April 1, 1958 H. F. SMITH 2,828,681

AIR CONDITIONING APPARATUS

Filed Oct. 28, 1953 4 Sheets-Sheet 1

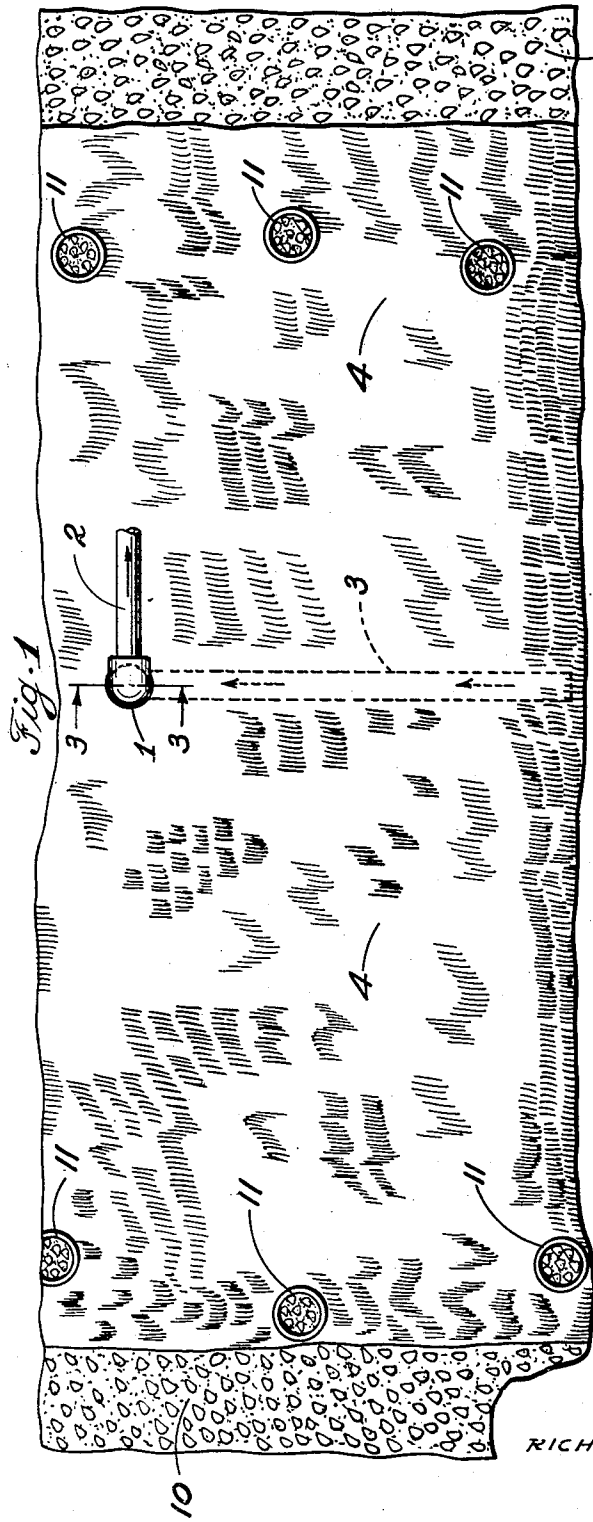


Fig. 1

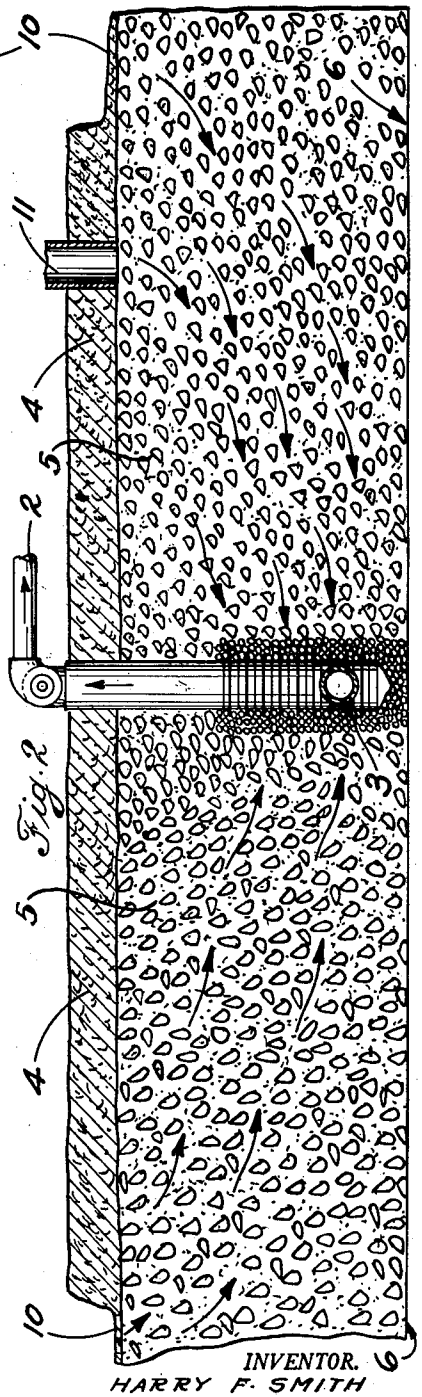


Fig. 2

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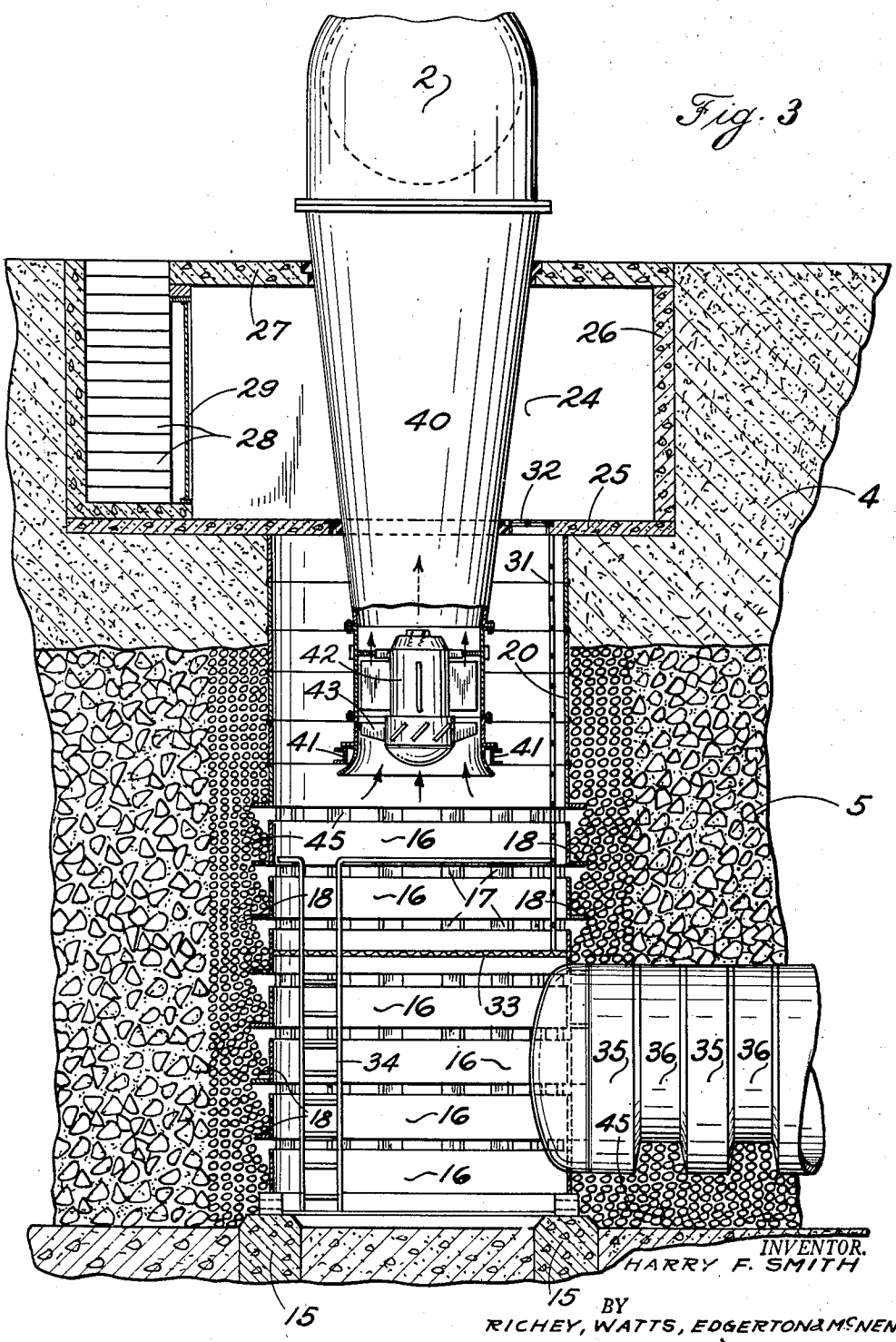
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AIR CONDITIONING APPARATUS

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Fig. 3



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AIR CONDITIONING APPARATUS

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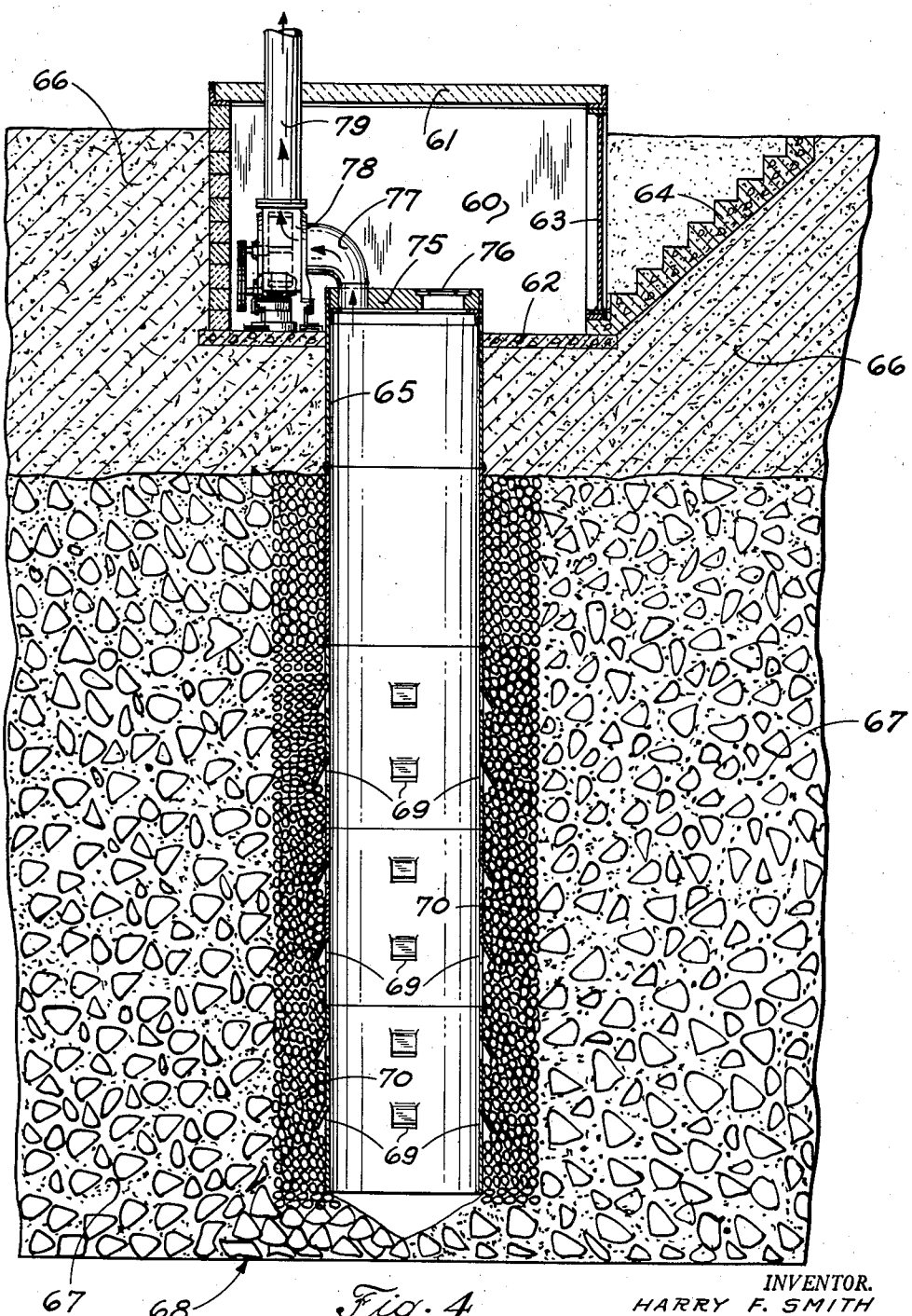


Fig. 4

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AIR CONDITIONING APPARATUS

Filed Oct. 28, 1953 4 Sheets-Sheet 4

Fig. 5

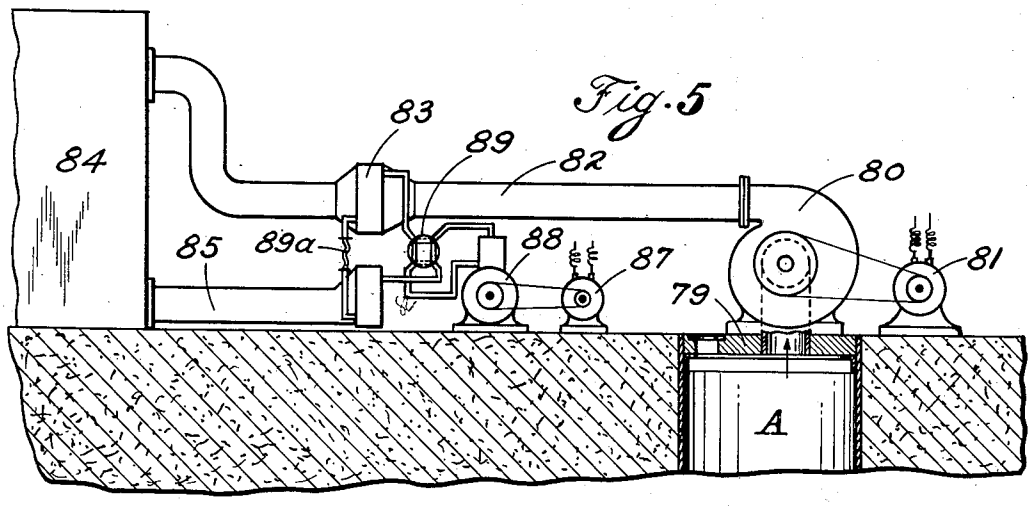
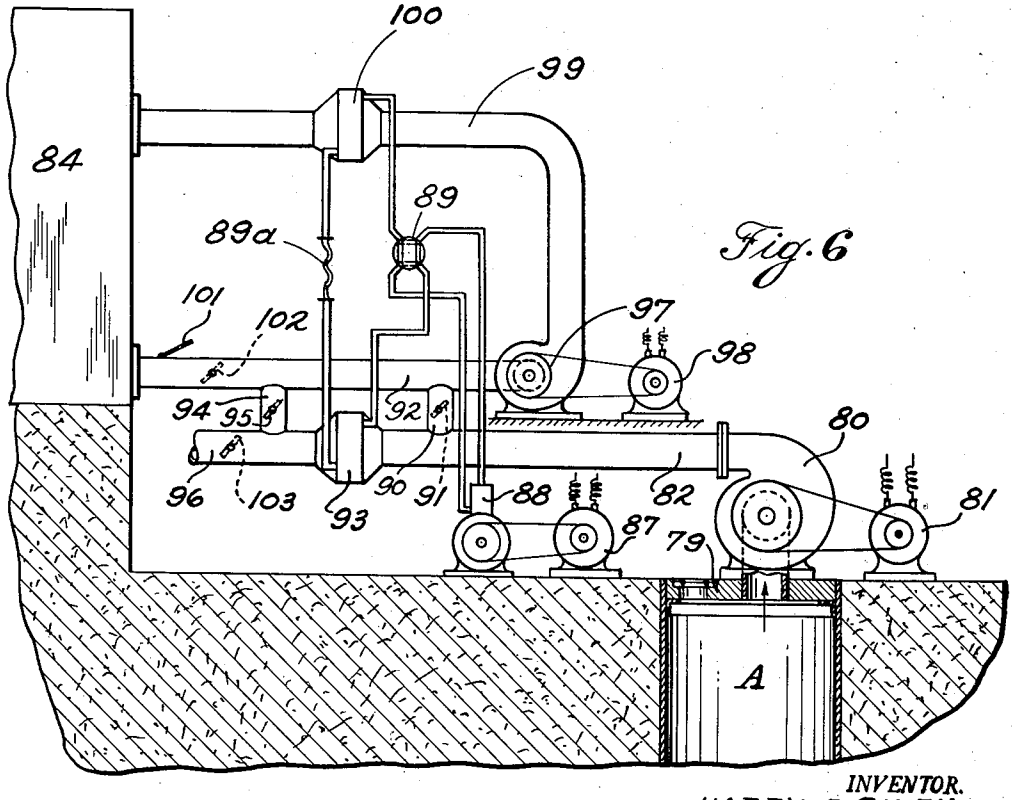


Fig. 6



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United States Patent Office

2,828,681

Patented Apr. 1, 1958

2,828,681

AIR CONDITIONING APPARATUS

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Application October 28, 1953, Serial No. 388,870

3 Claims. (Cl. 98—1)

This invention relates to the art of air conditioning. It is concerned generally with storing and conserving solar heat and utilizing it in spaces such as rooms in houses, office buildings and factories. It is particularly concerned with a new method of, and new apparatus for, air conditioning such spaces by means of air drawn for considerable distances through porous strata in the earth.

Much thought and effort have been expended on the matter of air conditioning during the past decade or more with the result that elaborate air conditioning apparatus has been devised. However, most of such apparatus is quite expensive to build, install and operate and, in some instances, cannot be used because of the scarcity of cooling water. Such apparatus is customarily built with a capacity sufficient to maintain the air in the space to be conditioned at a certain desired temperature when the outside air is at a predetermined maximum temperature, for example, to maintain a desired temperature of 85° F. dry bulb where the outside air does not exceed 95° F. dry bulb or 75° F. wet bulb. On the days when the outside temperature is above that predetermined maximum temperature, the air conditioning system is not entirely satisfactory. Only by increasing the capacity of the system at considerable increase in cost can the system be made satisfactory when the outside air temperatures are above the predetermined maximum temperature. Thus the conventional systems are relatively inflexible, that is, they can not be adjusted to meet extreme temperature conditions, are directly affected by and reflect sudden changes in the temperature of the atmosphere and consume considerable power in operation.

Moreover, conventional heat pumps can not be used effectively with such conventional systems because of the practical difficulty of finding an available source of heat at a moderately low temperature.

I have devised an air conditioning system which is based on the entirely new principle and concept of conserving and storing solar heat in the earth for subsequent removal and use and at the same time conditioning air for use in air conditioning systems. This system and invention depends for its success partly on the discovery that porous underground strata can absorb heat from, and give it us to, air flowing therethrough while filtering and washing such air and saturating it with moisture, thus fitting the air for various subsequent uses. It also depends for its success partly on the fact that a cubic foot of gravel in the porous strata can be the equivalent of melting 1.4 lbs. of ice per day in a conventional air conditioning system. Since a cubic foot of gravel weights 100 lbs. and its specific heat is .2, it has the capacity of storing 200 B. t. u. when air passing therethrough is cooled through 10° F.

It is well known that the rays of the sun pass through the air and strike the earth where they are absorbed and converted into heat, that this heat warms the earth and the air immediately in contact with it, and that such heat

is dissipated by air traveling over the earth's surface and into colder regions. So far as I know, no prior worker in the art has provided a system by which that heat could be stored in the earth and later utilized.

In practicing the present invention, a suitable site is selected and then suitable means are provided for causing air to flow through the ground at that site. A site suitable for the purpose is one where the top or surface layer of the earth is sufficiently impervious to prevent the rapid flow of air therethrough and overlies a less dense and more porous strata consisting largely of solids of small size such as gravels and the like, through which air may pass rather freely. A preferred site is one where deposits of gravel or similar granular material, for example, gravels laid down in a more or less horizontal strata by glaciers, are covered by a surface layer composed of clay, sedimental top soil and the like. Glacial gravel beds are quite satisfactory for they are usually quite porous in the horizontal plane or in the direction of stratification and average from about 15% to 30% voids which makes it possible for air to be readily passed therethrough. The surface layer of clay or top soil prevents the rapid and localized entry of air into these strata and hence, causes the air to flow into the strata throughout a wide surface area.

The present invention may be carried out by apparatus which consists of a combination of simple elements. An extremely simple form of such apparatus consists of a substantially vertical metal shaft extending down through the relatively impervious top surface layer of earth and into the porous strata to a place well below the lower side of said layer but at least a short distance above the ground water level in the porous strata. This shaft is impervious from its upper end to a level below the lower side of the surface layer and is provided with perforations in the part disposed in the porous strata through which air may pass. A conduit is provided to receive air discharged from the upper end of the shaft to conduct it to a space to be air conditioned and a fan or other suitable device, preferably motor driven, is provided to cause air to flow up in the shaft and into and through the conduit. When large volumes of air are required, one or more horizontal tunnels may be extended from the lower part of the shaft in the porous strata to afford the necessary area of separation, that is, the surface area of the porous strata from which air escapes into the shaft and its associated tunnel or tunnels. Each tunnel is so constructed that air may pass freely into it under the suction effect of the fan at the upper end of the shaft.

The air which is drawn into the ground during the summer time is heated by the heat created on the surface of the ground by the sun's rays and this air is at a temperature considerably above the temperature of the solids in the porous strata which normally have a temperature approximating that of the ground water which remains substantially constant throughout the year and which is 52° in the region in north central Ohio. In passing through this porous strata the warm air gives up heat to the solids of the strata, thereby raising the temperature of the latter and reducing the temperature of the air. When air is drawn into the ground during the winter time its temperature is lower than that of the solids in the porous strata and accordingly a reverse exchange of heat takes place with the solids being cooled and the air being warmed. I have found that the air withdrawn from the porous strata has a temperature which varies through a range of only a few degrees throughout the year but is cooler in the summer than it is in the winter. For example, the temperature of the withdrawn air fell slowly from about 56° F. in December to about 48° F. in May and then rose slowly to

about 57° F. in September. During that time the ground water temperature which had been about 52° F. in December rose to about 55° F. the following September.

It is seen, by the present invention, that heat from the sun's rays is conserved by being stored in the earth and in later utilized by being transferred to air and thereby removed from the place of storage.

The air so withdrawn from the earth is purified by being washed and filtered, is fresh, is saturated with moisture when withdrawn and is quite desirable for air conditioning uses and also for heating purposes. It will be understood that during the winter time such withdrawn air, having a temperature of near or above 50° F., may be used to supplement or largely replace artifical heating used at night to prevent freezing. The withdrawn air may be used alone or mixed with natural air for air conditioning. For such use it is preferably warmed to make it comfortable to human beings and can be used not only to maintain the temperature of the air in a space at a predetermined level but also to absorb moisture since as its temperature is raised its ability to absorb moisture increases. These factors make the withdrawn air suitable for use in places where considerable drying is required, for example, in a pottery where the moisture molded clay must be dried out preliminary to being fired.

The present system is quite flexible since almost any desired amount of air may be withdrawn from the porous strata and this amount may be readily adjusted to keep step with the extremes in atmospheric temperature by the simple expedient of varying the rate of withdrawal of the air from the porous strata. For example, if, as so frequently occurs in the summer time, the atmospheric temperature rises rapidly from 70° F. to above 90° F., a temperature of 76° F. may be maintained in a closed space by the simple expedient of increasing the amount of air withdrawn from the ground and delivered into such space. Conventional air conditioning systems have no such capability, as has been pointed out above. Similarly in the winter time the amount of air withdrawn may be greatly decreased during the day time when the space being air conditioned is artificially heated.

Moreover, conventional heat pumps may be used to good advantage with the system of the present invention because the air withdrawn from the porous strata constitutes a source of heat at a moderately low temperature, because there is no increase in the heat pump head in severe weather, and because of the reduction in heat pump head which is traceable to the heat given up by the water which is condensed out of the air while it is being cooled in the heat pump.

The present invention will be better understood by those skilled in the art from the following specification and the drawings which accompanying and form a part thereof, and in which:

Figs. 1 and 2 are, respectively, schematic plan and vertical section views showing apparatus embodying, and for use in carrying out, the present invention;

Fig. 3 is a fragmentary vertical view of the tunnel and and shaft of Figs. 1 and 2 taken on line 3—3;

Fig. 4 is a vertical sectional view similar to Fig. 3 but showing a modified form of apparatus;

Fig. 5 is a partly sectional view showing the system of Figs. 1 to 4 combined with a simple heat pump; and

Fig. 6 is a view similar to Fig. 5 but showing a modified form of heat pump in the system.

In Figs. 1 and 2 a vertical shaft 1 is shown as being connected at its upper end to a conduit 2 and near its lower end to a horizontal tunnel 3. The shaft 1 extends in an approximately vertical position down through the relatively impervious surface layer 4 and into the porous strata 5 therebelow with its lower end disposed a short distance above the ground water level 6. The tunnel 3 is disposed some little distance above the ground water level and within the porous strata. As is indicated, the porous strata 5 is made up of a multitude of solids of varying sizes, in this instance being glacial gravel. While porous strata having various percentages of voids may be used, I prefer to use glacial gravel beds for their percentages of voids is fairly high which means that air may flow through them without too much resistance.

It will be understood that the layer 4 may consist of top soil, clay and other common materials and that this layer should preferably be relatively impervious as compared with the porous strata so that air will pass through that layer in small volume per unit area and hence will flow for long distances or at slow rates in the porous strata.

It will also be understood that the entire area shown in Fig. 1 and preferably large surrounding areas should have the relatively impervious layer and the porous strata shown in Fig. 2. Where the surface layer is so dense that air will not pass therethrough in sufficient amounts for the desired purpose, the entry of air into the porous strata may be facilitated in any suitable manner, for example, by removing part of the impervious layer, or by sinking shafts 11, as is indicated in Figs. 1 and 2, or by using both of these expedients or equivalents thereof.

As has been indicated above and as will be explained more in detail hereinafter, air is withdrawn from shaft 1 and forced out through conduit 2 into a space to be air conditioned. The removal of air from shaft 1 results in flow of air from tunnel 3 into shaft 1 and in flow of air through the surface layer 4 into and through the strata 5 in the large area surrounding that shaft. In passing through the porous strata, the air gives up heat to the solids in that strata or picks up heat from those solids, as the case may be and depending upon the conditions present when the air enters the porous strata.

The combination of the shaft and tunnel in Figs. 1 and 2 will be better understood by reference to Fig. 3. The shaft is formed by a hollow metal cylinder or shaft which rests on a suitable annular footing 15 a short distance, for example, about 3 feet above the surface of the accumulated ground water. This shaft, as shown, consists of a plurality of narrow, corrugated metal rings 16 spaced apart vertically by circumferentially spaced vertical connectors 17 to provide a plurality of radial inlets. An outstanding flange 18 which may be continuous or made of short pieces is welded or otherwise suitably attached to the lower end of each ring 16 above the radial passages and extends outwardly beyond the ring 16 far enough to prevent solids of various sizes from falling through the radial openings and into the interior of the shaft. The shaft constructed as just described extends upwardly from the footing 15 to approximately the top of the porous strata. From its upper end an imperforate metal shell 20 substantially free from radial openings through its walls extends on up through the surface layer 4.

At its upper end shell 20 which preferably is positioned several feet below the surface of the ground, enters an enlarged space 24 defined by concrete bottom wall 25, upright walls 26, and top wall 27. Steps 28 lead down from the surface of the ground through a door 29 into space 24 and a ladder 31 leads downwardly from bottom wall 25 adjacent to manhole 32 to a cat-walk 33 in shaft 1 at approximately the top of horizontal tunnel 3. Another ladder 34 leads from cat-walk 33 to the bottom of the shaft.

The tunnel shown in Fig. 3 comprises a plurality of corrugated pieces of sheet metal, every other one constituting a complete circle and the alternate ones being cut away at the bottom throughout about 60°. Thus, the interior of the tunnel is in communication with the surrounding porous strata through the bottom portions of each of the alternate sections of the tunnel. The flanges at the ends of the circumferentially continuous sections 35 are preferably spaced from the corresponding flanges

of the alternate sections 36 so as to permit air to enter the tunnel between the sections but to prevent all but the finest solids from entering.

The bottom wall 25 of chamber 30 has a central opening through which extends a metal shell 40. Near its lower end, this shell is supported by structural members 41 supported by being attached at their ends to the shell 20. A housing 42 is disposed within shell 40 near its lower end and encloses a motor which has a fan 43 mounted on its rotor shaft to rotate within shell 40 and to cause air to flow out of shaft 1 and past the motor housing and thence through the upper part of shell 40 and into conduit 2 which serves to conduct the air to a space to be air conditioned. When the withdrawn air is to be used to condition office space, means is provided to warm the air to the preferred temperature of about 76° F., such means being any suitable conventional heating apparatus. When the air is to be used in factory space, it may not be desirable to warm the air in which case the heater is rendered inoperative. In certain cases the withdrawn air may be warmed by being passed in heat exchanging relation to highly heated articles which are to be cooled.

The openings in walls 25 and 27 through which shell 40 extends are sealed against ingress of air. Since the wall 25 extends outwardly in all directions from the top of shaft 1 far enough to prevent ingress of air directly into shaft 1 without passing through any substantial quantity of porous strata, it follows that the air which flows through conduit 2 has entered the porous strata some distance away from the shaft 1 and has passed through that strata where the above mentioned heat exchange has taken place.

Preferably both the portion of shaft 1 which is provided with radial inlet openings and also the tunnel 3 are surrounded with gravel of fairly uniform size. This gravel is indicated in Fig. 3 at 45. Since this gravel is substantially free from dirt, clay and the like, and the solids are of generally the same size, the flow of air through this gravel is facilitated and at the same time the area of separation of air from the porous strata is increased which is reflected directly in the volume of air which can be withdrawn from the ground with a given unit of horsepower or speed of the fan.

In Fig. 4 is shown a modified form of apparatus having a limited capacity and embodying variations of the apparatus shown in Figs. 1 to 4 previously described. In this figure, a chamber 60 is defined by a top wall 61 disposed approximately on ground level, a bottom wall 62 a number of feet therebelow and vertical walls 63 extending between these bottom and top walls. The stairway 64 leads down from the surface to the floor of this chamber 60. Extending downwardly through the central part of floor 62 is a sheet metal shell 65. This shell extends down through the surface layer indicated generally at 66 and into the porous strata indicated generally at 67, but stops a short distance, for example, 2 or 3 feet above the surface 68 of the accumulated ground water. The shell 65 has no openings through the portion thereof which is in the surface layer 66, but is provided with a plurality of louvre-like openings 69 in the part positioned in the porous strata. The shell 65 is preferably surrounded for the vertical height of the porous strata with solids of approximately uniform size, such as graded gravel and as is indicated at 70.

The upper end of shell 65 is provided with a cover 75 having a covered manhole 76 through which access may be had to the interior of shell 65. An air outlet 77 leads through the cover and into a fan housing 78 equipped with a fan adapted to draw air through outlet 77 and propel it through duct 79 to a building or other space to be air conditioned. If desired, a heater may be provided to heat air flowing in duct 79.

In Figure 5 is shown the combination of a conventional heat pump with the apparatus of Figures 3 or 4. In this instance, the upper end of the vertical shaft A, such as 20 of Figure 3 or 65 of Figure 4, is fitted with a cover 79 through which air may pass to the intake side of a centrifugal pump 80 which is driven by motor 81. The outlet of pump 80 communicates with a pipe or conduit 82 which contains a coil indicated at 83 and opens into a space 84 to be air conditioned. Air may be expelled from space 84 through conduit or pipe 85 at the discharge end of which it passes through a coil indicated at 86. The motor 87, compressor 88, the condensing and evaporating coils 83 and 86, multiported valve 89, the purpose of which is to reverse the functions of the coils, and expansion valve or flow resistor 89*a* are parts of a conventional heat pump.

When air, being withdrawn from the earth by pump 80, is to be warmed before being discharged into space 84, the valve 89 is set to direct fluid compressed by compressor 88 into coils 83. Such compression of the fluid increases its temperature to above the temperature of the air flowing in pipe 82 with the result that such air is heated in passing through coil 83. As the compressed fluid gives up heat to the air, the fluid is condensed and then flows into coil 86. There the air flowing through conduit 85 from space 84 is at a higher temperature than the condensed fluid and gives up some of its heat to that fluid with resultant evaporation of the fluid. This evaporated fluid returns to the compressor 88 where the foregoing cycle is repeated.

In the event that the air flowing in pipe 82 is to be cooled instead of heated the valve 89 is turned to direct the fluid compressed by compressor 88 first through coil 86 where the fluid is cooled by the passage of air through conduit 85. Then the thus cooled and condensed fluid flows through coil 83 where it is at a temperature lower than the air flowing in pipe 82 and as a result such air is cooled by the fluid with consequent evaporation of the latter before it returns to compressor 88.

Two simple illustrations will show the effectiveness of the apparatus of Figure 5. Let it be assumed that the air withdrawn from the ground is delivered into pipe 82 at a temperature of 65° F. and that such air is to be delivered into space 84 at 85° F., that is, that its temperature is to be increased 20° F. in passing through coil 83. This 20° F. rise in temperature must be supplied by an equal amount of heat absorbed by coil 86 from air leaving space 84. If the temperature of the air passing through conduit 85 is 65° F. it must be cooled to 45° F. to supply the necessary heat to increase the temperature of the air flowing in pipe 82 to 85° F. Thus the heat pump system would have to pump against a thermal head of 40° F. plus several additional degrees to compensate for heat flow drop from the air to the coil.

This is a relatively small temperature head to pump against and it is not increased, and may actually be decreased, when in colder weather it is necessary to increase the rate of air circulation to maintain a desired temperature of 85° F. Since the temperature ratios of the air entering and leaving space 84 remain the same an increase in the rate of air circulation may actually result in an increase in the temperature of the air flowing in conduit 85 thus actually reducing the temperature head as the weather gets colder.

It is important to note that the foregoing temperature head of about 40° F. is partly offset by heat derived from the air itself. Each pound of air withdrawn from the earth by this process and having a temperature of 60° F. will be fully saturated with moisture at that temperature and can be cooled through 25° F. without any danger of frosting up the heat absorbing coil. Since such air has a specific heat of .25 it will give up 6¼ B. t. u.'s when cooled through 25°. Moreover, since each pound of such air carries .01105 pound of water at 60° F. and .00427 pound of water at 35° F. the effect of cooling such air from 60° F. down through 25°

F. will result in condensing .00678 pound of water and thereby liberating 6¾ B. t. u.'s. The 13 B. t. u.'s obtained from these two sources may be utilized in heating the air in pipe 85 and may thus correspondingly reduce the temperature head from the above mentioned 40° F. to 27° F. This is a very important factor in making the heat pump commercially feasible as a means of winter heating.

Moreover, it should be noted that with the present system there is no increase in heat pump heat head during severe weather. As has just been shown, the heat head may remain substantially constant at about 27° F., regardless of the atmospheric temperature inasmuch as the air is being withdrawn from the ground where its temperature is substantially constant. In contrast therewith, the conventional heat pump would have to pump against a heat head of about 105° F., that is, from 20° F. below zero assuming the outside temperature to be zero to 85° F., the desired temperature of the air. This heat head of 105° F. would be four times the heat head required by my system as above stated and would require about four times as much power.

When the system of Figure 5 is being used in the summer time and the temperature of the air withdrawn from the ground is 50° F. or less, the air may not require any treatment to condition it for human comfort and hence, the compressor 88 need not be operated. If, however, the temperature of the air withdrawn from the ground rises and its humidity becomes uncomfortably high, or if for some other special condition lower humidity is required, then the heat pump may be operated as above described to cool the air flowing through coil 83 and thereby to reduce the moisture content to the desired amount. Air passing through the coil 83 will usually be from 5° F. to 15° F. cooler than the outside air and thus will be less humid than the outside air with the result that the temperature differential over which the compressor operates will be correspondingly reduced with consequent reduction of power required.

In Figure 6 is shown the combination of a conventional heat pump with a modification of the system of Fig. 5. As in Fig. 5, air is withdrawn from the shaft and is passed through shaft cover 79 into a centrifugal pump 80 which is driven by motor 81 and which delivers the air into conduit or pipe 82. The air flowing in pipe 82 may pass through branch pipe 90, when the valve 91 therein is open, and into pipe 92 or, when the valve 91 is closed, may pass through the fluid carrying coil 93 and thence through pipe 94, when the valve therein is open, and thence into pipe 92, or the air leaving coil 93 may be discharged into the air through the open ended pipe 96.

Pipe 92 leads from the space 84, which is being air conditioned, to pump 97 which is driven by motor 98 and pipe 99 leads from pump 97 to space 84 and contains fluid coils 100. Pipe 92 has valves 101 and 102 disposed as indicated and for purposes presently to appear. Pipe 96 has a valve 103 therein.

The heat pump combined with the above described parts includes a motor 87 driving a compressor 88 which is connected through a valve 89 with coils 93 and 100. It will be understood that this heat pump is substantially the same in construction and operation as that shown in Fig. 5 and described in connection therewith.

The apparatus of Fig. 6 may be operated in various ways to obtain various results. If desired, valves 91 and 95 may be closed and the motor 81 de-energized so that no air is being withdrawn from the earth through shaft A. If, under these conditions, motor 98 is energized air will be circulated from space 84 through pipe 92, fan 97, pipe 99 and back to space 84. Fresh air may be drawn into pipe 92 by opening valve 101. If it is not desirable either to heat or cool the air being so circulated the compressor motor 87 may remain de-energized.

If it is desired to warm the air returning through pipe 99 to space 84 the compressor motor 87 is energized, the fluid in the heat pump system is compressed by the compressor 88 and the thus compressed fluid is caused to flow through oil 100 where some of the heat of the compressed fluid is transmitted to the air flowing past the coil and into space 84. In order that this fluid may be evaporated for subsequent compression, motor 81 is energized and air is withdrawn from the earth by fan 80 and is caused to flow past coil 93 thereby cooling the fluid, as has been described above in connection with Fig. 5. The air which flows past coil 93 may be discharged to the atmosphere through pipe 96, valve 103 being open.

If it is desired to cool the air which enters space 84 from pipe 99, valve 89 is moved so that the compressed fluid passes through coil 93 where it is cooled and then passes through coil 100 where it is evaporated by extracting heat from the air flowing in pipe 99. This action is similar to the corresponding action described above in connection with Fig. 5.

Under certain conditions it may be desirable to replace some of the air withdrawn from space 84 with air from the ground. This result may be accomplished by opening valve 101 to permit escape of some of the air coming from space 84 and delivering air from pipe 82 into pipe 92 through either pipe 90 or pipe 94. If there is no objection to the humidity in the air flowing in pipe 82 this air may be passed through pipe 90 by opening valve 91, the amount entering pipe 92 in this manner being sufficient to force some of the air withdrawn from space 84 to flow out through valve 101. If, however, the moisture in the air flowing in pipe 82 is more than is desired in space 84 the excess moisture may be removed by cooling the air as it flows past coil 93 and then bringing the cool dried air through pipe 94 into pipe 92. For this purpose, valve 95 is opened and valves 91 and 103 are closed.

It will be understood that if desired some of the air flowing from pipe 82 into pipe 92 may pass through pipe 90 and some may pass through pipe 94. In this manner a wide range of adjustments of the humidity in the air eventually returned to space 84 may be made. Moreover, the various heating and cooling effects obtainable with the heat pump of Fig. 5 as described in connection therewith may also be made with the system illustrated in Fig. 6. By varying the extent of opening of valves 101, 102 and 103 it is possible to vary the proportion of air from shaft A and air from space 84 which is delivered into that space.

While a mechanical type of heat pump has been shown and described, it is to be understood that any other suitable type may be used, for example, a conventional heat pump in which heat is supplied by an absorption type of refrigeration cycle.

It will be understood by those skilled in the art that many different types of construction may be used instead of the shaft construction of Figs. 1 to 4 inclusive and likewise that many variations in the illustrated tunnel construction may be made. The important consideration is that whatever construction is used should be such that air can freely enter it from the porous strata but that such air must travel a considerable distance in the porous strata before entering either the tunnel or the shaft.

Many other variations and modifications of the hereinabove described system, apparatus and method may be made but all such variations and modifications which are not patentably different from the disclosures herein are included and intended to be included within the scope of what is claimed.

What is claimed is:

1. Apparatus for air conditioning comprising a shaft extending down through a relatively non-porous surface layer into a porous strata in the ground below said layer, said shaft having openings leading thereinto from said strata below said surface layer, said surface layer having

prepared portions to facilitate the passage of air therethrough disposed so remote from said shaft that the temperatures of the strata and the air will become substantially equal while the air is flowing in said strata to said shaft, a seal for the shaft near its upper end to exclude above-ground air from entering the shaft without flowing for a substantial distance in said strata, a conduit from the upper end of said shaft to a space to be air conditioned, means at the upper end of said shaft to withdraw air therefrom and pass it through said conduit, and means in said conduit for changing the temperature and humidity of air flowing in said conduit.

2. Apparatus for air conditioning comprising a shaft extending down through a relatively non-porous surface layer into a porous strata in the ground below said layer, said shaft having openings leading thereinto from said strata below said surface layer, said surface layer having prepared portions to facilitate the passage of air therethrough disposed so remote from said shaft that the temperatures of the strata and the air will become substantially equal while the air is flowing in said strata to said shaft, a seal for the shaft near its upper end to exclude above-ground air from entering the shaft without flowing for a substantial distance in said strata, a conduit from the upper end of said shaft to a space to be air conditioned, means at the upper end of said shaft to withdraw air therefrom and pass it through said conduit, and a pipe leading from said space, and means to change the temperature and humidity of air flowing in said conduit, including a coil in said conduit, a second coil, and a compressor, the coils and compressors being connected in series with one another for the flow of a compressible fluid therethrough.

3. Apparatus for air conditioning comprising a shaft extending down through a relatively non-porous surface layer into a porous strata in the ground below said layer, said shaft having openings leading thereinto from said strata below said surface layer, said surface layer having prepared portions to facilitate the passage of air therethrough disposed so remote from said shaft that the temperatures of the strata and the air will become substantially equal while the air is flowing in said strata to said shaft, a seal for the shaft near its upper end to exclude above-ground air from entering the shaft without flowing for a substantial distance in said strata, means at the upper end of said shaft to withdraw air therefrom, a first conduit to conduct air into a space to be air conditioned, a pipe leading from said space to said conduit, a second conduit leading from said shaft to said first conduit and means to change the temperature and humidity of air flowing in said conduit including a coil in said conduit, a second coil in said pipe, and a compressor, the coils and compressor being connected in series with one another for the flow of a compressible fluid therethrough.

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