United States Patent

Hohnerlein et al.

[15] **3,692,064**

[45] **Sept. 19, 1972**

[54] **FLUID FLOW RESISTOR**

[72] Inventors: **Gunther Ernst Hohnerlein**, Dusseldorf; **Gunther Max Meinhart**, Oberhausen; **Peter Hildebrand**, 464 Wattenscheid, all of Germany

[73] Assignee: **Babcock and Witcox Ltd.**, London, England

[22] Filed: **Dec. 12, 1969**

[21] Appl. No.: **884,443**

[30] **Foreign Application Priority Data**

Dec. 12, 1968 Germany.....P 18 14 191.8

[52] **U.S. Cl.**.....**138/42**, 138/38

[51] **Int. Cl.**.....**F15d 1/02**

[58] **Field of Search**.....138/42, 38, 40

[56] **References Cited**

UNITED STATES PATENTS

155,936	10/1874	Fell	138/38 X
1,557,838	10/1925	Hiller	138/38 X
1,606,739	11/1926	Averill	138/38
2,400,161	5/1946	Mockridge et al	138/42
2,688,986	9/1954	O'Brien	132/38

FOREIGN PATENTS OR APPLICATIONS

485,989	10/1953	Italy	138/38
55,970	12/1935	Norway	138/42

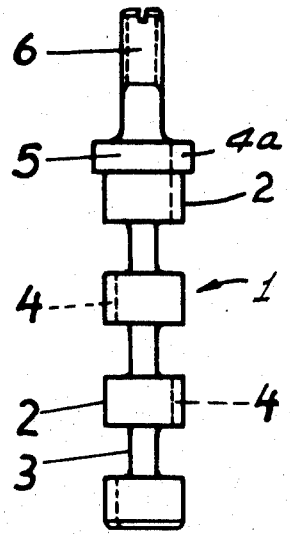
Primary Examiner—Herbert F. Ross

Attorney—Joseph M. Macguire

[57] **ABSTRACT**

A resistor for mounting into the tube of a heat exchanger to control the flow of fluid therethrough. The resistor is of unitary construction and includes a stem having laterally extending projections in the form of disk-like members spaced longitudinally of the tube. A flow path is defined through the resistor by providing an opening through each of the disk-like members with the openings of adjacent members being offset circumferentially. An alternate embodiment has the projections in the form of arcuate partitions laterally extending to one side of the stem with adjacent partitions being on opposite sides of the stem and including openings through the stem therebetween.

10 Claims, 7 Drawing Figures



PATENTED SEP 19 1972

3,692,064

SHEET 1 OF 2

FIG. 1

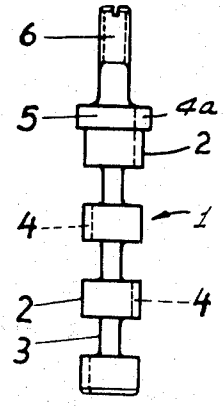


FIG. 2

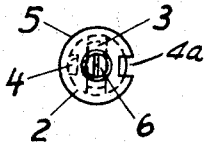


FIG. 3

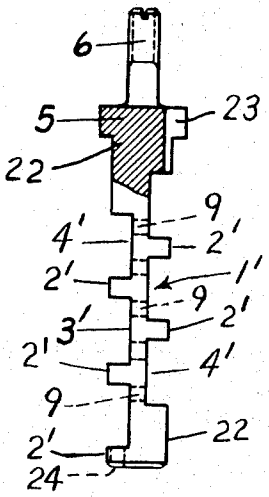


FIG. 4

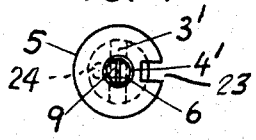


FIG. 6

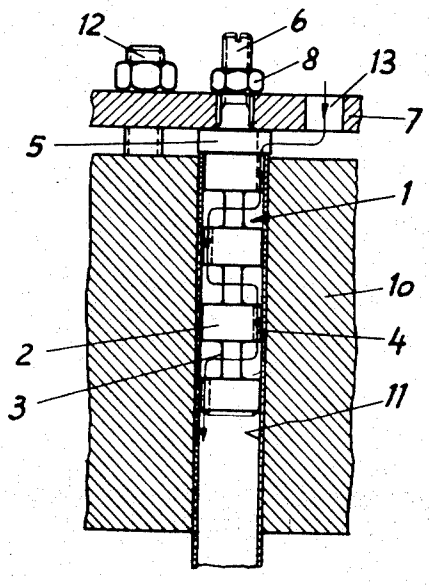
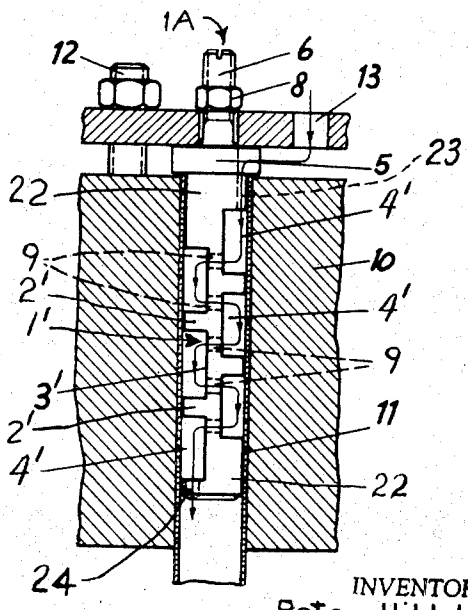
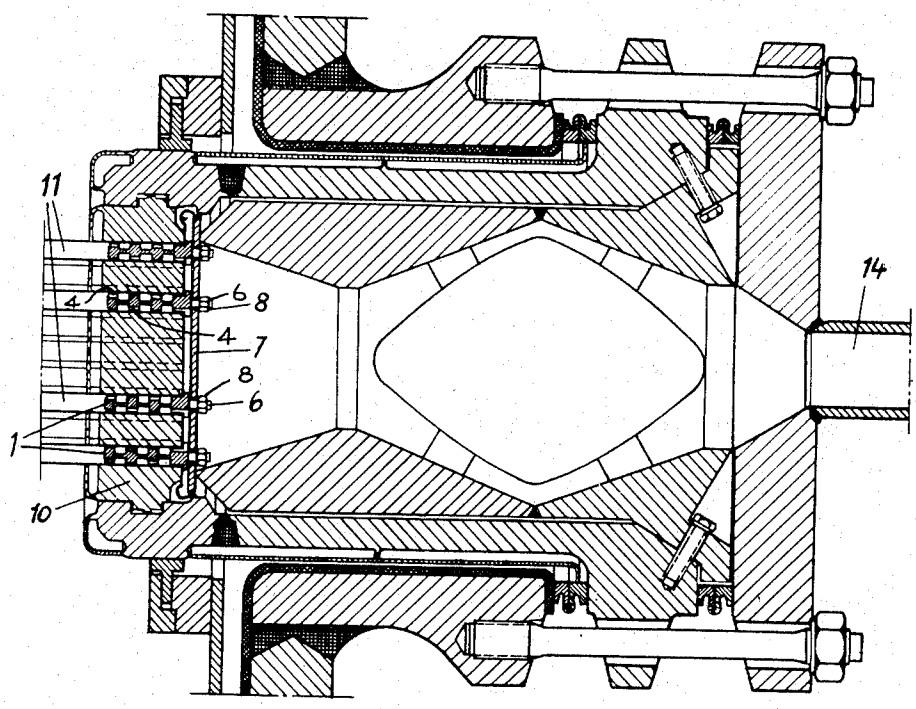


FIG. 7



INVENTORS
Peter Hildebrand
Gunther Ernest Hohnerlein
Gunther Meinhardt
J. Maguire
ATTORNEY

FIG. 5



FLUID FLOW RESISTOR

It is known to design heat exchangers having a plurality of tubes connected in parallel so that fluid supplied to a single inlet flows therefrom in parallel through more than one flow path. A particular form of such heat exchanger is a forced flow boiler.

Such boilers are designed to operate at predetermined normal loads but it is obviously desirable that they be able to operate satisfactorily at loads below these normal loads. When the load is reduced below normal, there is a tendency for instability to occur so that the rates of flow through all the flow paths cease to be uniform and consistent. The occurrence of instability limits the extent to which the load can be reduced however it has been found that the introduction of throttles, or flow resistors, into the fluid flow paths will lower the load level at which instability occurs.

The present invention is concerned with resistors for use in the tubes of heat exchangers that include a plurality of fluid flow paths connected in parallel.

According to the invention, there is provided in a tube of a plurality of tubes, connected in parallel in a heat exchanger, a resistor including a stem extending axially of the tube and so formed that fluid flowing through the resistor can flow from one side of a plane extending through, and longitudinally of, the stem to the other side of the plane at discrete locations spaced longitudinally of the stem, and projections extending laterally from the stem such as to permit flow from each location to the next on one side of the plane while preventing flow between those locations on the other side of the stem, the projections being so disposed that flow between any two locations is permitted on one side of the plane while flow between either of those locations and the next is permitted on the other side of the plane.

According to the present invention, there is also provided a resistor for restricting flow in a tube of a heat exchanger providing a plurality of discs having the same axis and diameter as each other and means connecting each disc rigidly to, but at a distance from the next, each disc being provided with a passage through which fluid can flow from one side of the disc to the other, the passage with which any disc is provided being diametrically opposite to the passage with which the, or either, next adjacent disc is provided, and the means by which the discs are each connected to the next being so formed as to provide a flow path from each passage to the next.

Further the present invention provides a resistor for use as a flow restrictor in a tube of a heat exchanger, providing a stem, a plurality of arcuate partition members extending to one side of the stem, and a plurality of arcuate partition members extending to the other side of the stem, wherein the projectors on one side of the stem are staggered relatively to the projections on the other side of the stem, between each projection on one side of the stem and the next projection on the other side of the stem, the stem is provided with a passage extending from one side to the other, and the opposite edges of the stem and the edges of the projections lie on a right circular cylinder with the edge of each arc extending from one edge of the stem to the other.

By way of example, embodiments of the invention will now be described with reference to the accompanying drawings in which

FIG. 1 is a side view of a unit including a resistor;

FIG. 2 is a plan view of the unit shown in FIG. 1;

FIG. 3 is a side view, partly cut away, of another unit including a resistor;

FIG. 4 is a plan view of the unit shown in FIG. 3;

FIG. 5 is an axial section of the feedwater inlet connection of a heat exchanger provided with units as illustrated in FIGS. 1 and 2;

FIG. 6 is a detail of FIG. 5 on an enlarged scale; and

FIG. 7 is the detail shown in FIG. 6 modified by the substitution of a unit as illustrated in FIGS. 3 and 4.

The unit shown in FIGS 1 and 2 is formed from a single piece of metal. The lower part 1 that serves as a resistor is shaped to provide four discs 2 all having the same axis and diameter. The discs 2 are connected together, each at the same distance from the next, by shanks 3 of smaller diameter than the discs 2. Each disc 2 is provided at its edge with a groove 4 extending from one side of the disc to the other and the grooves on alternate disc are displaced through 180° from each other.

The disc 2 at one end of the resistor portion 1 is provided at its outer end with an enlargement 5 in the form of a thinner disc of larger diameter that acts as a shoulder. An extension 4*a* of the groove 4 in the disc 2 that is provided with the enlargement 5 traverses the enlargement 5. Extending outwardly of the enlargement 5, co-axially with the disc 2 and shanks 3, is an externally screw-threaded stub 6.

The use of the units illustrated in FIGS. 1 and 2 is illustrated in FIGS. 5 and 6. FIG. 5 shows the feed water inlet branch of a heat exchanger used in a nuclear reactor. Feedwater is supplied from inlet 14 to parallel tubes 11 that are fixed in tube plate 10. Mounted parallel to the tube plate 10 by means of bolts 12 (see FIG. 6) is an impact plate 7 and the impact plate 7 is apertured at 13 to permit the flow of water into a gap between the impact plate 7 and the tube plate 10 and thence into the tubes 11. A resistor 1 lies co-axially within the inlet end of each of the tubes 11. The shoulder 5 associated with the resistor lies between the impact plate 7 and the tube plate 10 to establish the gap between them and nut 8 screwed on to the threaded stub 6 of each unit additionally secures the unit to the impact plate 7.

Water supplied through the inlet 14 flows through the openings 13 and thence, through the resistors 1, into the tubes 11. In the throttle, fluid flows through the recesses that extend across the discs, flowing transversely of a shank 3 in passing from one recess to the next.

The resistor 1 illustrated in FIGS. 3 and 4 is, in effect, a right cylindrical rod of metal cut away to provide recesses 4′ on opposite sides of a central stem 3. The recesses 4′ are all of the same dimensions and, on each side of the stem 3′, each recess 4′ is separated from the next by an arcuate projection 2′. The center of any projection on one side of the stem 3′ lies opposite the center of a recess 4′ on the other side of the stem 3′. At the ends of the stem 3′, are enlargements 22 of which the contours are the same as those of the projection 2′ but of which the lengths are greater. The two projections 22 at the upper end of the resistor are connected

to an enlargement 5 and stub 6 similar to those shown in FIGS. 1 and 2.

A recess 23 extends through the shorter of the two enlargements at the upper end of the throttle and through the enlargement 5. A bore 24 extends through the lowermost projection 2' and openings 9 extend from one side of the stem 3' to the other, each opening 9 lying midway between a projection 2' on one side of the stem 3' and the next adjacent projection 2' on the other side of the stem.

The resistor shown in FIGS. 3 and 4 is mounted and used in a way similar to the resistor shown in FIGS. 1 and 2. Fluid flows through the recess 23 into the first of the recesses 4' and thence to each of the other recesses 4' in turn, flowing through an opening 9 from one side of the stem 3' to the other in passing from one recess 4' to the next. The fluid escapes from the lowermost of the recesses 4' into the tube 11 through the opeing 24.

Fluid flowing through the resistors that have been described changes direction several times and it has been found that the resistors are not excessively prone to contamination so that a fixed and reliable pressure drop is effected at full load by their use. Welding is not used to fix them so that they would be comparatively easily replaced to effect a different pressure drop by others having different lengths or by others having different spacings between the partitions. Since the resistors are fixed by means other than welding they can be used in circumstances where good welding access is not available and where tube diameter and wall thicknesses are so small that welding is undesirable or impracticable.

What is claimed is:

1. In a fluid flow circuit comprising a plurality of fluid flow tubes arranged in spaced parallel flow relationship, means for mounting a flow resistor in at least one of said tubes, the flow resistor being of unitary construction and having a portion thereof inserted within said tube, the resistor including a plurality of flow restrictors equiaxially spaced longitudinally of said tube, one of said restrictors being adjacent the resistor receiving end of said tube and including a shoulder portion for substantially closing said tube, a stem interconnecting the restrictors, the stem being generally coaxial with said tube, the restrictors being generally disposed normal to the stem and having a surface slidably engaged with the inner surface of said tube, longitudinally adjacent restrictors including the restrictor having the shoulder portion cooperating with said inner surface to form chambers therebetween and means defining a flow path through said one of said restrictors and between said chambers for fluid communication between the chambers and through said tube.

2. A fluid flow circuit according to claim 1 wherein each of the restrictors is in the form of a cylindrical disc, each of discs being generally coaxial with the stem and having a radial cross-sectional area substantially equal to that of the bore of said tube.

3. A fluid flow circuit according to claim 2 wherein the means defining flow paths includes an opening formed through each of the restrictors, the opening extending substantially parallel to said stem.

4. A fluid flow circuit according to claim 3 wherein the openings of successive restrictors are offset circumferentially of said tube to form a tortuous flow path through said resistor.

5. A fluid flow circuit according to claim 3 wherein the opening is in the form of a circumferentially notched groove of rectangular cross-section.

6. In a fluid flow circuit according to claim 1 wherein said stem is of generally rectangular axial cross-section, the stem extending diametrically across the tube's bore and cooperating therewith to form a pair of axial passageways, said restrictors being alternately disposed between the passageways to form alternating successive chambers therein, said successive chambers overlapping one another.

7. In a fluid flow circuit according to claim 6 including each of the endmost restrictors having at least one portion thereof formed of a cylindrical disc, said cylindrical disc having a radial cross-sectional area substantially equal to that of the bore of said tube and each of the intermediate restrictors being formed of a partial disc, said partial disc having a radial cross-sectional area substantially equal to that of one of said passageways.

8. In a fluid flow circuit according to claim 7 wherein the means defining flow paths includes an opening extending substantially radially through the stem between each of said overlapping chambers, and an opening formed through the cylindrical disc portion of each of said endmost restrictors, said last named opening extending substantially parallel to the stem.

9. In a fluid flow circuit according to claim 1 wherein said resistor includes an end-threaded stub projecting from said shoulder portion in a direction axial of the stem.

10. In a fluid flow circuit according to claim 8 wherein the means for mounting said flow resistor includes a perforated plate member, said stub passing through one of the perforations, a locknut engaging the threaded-end of the stub to rigidly connect the flow resistor to said plate member.

* * * * *