March 14, 1967 H. STÖCKLI 3,308,805

HEATING AND AIR CONDITIONING APPARATUS

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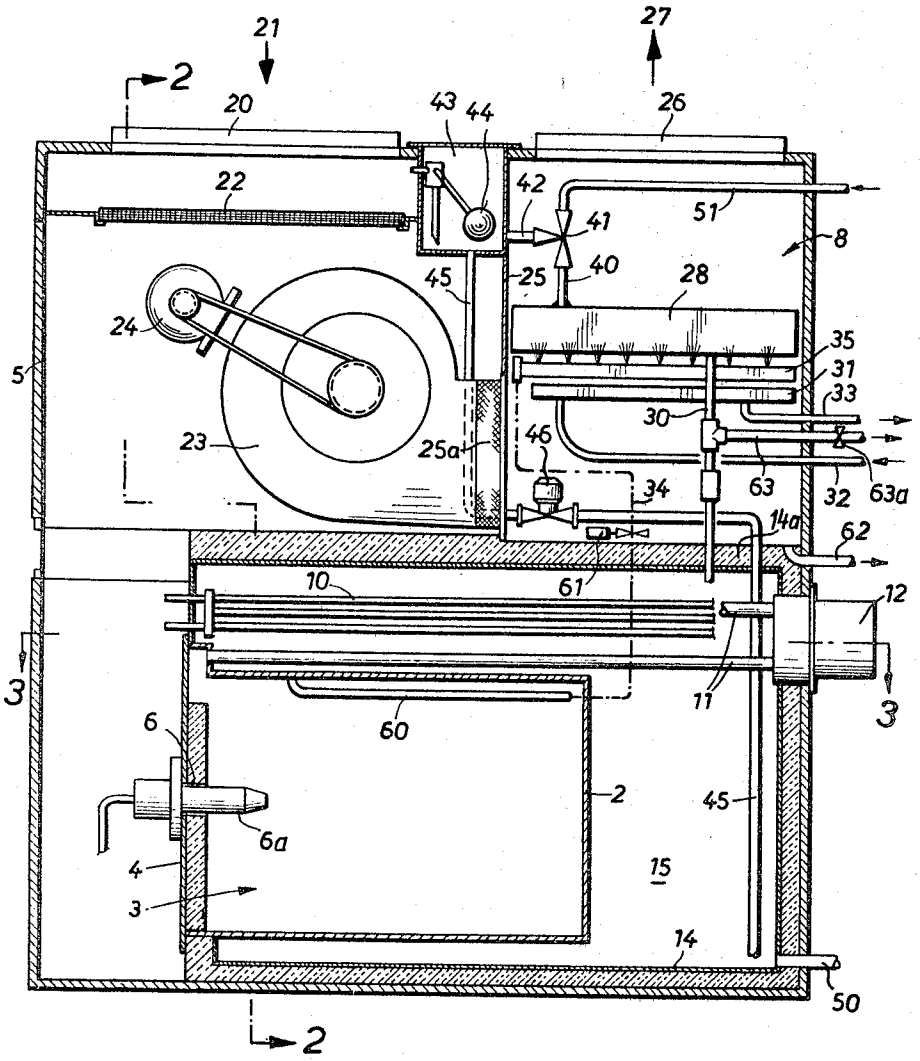
Fig. 1



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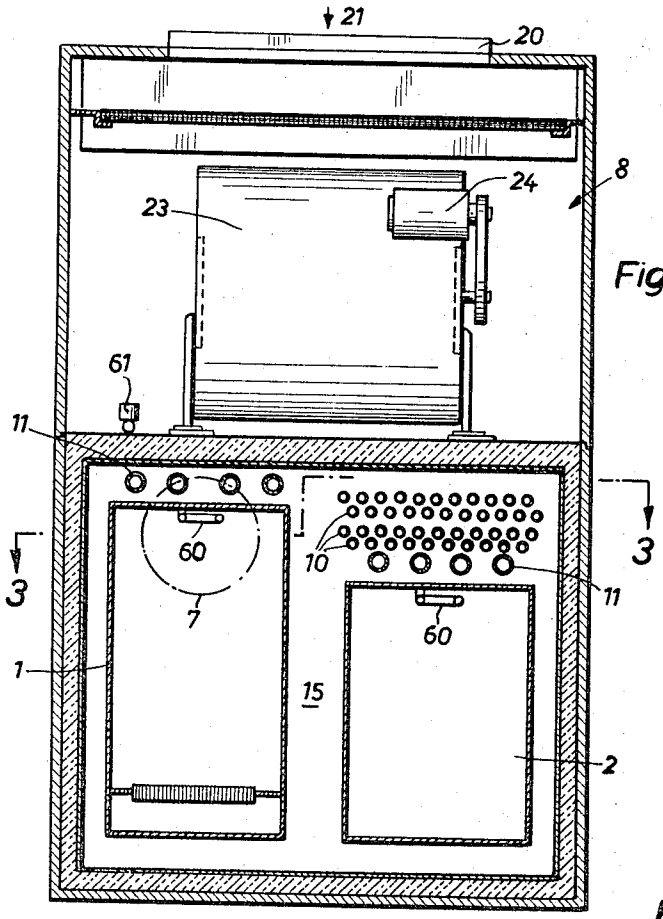

Fig. 2

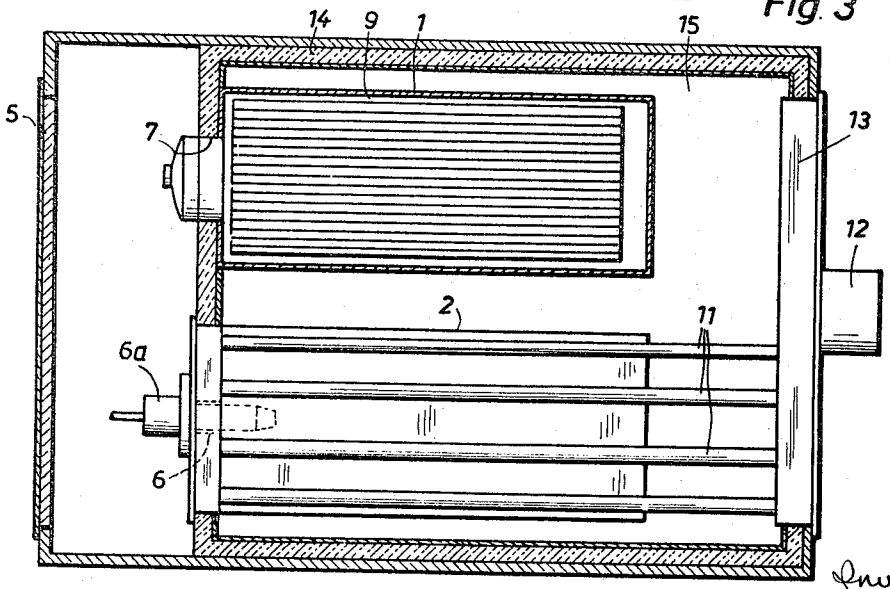

Fig. 3

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HEATING AND AIR CONDITIONING APPARATUS

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1 Claim. (Cl. 126—113)

The invention relates to an air conditioning apparatus and more particularly, though not exclusively, to a heating apparatus for the conditioning of air.

Heating units are known which can be operated at will either with solid fuel or with gaseous or liquid fuel but only with one kind of such fuel at the same time. There are also known heating devices comprising separate combustion chambers for the combustion of solid fuel and for the combustion of gaseous or liquid fuel respectively, the two combustion chambers being arranged in series in a common path for the combustion air and combustion gases so that the operation of one of the combustion chambers necessarily affects that of the other; this is undesirable in many cases. Also, air heating devices of the last mentioned kind are known in which the air to be heated is passed in series first through tubes in one of the combustion chambers and then through tubes in the other combustion chamber.

One of the objects of the invention is to provide a heating apparatus which can be operated both alternatively and simultaneously with solid fuel and with gaseous or liquid fuel and in which the operation on one kind of fuel will remain substantially unaffected by the operation, or absence of operation, on the other kind of fuel.

Another object of the invention is to provide a heating apparatus for the conditioning of air in which a fluid, preferably water, can be directly heated by means of either or both solid and gaseous or liquid fuel and can thereafter be used for heating the air to be conditioned, by means of a heat exchanger.

A further object of the invention is to provide a heating and air conditioning apparatus of this kind in which the said heat exchanger can also be used for cooling the air to be conditioned.

Still a further object of the invention is to provide an air conditioning apparatus of this kind in which the air can be consecutively cooled, especially in order to get rid of some of its moisture, and re-heated to a desired temperature.

The invention also has for its object to provide an air conditioning apparatus, especially an air heating apparatus, which also comprises means for heating water for consumption or heating purposes.

A further object of the invention is to provide an air heating apparatus also comprising means for heating, and if desired evaporating water to be used for moistening the heated air.

More generally, an object of the invention also is to provide an air conditioning apparatus, or a heating apparatus of any of the above-mentioned kinds which is constructed as a compact unit, and which is economical in manufacture, maintenance and operation.

Further objects and advantages of the invention will appear from the subsequent description of an embodiment thereof, represented by way of example only, in the accompanying drawings in which:

FIGURE 1 is a longitudinal vertical section through a heating apparatus;

FIGURE 2 is a vertical cross-section along the line 2—2 of FIGURE 1; and

FIGURE 3 is a horizontal section along the line 3—3 of FIGURE 2.

The heating apparatus shown in FIGURES 1 to 3 is of generally parallelepipedic shape and is about half as wide as it is long. Its lower part, generally designated by **3**, comprises a combustion chamber **1** for solid fuels and another combustion chamber **2** for gaseous or liquid fuels. Its front wall **4** is offset to the rear with respect to the outer front wall **5** of the unit as a whole, so that the front openings **6** and **7** of the two combustion chambers lay behind that front wall **5**. The lower portion of the front wall **5** may contain a control board (not shown) from which the whole operation of the unit is controlled and regulated. The lower part **3** of the unit takes about one-half of the volume of the whole.

As usual, the lower part **3** may constitute an assembly which can be separated from the upper part, generally designated by **8**. The solid fuel combustion chamber **1** is equipped with a grid and ash-box and consists of a rectangular box **9** into which pieces of wood, coke, waste, paper, cardboard boxes and the like can be introduced through the supply opening **7**. The combustion chamber **2** for gaseous or liquid fuel is somewhat similar to the solid fuel combustion chamber **1** but its height is smaller as can be seen in FIGURE 2. Conventional oil burner or gas burner **6***a* is screwed or otherwise mounted into the front opening **6** of the combustion chamber **6**.

Above the combustion chamber **2**, there is a system of tubes **10** which serves for the production of hot water independently from the air heating system, as will be explained later. Above each of the two combustion chambers **1** and **2**, a row of tubes **11** connect the front portion of the respective combustion chamber to a common combustion gas outlet **12**. The combustion gases of the two chambers **1** and **2** are collected in a common collecting box **13** before they reach the outlet **12**.

The lower part **3** of the unit is constructed as a liquid tank **14** provided with a heat-insulating envelope **14***a* made from asbestos, fire bricks or the like. There is no partition between the combustion chambers **1** and **2**, in order to permit free circulation of the fluid to be heated in the lower part, such as water.

The space **15** surrounding the two combustion chambers **1** and **2** and externally defined by the walls of the tank **14** contains a liquid, preferably water or, if desired, a suitable light oil, which becomes heated in direct contact with the walls of the combustion chambers **1** and **2** and of the combustion gas tubes **11** and in its turn serves for heating air as well as the water circulating through the tubes **10**.

The upper part **8** of the unit is also surrounded by the outer walls **5**, which are made from sheet metal with an insulating layer of crimpled aluminium foil, and it is also protected against heat transfer from the lower or heating part **3**, by the heat-insulating envelope **14***a* thereof.

In the present example, which is a unit to serve for room heating by warm air, that upper part is arranged as follows:

Fresh or recirculated air or a mixture of both enters the unit through a rectangular opening **20** in the top wall of the unit, as indicated by arrow **21**. It then passes through a filter **22**, whereupon it is fed by a blower **23** driven by an electromotor **24**. Through an opening **25***a* in a vertical partition wall **25** dividing the inside or the upper part **8** into two chambers. The outlet of the blower **23** is connected to the opening **25***a* by a fabric hose. Through that opening, the air enters that one of the said two chambers which is at the right (as seen in FIGURE 1), and before escaping through the outlet opening **26** as indicated by an arrow **27**, it passes through a box-shaped heat exchanger **28**.

In its bottom wall, this heat exchanger **28** has inlet openings for the air to be heated, and in its top wall, it has outlet openings for the heated air. Between these two walls, it contains a system of horizontal tubes (not shown), which is supplied through a tube **30** with the liquid directly heated in the space **15** of the lower part **3**. To asisst the transfer of heat from the circulating liquid to the air, the tubes of the system may be provided with vertical sheet metal fins extending either longitudinally or transversely of the tubes, or both with longitudinally and transversely extending fins.

Return of the water or other liquid which has yielded some of its heat in the heat exchanger **28** takes place through an outlet pipe **40**, a three-way valve **41** and a pipe **42** to an expansion vessel **43**. This is always partly filled with the liquid, which is ensured by a float valve **44**. From this expansion vessel, the liquid returns to the space **15** through a conduit **45** in which a circulating pump **46** is mounted to activate the circulation of the liquid. In the space **15**, the liquid is again heated so that continuous heat transportation is ensured by its circulation.

A pipe **50** is connected to the space **15** just above its bottom for draining the liquid from that space and for filling it up.

The heat exchanger **28** can also be used for cooling the air which enters the unit through the opening **20** and leaves it through the opening **26**. For this purpose, the outlet pipe **40** can be shut off from the pipe **42** by means of the three-way valve **41** and connected to a tap water conduit **51** which supplies fresh water; this is then circulated through the heat exchanger **28** in the direction opposite to that in which the heated water circulates when the air is to be heated. An escape conduit **63**, controlled by a valve **63***a*, branches from the tube **30** to permit the used water to be carried off from the heat exchanger **28** after the valve **63***a* has been opened. The finned tube system in the heat exchanger **28** now serves for cooling the air which is to leave through the outlet **26**. By this cooling of the air, part of the moisture carried by it can be caused to condensate and thus be extracted from the air. Of course, the lower part of the unit can be heated during such operation to maintain the supply of hot water, e.g. for the kitchen and bathroom, but also for heating the rooms with warm water if desired. Such warm water heating permits to restore the temperature of the circulating air if its cooling was intended to dehumidify it rather than to lower the temperature in the rooms.

A second heat exchanger **31** may be provided ahead of the exchanger **28** in the path of the air from the partition opening **25***a* to the outlet opening **26**. This second heat exchanger serves only for cooling the said air. It also comprises a set of horizontal finned tubes (not visible in the drawing) between which the air flows upwards. These finned tubes serve as evaporators for a refrigerant, e.g. Freon, which is supplied to it through a pipe **32** from the condenser of a conventional refrigerating installation not shown in the drawing. The evaporated refrigerant is returned to the compressor of the refrigerating plant through another pipe **33** and a liquid separator, whereupon it is compressed and returned to the said condenser to be liquefied again.

This arrangement makes it possible first to cool the comparatively moist air flowing from the partition opening **25***a* to the outlet **26** down to such a temperature that a desired part of the water contained in it becomes condensed and precipitated in liquid state, and then to heat again the cooled air, which contains a smaller absolute quantity of water, by means of the heat exchanger **28** which is supplied with hot liquid from the space **15**, until it has again the temperature at which it entered the unit, or any desired other temperature. Thereby, the relative humidity of the air is decreased.

If such re-heating of the air within the apparatus is not required, e.g. if it is not desired to dehumidify it but simply to reduce its temperature, for instance in summer, while the heating device is not in operation, then the second heat exchanger **31** can be dispensed with and it suffices to operate the first heat exchanger **28** with tap water as described. On the other hand, this second heat exchanger **31**, where provided, may render it superfluous to have the heating heat exchanger **28** connected to the tap water conduit **51**, since it can take charge of any required cooling of the air.

When heating the air, it may be desirable to raise its relative humidity at the outlet **26** to a higher value by injecting water into it.

For this purpose, the described embodiment is equipped with a further loop of tubing **60** preferably mounted in the uppermost portion of either or both of the combustion chambers **1** and **2**. This loop of tubing **60** can be supplied with water from the space **15** and it is connected by a conduit **34** (shown only schematically) to at least one sprayer **35** mounted in the upper part **8**, preferably ahead of the heat exchanger **28**. The loop of tubing **60** can be connected to a hygrometer placed in one of the rooms to be air-conditioned, in such a manner as to provide automatic regulation of the humidity in these rooms, e.g. by means of an electro-magnetically operated valve **61**.

A drain pipe **62** is connected at the bottom of the upper part **8** of the unit for draining any condensate resulting from the operation of the heat exchanger **31**, or of the heat exchanger **28** when the latter serves for cooling. This drain pipe is also useful in case of leakage from the expansion vessel **43** or from other liquid-carrying elements of the unit.

The temperatures of the fluid which is heated directly from one or both of the combustion chambers **1** and **2** in the lower part **3** of the unit may be automatically controlled by means of a thermostat (not shown) which acts on the fuel supply.

In the apparatus here shown and described, it would also be possible to direct some of the directly heated fluid, which preferably is water from the space **15** to heating radiators in the rooms to be air-conditioned, thereby rendering it feasible to provide simultaneously or alternatively hot air heating and/or room heating by radiators (warm water heating) and/or a warm water supply; also, the rooms can be cooled at the same time as warm water is supplied.

By an appropriate arrangement of the radiators which influence the room temperature, of the air distribution outlets or slots, it is also possible to heat one part of a room (especially a very large room such as a cinema theatre) and at the same time to cool another part of the same room, e.g. its upper part, and also to reduce the moisture content of the air circulating to and from that latter part.

I claim:

Air conditioning apparatus comprising a combustion chamber, a burner mounted in said combustion chamber, a combustion gas collector, a set of tubes connecting said combustion chamber to said combustion gas collector, a vessel to confine a fluid to be heated surrounding at least part of said combustion chamber and said set of tubes, an air ducting means, a blower within said

air ducting means for producing a unidirectional flow of air through said ducting means, a heat exchanger mounted in said air ducting means having a fluid inlet and outlet, fluid conduit means connecting said vessel to said heat exchanger fluid inlet and said heat exchanger fluid outlet to said vessel, means for circulating fluid from said vessel through said fluid conduit means and heat exchanger and back into said vessel, a boiler tube in said combustion chamber, a nozzle for discharging water or steam into said air ducting means, means for introducing water at one end into said boiler tube, a valve controlling said boiler tube, and a conduit connecting the opposite end of said boiler tube to said nozzle.

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