Dec. 20, 1960 F. L. SCHWARTZ 2,965,361

HEAT EXCHANGERS

Filed Aug. 1, 1957 2 Sheets-Sheet 1

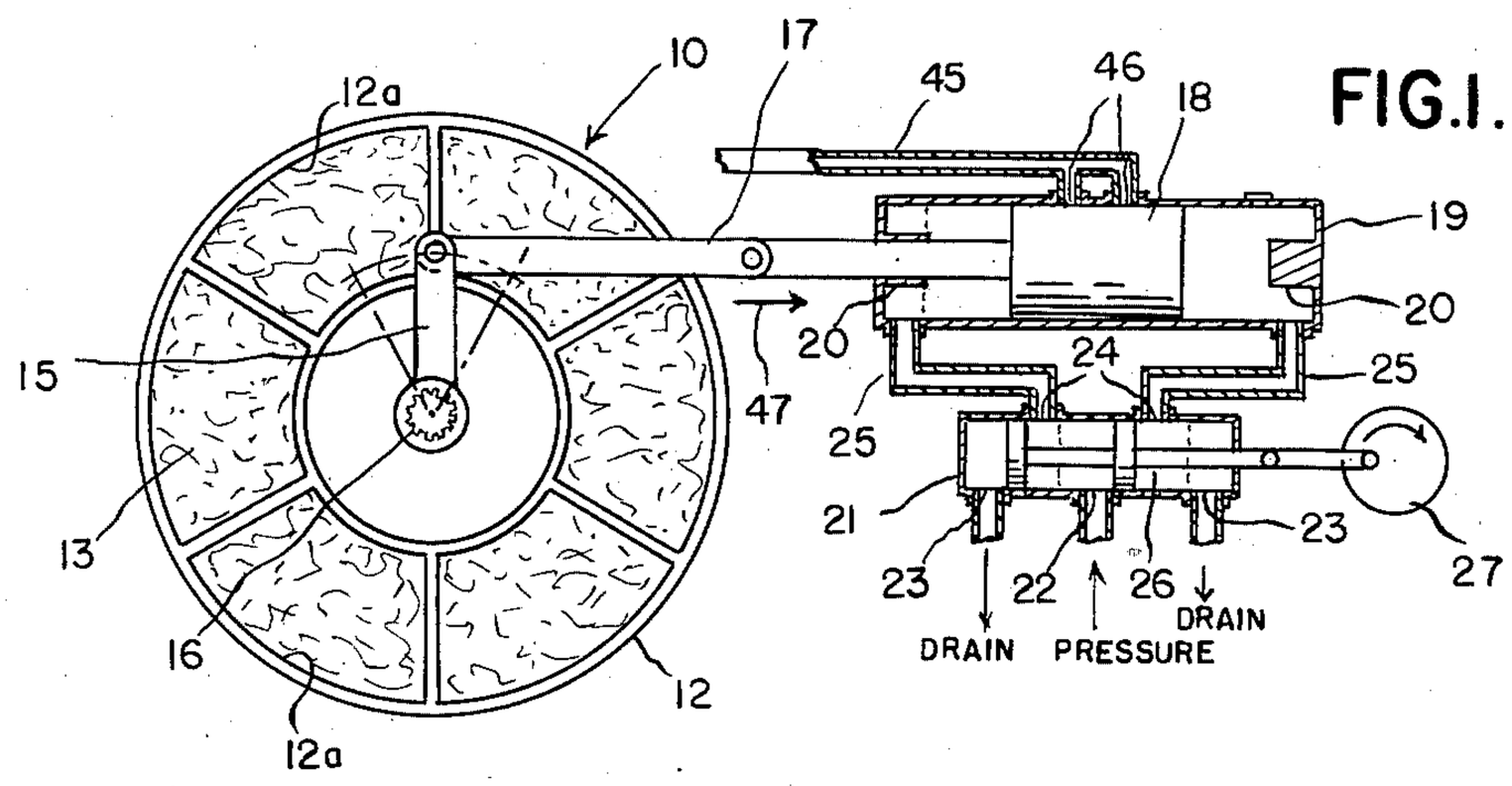


FIG.1.

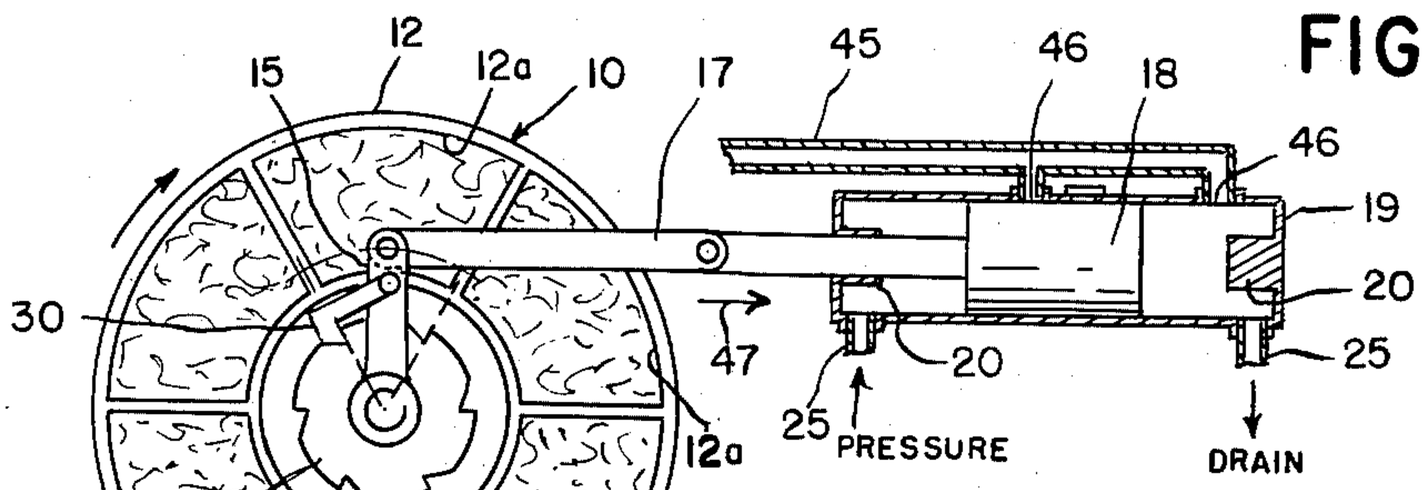


FIG.2.

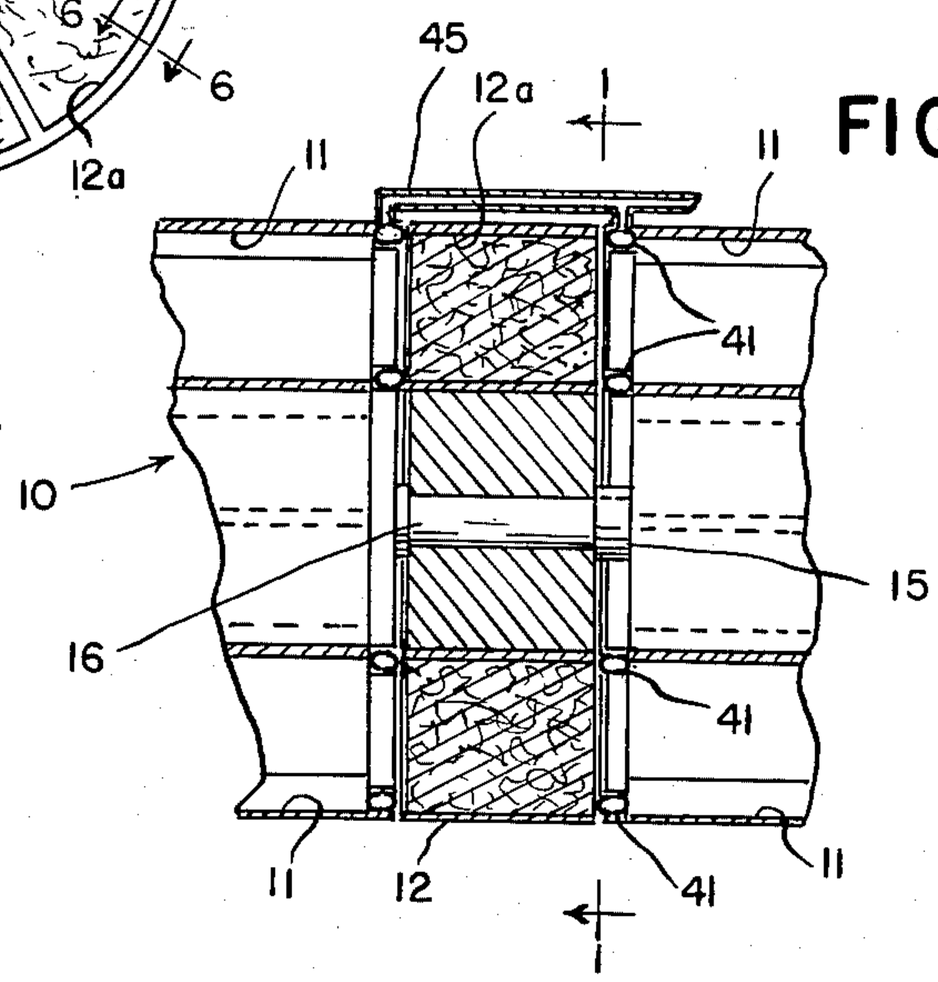


FIG.3.

INVENTOR.
FRANK L. SCHWARTZ
BY
ATTORNEYS

Dec. 20, 1960

F. L. SCHWARTZ

2,965,361

HEAT EXCHANGERS

Filed Aug. 1, 1957

2 Sheets-Sheet 2

FIG.4.

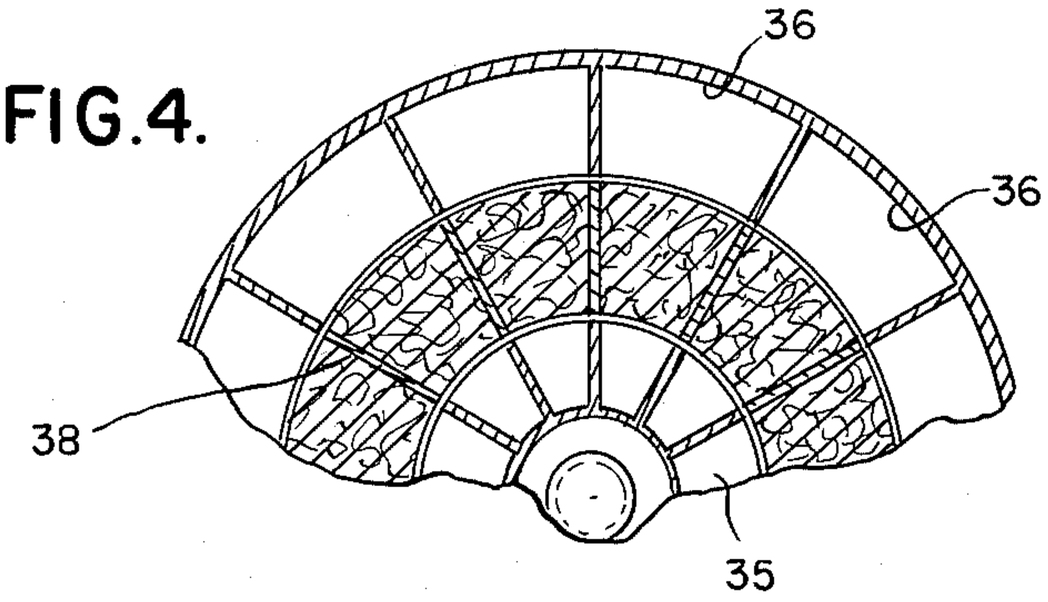


FIG.5.

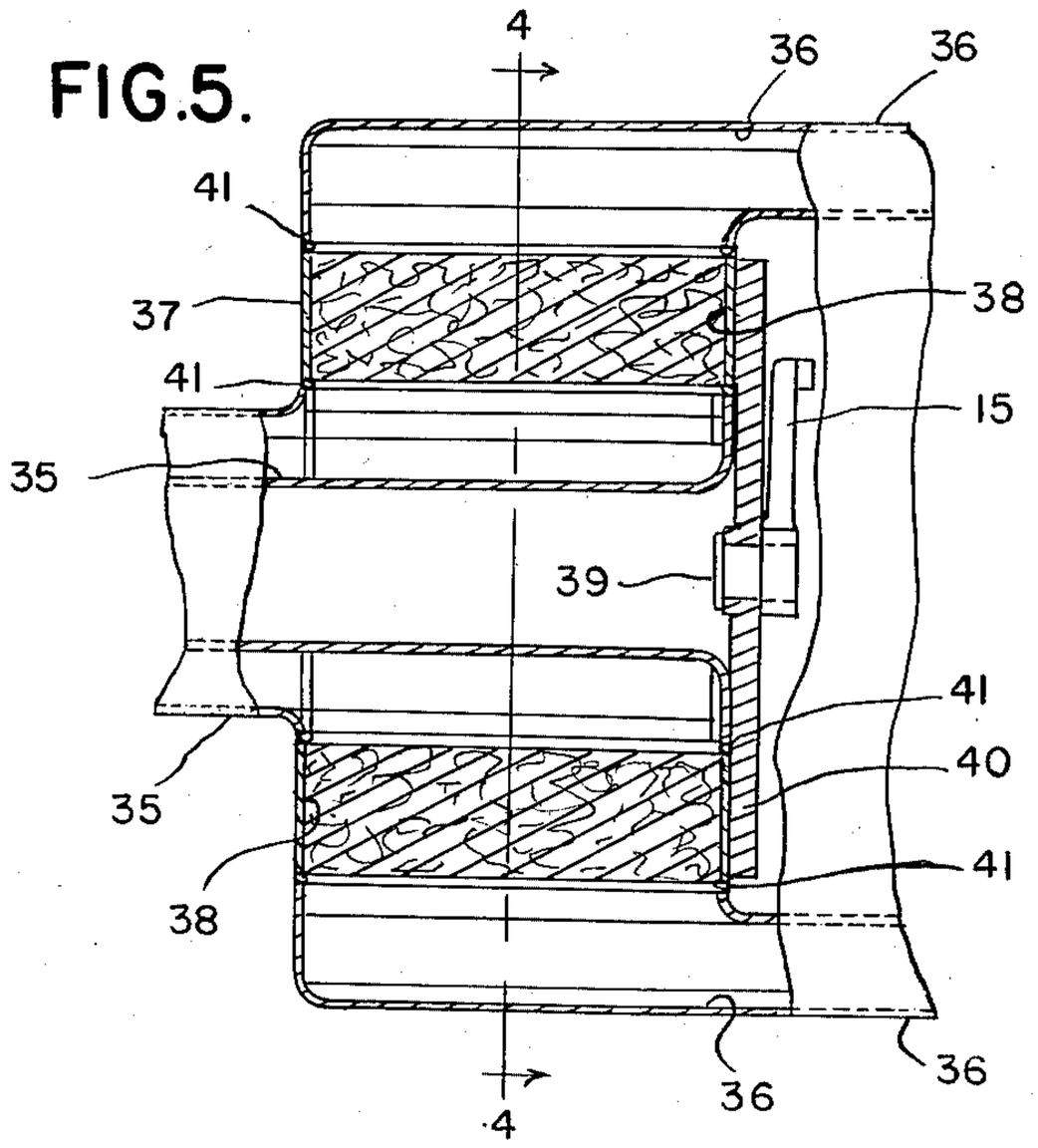
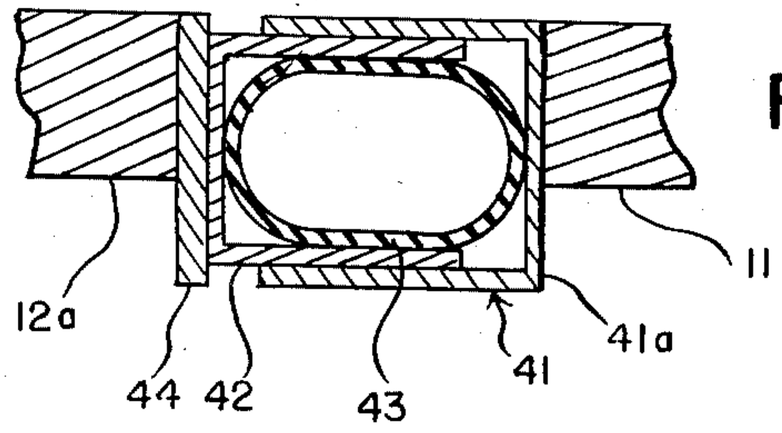


FIG.6.



INVENTOR.
FRANK L. SCHWARTZ
BY
ATTORNEYS

United States Patent Office

2,965,361

Patented Dec. 20, 1960

2,965,361

HEAT EXCHANGERS

Frank L. Schwartz, Ann Arbor, Mich., assignor to Continental Aviation and Engineering Corporation, Detroit, Mich., a corporation of Virginia

Filed Aug. 1, 1957, Ser. No. 675,698

2 Claims. (Cl. 257—267)

My invention relates to heat exchangers and more particularly to a control and sealing means for effecting minimum leakage losses in a rotary type heat exchanger.

One of the most persistent problems encountered in the development of heat exchangers is the fact of leakage between the two fluid mediums that occurs most of the time, and particularly during movement of the heat exchange matrix from on fluid to the other. In the case of heat exchangers adapted for use with machines such as gas turbines, the pressure losses from the incoming compressor air to the exhaust cuts down on the efficiency of the machines.

An object of the present invention is to improve heat exchangers by providing means for an intermittent rapid shifting of the heat exchange matrix from one fluid conducting means to another.

Another object of the invention is to reduce heat exchanger leakage by providing means intermittently actuating the heat exchanger and selectively indexing heat exchange matrix passages with alternate fluid ducts.

A further object of the invention is to improve heat exchangers by providing a rotatable drum having a plurality of matrix passages, the drum being intermittently oscillated or rotated to index each passage for a period of dwell with alternate fluid ducts.

Yet another object of the invention is to reduce heat exchanger leakage by providing an actuated pressure seal that cooperates with intermittent actuation of the heat exchanger to provide a tight seal during periods of dwell only.

For a more complete understanding of the invention, reference may be had to the accompanying drawings, illustrating a preferred embodiment of the invention in which like reference characters refer to like parts throughout the several views and in which—

Fig. 1 is a diagrammatic view of a preferred movable heat exchange structure substantially as seen from the line 1—1 of Fig. 3 and illustrating a preferred hydraulic actuating means therefor.

Fig. 2 is a diagrammatic view similar to Fig. 1 but illustrating a modified actuating means.

Fig. 3 is a fragmentary longitudinal cross-sectional view of a preferred type of heat exchanger embodying the invention,

Fig. 4 is a fragmentary cross-sectional view of another type of heat exchange structure taken substantially on the line 4—4 of Fig. 5.

Fig. 5 is a fragmentary longitudinal cross-sectional view of the heat exchanger illustrated in Fig. 4, and

Fig. 6 is a fragmentary cross-section of the pressure seal embodied in the invention taken substantially on the line 6—6 of Fig. 2.

Referring to Figs. 1 through 3, a preferred heat exchanger **10** is illustrated as comprising fluid ducts **11** interrupted by an intermediate heat exchange structure **12** preferably constructed as a rotatable drum having a plurality of annularly arranged passages **12***a* filled with any desired type of heat exchange matrix or material **13.**

In the usual embodiment of such a conventional drum type of heat exchanger, hot and cold fluids are conducted through respectively alternate ducts **11**, which are annularly arranged to match the annular arrangement of the drum passages **12***a*. Heat is thus absorbed by the matrix **13** of alternate passages **12***a*, the drum is rotated to align the heated matrix passages **12***a* with the cold fluid ducts **11** and to align the cold matrix passages **12***a* with the hot fluid ducts **11**, such that as the matrix in alternate passages **12***a* give up the absorbed heat to the cold air flowing through alternate ducts **11**, the matrix in the other passages **12***a* are being heated.

Heretofore, the rotation of the drum **12** was continuous, and of course during movement, closed segments had to be provided between alternate ducts to reduce pressure and fluid leakage between ducts. Even so, pressure and fluid leakage occurred, and the interval between exposure of matrix to alternate hot and cold fluids made for inefficient heat exchange. It is seen in the present case that the ducts **11** and passages **12** are each immediately adjacent the next respective ducts and passages, and of course continuous rotation would necessarily make open connections between adjacent passages.

The present invention, however, contemplates intermittently moving or rotating the drum very rapidly to index the passages **12***a* alternately with the hot and cold fluid ducts **11**, and providing a period of dwell between relatively short periods of movement, thus reducing leakage loss time to a minimum. Any desirable actuating means may be utilized for operating the drum in the above manner, and one method is illustrated in Fig. 1 as follows:

An arm or lever **15** is splined or otherwise secured to a hub **16** secured to the drum **12** on its longitudinal axis. Suitable linkage **17** connects the lever **15** with a piston **18** operable in a hydraulic or pneumatic cylinder **19.** The stroke of the piston is preferably limited by stops **20** so that at each end of the piston stroke the drum passages **12***a* are indexed with the ducts **11.** A pilot valve **21** is provided with a pressure inlet port **22** in the center, a drain port **23** at each end, and intermediate ports **24** connected by conduits **25** with respective ends of the cylinder **19.**

A valve piston **26** is reciprocated by rotation of a motor **27** or any means to direct pressure alternately to each end of the cylinder **19** and vent the other end to reciprocate the piston **18.** It will be seen that the system provides a period of dwell between strokes of the piston **18** dependent on the speed of reciprocation of the piston **26.**

Where it is desired that the drum **12** be rotated intermittently instead of oscillated, the lever **15** may be pivoted on the drum **12** as shown in Fig. 2 and provided with an actuating arm **30** which operates to turn a ratchet element **31**, which is secured to the drum **12**, in one direction only on every other stroke of the piston **18.**

Instead of axial fluid flow through the drum passages **12***a*, other arrangements may be made, one being illustrated in Figs. 4 and 5. Here, inner fluid ducts **35** and outer fluid ducts **36** are shown, being intercepted by an intermediate drum **37** having radial passages **38.**

The arm **15** in this modification would be secured or pivoted, whichever type of actuation is desired, on a hub **39** secured to a plate **40** on which the drum **37** is mounted. Fluid flow is thus directed radially between the inner and outer ducts **35** and **36** respectively through the passages **38**, each alternate duct **35** and each alternate duct **36** conducting hot and cold fluid and the passages **38** being selectively intermittently indexed alternately with ducts conducting hot and cold fluids.

In order to maintain maximum leakage sealing char-

acteristics between the ducts and the passages of any of the foregoing heat exchanger structures, without restricting motion of the drums, some sort of actuated pressure seal should be provided between the edges of the ducts and passages. A preferred arrangement of a seal **41** is shown in the detail of Fig. 6, in which a channel **41***a* is secured to the edge of the duct **11** and supports an oppositely faced channel **42** to provide an adjustable enclosing space for a flexible tubing **43**. The outer face of the channel **42** preferably rides on a plate **44** secured to the edge of the passage **12***a*.

The tubing **43** is adapted to be pressurized by any hydraulic or pneumatic means by pressure supplied through a conduit **45** in timed cooperation with actuation of the drum **12**, so that pressure will provide a tight seal only during periods of dwell and will be relieved when the drum **12** is being rotated or oscillated.

Such a means for sealing the oscillating drum is shown in Fig. 1, the conduit **45** being connected to intermediate ports **46** in the cylinder **19**. The piston, moving in the direction shown by the arrow **47** will open one of the ports **46** when it reaches the end of the stroke, thus directing pressure into the conduit **45**. During the subsequent period of dwell, pressure sealing will be maintained. But when pressure is directed to the other end of the piston **18** and the former end is simultaneously connected with drain, pressure in the tubing **43** is relieved, and the piston **18** moves in the other direction, opening the other port **18** at the end of the stroke to once more direct pressure to the tubing **43** for effecting a tight pressure seal between the duct and passage edges.

For sealing the rotary drum **12** shown in Fig. 2, everything is the same except that one of the ports **46** is located to be closed only at the extreme end of one operating cycle, thus maintaining pressure during the return stroke of the piston **18** when the drum is not being rotated as well as when the piston **18** is at rest during periods of dwell. Pressure in the line **45** is thus relieved only during the operative stroke of the piston as indicated by the arrow **47**.

In summary, it is noted that in all embodiments of the invention, whether as shown or otherwise, the motion of the structure effecting alternate flow of fluids through the heat exchange material or matrix is intermittent rather than continuous. Motion may be either in one direction or back and forth and the time of motion is small compared with the time of dwell; that is, movement is so rapid that the time for leakage is very small. Also, tight pressure seals may be provided to eliminate leakage during the dwell period, the pressure being relieved only to permit the required actuation.

It will be also be observed that the use of a plurality of small passages and ducts permits the time of motion between dwell periods to be reduced, thus further eliminating leakage.

I claim:

1. In a heat exchanger comprising two fluid conducting means and a heat exchange structure for transferring heat from fluid flowing in one conducting means to fluid flowing in the other conducting means, said heat exchange structure comprising a single annular drum rotatable on its longitudinal axis and having a plurality of equally annularly spaced longitudinal partitions defining segment passages provided with heat exchange material, actuating means intermittently rotating said drum on its axis through an arc relative to the spacing between adjacent partitions and selectively indexing said passages alternately in open communication with said conducting means, the ends of said drum having inner and outer annular rims, said conducting means comprising conduits having annular rims registering at all times with the rims of said drum, leakage sealing means comprising annular expansible tubular elements disposed intermediate the registered rims of said drum and said conduits, control means intermittently contracting and expanding said tubular elements in timed cooperation with said actuating means and operable when expanded to provide a positive seal against fluid leakage only when said drum is at rest.

2. In a heat exchanger comprising two fluid conducting means and a heat exchange structure for transferring heat from fluid flowing in the conducting means to fluid flowing in the other conducting means, said heat exchange structure comprising a single annular drum rotatable on its longitudinal axis and having a plurality of equally annularly spaced longitudinal partitions defining segment passages provided with heat exchange material, actuating means intermittently rotating said drum on its axis through an arc relative to the spacing between adjacent partitions and selectively indexing said passages alternately in open communication with said conducting means, the ends of said drum having inner and outer annular rims, said conducting means comprising conduits having annular rims registering at all times with the rims of said drum, leakage sealing means comprising annular expansible tubular elements disposed intermediate the registered rims of said drum and said conduits, control means intermittently contracting and expanding said tubular elements in timed cooperation with said actuating means and operable when expanded to provide a positive seal against fluid leakage only when said drum is at rest, said control means comprising a fluid pressure means operably connected with said actuating means and operable to direct fluid pressure to said tubular elements to expand same only when said actuating means is not rotating said drum.

References Cited in the file of this patent

UNITED STATES PATENTS

870,546	Cooke	Nov. 12, 1907
1,558,445	Ljungstrom	Oct. 20, 1925
2,700,537	Pennington	Jan. 25, 1955
2,863,644	Fallon	Dec. 9, 1958

FOREIGN PATENTS

459,992	Canada	Sept. 27, 1949
477,757	Germany	June 13, 1929