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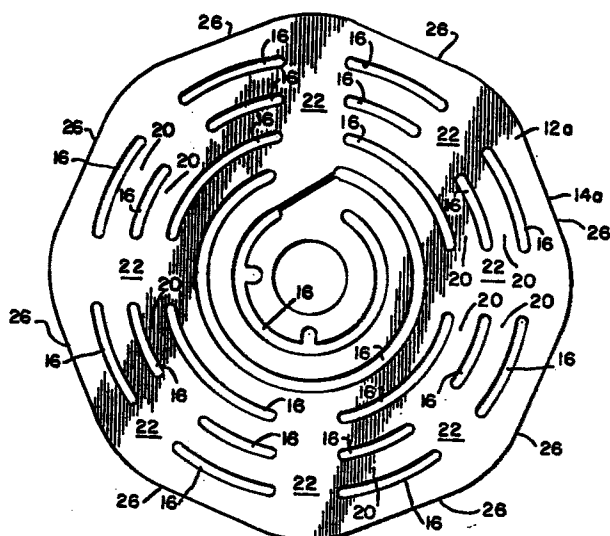
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54 **A valving element for a plate-type valve.**

57 The valving element, according to the first embodiment depicted, comprises a plate-type element having an undulated or scalloped edge or periphery. The plate-type element has a plurality of flow ports formed therein each of which subtends an arc drawn from the radial centre of the element. The ends of the ports, which other wise would be subject to fatigue, failure and fracture, are spaced further from the edge than in prior art practice. Accordingly, the shock of impact of the plate-type element on opening or closing is less likely to precipitate fatigue and failure of the port ends. Additionally, at a plurality of locations about the periphery, the plate-type element has linear portions upon the plate-type element impacting on any of these linear portions, it will make a line contact which more readily disperses the impact shock.



A Valving Element For
A Plate-type Valve

5 This invention pertains, specifically, to valving
elements, and generally to valves within which such
elements function, such as the valves used in
reciprocating gas compressors. These valves are
essentially one-way devices allowing gas flow in a single
direction. They (i.e., the valving elements therein)
respond to pressure differences across them and, commonly,
closing springs are used to assist the valving elements
therein in closing at a particular time relative to the
10 compressor cycle.

15 Valving elements come in a variety of types, and the
particular one addressed by this disclosure is of the
plate type well known in the prior art. Exemplary thereof
are the plate-type valving elements in the "Plate Valve"
disclosures in U.S.-A- 3,327,731 and 3,703,912, issued to
T.K. Kehler, and F. Bauer, et al, respectively, on 27 June
1967 and 28 November 1972. Each of such valving elements,
essentially, is a series of concentric rings joined
20 together by webs and strengthened by radial ligaments.
They can range in diameter from approximately three inches
up to twelve inches, and have a typical plate thickness of
.080 inches.

25 Valving elements in plate-type valves cycle as high as
twenty times per second with total lifts of approximately
.060 inches. Typically, impact velocities thereof, at the
valve seat, are in the four to eight feet per second range
although, in some cases, impacts in excess of ten feet per
30 second have been measured. Impact of the valving element
with the valve seat has been shown, experimentally, to
produce high stresses in the outer rim near the
theradjacent flow port(s). Typically, the valving element
approaches the valve seat in a tilted manner. Contact
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then takes place over a small area, i.e., a point contact, of the valving element periphery, causing bending. Eventually, the valving element plate material fatigues, and a crack develops, forcing the machine (i.e., gas compressor) to be shut down for repairs to be made.

It is an object of this invention to disclose a valving element for a plate-type valve which is not subject to early fatigue, failure and fracture. It is also an object of this invention to set forth a valving element for a plate-type valve, comprising a plate; said plate having (a) apertures formed therein for the conduct of fluid therethrough, (b) a given centre, and (c) an outer periphery defining the outermost edge of said plate; wherein said apertures subtend given arcs drawn from said given centre; and given ones of said apertures each have a first portion intermediate the length thereof which is more proximate to said edge than are other portions thereof which subsist at either sides of said first portion.

It is further an object of this invention to disclose a valving element for a plate-type valve, comprising a plate; said plate having (a) apertures formed therein for conduct of fluid therethrough, (b) a given centre, and (c) an outermost periphery; and wherein said periphery is defined, at least in part, by a plurality of radii drawn from radial centres which are spaced apart from said given centre.

Further objects of this invention, as well as the novel features thereof, will become more apparent by reference to the following description taken in conjunction with the accompanying figures, in which:-

Figure 1 is a plan view of a prior art, plate-type, valving element similar to those in the cited U.S. patents;

5 Figures 2A and 2B are (a) a partial plan view of an edge of such a prior art, valving element, and (b) an illustration in simple line drawing of such a plate approaching contact with its valving plate, the angle of incidence being shown in exaggeration only to clarify the matter;

10 Figures 3A and 3B are illustrations, generally corresponding with Figures 2A and 2B, representing the valving element (of Figures 2A and 2B) upon its having made contact with the valve seat, and showing a fatigue fracture occurring therein;

15 Figure 4 is a plan view of a first embodiment of the valving element, according to the invention;

Figure 5 is a greatly enlarged plan view of a portion of the valving element of Figure 4;

20 Figures 6 and 7 are plan views, similar to that of Figure 5, depicting alternate embodiments of the invention; and

25 Figure 8 is a plan view of the first embodiment of the invention, again with geometric reference lines superimposed thereon.

30 As shown in Figs. 1 to 3, known plate-type valving elements 10 commonly comprise a plate 12 having a circular edge or periphery 14, and having a plurality of apertures, or flow ports 16, formed therethrough, the periphery 14 and the flow ports 16 being concentric about the radial centre 18 of the plate 12. The apertures, or flow ports 16, are spaced in the radial direction by webs 20, and in the circumferential direction by radially extending ligaments 22. The webs 20 and ligaments 22 strengthen the plate. In use, the plates 12 are commonly cycled at a

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high rate, and almost always impact on the complementary valve seat at an angle. Consequently, inwardly of the point of contact, bending occurs. Too soon, the plate metal fatigues and experiences a fracture 24, usually
5 through an area adjacent an end of a radially-outermost flow port 16.

In order to render such valving elements more durable and long-lived, the invention contemplates the strengthening thereof adjacent the ends of the outermost flow ports 16,
10 by spacing at least one end of such outermost flow ports 16 a greater distance from the periphery 14 than the radial spacing of an intermediate part of such outermost flow passages from the periphery. This is achieved in one
15 embodiment by configuring the periphery of the plate as a plurality of arcuate portions joined by rectilinear edge portions, the arcuate edge portions having a radius of curvature less than that of the arcuate flow apertures. This results in a plate 12a having an undulated or
20 scalloped periphery 14a, as shown in the embodiment of Figs. 4 and 5. The rectilinear edge portions 26 avoid point-contact impacts. It can be seen that the outermost flow ports 16 are substantially in parallel with most adjacent, flat edge sections 26 of the periphery 14a of
25 the plate 12a. The outermost ports 16 are spaced between by arcuate sectors 28 which are substantially devoid of flow ports; sectors 28, for example, encompass areas subsisting between points "A" and "B", "C" and "D", and "E" and "F", and radius origins 30.

30 The flow ports 16 subtend the angles "I", "II", "III" and, in fact, are concentric with the radial centre 32 of the plate 12a. The sectors 28, however, are drawn on foreshortened radii from the origins 30. Hence, they
35 define plate portions, between the outermost ports 16, which are like extending lobes 34. By way of understanding a feature of the invention, each outermost

port 16 may be considered to be subdivided into sections "a" through "e". The centre section "a", as can be seen, is more proximate to the edge or periphery 14a of the plate 12a than are the terminal sections "d" and "e".

5 Increased spacing from the periphery 14a, for sections "d" and "e" is provided, therefore, by the arcuate sectors 28 or lobes 34 thereof, which, due to their foreshortened radii, define some of the undulation of the periphery 14a.

10 Each of the outermost ports 16 has a pair of surfaces 36 and 36a which are tangent to an imaginary, broken, straight line 38 drawn therebetween. This line 38 may also be regarded as a chord to the arcuate inner edge of the outermost ports 16. Lines 38 are parallel with the

15 thereadjacent flat edge sections 26 of the periphery 14a, in that such sections 26 are linear. Sections 26 obtain between peripheral points "B" and "C", and "E" and "A"; further ones thereof extend from points "D" and "F".

20 The ends of the outermost ports 16, then, which were at risk in prior art, plate-type valving elements, are considerably more inboard of the periphery 14a in this embodiment of the invention. Such ends enjoy a greater, protective width 42 of plate material to isolate them from

25 impacting shocks, and the latter shocks are more readily dissipated through the thereadjacent sectors 28. As for the greater, intermediate portions of the outermost ports 16, they too are less subject to damaging shock. The thereadjacent linear sections 26 can only effect a line

30 contact, upon impactingly closing on a complementary valve seat (or stop plate). This defines a marked improvement over prior art valving elements which, for being wholly arcuate about the periphery thereof, unavoidably must sustain localized, point-contact impacts.

35 The plate 12a has a maximum outside diameter 44, defined by the sectors 28 or lobes 34, and represented by a broken

line, as well as a minimum outside diameter 46, defined by the sections 26, and represented by a further broken line. The configuration of the plate 12a, then, comprises portions defined in part by sectors 28 or lobes 34 which are addendums to the minimum outside diameter 46, and portions defined in part by the sections 26 which are dedendums from the maximum outside diameter 44.

An alternative embodiment of the invention is shown in Figure 6, which is a fragmentary view, similar to Figure 5. Here too, the outermost flow ports 16a of the plate 12b are arcuate but in this case they are of a lesser radius of curvature so that instead of being concentric formed through arcs drawn from radial centres 48 which are about the centre 32a of the plate each is concentric about a separate centre 48 spaced radially outward from the radial centre 32a of the plate 12b. It is preferred that the centres 48 be equally spaced from the centre 32a. By this teaching, the valve plate 12b may have a circular configuration of the periphery 14b, concentric about the centre 32a, although the ends of the outermost ports 16a are spaced further from the periphery than an intermediate portion thereof so that these ends are protected from early fatigue and failure. The ports 16a have an arc of narrower angle and thus provide the increased radial dimension 42a between the outer ends thereof and a proximity thereof to the outer periphery 14b which would obtain if ports 16a were concentric with centre 32a. To revert to Figure 1, such more narrowly radiused ports 16a (as provided by this invention), and their radial centres 48, are shown, thereon, in two locations, by ports 16a depicted by broken or phantom lines. Thus it can be appreciated how simply the prior art valving elements can easily be improved by a practice of the invention.

As explained, and as shown in Figure 5, plate 12a is so configured as to define an improved, increased spacing, of

- both of the ends, i.e. sections "d" and "e", of outermost ports 16 from the edge or periphery 14a. The lobes 34, however, defining the addendums to the diameter 46, extend further than the width 42 thereof obtaining at the port ends. The further alternative embodiment shown in Figure 7, comprises a plate 12c in which the maximum width afforded by the lobes 34 is used to protect first ends of the outermost ports 16.
- 10 The Figure 7 embodiment has the lobes 34' and linear sections 40 slightly rotated, relative to the outermost ports 16. Accordingly, first ends, i.e., sections "e", of the latter ports are substantially in the midplane of the sectors 28. Sections "e", of the outermost ports, then, are at a maximum width 42b from the periphery 14c of the plate 12c. Second ends, i.e., sections "d" of the outermost ports 16, are spaced apart from the periphery 14c no further, perhaps, than in the prior art plates. However, the latter ends or sections "d" subsist in approximately the midplane of the peripheral linear sections 40. Consequently, impacts are borne there along a line contact, and the impacting shock is more widely dispersed.
- 25 The geometric definitions of the invention are critical to its superior durability. Accordingly, to enhance the disclosure and its clarity, Figure 8 is provided. The latter corresponds to the first embodiment, as depicted in Figures 4 and 5. As shown in Figure 8, plate 12a has a first, central, circular area 50 having an outer circumference 52; the latter is represented by a phantom circle, and is drawn from the plate centre 32 on a given radius. Plate 12a, then, has a second, outer, annular area 54 which is integral with, and in circumscription of, first area 50. The radius origins 30 of the sectors 28 are traversed by the circumference 52, and the sectors 28, as depicted, are spaced apart from each other.

Each of the sectors 28 is bounded by an arc 56 which is a portion of an imaginary circle 58 (two of which circles are represented in phantom). Arcs 56, of adjacent sectors 28, or lobes 34, bisect at points 60 in area 54. Then,
5 radial lines 62, drawn radially outward from the centre 32, and through points 60, traverse the outermost apertures or flow ports 16. Lines 62 subdivide these flow ports, traversing the midpoint of the length thereof.

10 The arcs 56 extend through approximately fifty degrees, and on opposite sides of each they merge into tangency with the intervening linear sections 26 of the periphery 14a.

15 It will be appreciated that the invention provides a valving element for a plate-type valve comprising a plate having flow apertures which are elongate about a given centre of the plate characterised in that at least one of the periphery of the plate and the outermost of the flow
20 apertures considered radially of said centre is configured to provide a greater spacing between at least one end of such outermost apertures and the periphery of the plate than is provided between an intermediate part of said apertures and said periphery.

25 With advantage the outermost apertures are arcuate and concentric about said centre, the periphery of the plate is configured as a plurality of spaced rectilinear edge portions joined by arcuate portions having a radius of
30 curvature less than said outermost apertures, said at least one end of the outermost apertures lies on a radius with respect to said centre which intersects a peripheral arcuate portion and said intermediate portion lies on a radius which intersects a peripheral rectilinear edge
35 portion.

Preferably both ends of the outermost apertures lie on radii with respect to said centre one of which radii

intersects a first peripheral arcuate position and the second of which radii intersects a second peripheral arcuate portion.

5 In an alternative embodiment the periphery of the plate is circular about the centre and the outermost apertures are arcuate to a radius of curvature less than that of the periphery.

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CLAIMS:

1. A valving element for a plate-type valve, comprising a plate (12a); said plate having (a) apertures (16) formed therein for the conduct of fluid therethrough, (b) a given centre (32), and (c) an outer periphery (14a) defining the outermost edge of said plate; wherein said apertures subtend given arcs (I, II, III) drawn from said given centre; and characterised in that given ones of said apertures each have a first portion (a) intermediate the length thereof which is more proximate to said edge than are other portions (d, b-c, e) thereof which subsist at either sides of said first portion.
2. A valving element, according to claim 1, wherein said given ones of said apertures each have surfaces (36, 36a), adjacent opposite ends thereof, which are tangent to a straight line (38) drawn between said surfaces; and respective sections (26) of said edge, which are most adjacent to said given ones of said apertures, are straight and are parallel with said drawn lines.
3. A valving element, according to claim 1, wherein sections (34) of said edge are arcuately formed from radial centres (30) spaced apart from said given centre.
4. A valving element, according to claim 1, wherein sections (26) of said edge are linear; and said first portions of said given ones of said apertures are more proximate, as aforesaid, to said linear sections of said edge.
5. A valving element, according to claim 4, wherein each of said linear sections (26) of said edge (14a) join others thereof through intervening sectors (28) of said plate; each of said intervening sectors terminates in a portion of said edge (34) which has an arcuate

conformation drawn from a radial centre (30) located outward from said given centre.

5 6. A valving element, according to claim 5, wherein said sectors (28) encompass areas of said plate (12a) which are substantially devoid of apertures.

10 7. A valving element for a plate-type valve, comprising a plate (12a); said plate having (a) apertures (16) formed therein for conducting a fluid therethrough, (b) a given centre (32), and (c) an outermost periphery (14a); and characterised in that said periphery is defined, at least in part, by a plurality of radii drawn from radial centres (30) which are located inwardly of said periphery and are spaced apart from said given centre.

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20 8. A valving element, according to claim 7, wherein said plate has a maximum outside diameter (44); and given portions (26) of said periphery comprise dedendums relative to said diameter.

25 9. A valving element for a plate-type valve, comprising a plate (12a) said plate having (a) apertures (16) formed therein for conduct of fluid therethrough, (b) a given centre (32) and (c) an outermost periphery (14a) and characterised in that said periphery is defined, at least in part, by a plurality of radii drawn from radial centres (30) which are spaced apart from said given centre; wherein said plate has a maximum outside diameter (44); given portions (26) of said periphery comprise dedendums relative to said diameter; and said given portions each define substantially linear edges of said plate.

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35 10. A valving element, according to claim 7, wherein said plate has a minimum outside diameter (46); and prescribed portions (34) of said periphery comprise addendums relative to said diameter.

11. A valving element, according to claim 7, wherein said apertures (16) are of arcuate configuration and are concentric with said given centre (32).

5 12. A valving element for a plate-type valve, comprising
a substantially circular plate (12a); said plate having
(a) apertures (16) formed therein for the conduct of fluid
therethrough, (b) a given centre (32), and (c) an outer
10 periphery (14a) defining the outermost edge of said plate;
wherein said apertures comprise flow ports which subtend
arcs (I, II, III) drawn from said given centre; said ports
each having a first section (a) intermediate the length
thereof, and second and third sections (d, b-c, e) at
15 opposite ends thereof; and characterised in that said
outermost edge of said plate has given portions (26)
thereof which are more proximate to at least one of said
first, second and third sections of said ports than to
others of said sections; and each of said more proximate,
20 given portions of said edge defines means, responsive to a
closure thereof onto a flat surface, for causing said
portion to impact, with such a flat surface, only with a
full line contact.

25 13. A valving element, according to claim 12, wherein
said given portions (26) of said edge are more proximate
to said first sections (a) of said ports.

30 14. A valving element, according to claim 12, wherein
said given portions (40) of said edge are more proximate
to one (d, b) of said second and third sections of said
ports.

35 15. A valving element for a plate-type valve, comprising
a plate (12a); said plate having (a) apertures (16) formed
therein for conduct of fluid therethrough, (b) a given
centre (32) and (c) an outermost periphery (14a); and
characterised in that said periphery is defined, at least

in part, by a plurality of radii drawn from radial centres (30) which are spaced apart from said given centre; wherein said plate further has a first, central, circular area (50) having a given circumference (52); said circumference has a radius drawn from said given centre; said plate further has a second, outer, annular area (54) integral with, and in circumscription of, said first area; said periphery comprises an outermost edge of said plate; said radial centres (30) are traversed by said circumference (52) and said radii of said plurality thereof define said second area with a plurality of spaced-apart sectors (28).

16. A valving element, according to claim 15, wherein each of said sectors (28) is defined by an arc (56) which intersects another such arc, of another, adjacent one of said sectors, at a prescribed point (60) on said second area; and an imaginary, radial line (62), drawn radially outward from said given centre (32) and through said prescribed point, traverses an outermost one of said apertures (16) substantially across a midpoint of the length of said one aperture.

17. A valving element, according to claim 15, wherein said radii of said plurality thereof define said edge with a plurality of spaced-apart, arcuate lobes (34); said edge has a plurality of linear portions (26); and adjacent ones of said lobes are joined therebetween by an intervening one of said linear portions.

18. A valving element, according to claim 17, wherein each of said intervening, linear portions (26) of said edge is tangent to those of said adjacent lobes which said linear portion joins.

19. A valving element, according to claim 17, wherein said lobes (34) number in excess of four.

20. A valving element, according to claim 17, wherein said lobes (34) in sum total, are of an even number.

5 21. A valving element, according to claim 15, wherein said sectors (28) extend through approximately fifty degrees of arc.

10 22. A valving element for a plate-type valve comprising a plate having flow apertures which are elongate about a given centre of the plate, characterised in that at least one of the periphery of the plate and the outermost of the flow apertures considered radially of said centre is configured to provide a greater spacing between at least one end of such outermost apertures and the periphery of
15 the plate than is provided between an intermediate part of said apertures and said periphery.

20 23. An element according to claim 22, characterised in that the outermost apertures are arcuate and concentric about said centre, the periphery of the plate is configured as a plurality of spaced rectilinear edge portions joined by arcuate portions having a radius of curvature less than said outermost apertures, said at least one end of the outermost apertures lies on a radius with
25 respect to said centre which intersects a peripheral arcuate portion and said intermediate portion lies on a radius which intersects a peripheral rectilinear edge portion.

30 24. An element according to claim 23, characterised in that both ends of the outermost apertures lie on radii with respect to said centre one of which radii intersects a first peripheral arcuate portion and the second of which radii intersects a second peripheral arcuate portion.
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25. An element according to claim 22, characterised in that the periphery of the plate is circular about the centre and the outermost apertures are arcuate to a radius of curvature less than that of the periphery.

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FIG. 1
PRIOR ART

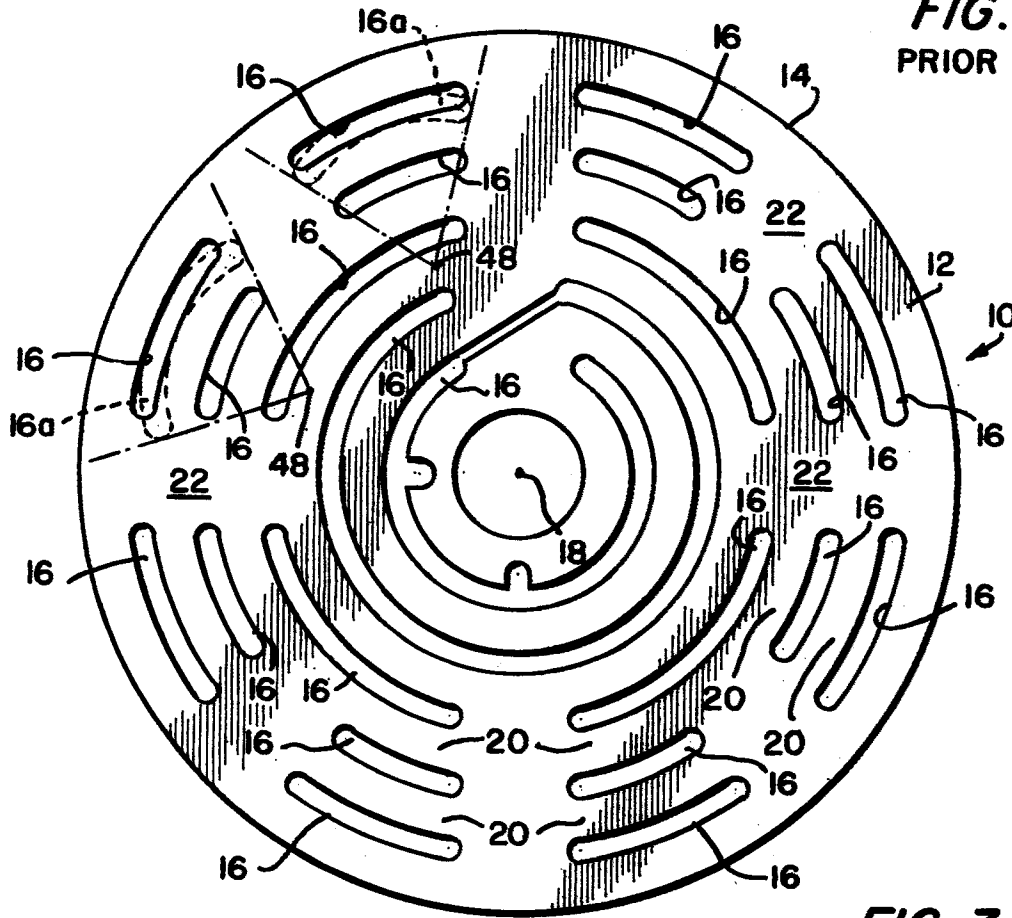


FIG. 2A
PRIOR ART

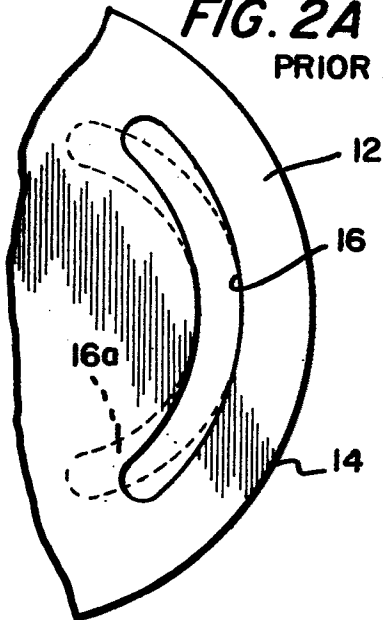
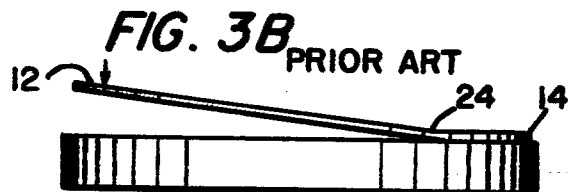
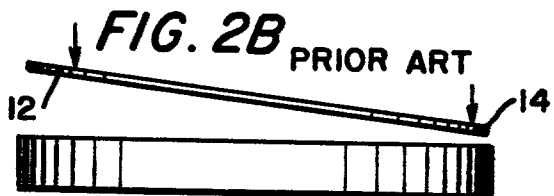
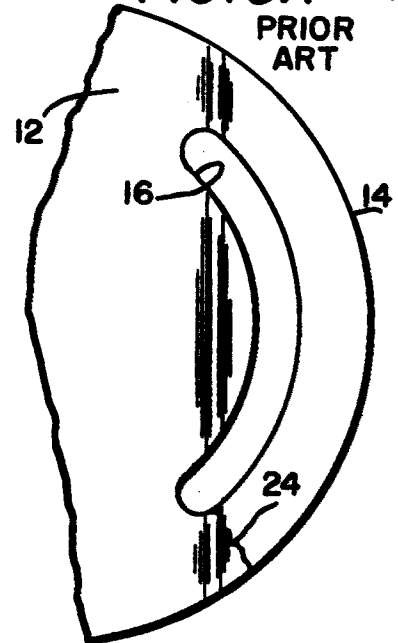
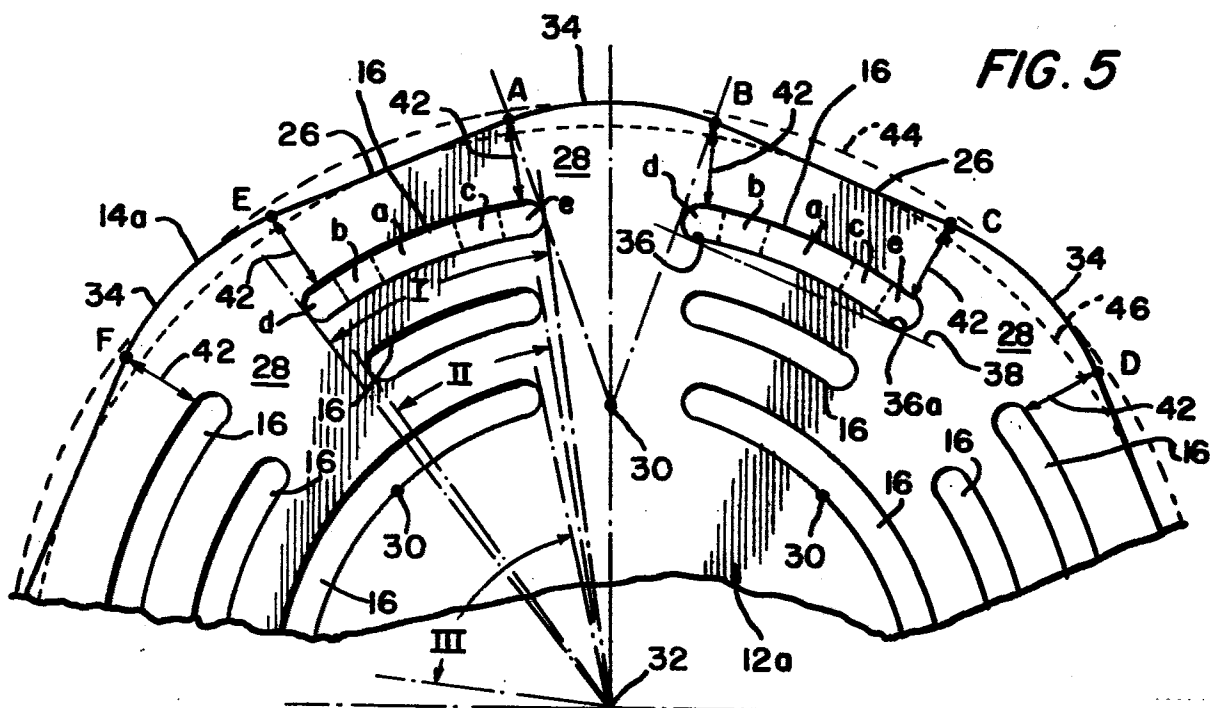


FIG. 3A
PRIOR ART





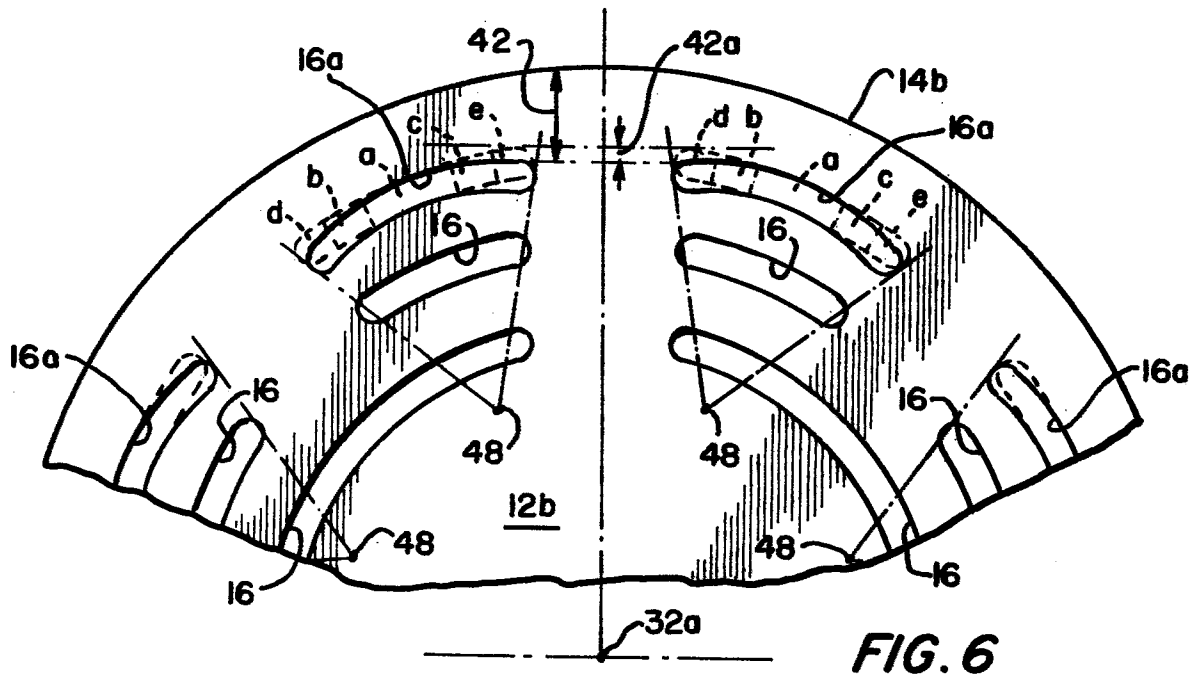


FIG. 8

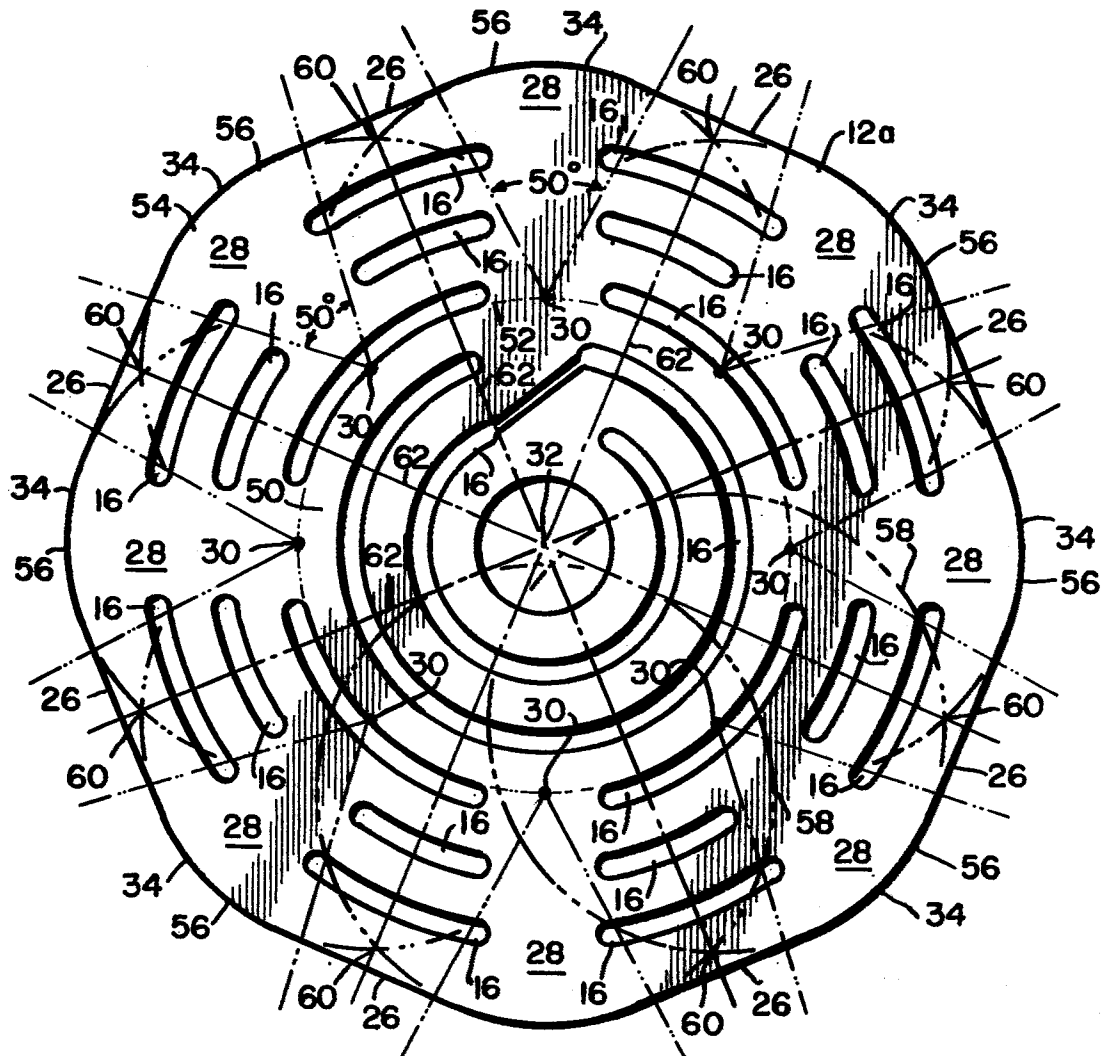
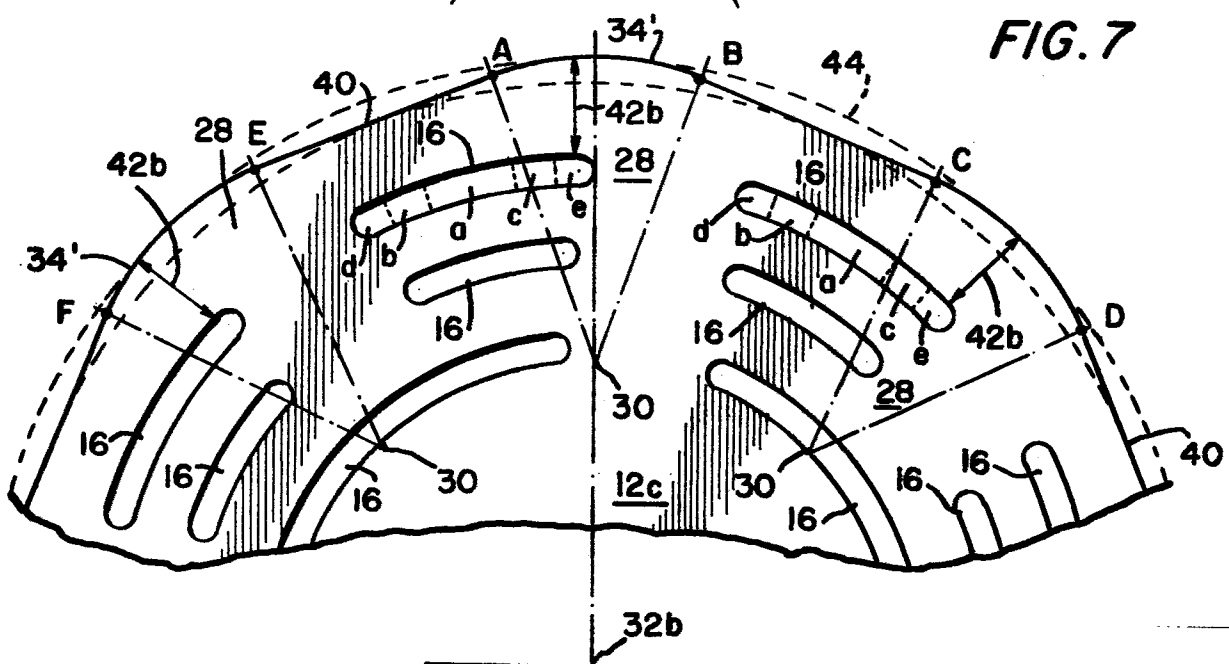


FIG. 7





European Patent
Office

EUROPEAN SEARCH REPORT

0208814

Application number

EP 85 30 4491

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
E	US-A-4 532 959 (K. HARTSHORN) * Whole document *	1-23	F 16 K 15/16 F 04 B 39/10
A	FR-A- 860 126 (H. BERNAT et al.)		
A	DE-C- 687 507 (L. SZIGETH)		
A	US-A-3 792 718 (R.F. KOHLER)		
A	GB-A-1 287 164 (ENFO ENTWICKLUNGS- UND FORSCHUNGS-AG)		
A	FR-A-2 030 739 (R. BOSCH GmbH)		
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			F 16 K F 04 B
Place of search THE HAGUE		Date of completion of the search 31-01-1986	Examiner FRANKS N.M.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			