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# (54) Crushing apparatus

Zerkleinerungsmaschine

Broyeur

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(73) Proprietor: **OXFORD BROOKES ENTERPRISES LTD.**
**Headington, Oxford OX3 0BP (GB)**

(72) Inventor: **Washbourne, Jim**
**Long Hanborough, Oxon OX7 2JN (GB)**

(74) Representative: **Arthur, Bryan Edward et al**
**Withers & Rogers**
**4 Dyers Buildings**
**Holborn**
**London, EC1N 2JT (GB)**

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**CH-A- 344 286**
**DE-A- 9 743**
**DE-A- 3 911 378**



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## Description

This invention relates to a crushing apparatus for crushing and thereby breaking down rock and other material into pieces of smaller size than that originally fed into the apparatus. A crushing apparatus in accordance with the present invention is suitable for use in conjunction with boring and tunnelling equipment as well as crushing quarried material. The crushing apparatus in accordance with the invention can be used in conjunction with both large and small scale boring/tunnelling equipment such as macro-tunnelling equipment for producing tunnels suitable for vehicular transportation and micro-tunnelling equipment for producing tunnels suitable for man-entry.

CH-A-344285 discloses a crusher for crushing rocks comprising a casing (1) having a through bore of octagonal cross section and a concentrically mounted rotor (3). Essentially the rotor (3) is a frusto-right circular cone having four flat faces (4) which are generally semi-illiptical in shape. Thus, since the four faces (4) are of equal transverse width, the top of the rotor (3) is square, whereas the base of the rotor (3) is circular as shown in figure 3.

DE-3911378A1 describes a crusher comprising an outer stationary frusto-conical cutting sleeve (8) having a frusto-conical surface (19) and an internal cone crusher (17) which is mounted for rotation about an axis which is eccentric relative to the sleeve (8). The internal cone crusher (17) is also formed with longitudinal crusher ribs (41) and concentric circular crushing rings (42).

When compared with the crushers disclosed in CH-A-344285 and DE-A-3911378 the crushing surfaces in the crusher of the present application are continuous over the full length of the crushing chamber and they extend downstream through the actual outlet so as to clear or extend beyond convergent parts of the cone crusher.

According to the present invention a crushing apparatus comprises a crushing apparatus comprising a generally annual crushing chamber (21) having an inlet (22) for receiving material to be crushed and outlet (23) through which crushed material is discharged, the annular crushing chamber comprising coaxially mounted inner (10) and outer members (20), each member having a frusto-conical peripheral wall which converge towards the outlet with each peripheral wall having a different number of faces (24, 25) and means for creating relative angular movement between the inner (10) and outer (20) members whereby material introduced into the crushing chamber through the inlet (22) is crushed between the peripheral walls during relative rotation thereof and passage from the inlet (22) to the outlet (23), characterised in that the faces (24, 25) of each peripheral wall extend from the inlet (22) to the outlet (23) of the crushing chamber (21) whereby the outlet (23) is annular and is defined by inner and outer peripheral walls having a number of faces corresponding to the number of faces (24,25) of the peripheral walls of the inner (10) and outer (20) members, in that the inner member (10) includes an extension (10A) located within the outlet (23) and in that the extension (10A) has a peripheral wall having the same number of faces (24) as the inner member (10).

According to one embodiment of a crushing apparatus and when considered in coaxial cross-section, the peripheral wall of the frusto-conical inner member (10) diverges outwardly towards the outlet (23) and the peripheral wall of the frusto-conical outer member converges inwardly towards the outlet (23) whereby the annular extent of the crushing chamber is progressively reduced from the inlet to the outlet. In this embodiment one end of the inner member (10) is located in the region of the inlet (22) and includes at least two equiangularly disposed arms (26) extending radially outwardly from the inner member (10). The inner member (10) is conveniently supported on a shaft (33) which is mounted coaxially within a bore (20A) formed in the outer member (20) and rotatable therein.

In order further to reduce the size of crushed material after passage through the outlet, an appropriate clearance exists between the shaft (33) and bore (20A) forming a secondary crushing chamber (28), in which the shaft and the bore are fitted with axially displaced and inter-digitated prongs (29,30) for effecting secondary crushing of the material.

The crushing apparatus according to the invention may be used in conjunction with tunnelling equipment and positioned to the rear of the tunnelling equipment so that material removed during tunnelling is immediately crushed into a required size thereby easing removal and transportation of the material from the tunnel. The crushing apparatus according to the invention is also eminently suitable for crushing quarried material.

If desired, two or more such crushing apparatus may be mounted in series in order to reduce the size of crushed material in a series of stages with the crushed material discharged from one stage fed as in-feed material to a subsequent stage and, according to the size of crushed material required, a discharge chute may be mounted between each successive apparatus. Conveniently, each discharge chute may include means for opening and closing the same so that when open, material crushed by an immediately preceding apparatus is discharged for removal whereas, when closed, material is fed to the next successive stage for further crushing.

Crushing apparatus in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 is an end view of a crushing apparatus;
Figure 2 is a cross section of the apparatus taken along line A-A of Figure 1;
Figure 3 shows a sectional end view of inner and outer members of the crushing apparatus having different members of faces, and
Figures 4 to 12 respectively show in sectional end

views of different multi-faced combinations of the inner and outer members as well as different shapes of the multi-faced members.

Referring to Figures 1 and 2, an inner member 10 having an extension 10A and outer member 20 having a bore 20A are mounted coaxially for relative rotation about axis X-X. The inner member 10 or the outer member 20 may be driven but, preferably, the inner member is driven by driving means not shown via a shaft 33. A crushing chamber 21 is, of general annular shape and converges from an inlet 22 to a discharge outlet 23. Inner and outer peripheral walls of the crushing chamber 21 are constituted by faces 24 and 25 respectively of the inner 10 and outer 20 members which are of right-conical shape. In the embodiments shown in Figures 1 and 2 the inner member 10 has nine faces 24 and the outer member 20 has eight faces 25.

Attached to the inner member 10 are three radial arms 26 bearing teeth 27 which together serve, during rotation, to assist introduction and crushing of material fed into the crushing chamber 21 via the inlet 22. It will be appreciated that during rotation of the inner member 10, crushing is effected by inter-action of the material and the faces 24, 25 of the multi-faced inner 10 and outer 20 members since, during rotation, the radial distance between the confronting faces 24,25 on the inner 10 and outer 20 members changes continuously. Crushed material exits through the discharge outlet 23 and passes for subsequent or secondary crushing into a secondary crushing chamber 28. Prongs 29, 30 carried by the inner 10 and outer 20 members respectively serve not only to create secondary crushing but are shaped to assist discharge via a discharge channel D. Lubricant/coolant is fed into the crushing chamber 21 and secondary crushing chamber 28 via conduits 31 and 32.

The number of faces of the inner 10 and outer 20 frusto-conical members differ in number as previously mentioned by at least one, but each face may also differ in shape and geometric configuration. Figures 3 to 12 show a number of different multi-faced configurations. A multi-faced inner member 10 having nine faces and a multi-faced outer member 20 having eight faces is one very effective combination of faces. Other combinations of faces are also effective.

The inner 10 and outer member 20 may each have an even number of faces with the number of faces on each member differing by two. In such a combination of faces, a progressive crushing action is produced between two or more confronting pairs of faces at any particular angular position during relative rotation of the members.

In arrangements having an even number of face combinations and where the number of faces in the respective members differs by two, e.g. Figure 9 where the inner member 10 has ten faces and the outer member 20 has 12 faces, it will be seen that, in the angular position shown progressive crushing is duplicated between confronting pairs of faces d/d' and i/f'. Similarly in Figures 10 and 11 where the faces are marked with the same reference letters, progressive crushing is duplicated between confronting pairs of faces a/a' and b/c' (Figure 10) and between confronting pairs of faces b,b' and e,f' (Figure 11).

Referring to Figure 12, the inner member 10 has nine faces (a....i) and the outer member 20 has twelve faces a' ....l'. Thus, a difference in the number of faces of three exists between the inner and outer members. In such a multi-faced configuration of the inner and outer members, it will be seen from Figure 12 that three confronting pairs of faces are substantially parallel. In this arrangement progressive crushing, therefore, takes place between three pairs of confronting faces and, as with the arrangements of Figures 9, 10 and 11, a crushing apparatus according to Figure 12 is, in use, substantially in rotational balance.

It will, therefore, be appreciated that

(i) where the main and outer members each have an even number of faces which differ by two, crushing action is duplicated between two confronting pairs of faces, and

(ii) where the inner and outer members each have a different number of faces which are respectively divisible by three, crushing action is triplicated between three confronting pairs of faces.

A suitable combination falling under category (i) above is a six/eight facial arrangement. As indicated previously the faces may be flat, convexly curved or concavely curved.

In contrast with conventional cone crushers, a crusher in accordance with the present invention possesses the advantage of reduced wear between the members since there is less shearing action of the input material with the lower angle of face motion of the respective members relative to the normal to the relevant face.

The included angles $\alpha$ and $\beta$ between the faces of the main member 10 and outer member 20 and the bases of their respective may fall within a range of 50° to 80° and, preferably, with a range of 55° to 70°. We have found that although the angles X and B may be different within the above ranges, an angle of 60° for both X and B is a practical and optinum relationship.

## Claims

1. A crushing apparatus comprising a generally annual crushing chamber (21) having an inlet (22) for receiving material to be crushed and outlet (23) through which crushed material is discharged, the annular crushing chamber comprising coaxially mounted inner (10) and outer members (20), each member having a frusto-conical peripheral wall which converge towards the outlet with each peripheral wall having a different number of faces

(24, 25) and means for creating relative angular movement between the inner (10) and outer (20) members whereby material introduced into the crushing chamber through the inlet (22) is crushed between the peripheral walls during relative rotation thereof and passage from the inlet (22) to the outlet (23), characterised in that the faces (24, 25) of each peripheral wall extend from the inlet (22) to the outlet (23) of the crushing chamber (21) whereby the outlet (23) is annular and is defined by inner and outer peripheral walls having a number of faces corresponding to the number of faces (24,25) of the peripheral walls of the inner (10) and outer (20) members, in that the inner member (10) includes an extension (10A) located within the outlet (23) and in that the extension (10A) has a peripheral wall having the same number of faces (24) as the inner member (10)

2. Apparatus according to claim 1 or 2 characterised in that the outlet (23) is coaxial with the annular crushing chamber (21).

3. Apparatus according to any one of claims 2 or 3 characterised in that when considered in coaxial cross-section, the peripheral wall of the frusto-conical inner member (10) diverges outwardly towards the outlet (23) and the peripheral wall of the frusto-conical outer member (20) converges inwardly towards the outlet (23) whereby the annular extent of the crushing chamber is progressively reduced from the inlet (22) to the outlet (23).

4. Apparatus according to any preceding claim characterised in that one end of the inner member (10) is located in the region of the inlet (22) and includes at least two equi-angularly disposed arms (26) extending radially outwardly from the inner member (10).

5. Apparatus according to any preceding claim characterised by at least one conduit (31, 32) for leading lubricant into the crushing chamber (21).

6. Apparatus according to any preceding claim characterised in that the inner member (10) includes a shaft (33) coaxially disposed within a bore (20A) formed in the outer member (20).

7. Apparatus according to claim 6 characterised by interdigitated prongs (29, 30) extending from the bore (20A) and the shaft (33) respectively for crushing in a secondary
crushing chamber (28), previously crushed material discharged from the outlet (23).

8. Apparatus according to any one of claims 1 to 7 characterised in that the inner peripheral wall has one face (24) greater or less in number than the number of faces (25) of the outer peripheral wall.

9. Apparatus according to any preceding claim characterised in that the peripheral wall faces (24, 25) of the inner and outer members define right cones.

10. Apparatus according to any preceding claim characterised in that each face of each peripheral wall (24, 25) is flat.

11. Apparatus according to any one of claims 1 to 9 characterised in that each face (24) of the peripheral wall of the inner member (10) is convex and each face of the peripheral wall (25) of the outer member (20) is flat.

12. Apparatus according to any one of claims 1 to 9 characterised in that wherein each face (24) of the peripheral wall of the inner member (10) is concave.

13. An apparatus according to claim 1 characterised in that the angle of inclination between each face (24,25) of the multifaced peripheral wall and the base of the respective
frusto-conical inner (10) and outer members (20) falls within a range of 50° to 80°.

14. Apparatus according to any one of claims 1 to 7 characterised in that the number of faces (24, 25) on each of the inner (10) and outer (20) members is an even number and wherein the number of faces on the respective members (10), (20) differs by two.

15. Apparatus according to any one of claims 1 to 7 characterised in that the number of faces (24, 25) on each of the inner (10) and outer (20) members is a multiple of three and the difference in the number of faces on the respective members (10), (20) is three.

**Patentansprüche**

1. Zerkleinerungsmaschine mit einer im allgemeinen ringförmigen Zerkleinerungskammer (21) mit einem Einlaß (22) zur Aufnahme des zu zerkleinernden Materials und einem Auslaß (23), durch welchen das zerkleinerte Material abgeführt wird, wobei die ringförmige Zerkleinerungskammer koaxial montierte innere (10) und äußere Bauteile (20) aufweist, wobei jedes Bauteil eine frustokonische periphere Wand aufweist, welche in Richtung auf den Auslaß hin konvergiert, wobei jede periphere Wand eine unterschiedliche Anzahl von Flächen (24, 25) und Mittel zur Erzeugung relativer Winkelbewegungen zwischen den inneren (10) und äußeren (20) Bauteilen aufweist, wobei das durch den Einlaß (22) in die Zerkleinerungskammer eingeführte Material zwischen den peripheren Wänden während der relativen Rotation derselben

zueinander zerkleinert wird und vom Einlaß (22) zum Auslaß (23) passiert, **dadurch gekennzeichnet**, daß die Flächen (24, 25) einer jeden der peripheren Wände sich vom Einlaß (22) zum Auslaß (23) der Zerkleinerungskammer (21) erstreckt, wobei der Auslaß (23) ringförmig ist und durch die inneren und äußeren peripheren Wände definiert ist, die eine mit der Anzahl der Flächen (24, 25) der peripheren Wände der inneren (10) und äußeren (20) Bauteile korrespondierende Anzahl von Flächen aufweisen, wobei das innere Bauteil (10) eine innerhalb des Auslasses (23) angeordnete Verlängerung (10a) aufweist, wobei die Verlängerung (10a) eine periphere Wand mit der gleichen Anzahl von Flächen (24) wie das innere Bauteil (10) hat.

2. Zerkleinerungsmaschine nach Anspruch 1, **dadurch gekennzeichnet**, daß der Auslaß (23) koaxial zu der ringförmigen Zerkleinerungskammer (21) ausgeführt ist.

3. Zerkleinerungsmaschine nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß im koaxialen Querschnitt die periphere Wand des frustokonischen inneren Bauteils (10) sich nach außen in Richtung auf den Auslaß (23) erweitert und die periphere Wand des frustokonischen äußeren Bauteils (20) einwärts in Richtung auf den Auslaß (23) konvergiert, wobei die ringförmige Ausdehnung der Zerkleinerungskammer vom Einlaß (22) zum Auslaß (23) hin sich zunehmend verringert.

4. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet**, daß ein Ende des inneren Bauteils (10) in dem Bereich des Einlasses (22) angeordnet ist und wenigstens zwei gleichwinklig angeordnete Arme (26) aufweist, die sich radial auswärts von dem inneren Bauteils (10) erstrecken.

5. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet**, daß wenigstens ein Kanal (31, 32) zur Führung eines Schmiermittels in die Zerkleinerungskammer (21) vorgesehen ist.

6. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet**, daß das innere Bauteil (10) eine koaxial in einer in dem äußeren Bauteil (20) eingeformten Bohrung (20a) angeordnete Welle (33) aufweist.

7. Zerkleinerungsmaschine nach Anspruch 6, **dadurch gekennzeichnet**, daß ineinandergreifende Zinken (29,30) sich von der Bohrung (20a) und der Welle (33) zwecks Zerkleinerung in einer sekundären Zerkleinerungskammer (28) und zur Entladung von zuvor zerkleinertem Material aus dem Auslaß (23) erstrecken.

8. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet**, daß die innere periphere Wand eine um Eins größere oder kleinere Anzahl von Flächen (24) aufweist als die Anzahl von Flächen (25) der äußeren peripheren Wand.

9. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet**, daß die peripheren Wandflächen (24, 25) des inneren und äußeren Bauteile rechte Kegel bilden.

10. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet**, daß jede Fläche jeder der peripheren Wände (24, 25) flach ist.

11. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet**, daß jede der Flächen (24) der peripheren Wand des inneren Bauteils (10) konvex ist und jede Fläche der peripheren Wand (25) des äußeren Bauteils (20) flach ist.

12. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 9, **dadurch gekennzeichnet**, daß jede der Flächen (24) der peripheren Wand des inneren Bauteils (10) konkav ist.

13. Zerkleinerungsmaschine nach Anspruch 1, **dadurch gekennzeichnet**, daß der Neigungswinkel zwischen jeder Fläche (24, 25) der mehrflächigen peripheren Wand und der Basis des entsprechenden frustokonischen inneren Bauteils (10) und äußeren Bauteils (20) im Bereich von 50° bis 80° liegt.

14. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet**, daß die Anzahl von Flächen (24,25) auf jeweils dem inneren (10) und äußerem Bauteil (20) geradzahlig ist und daß die Anzahl von Flächen auf den jeweiligen Bauteilen (10,20) sich um die Anzahl zwei unterscheiden.

15. Zerkleinerungsmaschine nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet**, daß die Anzahl von Flächen (24, 25) auf jedem der inneren und äußeren Bauteile (20) ein Vielfaches von drei ist und daß die Differenz der Anzahl von Flachen auf den entsprechenden Elementen (10,20) drei ist.

**Revendications**

1. Dispositif de concassage comprenant une chambre (21) de concassage globalement annulaire comportant une entrée (22) destinée à recevoir le matériau à concasser et une sortie (23) à travers laquelle le matériau concassé est déchargé, la

chambre de concassage annulaire comprenant des éléments interne (10) et externe (20) montés de manière coaxiale, chaque élément présentant une paroi périphérique tronconique qui converge vers la sortie, chaque paroi périphérique comportant un nombre de faces (24, 25) différent et des moyens destinés à créer un déplacement angulaire relatif entre les éléments interne (10) et externe (20), dans lequel le matériau introduit dans la chambre de concassage à travers l'entrée (22) est concassé entre les parois périphériques au cours de la rotation relative de celles-ci et du passage de l'entrée (22) vers la sortie (23), caractérisé en ce que les faces (24, 25) de chaque paroi périphérique s'étend de l'entrée (22) vers la sortie (23) de la chambre de concassage (21) dans lequel la sortie (23) est annulaire et est définie par des parois périphériques interne et externe comportant un nombre de faces correspondant au nombre de face (24, 25) des parois périphériques des éléments interne (10) et externe (20), en ce que l'élément interne (10) inclut une extension (10A) située à l'intérieur de la sortie (23), et en ce que l'extension (10A) comprend une paroi périphérique comportant le même nombre de faces (24) que l'élément interne (10).

2. Dispositif selon la revendication 1, caractérisé en ce que la sortie (23) est coaxiale avec la chambre (21) de concassage annulaire.

3. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que, lorsqu'elles sont considérées dans leur section transversale coaxiale, la paroi périphérique de l'élément interne (10) tronconique diverge vers l'extérieur, vers la sortie (23) et la paroi périphérique de l'élément externe (20) tronconique converge vers l'intérieur, vers la sortie (23), dans lequel la dimension annulaire de la chambre de concassage est progressivement réduite de l'entrée (22) vers la sortie (23).

4. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce qu'une extrémité de l'élément interne (10) est située dans la zone de l'entrée (22) et inclut au moins deux bras (26) angulairement répartis qui s'étendent radialement vers l'extérieur à partir de l'élément interne (10).

5. Dispositif selon l'une quelconque des revendications précédentes, caractérisé par au moins un conduit (31, 32) destiné à introduire un lubrifiant dans la chambre de concassage (21).

6. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que l'élément interne (10) inclut un arbre (33) disposé de manière coaxiale dans un alésage (20A) formé dans l'élément externe (20).

7. Dispositif selon la revendication 6, caractérisé par des dents (29, 30) intercalées s'étendant respectivement à partir de l'alésage (20A) et de l'arbre (33) afin de concasser dans une chambre (28) secondaire de concassage, un matériau préalablement concassé, déchargé de la sortie (23).

8. Dispositif selon l'une quelconque des revendications 1 à 7, caractérisé en ce que la paroi périphérique interne comporte un nombre de faces (24) supérieur ou inférieur d'une face par rapport au nombre de faces (25) de la paroi périphérique externe.

9. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que les faces (24, 25) de parois périphériques des éléments interne et externe définissent des cônes droits.

10. Dispositif selon l'une quelconque des revendications précédentes, caractérisé en ce que chaque face de chaque paroi (24, 25) périphérique est plate.

11. Dispositif selon l'une quelconque des revendications 1 à 9, caractérisé en ce que chaque face (24) de la paroi périphérique de l'élément interne (10) est convexe et chaque face (25) de la paroi périphérique de l'élément externe (20) est plate.

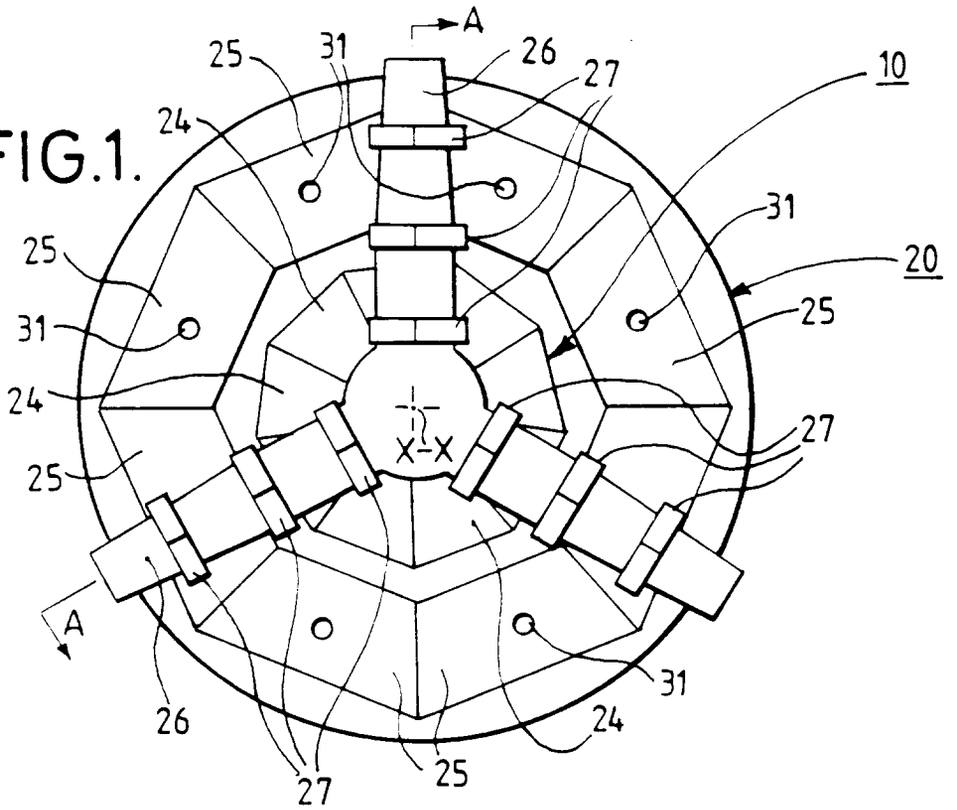
12. Dispositif selon l'une quelconques des revendications 1 à 9, caractérisé en ce que chaque face (24) de la paroi périphérique de l'élément interne (10) est concave.

13. Dispositif selon la revendication 1, caractérisé en ce que l'angle d'inclinaison entre chaque face (24, 25) de la paroi périphérique à faces multiples et la base des éléments interne (10) et externe (20) tronconiques respectifs se situe dans une plage de 50° à 80°.

14. Dispositif selon l'une quelconque des revendications 1 à 7, caractérisé en ce que le nombre de faces (24, 25) sur chacun des éléments interne (10) et externe (20) est un nombre pair et dans lequel les nombres de faces des éléments (10, 20) respectifs diffèrent de deux.

15. Dispositif selon l'une quelconque des revendications 1 à 7, caractérisé en ce que le nombre de faces (24, 25) sur chacun des éléments interne (10) et externe (20) est un multiple de trois et la différence entre les nombres de faces des éléments (10, 20) respectifs est de trois.

FIG.1.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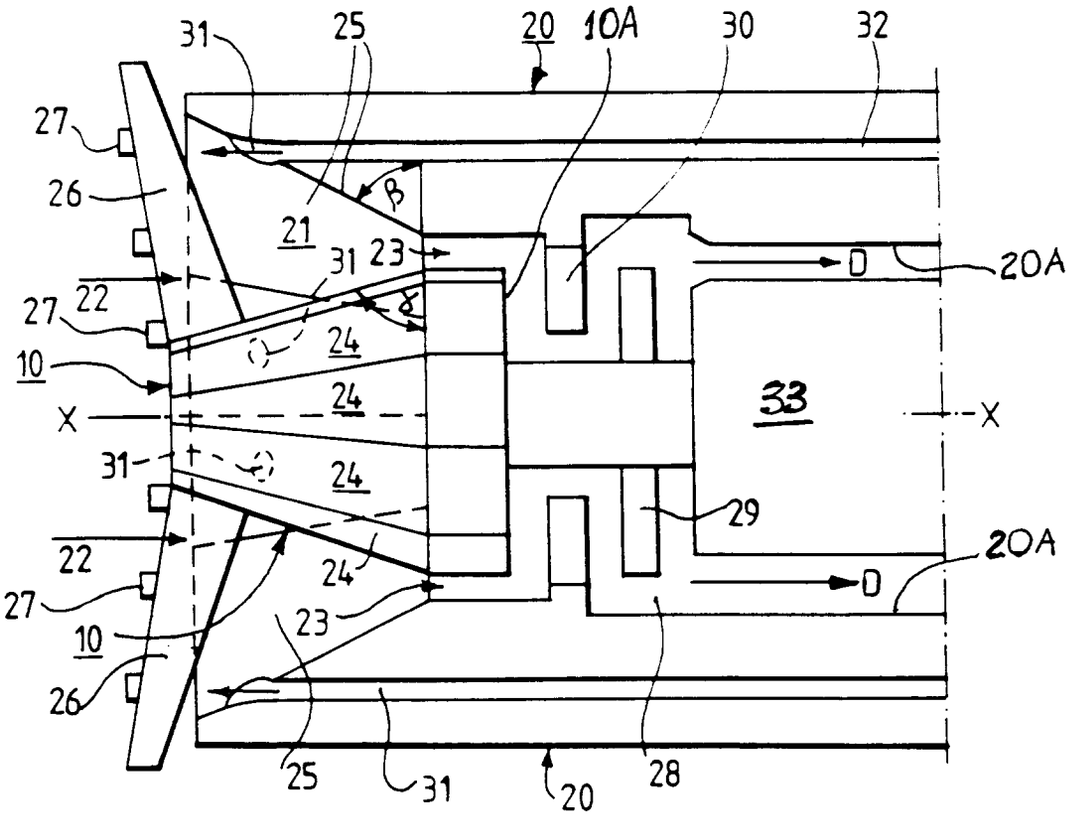
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28

FIG.2.

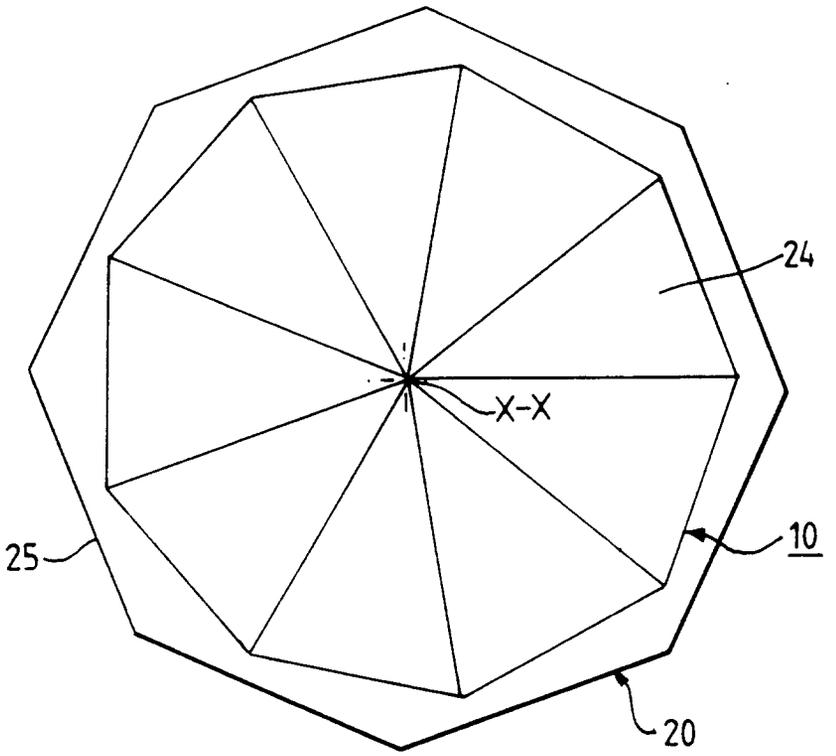


FIG.3.

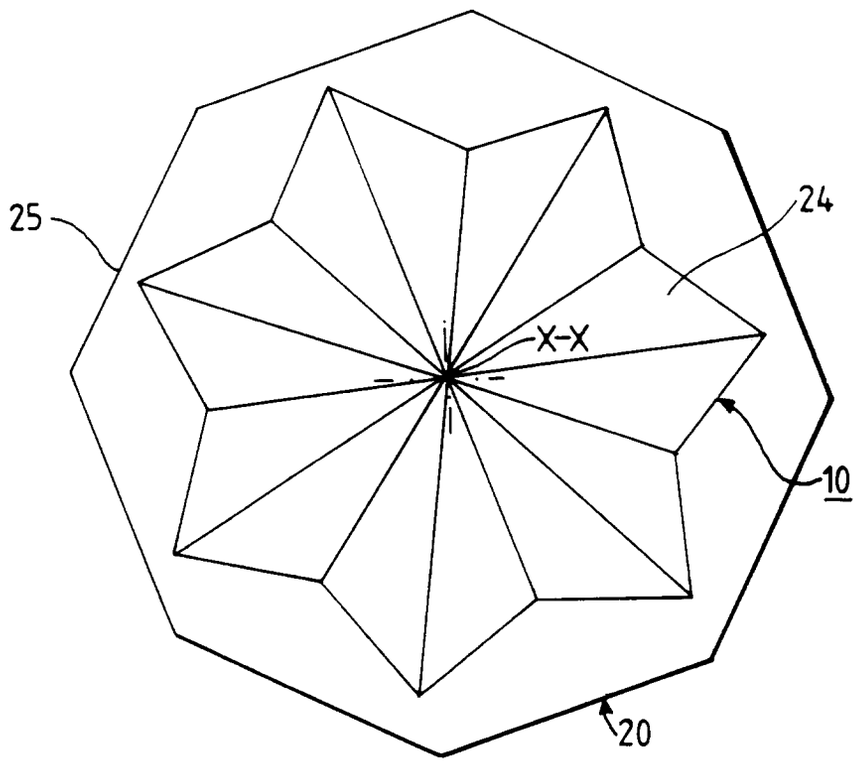


FIG.4.

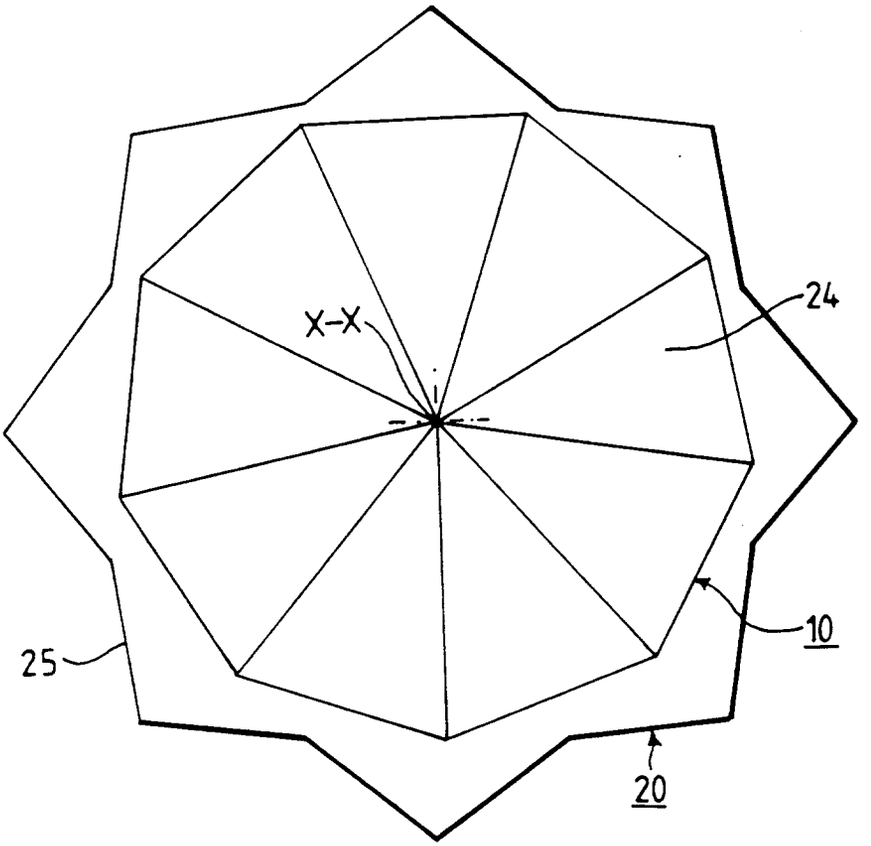


FIG.5.

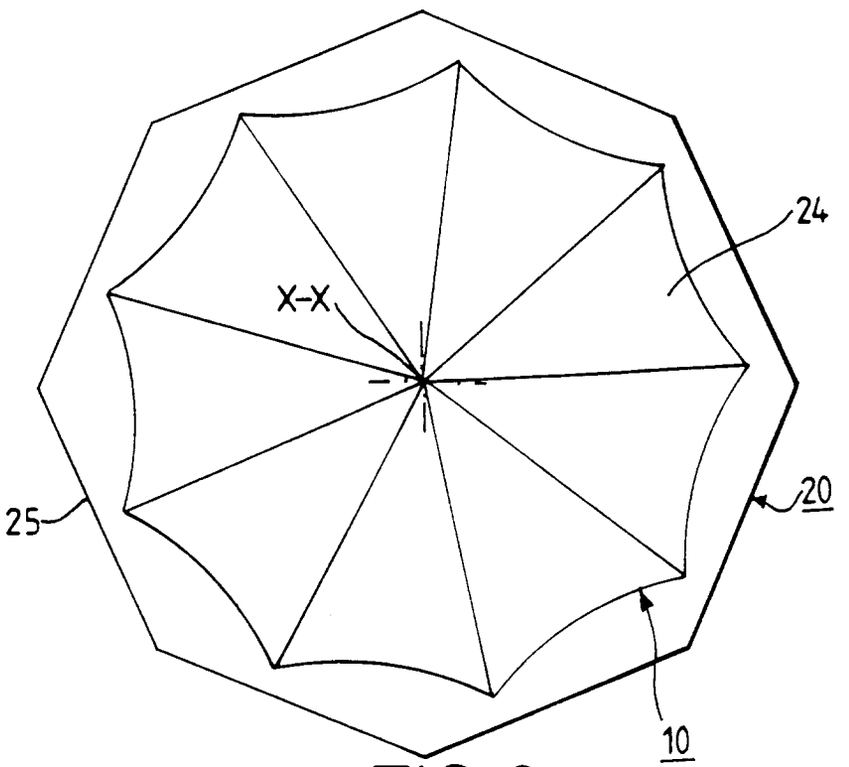


FIG.6.

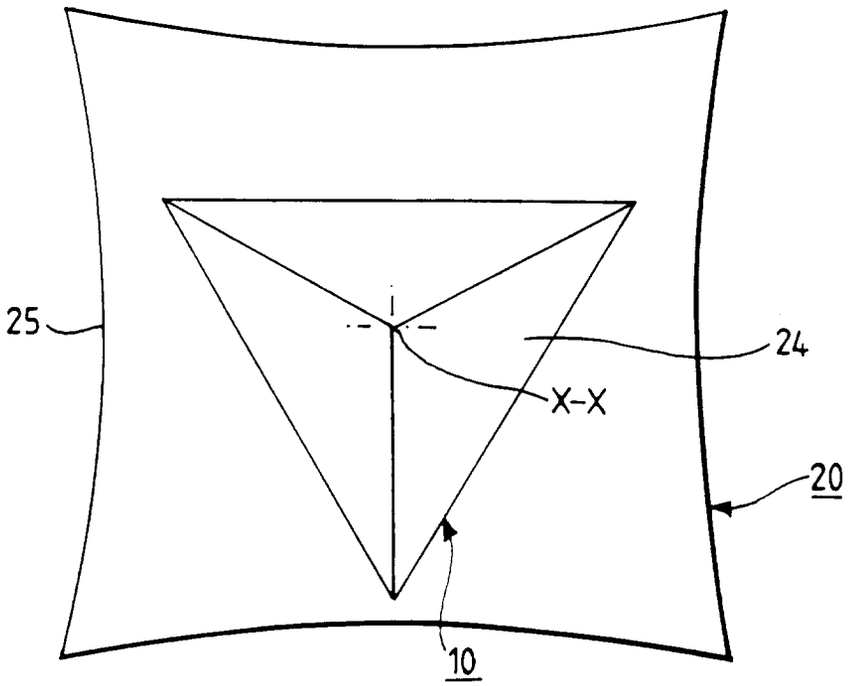


FIG. 7.

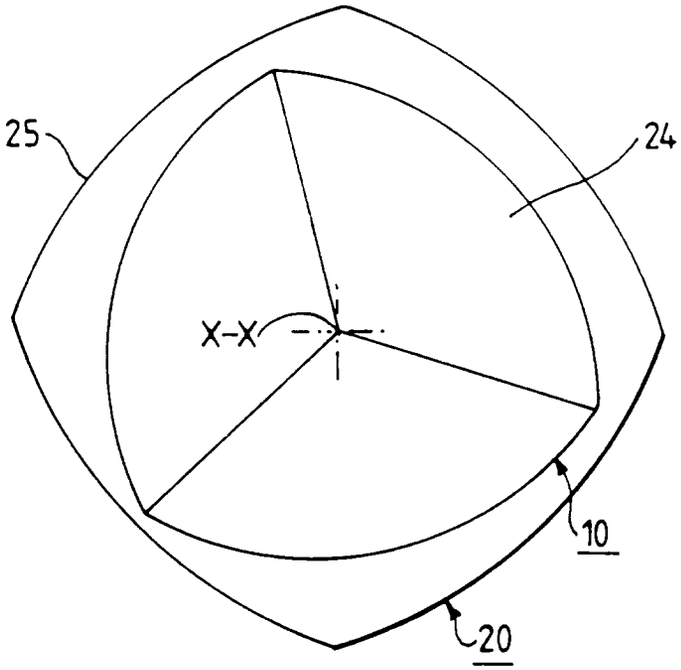


FIG. 8.

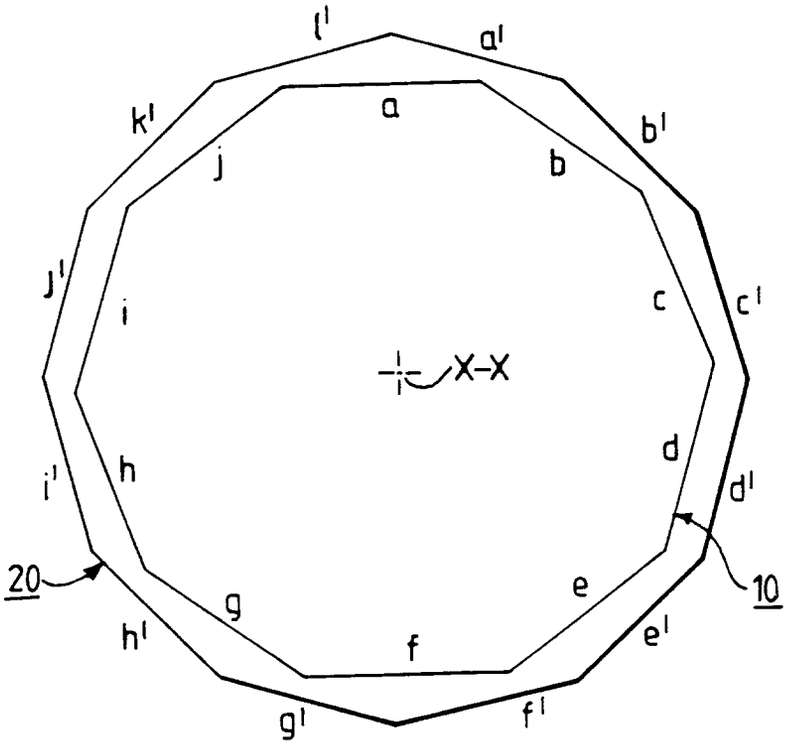


FIG.9.

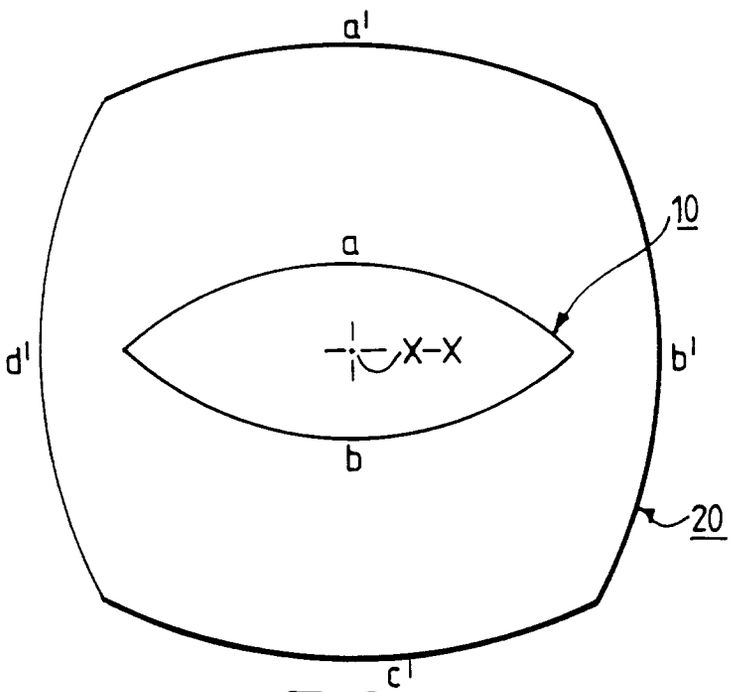


FIG.10.

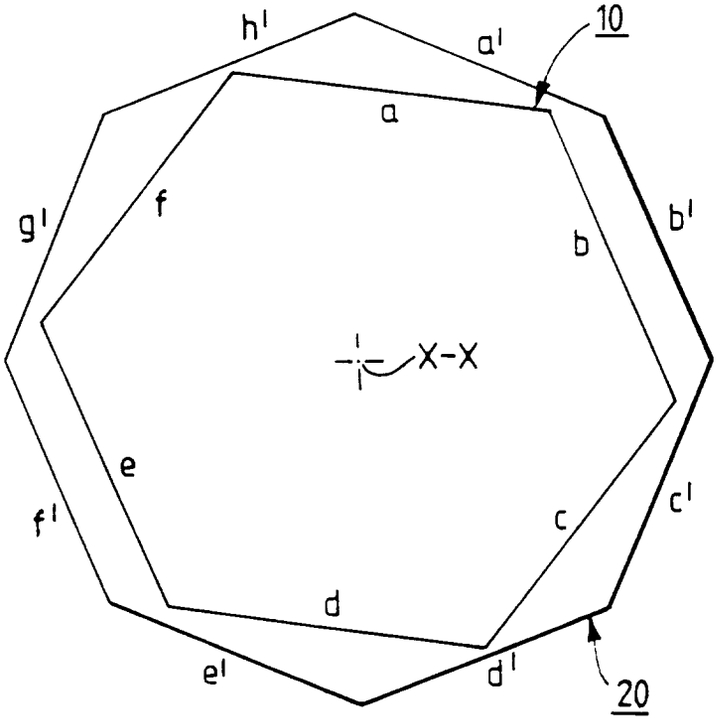


FIG.11.

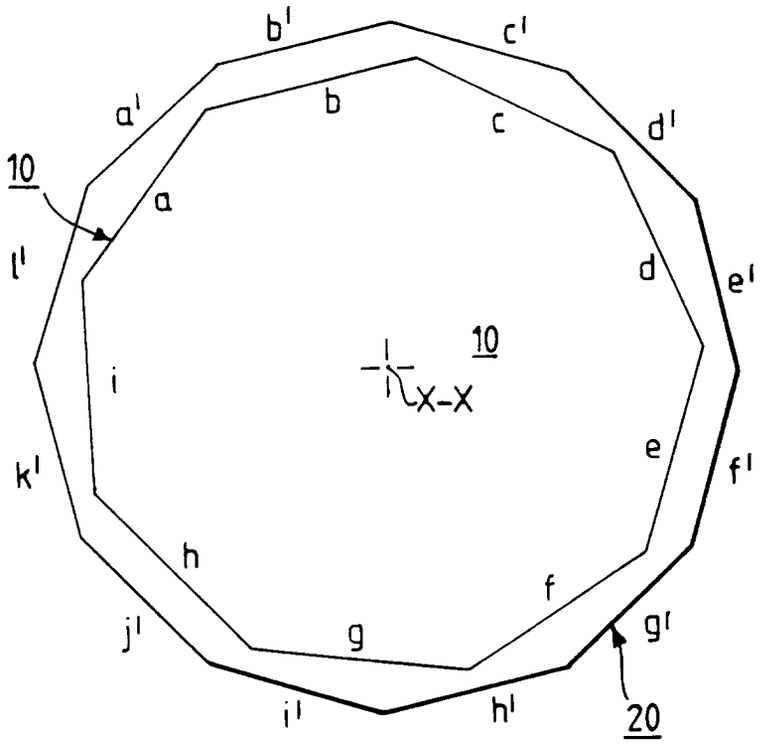


FIG.12.