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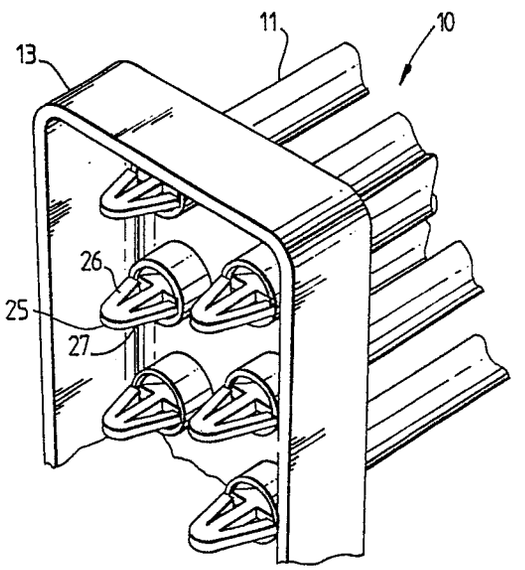
(54) Vehicle radiator turbulator.

(57) A turbulator for a vehicle radiator tube 11 comprises an elongate element which is inserted into the tube and is provided with a flow deflecting vane or vanes orientated to enhance turbulence in water flowing through the tube. Locking means 25 comprising two resilient tongues 26, 27 are provided at a leading end of the element. These tongues deflect inwardly to allow insertion of the turbulator into the tube and spring outwardly to lock behind the end of the tube after insertion.

Fig.4.



EP 0 282 148 A2

Vehicle Radiator Turbulator

The present invention is concerned with a turbulator for a vehicle radiator tube which is adapted to enhance the turbulence of water flowing through the tube.

Until recently vehicles have had their radiators positioned with the water tubes oriented vertically. The convection currents in the water flowing through the vertical tubes created sufficient turbulence in the water to assist the effectiveness of the radiator. However, modern aerodynamic vehicle designs now demand very low bonnet lines. This has led to the adoption of crossflow, or horizontally disposed, radiators. The drive towards weight saving in vehicles has also resulted in crossflow radiators being produced in a very dense, shallow form in aluminium alloys. This has produced radiator systems operating just within their maximum capability, with no effective convection currents to aid efficiency.

In order to improve the water flow it is known to insert into each tube a turbulator in the form of an aluminium spiral which is designed to increase the turbulence of the water as it flows through the radiator tube. This known type of turbulator however, creates a number of problems. It is limited in its effect, being loose within the tube it is liable to rotate as the water flows through the tube which sets up vibration and being made of aluminium, the vibration is liable to damage the wall of the aluminium tube causing leakage.

It is therefore an object of the present invention to provide a turbulator for a vehicle radiator tube which significantly enhances the turbulence in the water flowing through the tube, but which is fixed in relation to the tube and will not set up any significant vibration.

According to the present invention, we provide a turbulator for a tubed vehicle radiator, said turbulator comprising an elongate element adapted to be inserted into a tube of the radiator and provide with flow deflecting vane means orientated to enhance turbulence in coolant flowing through the tube, said turbulator further comprising means for retaining the elongate element in position in the tube, which position retaining means comprises a locking device at a leading end of the elongate element which locking device is insertable through the tube but adapted to resist withdrawal of the turbulator from the tube.

The locking device may comprise two resilient tongues adapted to spring outwardly and lock behind one end of the tube.

The position retaining means may comprise lug means extending transversely of the elongate element at the trailing end thereof to limit insertion of the elongate element through the tube.

The turbulator may comprise at least two said elongate elements adapted to be inserted into respective generally parallel tubes of the radiator, wherein said elongate elements are interconnected at their trailing ends to prevent rotation of the elongate elements in the tubes in which they are inserted in use. When lug means are provided as aforesaid the elongate elements may be interconnected at their lug means.

Preferably, the elongate element is in the form of a substantially flat strip having two opposed major faces, and said vane means extend outwardly from said faces. The vane means preferably comprise a plurality of vanes each of which is generally in the shape of a segment of an ellipse having a convexly curved outer edge and is orientated at an angle to the length of the strip such that said outer edges lie on a cylinder.

Advantageously the vanes form at least one generally spiral arrangement around the flat strip and in a presently preferred embodiment the vanes form two generally spiral arrangements around said flat strip and the strip is provided with side edges each of which is formed with a series of V-notches spaced along the length of the strip between the vanes extending from the two faces of the strip.

The invention also provides a turbulator for a vehicle radiator having generally parallel tubes, said turbulator comprising at least two elongate elements adapted to be inserted into respective tubes of the radiator, each elongate element being provided with flow deflecting vane means orientated to enhance turbulence in coolant flowing through the tubes, each elongate element being interconnected at one of its ends only with at least another said elongate element at the corresponding end thereof such that said elongate elements extend generally parallel to each other, whereby when the elongate elements are inserted in the tubes rotation of each element within a tube is prevented by virtue of said interconnection with at least one other elongate element which is inserted in another tube.

In such a turbulator, preferably the free ends of said elongate elements opposite said interconnected ends thereof are provided with respective locking devices which are insertable through the respective tubes of the radiator but adapted to resist withdrawal of the turbulator from the tube.

Presently it is preferred to provide a turbulator defined in either of the last two paragraphs with two elongate elements.

In order that the invention may be well understood, some embodiments thereof will now be de-

scribed with reference to the accompanying drawings, in which:

Figure 1 is a plan view of a vehicle radiator;

Figure 2 is a section taken on the line II-II of Figure 1;

Figure 3 is a perspective view of one end of the radiator shown in Figure 1 with the sealed end cap of the radiator removed;

Figure 4 is a perspective view of the opposite ends of the radiator;

Figure 5 is a front elevation of a turbulator;

Figure 6 is a side elevation of the turbulator shown in Figure 5;

Figure 7 is an end view of the turbulator shown in Figures 5 and 6;

Figure 8 is a side view of another turbulator;

Figure 9 is a side view of the turbulator shown in Figure 8 rotated through 90°;

Figures 10 and 11 are views similar to Figures 8 and 9 showing yet another turbulator;

Figure 12 is a section through yet another turbulator mounted in an oval section tube;

Figure 13 is a side elevation of a turbulator adapted for use particularly with the radiator tube of Figure 12;

Figure 14 is a side view of yet another turbulator;

Figure 15 is a side view of the turbulator shown in Figure 14 rotated through 90°;

Figure 16 is an end view of the turbulator shown in Figures 14 and 15 taken from the left-hand side of Figure 15;

Figures 17 and 18 are fragmentary side views at 90° to each other of another turbulator showing a presently preferred configuration for the elongate element or elements thereof; and

Figures 19A, B, C, D and E are respectively views taken along the lines A-A, B-B, C-C, D-D and E-E of Figure 17.

In Figure 1 a vehicle radiator is indicated generally at 10. The vehicle radiator 10 comprises a plurality of radiator tubes 11 joined by end plates 12 and 13, each of which is sealed by an end cap 14 and 15 respectively. The end plates 12 and 13 are cup-shaped so as to form water reservoirs into which the open ends of the tubes 11 project. Vanes 16 are provided on the tubes 11 to protect the tubes and enhance the heat exchange capability of the radiator.

In order to enhance the turbulence of the water coolant, such as flowing through the tubes 11, a turbulator is retained in position in each tube. One of the turbulators 20 is shown in Figures 5 to 7 and will now be described in more detail.

The turbulator 20 is formed from a synthetic plastics material such as polypropylene and comprises an elongate element, which in the embodiment of Figures 5 to 7 is in the form of a flat strip 21 formed with a plurality of apertures 22 and a plurality of deflecting vanes 23. The width of the strip 21 over a major part of its length is such that it is a close fit within the tube 11, as shown particularly in Figure 2 and will not therefore move transversely within the tube to any significant extent.

Each vane 23 extends outwardly generally normally to and from a major face of the strip and is in the shape of a segment of an ellipse, having a convexly curved outer edge 24. The vanes 23 are spaced along the length of the turbulator and arranged alternately on opposite sides of the strip 21. In the particular example shown, each vane is orientated at an angle of approximately 35° to the longitudinal axis of the strip 21 and adjacent vanes, on opposite sides of the strip, are inclined at approximately 110° to one another. However, the angle of inclination of the vanes to the length of the strip may be varied to give the required turbulence. As is clear from Figure 7 the angle of orientation of the vanes is such that the outer edges thereof lie on a cylinder whereby they are able to closely cooperate with the inner cylindrical surface of a tube 11 when inserted therein.

An aperture 22 is provided in the strip adjacent and to the same side of each vane so that, as water flows through the tube it is deflected by a vane on one side of the strip through the aperture adjacent the strip and then deflected by the next vane on the opposite side of the strip back through the next adjacent aperture to the first side of the strip and so on. The turbulator thus creates a sinuous flow of water along the length of the tube from side to side of the strip.

The leading end of the turbulator 20 is formed with locking means 25 in the form of resilient tongues 26 and 27 which can be compressed to pass through the tube but which then spring outwardly to abut the end of the tube and resist withdrawal of the turbulator from the tube. The trailing end of the turbulator 20 is formed with locating means in the form of two outwardly directed lugs 28 and 29. The lugs 28 and 29 extend outwardly further than the width of the strip 21 and are adapted to locate in slots in an end location cap 30, so as to resist rotation of the turbulator relative to the tube.

In order to assemble the turbulator 20 in a tube 11, an end location cap 30 is first fitted onto an end of the tube 11. As shown in Figure 3, the end location cap 30 is tubular and adapted to fit onto an end of the tube 11 as a tight friction fit. To enable the end location cap 30 to fit a range of tube diameters, the cap 30 is made from a resilient plastics material such as polypropylene and is formed with two axially extending expansible webs 31 and 32. The cap 30 is also provided with two

diametrically opposed slots 33 and 34. The turbulator is inserted through the cap 30 and the tube 11 until the lugs 28 and 29 locate in the slots 33 and 34. As the leading end of the turbulator is inserted through the tube 11, the tongues 26 and 27 are compressed and then spring outwardly to abut the end of the tube and resist withdrawal of the turbulator from the tube. As shown in Figure 4, the length of the turbulator is such, in relation to the length of tube 11, that in the assembled position, the lugs 28 and 29 of the turbulator abut the opposite end of the tube 11.

When the turbulator is mounted in the tube 11, lengthways movement of the turbulator is prevented by the tongues 26, 27 and the lugs 28, 29 and rotation of the turbulator is resisted by the engagement of the lugs 28 and 29 with the end cap 30.

When a turbulator 20 has been mounted in each of the tubes 11, the radiator is filled with water and the reservoirs at each end of the radiator sealed with the closure lids 14 and 15. In use, as water flows along the tubes, it is deflected by alternate vanes from side to side through the strip 21 so that a sinuous movement of water is achieved along the length of each tube. This turbulence in the water flow significantly enhances the heat exchange characteristics and efficiency of the radiator.

It is envisaged that an end of each tube may be formed with slots to receive the lugs 28 and 29 of the turbulator so as to eliminate the need for the end cap 30. The turbulator may also take other forms than that shown in Figures 5 to 7. For instance, as shown in Figures 8 and 9, a turbulator 40 may comprise a circular section elongate element in the form of a rod 41, and vanes 42, 42a each of which partly encircles the rod 41 so as to form an interrupted spiral around the rod. In use, water is caused to flow around the rod 41 as it passes along the radiator tube thereby increasing the movement and turbulence of the water.

Figures 10 and 11 illustrate a further embodiment of the invention, comprising a turbulator 43 having a circular section elongate element in the form of a rod 44, and vanes 45, 45a and 46,46a which are similar to the vanes 42,42a but which are arranged around the rod 44 to form a double spiral.

It is also envisaged that each tube of the radiator may be oval in section as shown in Figure 12 which illustrates a vehicle radiator tube 50 and a turbulator 51 similar to the turbulator 20 except that vanes 52 of the turbulator are shaped so as to fit closely within the oval section tube. In this embodiment, it will be apparent that rotation of the turbulator within the tube is resisted by the fact that the tube is oval in cross-section and the vanes are a close fit within the tube.

In yet a further embodiment of the invention it is envisaged that similar locking means may be provided at each end of the flat strip, as shown in Figure 13, which illustrates a turbulator 60. The turbulator 60 comprises a flat strip 61 which is provided with locking means at each end in the form of tongues 62, 63 and 64, 65, respectively. The turbulator 60 can be inserted either end first into a radiator tube until the tongues at the leading end of the strip snap through the end of the tube. The turbulator is then locked in position by the tongues at each end, which overlap the end of the tube.

Figures 14 to 16 show a further embodiment of the invention in which the turbulator 70 comprises more than one elongate element 71 provided with flow directing means 72. As illustrated the turbulator 70 comprises two elongate elements 71 adapted to be inserted into respective tubes 11 of the radiator which elements 71 are interconnected at one end only such that they extend generally parallel to each other. However, it is to be understood that the turbulator may comprise more than two elements 71, in which case each element 71 would be interconnected at one of its ends only with at least another element 71 at the corresponding end thereof such that all of the elements 71 extend generally parallel to each other.

As illustrated, the configuration of each elongate element 71, the vanes 72 thereon, the locking means 73 at the leading ends of the elements and the lugs 74 at the trailing ends thereof, is generally identical to the corresponding parts of the turbulator shown in Figures 10 and 11. The two elements 71 are interconnected at their trailing ends, and more particularly they are interconnected at their lugs 74. Alternatively or, as illustrated, additionally the trailing ends of the elements are interconnected by a gating arrangement 75 used in the injection moulding process for manufacturing the turbulator in an integral moulding. It will be appreciated that when the elements 71 are inserted in respective radiator tubes 11 they are located axially therein by the locking means 73 and lugs 74 abutting against the opposite ends of the tubes, and each element 71 is prevented from rotating within the tube in which it is inserted by virtue of its interconnection with the other element at the trailing ends of the elements, thus obviating the need for the tubes to be provided with slotted caps 30 shown in Figure 3

Figures 17, 18 and 19A-E illustrate an alternative elongate element and vane arrangement for the previously described turbulators.

In this alternative, the elongate element is in the form of a flat strip 80 having two opposed major faces 81, 82. The vanes 83 extend outwardly from these faces 81, 82 and form two generally spiral arrangements around the strip 80. Each vane

83 is generally in the shape of an ellipse having a convexly curved outer edge 84 and is orientated at an angle to the length of the flat strip such that the outer edges lie on a cylinder, as best appreciated from Figures 19A and 19B. As shown the vanes 83 are orientated at 30° to the longitudinal axis 85 of the strip 80. When inserted into a tube 11, the outer edges 84 of the vanes closely cooperate with the tube's inner cylindrical surface.

The vanes are spaced along the strip, and the side edges 86 of the strip are each formed with a series of V-notches 87 spaced along the strip between the vanes extending from the opposite faces of the strip. These notches enable the coolant to flow from one side of the element to the other when the element is inserted into a tube. More specifically, each side edge 86 comprises spaced apart flats 88 parallel to axis 85 at the points of maximum width of the elongate element where adjacent vanes on opposite faces of the strip in the same spiral arrangement are contiguous, and between these flats, slopes 89, 90 inclined with respect to axis 85 forming the V-notches 87. Each slope 89, 90 smoothly merges into a portion of a face of a vane and opposed notches 87 in the side edges 86 are formed between the same pair of vanes.

Since the turbulators described above are made from plastics material they are not subject to corrosion. Also it will be understood that they cannot move significantly within the tube once inserted in place, axially, transversely or rotationally and consequently are not liable to vibrate and set up undesirable noise. As they are retained in position in the tube and made of a plastics material the risk of the turbulator damaging the wall of the tube is reduced to a minimum.

While the preferred shape and orientation of the vanes is disclosed in the embodiments described herein, it is envisaged that the number, orientation and shape of the vanes may be varied, and other changes of a minor nature may be made to the turbulator without departing from the scope of the invention.

Claims

1. A turbulator for a tubed vehicle radiator, said turbulator comprising an elongate element adapted to be inserted into a tube of the radiator and provided with flow deflecting vane means orientated to enhance turbulence in coolant flowing through the tube, said turbulator further comprising means for retaining the elongate element in position in the tube, which position retaining means comprises a locking device at a leading end of the elongate element which locking device is insertable through the tube but adapted to resist withdrawal of the turbulator from the tube.

2. A turbulator as claimed in claim 1, wherein the locking device comprises two resilient tongues adapted to spring outwardly and lock behind one end of the tube.

3. A turbulator as claimed in claim 1 or 2, wherein said position retaining means comprises lug means extending transversely of the elongate element at the trailing end thereof to limit insertion of the elongate element through the tube.

4. A turbulator as claimed in claim 3, comprising at least two said elongate elements adapted to be inserted into respective generally parallel tubes of the radiator, wherein said elongate elements are interconnected at their lug means.

5. A turbulator as claimed in claim 1, 2 or 3, comprising at least two said elongate elements adapted to be inserted into respective generally parallel tubes of the radiator, wherein said elongate elements are interconnected at their trailing ends to prevent rotation of the elongate elements in the tubes in which they are inserted in use.

6. A turbulator as claimed in any one of the preceding claims, wherein said elongate element is in the form of a substantially flat strip having two opposed major faces, and said vane means extend outwardly from said faces.

7. A turbulator as claimed in claim 6, wherein said vane means comprises a plurality of vanes each of which is generally in the shape of a segment of an ellipse having a convexly curved outer edge and is orientated at an angle to the length of the strip such that said outer edges lie on a cylinder.

8. A turbulator as claimed in claim 6 or 7, wherein said vanes form at least one generally spiral arrangement around said flat strip.

9. A turbulator as claimed in claim 6 or 7, wherein said vanes form two generally spiral arrangements around said flat strip and the strip is provided with side edges each of which is formed with a series of V-notches spaced along the length of the strip between the vanes extending from the two faces of the strip.

10. A turbulator for a vehicle radiator having generally parallel tubes, said turbulator comprising at least two elongate elements adapted to be inserted into respective tubes of the radiator, each elongate element being provided with flow deflecting vane means orientated to enhance turbulence in coolant flowing through the tubes, each elongate element being interconnected at one of its ends only with at least another said elongate element at the corresponding end thereof such that said elongate elements extend generally parallel to each other, whereby when the elongate elements are

inserted in the tubes rotation of each element within a tube is prevented by virtue of said interconnection with at least one other elongate element which is inserted in another tube.

11. A turbulator as claimed in claim 10, wherein free ends of said elongate elements opposite said interconnected ends thereof are provided with respective locking devices which are insertable through the respective tubes of the radiator but adapted to resist withdrawal of the turbulator from the tubes.

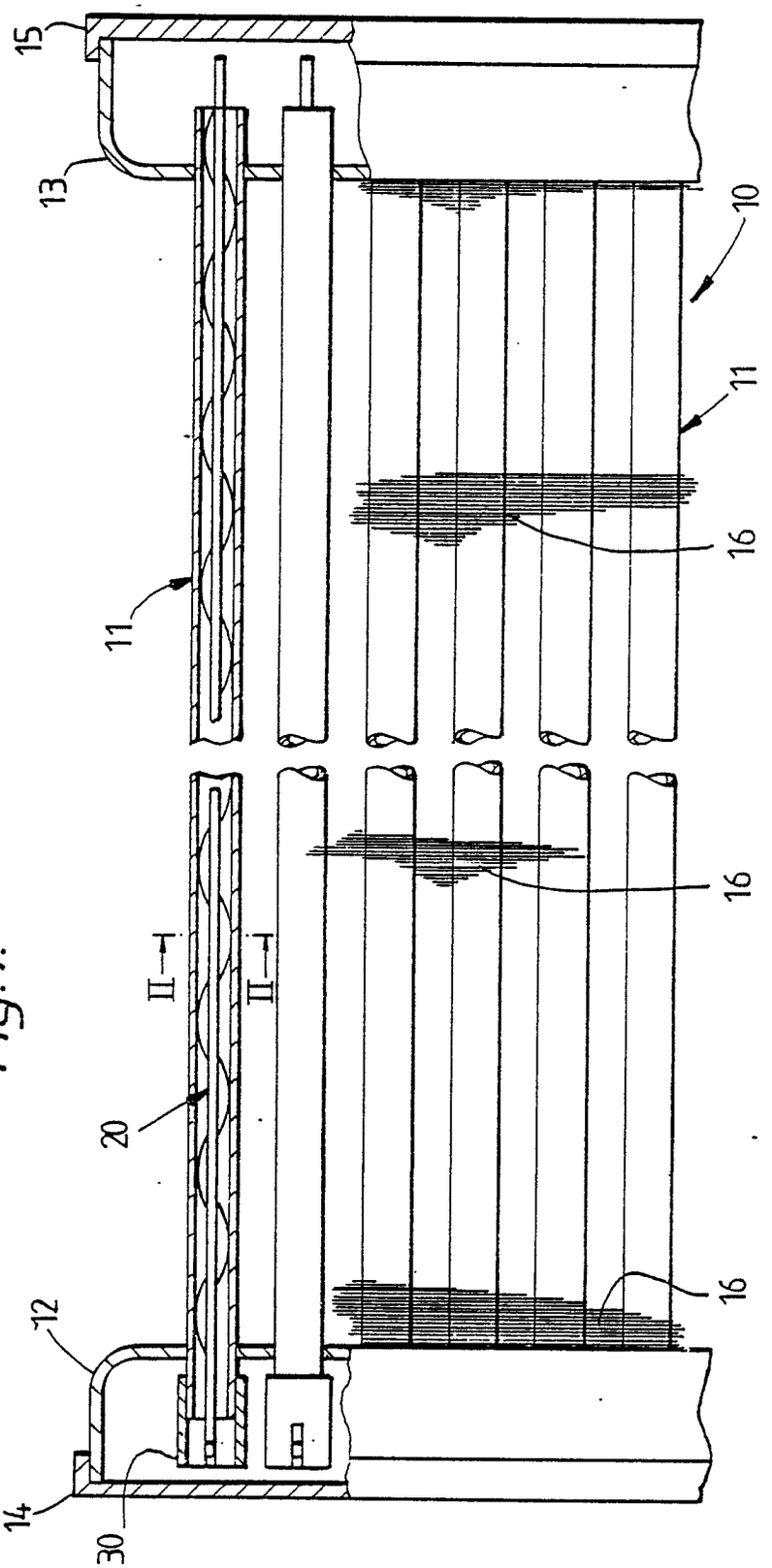


Fig.1.

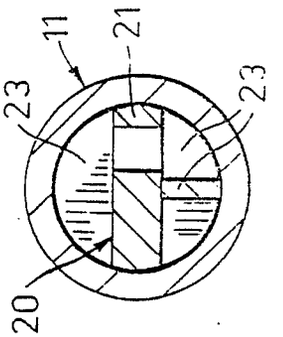


Fig.2.

Fig.3.

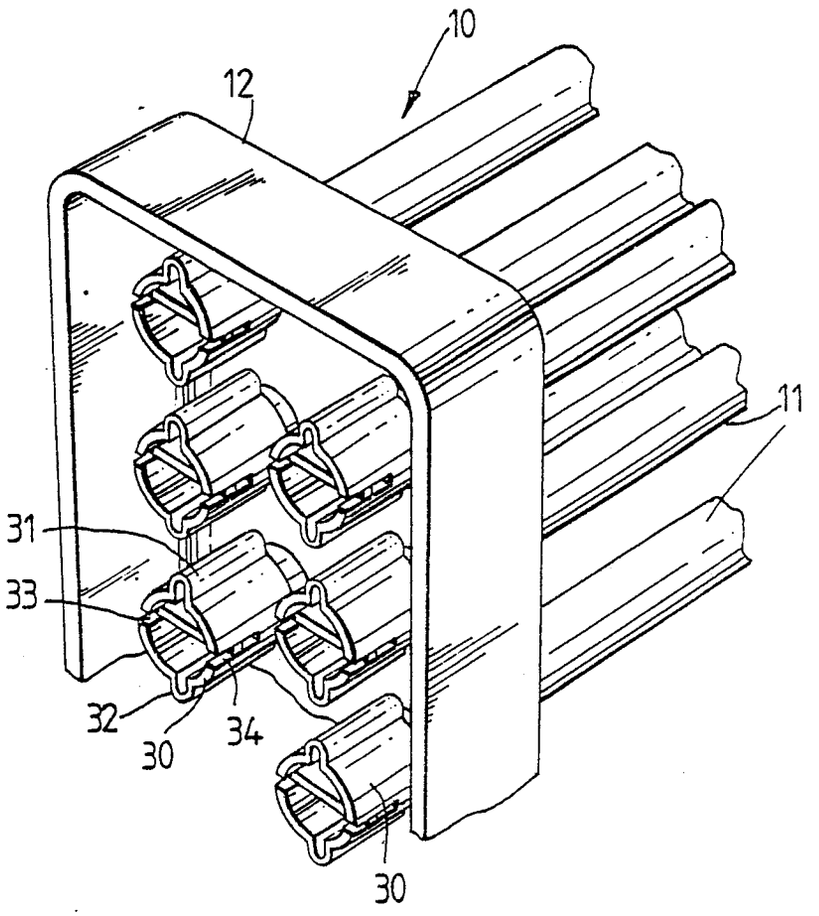


Fig.4.

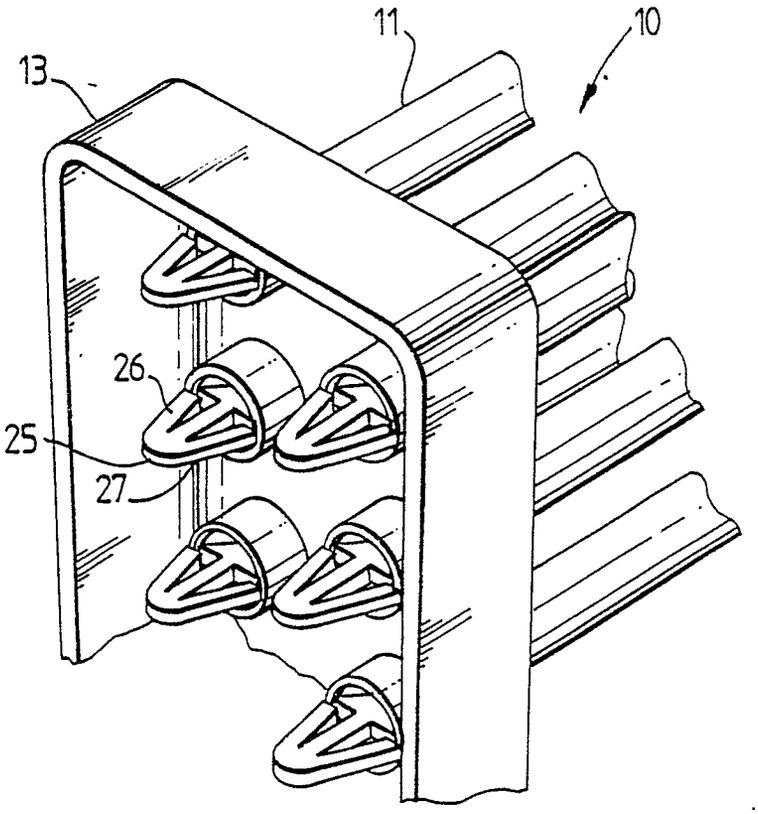


Fig.5.

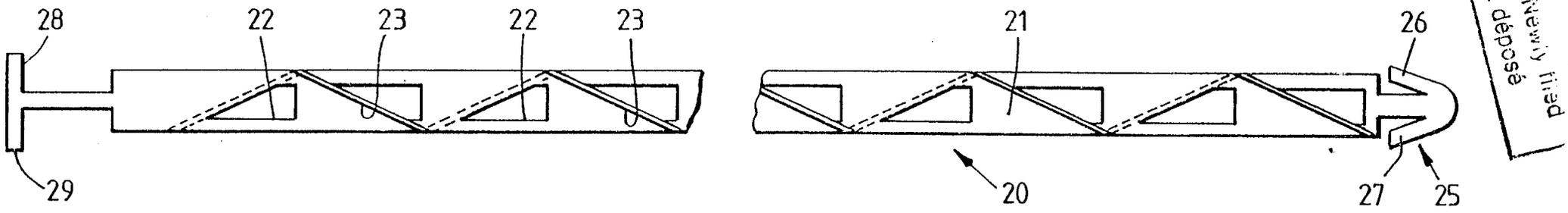


Fig.6.

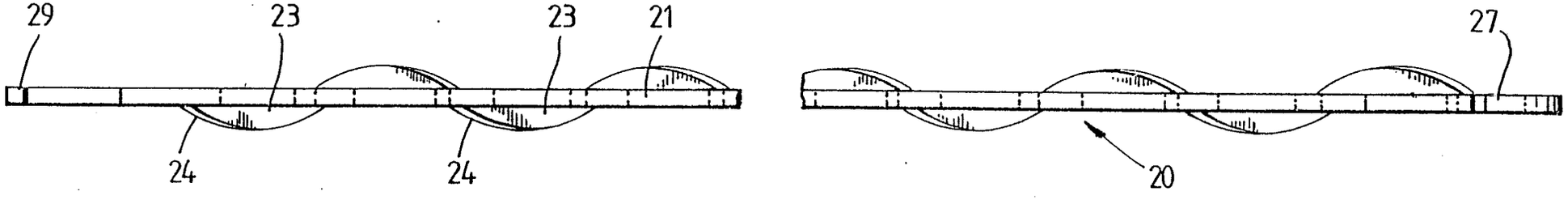
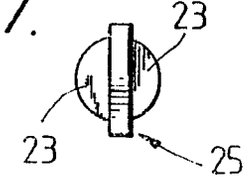


Fig.7.



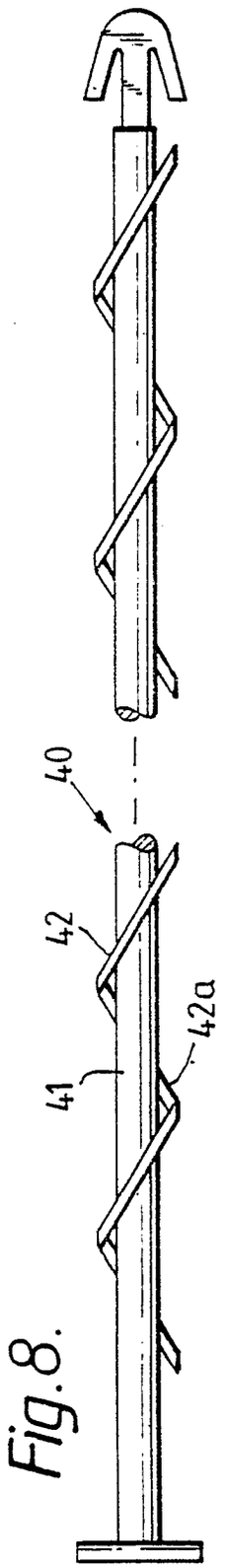


Fig.8.

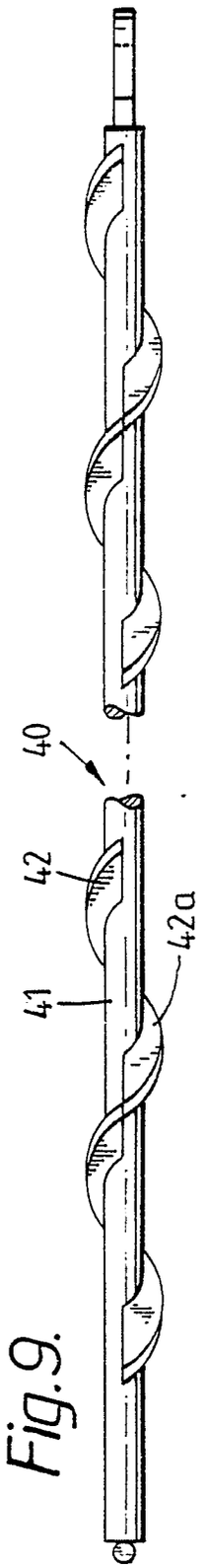


Fig.9.

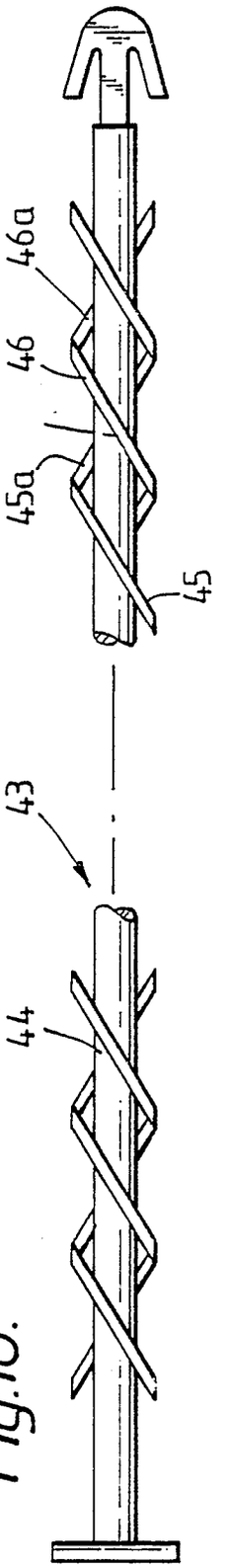


Fig.10.

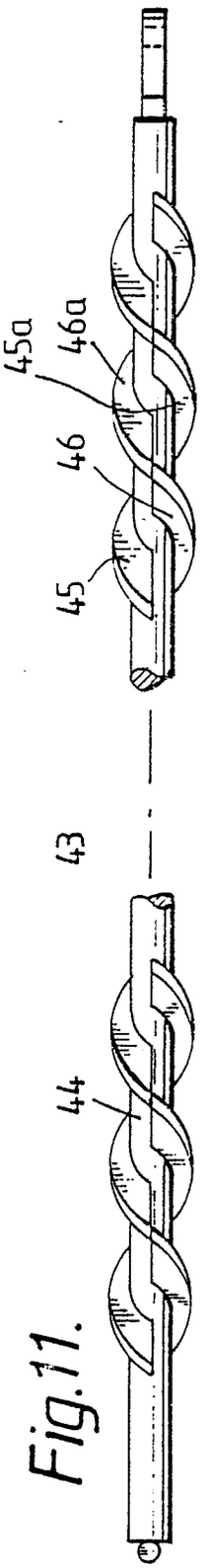


Fig.11.

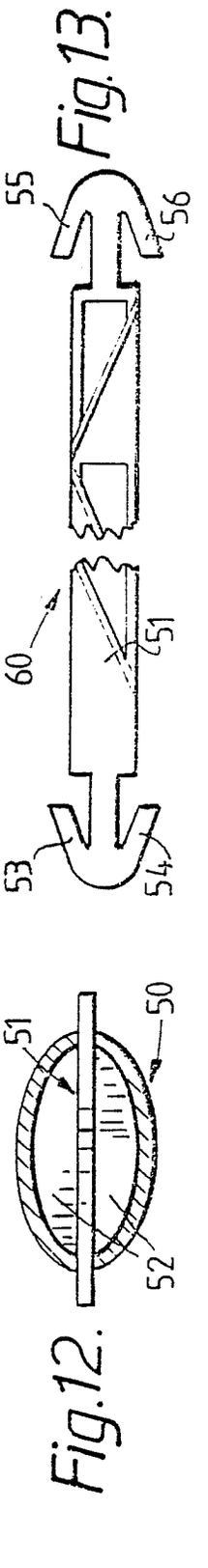


Fig.13.

Fig.12.

Fig.14.

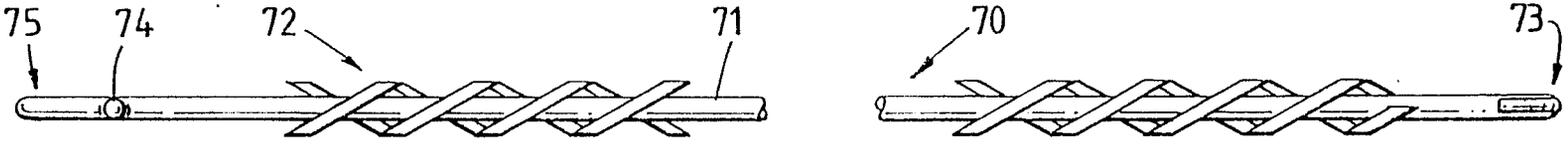


Fig.15.

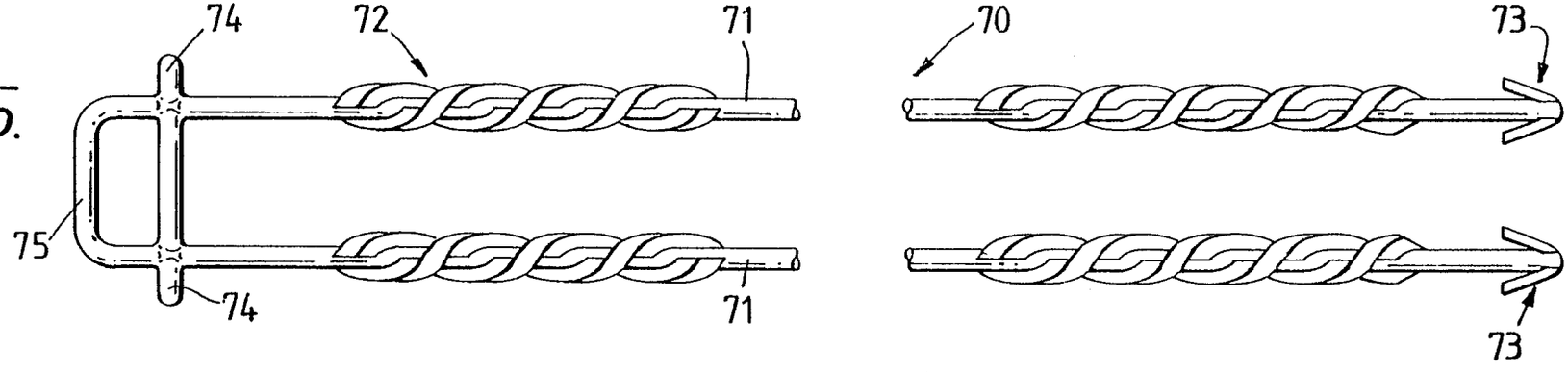


Fig.16.

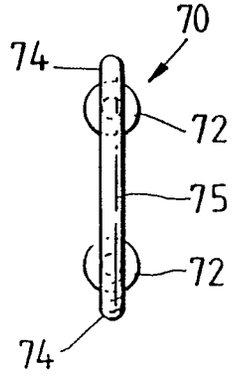


Fig.17.

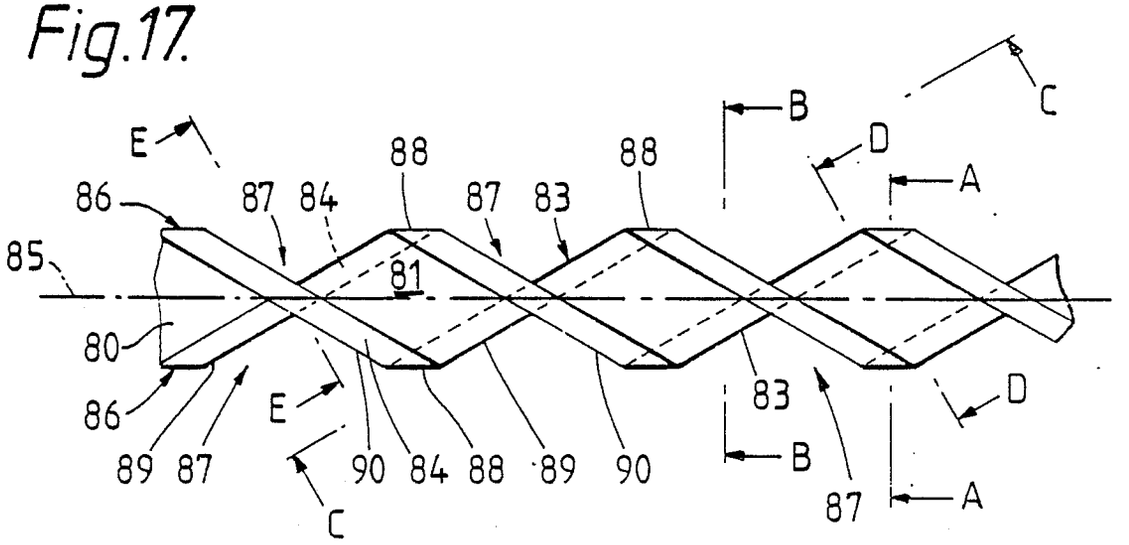


Fig.18.

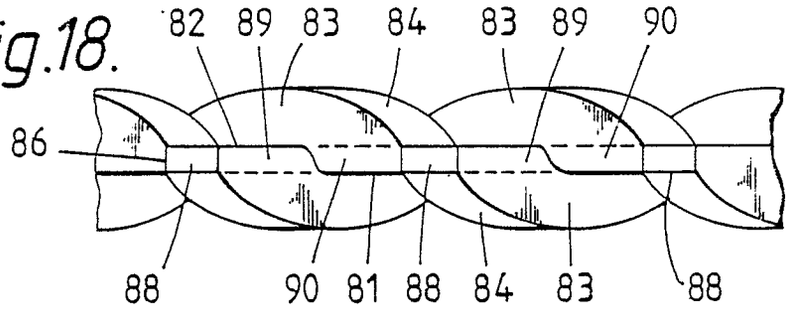


Fig.19A.

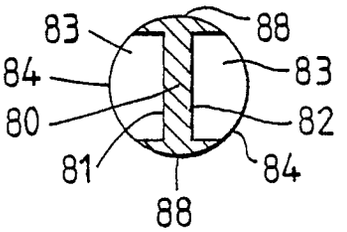


Fig.19B.

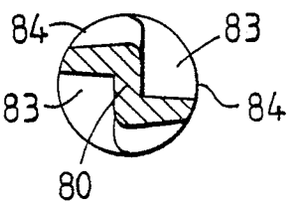


Fig.19C.

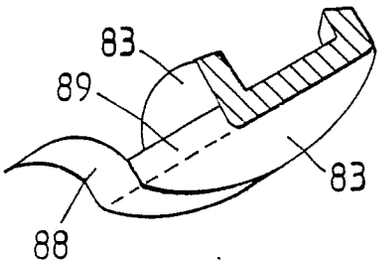


Fig.19D.

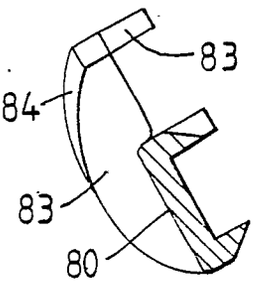


Fig.19E.