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(54) Titre : APPAREIL ET PROCEDE PERMETTANT D'OBTENIR DES PRODUITS D'EXTRUSION MULTIPLES A MOTIFS COMPLEXES

(54) Title: APPARATUS AND METHODS FOR MAKING MULTIPLE, COMPLEXLY PATTERNED EXTRUDATES

(57) Abrégé/Abstract:
Apparatus (10) and methods are disclosed where plastic extrudable food product is provided such as by a food cooker extruder (12) and is mixed with a food color to form a complexly patterned food product, such as by a pattern forming die (20). The cross-sectional area of the patterned food product is reduced from an inlet end (34) to an outlet end (36) by a factor of at least 50:1 at an average convergence angle of ≤ 45° while maintaining the cross-sectional pattern to form a reduced cross-sectional patterned dough, and then is extruded through a die port having an opening equal to the reduced cross-sectional area to form a complexly patterned extrudate. In the preferred form multiple extrudates are simultaneously formed with the flow rates for each extrudate being adjustable by an adjuster plug (16) including a smooth cylindrical portion (86) extendable into a passageway (14) having a circular cross section of a larger diameter than the cylindrical portion (86). In a preferred form, the extrudates are extruded in a non-circular pattern and specifically in a horizontal, single plane by a manifold (100) including ports (134,136) and ducts (132,138) receiving flow from passageways (128,130) receiving flow from conduits (116,118,120) receiving flow from the food cooker extruder (12).

22694-1560D

Abstract

Apparatus (10) and methods are disclosed where plastic extrudable food product is provided such as by a food cooker extruder (12) and is mixed with a food color to form a complexly patterned food product, such as by a pattern forming die (20). The cross-sectional area of the patterned food product is reduced from an inlet end (34) to an outlet end (36) by a factor of at least 50:1 at an average convergence angle of $\leq$ 45° while maintaining the cross-sectional pattern to form a reduced cross-sectional patterned dough, and then is extruded through a die port having an opening equal to the reduced cross-sectional area to form a complexly patterned extrudate. In the preferred form multiple extrudates are simultaneously formed with the flow rates for each extrudate being adjustable by an adjuster plug (16) including a smooth cylindrical portion (86) extendable into a passageway (14) having a circular cross section of a larger diameter than the cylindrical portion (86). In a preferred form, the extrudates are extruded in a non-circular pattern and specifically in a horizontal, single plane by a manifold (100) including ports (134,136) and ducts (132,138) receiving flow from passageways (128,130) receiving flow from conduits (116,118,120) receiving flow from the food cooker extruder (12).

22694-1560D

This is a division of our Co-pending Canadian Patent Application No. 2192 684 having a filing date of 10 May 1995.

1. Field of Invention

The present invention comprises apparatus and methods for making complexly patterned multicolored extruded food products. More particularly, the present invention relates to apparatus and methods for reducing a large cross sectional area complexly patterned food extrudate to a smaller area while maintaining the complex pattern, to apparatus and methods for adjusting flow of plastic extrudable food product, and to a manifold for making multiple extrudates formed of plastic extrudable food product and having uniformity of flow.

2. Background

Food products such as Ready-To-Eat ("R-T-E") cereals and snack products vary widely in composition, shape, color, flavor, texture, etc. Such products can include both puffed and unpuffed varieties. One attractive feature is their appearance which can include specific attributes such as shape and coloration. Especially attractive are products having a complex but organized pattern of coloration, shape and/or complex shape.

A wide variety of techniques are known to provide complexly shaped products such as rings, stars, letters, figures, etc. Problems generally include how to provide consistently the desired degree of shape detail or resolution in the finished pieces. Similarly, for colored products, a problem is how to consistently provide a fine level of detail. This problem of imparting a fine level

22694-1560D

of detail is particularly difficult in the provision of complexly patterned R-T-E cereals due to their generally smaller size. The problem is even more severe for puffed R-T-E cereal products due to the very tiny size of the pellets that are expanded to form the finished products. Of course, the pellets must contain and retain the complex pattern.

In particular, it would be desirable to prepare puffed R-T-E cereals having a shape and color pattern reminiscent of various sports balls such as baseballs, footballs, basketballs and soccer balls, such as are disclosed in 1) U.S. Design Pat. No. D373671, issued Sep. 17, 1996, 2) U.S. Design Pat. No. D384785, issued Oct. 14, 1997, 3) U.S. Design Pat. No. D368791, issued Apr. 16, 1996, and 4) U.S. Design Pat. No. D372352, issued Aug. 6, 1996 respectively.

Such products are characterized in part by high degrees of resolution such as by line features (such as to indicate traditional sticking patterns) 1mm> in thickness and even 0.5mm>. Providing a cereal pellet which upon puffing provides a puffed R-T-E cereal exhibiting such a fineness of detail is a difficult problem to overcome.

Line colored or externally striped food products such as R-T-E cereals as well as apparatus and methods for their preparation are described in U.S. 2,858,217 entitled Cereal Product With Striped Effect and Method of Making Same (issued Oct. 28, 1958 to J. O. Benson).

The '217 patent describes an extrudate extruder having a color injecting die insert for making a complexly patterned extrudate. However, the extrudate is directly extruded without any reduction in its cross sectional area.

22694-1560D

Also, the method appears to be limited to producing only flakes in a simple pattern of generally parallel more or less straight lines.

22694-1560D

The method is not capable of generating a direct expanded cereal or snack (i.e., expanded directly from the extruder) having a line detail of such a degree of fineness.

An improvement or modification in the technique for providing a line colored cereal based snack piece is described in U.S. 3,447,931 (issued June 3, 1969 also to Benson et al.) entitled Process For Preparing a Puffed, Concave Shaped Cereal Product. More particularly, the '931 patent describes a process for making a cup flower shaped R-T-E cereal piece having a complex line pattern. The process involves extruding a plurality of rope dough filaments which are pressed together to form a column or rope without a material decrease in the cross section which is then combined under conditions such that no puffing occurs. The composite strand of compressed filaments is then cut into wafers and which are subsequently heat puffed. While useful, the process appears to be limited to producing only the "flower bloom" shape. Also, the pieces prepared are of a larger snack piece size rather then the relatively smaller pieces characteristic of R-T-E cereals.

Especially in commercial applications, the plastic extrudable food product is supplied in an amount to form a plurality of extrudates. Problems that arise that extrudates have uniformity of flow for consistency in the final product, with adjustment of the flow rate and pressure being accomplished without increasing the likelihood of downstream plugging. Furthermore, problems also arise that the extrudates interfere with each other such as by falling on top of each other thereby making downstream processing difficult.

In a first aspect, the present invention provides apparatus for adding at least a first additive to flowing dough including a die dividing member in the flowing dough to impart at least one dough interstitial gap, with the die dividing

22694-1560D

member including an upstream face and a downstream face; means for injecting the additive at the downstream face and into the interstitial gap, with the additive traveling in the interstitial gap characterized in a notch formed in the die dividing member extending from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the dough to flow into and fill the interstitial gap within the notch.

The invention also provides method for adding at least a first additive to flowing dough including the steps of: dividing the flowing dough to impart at least one dough interstitial gap in the flowing dough, and injecting the additive in the interstitial gap characterized in the step of partially filling the interstitial gap with dough from the flowing dough, with the additive being injected at a location downstream of where the interstitial gap is partially filled in remaining portions of the interstitial gap.

The invention further provides flow rate adjustment apparatus for adjustment of plastic extrudable food flow through a port, with the port having circular cross sections and a center line, including a plug having circular cross sections of a diameter less than the cross sections of the port and a center line, and means for extending the plug into the port with the center line of the port being at a non-parallel angle to the center line of the plug, with the plug having an axial end located inside of the port, characterized in the axial end of the plug having a configuration which can not mate with the port allowing flow of dough between the axial end of the plug and the port at all positions of the plug.

The invention further provides a flow rate adjustment apparatus for adjustment of plastic extrudable food flow in a passageway of a food extruder including a rounded smooth retractably adjustable plug projecting into the passageway, means for adjustably retractably extending the plug into the passageway, and means for sealing the plug against food leakage characterized in that the means for adjustably retractably extending the plug includes stop means exterior to the passageway for terminating the extension of the plug into the passageway, and wherein the length of the plug extending into the passageway when stopped is less than 90% of the width of the passageway.

The invention further provides manifold for making multiple extrudates formed from a food dough exiting from a source and having uniformity of flow, including a plurality of exit orifices located at differing spacings from the source; and with each of the exit orifices including a flow path for the food dough from the source to the exit orifice, with the flow paths of at least two pair of the exit orifices being formed by at least first and second passageways and first, second, third, and fourth ports, with the first and second passageways extending downstream from an interconnection at a passageway angle relative to each other and having equal cross-sectional sizes and shapes, with the first and second ports extending downstream from the first passageway and having generally equal cross-sectional sizes and shapes and the third and fourth ports extending downstream from the second passageway and having generally equal cross-sectional sizes and shapes generally equal to the cross-sectional sizes and shapes of the first and second ports and less than the cross-sectional sizes of the first and second passageways, with the first and second passageways having generally equal lengths, with the first, second, third, and fourth ports having generally equal

lengths characterized in the flow path of at least one of the exit orifices being formed by a duct having a constant size from the interconnection of the first and second passageways to the exit orifice, with the cross-sectional size of the duct being less than the cross-sectional size of the first and second passageways.

BRIEF DESCRIPTION OF THE DRAWING

Figure 1 is an end view particularly cut away of the die face of a food cooker extruder showing a plurality of exit ports.

Figure 2 is a sectional view greatly cut away of a reduction passageway of the present invention taken along lines 2-2 of Figure 1.

Figure 3 shows an enlarged sectional view of a die insert for making an enlarged complexly shaped dough taken along lines 3-3 of Figure 2.

Figure 4 is an enlarged sectional view of a die insert showing the channels for the food color flow taken along lines 4-4 of Figure 3.

Figure 5 is an enlarged sectional view of the die insert taken along lines 5-5 of Figure 4 in an upstream orientation.

Figure 6 is an enlarged sectional view of the die insert taken along lines 5-5 of Figure 4 similar to Figure 5 but showing a downstream orientation.

Figure 7 is an enlarged plan view of a finished puffed complexly patterned R-T-E cereal piece prepared using the present methods and apparatus.

Figure 8 is an enlarged sectional view of the R-T-E cereal piece taken along lines 8-8 of Figure 7 showing the concave shape of the cereal piece.

Figure 9 is a partial sectional view of the food cooker extruder taken along lines 9-9 of Figure 2.

Figure 10 is a front elevational view of a manifold for making multiple extrudates secured to the outlet of a food cooker extruder.

Figure 11 is a partial cross-sectional view of the manifold taken along lines 11-11 of Figure 10.

Where used in the various figures of the drawing, the same numerals designate the same or similar parts. Furthermore, when the terms "top," "bottom," "first," "second," "upper," "lower," "height," "width," "length," "end," "side," "horizontal," "vertical," and similar terms are used herein, it should be understood that these terms have reference only to the structure shown in the drawing and are utilized only to facilitate describing the invention.

DESCRIPTION

Referring now to the drawing and briefly in particular to Figure 1, there is shown an apparatus for preparing a complexly patterned cereal dough piece according to the preferred teachings of the present invention that is generally designated 10. In the most preferred form,

apparatus 10 generally includes a means for providing at least one extrudable food product or cooked cereal dough such as a cooker extruder 12 as seen in Figure 1. Extruder 12 is seen to have at least one, and more preferably a plurality of, exit ports or orifices 13 each for extruding of a complexly patterned cooked cereal dough of the present invention (not shown) or other extrudable food product.

While a cooker extruder is the preferred equipment to provide the extrudable food, other conventional equipment and techniques can also be employed. For example, a batch cooker or semi-continuous cooker for cooking the ingredients in bulk can be equipped with dough forming and conveying extruder element. In other embodiments, e.g., a low moisture fruit paste, a simple screw conveyor can be employed. While in the present description particular reference is made to the provision of complexly patterned farinaceous materials such as R-T-E cereals and snack products, the skilled artisan will appreciate that the apparatus and techniques can be employed with a wide variety of extrudable food products, especially such plastic foods as low moisture fruit products.

Now referring to Figure 2, the cooker extruder 12 provides the cooked cereal dough in quantity which can supply one or preferably, especially in commercial applications, a plurality of passageways 14, each leading to an exit port 13. In highly preferred embodiments, the apparatus 10 can additionally include a means for adjusting the cooked cereal dough flow rate and pressure such as the adjustably retractable dough flow adjuster plug 16 depicted. Such a flow rate adjustment means is particularly useful when, as in the embodiment depicted, the extruder supplies a large number of extrudate orifices. Absent such a flow rate adjustment means, the particular extrudate characteristics (e.g., pressure, mass flow) from each of so many orifices are difficult to

control since the length of passageway 14 from the central supply can vary.

Flow adjuster plug 16 can include a rod or bolt 80 having at least upper and lower cylindrical portions 84 and 86. Upper portion 84 in the most preferred form includes threads 82. Lower cylindrical portion 86 is in the most preferred form of a plug having a smooth outer periphery of a diameter which is less than the diameter of passageway 14. Further, the inner axial end 88 of portion 86 opposite to portion 84 has a generally flat configuration and specifically has a diameter which is considerably larger than the diameter of passageway 14. Extruder 12 has a cylindrical bore which intersects generally perpendicular with passageway 14 and which includes a radially outward, threaded portion and a radially inward, smooth portion having a diameter generally equal to and for slideable and rotatable receipt of portion 86 such that the center line of portion 86 is generally perpendicular to the center line of passageway 14. Bolt 80 further includes a threaded portion located intermediate portions 84 and 86 of a size for threadable receipt in the extruder bore. Plug 16 further includes a means for sealing against dough of extruder 12 leaking from passageway 14 such as at least a first "O" ring 90, 91 inset into a receiving peripheral seal groove 92, 93, respectively. Plug 16 can further include lock nut 94 threaded on threads 82 of portion 84 and which can be tightened against block 96 to secure bolt 80 against movement such as caused by vibration of extruder 12.

By rotating bolt 80 into or out of the extruder bore, portion 86 can be adjustably retractably extended into passageway 14. It can then be appreciated that the area of flow through passageway 14 at plug 16 is inversely related to the extent that portion 86 extends into passageway 14. It should be appreciated that portion 86 can not choke or stop dough flow through passageway 14 or provide a buildup location for dough in passageway 14.

In particular, due to the smaller diameter of portion 86 than passageway 14, the outer extent of portion 86 will extend along a chord of the circular cross section of passageway 14 at a spacing from its center less than its radius allowing flow of dough therebetween. It should be appreciated that due to the circular cross sections of portion 86, dough will tend to flow around portion 86 through passageway 14 and not stop in front thereof such as can occur if a flat or other non-cylindrical surface were presented. Likewise, when portion 86 is fully retracted out of passageway 14, the extruder bore does not form locations outside of passageway 14 in which dough can accumulate. Further, due to the preferred shape of end 88 relative to passageway 14, even if bolt 80 were rotated such that end 88 engaged the wall in extruder 12 defining passageway 14, end 88 does not closely mate passageway 14 but will similarly generally extend along a chord of the circular cross section of passageway 14 at a spacing from its center less than its radius allowing flow of dough therebetween. Stopping dough flow or allowing dough buildup or accumulation can lead to hardening of the dough, with hardened dough potentially causing plugging problems downstream. In the most preferred form, with end 88 engaging the wall in extruder 12 defining passageway 14, portion 86 covers less than 90% of the cross-sectional area of passageway 14 allowing flow of dough through at least 10% of the cross-sectional area of passageway 14 at all times.

The apparatus 10 further essentially includes at least one food color supply 18 which can supply a flowable colored food material such as food color liquid (whether oil or preferably water based). The color supply 18 is in fluid communication with and the apparatus 10 further includes a means for mixing or forming the food color liquid and extrudable food product into a complexly patterned food extrudate such as a greatly enlarged

(relative to the exit orifice) pattern forming die insert 20 depicted. In the preferred embodiment, the passageway 14 can include a first flared or divergent portion 21 immediately upstream of the die insert 20 to widen the passageway 14 to an equal diameter to the die insert 20 as well as a second convergent flared portion 22 downstream. In the drawing, the passageway 14 and other constituent elements are depicted in close to actual size. Thus, the diameter of the die insert 20 is about 30 mm and is positioned within a slightly enlarged portion 24 of passageway 14. As a result, the diameter of the complexly patterned dough extrudate as it exits the die insert 20 will have an enlarged initial diameter about 30 mm. Of course, other sizes for the die insert 20 can be used (e.g., 15 to 100 mm).

In Figure 2, it can be seen that the complexly patterned dough extrudate so formed then moves through by pressure flow and apparatus 10 further includes a means for reducing the cross sectional area of the complexly patterned food extrudate while maintaining the pattern such as a reducing or necking passageway 25 depicted. The reducing passageway 25 can be fabricated from a single piece having, for example, a frusto conical bore or, as depicted, with a plurality of individual pieces such as the first, second, and third pieces 26, 28 and 30, respectively, depicted. Individual pieces can be more easily cleaned. Also, the convergence angle and other attributes, e.g., internal surface, can be adjusted as needed (e.g., smoothness, anti-stick surface) to accommodate differences in the extrudate characteristics of different food products. In Figure 2, it is seen that the passageway 14 has an initial relatively larger diameter 34 and a final relatively smaller or exit diameter 36 at the exit port 13. Moreover, while the passageway 14 is depicted as having a circular cross sectional area, in other embodiments the passageway 14 can be fabricated with a more complex pattern or peripheral

configuration to define or define in part the exterior shape or configuration of the finished piece, including both regular shapes (e.g., stars, rings, ovoids, geometric shapes) as well as irregular shapes (e.g., animals, objects such as trees, cars, etc.). Furthermore, the passageway 14 can be fabricated with an interior surface of desired characteristics, e.g., polished or Teflon or other non-sticking surface, such as to provide decreased friction to facilitate retention of the complex pattern or to reduce the pattern's deformation. Especially desirable is an ovoid cross section for the passageway for preparation of an American style football or a rugby ball.

An important feature of the present invention is the convergence angle of the reducing passageway 25. It has been found important to maintain an average convergence or confinement angle of 5° to 45°, preferably 5° to 20°, and most preferably 10° to 15° in order to maintain the pattern while the cross sectional area is reduced. By "average convergence" is meant the angle formed from the diameter of the die insert 20 to the diameter 36 of exit port 13 over the length of the reducing passageway 25. As depicted, with passageway pieces 26, 28, and 30, some pieces, e.g., 26 and 30, have a sharper convergence angle while piece 28 has a shallower angle. Internal obstructions (e.g., shoulders) are to be avoided so as to provide a continuous passageway to minimize disrupting the complex pattern formed in the dough. Figure 2 shows that the exit orifice diameter 36 is about 3 mm. Since the passageway 14 can have a complex cross sectional shape as described above, the extent of reduction of the pattern is more aptly characterized in terms of cross sectional area reduction rather than more simply a reduction in diameter. Thus the degree of reduction of cross sectional area in the illustrated embodiment is about 100:1. Of course, for other embodiments (e.g., for larger snack pieces), the extent of cross section reduction can be as little as 25:1.

The exit orifice diameter 36 for a snack product can be correspondingly larger, e.g., 5 to 15 mm.

Surprisingly, such a shallow convergence angle allows for a reduction in cross sectional areas of at least 50:1 and even about 100:1 while maintaining a fine level of detail in the complex pattern. Thus, a complex shape can be imparted to a larger dough face or cross section and then reduced to the much smaller desired finish cross sectional area. This arrangement allows for the fabrication of a relatively large die insert to impart the complex pattern. Fabricating a small die insert to impart the desired degree of detail for the final exit diameter while possible on a development scale extruder is not commercially practical due in part to plugging or fouling of the die insert 20. The provision of a reducing passageway 25 having the requisite convergence angle allows for the provision of three dimensional shapes to be produced with a fine level of color detail. Moreover, the finished pieces are characterized by a color through the entire piece as compared to only topical coloration.

Also, it is seen that the mixing is not immediately proximate the discharge port 13 but distanced therefrom. This allows for the dough to modestly "set" so as to assist in maintaining the complex shape.

Reference is now made to Figure 3 which shows an enlarged cross section of the pattern forming die insert 20. As can be seen, this particular die insert can be used to fabricate a bicolored food piece 40 as seen in Figure 7 having a swirl or spiral pattern. However, other pattern forming die inserts can be substituted therefor which, for example, can impart the line pattern for products reminiscent of soccer balls, basketballs, baseballs, and other sports objects.

The die insert 20 includes a means for imparting at least one, and more desirably a plurality of, dough interstitial gaps such as between a plurality of dough dividing passageways such as passageways 44, 45, and 46

respectively formed by die dividing members 47. The die insert 20 can further include a means for injecting a food color or second colored dough into the interstitial dough gaps such as a plurality or array of evenly spaced food color injection ports 48 formed in die dividing members 47 and fed by a fluid supplying passageway 50 therethrough. The extrudable food product itself may be colored. The color supply 18 may supply a different color or the same color having a darker or lighter hue. Specifically, the food color passageways 50 are supplied with the food liquid from one or more food color supply ports such as ports 52, 54, and 56, respectively in the die dividing members 47. Of course, when the second or colored material is a food product such as a second dough or fruit paste, the passageways and injection ports can be enlarged to reduce friction and the potential for blockage.

Referring now briefly to Figure 4, it can be seen that the die insert 20 can further include a color fluid supply reservoir 58 supplied by the color supply 18 and which is in fluid communication with or supplies food color supply ports 52, 54, and 56. The die insert 20 can further include a means for sealing the color fluid supply reservoir 58 against premature admixture with dough such as "O" rings 60 and 62 depicted.

Reference is now briefly made to Figure 5 which shows the upstream face 64 of the die insert 22. Figure 5 shows that the upstream face 64 for this particular die insert contains no color supply discharge ports and that the discharge of color is preferably in a downstream direction.

Reference is now made briefly to Figure 6 wherein the relationship between the supply inlet ports 52, 54, and 56, supply passageways 50 and color discharge ports 48 can be most simply seen. It can then be appreciated that the color will tend to fill the interstitial gaps in the flowing dough between passageways 44, 45, and 46 formed by and behind die dividing members 47 to create a line in

the shape of die dividing members 47 in the extruded dough flow. Referring now to Figures 3 and 4, notches 57 are provided in die dividing members 47 extending axially from the downstream face towards but spaced from upstream face 64 and specifically upstream from the discharge ends of ports 48. The axial length of notches 57 is sufficient such that the dough extruded through passageways 44, 45, and 46 tends to flow into and fill the portions of the interstitial gaps in notches 57 upstream of where the color is discharged from ports 48. The portions of the interstitial gaps axially in line with notches 57 are then filled with dough upstream from where the color is discharged to prevent color added by ports 48 from flowing into those portions.

In the preferred form shown in Figures 3 and 4, notches 57 are shown formed in die dividing members 47 intermediate ports 48 and the interior surface wall and in the preferred form adjacent to the interior surface wall of die insert 20. If die dividing members 47 extend to and engage the interior surface wall of die insert 20, color will tend to travel in the interstitial gaps all the way to the interior surface wall of die insert 20 and will tend to fill the void between the dough passing through passageways 44, 45, and 46 and the interior surface wall of die insert 20. This leads to a disproportionate amount of color being on the outside of the extruded dough. Thus, notches 57 generally prevent color from traveling all the way to the interior surface wall of die insert 20 to practically eliminate or reduce the color on the outside of the extruded dough.

It can also be appreciated that notches 57 can also be provided in die dividing members 47 spaced from the interior surface wall of die insert 20. One reason for such an arrangement would be where multiple colors are desired in the extruded dough. This can be accomplished by supplying a first color to certain of the ports 48 with the other ports 48 being supplied with a different

color(s) or hue(s). Notches 57 can then be provided in die dividing members 47 separating those certain ports 48 from the other ports 48 to generally prevent intermixing of the additives in the extruded dough.

Reference now is next briefly made to Figures 7 and 8 which show that the food piece 40 can have a cupped shape and that the coloration can extend throughout the body of the piece. The piece 40 depicted is a puffed R-T-E cereal piece prepared by direct expansion from the extruder having a finished diameter of about 70 mm.

In the present invention, the complexly patterned dough of reduced cross sectional diameter is extruded through the reduced diameter exit orifice 36 (e.g., about 3 mm). Thereafter, the extrudate is face cut in a conventional manner to form individual pieces such as with one or more rotating knives. Depending upon the conditions of the extrudate, an unpuffed pellet piece can be formed for subsequent puffing, or, alternatively, and preferably herein, a directly expanded finished puffed piece is formed. The finished food piece whether subsequently puffed or puffed by direct expansion upon exiting the exit orifice 13 is essentially characterized by exhibiting a high resolution or fine degree of color detail. The detail can include surface line coloration of as thin as about 0.5 mm in the puffed product. In certain embodiments, the interior is also bicolored or multicolored as well as having topical or surface coloration.

The extrudable food can comprise a wide variety of conventional food types and in particular can include a fruit paste, potato dough (e.g., for a fabricated chip) or a cooked cereal dough. The cooked cereal dough can be for either R-T-E cereals (whether puffed or unpuffed), snack products, baked goods, or pastas. Especially desirable are cooked cereal doughs for puffed R-T-E cereals. Puffed food products such as snacks can be prepared by hot air puffing, deep fat frying, gun puffing or microwave

(especially high intensity, e.g., >100 V/cm field strength). Product puffed without deep fat frying can have oil added to the composition or have a topical oil application. R-T-E cereals can have a sugar coating. Puffed food pieces of the product base (i.e., prior to or without oil or sugar) can have a density of about 0.1 to 0.5g/cc. The colored portion forms a line or a plane through the body of the food piece. "Highly complex" food products are characterized as having a plurality of colored features at least two of which (e.g., two planes or a line and a plane) intersect within the body of the food piece.

While in the present invention, the particular die insert 20 depicted is designed to admix a liquid food color into a cooked cereal dough so as to provide line coloration of extremely fine detail, the die insert 20 can be modified (e.g., such as by enlargement of ports 52, 54, and 56, fluid passageways 50, and discharge ports 48) to admix two or more cooked doughs or other flowable colored food materials, especially liquefied fats (e.g., chocolate, cheese), or fruit paste.

Also, while the particular die insert 20 depicted is designed to provide the swirled finished product depicted, other die inserts can be interchanged to provide the line coloration detail to provide the particular desired end products such as the various sports balls (e.g., soccer, baseball, basketball, American football) referenced above.

It will be appreciated that for those embodiments that are extruded without direct expansion or puffing upon extrusion that lines having a detail of about 0.1 mm in width can be obtained. Upon subsequent expansion (e.g., deep fat frying, gun puffing, fluidized bed puffing, radiant heat puffing or other puffing methods), puffed pieces will of course expand causing an increase in the width of the line. These enlarged lines (i.e., 0.5 mm>), however, are nonetheless thinner than lines obtainable by

any other known method. If desired, thicker lines (e.g., about 3 mm) can also be formed.

Other dough flow adjustment devices can be used with or in substitution for the preferred flow adjuster plug 16 herein if 1) positioned upstream of the die insert 20, and 2) do not increase the likelihood of downstream plugging. For example, and referring to Figures 10 and 11, an alternate embodiment of a dough manifold 100 is shown according to preferred teachings of the present invention. In particular, manifold 100 includes body portions 102, 104, 106 and 108 which are secured together into a unitary assembly. In particular, body portion 102 includes a circular disc 110 which abuts with the mounting flange 112 of the outlet of food cooker extruder 12. Disc 110 can be secured to extruder 12 by any conventional means and in the preferred form includes an annular lip 114 formed on its outer periphery at the inner axial end which abuts with flange 112, with lip 114 being of a size and shape generally corresponding to flange 112.

Bores or conduit portions 118 intersect at the inner axial end of disc 110 at the center line of extruder 12 and disc 110 and extend therefrom at equal acute angles on opposite sides of the center line of extruder 12 and disc 110 in the order of 62° in the most preferred form, with the center lines of bores 118 and the center line of extruder 12 and disc 110 being arranged in a horizontal plane in the most preferred form.

Body portion 102 further includes first and second pipes or conduit portions 116 which extend linearly from bores 118 formed in disc 110 past the outer axial end of disc 110 to equal distances from disc 110.

Body portion 102 further includes first and second conduit portions 120 located on opposite sides, parallel to, and at equal distances from the center line of extruder 12 and disc 110, with the center lines of conduit portions 120, extruder 12 and disc 110 being arranged in a horizontal plane in the most preferred form. Conduit

portions 120 have cross sections of an equal size and shape to pipes 116. The outer axial ends of first and second pipes 116 opposite to disc 110 are integrally connected to and in fluid communication with the inner axial ends of first and second conduit portions 120, respectively, in the most preferred form by a mitered interconnection. The outer axial ends of conduit portions 120 are equally spaced from disc 110 and extruder 12.

Body portion 102 further includes a flat mounting plate 122 which is held generally perpendicular to the center lines of conduit portions 120, extruder 12 and disc 110 by a support 124 extending between and integrally connected to the outer axial end of disc 110 and the inner axial end of plate 122. Conduit portions 120 extend through suitable bores formed in mounting plate 122 and are integrally secured to mounting plate 122. The outer axial end of mounting plate 122 is perpendicular to the center lines of conduit portions 120, disc 110, and extruder 12 and is at the same axial extent from disc 110 and extruder 12 as the outer axial ends of conduit portions 120.

Body portion 104 is in the most preferred form of a block having an inner axial end which abuts with mounting plate 122. Body portion 104 is symmetrical on opposite sides of the center line of disc 110 and extruder 12 according to preferred teachings of the present invention. In particular, body portion 104 includes first and second conical chambers 126 having center lines which are linear with the center lines of conduit portions 120. The bases of chambers 126 are located at the inner axial end of body portion 104 and have a diameter equal to the inner diameter of conduit portions 120.

First and second passageway portions 128 of equal size and diameter extend from each of chambers 126 at equal acute angles on opposite sides of the center line of chamber 126 and conduit portion 120 in the order of 49° in the most preferred form, with the center lines of

passageway portions 128, chambers 126, conduit portions 120, bores 118, pipes 116 and extruder 12 being arranged in a horizontal plane in the most preferred form. Body portion 104 further includes third and fourth passageway portions 130 in fluid communication with first and second passageways 128, respectively, and located on opposite sides, parallel to and at equal distances from the center lines of the first and second chambers 126 and conduit portions 120, respectively, with the center lines of passageway portions 128 and 130 being in a horizontal plane in the most preferred form. Passageway portions 128 and 130 have cross sections of an equal size and shape and in the most preferred form have diameters which are approximately 57% of the diameter of conduit portions 116, 118, and 120.

Body portion 104 further includes first and second duct portions 132 having center lines which are coextensive with the center lines of the first and second chambers 126 and conduit portions 120, respectively, with duct portions 132 extending from chambers 126 concentric to the center line of chambers 126 and opposite to their bases. In the most preferred form, duct portions 132 have a cross-sectional shape corresponding to passageway portions 128 and 130 which is circular in the most preferred form but have a size which is smaller than passageway portions 128 and 130 and in the most preferred form have diameters equal to approximately 65% of the diameter of passageway portions 128 and 130. In the most preferred form, duct portions 132 have a size which do not intersect with passageway portions 128 at chamber 126, with duct portions 132 having a diameter equal to the diameter of chambers 126 equal to the outer axial extent of passageway portions 128 at the surfaces of chambers 126 in the most preferred form.

Body portion 106 is in the most preferred form of a block having an inner axial end which abuts with the outer axial end of body portion 104. Body portion 106 is

symmetrical on opposite sides of the center line of disc 110 and extruder 12 according to the teachings of the present invention. In particular, first and second ports 134 of equal size and diameter extend from the first passageway portions 130 extending from first and second chambers 126 at equal acute angles on opposite sides of the center line of first passageway portion 130 in the order of 43° in the most preferred form, with the center lines of ports 134 and passageway portions 130 being arranged in a horizontal plane in the most preferred form. Further, third and fourth ports 136 of equal size and diameter extend from the second passageway portion 130 extending from first and second chambers 126 at equal acute angles on opposite sides of the center line of second passageway portion 130 in the order of 43° in the most preferred form, with the center lines of ports 136 and passageway portions 130 being arranged in a horizontal plane in the most preferred form. Ports 134 and 136 have equal lengths. Body portion 106 further includes first and second duct portions 138 having center lines which are coextensive with the center lines of first and second duct portions 132 and chambers 126 of body portion 104 and of conduit portions 120, respectively. Duct portions 138 have a cross-sectional size and shape corresponding to duct portions 132. Ports 134 and 136 have the same cross-sectional size and shape which in the preferred form also are equal to the cross-sectional size and shape of duct portions 132 and 138.

Body portion 106 according to the preferred teachings of the present invention then includes a plurality of flow adjuster plugs 16 of a number corresponding to the total number of ports 134 and 136 and duct portions 138 formed therein and mounted to the upper surface thereof. In particular, plugs 16 are mounted such that smooth portion 86 can be adjustably extended into the corresponding port 134 or 136 or duct portion 138 to adjust the flow rate and pressure of the dough flow therethrough.

Body portion 108 is in the most preferred form of a block having an inner axial end which abuts with the outer axial end of body portion 106. Body portion 108 is symmetrical on opposite axial sides of the center line of disc 110 and extruder 12 according to the teachings of the present invention. In particular, sockets 140 equal in number and location to ports 134 and 136 and duct portion 138 are provided for slideable receipt of the desired inserts 142. It can be appreciated that inserts 142 can be of the type including die inserts 20 and passageway pieces 26, 28, and 30 or can be of alternate types and forms.

Body portions 102, 104, 106, 108 can then be suitably secured together such as by bolts 144 extending through body portions 108 and 106 and threaded into body portion 104 and by bolts 146 extending through body portions 108, 106, and 104 and threaded into mounting plate 122. To insure proper alignment and for ease of assembly, dowel pins 148, 150, and 152 can be provided between body portions 108 and 106, body portions 106 and 104, and body portion 104 and mounting plate 122, respectively.

In operation of manifold 100 according to the teachings of the present invention, dough extruded by extruder 12 will flow through flow paths at equal rates and pressure through conduits 116, 118, and 120 into chamber 126 since they provide the same resistance to flow due to their equal lengths, cross-sectional sizes and shapes, and arrangement much like through passageways 14. Likewise, dough will flow through passageways 128 and 130 from chambers 126 at equal rates and pressure since they provide the same resistance to flow due to their equal lengths, cross-sectional size and shape, and arrangement. Similarly dough will flow through ports 134 and 136 from passageways 128 and 130 at equal rates and pressure since they provide the same resistance to flow due to their equal lengths, cross-sectional size and shape, and arrangement. However, since ducts 132 and 138

have a smaller cross-sectional size than passageways 128 and 130, the flow rate of dough through a single duct 132 and 138 is one-half the flow rate through one of ports 134 and 136. In particular, due to the much shorter length that the dough must flow to reach die inserts 142 through one duct 132 and 138, the cross-sectional size is reduced to a size to provide equal flow resistance therethrough as through dough flowing through one of the ports 134 and 136. Further, according to the preferred teachings of the present invention, the cross-sectional size of ports 134 and 136 and ducts 132 and 138 are equal for ease of fabrication and to allow the same size adjuster plugs 16 to be utilized in all of the ports 134 and 136 and duct portions 138.

It can then be appreciated that the flow rate and pressure from extruder 12 to inserts 142 are equal even though the flow distances from extruder 12 to inserts 142 are not equal according to the teachings of the present invention. Specifically, the flow rate and pressure to inserts 142 are generally compensated by providing unequal flow areas to effect equalizing flow resistance and are fine tuned through the use of adjuster plugs 16 according to the teachings of the present invention. Thus, utilizing the present invention, it is no longer required that the inserts 142 be located in a circular pattern centered on the center line of extruder 12 to obtain equal flow distances in symmetrical arrangements. Particularly, other patterns are possible according to the teachings of the present invention such as horizontal in a single plane which avoids problems of individual extrudates interfering with each other such as upper extrudates falling on lower extrudates in the circular pattern and which allows easier placement on horizontally arranged conveyors.

Now that the basic teachings of the present invention have been explained, many extensions and variations will be obvious to one having ordinary skill in the art. For example, several inventive aspects of the present invention

have been disclosed and it is believed that the combination thereof produces synergistic results. However, such inventive aspects can be utilized alone or in other combinations according to the teachings of the present invention. As an example, although notches 47 have been disclosed in die insert 20 forming complexly patterned extrudates, similar inserts could be provided upstream of a static mixer to provide several lines of colorant, flavor or other additives rather than typical point type injections into the cross section of flow. In particular, notches 47 prevent the colorant, flavor or other additives from coming in contact with the interior surface wall of the insert where the static mixer has difficulty mixing it thoroughly with the main flow of product. This would allow the static mixer to be shorter and still provide a uniform extrudate and thus reducing the cost, space and pressure drop requirements of the static mixer.

Thus since the invention disclosed herein may be embodied in other specific forms without departing from the spirit or general characteristics thereof, some of which forms have been indicated, the embodiments described herein are to be considered in all respects illustrative and not restrictive. The scope of the invention is to be indicated by the appended claims, rather than by the foregoing description, and all changes which come within the meaning and range of equivalency of the claims are intended to be embraced therein.

CLAIMS:

1. A puffed food piece having a body of one color and at least two intersecting colored lines or planes of at least a second color or hue extending through the body.

2. The puffed food piece of claim 1 wherein the colored lines have a thickness of 1 mm or less.

3. The puffed food piece of claim 1 or 2 wherein the two intersecting colored lines or planes are of the second and a third color or hue.

4. The puffed food piece of any one of the preceding claims having a round shape with a plurality of lines forming a shape reminiscent of a soccer ball, a baseball, a basketball, or an American style football.

5. The puffed food piece of any one of the preceding claims having a diameter of about 15 to 30 mm.

6. The puffed food piece of any one of the preceding claims with at least one of the intersecting lines or planes crossing or meeting a second to indicate traditional sticking patterns.

7. A food piece including a body having a round shape of one color and a plurality of colored lines of at least a second color or hue extending through the body forming a shape reminiscent of a soccer ball.

8. The food piece of claim 7 fabricated from cooked cereal dough.

9. The food piece of any of claims 7-8 being puffed and having a density of 0.1 to 0.5 g/cc.

10. The food piece of any one of the claims 7-9 wherein the colored lines have a thickness of 1 mm or less.

11. The food piece of any one of the claims 7-10 having a topical oil coating.

12. The food piece of any one of the claims 7-11 having a diameter of about 15 to 30 mm and prepared by direct expansion from an extruder.

13. A food piece having a body of one color and a colored line or plane of at least a second color or hue extending through the body to impart a line pattern reminiscent of a soccer ball, a baseball, a basketball or other sports balls.

14. The food piece of claim 13 fabricated from cooked cereal dough.

15. The food piece of claim 14 being puffed and having a density of 0.1 to 0.5 g/cc.

16. The food piece of any one of the claims 13-15 wherein the colored line has a thickness of 1 mm or less.

17. The food piece of any one of the claims 13-16 having a diameter of 15 to 30 mm.

18. The food piece of any one of the claims 13-18 having a topical oil coating.

19. A food piece having a body fabricated from cereal dough of one color and at least two intersecting colored lines or planes of at least a second color or hue extending through the body.

20. The food piece of claim 19 fabricated from cooked cereal dough.

21. The food piece of claims 19 or 20 being puffed.

22. The food piece of any one of the claims 19-21 wherein the colored lines have a thickness of 1 mm or less and having a density of 0.1 to 0.5 g/cc.

23. The food piece of any one of the claims 19-22 wherein the two intersecting colored lines or planes are of the second and a third color or hue.

24. The food piece of any one of the claims 19-23 having a rounded shape with a plurality of lines forming a shape reminiscent of a soccer ball, a baseball, a basketball, or an American style football.

25. The food piece of any one of the claims 19-24 having a diameter of about 15 to 30 mm.

26. The food piece of any one of the claims 19-25 with the intersecting lines or planes crossing to indicate traditional sticking patterns.

27. A food piece substantially as hereinbefore described with reference to the accompanying drawings.

28. An apparatus for making a complexly patterned flowable extrudate, comprising, in combination:

means for providing a first extrudable food material;

means for supplying a second flowable colored food material;

means for forming the first extrudable food material and the second flowable colored food material into a complexly patterned food mass having an initial cross sectional area;

reducing passageway means for reducing the initial cross sectional area to a reduced cross sectional area of at least 25:1 operatively connected to the pattern forming means having an average convergence angle ranging from about 5° to 45° and having a larger inlet end and a smaller outlet end; and

an extrudate exit port having a diameter of about the reduced cross sectional area proximate the outlet end.

29. The apparatus of claim 28

wherein the means for providing at least one extrudable food product includes at least one extrudate passageway each having an initial cross sectional area,

wherein the means for forming a complex patterned food mass includes an enlarged die insert having an enlarged cross section relative to the cross section of the exit port within an enlarged portion of the extrudate passageway having a die insert diameter and cross sectional area and wherein the ratio of the die insert cross section area to the reduced cross sectional area ranges from 25 to 100.

30. The apparatus of claim 29 wherein the die insert includes at least one food product dividing member having a passageway therethrough in fluid communication with the second colored food material supply means and a plurality of second colored food material supply discharge holes.

31. The apparatus of claim 30 wherein the second colored food material supply discharge holes are evenly spaced and are in the downstream face of the die insert.

32. The apparatus of claim 31 wherein the reducing passageway includes a plurality of pieces.

33. The apparatus of claim 32 wherein each passageway piece has a cross section equal to the upstream cross section of the next downstream piece so as to form a continuously smooth passageway.

34. The apparatus of claim 33 wherein at least a portion of the reducing passageway has a circular cross section.

35. The apparatus of claim 33 wherein at least a portion of the reducing passageway has an irregularly shaped periphery.

36. The apparatus of claim 35 wherein the passageway includes a passageway expanding flared portion immediately upstream of the die insert.

37. The apparatus of claim 36 wherein the means for providing a first extendable food material additionally comprises a means for externally adjusting the dough flow rate upstream of the die insert.

38. The apparatus of claim 37 wherein the means for externally adjusting the dough flow rate includes

a rounded smooth retractably adjustable plug projecting into the passageway;

means for adjustably retractably extending the plug into the passageway including stop means exterior to the passageway for terminating the extension of the plug into the passageway;

means for mounting the flow rate apparatus to the food extruder;

wherein the length of the plug extending into the passageway when stopped is less than 90% of the width of the passageway; and

means for sealing the plug against food leakage.

39. The apparatus of claim 33 wherein at least a portion of the reducing passageway has an oval cross section.

40. The apparatus of claim 30 wherein the food product dividing member imparts at least one interstitial gap, with the dividing member including an upstream face and a downstream face; wherein the second colored food material supply discharge holes supply the second colored food material at the downstream face and into the interstitial gap, with the second colored food material traveling in the interstitial gap; and wherein the apparatus further comprises, in combination: a notch formed in the dividing member extending from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the first extrudable food material to flow into and fill the interstitial gap within the notch.

41. The apparatus of claim 40 wherein the die insert further includes an interior surface wall, with the food product dividing member extending to and engaging the interior surface wall with the notch located in the food product dividing member intermediate the second food material supply discharge holes and the interior surface wall.

42. A method for preparing a food product having at least two colors exhibiting improved detail resolution; comprising the steps of:

(a) providing a first plastic extrudable food mass having a first color;

(b) providing at least a second flowable food material having a second color differing from the first color in color or hue;

(c) mixing the food mass and the second food material to form a complexly patterned food mass having an initial cross sectional area;

(d) reducing the cross sectional area of the complexly patterned food mass by a factor of at least 4:1 through a reducing passageway with an average convergence angle of 5° to 45° while maintaining the cross sectional pattern to form a reduced cross sectional patterned extrudate; and

(e) extruding the reduced cross sectional extrudate through a die port.

43. The method of claim 42 wherein the initial cross section of the first food mass is about 1200 to 3000 mm^2 and wherein the reduced cross sectional area is about 10 to 300 mm^2.

44. The method of claim 43 wherein the food and color are mixed in a passageway of a cooker extruder with a die dividing insert therein and wherein the reducing passageway is continuous.

45. The method of claim 44 wherein the first food mass comprises a cooked cereal dough.

46. The method of claim 45 wherein the cross sectional area is reduced in a converging frusto conically shaped passageway.

47. The method of claim 46 wherein the extrudate is directly expanded upon and cut to form individual pieces of puffed cereal dough.

48. The method of claim 46 wherein the extrudate is extruded to form an unexpanded complexly patterned dough of reduced cross sectional area; and wherein the method additionally comprises the steps of:

F. sectioning the extruded complexly patterned dough to form individual half product or pellet pieces having a complex pattern; and

G. puffing the pieces to form puffed food pieces.

49. The method of claim 48 wherein the puffed food pieces have a spherical shape.

50. The method of any claim 42 to 49 wherein the mixing step comprises the steps of: dividing the food mass to impart at least one interstitial gap in the food mass; partially filling the interstitial gap with the food mass; and injecting the second flowable food material at a location downstream of where the interstitial gap is partially filled in remaining portions of the interstitial gap.

51. The method of claim 50 wherein the step of dividing the food mass comprises the step of providing a die dividing member including an upstream face and a downstream face; wherein the partially filling step comprises the step of notching the die dividing member from the downstream face towards but spaced from the upstream face and having an axial length sufficient for the food mass to flow into and fill the interstitial gap within the notch; and wherein the injecting step comprises the step of injecting the second

22694-1560E

flowable food material at the downstream face and into the interstitial gap, with the second flowable food material traveling in the interstitial gap.

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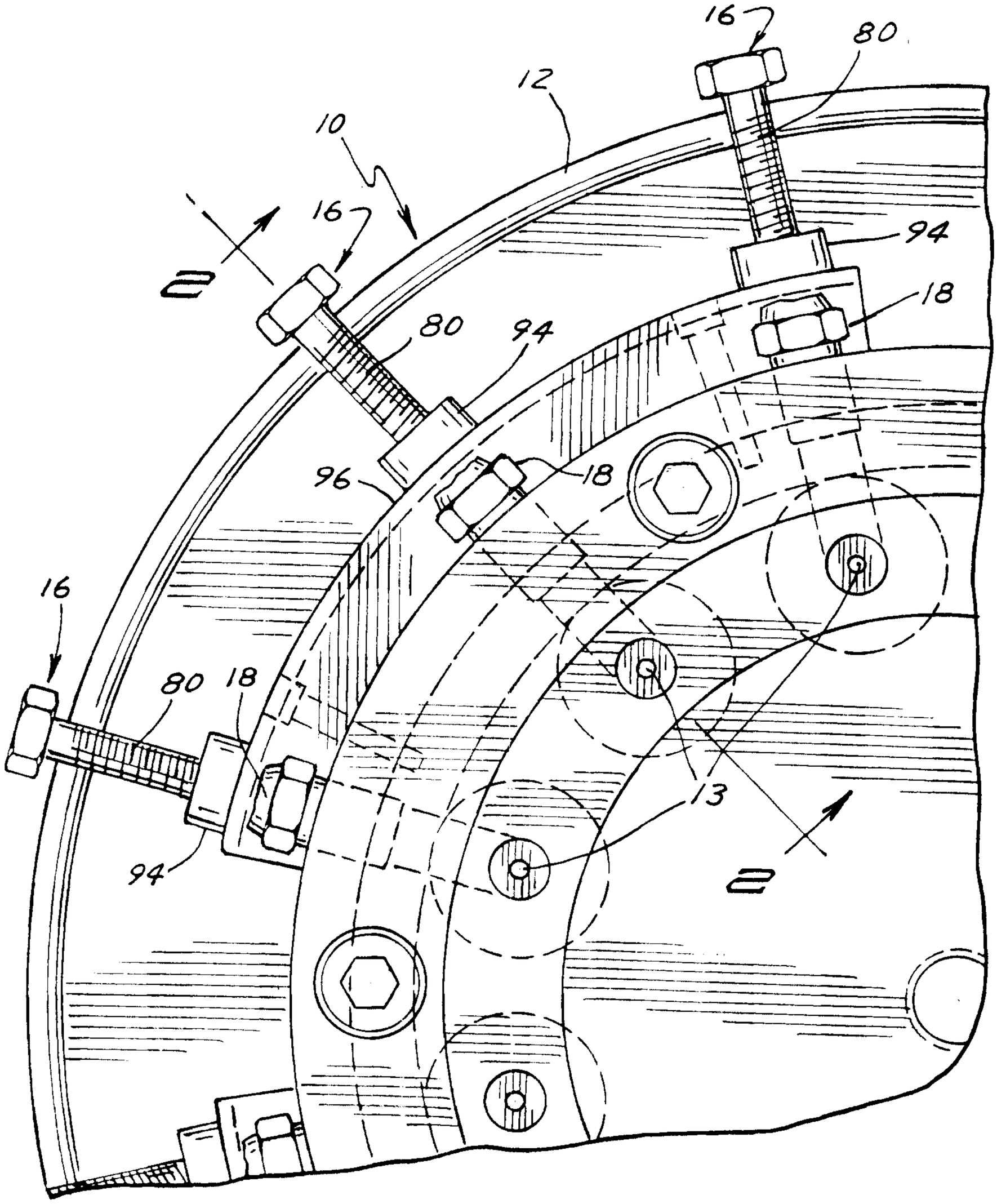
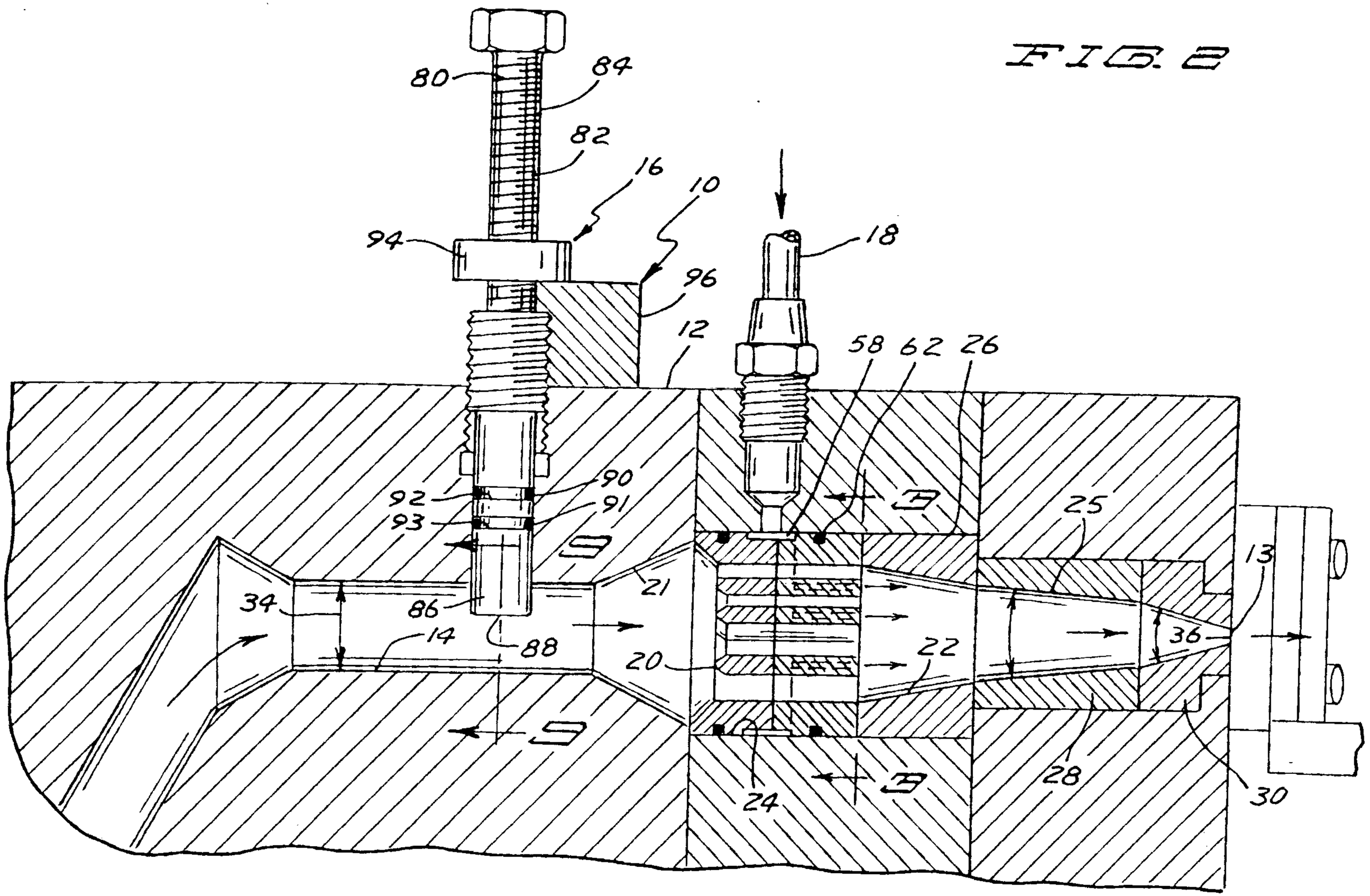


FIG. 1

CA 02421135 2003-03-19

FIG. 2



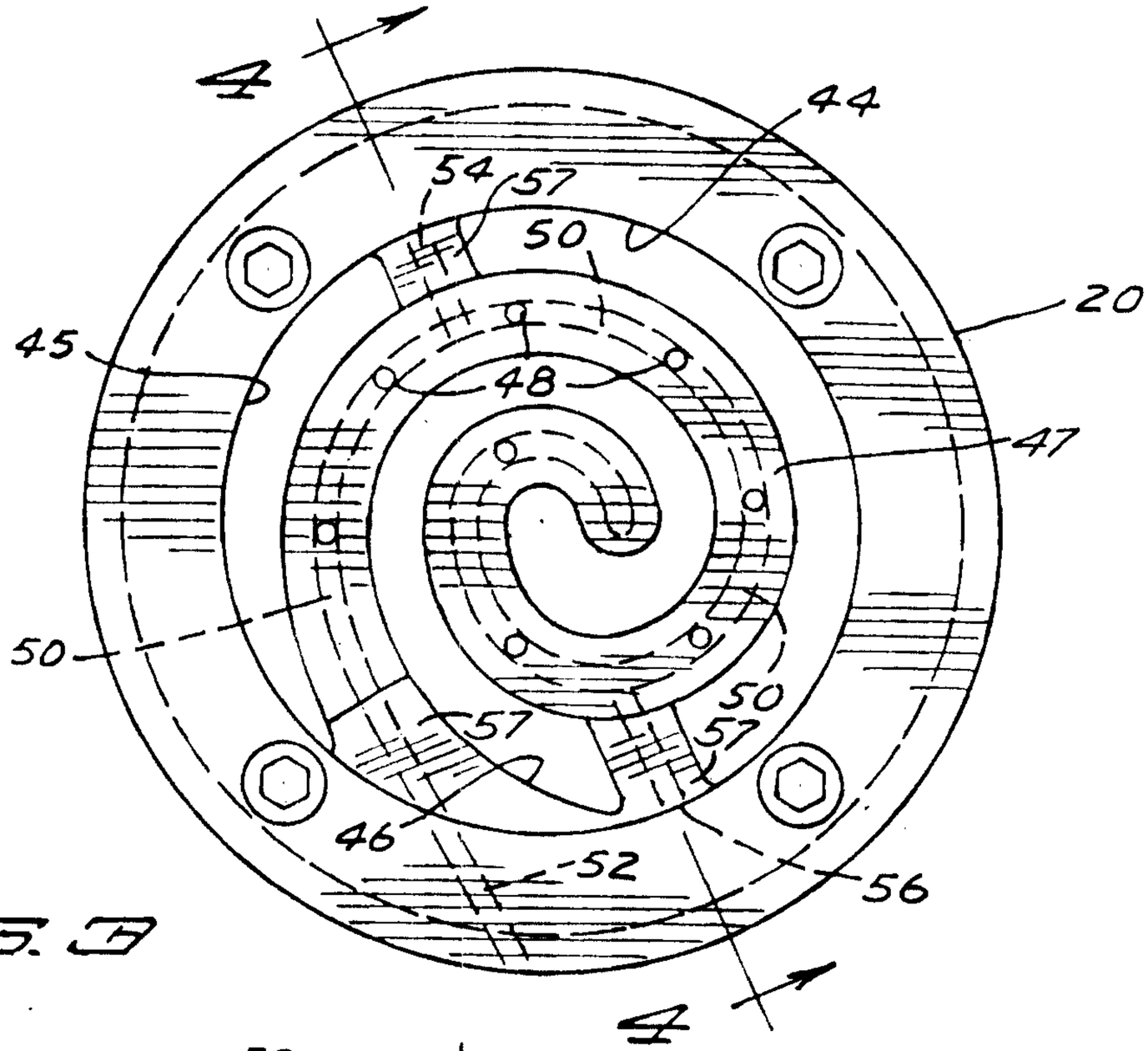

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FIG. 3

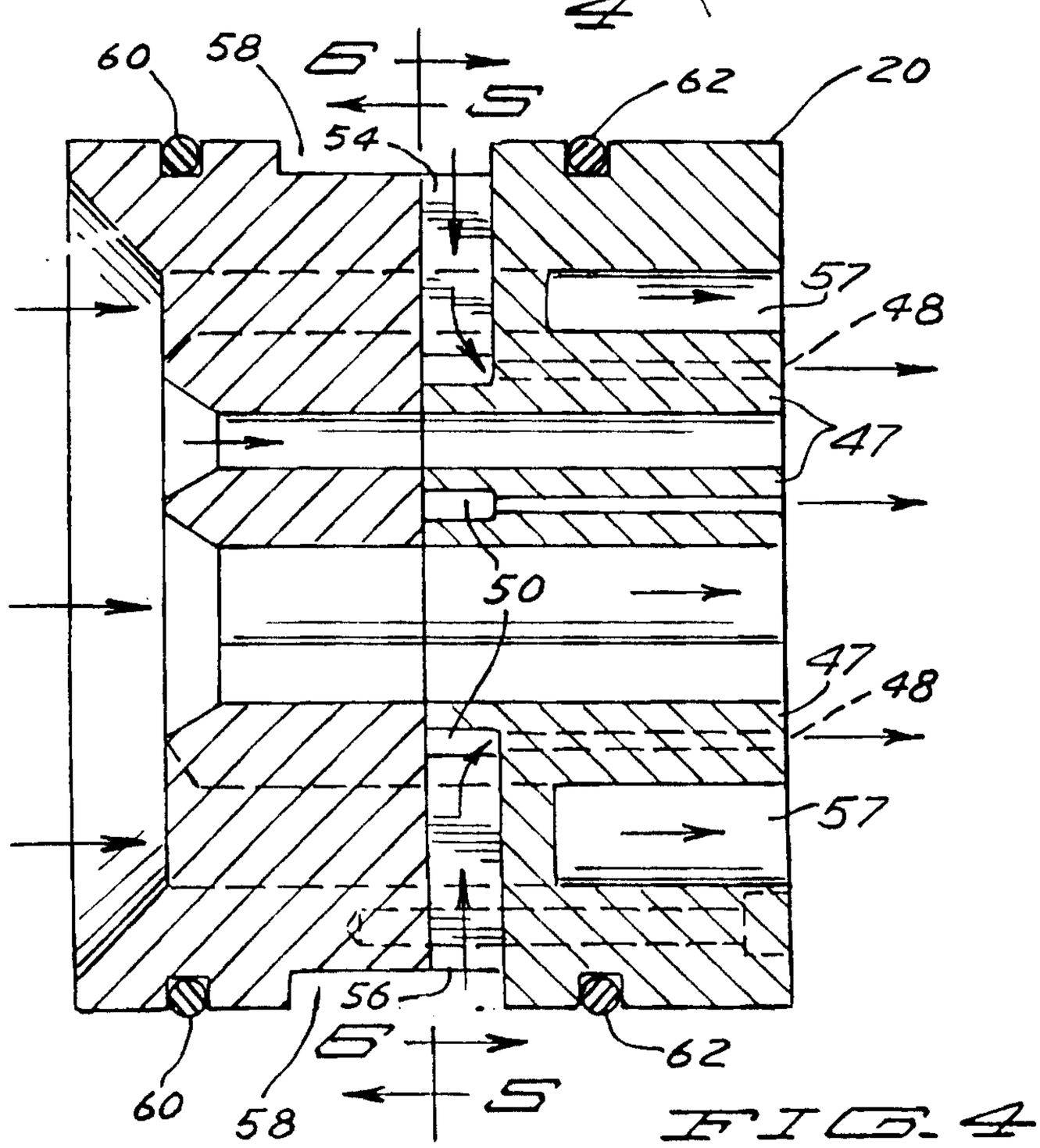

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FIG. 4

CA 02421135 2003-03-19

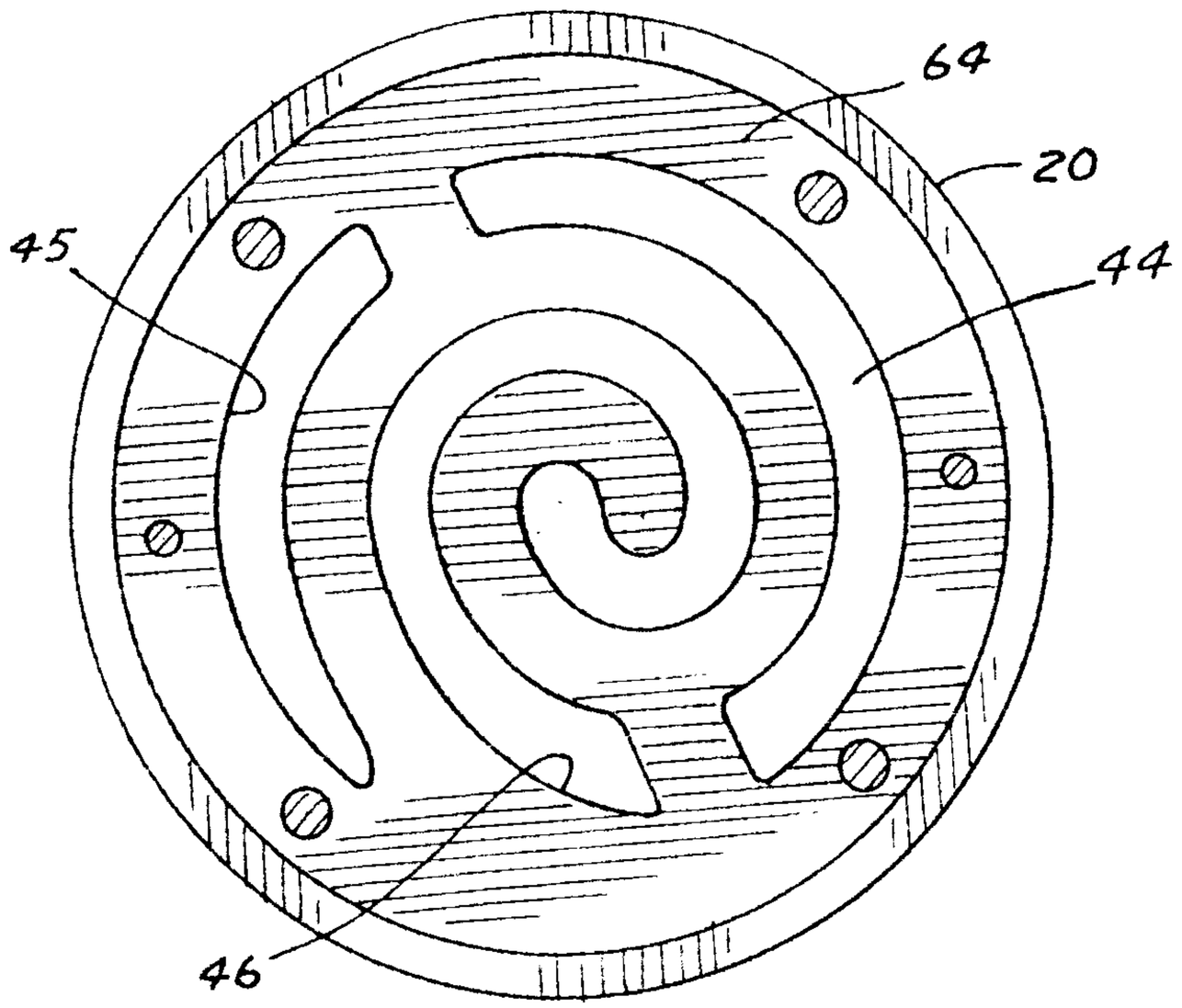


FIG. 5

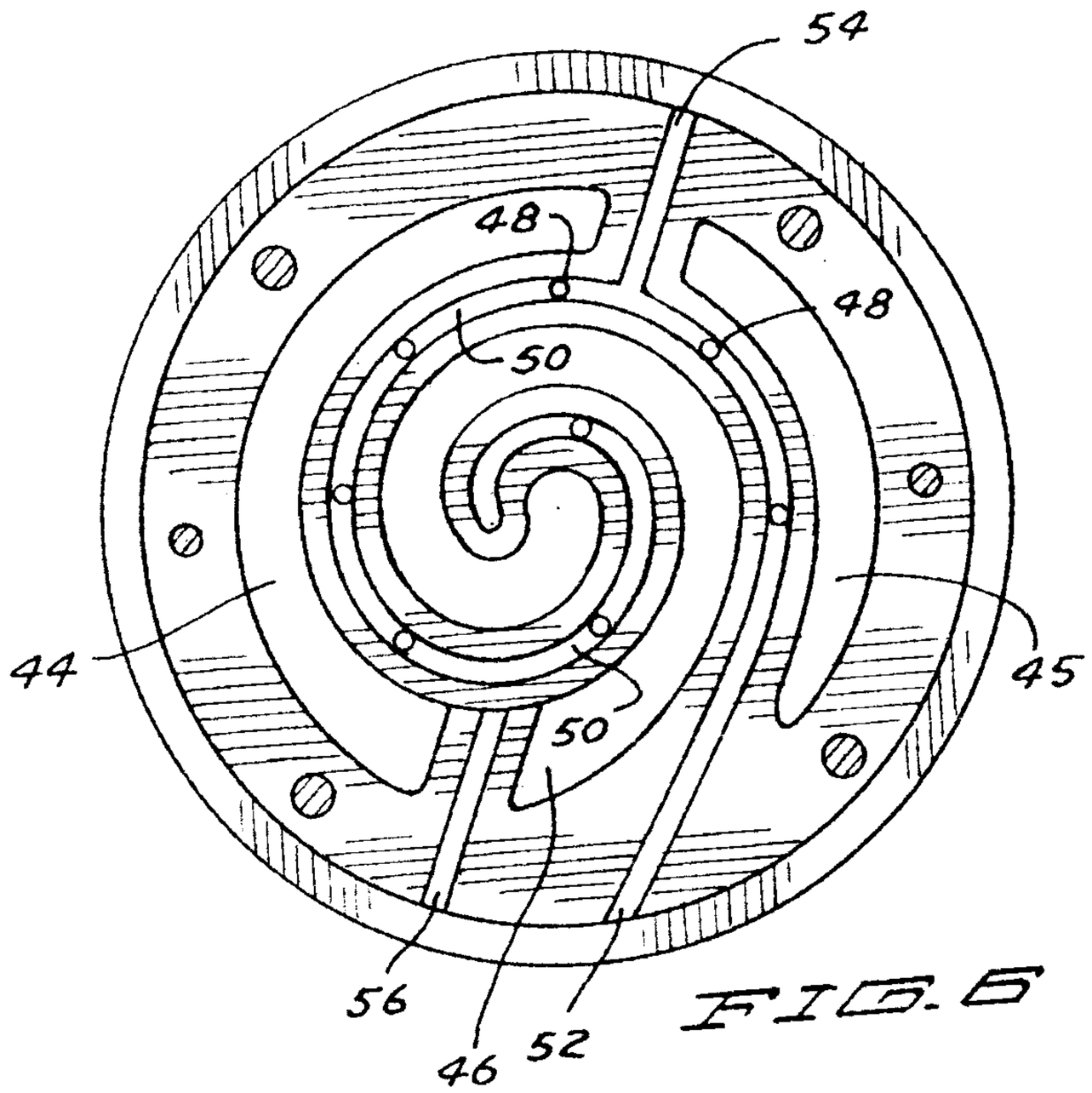


FIG. 6

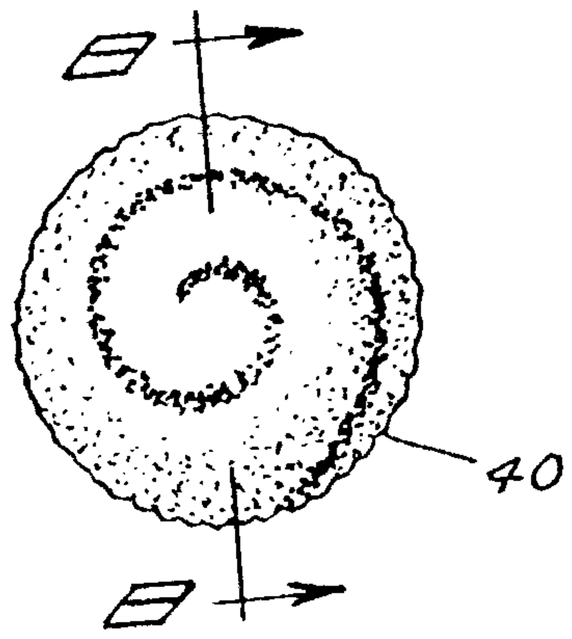


FIG. 7

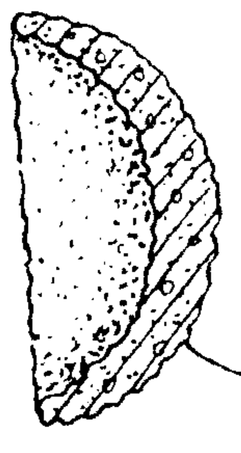


FIG. 8

CA 02421135 2003-03-19

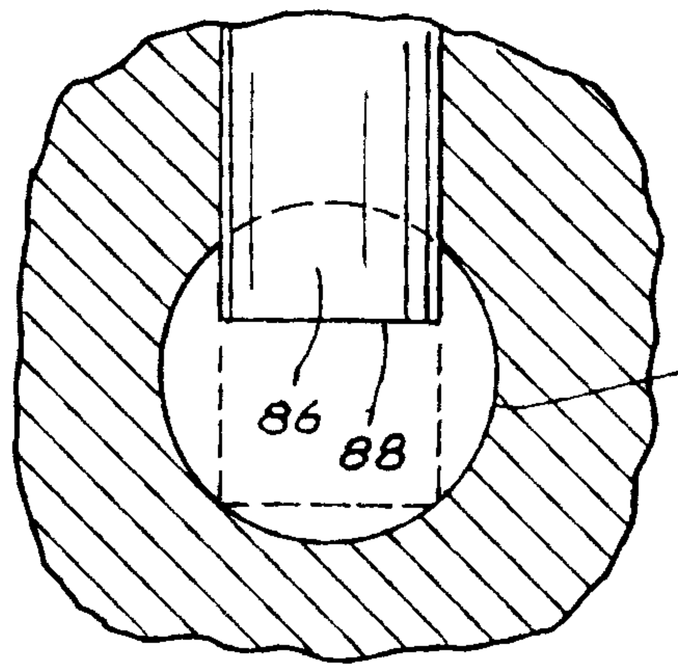


FIG. 9

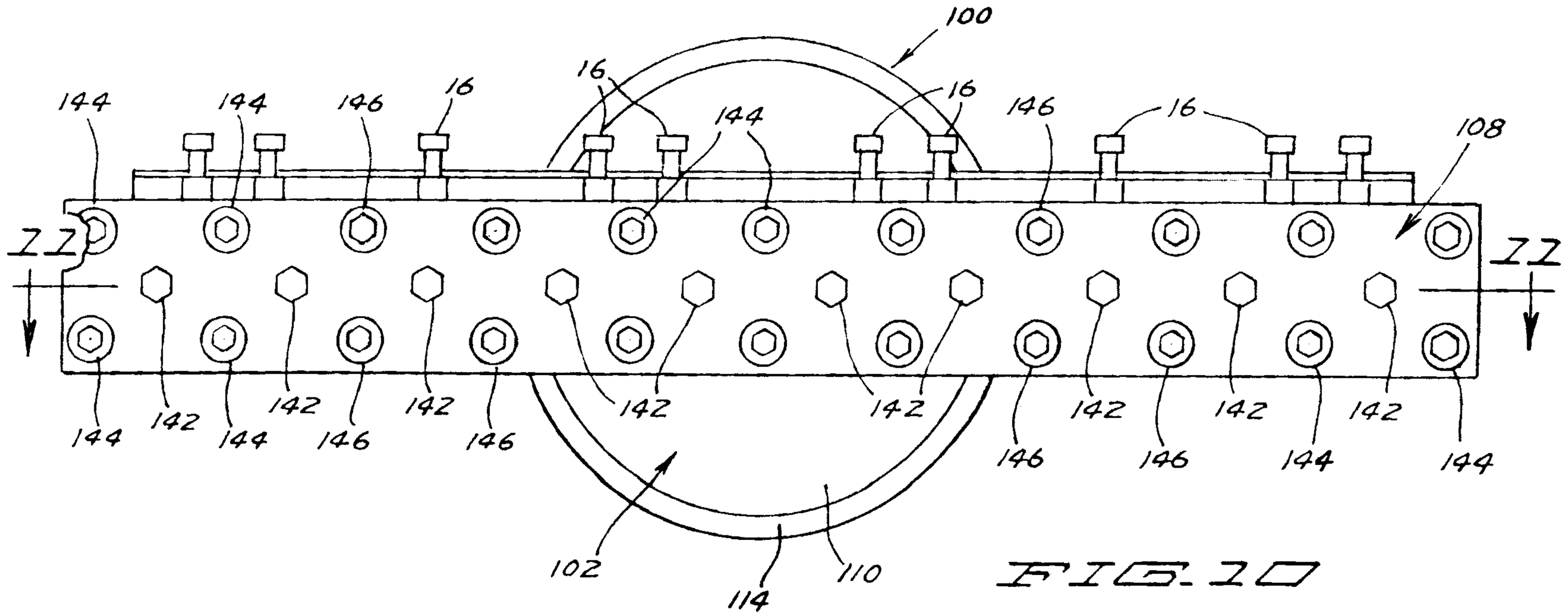


FIG. 10

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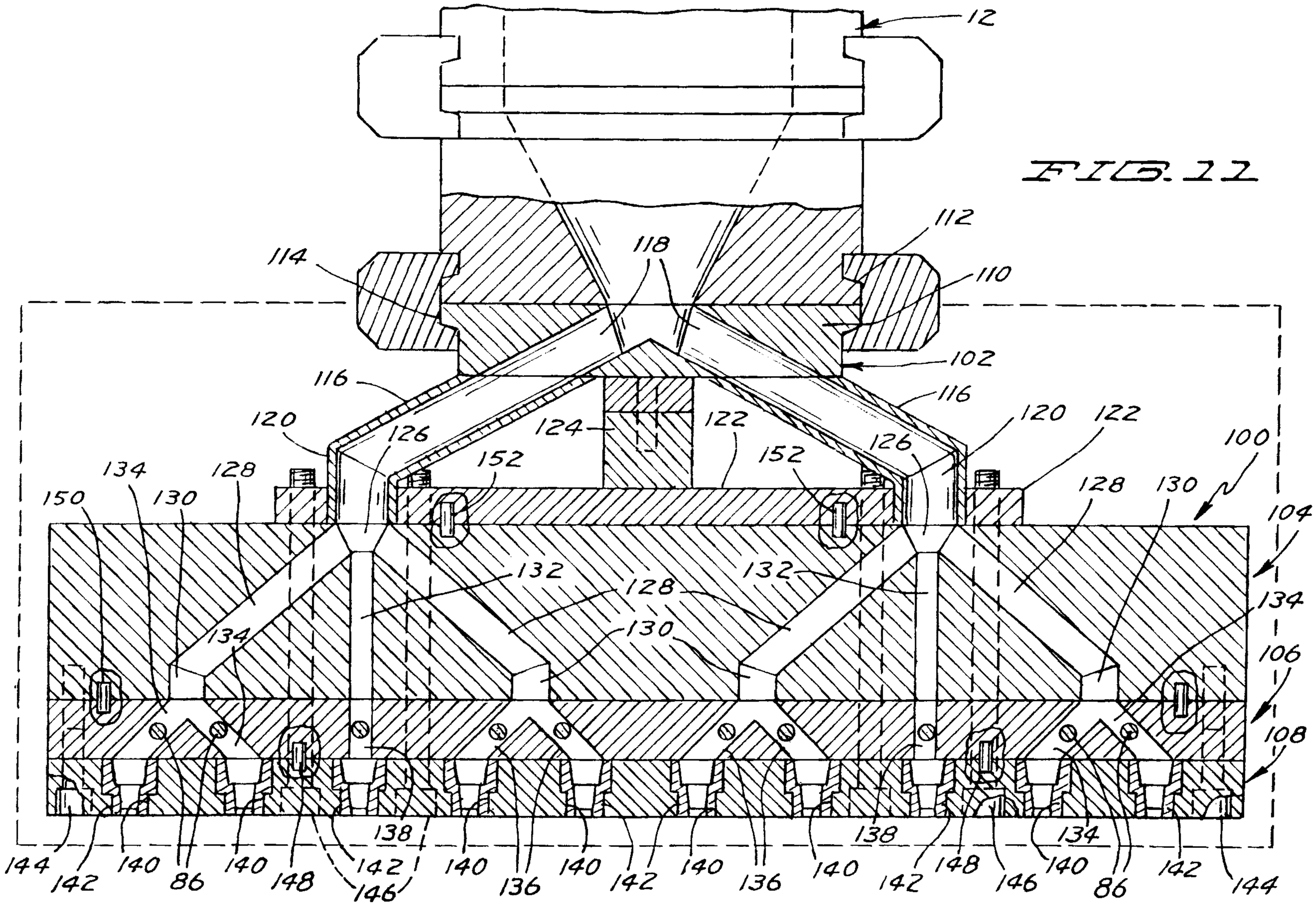


FIG. 11