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FLUID CUSHIONING SYSTEMS

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2 Sheets-Sheet 1

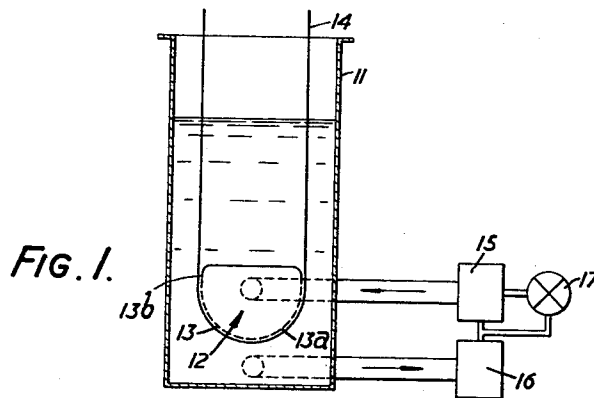
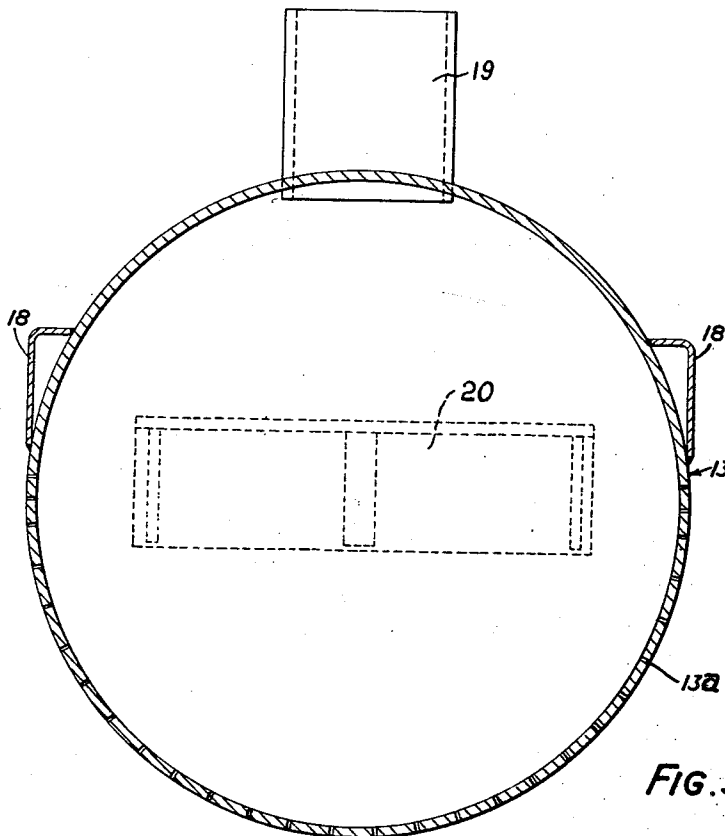


FIG. 3.

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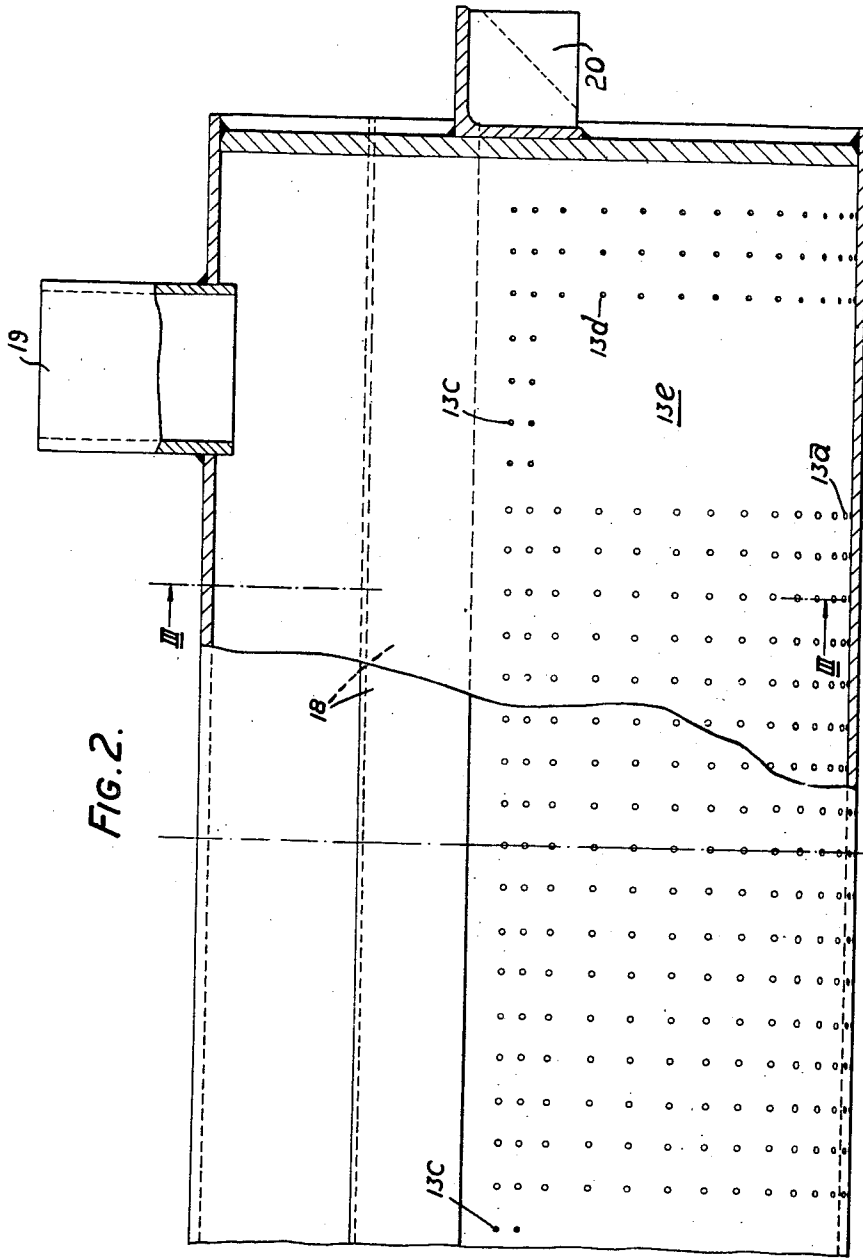
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FLUID CUSHIONING SYSTEMS

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2 Claims. (Cl. 134—15)

This invention relates to fluid cushioning systems.

Proposals have been made for use of fluid cushioning systems to support and guide elongate material, such as tinplate for example, in a continuous treatment line whereby use of conventional rollers and the disadvantages thereof such as marking are largely obviated. However, while these proposals have been satisfactory in many applications, they are either not always practicable or they are relatively inefficient in other applications.

In particular many continuous treatment lines are operated at high tension, in association with high strip speeds or by passing the strip through liquid processing tanks, and it is in connection with such circumstances that the present invention is concerned.

According to the invention in one aspect the present invention provides a method of guiding elongate material during passage of the material through a liquid bath for treatment of the material, which method comprises forcing liquid under pressure through discharge orifices in a curved guide surface forming part of a pressure chamber within the liquid bath so as to form and maintain a cushion of pressurised fluid between said guide surface and elongate material passing thereacross, whereby the material is maintained out of contact with said surface.

In another aspect the present invention provides apparatus for guiding elongate material through a liquid treatment bath comprising a bath, a pressure chamber for treatment liquid which chamber is located in said bath, said chamber having a perforated bearing surface of perforated form, means for supplying liquid to said chamber, and means for collecting liquid from said bath for supply to said chamber.

In a preferred form, the pressure chamber according to the present invention has a bearing surface having orifices substantially uniformly distributed over an intermediate area thereof and additional orifices located substantially around the periphery of further areas of said surface adjacent the sides of said intermediate area relative to the direction of material passage over the surface.

In order that the present invention may be clearly understood and readily carried into effect, the same will now be more fully described, by way of example, with reference to the accompanying drawings, in which:

FIGURE 1 is a schematic illustration of a liquid bath containing a pressure chamber according to the invention, and includes the liquid circulation circuit,

FIGURE 2 is a part front view, partly shown in section, of a pressure chamber according to the invention, and

FIGURE 3 is a cross-section of the chamber of FIGURE 2.

FIGURE 1 shows a liquid bath 11 having located therein a pressure chamber 12 the lower or curved surface 13 of which is perforated to form substantially uniformly distributed liquid orifices 13a. This curved sur-

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face acts as a bearing surface for strip material 14 passed through the treatment liquid in bath 11.

During passage of the strip 14 through liquid in the bath 11 and around chamber 12, treatment liquid is supplied, under pressure, to the inside of chamber 12 whence it passes through the orifices of surface 13 and then between the surface 13 and strip 14 into the bath 11. Passage of liquid in this manner creates and maintains a cushion of pressurised liquid between the strip and bearing surface whereby the strip is maintained out of contact with the bearing.

Since treatment liquid is continuously supplied to the bath 11 by way of the chamber during strip treatment, it will normally be necessary to drain liquid from the bath at the same time. In a preferred arrangement, such as shown by FIGURE 1, a pump 15 is provided to supply liquid to the pressure chamber and the pump draws liquid from the bath through a filter 16 for this purpose, thus forming a closed loop liquid recirculation system. It will be usual to provide some means for controlling the liquid flow through the closed system and this may be effected in any convenient manner, such as by use of a by-pass valve 17 for pump 15.

The provision of a filter is primarily to avoid any blockage accumulating within the pressure chamber on the perforated bearing surface, and this will be relevant where the strip carries scale or other matter which may dislodge therefrom during passage through the bath. However, it will be noted that for this purpose the "mesh size" of the filter need be no smaller than the smallest orifice of the bearing surface.

In some circumstances it may be desirable to make the bearing surface flat along its leading and trailing edges relative to strip flow as indicated at 13b, to ensure that the strip does not contact the bearing at these locations. However, it will be noted that this is not essential for operation in accordance with the invention in normal circumstances.

Also, the bearing surface may be provided with strip guide members at its sides relative to strip flow to maintain the strip in line with the bearing. Liquid leaving the pressure chamber will then flow between the strip and bearing surface, and thereafter between the strip edge and guide members into the bath, so that the general effect will be to maintain the strip centred on the bearing. Again, this is found to be unnecessary for operation in normal circumstances but may be desirable in the event of difficulty in maintaining correct strip track.

The pressure chamber according to this invention may be formed of any suitable material, such as metal or plastic, for example polyvinylchloride, re-inforced if necessary.

Turning now to FIGURES 2 (the partly illustrated end of which will be understood to be the same as the fully illustrated end) and 3, these show a preferred form of pressure chamber developed for guiding steel strip which may have a width within a range of from 20 to 40 inches, say. It will be seen that in this instance the pressure chamber is basically of right circular cylindrical form with circular orifices provided over a central area of the lower half of the cylinder, this lower half forming the bearing surface. This central perforated area will be of the same order of width as the minimum strip width above, and in use with such strip operation will be generally as described above in relation to FIGURE 1.

As strip width is increased, the sides of strip passing over the bearing surface will tend to touch down and contact the surface. For initial increase of strip width, touch down is avoided by continuing to provide additional peripheral orifices 13c along the leading and trailing edges of the bearing surface. Orifices 13c act to form a pressurized liquid curtain during operation, the effect of which is to maintain the principal outflow of liquid from pressure chamber to the sides of surface 13 between such surface and strip 14.

This continuation of peripheral orifices, 13c, along the leading and trailing edges of the bearing surface permits a significant increase in strip width without touch down. However, a stage is reached where further increase of strip width requires additional measures and this takes the form of additional peripheral orifices 13d at the sides of surface 13. The result of this arrangement is to define areas 13e (only one of which is shown) of surface 13 with orifices around each of their peripheries providing pressurized fluid curtains surrounding the respective areas 13e. The effect of the surrounding fluid curtains is to form and maintain pressurized liquid cushions there-within above the areas 13e to maintain the strip spaced apart from the bearing surface. Thereafter the strip width may be slightly extended once more.

The advantage of the arrangement of FIGURES 2 and 3 is that varying widths of strip may be employed with the same bearing surface without prohibitive decrease of efficiency when employing relatively narrow strip since the number of orifices 13c "exposed" in such circumstances is not high compared to the number of orifices 13a within the central area of surface 13. That is to say, a major proportion of the orifices are formed by orifices 13a and in the case where relatively narrow strip is passed only over orifices 13a, say, the "loss" of pressurized liquid through orifices 13c and 13d which does not contribute to supporting the narrow strip is not so significant that the efficiency of the required strip supporting operation could only be maintained by excessively increasing the liquid pressure input relative to that required for similar operation with wide strip passing over all of the orifices.

Also, it will be seen that orifices 13c and 13d are of smaller diameter than 13a.

In a particular embodiment of FIGURES 2 and 3 developed for steel strip or the like having width in the range from 20 to 40 inches, orifices 13a are of $\frac{3}{32}$ inch diameter and orifices 13c and 13d are of $\frac{1}{32}$ inch diameter. The pressure chamber diameter is $1\frac{1}{2}$ inches with adjacent orifices mutually disposed at 1 inch centres apart, except for the first three rows each at the leading and trailing edges where the orifice spacing between rows, as distinct from columns, is reduced to less than 1 inch. The spacing between corresponding adjacent orifices of the first and second rows nearest the leading and trailing edges is approximately 0.5 inch, while such spacing for the second and third rows nearest these edges is approximately 0.67 inch.

The cylinder of the pressure chamber in this instance is formed of steel and is provided with stiffening members 18 adjacent the leading and trailing edges. If necessary, to avoid strip touch down on the members 18, orifices may be provided in these members and the cylinder surface therebeneath to provide additional pressurized liquid flow from the bearing against the strip.

Also shown in FIGURES 2 and 3 is one of the two inlet ports 19 for entry of pressurized liquid, and one of the two lug arrangements 20 whereby the pressure chamber can be mounted in a liquid treatment bath.

The arrangement of orifices is symmetrical about the centre line of the bearing surface relative to strip flow, with the central area extending over a width of 16 inches. Orifices 13d are introduced at a width of 30 inches and the overall width of bearing surface 13 is 34 inches.

In operation of the particular embodiment just de-

scribed it has been found that, employing water as a cleaning liquid, tin plate of 32 inches width say requires a pump rate of about 180 gallons per minute to maintain a means clearance of 0.05 inch between the tinplate and the bearing surface when the strip tension is 2,000 lbs. The corresponding pump rate for a clearance of 0.075 inch clearance, at the same strip tension, is about 260 gallons per minute. These rates will be reduced, for the same clearances, to about 110 and 175 gallons per minute respectively for a strip tension of 1,000 lbs.

Considering similar clearances and tensions for tinplate of 20 inch width, the corresponding pump rates are about 315, 350, 165 and 245 gallons per minute, respectively.

It has been found that variation of strip thickness is not a significant factor in determining the pump rate required for a given mean clearance, and the main criterion is strip tension: except that in extremes of strip weight per unit length this factor may become more significant, although the significance will be less than that of tension. This also applies in generally similar manner to the question of strip speed, and in the case of tinplate satisfactory operation has been achieved in the range of 600 to 800 feet per minute, these being high speeds in relation to current practice. Again, it is thought that equally satisfactory operation attains at yet higher strip speeds, of the order of 1,500 feet per minute.

We claim:

1. A strip treatment line comprising a tank for holding a liquid bath, a liquid outlet port for said tank, a pressure chamber disposed in said bath, and at least one inlet port for pressurized liquid entry into said chamber, said chamber having a part-cylindrical element, the curved surface thereof defining a bearing surface over which said strip material is passed; said bearing surface being bounded by two opposite, parallel side edges formed by the intersection of said curved surface with the opposite, parallel sides of said part-cylindrical element, and by two opposite, parallel, longitudinal edges parallel to the axis of said part-cylindrical element, said longitudinal edges defining the extent of said curved surface about said axis; one of said longitudinal edges defining a leading edge corresponding to the first portion of said curved surface over which the strip passes and the other of said longitudinal edges defining a trailing edge corresponding to the last portion of said curved surface over which the strip passes; said bearing surface having a pattern of outlet orifices for pressurized liquid exit from said chamber to maintain strip passing over said curved surface supported on a liquid cushion and out of contact with said bearing surface; said pattern of orifices consisting of a first area spaced inwardly from said side edges and extending around the median of said curved surface substantially fully between said leading and trailing edges and containing a substantially uniform distribution of orifices of constant diameter arranged in columns over the entirety of said first area; second and third areas each respectively adjacent to one of said side edges and axially spaced from said first area and extending around said curved surface substantially fully between said leading and trailing edges and containing a uniform distribution of orifices of constant diameter arranged in columns over the entirety of said second and third areas; fourth and fifth areas, each adjacent to said leading edge and extending a short distance therefrom around said curved surface and containing a uniform distribution of orifices of constant diameter arranged in columns over the entirety of said fourth and fifth areas, said fourth area being positioned between and contiguous to said first and second areas, said fifth area being positioned between and contiguous to said first and third areas, sixth and seventh areas, each adjacent to said trailing edge and extending a short distance therefrom around said curved surface and containing a uniform distribution of orifices of constant diameter arranged in columns over the entire said sixth and seventh areas, said sixth area

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being positioned between and contiguous to said first and second areas, said seventh area being positioned between and contiguous to said first and third areas; said first, third, fifth and seventh areas enclosing a first space on said curved surface having no orifices and said first, second, fourth and sixth areas enclosing a second space on said curved surface having no orifices, the axial dimension of said first and second spaces being several times greater than the axial distance between any two adjacent columns of said orifices, and the diameter of said orifices in said second, third, fourth, fifth, sixth and seventh areas being dimensionally smaller than the diameter of said orifices in said first area.

2. A strip treatment line as claimed in claim 1 in which those orifices nearest said leading and trailing edges are spaced from the orifices next nearest said leading and trailing edges respectively, in a direction parallel to said side edges, by a distance smaller than the average distance

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in said direction between adjacent orifices in other portions of said surface.

References Cited by the Examiner

UNITED STATES PATENTS

5	1,844,798	2/32	Schroeder	68—62 X
	2,454,585	11/48	Alderman	134—10
	2,590,407	3/52	Haas	134—122 X
	2,689,196	9/54	Daniels	226—97 X
10	2,736,106	2/56	Offen	226—97 X
	2,900,992	8/59	Johnson	134—122
	3,022,203	2/62	Mains et al.	134—15
	3,050,422	8/62	Zak	134—36 X
	3,087,664	4/63	Streeter	226—97
15	3,097,971	7/63	Carlisle et al.	134—15

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