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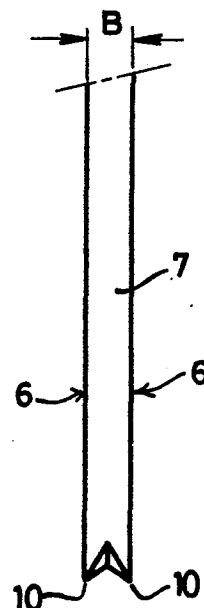
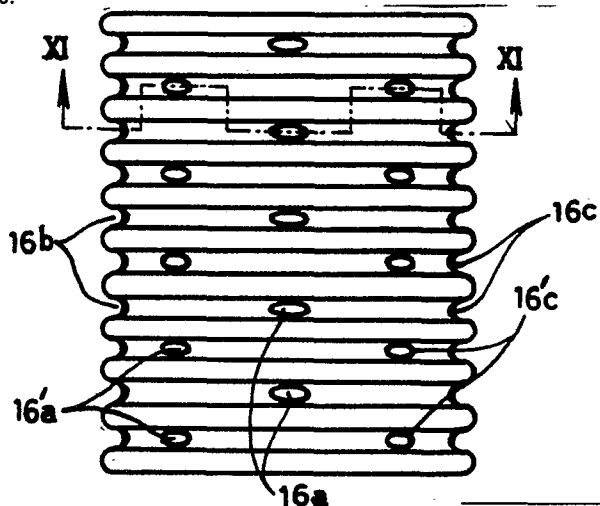
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⑤④ **Perforated plastic pipe and punch for forming perforations therein.**

⑤⑦ This invention relates to a plastic pipe having in its wall punched holes 16a, b, c; 16'a, b, c, with rounded short end edges 2a and long continuously curved side edges 15 and to a punching knife for making the punched holes, having a large length/width ratio in cross-section with curved side flanks 6 between rounded portions 7 and sharp knife edges 10.



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PERFORATED PLASTIC PIPE AND PUNCH FOR FORMING PERFORATIONS
THEREIN

BACKGROUND OF THE INVENTION

This invention relates to a plastic pipe, more particularly a plastic drainage pipe, having in its wall and distributed over the periphery thereof a number of holes having an elongate design with rounded short end edges and long side edges therebetween, and to a punch, more particularly a punching knife having a cutting tip for making holes in the wall of a plastic pipe, as disclosed in German Auslegeschrift 1 778 094.

Plastic pipes, more particularly corrugated pipes, having a large number of small holes in their wall are at present used for drainage purposes. Corrugated pipes are preferably used for this purpose because such a pipe offers considerable resistance to compression in relation to the material used, while there is a high elasticity in the longitudinal direction.

Smooth drainage pipes are also used for certain purposes. Irrespective of the pipe construction, however, it has been

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a plastic pipe, more particularly a drainage pipe, with holes without any tears occurring along the edges of said holes.

To this end, in a plastic pipe of the type as described,
25 the long side edges of the hole are curved continuously, the
hole transverse dimensions extending perpendicularly to the
longitudinal direction of the hole being smaller, near the
short rounded end edges, than the transverse dimensions of
the hole further away from the rounded end edges.

The advantage of this is that the continuous form of the radius of curvature results in no tearing occurring along the edges of the holes, This has also been proved by tests.

5 It should be noted that it is known per se to use diamond-shaped holes with the sharp corners rounded off. Even with these holes, however, tearing occurs at the corner of the diamond where straight portions of the flanks meet. In such holes the long side edges are accordingly not continuously curved.

10 In a practical embodiment of the present invention, the plastic pipe is so constructed that the holes of elongate design are oval and preferably elliptical.

To form these holes use is made of a punch, more particularly a punching knife with a cutting tip for forming
15 the holes in the wall of the plastic pipe, the punch having a large length/width ratio in its operative cross-section, with rounded portions extending in the direction of the width between the side flanks of the punch. According to the invention, this punch is thus constructed that the side flanks
20 are so curved in the longitudinal direction of the cross-section that a tangent extending from one rounded portion to the other always intersects the associated side flank at one point in the cross-sectional plane. There is therefore a continuity in the radius of curvature in the case of the
25 punch too. The punch according to the invention is also so constructed that a descriptive line extending on a curved side flank from a cross-sectional plane to the cutting edge at the tip is shorter near a rounded portion than a similar descriptive line further away from the associated rounded

portion.

SURVEY OF THE DRAWINGS

Figs. 1-5 illustrate the tearing pattern in various known types of hole in a plastic pipe wall;

5 Fig. 6 is a side elevation of part of a punch of the invention viewed at the flank side;

Fig. 7 is an end elevation of the cutting tip of the punch of fig. 6;

Fig. 8 is a side elevation of the punch of fig. 6
10 viewed at the side of the rounded part;

Fig. 9 is an indication of the groove shape;

Fig. 10 is a similar view of a hole in a plastic pipe according to the invention of figs. 1-5;

Fig. 11 is a cross-section of a plastic pipe with holes
15 of the invention on line XI-XI in fig. 12;

Fig. 12 is a side elevation of part of a plastic pipe with holes according to the invention in the form of a corrugated drainage pipe;

Figs. 13-20 are side elevations of a punch of the in-
20 vention with different cutting tip designs from the punch of figs. 6 and 8.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The holes in the wall of a drainage pipe are preferably
25 not formed exactly radially therein but substantially tangentially on both sides of the pipe, preferably so as to slope inwardly so that it is possible to refer quite legitimately

to the outside and the inside of the hole. Although there is no difficulty in forming the holes radially, it is advantageous to form them substantially tangentially, for reasons associated with production, in order to provided
5 smoother operation of the perforator and in order to reduce pipe deformation. Viewed from the outside of the pipe, the holes can therefor be regarded as a part having an outside and a part having an inside. In figs. 1-5, the right-hand sides of the holes illustrated are the insides and the left-
10 hand sides are the outsides of the holes, the material of the pipe wall also being visible as a result.

Fig. 1 shows a hole of elongate design with rounded short end edges 1 and 2 for the inside and outside of the hole respectively. Long side edges 3 extend between these
15 rounded short end edges 1 and 2. Experiments have proved that tearing occurs at the transition between the long straight side edges 3 and the rounded short end edges 1 and 2. This tearing is referenced 4.

If the end of the hole is rounded to a smaller radius
20 as shown in fig. 2, the rounded portion has no tearing but this does occur where the straight side flanks 3a merge into the rounded portion 2a via oblique flanks 5; tears occur here.

In this connection experiments were carried out with
25 a falling weight applied to the inside of the hole at the rounded portion 1 and also to the outside of the hole at the rounded portions 2, 2a respectively. In cases in which the oblique lines extend from the rounded portions 2a to the rounded portion 1 as shown by the oblique flanks 5a in fig. 3,

tearing 4 occurs only at the transition between the flanks and the rounded portion 1. In fig. 4 use has been made of flanks 3b and oblique flanks 5b and it has been found that no tearing now occurs between the flanks 3b and 5b.

5 In the light of this experience, therefore, the rounded portion 2a has also been shifted to the inside of the hole as shown at reference 2b in fig. 5. Experiments proved, however, that tearing occurs nevertheless at the transition between the oblique flanks 5b and 5c as denoted by reference
10 4b.

Attempts were then made to find a hole with no tearing in a plastic pipe, more particularly a plastic drainage pipe having in its wall holes each of elongate form with rounded short end edges and long side edges therebetween. This is
15 made possible according to the present invention by curving the long side edges of the hole continuously, the transverse dimensions of the hole perpendicular to the longitudinal direction of the hole being smaller, near the short rounded end edges, than the transverse dimensions of the hole situated further away from the rounded end edges. The plastic
20 pipe may in this case have holes which are oval or elliptical with a continuous radius of curvature of elongate design. This will be explained with reference to the punch for making these holes as illustrated in figs. 6 to 9, the shape
25 of the holes also being shown in fig. 10.

The side elevation in fig. 6 and the end elevation in fig. 7 show a punch, more particularly a punching knife having a cutting tip for making holes in the wall of a plastic pipe, the effective cross-section of the punch having a large

length/width ratio with rounded portions extending in the direction of the width between the side flanks of the punch. The length and width of the cross-section of the punch are denoted by letters L and B respectively in figs. 6, 7 and 8. In the punch according to the invention, the side flanks in the longitudinal direction L of the cross-section are so curved that a tangent 8 extending from one rounded portion 7 to the other rounded portion 7 always contacts the relevant side flank 6 at one point in the cross-sectional plane. With this punch, therefore, it is possible to punch holes having a continuous radius of curvature.

As shown in fig. 6, a descriptive line 11a extending from a cross-sectional plane indicated by line 9 to the cutting edge 10 on a curved side flank 6 near a rounded portion 7 is shorter than a similar descriptive line 11b further away from the associated rounded portion 7. The cross-sectional plane of the operative part of the punch in a practical embodiment is oval-elliptical or approximately elliptical.

The cutting tip of the punch is also so constructed that a tangent indicated by line 12 extending perpendicularly to the centerline 13 touches the said tip of the punch at a distance from the centerline 13 thereof. The punch thus has a knife edge at the flanks at the tip, but the knife edge at each flank extends to a curved line from one rounded portion 7 to the other as will be apparent from fig. 6.

Each knife edge of the punch also extends to a curved line in the transverse direction (fig. 7). The knife edges 10 are formed in known manner by a V-shaped groove in the tip and the resulting cutting edge may be referred to as a fish

snout. The V-shaped groove extends from one rounded portion to the other and the base of the V-shaped groove has a straight configuration as shown by broken line 14 (fig. 6). Also, the base of the V-shaped groove includes an acute angle with a transverse plane extending perpendicularly to the plane of the centerline of the punch, like the tangential plane 12. Experiments have proved that no tearing occurs in a hole made in a pipe wall with a punch of this kind, and fig. 10 illustrates a hole made in a pipe wall with this punch.

This elongate hole thus has small rounded portions 2a at the short side produced by the rounded portions 7 of the punch and long continuously curved flanks 15 produced by the flanks 6 of the punch. The hole as illustrated in fig. 10 is, for example, a top plan view of the hole 16a (fig. 11) and since this hole is disposed tangentially the wall 2'a of the rounded portion 2a is visible and the hole is therefore regarded as having part of it as the outside. The wall 2'b of the opposite rounded portion 2a is not visible and this portion is therefore regarded as the inside.

At the small rounded portions 2a, burrs may form on the inside of the pipe (reference 17 in fig. 10), but this does not affect the passage shape of the hole. The hole according to the present invention accordingly has an invariable passage in the punching direction and this is to the advantage of the water flow when the pipe is used for drainage purposes.

The holes in the pipe wall are all disposed tangentially, there being simultaneous formation of the holes 16a and

and 16b and the holes 16c and 16d diametrically opposite the same. The direction of the punches for these holes is offset 45° peripherally with respect to the punches for making the holes 16'a and 16'b together with the holes 16'c and 16'd diametrically opposite the same. However, the holes 16a-16d are axially offset with respect to the holes 16'a-16'd.

Although it is possible to make the holes at the crests of the corrugation in a corrugated pipe, they are preferably made in the troughs between the corrugations as will be seen in fig. 12. The holes 16-16d in this case are situated in one corrugation and the holes 16'a-16'd are situated in the next corrugation. It is not absolutely essential for two sets of holes always to be formed diametrically with respect to each other. Depending on the required passage characteristics a smaller number of holes may be provided along the periphery, and it is also possible to miss some of the troughs between the corrugations. Preferably, however, the hole pattern is as illustrated in figs. 11 and 12.

The holes described do not have to be made just with a cutting punch tip as shown in figs. 6, 8 and 9, but may also be produced by means of a pricking punch tip as illustrated in figs. 13 and 14. The cross-section of this latter punch is completely in accordance with fig. 7. The rounded portion 7 at the left-hand side in fig. 13 is much longer with respect to the flanks 6 of the tip than the rounded portion 7 on the right-hand side of the punch. The punch thus has a rounded but cutting tip 17. A descriptive line extending close to the rounded portion 7 from a cross-sectional plane 9 to

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the tip of the punch is accordingly longer than a descriptive line situated closer to the centerline 13 of the punch. These descriptive lines are again referenced 11a and 11b respectively, for the left-hand side of the punch. The conditions
5 applicable to the descriptive lines 11a and 11b in fig. 6 again apply to the right-hand side of the punch.

A pricking punch of this kind can be of a double construction as illustrated in figs. 15 and 16. Here there are two points 17a and 17b respectively at the cutting tip of
10 the punch. Curved cutting edges 10 are again provided along the flanks 6 by the provision of a V-shaped groove 14b at the end. The points 17a and 17b, which contact a tangential plane 12 extending perpendicularly to the centerline 13 of the punch are again at a distance from the centerline 13.
15 In the case of the punch illustrated in figs. 17 and 18, one central pricking point 17c is provided at the centerline 13 where it intersects the tangential plane 12. The centerlines 11a and 11b again satisfy the conditions described with respect to fig. 6.

20 Figs. 19 and 20 show a variant of the punch of figs. 17 and 18. The cutting tip is again provided with curved cutting edges 10 but these curved cutting edges are bent at the point 17d. The provision of a groove denoted by the line 14c again provides a fish snout for producing the cutting
25 edges 10. In all these variations of the punch, however, the cross-section is in accordance with that illustrated in fig. 7 in order ultimately to produce the holes illustrated in fig. 10.

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WHAT IS CLAIMED IS:

1. A plastic pipe, more particularly a plastic drainage pipe having in its wall and distributed over the periphery thereof a number of holes made by means of a punch, the holes having an elongate design with rounded short end edges and long side edges therebetween, wherein
5 the long side edges of the punched hole are curved continuously, the punched hole transverse dimensions extending perpendicularly to the longitudinal direction of the punched hole being smaller, near the short rounded end edges,
10 than the transverse dimensions of the punched hole further away from the rounded end edges.

2. A plastic pipe according to claim 1, in which the punched holes of elongate design are oval or elliptical.

15 3. A punch, more particularly a punching knife with a cutting tip for making punched holes in the wall of a plastic pipe according to claim 1, the punch having a large length/width ratio in its operative cross-section, with rounded portions extending in the direction of the
20 width between the side flanks of the punch, wherein the side flanks are so curved in the longitudinal direction of the cross-section that a tangent extending from one rounded portion to the other always intersects the associated side flank at one point in the cross-sectional plane.

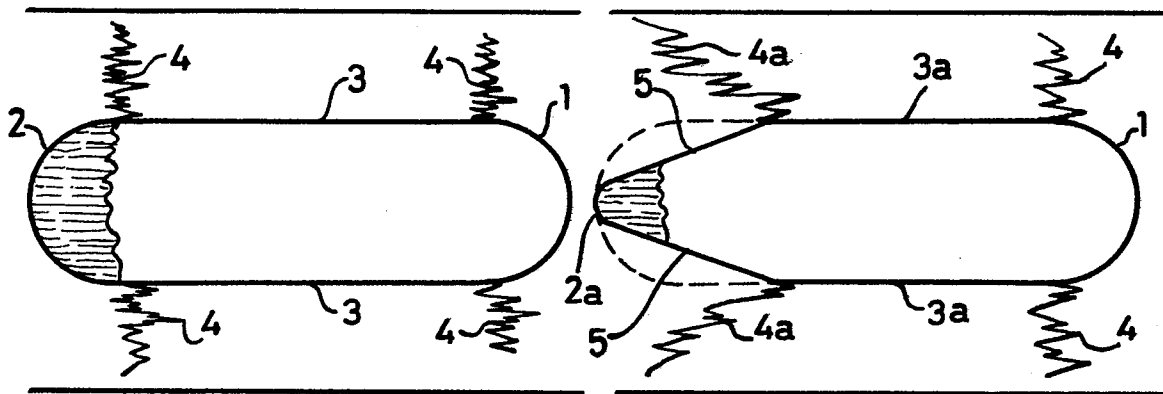
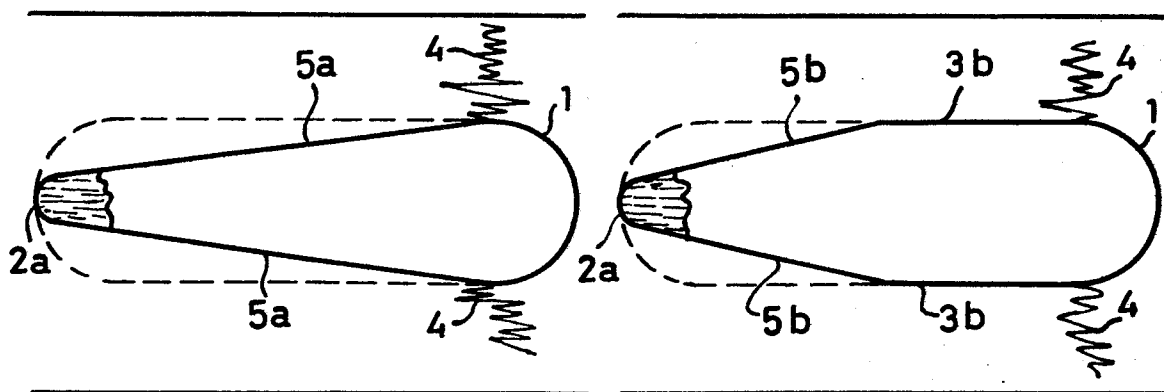
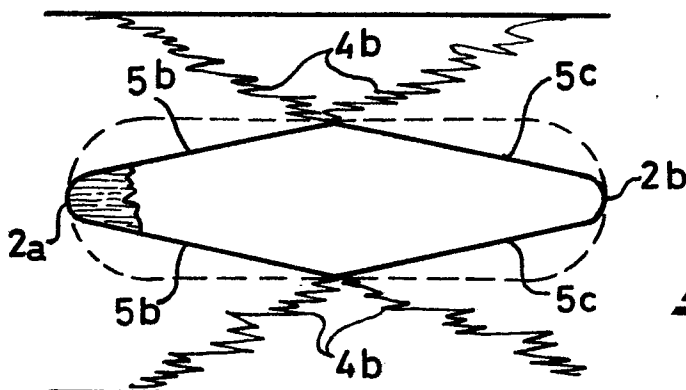
25 4. A punch according to claim 3, in which a descrip-

tive line extending on a curved side flank from a cross-sectional plane to the cutting edge at the tip is shorter near a rounded portion than a similar descriptive line further away from the associated rounded portion.

5 5. A punch according to claim 3, in which a descriptive line extending on a curved side flank from a cross-sectional plane to the cutting edge at the tip is shorter near a rounded portion than a similar descriptive line near the other rounded portion.

10 6. A punch according to claim 3, in which a descriptive line extending on a curved side flank from a cross-sectional plane to the cutting edge at the tip is longer near a rounded portion than a similar descriptive line further away from the associated rounded portion.

15 7. A punch according to claim 3, wherein the cross-sectional plane is oval or elliptical.

**FIG: 1.****FIG: 2.****FIG: 3.****FIG: 4.****FIG: 5.**

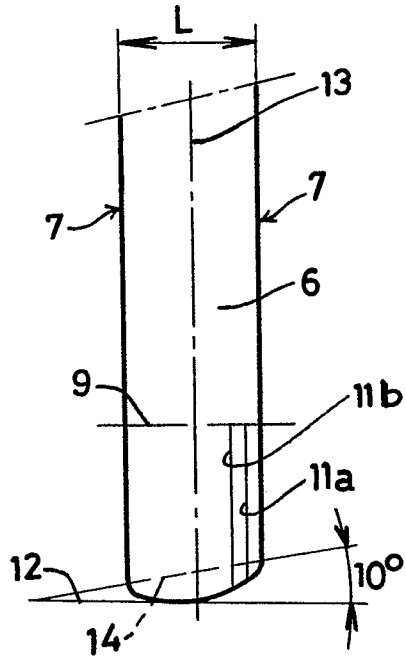


FIG. 6.

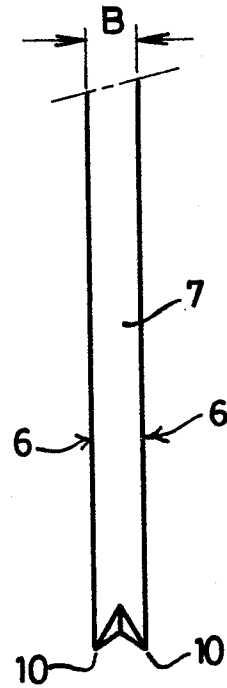


FIG. 8.

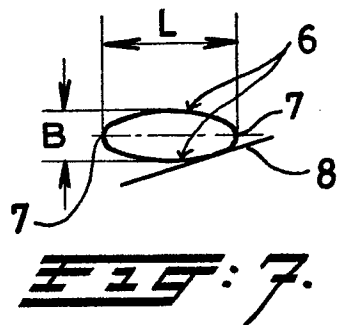


FIG. 7.

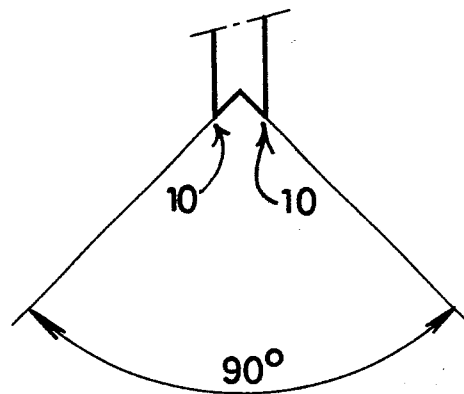


FIG. 9.

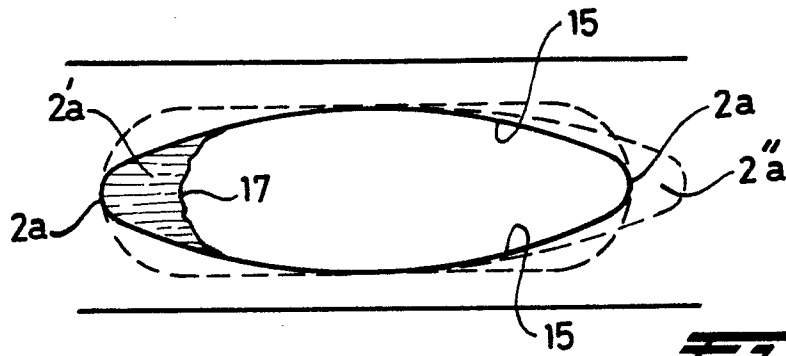


FIG:10.

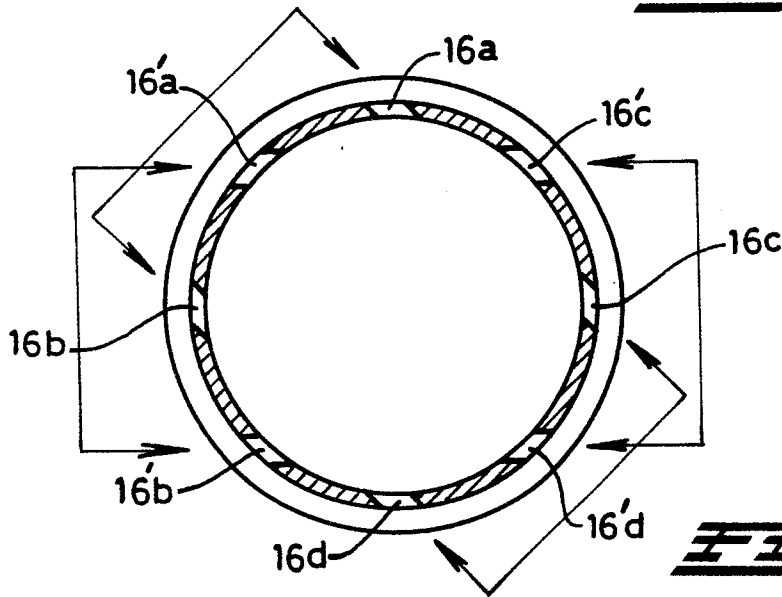


FIG:11.

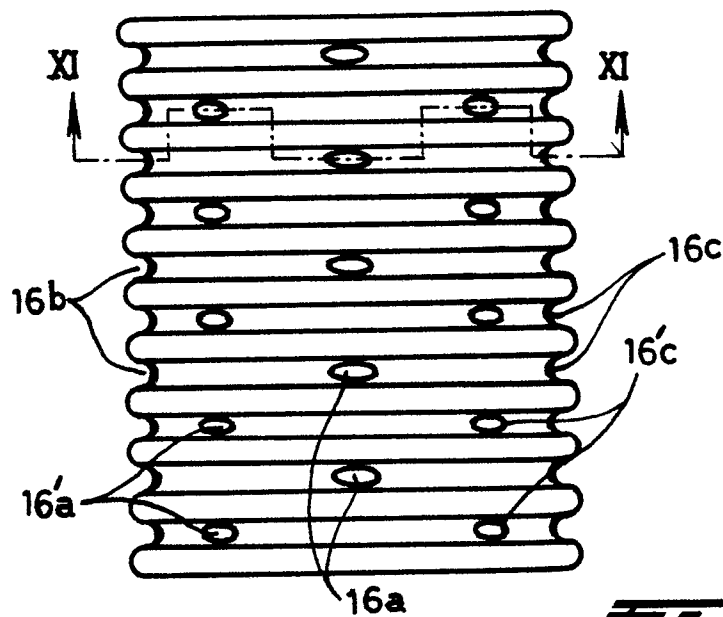
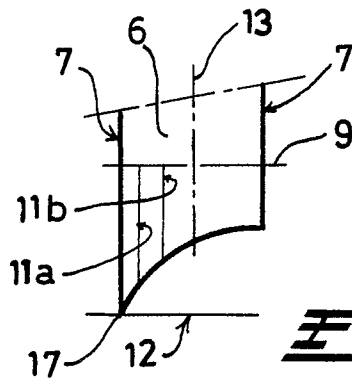
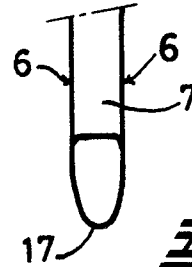
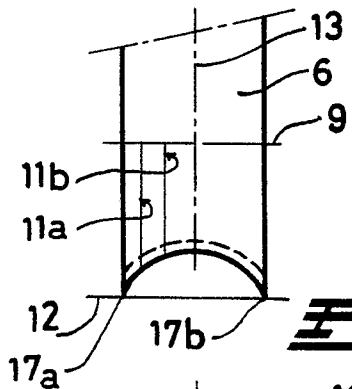
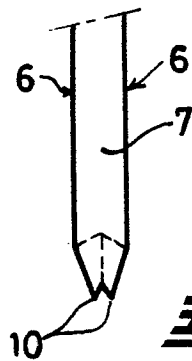
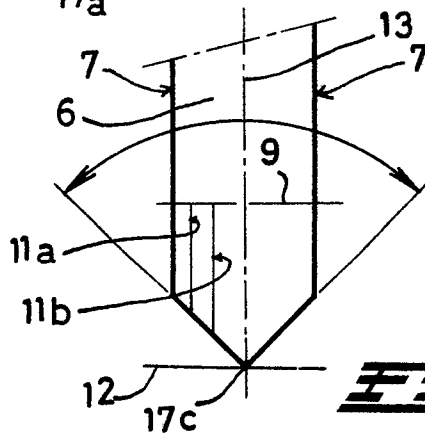
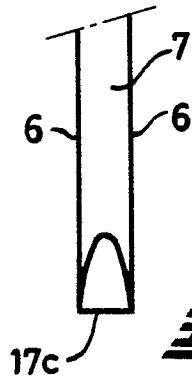
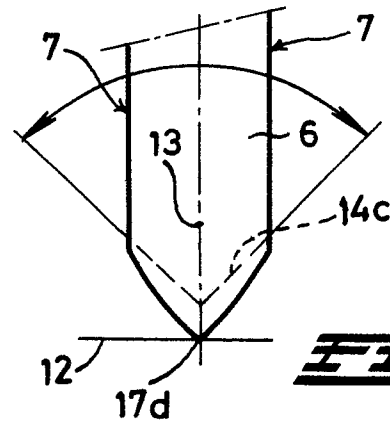
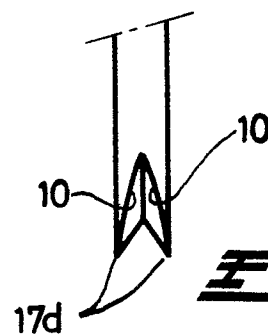


FIG:12.

**FIG:13.****FIG:14.****FIG:15.****FIG:16.****FIG:17.****FIG:18.****FIG:19.****FIG:20.**