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(71) Applicant(s)

**Pall Corporation**

**(Incorporated in USA - New York)**

**2200 Northern Boulevard, East Hills, New York 11548,  
United States of America**

(72) Inventor(s)

**Martin Jay**

**Roger Stott Riley**

(74) Agent and/or Address for Service

**Mathisen Macara & Co**

**The Coach House, 6-8 Swakeleys Road, Ickenham,  
UXBRIDGE, Middlesex, UB10 8BZ, United Kingdom**

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(56) Documents Cited

**GB 2225543 A**

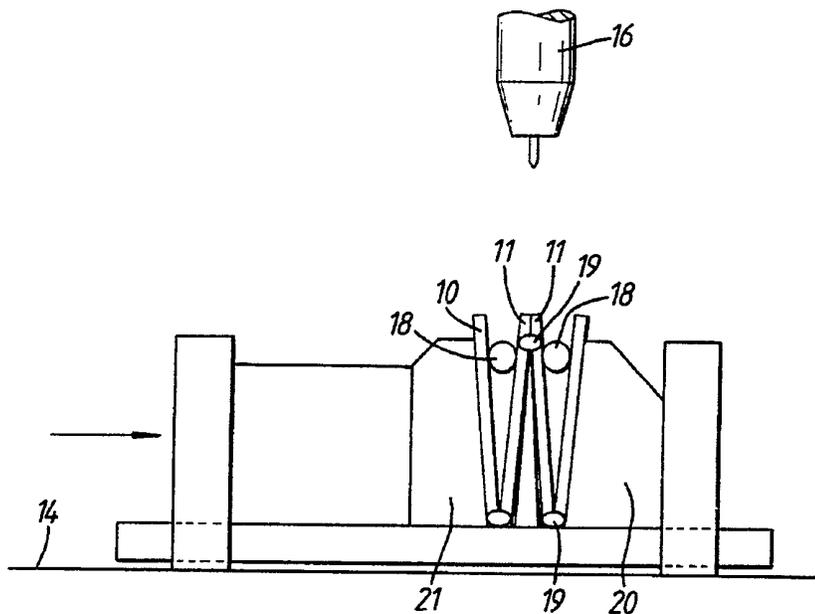
(58) Field of Search

UK CL (Edition L.) **B1D DDGA DDQA DDRA , B1T  
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(54) **Filters and filter manufacture**

(57) A filter of pleated shape is formed from porous metal sheet filter medium which is cut into strips 10 and then connected edge-to-edge by welding to form V-shaped pleats with the welds 19 forming ridges on alternately opposite sides of the filter. This has significant benefits over corrugating the sheet by bending including an absence of cracking and so a significantly better filter performance. The filter may be generally flat or tubular. The filter medium may be sintered stainless steel fibres laminated with a second layer of stainless steel woven mesh with sintered stainless steel powder in the interstices.



**Fig.2**

**GB 2 277 458 A**

1/1

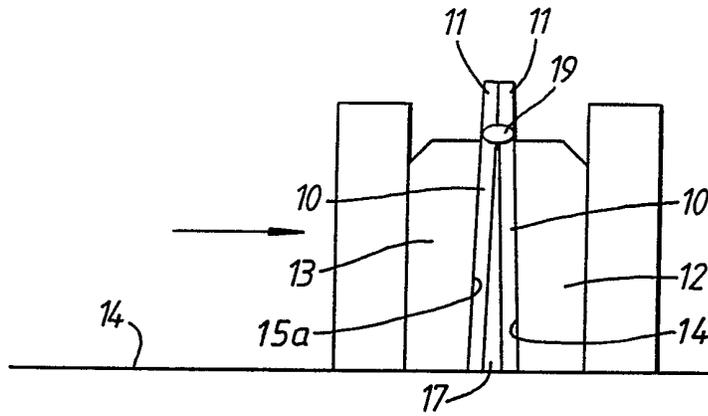
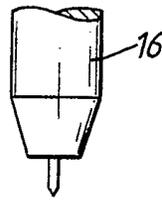


Fig.1

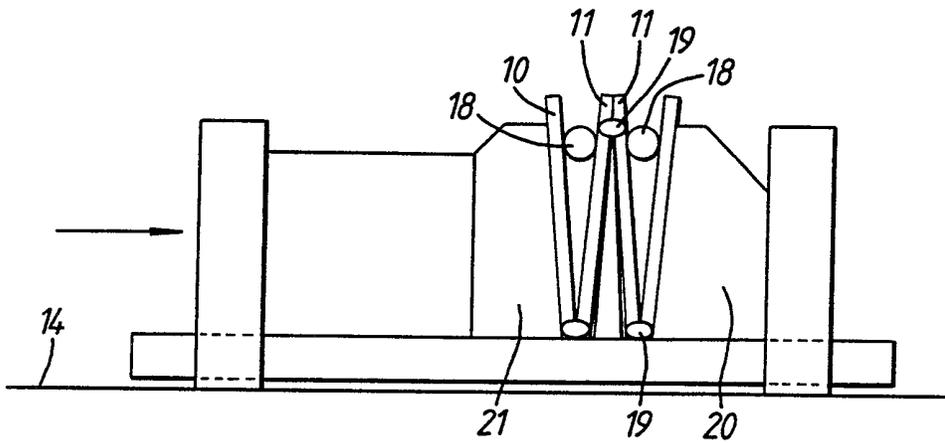
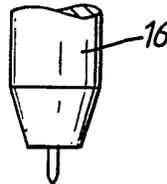


Fig.2

FILTERS AND FILTER MANUFACTURE

The invention relates to filters and filter manufacture and particularly to metal filters and their manufacture.

Metal filters are used in hostile environments where filters of, for example, plastics materials are not satisfactory. It has been proposed to form such filters from a sheet of porous stainless steel pleated into corrugations. The corrugated sheet may be formed into a cylinder.

It has been found that some stainless steel media are prone to damage when subject to the pleating necessary to form the corrugations. This is particularly the case where the medium is a thick composite of more than one layer. The media can crack along the stressed ridges of the corrugations and sometimes delamination occurs.

Such damage and inherent weakness can be exaggerated when the media is subject to reverse flows, flows near sonic velocity and high differential pressures. Any one of these can stress the weakened ridges to the point of collapse. This can cause the corrugations to vibrate, bend or close-up, blocking the flow path through the media.

According to a first aspect of the invention, there is provided a filter comprising V-shaped corrugations having a plurality of ridges on alternately opposite sides of the filter, each wall of each corrugation being formed by a porous metal strip having spaced side edges and each ridge being formed by a welded connection between two side edges of adjacent strips.

By welding together sheets to form the ridges, the ridges are unstressed. The weld supports and strengthens the ridge and cracking and damage are mitigated.

According to a second aspect of the invention, there is provided a method of manufacturing a filter comprising forming a plurality of porous metal strips with each strip having spaced side edges and then connecting the strips to form a corrugated filter having a plurality of ridges on alternately opposite sides of the filter, the corrugations being V-shaped and each ridge being formed by a welded connection between two sides edges of two adjacent strips.

The following is a more detailed description of the embodiment of the invention, by way of example, reference being made to the accompanying drawings in which:-

Figure 1 is a schematic elevational view of a welding jig showing two porous metal strips arranged in a V-configuration and welded together along respective side edges, and

Figure 2 is a view of the jig similar to the view of Figure 1 showing the connection of further porous sheets to form a succession of oppositely directed V-shaped corrugations with the ridges being formed by a weld.

Referring to the drawings, the filter to be described is formed from a sheet of porous metal media. The first layer of the sheet is of the kind manufactured and sold by Pall Corporation under the trade mark PMF. The media is formed from very fine short 316L stainless steel fibres in a uniform structure with the fibres sintered together at their points of contact. The PMF is supported by a second layer of a porous metal media of the kind manufactured and sold by Pall Corporation under the trade mark PMM. This is a thin sintered matrix of stainless steel powder within the pore structure of a stainless steel woven wire mesh.

Such media are described in GB-A-2160895. The rating of the PMF media is  $2\mu\text{m}$  as measured by a modified F2 test method at  $\beta = 100$ .

The sheet is cut into strips 10 so that each strip has parallel side edges 11 with the width between the side edges 11 of each strip being identical. The strips 10 have identical lengths equal to the required length of the filter.

The strips 10 are welded together in a manner to be described below using the jig shown in Figures 1 and 2. As seen in these figures, the jig comprises a fixed chill 12 and a moveable chill 13 mounted on a table 14. The chills 12,13 are formed from copper and have co-operating faces 14,15 lying in respective planes inclined to the vertical by equal amounts and converging as they extend away from the table 14.

A welding torch 16 is arranged above the table and is reciprocable in a vertical direction between the position shown in Figure 1 and a position in which the torch is adjacent the chills 10,11. The welding torch 16 may be part of a MICROTIG (trade mark) welding system using a micropulse 75 amps (max) tungsten inert gas power source supplied by Precision Beam Technologies. The welding system is mounted on a lathe to allow the welding torch 16 to be moved in a linear path. The position of the torch 16 in directions normal to said path is controlled by a touch and retract system also supplied by Precision Beam Technologies.

An inner chill spacer 17, also of copper extends between the chills 12,13 and has a cross-section which is an isosceles triangle with the side faces each parallel to a respective face 14,15 of the adjacent chill 12,13.

The filter is formed by placing two strips 10 between the chills 12,13, with one strip 10 located between one of the faces of the inner chill spacer and an associated face 14 or 15 of the adjacent chill 12 or 13, as seen in Figure 1. The two strips 10 thus form an inverted V-shape with respective ones of their two side edges 11 in contact and spaced above the upper edges of the chills 12,13. The chills 12,13 act to clamp the strips 10 in this position. The torch 16 can then be moved by the touch and retract system downwardly to a position against these contacting edges 11 and then be moved by the lathe along the edges to form a weld 19 between the edges 11.

The welded V-shaped sub-unit so produced is then removed from the jig and a second and subsequent pairs of sheets 10 welded together in the same way to form a plurality of V-shaped sub-units.

Next, two V-shaped sub-units are inverted and located between two further chills 20,21, as seen in Figure 2. The angle between the adjacent sheets 10 of the two

V-shaped sub-units is maintained by the inner chill spacer 17 and the angle between the sheets 10 of each V-shaped sub-unit is maintained by a copper rod chill 18 extending along the length of each V-shaped sub-unit.

The adjacent side edges 11 of the sheets 10 of the two V-shaped sub-units are then welded together by the welding torch 16 to form a W-shaped unit, as seen in Figure 2.

The W-shaped units are then welded together until a sheet is formed with as many corrugations as required. In every case, each ridge of the corrugations is formed by a weld as described above. When the sheet is complete, it may be bent into a circle and the side edges 11 of the final sheets 10 welded together to form a cylindrical filter. Such a cylindrical filter can then be provided with stainless steel end caps (not shown) connected thereto by a two-part epoxy resin in known manner.

In order to test the performance of a filter manufactured as described above, such a filter ("the welded filter") was manufactured with 140 pleats (involving 280 welds) in the manner described above. A second filter ("the pleated filter") of the same dimensions was manufactured using a method in which a sheet formed as described above (from which the strips 10 were cut) was not formed into strips but pleated by bending.

The two filters were first examined visually. The pleated filter had obvious signs of cracking, despite several intermediate annealing stages. These cracks were sealed using powdered stainless steel which was subsequently sintered in place.

The welded filter was free from cracks.

Both filters were bubble-tested in isopropylalcohol. In this test, a filter is immersed in isopropylalcohol and air under pressure applied to the interior of the filter. The pressure is increased until the first bubble is observed emerging from the outer surface of the filter being tested.

The pressure at which the first bubble was observed in the welded filter was three times higher than the pressure at which the first bubble was observed in the pleated filter. The leaks, when they appeared in the welded filter, were located in portions of the strips 10 which were not adjacent to any weld whereas, with the pleated filter, the leaks were observed from the ridges of the corrugations.

It is concluded, therefore, that a welded filter, has significantly improved performance over a pleated filter. Each weld acts as a beam supporting the two sheets 10 on

either side of the weld. The beams resist movement in all directions preventing collapse of the sheets 10 or flapping or vibration of the sheets 10.

The filter can be constructed by a semi-automated manufacturing process which gives constant corrugation configuration and strength. The corrugations formed are sharp uniform and regular and exhibit uniform height giving low entrance and exit pressure losses.

A test on a filter produced as described above with reference to the drawings shows low leakage when the flow is cyclically reversed or when subjected to a constant back flow. Examples of filters manufactured as described above with reference to the drawings exhibited no delamination, good integrity, straight regularly-shaped pleats and an overall performance significantly better than filters formed with bent corrugations.

CLAIMS

1. A filter comprising a V-shaped corrugation having a plurality of ridges on alternately opposite sides of the filter, each wall of each corrugation being formed by a porous metal strip having spaced side edges and each ridge being formed by a welded connection between two side edges of adjacent strips.
2. A filter according to claim 1 wherein the side edges of each strip are parallel and the spacing between said side edges is the same in each strip.
3. A filter according to claim 1 or claim 2 and in the form of a cylinder so that the ridges lie alternately on one of two imaginary concentric circles.
4. A filter according to any one of claims 1 to 3 wherein the foraminous metal strip comprises two layers of porous metal media, the first layer being of stainless steel fibres in a uniform structure with the fibres sintered together at their points of contact and the second layer being a stainless steel woven wire mesh and a sintered metal particulate bonded in the openings in said mesh.

5. A filter substantially as hereinbefore described with reference to the drawings.

6. A method of manufacturing a filter comprising forming a plurality of porous metal strips, each strip having spaced side edges, and then connecting the strips to form a corrugated filter having a plurality of ridges on alternately opposite sides of the filter, the corrugations being V-shaped and each ridge being formed by a welded connection between two side edges of two adjacent strips.

7. A method according to claim 6 including arranging two strips in a V-configuration with respective ones of said respective two side edges in contact and then welding said contacting side edges to form a ridge.

8. A method according to claim 7 and further comprising arranging two pairs of V-configuration strips to form a W-configuration with the other side edge of one of the sheets of one of the V-configurations contacting the other side edges of one of the sheets of the other V-configuration, said contacting sides being welded together to form a ridge.

9. A method according to claim 8 and comprising connecting together at least two of said W-configurations

by contacting respective other side edges of respective final sheets of the two W-configurations together and then welding said contacting edges to form a ridge.

10. A method according to claim 9 and further comprising bending said plurality of connected W-configurations into a cylinder so that the other edges of the final sheets of the connected W-configurations contact one another, with a weld being provided between said contacting edges to form a ridge.

11. A method of manufacturing a filter substantially as hereinbefore described with reference to the accompanying drawings.

**Patents Act 1977**  
**Examiner's report to the Comptroller under**  
**Section 17 (The Search Report)**

Application number

GB 9308800.3

-12-

**Relevant Technical fields**

- (i) UK CI (Edition L) B1D (DDGA DDQA DDRA)  
B1T (TDGA TDQA TDRA)
- (ii) Int CI (Edition 5) B01D (29/03 29/07 29/21  
29/23 29/35)

**Search Examiner**

R T HAINES

**Databases (see over)**

- (i) UK Patent Office
- (ii)

**Date of Search**

24 MAY 1993

Documents considered relevant following a search in respect of claims 1-11

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2225543 A (ENVAIR LTD)	1, 6



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