

April 19, 1938.

N. L. MERCUR

2,114,567

THERMOSTATIC PUMP

Original Filed June 21, 1935

2 Sheets-Sheet 1

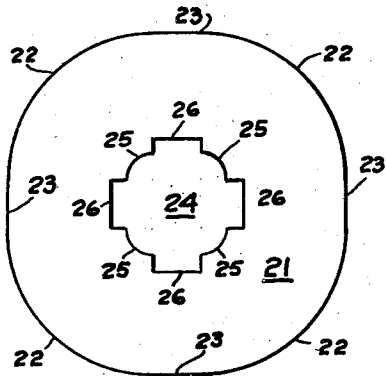


Fig. 1

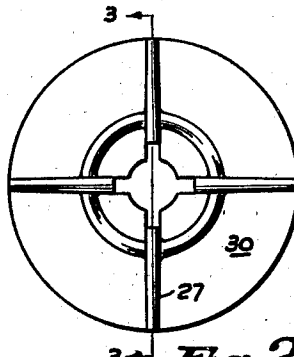


Fig. 2

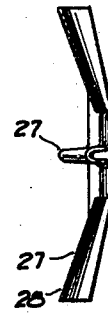


Fig. 3

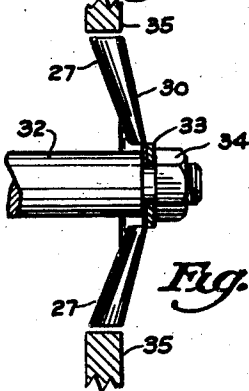


Fig. 4

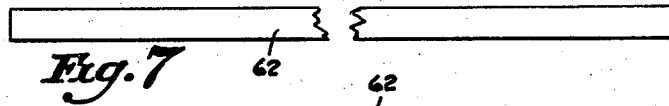


Fig. 7

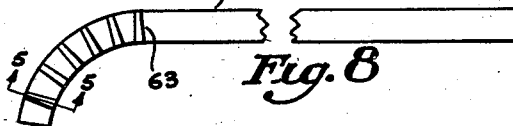


Fig. 8



Fig. 9



Fig. 5

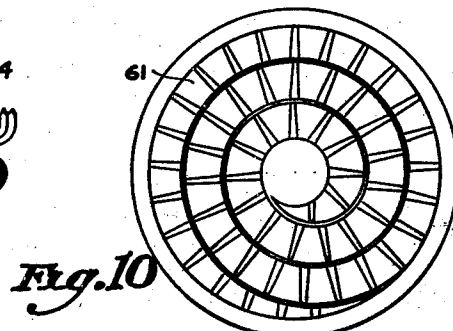


Fig. 10

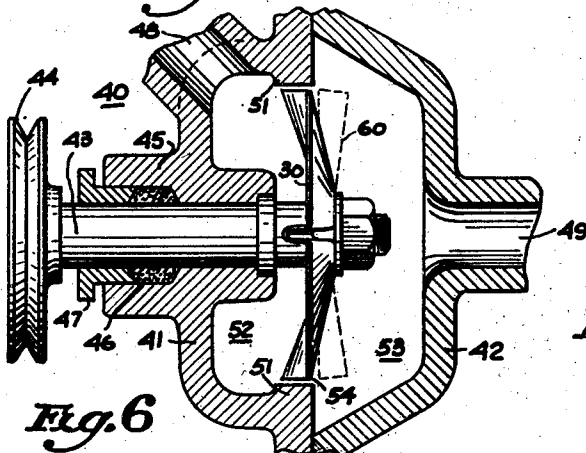


Fig. 6

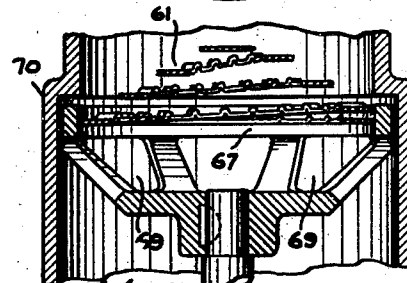


Fig. 11

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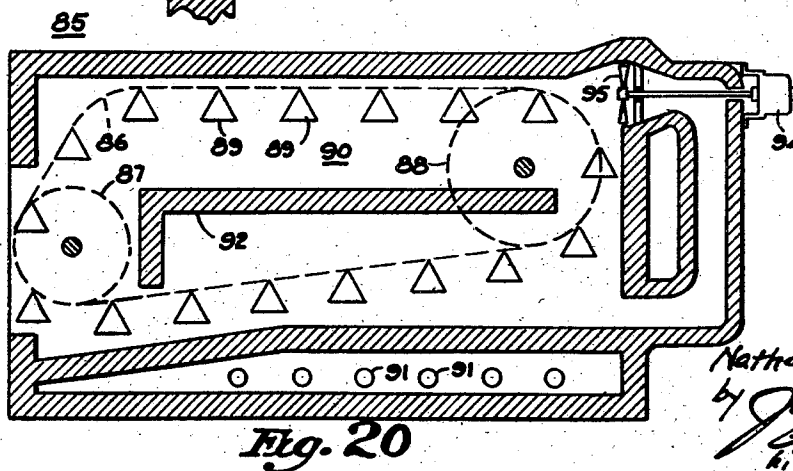
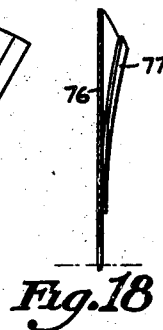
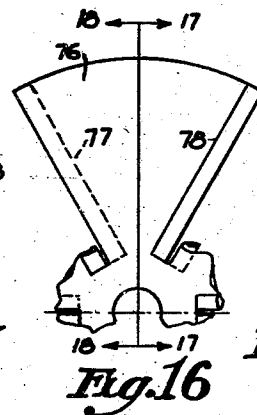
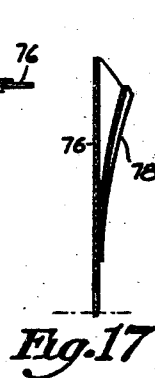
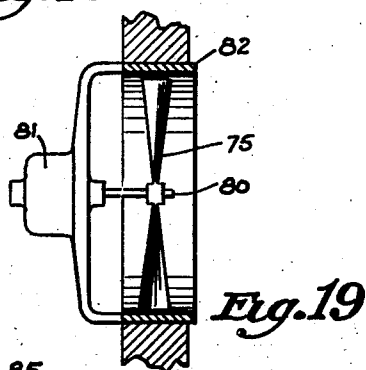
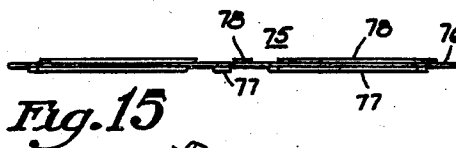
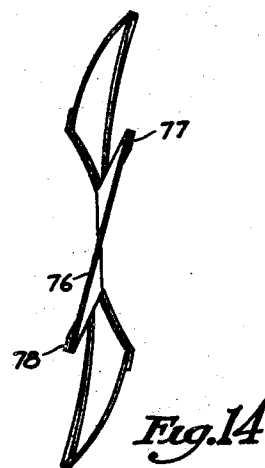
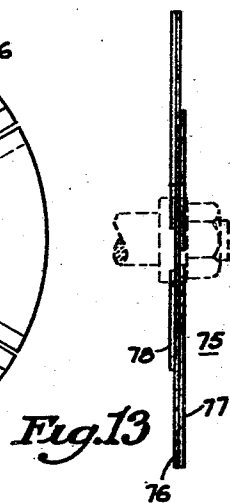
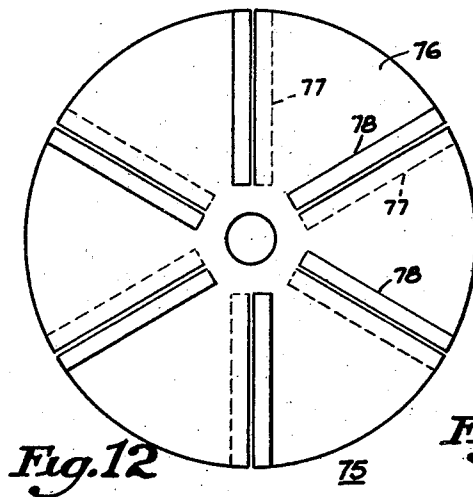
N. L. MERCUR

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THERMOSTATIC PUMP

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UNITED STATES PATENT OFFICE

2,114,567

THERMOSTATIC PUMP

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Application June 21, 1935, Serial No. 27,696

Renewed September 21, 1937

15 Claims. (Cl. 103—97)

This invention relates to thermostatic pumps and particularly to pumps for controlling the movement of a heating or cooling medium.

One object of my invention is to provide a thermostatic pump embodying a temperature responsive element such as bi-metal, as the impeller, or as part of the impeller, with the impeller so constructed as to change its form in response to changes in temperature of the medium to be moved thereby, so that the efficiency or power-transmitting ability of the thermostatic element as a pump will vary according to the amount of work which the pump may be called upon to do.

In illustrating my invention I have shown three bi-metal elements of different construction to function as impellers, and also arranged to modify their respective shapes to vary their pumping efficiency according to the temperature of the medium with which they are to work.

In all three modifications of the thermostatic impellers embodying my invention, a provision is made for a certain amount of free leakage of bypassing of the controlled medium at all temperatures, in order that the impellers may be affected by the average or mean temperature of the medium to be controlled.

I have illustrated the three modifications, briefly referred to, in the accompanying drawings, in which—

Figure 1 is a plan view of a stamping of thermostatic metal as stamped from a flat plate before it is formed to constitute an impeller;

Figure 2 is a plan view of the impeller disc after it is formed from the stamping of Figure 1;

Figure 3 is a vertical sectional view of the impeller taken along the lines 3—3 of the view shown in Figure 2;

Figure 4 is a side view, partially in elevation and partially in section, of the impeller disc of Figure 3, shown mounted upon a rotatable drive shaft;

Figure 5 is an enlarged perspective view, partially in elevation and partially in section, of a radial rib or corrugation formed in the disc shown in Figure 2;

Figure 6 is a side view, partially in section and partially in elevation, of a pump assembly employing a bi-metal disc impeller of the form illustrated in Figure 2;

Figure 7 is a plan view of a strip of bi-metal from which a spiral impeller is to be formed for the second modification referred to above;

Figure 8 is a similar view of the strip of Figure 7, showing the manner in which one end of the strip is curved by suitably crimping or cor-

rugating the strip by transverse corrugations along the length of the strip;

Figure 9 is a perspective front view of one of the corrugations formed in the strip in Figure 8, and illustrates the manner in which the corrugation is tapered or inclined to establish a sharper, smaller curvature on one edge of the strip than on the other;

Figure 10 is a plan view of a spiral involute formed from the strip in Figure 8;

Figure 11 is a sectional view through a pump assembly provided with a bi-metal spiral formed as shown in Figure 10, with the spiral extended to constitute an involute screw;

Figure 12 is a plan view of the disc subdivided into vanes or segments with bi-metal strips secured to the edges of each vane on opposite sides thereof;

Figure 13 is a vertical edge view of the disc shown in Figure 12;

Figure 14 is a side view of the disc of Figure 12 illustrating the positions assumed by three vanes of the disc in response to the flexing of the bi-metal strips when the temperature of the bi-metal strips is changed from normal;

Figure 15 is a lower edge view of the disc of Figure 12;

Figure 16 is a front elevational view of one vane of the disc of Figure 12;

Figure 17 is a vertical section of the disc in its twisted position taken along the line 17—17 in Figure 16;

Figure 18 is a similar vertical sectional view of the vane in Figure 16 taken along the line 18—18 in Figure 16;

Figure 19 illustrates an assembly of the disc of Figure 12 on a motor shaft and within a housing to function as a motor operated blower; and

Figure 20 illustrates schematically an application of the motor driven blower of Figure 19 to a bread oven in which the temperature is to be maintained uniformly.

As illustrated in Figure 1, a bi-metal element 21 is stamped from a sheet of bi-metal, substantially in the form illustrated, with corners of quarter-circle shape and flat connecting side portions 23 between the adjacent quarter circle corner portions. The stamped plate 21 is provided with a central opening 24, the edges of which are shaped or contoured in accordance with the corresponding outer edges, to embody four quarter circle portions 25 concentric with the four outer portions 22, and four connecting straight edges 26 parallel to the outer edges of the portions between the corners.

The bi-metal plate 21 of Figure 1 is then formed to constitute an impeller disc 30, as shown in Figure 2, in which the outer periphery is substantially in a circle. The portions 23 between the quarter-circle corners 22 are bent laterally upward from the normal plane of the disc to constitute four ribs or corrugations 27 extending radially inward from the periphery of the disc. In order to impart a slight cupping to the disc, the corrugations or ribs 27 are inclined or tapered to be of slightly greater height, and therefore utilize more metal, adjacent the outer end of the rib near the periphery of the disc, as is illustrated in Figure 3. The purpose of such cupping is to maintain the shape of the disc substantially until a predetermined temperature is attained by the disc, at which time the accumulated stress will be sufficient to overcome the cupping of the disc and cause the disc to snap over to a reversely cupped position with respect to the normal position that is shown in Figure 3.

In Figure 4, the disc 30 is illustrated in its normal condition mounted upon a rotatable drive shaft 32 and secured in position on the drive shaft by means of a suitable lock washer 33 and nut 34. In the normal cold position of the disc, as illustrated in Figure 4, the surrounding wall 35 within which the pump disc is normally disposed should be directly opposite the peripheral edges of the formed disc 30 and the ribs 27.

In Figure 5, a rib is illustrated to show the manner in which the ribs are gradually tapered from the relatively low portion of the rib adjacent the center of the disc to the higher portion of the rib adjacent the periphery of the rib.

In Figure 6 I have illustrated a pump structure 40, consisting of an intake housing 41, an outlet housing 42, and a drive shaft 43 having a driving pulley 44 on its outer end and a bi-metal impeller disc 30 mounted on the inner end. The shaft 43 extends through a bearing 45 on the intake housing 41. A suitable packing medium 46 and a retaining gland 47 are schematically illustrated.

The intake housing 41 is provided with an intake port 48, and the outlet housing 42 is provided with outlet port 49. The inlet housing 41 is shown provided with a partition wall 51 on the inner edge of the inlet housing 41 between an inlet chamber 52 in the inlet housing 41 and an outlet chamber 53 in the outlet housing 42. The pump impeller and shaft are mounted so that the periphery of the impeller disc 30 will be adjacent to the surface of the partition wall 51, and the relative dimensions of the orifice in the wall 51 are such that a small space 54 is left between the wall and the disc to permit a small amount of leakage of the cooling water past the disc.

So long as the temperature of the cooling water is below a predetermined value, the thermostatic disc impeller 30 will remain in the position illustrated in full line in Figure 6, where the periphery of the disc and the outer edges of the ribs 27 will be opposite and adjacent the inner surface of the wall 51. When the disc is rotated while in such position, the disc merely rotates within the water in the pump housing, without building up pressure to force the water into the outlet chamber.

When the temperature of the water and of the disc increases to a predetermined value, at which the action of the pump is desired for the purpose of increasing the flow of the cooling water, the disc flexes and snaps over to the cupped position in the opposite direction as illustrated by

the broken lines 60 in Figure 6. The disc when rotating in such position receives the water from the intake chamber 52 by means of the radial ribs 27, and centrifuges the water into the outlet chamber, thus building up a pressure in the outlet chamber which serves to move the water under pressure through the outlet port 49 and through the circulating system to which the pump is connected.

So long as the temperature of the water circulated by the pump continues above the predetermined value for which the operation of the pump disc is adjusted, the disc will remain in its oppositely cupped position where it will circulate the cooling fluid under pressure. When the temperature of the cooling fluid diminishes to or below the temperature for which the pump disc is adjusted, the disc will snap back to its normal operating position at which only a relatively small amount of free circulation of the cooling fluid is permitted.

By means of the construction which is illustrated in Figure 6, the thermostatic disc which serves as the pumping element, adjusts or changes its position according to the temperature of the cooling fluid and does only so much work as is necessary to establish the best temperature in the cooling fluid for proper working conditions of the engine.

In Figures 7 to 10, inclusive, I have illustrated in simple fashion, the evolution or development of the thermostatic spiral member 61 which is employed as a water propelling screw in the pump shown in Figure 11. The spiral member 61 which serves as the water propelling member is made from a narrow strip of bi-metal 62, as illustrated in Figure 7, which is corrugated or crimped as shown in Figure 8 to embody spaced tapered corrugations 63 to introduce the proper and required amount of curvature in the strip to form the ultimate spiral 61 as illustrated in Figures 10 and 11.

As shown in Figure 9, the corrugations 63 are tapered, being higher at the inner edge 64 than at the outer edge 65, in order to absorb the greater amount of metal that is available on the smaller arc formed by the inner edge of the strip where it is curved. It will be obvious that the sizes and spacing of the corrugations will vary according to the amount of curvature required to make the strip assume the proper shape to form the spiral. By reason of the formation of the spiral in the manner illustrated, undesirable curving or concaving is prevented between opposite edges of any part of the strip. If the spiral were cut from a flat plate, each convolution so formed would curve or form a concavity from edge to edge which would prevent proper movement of the spiral to form a screw as illustrated in Figure 11. By providing the same amount of metal on both edges of each convolution, however, by the method of forming that is illustrated, any tendency of each convolution to bend or buckle transversely of the convolution is obviated.

As illustrated in Figure 11, the bi-metal spiral 61 is supported at its periphery by a ring spider 67, which is suitably keyed to a drive shaft 68. The spider is provided with several openings 69 through which the cooling water may readily pass when the spiral 61, expanded axially to form a screw, propels the water. An enclosing conduit 70 surrounds the spider assembly and the spacing between the housing and the assembly determines the normal leakage permitted.

When the temperature of the water is below

proper desired temperature, the bi-metal spiral is substantially flat and closed, and only a nominal quantity of water passes through the cooling system to which the conduit 70 is connected. Under such conditions the spider and the bi-metal spiral merely rotate in the cooling medium. As the temperature of the cooling medium increases, however, to or beyond a desired maximum value, the spiral gradually opens up axially to form a screw for propelling the cooling medium through the conduit and the cooling system connected to the conduit.

The spiral thus gradually adapts its shape according to the temperature of the medium which is being propelled thereby, and, thus, according to the amount of work it is called upon to do.

In the remaining figures of the drawings, I have illustrated a fan-type propelling device in which a disc 75 is separated into several blades or vanes 76 that are individually controlled by two co-operating bi-metal elements 77 and 78 to bend the blades or vanes to compel them to assume a shape according to the temperature of the medium being propelled thereby as measured by the bi-metal strips 77 and 78. The disc 75 may be made of any suitable medium having sufficient resiliency or pliability to permit its form or shape to be changed or modified by the action of the thermostatic strips 77 and 78. It may be made of thin metal or of a fabric. In either case, of course, it is desirable that the disc be in substantial dynamic balance.

As illustrated in the several detailed figures, the bi-metal strips 77 and 78 are mounted on opposite sides of each vane on the opposite edges thereof, in such manner as to be oppositely effective in shaping the vane upon which they are to be mounted. For example, as illustrated in Figure 14, the middle vane 76 is acted upon by the two bi-metal elements 77 and 78 to move the opposite edges of the vane in opposite directions. Each of the other two vanes that are shown are illustrated as being correspondingly affected by their respectively associated bi-metal strips. Figures 16, 17 and 18 serve further to illustrate the manner in which the bi-metal strips function to change the shape of a vane. In one predetermined normal temperature, the disc may assume a substantially flat shape, with all of the vanes in one plane or substantially so, as illustrated in Figure 13. When the temperature rises above such predetermined value, the vanes will be moved to one position as shown in Figure 14, and, when the disc is rotated in one direction, the vanes will serve to propel the air or other medium away from the blades in one direction. When the temperature diminishes below such predetermined normal, the vanes will be caused to assume an opposite pitch with respect to the normal position, and, when the disc is rotated in the same direction, the vanes will now move the medium in the opposite direction.

In Figure 19 the disc is illustrated as mounted upon a shaft 80 of a motor 81 to function as a blower, being supported to revolve in an encircling ring 82 that serves as the limiting conduit through which the disc may propel the air or other medium that is to be controlled.

In Figure 20 is illustrated one application in which such a blower or pump may be applied, to utilize the temperature-responsive character of the blades. Such responsiveness adjusts the blades so that they will function according to the requirements of the system in which they are employed.

I have schematically illustrated, in Figure 20, a bake oven 85 in which a driving chain 86 is suitably propelled by two wheels 87 and 88 to carry a series of dough supporting trays 89 through a heated zone 90. The heat is supplied to the oven through a series of burners 91 schematically illustrated at the base of the oven. The space in the oven is suitably divided into two compartments by a horizontal partition 92 in order that the heated air inside the oven may be circulated in a closed path which corresponds to the locus of travel of the dough supporting trays 89.

The heated air in the oven is circulated by means of a motor driven fan 94 provided with thermostatically self-adjustable blades 95 of the character described. The blower 94 may be arranged to function continuously, while the oven is operating. When the temperature at the top of the oven tends to become too hot, the vanes of the disc 95 adjust their positions correspondingly and thus control the amount of circulation of the air within the oven, so that the proper average temperature may be maintained throughout the path of travel of the trays that carry the dough.

I have thus illustrated in the accompanying drawings and in the foregoing description, three modifications or structures embodying the principle of my invention, according to which the blades or vanes of the impeller thermostatically respond to the temperature of the transferred medium so that the medium may be controlled to the extent that may be necessary to maintain a predetermined temperature.

My invention is therefore not limited to the specific details that are illustrated, since they obviously may be modified in structure and design without departing from the spirit and scope of the invention as set forth in the appended claims.

I claim as my invention:

1. A thermostatic pump comprising a rotatable drive shaft and a bi-metal disc supported thereon to function as an impeller and formed to change its position in response to the temperature of the medium moved thereby, the bi-metal disc being formed to be relatively concave in one direction below a certain temperature, and to change position to be concave in the opposite direction above said temperature, the concave surface of the disc at the lower temperature being provided with radial ribs that serve as pumping impellers in both positions of the disc.

2. A thermostatic pump comprising a drive shaft and a bi-metal member supported thereon to function as an impeller, and formed to centrifuge a medium to be moved thereby, to move the medium at a rate depending upon the temperature of the medium, the bi-metal member, being a disc, being formed to be relatively concave in one direction below a certain temperature, and to change position to be concave in the opposite direction above said temperature, the concave surface of the disc at the lower temperature being provided with radial ribs that serve as pumping impellers in both positions of the disc.

3. A thermostatic pump comprising a housing having an inlet port and an outlet port, with a chamber adjacent each port and a wall with an orifice between the two chambers, a rotatable drive shaft supported to extend to or through the orifice between the two chambers, and a bi-metal disc on the shaft to be rotated thereby, the disc normally filling the space within the orifice at one temperature, and formed to as-

sume such a different position at a predetermined different temperature, that the disc when rotated will then receive the medium from the inlet chamber and centrifuge it into the outlet chamber.

4. A thermostatic pump comprising a motor, and an impeller driven thereby, the impeller being a cupped bi-metal disc capable of changing its shape or form from concave in one direction to concave in the opposite direction according to the temperature of the medium propelled thereby, and a group of radial bars on the disc to serve as impellers.

5. A thermostatic pump comprising a rotatable drive shaft and a thermally responsive impeller mounted on the shaft, and operable automatically to change its inclination to the axis according to the temperature of a medium propelled by the pump.

6. A thermostatic pump comprising a housing having an intake port and an outlet port, an intake chamber and an outlet chamber, and a self-adjusting thermally-responsive disc impeller so disposed and of such shape as to rotate freely in the medium transferred by the pump, while the medium is below a predetermined temperature, and adapted to change position and shape, when the medium exceeds such temperature, in order to propel the medium into the outlet chamber and thence to the outlet port, the disc embodying radial vanes which are positioned to propel the medium into the outlet chamber only when the disc changes shape in response to the predetermined temperature.

7. A thermostatic pump comprising a rotatable drive shaft, a thermostatic disc mounted thereon to rotate therewith, a housing enclosing the disc and providing an inlet chamber on one side of the disc and an outlet chamber on the other side of the disc, the disc embodying radial vanes and functioning to rotate freely in one position in the medium below a predetermined temperature and changing position above said temperature to rotate the radial vanes to force the medium into the outlet chamber.

8. A thermostatic pump comprising a rotatable drive shaft and a bi-metal disc mounted thereon and provided with radial corrugations extending laterally from the face of the disc, the disc being shaped to be normally concave in one direction under a predetermined temperature and operative to reverse its direction of concavity above said temperature, and a housing around the shaft and disc provided with an inlet port and an outlet port and so positioned that the disc will centrifuge the medium to be transferred towards the outlet port only when the disc reverses its concavity in response to a temperature above the predetermined operating temperature.

9. A thermostatic pump comprising a rotatable drive shaft and a bi-metal disc mounted thereon and cupped or concave in one direction below a predetermined temperature and adapted to reverse the direction of the concavity above said temperature, the disc embodying radial corrugations or vanes by means of which the pumping action is effected when the disc changes its shape in response to a temperature exceeding the predetermined temperature.

10. A fluid pump consisting of a rotatable shaft

supporting a disc of bi-metal provided with radial corrugations and having a concavity to be disposed to face a source or supply chamber of fluid, the disc being capable of reversing its concavity upon attaining a predetermined temperature, thereby to shift the position of the radial corrugations to communicate with a receiving chamber, whereby the fluid entering the concave corrugations may be forcibly centrifuged into the receiving chamber.

11. A thermal pump, for controlling the passage of fluid through a conduit, comprising a rotatable drive shaft and a disc concentrically mounted thereon transversely of the conduit, the disc being formed of bi-metal and normally cupped in one direction below a predetermined temperature, and adapted to change shape in response to variations in the temperature of the fluid, thereby to vary the propelling effect of the disc upon the fluid.

12. A thermostatic pump comprising a rotatable drive shaft and a bi-metal member mounted on the shaft, a housing enclosing the bi-metal member and the shaft, the housing having an intake compartment and an outlet compartment, with the bi-metal member serving as a substantial but incomplete barrier between the two compartments, while the temperature of the medium to be transferred by the pump is less than a pre-determined value, and the bi-metal member further operating to change its shape in response to the temperature of the medium to diminish its effect as a barrier and to become an actuator, as the temperature of the medium increases beyond such pre-determined value.

13. A thermostatic pump comprising a rotatable drive shaft and a bi-metal member mounted on the shaft and disposed in a passage to be traversed by a medium to be propelled by the pump, the bi-metal member functioning as a substantial but incomplete barrier while the temperature of the medium is on one side of a pre-determined value, and the bi-metal member changing its shape to function as an actuator when the temperature of the medium moves beyond such pre-determined value.

14. A thermostatic pump comprising a rotatable drive shaft and a bi-metal member mounted on the shaft and operable automatically to change its relation to the shaft to function as a barrier or as an actuator for a medium in a passage in which the pump is disposed, the bi-metal member serving, when it changes its automatic relation to the shaft, to vary its function from barrier to propeller in response to the temperature of the medium being propelled by the pump.

15. A thermostatic pump comprising a rotatable drive shaft and a bi-metal member mounted on the shaft and operable automatically to change its relation to the shaft, and a housing for enclosing the shaft and the bi-metal member, with the bi-metal member disposed in a passage formed in the housing, the bi-metal member functioning both as a valve and as an actuator, and responding to the temperature of the medium traversing the pump in such manner as to vary the actuator or valve function according to the temperature of the controlled medium.