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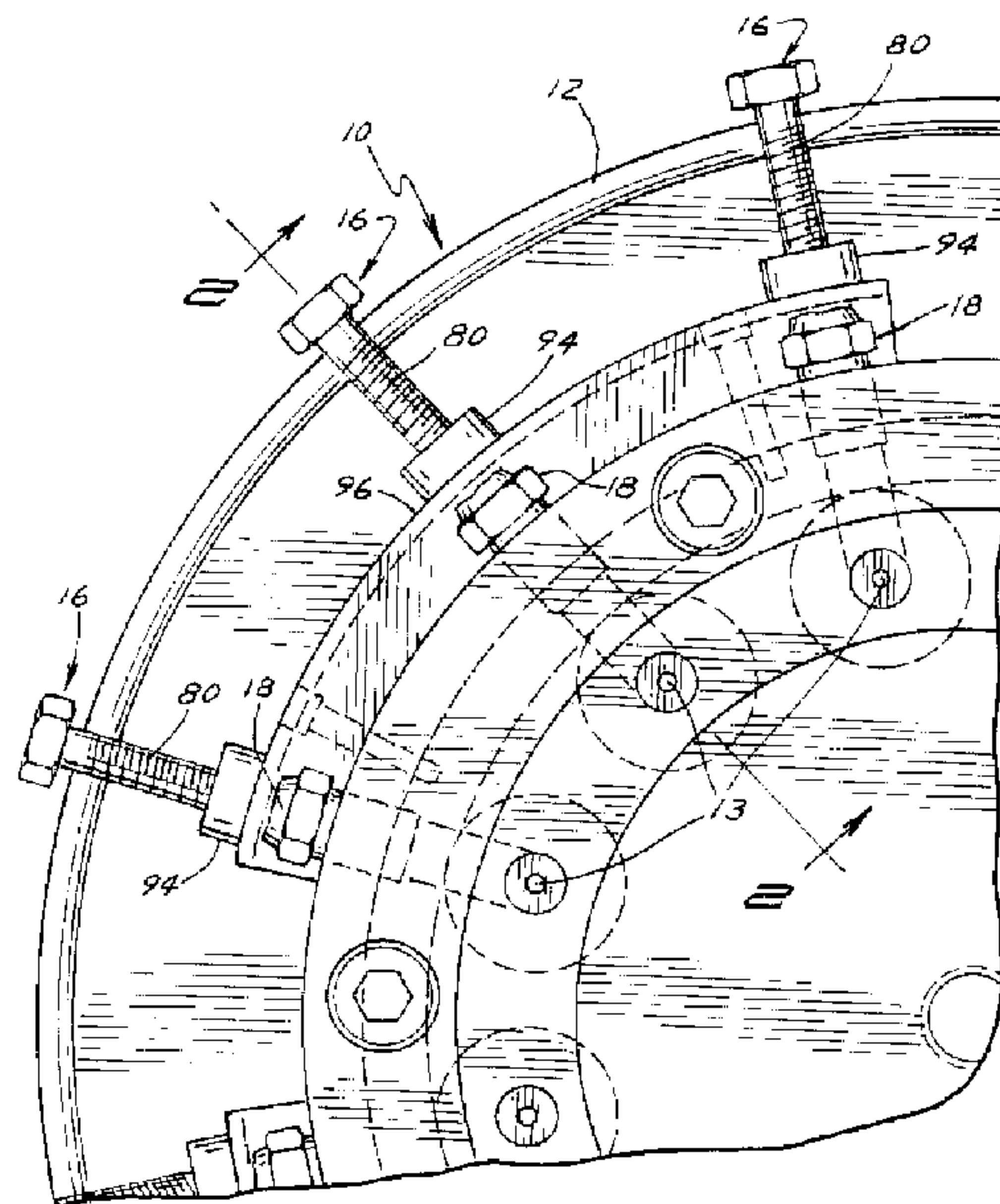
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(54) Titre : APPAREIL ET PROCEDE PERMETTANT D'OBTENIR DES PRODUITS D'EXTRUSION MULTIPLES A
MOTIFS COMPLEXES

(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 $\geq 45^\circ$ 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).

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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
5 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 $\leq 45^\circ$ while maintaining the cross-sectional pattern to form a
10 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
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20 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).

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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
5 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
10 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
15 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
20 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
25 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

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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. Patent No. D373,671 by Laughlin et al. entitled Food Product Piece, 2) U.S. Patent No. D384,785 by Laughlin entitled Food Product Piece, 3) U.S. Patent No. D368,791 by Laughlin entitled Food Product Piece, and 4) U.S. Patent No. D372,352 by Laughlin entitled Food Product Piece, 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 0.5 mm>. 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. Also, the method appears to be limited to producing only flakes in a simple pattern of generally parallel more or less straight lines.

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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
5 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
10 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
15 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 than the relatively
20 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
25 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
30 difficult.

In a first aspect, the present invention provides apparatus for adding at least a first additive to dough

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flowing through a supply passageway, including a die
dividing member in the supply passageway to impart at least
one dough interstitial gap in the flowing dough, with the
die dividing member including an upstream face and a
5 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
10 and having an axial length sufficient for the dough to flow
into the notch and fill a portion of the interstitial gap.

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
15 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
20 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
25 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
30 plug, with the plug having an axial end located inside of
the port, characterized in the axial end of the plug having

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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
5 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
10 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
15 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;
20 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
25 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
30 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

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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.

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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.

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1 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.

5 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.

10 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
15 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
20 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.
25 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
30 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
35 complexly patterned cereal dough piece according to the preferred teachings of the present invention that is generally designated 10. In the most preferred form,

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1 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
5 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
10 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
15 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
20 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
25 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
30 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
35 particular extrudate characteristics (e.g., pressure, mass
flow) from each of so many orifices are difficult to

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1 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
5 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
10 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
15 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
20 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,
25 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.
30 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
35 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.

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1 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
5 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
10 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
15 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
20 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
25 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
30 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
35 liquid and extrudable food product into a complexly
patterned food extrudate such as a greatly enlarged

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1 (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
5 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
10 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
15 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
20 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
25 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
30 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
35 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

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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.

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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
5 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
10 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
15 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
20 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.

25 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
30 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
35 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

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1 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
5 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.
10 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
15 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
20 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.

25 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
30 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
35 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

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1 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
5 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
10 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.

15 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
20 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
25 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
30 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
35 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

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1 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.

5 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
10 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
15 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
20 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
25 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
30 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
35 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

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1 (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.
5 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
10 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
15 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
20 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
25 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
30 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
35 width of the line. These enlarged lines (i.e., 0.5 mm>),
however, are nonetheless thinner than lines obtainable by

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1 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
5 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.
10 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
15 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.

20 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,
25 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
30 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
35 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

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1 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
5 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
10 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
15 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
20 110 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
25 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
30 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
35 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

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1 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
5 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
10 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,
15 118, 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
20 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
25 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
30 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.

35 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

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1 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
5 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
10 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
15 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
20 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
25 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
30 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
35 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.

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1 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
5 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
10 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
15 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
20 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
25 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
30 130 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
35 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

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1 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
5 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
10 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.

15 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
20 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
25 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
30 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
35 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

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1 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
5 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
10 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
15 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
20 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,
25 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.

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CLAIMS

1. Apparatus for adding at least a first additive to dough flowing through a supply passageway, including a die dividing member in the supply passageway to impart at least one dough interstitial gap in the flowing dough, with the die dividing 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 the notch and fill a portion of the interstitial gap.

2. The apparatus of claim 1 wherein an insert is located in the supply passageway, with the insert having an interior surface wall within which the dough flows, with the die dividing member extending to and engaging the interior surface wall, with the notch located in the die dividing member intermediate the injecting means and the interior surface wall.

3. The apparatus of claim 2 wherein the notch is formed adjacent to the interior surface wall.

4. The apparatus of any preceding claim wherein the die dividing member divides the flowing dough into at least first and second passageways.

5. 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.

6. The method of claim 5 wherein the step of dividing the flowing dough comprises the step of providing a die dividing member including an upstream face and a downstream face; wherein

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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 dough to flow into the notch and partially fill the interstitial gap; and wherein the injecting step comprises the step of injecting the additive at the downstream face and into the interstitial gap, with the additive traveling in the interstitial gap.

7. The method of claim 6 wherein the providing step comprises the step of providing the die dividing member extending to and engaging an interior surface wall of an insert, with the flowing dough flowing within the interior surface; and wherein the notching step comprises the step of notching the die dividing member intermediate the location at which the additive is injected and the interior surface wall.

8. The method of any one of claims 5-7 wherein the dividing step comprises the step of dividing the flowing dough into at least first and second passageways.

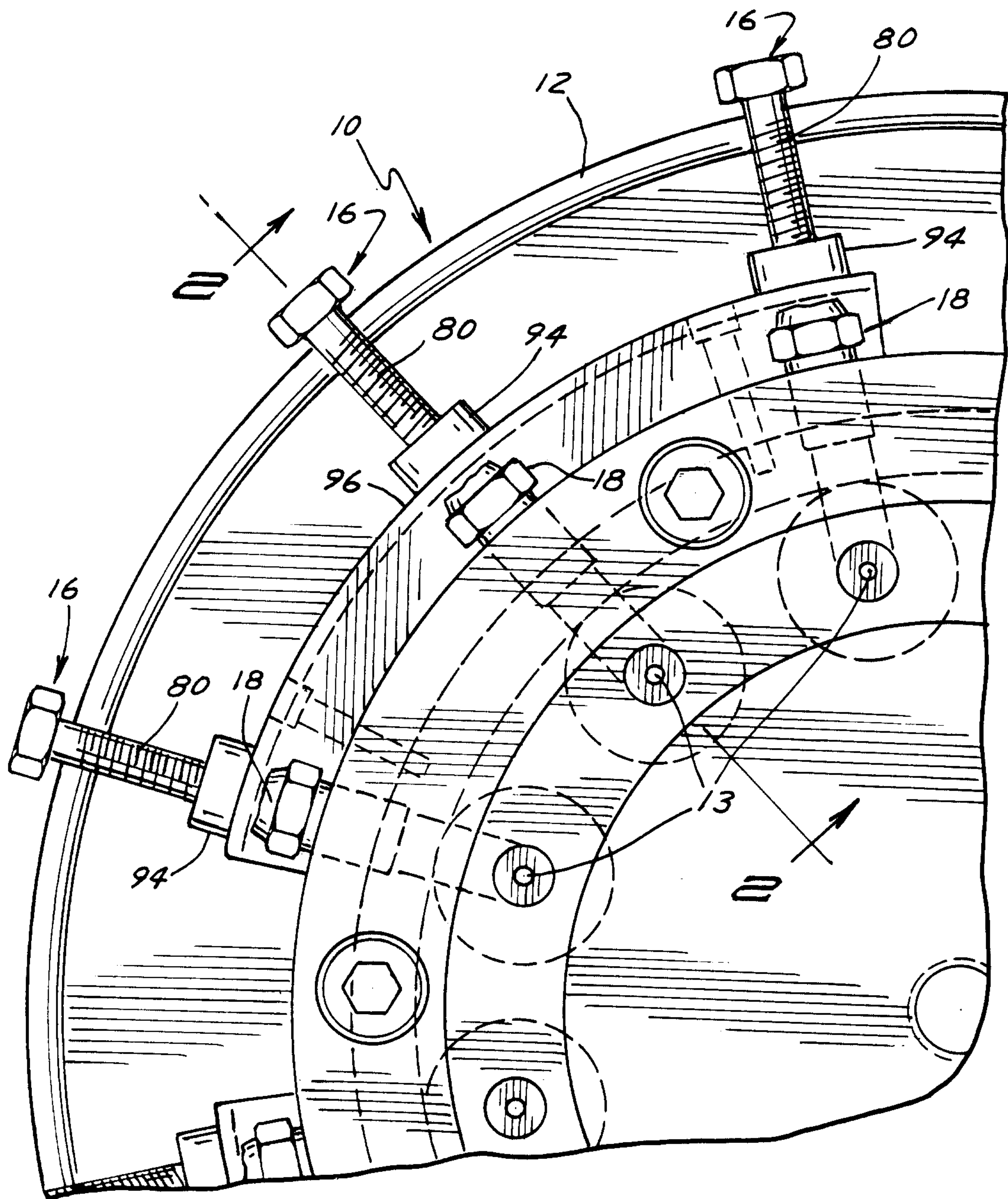


FIG. 1

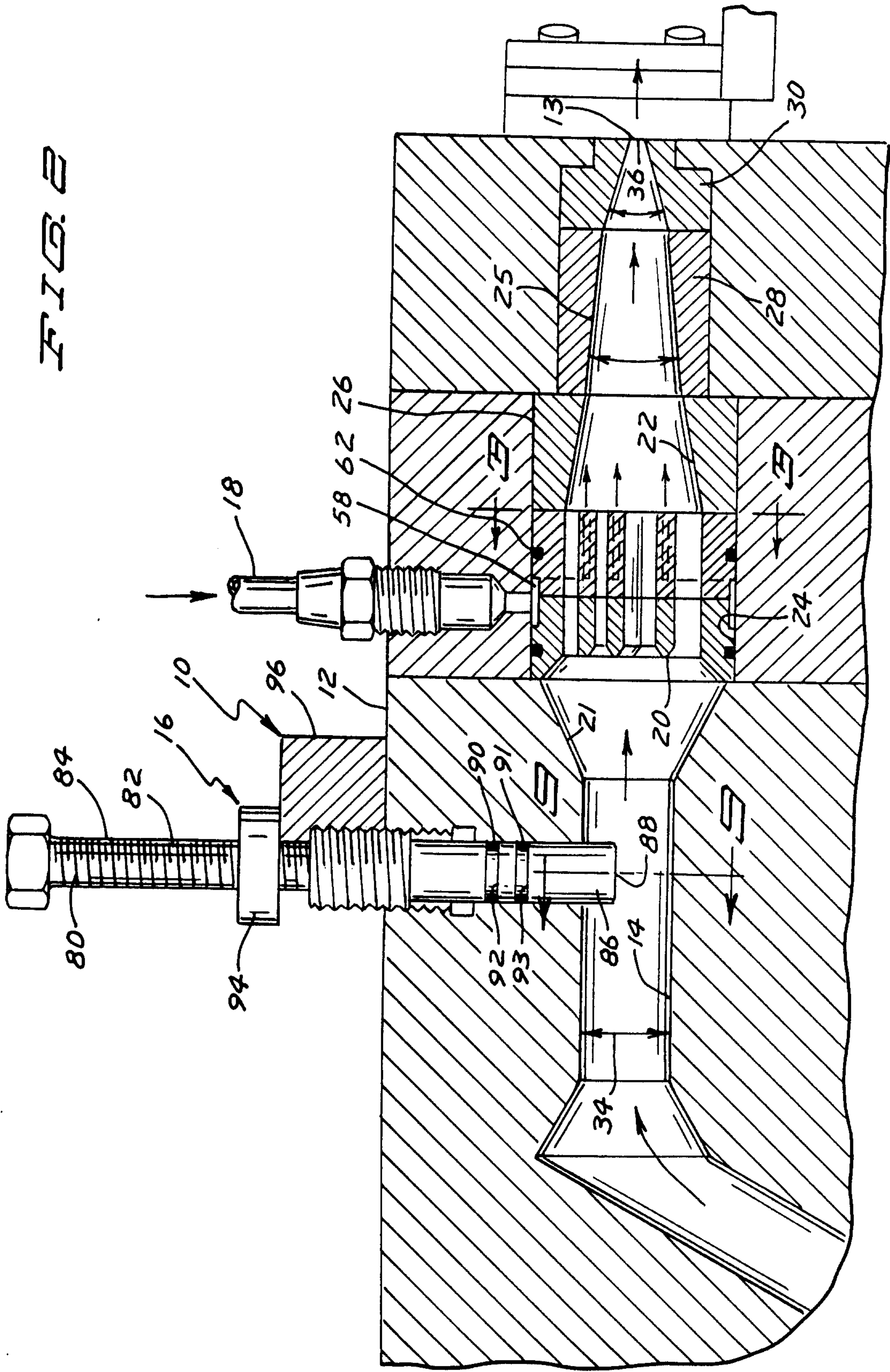


FIG. 2

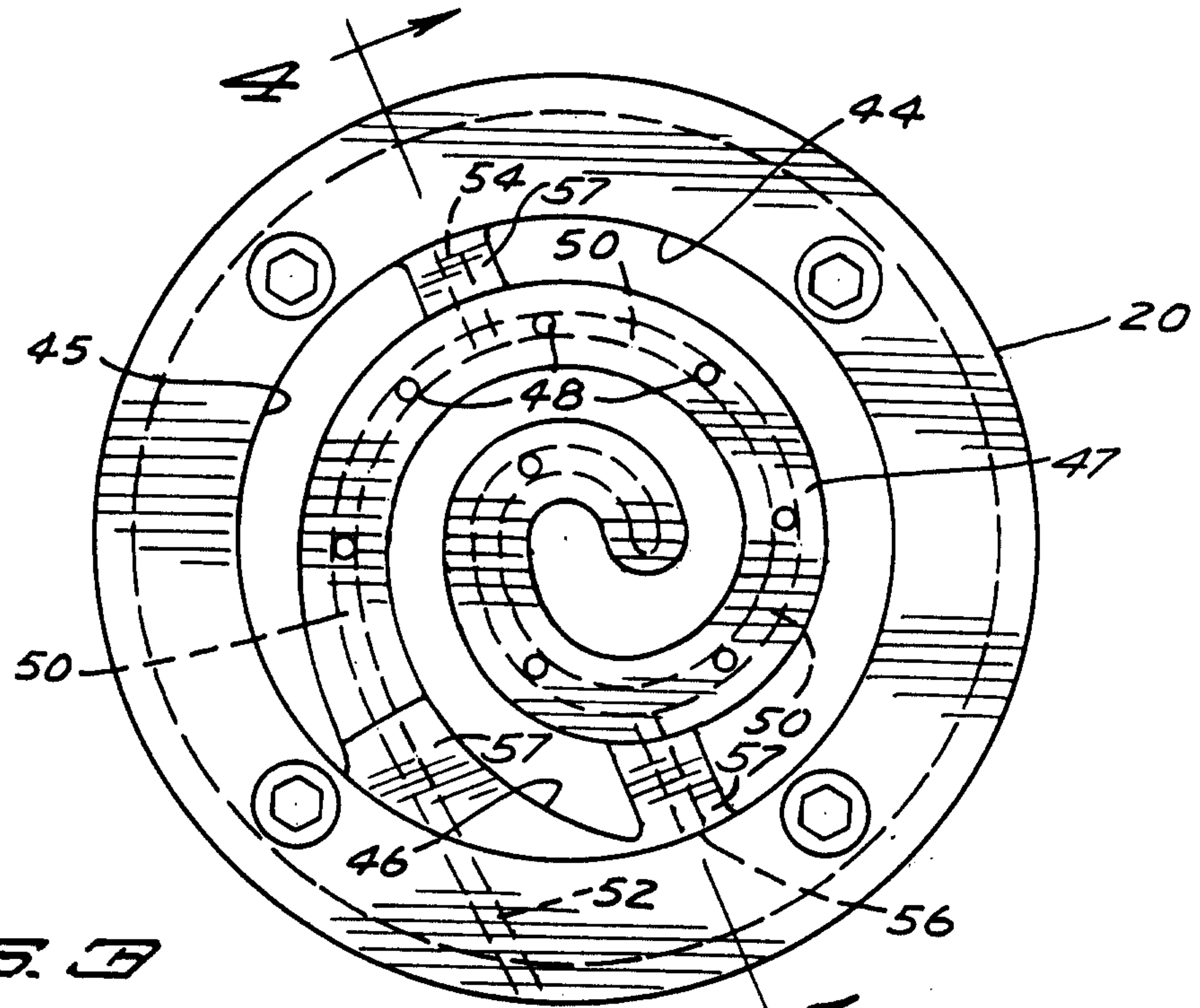


FIG. 3

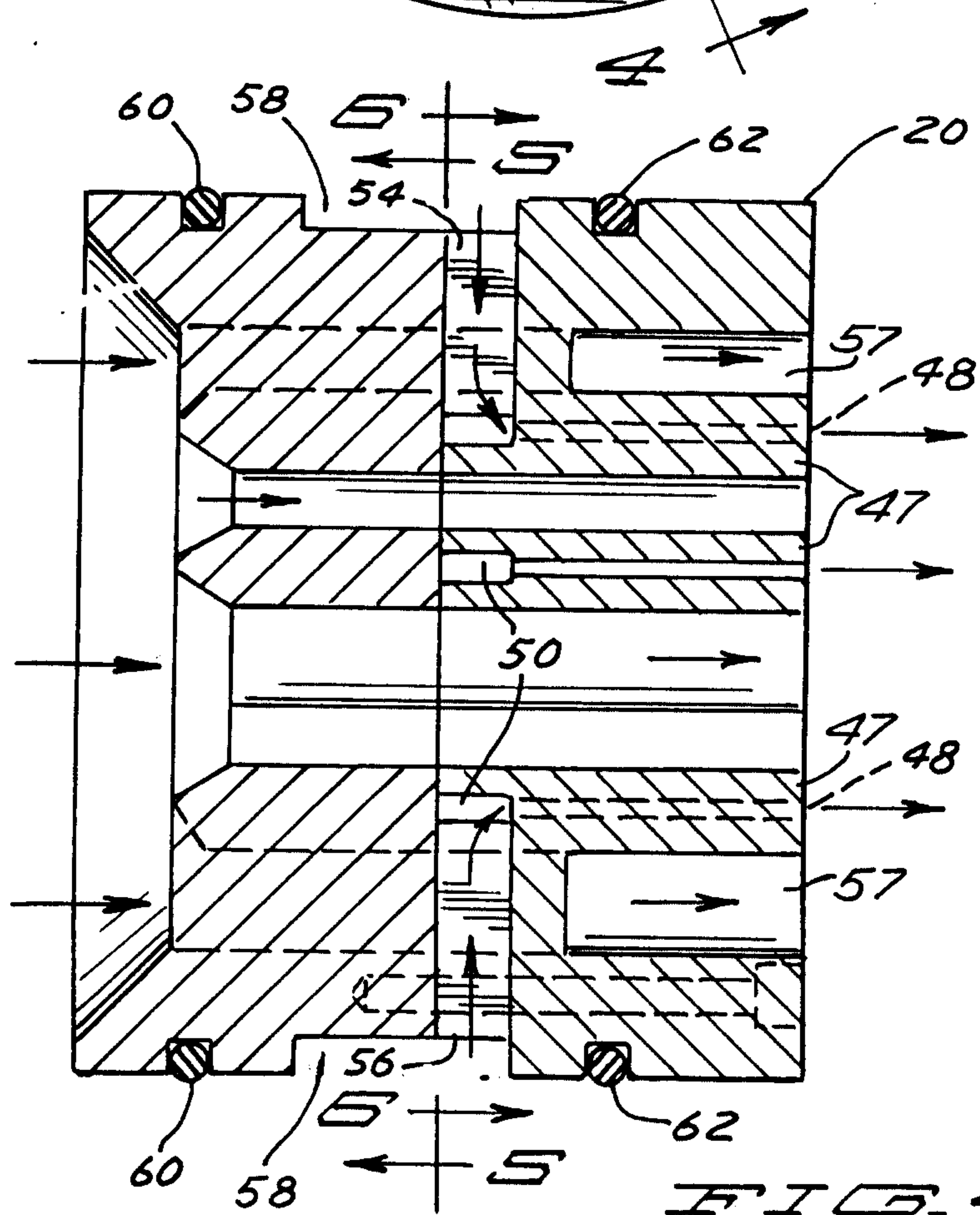


FIG. 4

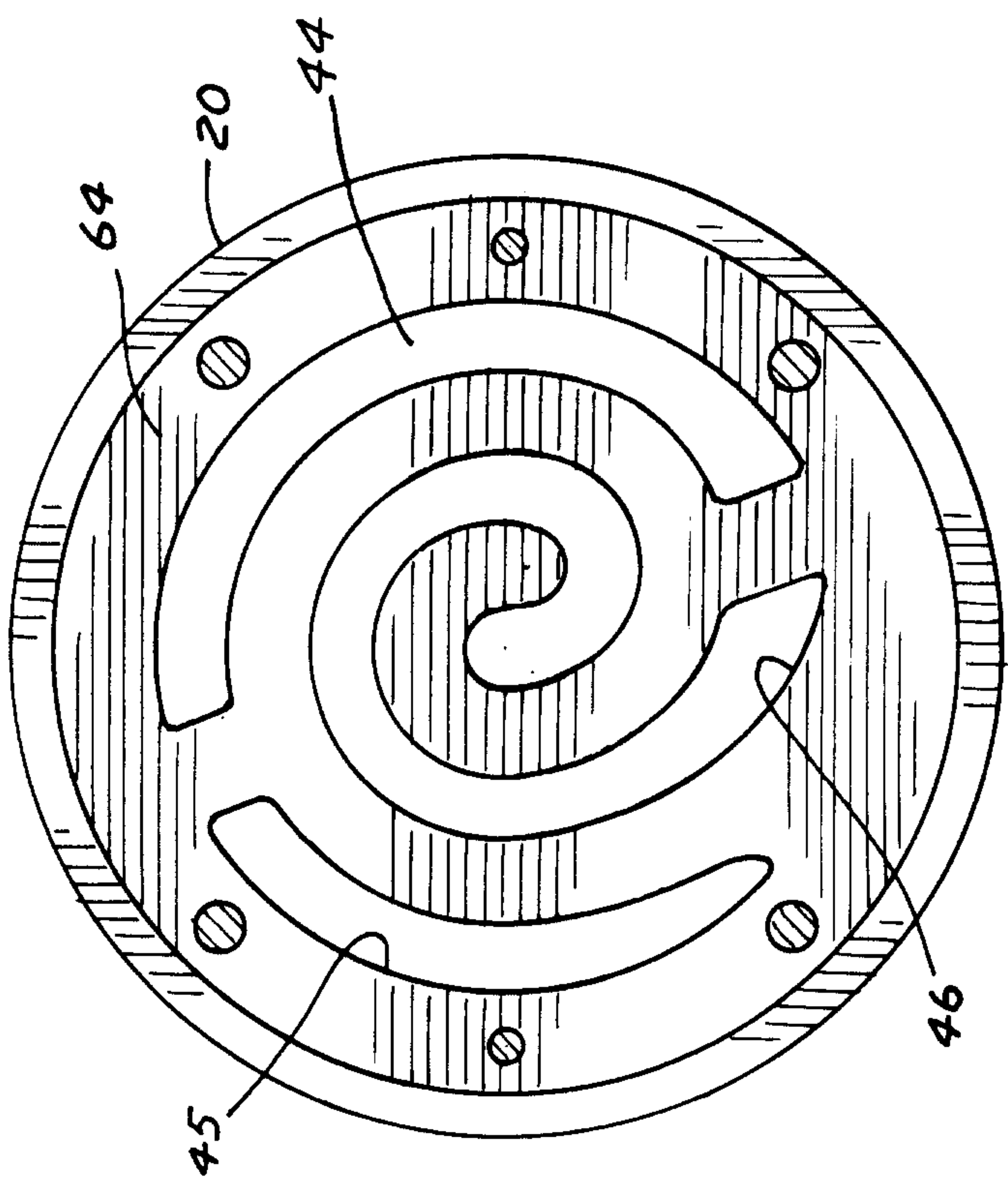
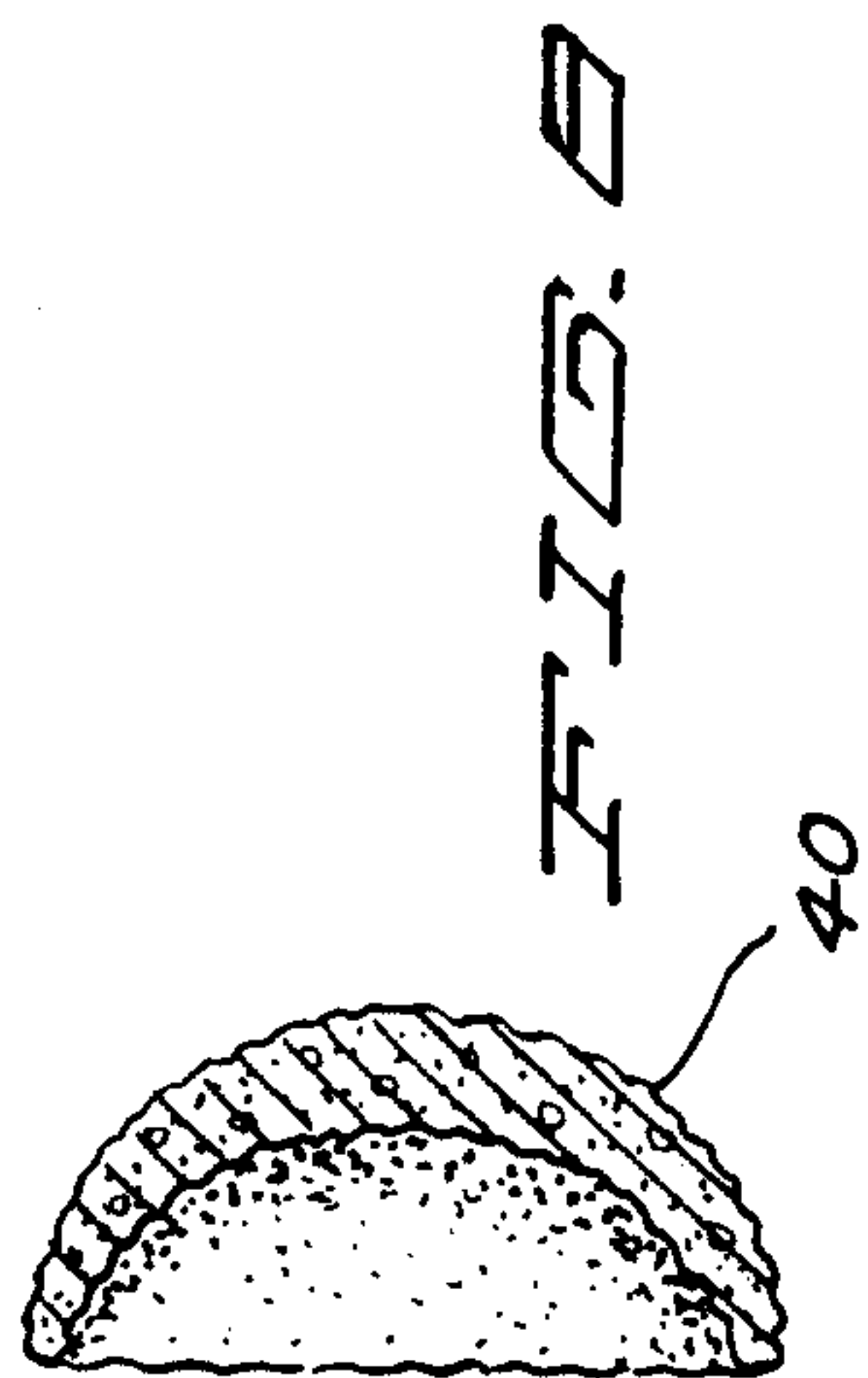
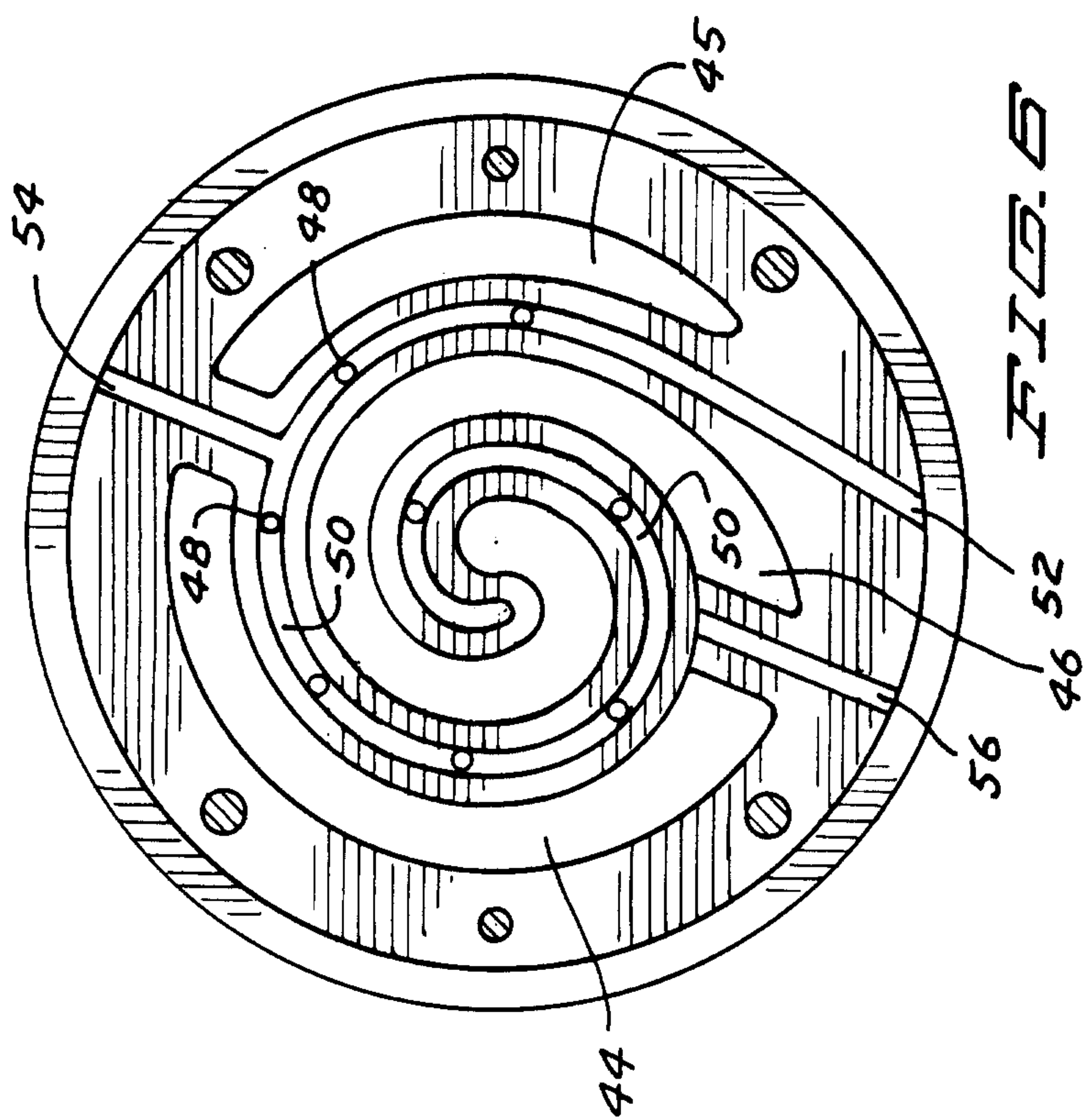


FIG. 5

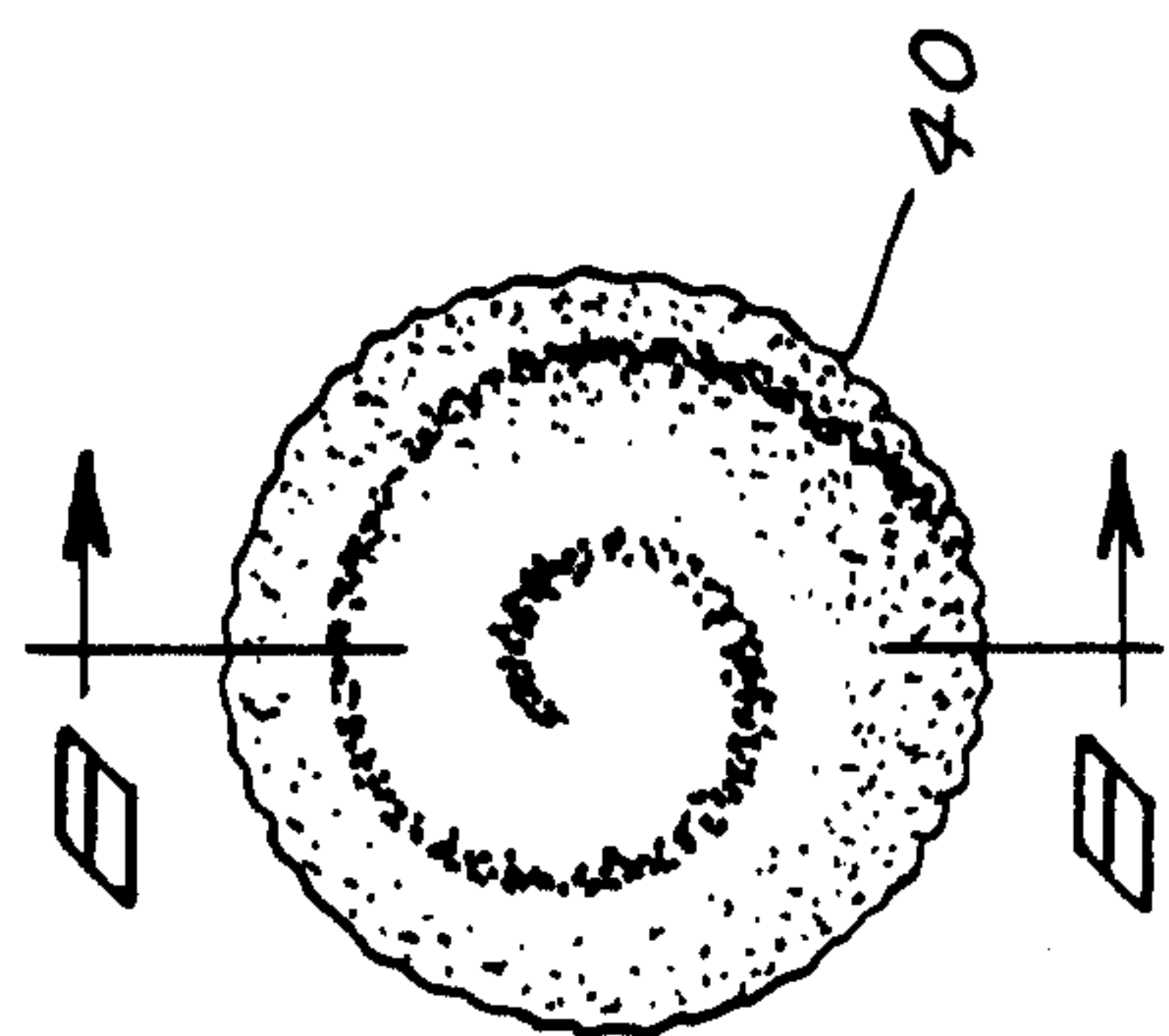


FIG. 7

