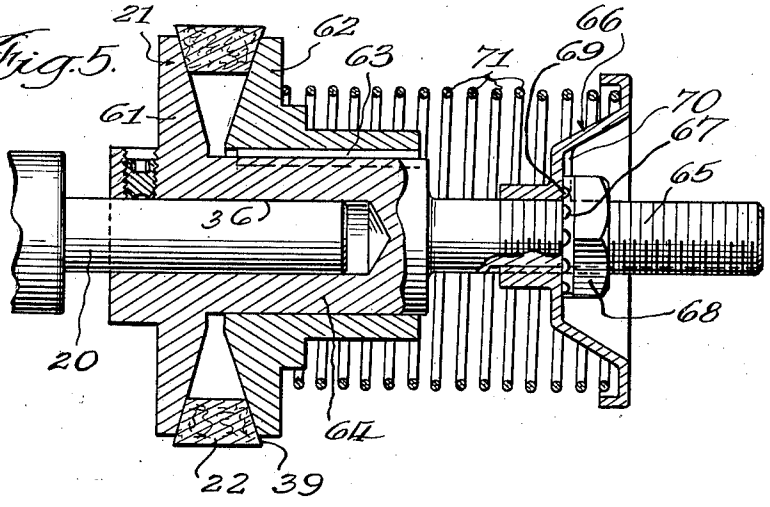


Fig. 5.



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UNITED STATES PATENT OFFICE

2,295,841

HEATING SYSTEM

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Application October 26, 1939, Serial No. 301,325

11 Claims. (Cl. 236—10)

The present invention relates to heating systems, and is particularly concerned with heating systems of the type having a hot air furnace or a heat unit, such as a radiator, and an air blower for moving the air from the heating source to the space in the rooms to be heated.

The present invention is related in subject-matter to my prior application, Serial No. 196,003, filed March 15, 1938, for Variable speed pulleys, now United States Patent No. 2,210,976, issued August 13, 1940.

The heating systems of the prior art of this character are subject to the disadvantage that they are either complicated or they are so constructed that the volume of air circulated by the blower or fan must be adjusted to take care of the maximum heating load. This latter requirement inevitably results in a higher operating temperature for the furnace because a high speed blower or fan cannot be started until the furnace has reached a predetermined temperature, as the high speed of delivery of the air makes air which is not quite warm seem cold, causing complaints regarding blasts of cold air.

Furthermore, such arrangements of the prior art put out too great a volume of cold air when there is but little demand for heat and there is a tendency of the systems of the prior art of this character to start the fan and deliver so much cold air that the bonnet temperature is so diminished that the fan is turned off again.

One of the objects of the present invention is the provision of an improved heating system in which the fan may be operated continuously or it may commence its operation at a relatively low temperature, and in which the speed of operation of the fan is continuously modulated from a low speed at low furnace output to a maximum speed at maximum furnace load.

Another object of the invention is the provision of an improved heating system of the class described, in which the operating temperature may be reduced to a lower value than the devices of the prior art, thus reducing the furnace losses at the stack and losses in the cellar, and providing a more efficient heating system.

Another object of the invention is the provision of an improved heating system of the class described, which is adapted to operate within a smaller range of temperature variation for the purpose of maintaining a more uniform temperature in the rooms to be heated, and for the purpose of eliminating any possibility of a blast of cold air.

Another object of the invention is the provision of an improved heating system of the class described, by means of which the volume of air circulated in the system is dependent upon the temperature of the circulating air or of the air in the plenum chamber in the furnace, so that a maximum efficiency of distribution of heat from the furnace is achieved and the circulating system is adapted at all times to circulate a volume of air which is required to carry away the heat from the furnace.

Another object of the invention is the provision of an improved variable speed driving system for air circulating fans, which is efficient, economical, and capable of manufacture and installation at a reasonable cost.

Another object of the invention is the provision of a simplified heating system of the class described, in which the variable speed pulley is controlled by thermostatic devices of standard commercial construction, which are adapted to rotate with the pulley, thus eliminating thrust bearings and other undesirable complicated constructions which are sometimes involved when a variable speed pulley is to be controlled by a thermostat, which is maintained in fixed position.

Other objects and advantages of the invention will be apparent from the following description and the accompanying drawings, in which similar characters of reference indicate similar parts throughout the several views.

Referring to the two sheets of drawings accompanying this specification,

Fig. 1 is a diagrammatic elevational view of a heating system embodying the invention shown in connection with a hot air furnace;

Fig. 2 is an axial sectional view of a thermostatically controlled variable speed pulley to be used with a bulb structure such as shown by Fig. 6, showing the thermostat in elevation;

Fig. 3 is a plan view of the variable speed pulley as it appears when it is used in Fig. 1;

Fig. 4 is an end elevational view of a variable speed pulley of Fig. 2, taken from the right;

Fig. 5 is a sectional view, taken on the axis of the driven shaft, showing the structure of a spring pressed variable diameter pulley, such as may be employed on the blower;

Fig. 6 is a fragmentary modification, in which the bulb temperature is made responsive to the temperature of the metal wall of the furnace.

Referring to Fig. 1, 10 indicates in its entirety a heating system which includes a furnace 11, having an outer housing 12, forming a plenum cham-

ber 13 surrounding the furnace, and within the housing.

The housing has the usual frusto-conical bonnet 14, which may be provided with a multiplicity of hot air pipes 15 leading to the rooms to be heated. The cold air pipes from the rooms to be heated may be connected to the cold air inlet 16, which communicates through the filters 17 with an auxiliary housing 18 for the motor and blower. The cold air may be circulated by means of a centrifugal blower, including the housing 19, blower shaft 20, a suitable impeller on the shaft 20 in the housing 19, and a driven pulley 21.

The blower is driven by means of a wedge-shaped leather or rubber belt 22, which is driven by a variable diameter pulley 23, carried by the shaft 24 of motor 25. The motor 25 may be a substantially constant speed motor, that is, a motor the speed of which does not vary greatly when subjected to variations of load within predetermined limits for which it has been constructed.

The motor is preferably provided with a suitable mounting for maintaining proper belt tension, such as, for example an auxiliary motor mounting plate 26, which is pivotally carried at 27 on a base 28 in such manner that the weight of the motor pivoting in a counterclockwise direction about the axis 27 tends to draw the belt 22 taut.

The weight of the motor in this arrangement is not sufficient, however, to change the relative positions of the parts of the pulley 21 solely by virtue of the weight of the motor, as the motor pivot is arranged in the drawings.

The blower housing 19 has suitable air inlets surrounding one or both ends of the shaft 20 and has its outlet at 29 into the plenum chamber 13. An auxiliary conduit 30 may extend from the bonnet 14 to a discharge outlet 31, which is located adjacent the thermostat of the variable diameter pulley 23 so that when the blower is operating and the furnace is heated, hot air is delivered by the conduit 30 and blown on the thermostat of the variable diameter pulley 23 in the embodiment of Fig. 1.

This makes the thermostat forming a part of the variable diameter pulley 23 responsive to the temperature of air delivered from the furnace bonnet.

Referring to Fig. 2, this is an illustration of the structure of the variable diameter pulley 23, which may be utilized in the present heating system. This pulley may be mounted on the motor shaft 24 and secured against rotation thereon by a set screw 32 secured in the threaded bore 33 or by a suitable key and keyway.

The pulley 23 preferably comprises a pair of relatively movable pulley sections 34 and 35, and the pulley section 35 is provided with a centrally located bore 36 for receiving the shaft 24. The pulley section 34 has an outwardly extending flange 37 provided with a frusto-conical surface 38, which is adapted to engage one side of the wedge-shaped belt 39.

This pulley section 34 is also preferably provided with a substantially cylindrical hub 40, which is elongated to provide a long bearing surface for the bore 41, which is located in the tubular body 42 of the second pulley section 35.

The pulley section 35 also has an outwardly extending flange 43 provided with a frusto-conical belt-engaging surface 44. The two surfaces 38 and 44 define what may be called a V-shaped groove of variable effective diameter with respect to the wedge-shaped belt 22 of constant width.

The pulley section 35 is slidably mounted on the hub 40, but is secured against rotation except for a slight tolerance, by inter-engagement of the walls of a pair of longitudinally extending slots 45 with the ends of a supporting frame 46, which are located in the slots and secured to the hub. The slots 45 may be substantially rectangular in plan, as shown in Fig. 43, and the slots extend through the tubular portion 42 of the pulley section 35.

The supporting frame 46 may comprise a substantially U-shaped metal member having a pair of legs 47, 48 joined by the yoke or end portion 49. Each leg 47, 48 is secured by means of a screw bolt 50 passing through the leg and threaded into a threaded bore 51 in the hub 40. The sides of the legs 47, 48 are adapted to engage the walls of the slots 45 and substantially prevent rotation between the pulley sections, but the pulley sections are mounted for sliding movement, as the length of the slots 45 is sufficient to permit this movement.

The yoke 49 of the frame 46 may be provided with a centrally located bore 50*a* for receiving the threaded hub 51*a* of a bellows-supporting plate 52. The thermostat 53 comprises an expansible metal bellows, one of the endmost folds of which is secured by soldering, welding, or other suitable liquid-tight means to the plate 52.

The hub 51*a* may have a centrally located filling conduit 53*a* passing through it, and the hub may be secured in place by a pair of lock nuts 54 so that this end of the thermostat is fixedly supported on the frame 46.

In the embodiment of Fig. 1 and Fig. 3 the conduit 53*a* in the thermostat-supporting hub may be closed with a drop of solder after a thermally expansible fluid has been placed in the thermostatic bellows 53.

In the embodiment of Fig. 2, the conduit 53*a* is connected by a rotating joint 55 with a copper tube 56, which extends to a metal bulb 57 that may be carried by a metal block 57*b* in contact with the metal wall of the bonnet 14.

The opposite end of the thermostat 53 has a similar fluid-tight connection with a metal plate 58, which may be of sufficient size to engage the end of the tubular portion 42 of the pulley section 35. The plate 58 has a pair of slots 59 for accommodating the legs 47, 48 of the U frame 46, and when the thermostat expands, the plate 58 reacts against the flat end surface 60 of the tubular portion 42 of the pulley section 35 and tends to move the pulley sections together.

When the thermostat is subjected to a decreased temperature so that it contracts, the thermostat permits the belt 22 to force the pulley sections 34, 35 apart. The effective diameter of the variable diameter pulley 23 depends upon the distance from the center of the shaft 24 to the belt 22, and this in turn depends upon the relative positions of the pulley sections 34 and 35. The range of movement of the pulley sections is illustrated in Fig. 2 at minimum diameter to Fig. 3 at maximum diameter.

The characteristics of the thermostat and pulley sections may be made such that there is a substantially continuous and uniform variation in effective diameter, and therefore in the speed of rotation and delivery of air by the blower from minimum delivery to maximum delivery.

The temperature-air volume curve may be made substantially a straight line and, although

a constant speed motor is used, the volume of air delivered or the speed of rotation of the fan may be made substantially proportional to the temperature expressed in this manner.

Referring to Fig. 5, this is a sectional view of a variable diameter driven pulley which may be utilized at the point **21** on the blower. This pulley has a pair of pulley sections **61** and **62**, similar in construction to those just described, and mounted for sliding movement, but prevented from rotation by a key and key-way **63**.

The hub **64** may have a reduced threaded portion **65** for supporting a spring seat **66**, which is secured in adjusted position by means of a spring washer **67** and lock nut **68**. The spring washer **67** has radial slots **69** for receiving a rib **70**, carried by the spring seat.

The helical coil spring **71** engages a pulley section **62** at one end, and the spring seat **66** at the other end. When a spring pulley, such as shown in Fig. 5, is used in Fig. 1 or Fig. 6, the pivotal mounting **27** of the motor **25** may be eliminated and the belt kept at constant tension by the spring pulley **21**. This also facilitates a greater variation in speed, as the belt **22** may ride outward in the pulley **21** when it is pulled farther inward in the pulley **23**; that is, the effective diameter of the driven pulley **21** decreases as the effective diameter of the driving pulley increases, and vice versa, and both pulleys are controlled by the thermostat **53** because the length of the belt is constant.

Referring to Fig. 6, this is a modification in which the thermostat is provided with the copper tube **56** and bulb **57** for the purpose of making the thermostat responsive to the temperature of the metal wall of the furnace.

In this case, however, a rotating joint is required at **55** for permitting rotation between the thermostat and its connecting copper pipe **56**. The thermostatic bulb **57** need not be located in the plenum chamber, but may be located outside, on the wall to which it may be attached by heat conducting metal block, as shown in Fig. 6.

The operation of my heating system is as follows: The blower **19**, which is driven by a motor **25**, the motor operating at substantially constant speed, may be driven at a relatively low speed continuously, if desired; or it may be turned on when the furnace reaches a predetermined temperature, by means of the thermostatically controlled switch, which controls the motor circuit, which is located in the plenum chamber.

The furnace **11**, which may be a gas fired furnace, oil burner, or a coal stoker, is controlled by thermostatic devices located in the rooms to be heated, so that the furnace is turned on whenever there is a demand for heat.

Assuming that there is a demand for heat, the furnace will be turned on, and the air in the plenum chamber **14** will be heated, and when it reaches a predetermined value the motor **25** will be started, driving the blower **19** at such a low speed that, although the air issuing from the plenum chamber is only a few degrees higher than body temperature, there will be no sensation of a cold blast of air.

As the temperature of the air in the plenum chamber increases, hot air will be discharged by the conduit **30** on the thermostat **53**, and it will expand to increase the diameter of the variable pulley **23** to drive the blower faster. The speed of operation of the blower will be varied continuously and uniformly in accordance with the increase of temperature of air delivered from the plenum chamber.

The efficiency of delivery of heat from the furnace to the room will be greatly increased because the output of the delivering apparatus, that is, the air blower, is increased as the output of the furnace is increased.

The furnace may be operated at a much lower temperature without any possibility of cold air blasts, because air which is only slightly warm does not feel cold when it is circulated at a low speed. The blower does not have to be set to operate at maximum speed all of the time as in the devices of the prior art, and it may operate more efficiently and prevent stratification. The tendency of the prior art devices to deliver so much cold air that the temperature is so diminished that the blower is shut off is wholly eliminated by my invention.

The present system operates smoothly and uniformly, and it may be applied to a hot air furnace or to one of the units of a hot water, vapor, or steam system, such as a radiator.

While I have illustrated a preferred embodiment of my invention, many modifications may be made without departing from the spirit of the invention, and I do not wish to be limited to the precise details of construction set forth, but desire to avail myself of all changes within the scope of the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a heating system, the combination of a source of heat with a housing forming a plenum chamber about said source of heat, said housing having a hot air outlet and a cold air inlet, said outlet and inlet being connected with a space to be heated, a blower connected in circuit with said outlet and inlet for the purpose of forcing air through said plenum chamber, said outlet, and back through said inlet from the space to be heated, a motor for driving said blower, said motor and blower being provided with V pulleys, a wedge-shaped belt engaging said V pulleys, one of said pulleys being formed of a pair of sections slidably mounted with respect to each other, each of said sections having a frusto-conical surface for engaging the side of said wedge-shaped belt, thermostatic means rotating with one of the sections of said latter pulley for controlling the sliding movement of one section relative to the other and controlling the effective diameter of said pulley, and conduit means leading from the upper part of said plenum chamber to a point adjacent said rotating thermostatic means to control the thermostatic means responsive to temperature of heated air discharged from the plenum chamber.

2. In a heating system, the combination of a source of heat with a housing forming a plenum chamber about said source of heat, said housing having a hot air outlet and a cold air inlet, said outlet and inlet being connected with a space to be heated, a blower connected in circuit with said outlet and inlet for the purpose of forcing air through said plenum chamber, said outlet, and back through said inlet from the space to be heated, a motor for driving said blower, said motor and blower being provided with V pulleys, a wedge-shaped belt engaging said V pulleys, one of said pulleys being formed of a pair of sections slidably mounted with respect to each other, each of said sections having a frusto-conical surface for engaging the side of said wedge-shaped belt,

and thermostatic means rotating with one of the sections of said latter pulley for controlling the sliding movement of one section relative to the other and controlling the effective diameter of said pulley, said thermostatic means reacting against the part carried by one section and acting against a part carried by the other section, to move the sections in one direction relative to each other, means for maintaining the belt in taut condition and driving the sections in the opposite direction by means of the belt action, and conduit means leading from the upper part of said plenum chamber to a point adjacent said rotating thermostatic means to control the thermostatic means responsive to the temperature of heated air discharged from the plenum chamber.

3. In a heating system, the combination of a source of heat with a housing forming a plenum chamber about said source of heat, said housing having a hot air outlet and a cold air inlet, said outlet and inlet being connected with a space to be heated, a blower connected in circuit with said outlet and inlet for the purpose of forcing air through said plenum chamber, said outlet, and back through said inlet from the space to be heated, a motor for driving said blower, said motor and blower being provided with V pulleys, a wedge-shaped belt engaging said V pulleys, one of said pulleys being formed of a pair of sections slidably mounted with respect to each other, each of said sections having a frusto-conical surface for engaging the side of said wedge-shaped belt, thermostatic means rotating with one of the sections of said latter pulley for controlling the sliding movement of one section relative to the other and controlling the effective diameter of said pulley, said thermostat and sectional pulley being so arranged that the speed of operation of the fan increases with increase of temperature of the thermostat, and means for subjecting the expansible fluid in said thermostat to heat from said furnace, and conduit means leading from the upper part of said plenum chamber to a point adjacent said rotating thermostatic means to control the thermostatic means responsive to the temperature of heated air discharged from the plenum chamber.

4. In a heating system, the combination of a source of heat with a housing forming a plenum chamber about said source of heat, said housing having a hot air outlet and a cold air inlet, said outlet and inlet being connected with a space to be heated, a blower connected in circuit with said outlet and inlet for the purpose of forcing air through said plenum chamber, said outlet, and back through said inlet from the space to be heated, a motor for driving said blower, said motor and blower being provided with V pulleys, a wedge-shaped belt engaging said V pulleys, one of said pulleys being formed of a pair of sections slidably mounted with respect to each other, each of said sections having a frusto-conical surface for engaging the side of said wedge-shaped belt, and thermostatic means rotating with one of the sections of said latter pulley for controlling the sliding movement of one section relative to the other and controlling the effective diameter of said pulley, said thermostat and sectional pulley being so arranged that the speed of operation of the fan increases with increase of temperature of the thermostat, and means for subjecting the expansible fluid in said thermostat to heat from said furnace, comprising a hot air conduit leading from said furnace housing and discharging hot air on said thermostat when the blower and furnace are operating.

5. A blower system for heating and ventilating, comprising a centrifugal blower having an impeller, a housing, and a shaft, a sectional pulley carried by said shaft, said sectional pulley having a pair of sections slidably mounted with respect to each other, and having opposed frusto-conical surfaces for engaging a wedge-shaped belt, a spring for pressing said sections together, an electric motor of substantially constant speed, and a similar sectional pulley carried by the motor shaft, a wedge-shaped belt of constant length and width engaging said pulleys, rotating thermostatic means for controlling the movement of the sections of the latter pulley with respect to each other to determine the effecive diameter of said latter pulley, the said belt riding further into one pulley as it is forced out of the other pulley, whereby the effective diameter of one pulley increases as the effective diameter of the other pulley decreases, to produce a greater variation in speed, and conduit means leading from the upper part of said plenum chamber to a point adjacent said rotating thermostatic means to control the thermostatic means responsive to the temperature of heated air discharged from the plenum chamber.

6. A blower system for heating and ventilating, comprising a centrifugal blower having an impeller, a housing, and a shaft, a sectional pulley carried by said shaft, said sectional pulley having a pair of sections slidably mounted with respect to each other, and having opposed frusto-conical surfaces for engaging a wedge-shaped belt, a spring for pressing said sections together, an electric motor of substantially constant speed, and a similar sectional pulley carried by the motor shaft, a wedge-shaped belt of constant length and width engaging said pulleys, thermostatic means for controlling the movement of the sections of the latter pulley with respect to each other to determine the effective diameter of said latter pulley, the said belt riding further into one pulley as it is forced out of the other pulley, whereby the effective diameter of one pulley increases as the effective diameter of the other pulley decreases, to produce a greater variation in speed, said thermostatic means comprising an expansible metal member adapted to rotate with the sections of said pulley to act against one section and react against a part carried by the other, and conduit means leading from the upper part of said plenum chamber to a point adjacent said rotating thermostatic means to control the thermostatic means responsive to the temperature of heated air discharged from the plenum chamber.

7. In a heating system, the combination of a source of heat with a housing forming a plenum chamber about said source of heat, said housing having an air outlet and inlet, and said inlet being connected with the outlet of a blower, said blower having its inlet connected to the space to be heated by a cold air duct, and said housing having its outlet connected by a hot air duct to the space to be heated, a substantially constant speed motor, mechanical drive means between said motor and blower comprising a V belt, a V pulley carried by the shaft of said blower, a V pulley carried by the shaft of said motor above said V pulleys having a pair of members slidably mounted and provided with conical surfaces for engaging said V belt, one of said pulleys having its members spring pressed toward each other, and

the other of said pulleys having the positions of its sliding members controlled by thermostatic means, a conduit leading from the outlet end of said housing to said thermostatic means, said thermostatic means being controlled responsive to the temperature of air discharged from said plenum chamber through said conduit, whereby the speed of the blower is increased as the temperature of the discharged air increases.

8. In a heating system, the combination of a source of heat, with a housing surrounding said source, a medium of heat transfer adapted to circulate through said housing and to convey heat from said source, said housing having an inlet and outlet, a forced circulation member connected with the inlet of said housing, and adapted to control the circulation of the medium through said housing, a constant speed motor for driving said circulation member, a mechanical variable speed connection between said forced circulation member and said motor, and thermostat means located at a point remote from said housing for controlling the rate of speed of said forced circulation member by acting directly upon said variable speed connection and a conduit extending from the outlet end of said housing and conducting heated air into engagement with said thermostatic means for controlling said thermostatic means.

9. In a heating system, the combination of a centrifugal blower with a constant speed motor, said motor and blower being provided with sectional V-pulleys, the walls of which are adapted to engage a V-belt, a V-belt embracing said pulleys, one of said pulleys having its sections spring pressed together, temperature responsive means acting directly on one of said sections and reacting against the other of said sections for producing relative movement between the sections of said other pulley, whereby the speed of drive of the blower and the air circulation of the furnace may be controlled, responsive to temperature conditions in the furnace, and a control air conduit communicating with said centrifugal blower and adapted to conduct air into engagement with said temperature responsive means.

10. In a heating system, the combination of a source of heat with a housing surrounding said source, a blower located in the cold air intake of said housing, constant speed means for driving said blower, driving connections between said constant speed means and said blower, including a variable diameter V pulley, thermostatic means rotating with the pulley for controlling its effective diameter, conduits leading from said housing to a space to be heated and to a point adjacent said thermostatic means whereby heated air from the housing is delivered at said thermostatic means to control the speed of circulation of the air responsive to the temperature of the air discharged from the housing.

11. In an air conditioning system having a plenum chamber and a blower arranged to force air through said chamber, the combination of a substantially constant speed motor, a variable speed drive interposed between said motor and blower to actuate said blower at a multiplicity of different speeds, and heat responsive mechanism having a controlling element located at a point remote from said plenum chamber and operative to change said drive to regulate the speed of said blower in accordance with the changes in the temperature of air applied to said controlling element, and a control air conduit leading from the hot air discharge portion of said plenum chamber to said element to conduct heated air to said controlling element.

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