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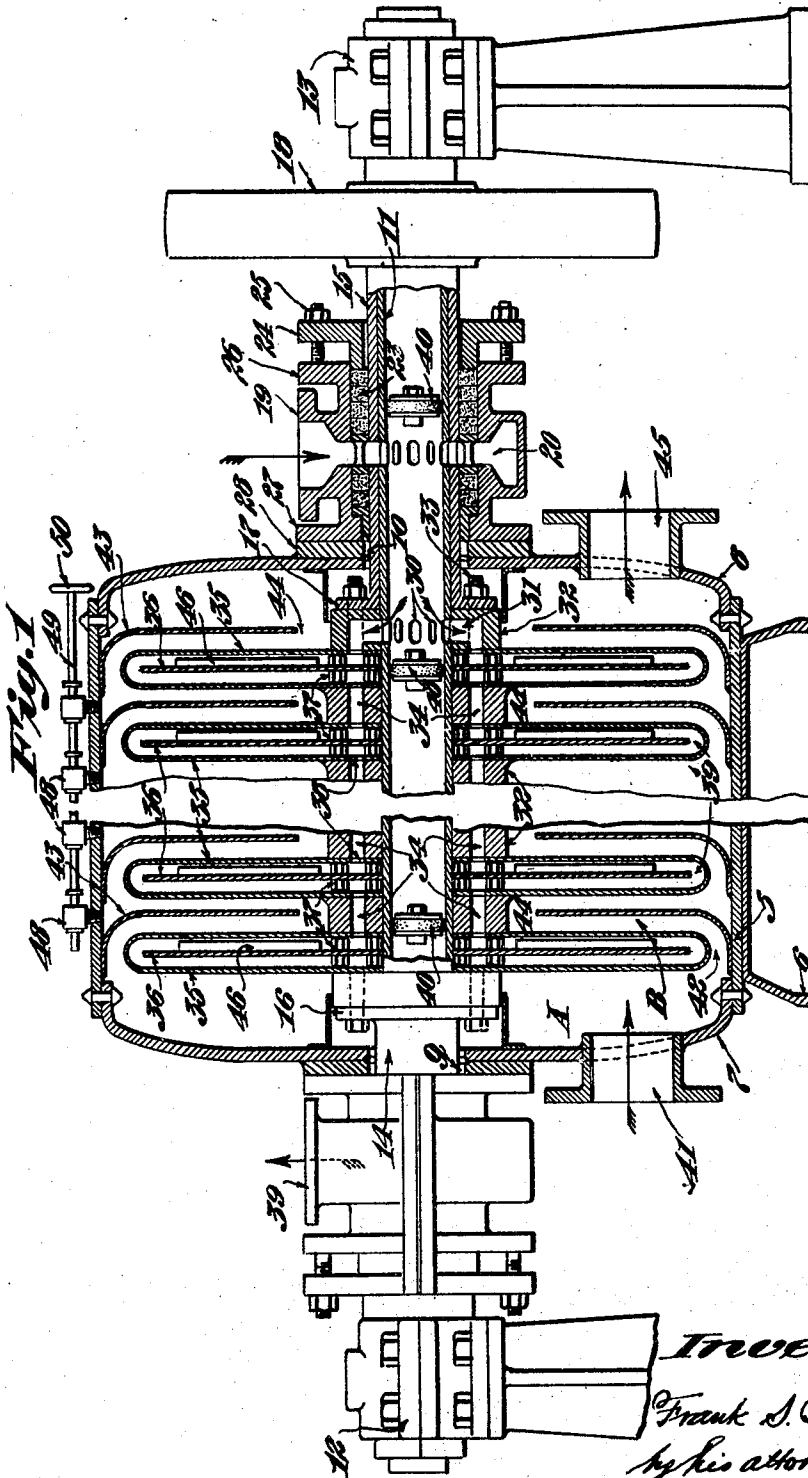
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ROTARY HEAT EXCHANGER

Filed March 30, 1925

2 Sheets-Sheet 1



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Fig. 2

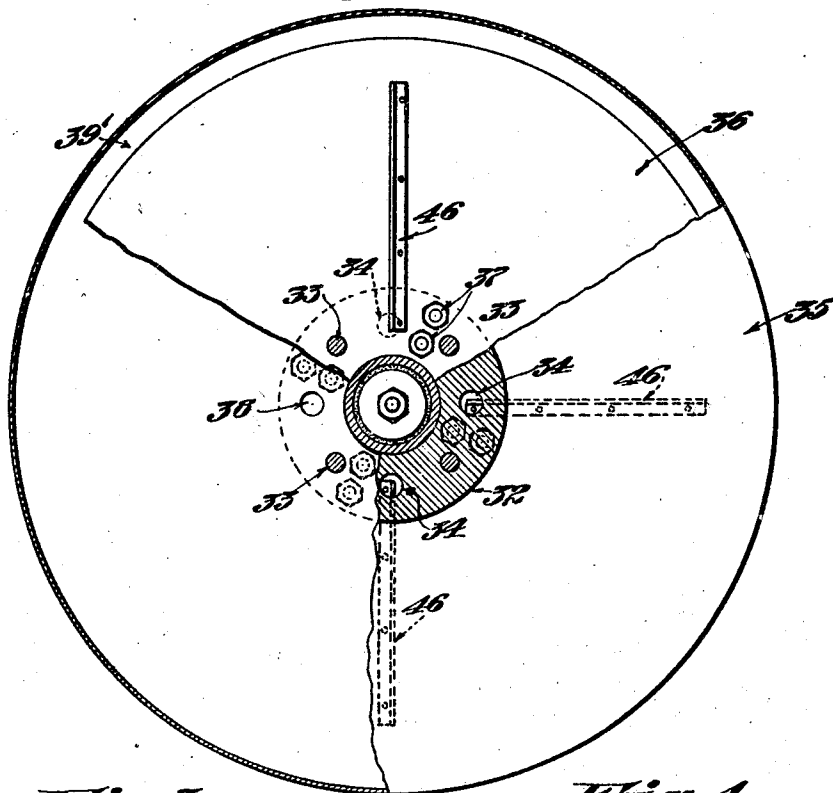


Fig. 3

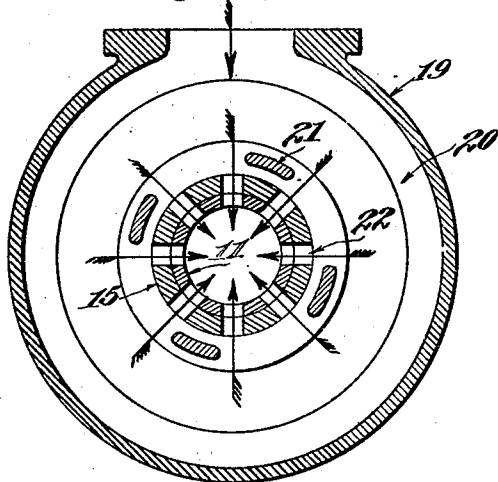
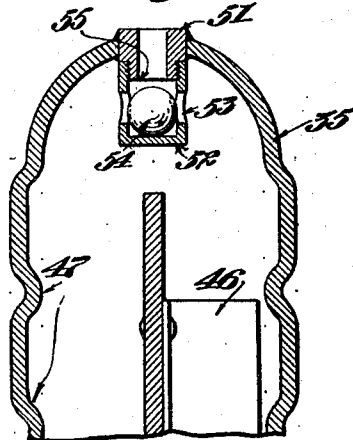


Fig. 4



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ROTARY HEAT EXCHANGER.

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This invention relates to apparatus for transferring the heat from one stream of fluid to another stream to raise or lower the temperature, as the case may be, known generically as "heat exchangers"; and more particularly to such apparatus for handling hot streams of a semi-fluid character, in a manner that successfully prevents clogging of the conduit through which they are conducted.

In the operation of many industrial plants large volumes of hot semi-fluid materials are either discharged to a sewer or cooled to permit handling in a further industrial operation thereon, no attempt being made to utilize these hot fluids as an agent for raising the temperature of the water or other heat absorbing fluid that is used in the industrial processes which produced the hot semi-fluid materials. The principal reason for this waste of heat is due to the fact that the solid matter in the semi-fluid material is of such a character that the ordinary commercial heat exchanger will become clogged after a brief period of use and the process will frequently have to be stopped for the purpose of cleaning.

One object of the invention is to provide a heat exchanger which will operate efficiently upon fluids of the kind that clog heat exchangers of the ordinary type. Other objects of the invention are to improve the design of heat exchangers for use on clear or semi-clear fluids so that the maximum heat exchange may take place between the hot fluid and the heat absorbing fluid, and to provide a heat exchanger in which at least one of the conduits is bodily rotated.

To the accomplishment of these objects, and such others as may hereinafter appear, the features of the invention relate to certain devices, combinations and arrangements of parts, hereinafter described and then set forth broadly and in detail in the appended claims, which possess advantages readily apparent to those skilled in the art.

The various features of the present invention will be readily understood from an inspection of the accompanying drawings illustrating the best form of the invention at present devised, in which,

Figure 1 is a front elevation, partly in section, of the heat exchanger;

Fig. 2 is a detail in right side elevation, partly broken away to show underlying parts and partly in section, of one of the rotary disks secured in place to the hollow shaft;

Fig. 3 is a right side sectional elevation of one of the glands that are located at each end of the heat absorbing fluid conduit; and

Fig. 4 is a detail in front sectional elevation showing the means for venting the hollow disks.

While capable of many other uses, for the purpose of illustration the invention will be described as applied to heating water by a transfer of heat thereto from a fluid mixture containing a quantity of solid matter, such for instance, as the hot pulp handled in a paper mill. This solid matter may or may not be an industrial refuse.

Described in general terms the novel heat exchanger comprises a cylindrical shell in which a tortuous conduit for the heat absorbing fluid is bodily rotated. The walls of this conduit constitute the heat-conducting or transferring surface. The tortuous conduit for the heat absorbing fluid is constructed to cause this fluid to flow alternately in directions away from and toward the axis of the conduit, the fluid assuming during each of the alternate flows a substantially flat circular sheet formation to engage a thin stream of the fluid with a large surface of the heat conductor. The hot pulp flows past the heat conductor in a tortuous conduit, one wall of which comprises the rotary heat-transferring surface. Flowing the hot pulp through a conduit provided with stationary and moving walls effectively resists all tendency for the semi-fluid pulp to form a plug and thus clog the heat-exchanger. The hot pulp flows past one side of the heat-transferring surface in a direction opposite to the flow of the heat absorbing fluid on the other side of the heat-transferring surface. That is, when the heat absorbing fluid is flowing away from the axis of the rotary conduit the hot pulp is flowing towards the axis. When the heat absorbing fluid is flowing toward the axis of the rotary conduit the hot pulp flows away from the axis. During its alternate flows the hot pulp assumes a substantially flat circular sheet formation in order to engage a thin stream of the hot pulp over an ample area on the heat-transferring surface directly opposite the surface engaged by the thin stream of the heat absorbing fluid.

In the embodiment of the invention illustrated in the drawings, the heat exchanger comprises a cylindrical shell 5 mounted on a base 6. Riveted to the shell 5 are a pair of heads 7 and 8 provided, respectively, with

central openings 9 and 10. Passing through the openings 9 and 10 and across the longitudinal axis of the shell 5 is a hollow shaft 11 journaled at its opposite ends in outboard bearings 12 and 13. Fitted to the outboard ends of the shaft 11 are tubes 14 and 15 which terminate inside the shell 15 in flanges 16 and 17. The tube 15 also carries a pulley 18 through which power is transmitted to rotate the shaft 11.

The heat absorbing fluid, hereinafter termed "water" for brevity, is introduced into the heat exchanger through a split packing gland 19 surrounding the tube 15. The packing gland 19 is provided with a central peripheral passage 20 which registers with a lantern gland 21 (Figs. 1 and 3) interposed between the packing gland 19 and the tube 15. The lantern gland 21, by being cut away (Fig. 3) allows a free passage of the water from the passage 20 through the lantern gland 21 and then through valve ports 22 comprising a circular series of openings formed in the tube 15 and hollow shaft 11. The lantern gland 21 is interposed between the sections of a gland packing 23, one section of which is engaged by an adjusting device 24 connected by bolts 25 to an end flange 26 on the packing gland 19. The other end of the packing gland 19 is provided with a flange 27 engaged with a plate 28 on the head 8.

The water in the hollow shaft 11 passes through a second series of valve ports 30 into a circular passage 31 formed in the first of a series of hubs 32 mounted on the shaft 11 and held in place by a series of long bolts 33 extending through all the hubs 32 and the flanges 16 and 17. In addition to the bolt holes for the bolts 33 the hubs 32 are provided with a series of aligned openings 34, the openings 34 in the first hub of the series communicating with the passage 31.

Interposed between each hub of the series is a hollow disk 35 comprising a pair of spaced circular plates having their peripheral edges flanged and welded together. Centrally located within the disk 35 is a baffle 36 having a diameter less than that of the disk 35 and provided on opposite sides with bolt heads 37 to prevent collapse of the disk 35 when the bolts 33 are tightened. The series of disks 35 are provided with a series of openings 38 which register with the openings 34 in the hubs.

With this construction the water passes from the packing gland 19 through the valve ports 22 into the hollow shaft 11. From the shaft 11 the water passes into the passage 31 and then through the openings 34 in the first hub of the series which register with the openings 38 in the first disk of the series. The water then flows from the hub towards the periphery of the disk spreading out in a flat circular sheet in the space be-

tween the baffle 36 and the right hand plate of the disk 35. After rounding the circular corner 39' (Fig. 1) the water flows from the periphery of the disk towards the hub thereof and again spreads out in a flat circular sheet in the space between the baffle and the left hand plate of the disk 35. The water then passes out of the openings 38 into the openings 34 in the second hub of the series which register with the openings 38 in the second disk of the series. In this manner the water flows through the entire series of hubs and disks finally passing out of the last hub of the series through a series of valve ports in the shaft 11 similar to the valve ports 30. From the hollow shaft 11 the water passes through a series of valve ports similar to the valve ports 22 and then out through a split packing gland 39 similar to the packing gland 19. The water is prevented from flowing through the whole length of the hollow shaft by a series of expansible rubber plugs 40 which may be tightened or loosened by a long socket wrench introduced through an open end of the shaft 11. As the shaft 11 is rotated during the passage of the water through the heat-exchanger, the series of hubs and disks comprises a rotary conduit therefor.

The hot pulp, under pressure, enters the heat exchanger through the inlet 41. This hot pulp is a semi-fluid so that when it engages the last disk 35 in the series it spreads out until it completely fills the section marked A in Fig. 1. Continued pressure on the pulp causes it to round the circular corner 42 of the disk and enter a section marked B in Fig. 1. This section is formed by a dish-shaped partition 43 welded to the internal surface of the shell 5 and provided with a central opening 44.

The hot pulp in section B flows from the periphery of the disks towards the hub thereof and assumes during its flow a flat circular sheet formation in contact with the right hand plate of disk 35. The whole surface of the disk 35 is thus covered with hot pulp. The heat from the pulp is thus conducted through the heat-transferring surface comprising the disk 35 to the water inside the disk. The water is also spread out over the internal surface of the disk 35 in a flat circular sheet so that a very efficient transfer of heat from the pulp to the water is effected.

The hot pulp flows from section B through the opening 44 into the next section of the series in which it flows from the hub of the disk towards the periphery thereof. The pulp continues to flow from one section to another alternately changing its direction as it flows toward and from the axis of the shaft 11 and maintaining during its alternate flow a substantially flat circular sheet formation in contact with the heat-transferring

surface of the rotary conduit. After passing through the last section of the series the pulp passes out of the heat exchanger through the outlet 45.

5 In order to reduce pumping expense the heat exchanger may be provided with means for propelling the water through its rotary conduit or, at least, for aiding the outside pumping agent in pumping the water
10 through the heat exchanger. To this end each of the baffles 36 may be provided on one face with a series of vanes 46 which, during the rotation of the shaft 11, impel the water forwardly as it flows from the hub to the
15 periphery of the disk.

In order to facilitate the alternate spreading of the pulp towards and away from the periphery of the disks the exterior end faces of each disk may be provided with a spiral
20 47 (Fig. 4), the spiral on the left-hand plate of each disk running outward and the spiral on the right-hand plate running inward as the shaft 11 is revolved. These spirals, in addition to assisting the circulation of the
25 pulp through the heat exchanger, are beneficial in breaking down any plug that may form tending to clog the heat exchanger. As shown in Fig. 4 the spirals may be formed directly in the material of the disks.

30 If the heat exchanger is empty it is necessary to free it of air when the pulp and water are introduced therein. To free the sections occupied by the pulp from air, each pulp section is provided with a valve 48. All
35 the valves 48 may be opened or closed simultaneously by a horizontal shaft 49, mounted exteriorly of the shell 5, and provided with a hand-wheel 50.

In order to free the rotary conduit from
40 air each of the disks carries a vented boss 51 to the lower end of which is fitted a ball cage 52 having openings 53 therein open to the interior of the disk. The cage 52 also carries loosely a ball 54 which normally is held, under
45 the influence of gravity, off its seat 55 in the boss 51. The water is introduced into the heat exchanger while the shaft 11 is stationary. The trapped air is driven by the water out through the vented boss 51 into
50 one or the other of the sections for the pulp. No harm is done if some water also escapes through the vented boss 51. When the rotary conduit is full the shaft 11 is rotated whereby the balls 54 are forced by centrifugal action
55 upon their seats 55.

Nothing herein contained is to be interpreted as limiting the invention in the scope of its application to use in connection with the particular apparatus or the particular
60 mode of operation or both selected for purposes of illustration and explanation. While the particulars of construction herein set forth are well suited to one mechanical form of the invention, it is not limited to these details of construction, nor to the conjoint use

of all its features, nor is it to be understood that these particulars are essential since they may be variously modified within the skill of the artisan without departing from the true scope of the actual invention, characterizing
70 features of which are set forth in the following claims by the intentional use of generic terms and expressions inclusive of various modifications.

What is claimed as new, is:

1 A heat exchanger having, in combination, means for transferring heat from one fluid to another comprising a heat conductor, means for flowing the fluids on opposite sides of the conductor, means for causing the fluids
75 to assume during their flow a substantially flat circular sheet formation in contact with the entire inner and outer surfaces of the conductor, and means for rotating the conductor.
80

2. A heat exchanger having, in combination, a shell, a series of partitions each having a central opening secured to the internal peripheral surface of the shell, a hollow disk having non-central openings mounted between adjacent partitions, and hubs for each disk having openings communicating with the openings in the disk, said internal peripheral surface, partitions, openings therein, and the exterior surface of the disks forming a
85 tortuous conduit for a fluid, the interior of the disks, openings therein and in the hubs forming a tortuous conduit for another fluid.

3. A heat exchanger, having, in combination, a shell, a series of partitions each having a central opening secured to the internal peripheral surface of the shell, a hollow disk having non-central openings mounted between adjacent partitions, hubs for each disk having openings communicating with the openings in the disk, said internal peripheral surface, partitions, openings therein, and the exterior surface of the disks forming a
90 tortuous conduit for a fluid, the interior of the disks, openings therein and in the hubs forming a tortuous conduit for another fluid, and means for simultaneously rotating the series of hubs and disks.
95

4. A heat exchanger having, in combination, a tortuous conduit for a hot fluid, a
100 tortuous conduit for a heat absorbing fluid, said fluids having a counter-current passage alternating at the center only and at the periphery only through each conduit, and means for rotating the heat absorbing fluid conduit.
105

5. In a heat exchanger, a hollow shaft, a series of hubs thereon, a hollow disk interposed between each hub, means permitting the entrance and exit of a clear fluid to the hollow shaft, a series of connected passages
110 through the hubs and disks communicating with the hollow shaft and arranged parallel thereto, and a baffle within each disk to cause the fluid flowing through said connected passages to move first in a direction away from
115

said shaft and then in a direction towards said shaft during its passage through each disk.

6. A heat exchanger having, in combination, means for transferring heat from one fluid to another fluid comprising a shell, a rotary shaft therein, a series of hollow disks mounted on the shaft, hubs having communicating passages at each side of each disk, means within the hollow disks for confining the heat absorbing fluid to a flow first towards the periphery of the disks and then towards the hubs thereof during its passage through each disk, and means for confining the hot fluid to a flow first towards the hubs of the disks and then towards the peripheries thereof during its passage past each disk.

7. A heat exchanger having, in combination, means for transferring heat from one fluid to another fluid comprising a shell, a rotary shaft therein, a series of hollow disks mounted on the shaft, means within the hollow disks for confining the heat absorbing fluid to a flow first towards the periphery of the disks and then towards the hubs thereof during its passage through each disk, and means for confining the other fluid to a flow first towards the hubs of the disks and then towards the peripheries thereof during its passage past each disk, said first named means having provision for pumping the heat absorbing fluid through the heat exchanger.

8. A heat exchanger having, in combination, means for transferring heat from one fluid to another fluid comprising a shell, a rotary shaft therein, a series of hollow disks mounted on the shaft, means within the hollow disks for confining the heat absorbing fluid to a flow first towards the periphery of the disks and then towards the hubs thereof during its passage through each disk, and means for confining the hot fluid to a flow first towards the hubs of the disks and then

towards the peripheries thereof during its passage past each disk, said disks having provision for impelling the hot fluid through the heat exchanger.

9. In a heat exchanger, a shell, a series of communicating sections therein, a shaft, a series of hollow disks mounted thereon, one disk to each section, and a vent in each disk having a ball associated therewith normally off its seat and arranged to seat itself and close the vent by centrifugal action when the shaft is rotated.

10. A heat exchanger having, in combination, means for transferring heat from one fluid to another fluid comprising a shell, a hollow shaft therein, a series of hollow disks mounted on the shaft, hubs on the shaft for spacing the disks, a passage for the heat absorbing fluid through the series of hubs and disks, means within the hollow disks for confining said fluid to a flow first towards the peripheries of the disks and then towards the hubs during its passage from one hub to another, means for confining the other fluid to a flow first towards the hubs and then towards the peripheries of the disks during its passage past each disk, and a series of valve ports in the hollow shaft permitting the entrance of the heat absorbing fluid into the shaft and from the shaft into the first hub of the series and its exit from the last hub of the series into the shaft and then out of the shaft.

11. A rotary heat exchanger having, in combination, a rotary shaft, a series of hollow disks mounted along the shaft provided with connecting passages outside the shaft for the flow of a fluid successively through the disks from one end of the series to the other, and a baffle within each hollow disk and rotating therewith to cause the fluid to move alternately away from and toward the shaft during its passage through the hollow disks.

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