United States Patent

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[54] **MANUALLY ACTUATED HEAT PUMP**
8 Claims, 5 Drawing Figs.

[52] **U.S. Cl.** **62/467,** 62/56
[51] **Int. Cl.** **F25b**
[50] **Field of Search** 62/467

[56] **References Cited**

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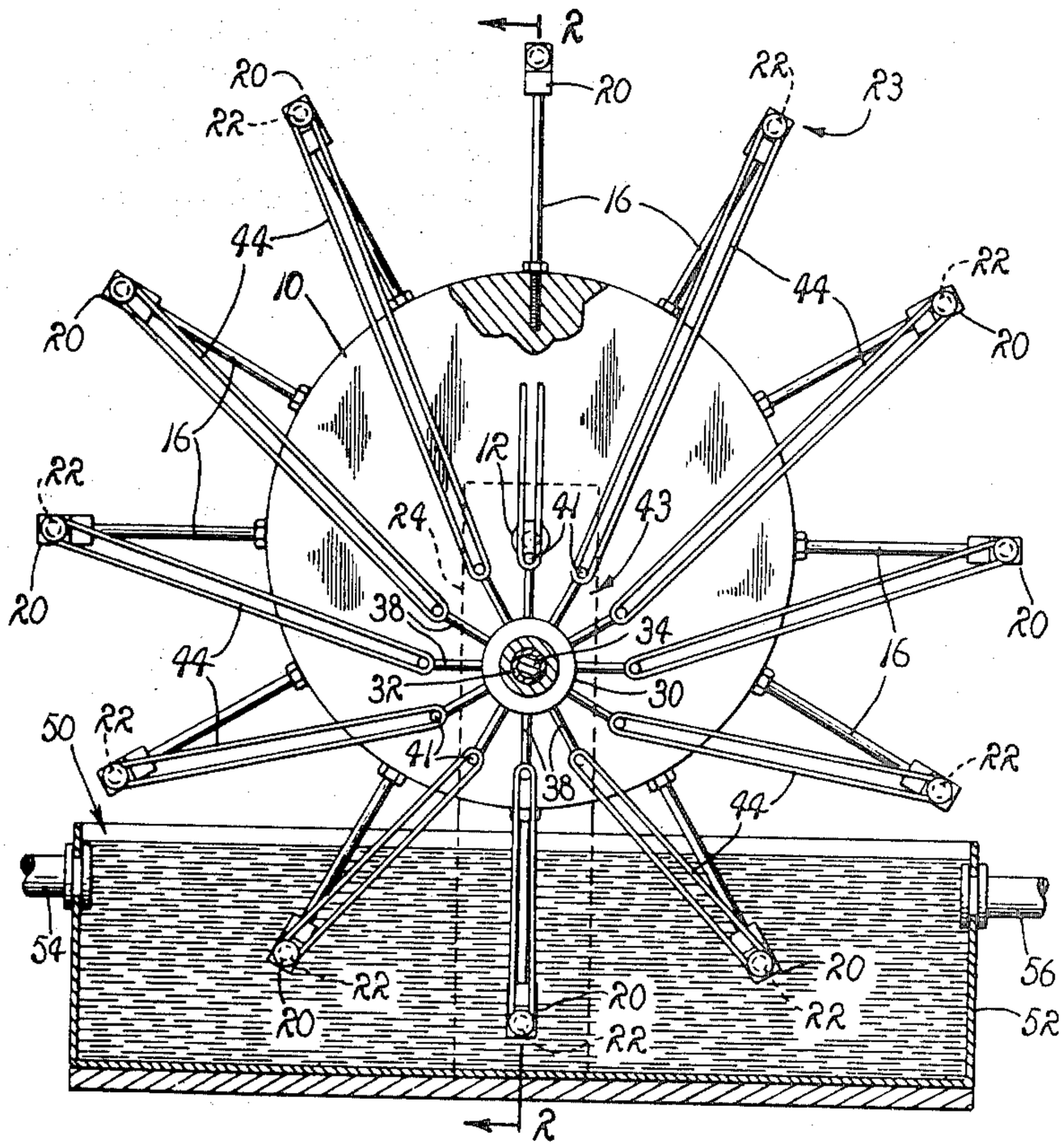
ABSTRACT: A manually actuated heat pump particularly suited for use as an auxiliary device in selectively warming and cooling an ambient medium, characterized by a pair of abaxially related, independently mounted rotatable hubs, interconnected through a plurality of elastomeric bands extending between the peripheries of the hubs and which, upon being rotated, achieve alternating elongation and contraction for the bands, whereby the bands cyclically are caused to experience a continuously reversing heat transfer process, in accordance with the principles of the so-called Joule effect in rubber, for selectively delivering and extracting heat energy from an ambient atmospheric medium, a feature of the pump being an employment of a fluid bath which receives therein the bands in selected states of elongation for effecting a heat transfer between the fluid of the bath and the bands whereby a selective preheating and precooling of the bands are achieved in a medium divorced from the ambient atmosphere for thus controlling the reversibility of the transfer of energy within the atmosphere.



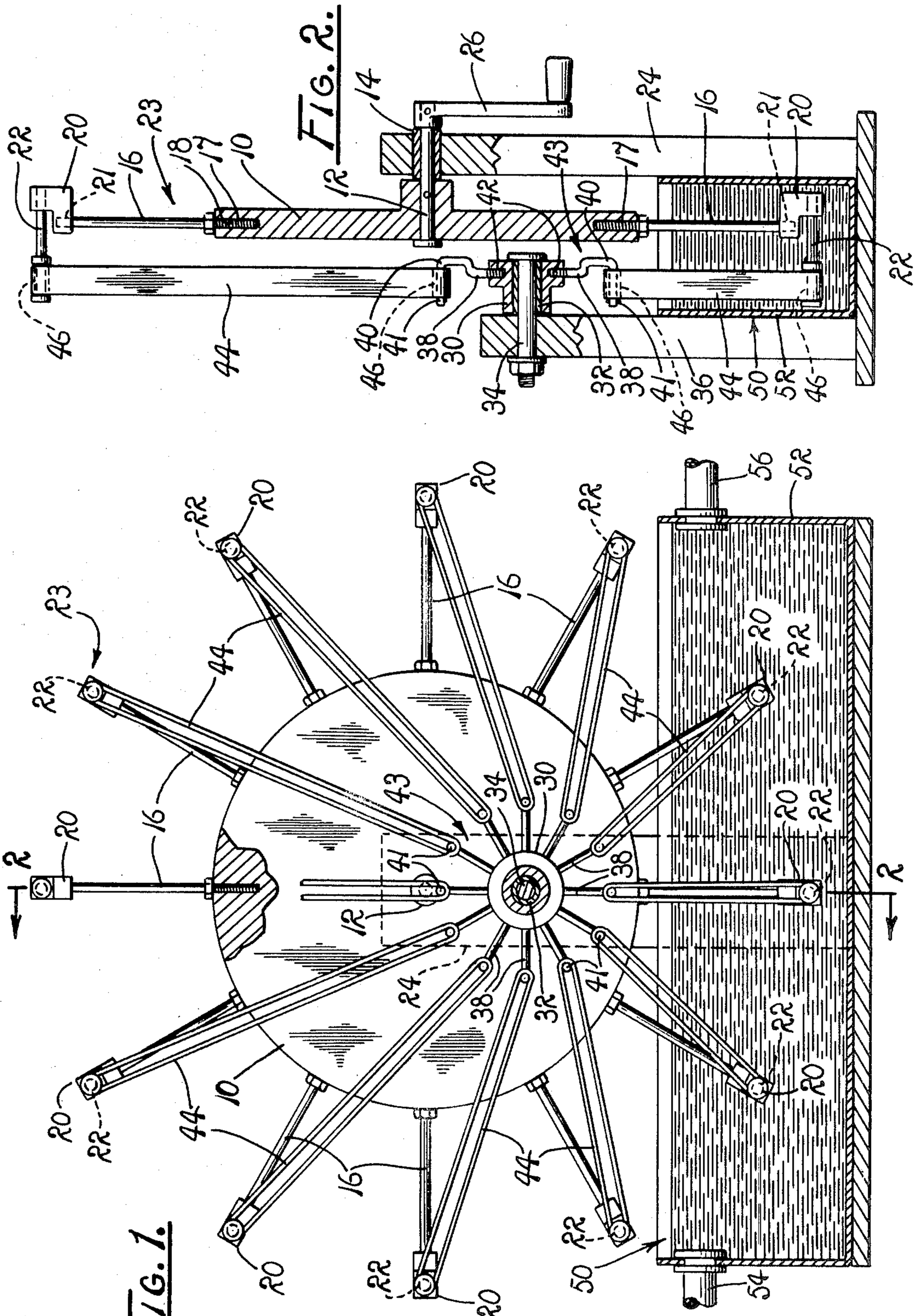


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FIG. 3.

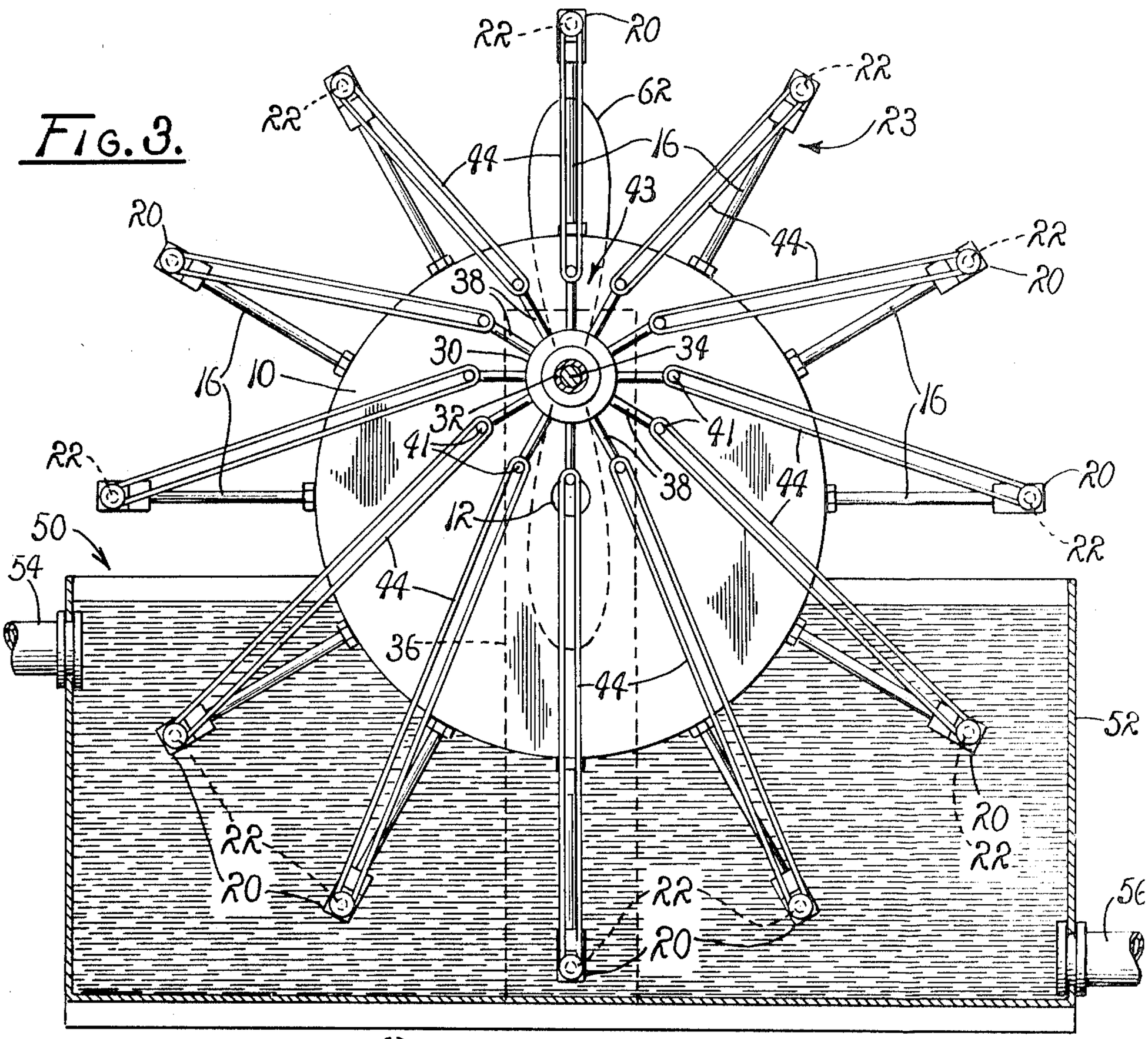


FIG. 5.

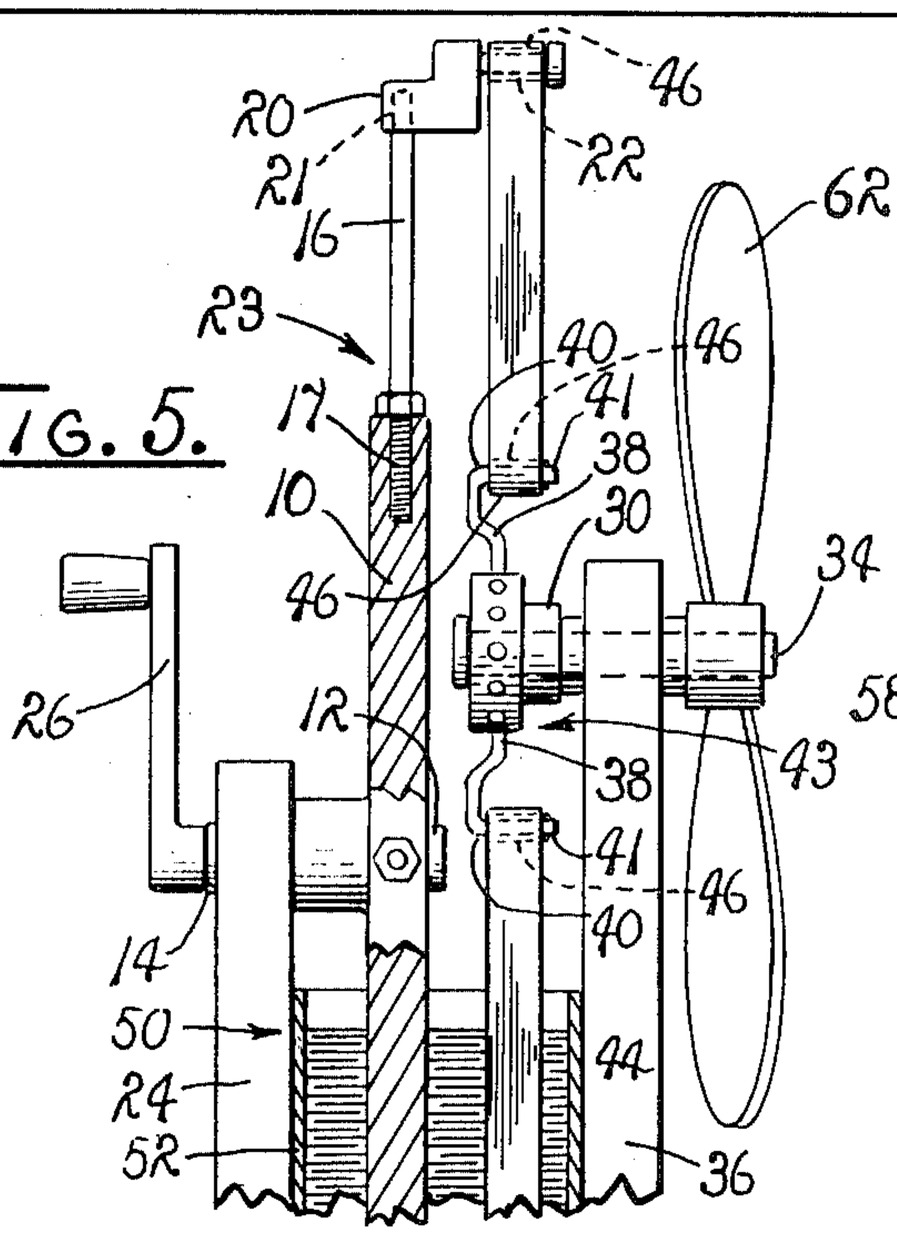
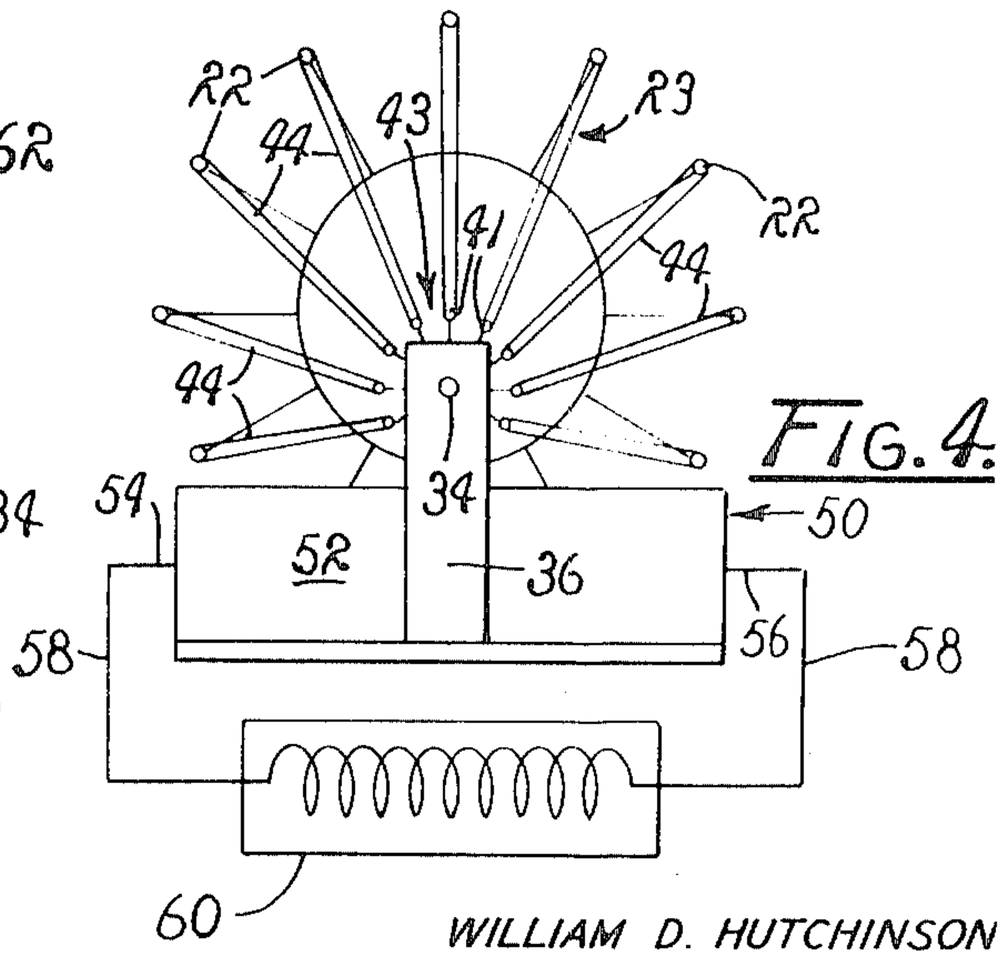


FIG. 4.



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MANUALLY ACTUATED HEAT PUMP

ORIGIN OF INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85–568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to heat pumps and more particularly to a simplified device particularly suited for use in mechanically converting the work output of a human operator directly into heat energy for controlling temperatures of selected mediums.

2. Description of the Prior Art

Numerous devices heretofore have been employed in heating and cooling certain mediums, particularly those of a fluid nature such as atmospheres and the like. Normally, a heating effect is achieved through a conversion of a given type of energy to heat energy while a cooling function is achieved through a conversion of heat energy to other types of energy. Manually operable devices, such as hand-powered, electrical generators and friction actuated devices heretofore employed in heating and cooling functions, have not fully satisfied the existing need for a simplified, lightweight and efficient manually operable energy conversion system. Where systems, such as hand-powered generators have been employed they have been found inefficient in converting mechanical energy to heat. Friction actuated systems experience rapid wear and an accelerated loss of efficiency. Consequently, previously employed manually actuated heat generating devices are not readily adaptable for use under emergency conditions of extensive duration, particularly in environments wherein they must compete with pay loads for space and weight priorities.

OBJECTS AND SUMMARY OF THE INVENTION

This invention overcomes many of the aforementioned difficulties through the use of a simplified and efficient device which makes particular use of the reversible energy conversion process accompanying a stretching of natural rubber, as well as certain other elastomeric materials, for efficiently converting energy manually expended by an operator directly to heat energy without progressing through a series of energy conversion steps.

Accordingly, an object of the instant invention is to provide an improved heat pump.

Another object is to provide a manually actuated heat pump for mechanically converting the energy output of the human operator directly into heat energy.

Another object is to provide an improved manually actuated heat pump which utilizes a plurality of bands of elastomeric material and a manually actuated structure for cyclically elongating the bands within their elastic limits, whereby the band alternately are caused to give up and subsequently absorb heat energy in achieving a reversing transfer of heat energy for affecting the temperature of an ambient medium.

These together with other objects and advantages will become more readily apparent by reference to the following description and claims in light of the accompanying drawings.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevation of a heat pump embodying the principles of the present invention.

FIG. 2 is an end elevation of the heat pump illustrated in FIG. 1.

FIG. 3 is a side elevation of a modification of the heat pump shown in FIGS. 1 and 2 wherein heat is extracted from the ambient atmosphere.

FIG. 4 is a schematic view of a system which may be utilized by the heat pump of the instant invention.

FIG. 5 is a fragmentary elevation of a modified form of the heat pump shown in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning now to FIG. 1, therein is illustrated a heat pump embodying the principles of the instant invention which includes a first hub 10 fixed to a drive shaft 12. This drive shaft, in turn, is supported for rotation by a suitable bearing sleeve 14, FIG. 2. As shown, the hub 10 is of a generally disc-shaped configuration and is formed of a rigid, lightweight material, such as aluminum. However, the hub may assume any suitable configuration and the specific material from which the hub 10 is fabricated varies, depending upon the intended use-environment of the heat pump. Furthermore, in order to reduce the weight of the heat pump, the hub may be provided with a plurality of weight-reducing openings or, if desired, may be fabricated from a plurality of radiating spokes and the like.

About the periphery of the hub 10 there is provided a plurality of radially extended arms 16. The arms include screw-threaded end portions 17 coupled with the hub 10 through mated screw-threaded sockets 18. At the distal end of each of the arms 16 there is provided a coupling 20 which operatively supports an orthogonally disposed and cantilevered support pin 22. The couplings 20 are joined to the distal ends of the arms 16, through any suitable means including screw-threaded couplings 21, and serve to support the pins 22 in parallelism with the shaft 12. The pins 22, together with the arms 16 and hub 10, form a structural web 23 of a first diameter.

In practice, the hub 10 is supported by a suitable beam 24 which serves to support the shaft 12 and hub 10 in a selected operable orientation, whereby the hub may be driven in rotation. To the distal end of the shaft 12 there is secured a manually operable crank arm 26, of a suitable configuration adapted for manual actuation. The crank arm serves to impart a selected rate of rotation to the shaft 12, as it is manipulated for thus driving the hub 10 in displacement about its axis of rotation.

Arranged in spaced parallelism with the hub 10, there is a second rotatable hub 30, also of a generally disc-shaped configuration. The hub 30 is supported for rotation by a concentrically associated bearing sleeve 32 and a supporting axle 34. The axle extends through the sleeve and is concentrically coupled with the hub, whereby the hub is mounted to be freely rotated as it is retained in a parallel and abaxial relationship with the drive shaft 12. A rigid support 36, of a beamlike configuration similar to that of the beam 24, receives the sleeve and axle in a manner such that the support 36 rigidly mounts the axle 34 and supports the hub 30 in operative association with the hub 10.

About the periphery of the hub 30 there is provided a plurality of radially extended arms 38, each having a laterally extended hook 40 formed at its distal end. Each hook includes an end portion 41 arranged in parallelism with the pins 22. The arms 38 are coupled with the hub 30 through a suitable screw-threaded coupling 42, of a type quite similar to that employed in joining the arms 16 with hub 10. Hence, the hub 30, arms 38 and hooks 40 are interconnected, in a manner quite similar to that in which the hub 10, arms 16 and pins 22 are interconnected and form a second structural web 43 of a second diameter which is substantially shorter than that of the first structural web, as best illustrated in FIG. 2.

Between the distal ends of the support pins 22 of the web 23 and the extended hooks 40 of the web 43, there are extended bands 44 formed of a suitable elastomeric material, such as natural rubber, for example. However, the material employed in the bands 44 may be varied as desired so long as the characteristics of the material conform to characteristics consistent with materials which, upon being stretched, tend to give up heat, and upon contraction tend to absorb heat. As illustrated, the bands 44 are of an annular configuration and are received by bearing sleeves 46 seated on parallel portions of the pins 22 and hooks 40, whereby the effective life of the device may be prolonged. However, it should readily be apparent that vari-

ous other types of connecting devices can be employed in coupling the bands **44** with the webs, as dictated by the physical shape, size and resistance of the bands being employed.

The webs **23** and **43** are related, diametrically, in a manner such that the bands **44** are extended inwardly from the distal end of the arms **16** toward the distal ends of the arms **38** at all positions for the hub **10**, as it is rotated by a manipulation of the crank arm **26**. However, due to the abaxial relationship of the hubs **10** and **30**, the bands **44** alternately are tensioned and relaxed for thus causing the bands to be stretched and contracted as they are advanced along a circular path. A maximum stretching condition is established for each of the bands **44** as it is caused to extend across the center of the web **23**, while a maximized contracting condition is established as the axle **34** is disposed between the associated coupling **20** and the drive shaft **12**, as best illustrated in FIG. **1**.

Therefore, it should be appreciated that as the hub **10** is driven through 360° of rotation, the bands **44** are advanced and stretched, from a contracted state wherein the axle **34** is disposed between the associated coupling **20** and the drive shaft **12**, to a fully stretched state, wherein the drive shaft **12** is disposed between the coupling **20** and the axle **34**, and thence back to a contracted state. During stretching, each of the bands gives off heat, due to latent heat of crystallization, and as each band is permitted to contract, it absorbs heat from its environment. Consequently, where the heat pump is being employed to heat an ambient medium, such as ambient atmosphere, a stretching of the bands is achieved in the atmosphere. However, in order to preclude an absorption of the heat energy from the heated atmosphere, as the bands are relaxed, a fluid bath **50** is arranged within the path of the rotating bands **44** and serves to receive and immerse the bands as contraction thereof is accommodated as the bands are relaxed.

In practice, the fluid bath **50** is a water-filled container **52** through which a flow of warm water is circulated by way of an inlet port **54** and an outlet port **56**, As best illustrated in FIG. **4**, the bath **50** is coupled through a suitable closed circuit, including conduits **58**, with a suitable source of heat energy **60** which delivers heat to the water as a flow is established therethrough. The source **60** is of any suitable type, such as a solarized device which employs the energy of the sun's rays. Where convenient, other sources of heat, such as the water jacket of an internal combustion engine, can be employed in maintaining the bath at suitable temperatures. In any event, it is to be understood that as the webs **23** and **43** are driven in rotation, heat energy is delivered to the bands, from the water bath, as the bands are contracted, and subsequently is delivered to the ambient medium as the bands are stretched within their elastic limits. It is important to note that the heat energy delivered to the bath is utilized merely to maintain a selected temperature for the bath, since the energy given up to the atmosphere is derived directly from the stretched bands **44**. Furthermore, if the bands are cooled below room temperature, while in a stretched condition, they tend to remain deformed until their temperature is elevated within the bath, therefore contraction is enhanced in the presence of the warm temperature of the bath.

Under certain conditions, it is desirable to cool rather than heat a given atmospheric medium. This is achieved simply by reversing the positions of the web **43** of the hub **30**, relative to the fluid bath **50** so that a maximum stretching of the bands is achieved within the fluid bath **50**, while contraction of the bands **44** is accommodated within the atmospheric medium. Such relative positioning of the web is best illustrated in FIG. **3**.

Therefore, in instances where the heat pump is to be employed in a cooling operation, the axle **34** of the hub **30** rigidly is supported in a displaced relationship with the fluid bath **50** a distance sufficient to achieve a stretching of the bands **44** within the fluid of the bath. In such instances, instead of being connected with a source of heat energy **60**, the bath **50** is coupled with a suitable heat sink, which is cooled in any convenient manner, such as by evaporation, for example. Therefore, it is to be understood that as the web **23** of the hub **10** is driven in rotation, contraction of the bands **44** is achieved within the atomospheric medium, while the desired stretching thereof is achieved within the bath **50** so that a transference of heat energy from the atmospheric medium to the bands **44** is achieved as the bands are relaxed and permitted to contract.

As shown in FIG. **5**, where desired, an impeller **62** also may be provided and incorporated in the structure of the heat pump for establishing a flow of atmospheric medium across the bands **44**. While various devices may be employed for driving the impeller, it has been determined practical to couple the impeller with either the drive shaft **12** or, as shown in FIG. **5**, with the axle **34**, in order that the impeller be driven in rotation as a rate of rotation is imparted to the hubs **10** and **30**.

OPERATION

It is believed that in view of the foregoing description, the operation of the device will be readily understood, however, it will be briefly reviewed at this point. With the webs **23** and **43** of the heat pump being arranged adjacent to a fluid bath **50**, in the manner heretofore described, the device may be actuated simply by manipulating the crank arm **26**. As the crank arm is actuated, the hub **10** is driven in rotation, through the drive shaft **12**. As the hub **10** is advance in rotation through a series of angular positions, defining 360° of rotation. The bands **44** are successively stretched and then permitted to contract.

During the stretching of the bands the heat evolved is directly proportional to the mechanical work input. Conversely, as the bands are contracted, a cooling of the bands is achieved in a manner such that heat energy equal to the discharged quantity of energy is returned to the bands. Where the device is being employed to heat an ambient atmospheric medium, the major portion of contraction for the bands is achieved within the heated fluid of the fluid bath **50**, as illustrated in FIG. **1**. Conversely, where the device is being employed to extract heat from ambient atmospheric medium, the bands are stretched within the cooling fluid of the bath **50**, while being contracted in the atmospheric medium, so that heat is extracted from the medium as the bands are relaxed and permitted to contract.

While the device embodying the instant invention has been illustrated as employing a fluid bath coupled within a circulating system, it should readily be apparent that the fluid of the bath may be chemically or otherwise treated to achieve either a heating or cooling effect therewithin without employing a water circulating system. For example, if it is desired that the ambient medium be heated, then a fluid bath **50** could be filled with a suitable chemically active fluid bath **50** could be filled with a suitable chemically active fluid material whereby heating may be achieved through chemical reactions. Likewise, should the heat pump be employed for extracting heat from the ambient medium, the fluid bath could be filled with a fluid readily susceptible to evaporation, whereby cooling may be achieved through evaporation. Further, the fluid bath may be supplanted by any environmental factor capable of supplying or dissipating heat as the function to be performed requires.

In view of the foregoing, it should readily be apparent that the instant invention provides a simplified heat pump, which is particularly adapted to be employed for heating or cooling a given body of ambient medium, such as an atmosphere confined within the cabin of a space craft, by converting work input of a human operator directly to heat energy generated through a cyclic stretching and contracting of elastomeric bands.

Although the invention has been herein shown and described in what is conceived to be the most practical and preferred embodiment, it is recognized that departures may be made therefrom within the scope of the invention.

What I claim is:

1. A manually actuated heat pump comprising:

A. a pair of webs, each having a substantially disc-shaped configuration and a mutually independent diameter;

B. means independently supporting said webs for rotation in a substantially parallel and abaxial relationship;

C. A plurality of bands of elastomeric material interconnecting the peripheries of said webs; and

D. manually operable drive means coupled with said webs adapted to be actuated for imparting a rate of rotation to said webs, whereby the ands of elastomeric material are caused to traverse a circular path and alternately are elongated and contracted,

2. The heat pump of claim **1** further comprising heat transfer means operatively associated with said pump and adapted to deliver heat energy to said bands preparatory to their being elongated.

3. The heat pump of claim **2** wherein said heat transfer means includes a fluid bath disposed within the path of the bands.

4. The heat pump of claim **1** further comprising heat transfer means for receiving heat energy from said bands preparatory to their being contracted.

5. The heat pump of claim **4** wherein the heat transfer means comprises a fluid bath.

6. A manually actuated heat pump comprising:

A. means defining a first hub;

B. means rotatably supporting said first hub for rotation about a first given axis of rotation;

C. a plurality of radially extended arms extending from said hub defining a first web of a first diameter;

D. a second hub;

E. means supporting said second hub for rotation about a second given axis of rotation abaxially related to said first axis of rotation;

F. a plurality of radially extended arms extending from said second hub defining a second web of a second diameter substantially less than the first diameter of said first web;

G. a plurality of bands of elastomeric material extended from the distal ends of the arms of the first web to the distal ends of the arms of the second web;

H. manually actuatably drive means operatively coupled with said first web and adapted to be manually actuated for imparting a selected rate of rotation to the web, whereby the bands of elastomeric material are advanced along a circular path and alternately and sequentially are stretched within their elastic limits and permitted to contract as they are advanced; and

I. a fluid bath including therewithin a fluid disposed in the path of said bands and adapted to receive the bands as they are advanced, whereby the bands are caused to be immersed and a transfer of heat achieved between said bands and the fluid.

7. The heat pump of claim **6** wherein said fluid bath is disposed within the path of the bands in a manner such that the bands are permitted to contract within the fluid bath.

8. the heat pump of claim **7** wherein a fluid bath is disposed within the path of the bands in a manner such that the bands are elongated as they are immersed within the fluid bath.