March 19, 1957 E. W. CONRAD 2,785,878

POROUS WALLED CONDUIT FOR FLUID COOLING

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Fig. 1

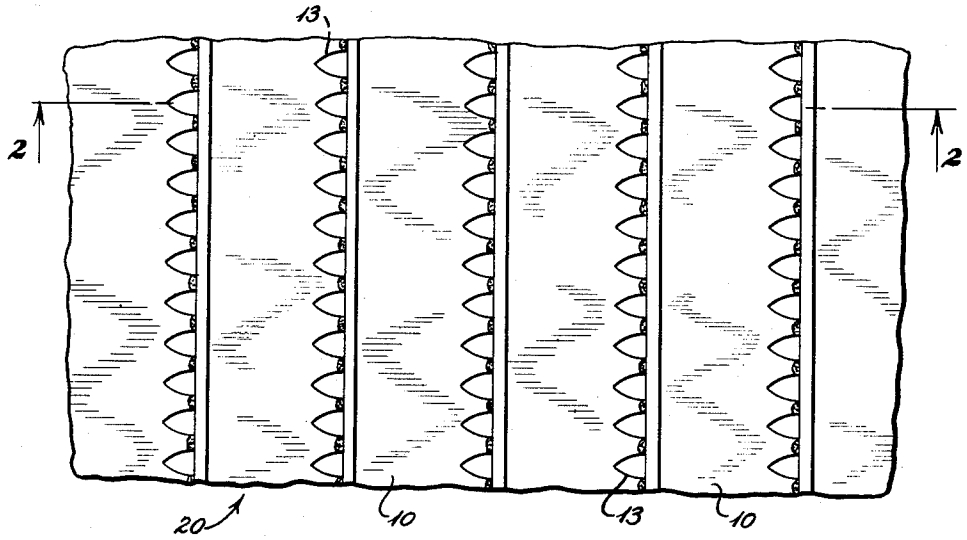


Fig. 2

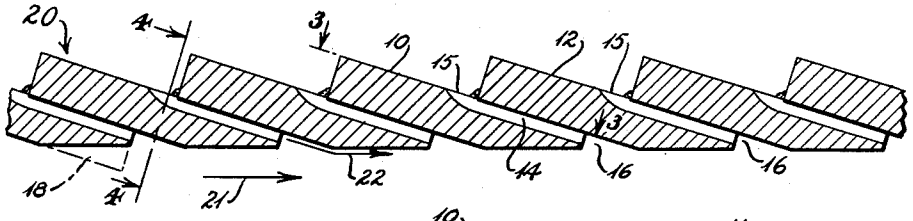


Fig. 3

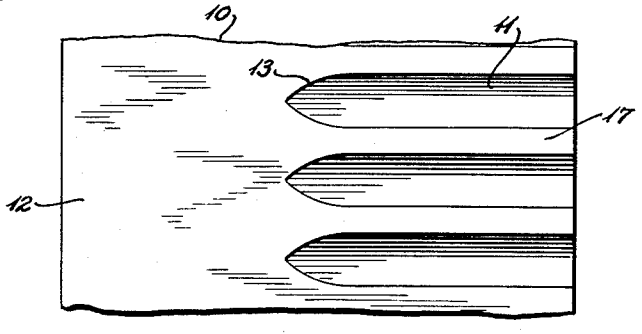
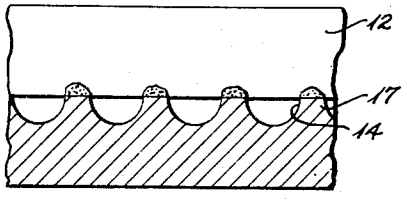


Fig. 4



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Fig. 5

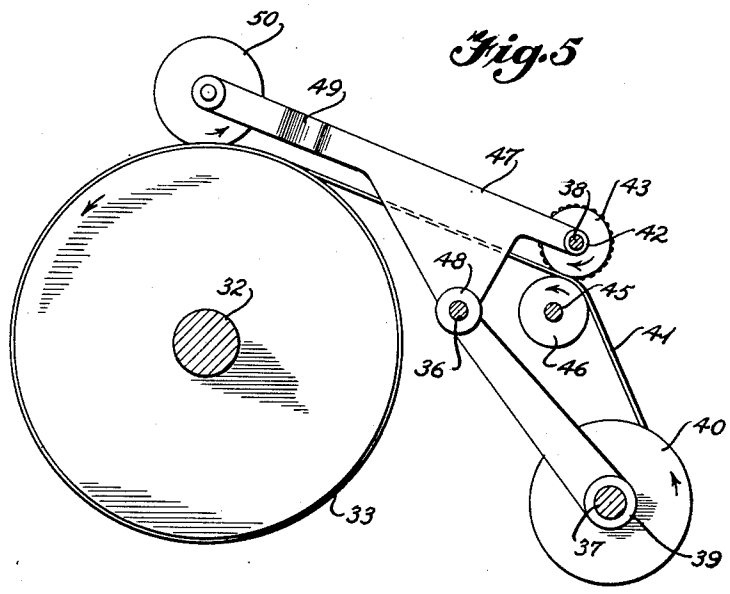
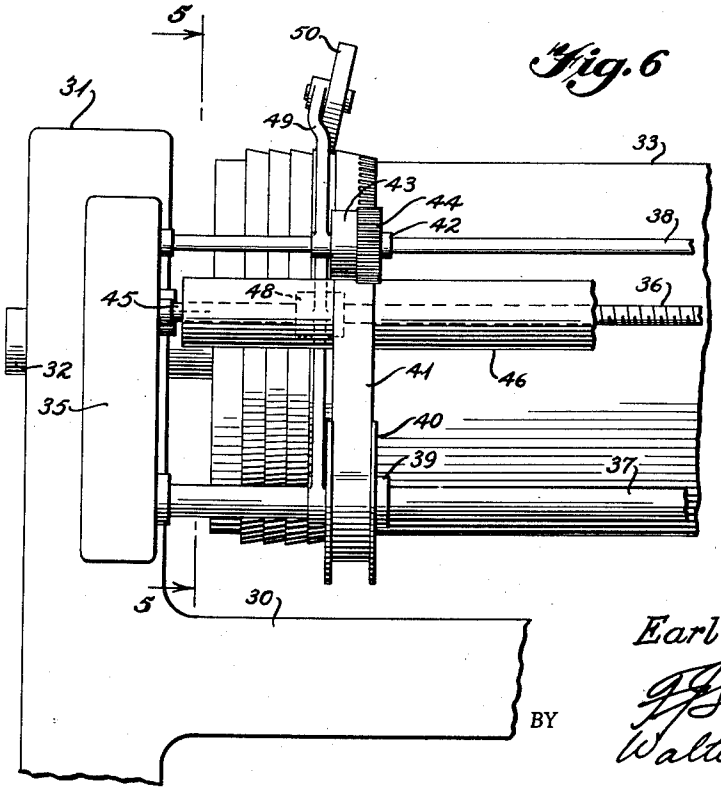


Fig. 6



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POROUS WALLED CONDUIT FOR FLUID COOLING

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Application September 16, 1953, Serial No. 380,628

1 Claim. (Cl. 257—1)

(Granted under Title 35, U. S. Code (1952), sec. 266)

This invention relates to fabricated walls suitable for fluid cooling, as applied for example to afterburners of turbo-jet engines.

Heretofore, use has been made of transpiration fluid cooling for heated flow conduits by employment of wire cloth or porous sintered plates of stainless steel. A disadvantage common to these structures is that the coolant gases penetrating the material emerge in random jets of diverse direction and mass content rather than in a controlled direction with uniform mass providing the most effective cooling. In addition, the wire cloth must be supported by additional frame units while the sintered plates have excessive weight.

In brief, the present invention comprises an assemblage of overlapping grooved strips so positioned that substantial structural strength is provided while controlled transpiration of coolant through the walls readily takes place.

An object of the invention is to provide a wall construction having sufficient structural strength to be self supporting and at the same time, resistant to face pressures.

An object also is to provide a wall construction which has ducts therein, so alined as to emit ejected coolant in predetermined directions for efficient wall cooling.

Still another object is to provide a transpiration wall wherein ducts formed therethrough are of uniform size and relationship.

Other objects will appear on consideration of the following detailed description of a preferred embodiment of the invention together with the accompanying drawing in which:

Fig. 1 is a plan view of a fragment of the material;

Fig. 2 is an edge view of a section of the material taken on lines 2—2 of Fig. 1;

Fig. 3 is a view of a fragment of the structural strip used in building the material, as taken along lines 3—3 of Fig. 2;

Fig. 4 is a detailed view showing the grooved metal surface for conducting coolant, as taken along lines 4—4 of Fig. 2;

Fig. 5 is an end view partly in section showing mechanism for fabricating the strip material into tubular form, as taken along lines 5—5 of Fig. 6; and

Fig. 6 is a plan view of the mechanism of Fig. 5.

Reference is made to Fig. 3 for a showing of the strip material which may be utilized in forming the transpiration wall. This is a thin flat strip 10, as metal of sufficient softness to take readily the knurling action of the groove former to produce grooves 11, the latter extending slightly over one half the strip side width in parallel directions leaving an ungrooved flat area 12. While the inclined pointed groove ends 13 are not necessary, they are advantageous in producing a smooth funnelling action on the incoming coolant.

To make the coolant structure, a plurality of these grooved strips 10 are overlapped to form a wall 20 as indicated in Figs. 1 and 2, the smooth plate section 12 of one strip overlying the grooves 11 of an adjacent strip to a point short of the groove length, thus providing a plurality of uniformly dimensioned and parallel ducts 14 between strips with exposed inlets 15 for coolant, such as air, and alined outlets 16 for the coolant jets. In this position the overlapping strips 10 are fixedly attached, as by welding, the base of strip section 12, for example, in the welding attachment, being integrated with the outer edges of the underlying ribs 17 of the adjacent strip as indicated in Fig. 4. The projecting inner corners 18 of the strips may then be removed by any appropriate means to obtain a smooth inner wall surface and thus reduce heat transfer to the wall 10 due to scrubbing action.

Fig. 1 illustrates a fabricated plate, assembled of strips 10 as described, which may be used as a tube or cone wall for supporting and cooling purposes. Such a fabrication may be usefully employed as a wall for a jet afterburner, as a diffuser inner cone for high temperature engines, or for supercharging boundary layers.

In use, assuming hot fluid flow on the exit side of the wall 20, as indicated by arrow 21, coolant, such as air is drawn or forced through inlets 15 and ducts 14 and is emitted in uniform jets at exits 16. Since the channels 11 are inclined in the general direction of the main fluid flow, the coolant is drawn smoothly into the same direction of flow, as indicated by arrow 22, the coolant forming a film intermediate the hot main gases and the wall 20. The wall is further cooled by contact of the coolant with the duct surfaces in passing through the wall, it being observed that the groove 11 of each duct increases the contact area of the coolant on the strip by about one and one-half times, for the groove curvature as shown in Fig. 4. It is at once apparent that not only is the cooling efficient in that it is applied directly to the area where cooling is needed, but also that the cooling possesses a high degree of uniformity so that the distortions due to random cooling action is eliminated. It appears further that the cooling structure is sufficiently rigid to be self supporting and to be resistant to important transverse fluid pressures, as distinguished, for example, from wire cloth structures.

While various apparatus may be used in manufacturing the wall structure, that as indicated in Figs. 5 and 6 is suitable for simple fabrication. A frame 30 (Fig. 6) has terminal standards 31 between which a shaft 32 for rotatably supporting forming drum 33 is mounted. The drum 33 is shown as cylindrical but any desired form may be used.

Auxiliary end standards 35 on the frame 30 support a worn shaft 36 therebetween as well as slide rods 37 and 38, rod 37 supporting a rotatable flanged wheel or reel 40 adapted to receive a roll of wall strip 41, a slidable shaft 39, and rod 38 supporting slidably a shaft 42 upon which knurling wheel 43, provided with knurl ridges 44, is freely rotatable. An additional rod 45 adjacent rod 38 is mounted between standards 35 for support of a freely rotatable cylinder 46. This cylinder supplies the blocking area for coaction with knurling wheel 43 whereby a continuous series of uniform grooves are formed in one side of the surface of the strip when passed between the cylinder and wheel.

In order to hold wheels 40 and 43 in lateral alignment and to secure simultaneous axial adjustment of these units, a connecting frame 47 is provided in the form of a flat angular plate or spider having fixed connection to the travelling member 48 on the worm 36, the bearing 42 of knurled wheel 43, and the bearing 39 of strip reel 40. Connected also to this frame 45 is an arm 49 supporting at its end a welding roller 50 for binding the overlapped strips into an integral structure. Appropriate electric connections to the roller 50 are made in accordance with well known procedure.

It now appears that by passing the free end of strip 41

between cylinder 46 and knurling wheel 43, attaching the strip end to the drum 33 and rotating the drum in the direction indicated by the arrow, the strip is unwound from wheel 40, knurled by knurling wheel 43, and laid on the forming drum 33. Then, by rotating the worm in a direction to obtain a slow axial movement of the frame 47, the strip is overlapped, the preferable amount of overlap being such as to expose only a small fraction of the grooved surface of the strip, as indicated in Figs. 1 and 2. It is apparent that, as the worm 36 rotates, the overlapped strip forms a spiral on the drum 33, the angle of pitch of the spiral being regulated by the speed of worm and drum rotation. As the overlapped strip passes under the welding roller 50 a seam weld forms between the upper edges of the groove ridges and the adjoining base surface of the strip, as indicated in Fig. 4. Appropriate power means (not shown) are supplied for rotation of the worm shaft 36 and the drum 33. If necessary retarding means, such as a frictional shoe, may be applied to strip reel 40 to prevent too free movement thereof.

Obviously many modifications and variations of the present invention are possible in the light of the above teachings. It is therefore to be understood that within the scope of the appended claim the invention may be practiced otherwise than as specifically described.

The invention described herein may be manufactured and used by or for the Government of the United States of America for governmental purposes without the payment of any royalties thereon or therefor.

What is claimed is:

A cooling construction for fluid conduit walls of gas conveyors subject to excessive heat on the fluid flow side thereof, comprising a tubular spiral strip of uniformly sized strip material with strip edges approximately transverse to the direction of fluid flow in the conveyor, each strip section overlapping and contacting the adjacent rear strip section and a forward area of the outer surface of each strip section being grooved in a direction at an angle to the transverse strip edge, the overlap of each strip section covering a part only of the grooved area of the next preceding strip section and with the edges of the grooves of each strip section being sealed directly to the overlying surface of the overlapping strip section forming plural ducts embedded in the overlaid strip section, the rearward ends of said ducts terminating on the forward strip section side adjacent the forward ends of the ducts on the rearward strip section side, whereby the strip is directly cooled approximately throughout its entire length and width.

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