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**DE-A- 2 139 497**
**GB-A- 1 451 533**
**GB-A- 2 169 814**
**US-A- 3 606 270**

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## Description

Background of the Invention.

1. Field of the Invention.

This invention pertains to mixing apparatus, and more particularly to apparatus for continuously blending powders with a liquid.

2. Description of the Prior Art.

Exemplary apparatus for blending liquids and particulate solids is disclosed in U. S. Patent No. 3,606,270. That blender has met with considerable commercial success.

However the blender of the 3,606,270 patent is somewhat limited in its ability to handle high viscosity liquid-powder end products. That is because, as the end product viscosity increases, the blender outlet pressure decreases and the vacuum created in the eye of the blender impeller becomes quite low. Consequently, the amount of powder drawn into the impeller decreases and yields a higher ratio of liquid to powder than is desired. To alleviate that problem, the screen that normally surrounds the impeller periphery may be removed, but then the mixing action produced by the liquid and powder flowing through the screen becomes unavailable. Accordingly, blender performance and product consistency occasionally become unacceptable at high end product viscosities. GB 2169814A discloses a blender for mixing solid particulates and liquid, said blender having inlets for the particulates and liquid at the top of a casing in which is a first rotatable impeller arranged to feed a second rotatable impeller in the casing for onward discharge to an outlet. This blender is used for preparing a slurry of pulverent bodies such as pulverised coal or oil coke which which is not particularly viscous. As has been explained above above in relation to the blender of US Patent No. 3,606,270 when handling viscous material, as the viscosity increases, the vacuum created between the inlets and first impeller becomes insufficient to draw the correct proportion of the particulates into the blender. This yields a higher liquid level for the discharge than is desirable.

Thus, a need exists for a blender capable of handling high viscosity liquid-powder end products.

According to the invention a blender is provided which is characterised in that an annular screen with holes in surrounds the periphery of the first impeller, leading to a first annular passage formed within the casing around the first impeller having a height generally equal to imperforate vanes provided on the first impeller, a second annular passage is concentric with and below the first impeller and connects the first annular passage, via an annular inlet around the hub, to the second impeller, wherein the vanes of the first impeller extend radially outwards from the hub for a length having a lesser height than outer portions of the vanes so as to form a centrally located recess for creating a vacuum to draw the solid particulates into the recess from the particulate inlet placed directly above it.

In accordance with the present invention, a liquid-solid particulate blender is provided that efficiently mixes and discharges high viscosity end products. This is accomplished by apparatus that includes a second stage mixing zone that assists drawing the liquid-powder mixture from the first stage and that increases the blender outlet pressure.

In the first stage mixing zone the liquid and powder are blended in a known fashion. Liquid is pumped tangentially around a diffuser tube and into the first stage mixing zone in the same direction as the rotation of a blender impeller. The liquid is introduced at the leading edge of the impeller, which has a central recess radially inwardly from the impeller vanes. The impeller accelerates the liquid radially outwardly, thereby creating a vacuum at the central recess. The natural suction created at the impeller recess pulls the powder from a storage hopper to the recess through the diffuser tube. Powder and liquid mixing occur as they are accelerated radially outwardly by the impeller. The mixture is forced through an annular screen surrounding the impeller periphery, thereby further mixing the ingredients.

The liquid and powder leaving the first stage mixing zone are discharged to the second stage mixing zone that is in series with the first stage. The mixture is directed downwardly and radially inwardly after leaving the first stage annular screen. Simple baffles create an internal passage through which the mixture from the first stage enters the central recess of a second stage impeller. The second stage impeller again accelerates the mixture radially outwardly and through a second stage annular screen. As a result of the operation of the second stage mixing zone, the vacuum produced at the first stage impeller recess is enhanced, and the flow of powder into the first stage mixing zone remains relatively constant, even with high viscosity end products. Moreover, the second stage increases the blender outlet pressure to provide increased flow notwithstanding high viscosity end products.

Further in accordance with the present invention, the baffles between the first and second mixing zones are designed to permit cleaning in place the blender first stage mixing zone. For that purpose, a clearance is provided between the first

stage impeller and the baffle member adjacent thereto. Accordingly, the blender may be flushed and cleaned without complete disassembly, thereby reducing lost production time.

Other objects and advantages of the invention will become apparent to those skilled in the art from reading the disclosure.

Figure 1 is a partial longitudin al cross-sectional view of the blender of the present invention;

Figure 2 is a cross-sectional view taken along lines 2-2 of Fig. 1; and

Figure 3 is a set of performance curves for a prior blender and for the blender of the present invention.

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structure. The scope of the invention is defined in the claims appended hereto.

Referring to Figs. 1 and 2, a two-stage blender 1 is illustrated that includes the present invention. The blender is particularly useful for mixing liquid and solid food and beverage ingredients into a high viscosity edible end product. However, it will be understood that the invention is not limited to sanitary applications.

The blender 1 is used in connection with an electric motor, drive system, and storage hopper that are not illustrated in Figs. 1 and 2. The motor, drive and hopper are described in U.S. Patent No. 3,606,270, which is incorporated by reference herein. The blender may be supported on a stand, not shown, by posts 3 that are attached to a bottom ring 5.

Located above the blender 1 is the hopper for storing particulate solids, which may be in the form of powders. The powder enters the blender by means of diffuser tube 7. The lower end 9 of the diffuser tube 7 is provided with an annular flange 11. The upper surface of the flange 11 is shaped with a radius 21 that approximates the radius 23 of the inner surface of the blender casing inlet 15 adjacent the flange 11. The diffuser tube 7 is concentrically located within the blender casing inlet 15.

The blender 1 includes a first stage mixing zone 16 bounded by the casing 44. Although in the disclosed construction the casing 44 is one piece, an alternate construction could employ a two-piece casing split, for example, along line 45.

The components within the first stage mixing zone 16 comprise a first stage impeller 27, which, as best shown in Fig. 2, may have four vanes 28. The vanes 28 extend radially outwardly from a central hub 30 having a length less than the height of the vanes, thereby forming a central recess 33. As illustrated, the lower end 9 of the diffuser tube 7 extends into the recess 33. The impeller 27 is attached to a drive shaft 29 for rotation therewith by an electric motor and drive system. The first stage impeller 27 is secured to the end of the shaft 29 by a screw 31 through a washer 71. Surrounding the periphery of the impeller 27 is a first stage annular screen 37. The first stage annular screen 37 rests on an upper baffle member 35 that has four equally spaced tabs 72 on the outer circumference of the upper baffle member 35. A pin 73 is fixedly attached to the first stage annular screen 37 extending below the bottom of the first stage annular screen 37 and abutting against one of the four equally spaced tabs 72 of the circular plate 35 to prevent rotation of the first stage annular screen 37. The casing 44 bounding the first stage mixing zone 16 is fabricated with a wall 38 that is radially spaced outwardly from the screen 37 to create a first discharge volume 39.

In accordance with the present invention, the blender 1 further includes a second stage mixing zone 41. The second stage mixing zone 41 is bounded by the common casing 44 and includes a second impeller 43 secured for rotation to the shaft 29. The second stage impeller 43 is separated from the first stage impeller 27 by spacer 74 that fits concentrically around shaft 29. The second stage impeller 43 is generally similar to the first stage impeller 27, having a central recess 48 and several vanes 52 radiating therefrom. However, the second stage impeller vanes 52 extend radially inwardly farther than the vanes 28 of the first stage impeller 27, so that the second sta ge recess 48 is smaller than the first stage recess 33. The periphery of the impeller 43 is surrounded by a second stage annular screen 45. The second stage annular screen 45 rests on a circular plate 70 to which is fixedly attached the support ring 5. The shaft 29 extends through a sealing means 50 in the circular plate 70. Casing 44 has a wall portion 46 that is radially spaced outwardly from the screen 45 to create a second discharge outlet 47. The casing 44 and the support ring 5 may be releasably joined to each other by means of a quick-couple connector 49.

In the illustrated construction, a passage 51 is formed between the first and second mixing zones 16 and 41 by means of internal baffles. The baffles comprise an upper baffle member 35 that has four equally spaced tabs 72 on its outer circumference. The baffles further include a generally horizontal lower member 55 which provides four spacer supports 76 to provide an axial spacing from the upper baffle member 35 and is preferably concentric with the upper baffle member 35. A downwardly sloped wall portion 57 of the casing 44 completes the contours of the passage 51. The lower member 55

has provisions to receive a pin 74 that is fixedly attached to the upper portion of the second stage annular screen 45 to prevent rotation of the second stage annular screen. Slots 75 are formed in casing 44 to prevent the rotation of the lower member 55.

Further in accordance with the present invention, the first stage mixing zone 16 is constructed so that the components thereof may be cleaned in place. For that purpose, the impeller 27 and upper baffle member 35 are located with respect to each other such that a radial clearance 58 and an axial clearance 60 exist between the impeller 27 and upper baffle member 35. The clearances 58 and 60 are sized to permit only minimal amounts of the powder-liquid mixture to pass through the clearances, but to allow passage of sufficient flushing fluid to permit cleaning the components without disassembling them. As a result, the first stage mixing zone of the blender 1 of the present invention may be cleaned with only minimum loss of production time.

In operation, the blender 1 of the present invention mixes liquids and powders into end products having higher viscosities than can be handled by single stage blenders. Liquid is introduced into the blender first stage 16 through the hollow cylindrical space 13 that is located between the diffuser tube 7 and the blender casing inlet 15. The entering liquid has a rotational component of motion about the central axis 17 and a downward component of motion, as indicated by arrows 19. When the liquid strikes the radius 21 of the flange 11, it is deflected radially outwardly, as indicated by the arrow 25. The rotational motion of the incoming liquid is in the same direction as the rotation of the impeller 27.

The impeller 27 imparts a radially outward acceleration to the liquid. Simultaneously, the impeller creates a natural vacuum within the recess 33, thereby drawing particulate solids from the hopper through the diffuser tube 7 and into the recess 33, as indicated by arrow 34. The solids are then accelerated outwardly by the impeller vanes 28, arrow 36, and they are mixed with the liquid. The mixture is forced through the first stage screen 37, which further mixes the ingredients. As illustrated by arrows 59, the mixture discharged from the first stage mixing zone 16 is diverted downwardly by the casing wall 38 into the passage 51. The baffles composed of the members 35 and 55 and the casing wall 57 direct the mixture radially inwardly toward axis 17 and into the recess 48 of the second stage mixing zone impeller 43, as indicated by arrows 61. From the second mixing zone recess 48, the impeller 43 again accelerates the mixture radially outward. Finally, the mixture is forced through the second stage screen 45 and into the discharge outlet 47, arrow 63.

The addition of the second stage 41 of the blender 1 of the present invention enhances the vacuum produced at the first stage recess 33, thereby drawing the particulate solids through the diffuser tube 7 in a uniform manner, even with high viscosity end products. Referring to Fig. 3, the improved performance of the two stage blender 1 is graphically illustrated. Curves 67a and 69a qualitatively depict, for two certain typical operating conditions, the changes in vacuum at the first stage recess 33 with change in product flow. The decrease in vacuum with increased product flow corresponds to a decreased powder-to-liquid ratio, i.e., with less vacuum, less powder is pulled from the hopper at a particular liquid flow. Consequently, the end product consistency and ingredient ratio may fall outside the formula specification. Curves 67b and 69b qualitatively depict the performance of the two stage blender 1 of the present invention under the same operating conditions as curves 67a and 69a, respectively. The volume at the first stage mixing recess 33 remains relatively constant with increased product flow, thus ensuring proper ingredient ratios even at high end product viscosities. Further, the second stage 41 increases the discharge pressure at the discharge outlet 47, thereby overcoming the problems associated with mixing high viscosity end products in a single stage blender.

## Claims

1. A blender for mixing sold particulates and liquids, said blender having inlets for the particulates (7) and, placed concentrically around it, for liquid (13) at the top of a casing (44) in which is a first rotatable impeller (27) arranged to feed a second rotatable impeller (43) in the casing for onward discharge to an outlet (47) characterised in that an annular screen with holes in (37) surrounds the periphery of the first impeller, leading to a first annular passage (39) formed within the casing around the first impeller having a height generally equal to imperforate vanes (28) provided on the first impeller, a second annular passage (51) is concentric with and below the first impeller and connects the first annular passageway, via an annular inlet around the hub (30), to the second impeller (43), wherein the vanes (28) of the first impeller extend radially outwards from the hub (30) for a length having a lesser height than outer portions of the vanes so as to form a centrally located recess (33) for creating a vacuum to draw the solid particulates into the recess from the particulate inlet (7) placed directly above it.

2. A blender according to claim 1 wherein the second annular passage (51) is defined by a plurality of baffles, the baffles comprising a generally horizontal upper member (35) concentric with the prior impeller and having an outer diameter in general radial alignment with the first impeller vanes (28) outer diameter and an inner diameter in radial clearance relationship with the impeller hub (30); a generally horizontal lower member (55) axially spaced from and concentric with and parallel to the upper member; and an inwardly and downwardly sloped wall portion (57) of the casing wall uniformly bounding the first annular passage (39).

3. A blender according to claim 2 wherein the upper baffle member (35) is formed with its radial clearance relationship with the inner hub so as to permit passing a flushing fluid through the clearance to enable claning the blender in place.

4. A blender according to any one of claims 1 to 3 further comprising a base means (3,5) for supporting the blender on a support surface; and quick couple means (49) for releasably connecting the casing (44) to the base means.

5. A blender according to any one of claims 1 to 4 wherein the liquid inlet (13) is provided with a flange (11) having an outer radius (21) arranged to deflect liquid outwardly towards the vanes (28) of the first impeller (27).

**Revendications**

1. Mélangeur pour mélanger des particules solides et des liquides, ledit mélangeur ayant une entrée pour les particules (7) et située concentriquement autour d'elle, une entrée pour le liquide (13) au sommet d'un carter 44 dans lequel se trouve une première palette d'agitation (27) disposée pour alimenter une seconde palette d'agitation (43) dans le carter pour décharger en avant vers une sortie (47) caractérisé en ce que un écran annulaire entoure la périphérie de la première palette d'agitation avec des trous conduisant vers un premier passage annulaire (39) formé à l'intérieur du carter autour de la première palette d'agitation ayant une hauteur généralement égale aux ailettes imperforées (28) prévues sur la première palette d'agitation, un second passage annulaire (51) est concentrique à et au-dessous de la première palette d'agitation et connecte le premier passage annulaire, via une entrée annulaire autour du moyeu (30) à la seconde palette d'agitation (43) dans lequel les ailettes (28) de la première palette d'agitation s'étendent radialement vers l'extérieur à partir du moyeu (30) sur une longueur ayant une hauteur inférieure aux parties extérieures des ailettes de façon à former un évidement situé centralement (33) pour créer un vide pour insérer les particules solides dans l'évidement à partir de l'entrée des particules (7) placée directement au-dessus de lui.

2. Mélangeur selon la revendication 1 dans lequel le second passage annulaire (51) est défini par une pluralité de chicanes, les chicanes comprenant un élément supérieur généralement horizontal (35) concentrique à la première palette d'agitation et ayant un diamètre extérieur en alignement radial général avec les ailettes (28) de la première palette d'agitation et un diamètre intérieur correspondant au passage radial du moyeu des palettes d'agitations (30) ; un élément inférieur généralement horizontal (55) espacé axialement de et concentrique à et parallèle à l'élément supérieur ; et une partie de paroi inclinée vers l'intérieur et vers le bas (57) de la paroi du carter limitant de façon uniforme le premier passage annulaire (39).

3. Mélangeur selon la revendication 2 dans lequel l'élément de chicane supérieur (35) est formé avec son passage radial correspondant au moyeu intérieur de façon à permettre de faire passer un fluide de purge à travers le passage pour permettre de nettoyer le mélangeur sur place.

4. Mélangeur selon l'une quelconque des revendications 1 a 3 comprenant en plus des moyens de base (3,5) pour supporter le mélangeur sur une surface de support ; et des moyens d'accouplement rapide (49) pour relier de façon libérable le carter (44) aux moyens de base.

5. Mélangeur selon l'une quelconque des revendications 1 à 4 dans lequel l'entrée de liquide (13) est prévue avec une bride (11) ayant un rayon extérieur (21) disposé pour dévier le liquide vers l'extérieur vers les ailettes (28) de la première palette d'agitation (27).

**Patentansprüche**

1. Zweistufenmischer zum Mischen von Festkörperteilchen und Flüssigkeiten, bestehend aus einem Gehäuse (44), welches in seinem oberen Bereich mit einem Festkörpereinlaß (17) sowie einem konzentrisch darum angeordneten

Flüssigkeitseinlaß (13) versehen ist, und welches in seinem Inneren ein erstes drehbares Flügelrad (27) aufweist, von welchem aus eine Speisung eines zweiten drehbaren Flügelrades (43) erfolgt, von welchem aus die Mischung einer an dem Gehäuse angeordneten Abgabe zugeführt ist,
dadurch **gekennzeichnet,**
daß die Peripherie des ersten Flügelrades mit einem ringförmigen Gitter (37) umgeben ist, welches mit entsprechenden Durchbrechungen versehen ist, ferner daß innerhalb des Gehäuses um das erste Flügelrad herum ein erster Ringkanal (39) vorgesehen ist, dessen Höhe im wesentlichen der Höhe der nicht perforierten Flügelblätter (28) des ersten Flügelrades entspricht, und daß konzentrisch und unterhalb des ersten Flügelrades ein zweiter Ringkanal (51) vorgesehen ist, welcher den ersten Ringkanal über einen um die Habe (30) herum angeordneten ringförmigen Einlaß mit dem zweiten Flügelrad (43) verbindet, wobei die Flügelblätter (28) des ersten Flügelrades in radialer Richtung von der Nabe (30) sich über eine Strecke erstrecken, die eine geringere Höhe als die äußeren Bereiche der Flügelblätter aufweisen, so daß auf diese Weise eine konzentrisch angeordnete Ausnehmung (33) gebildet ist, mit welcher ein Unterdruck erzeugt ist, so daß die Festkörperteilchen von dem unmittelbar darüber angeordneten Festkörpereinlaß (7) in diese Ausnehmung gezogen werden.

**2.** Zweistufenmischer nach Anspruch 1, dadurch gekennzeichnet, daß der zweite Ringkanal (51) durch eine Mehrzahl von Umlenkblechen gebildet wird, welche jeweils ein horizontales oberes Element (35) aufweisen, das konzentrisch zu dem Flügelrad verläuft und dessen Außendurchmesser in radialer Ausrichtung dem Außendurchmesser der Flügelblätter (28) des ersten Flügelrades entspricht, während der innere Durchmesser mit entsprechendem radialen Abstand dem Durchmesser der Nabe (30) des Flügelrades entspricht, ferner daß ein im wesentlichen horizontales unteres Element (55) vorgesehen ist, welches in einem axialen Abstand, jedoch konzentrisch und parallel zu dem oberen Element verläuft und daß schließlich ein nach innen und abwärts geschrägter Wandteil (57) der Gehäusewandung den ersten Ringkanal (39) gleichförmig begrenzt.

**3.** Zweistufenmischer nach Anspruch 2, dadurch gekennzeichnet, daß das obere Umlenkblech (35) mit einem radialen Abstand gegenüber der Innennabe ausgebildet ist, so daß durch den Abstand eine Reinigungsflüssigkeit einleitbar ist, um eine Reinigung des Mischers an Ort und Stelle zu gestatten.

**4.** Zweistufenmischer nach einem der Ansprüche 1 bis 3, dadurch gekennzeichnet, daß derselbe mittels Basiselementen (3, 5) auf einer Tragfläche befestigbar ist, und daß Schnellkopplungselemente (49) vorgesehen sind, mit welchen das Gehäuse (44) an den Basiselementen lösbar befestigt ist.

**5.** Zweistufenmischer nach einem der Ansprüche 1 bis 4, dadurch gekennzeichnet, daß der Flüssigkeitseinlaß (13) mit einem Flansch (11) versehen ist, welcher eine gekrümmte Außenfläche (21) aufweist, mit welcher die Flüssigkeit in Richtung der Flügelblätter (28) des ersten Flügelrades (27) geleitet wird.

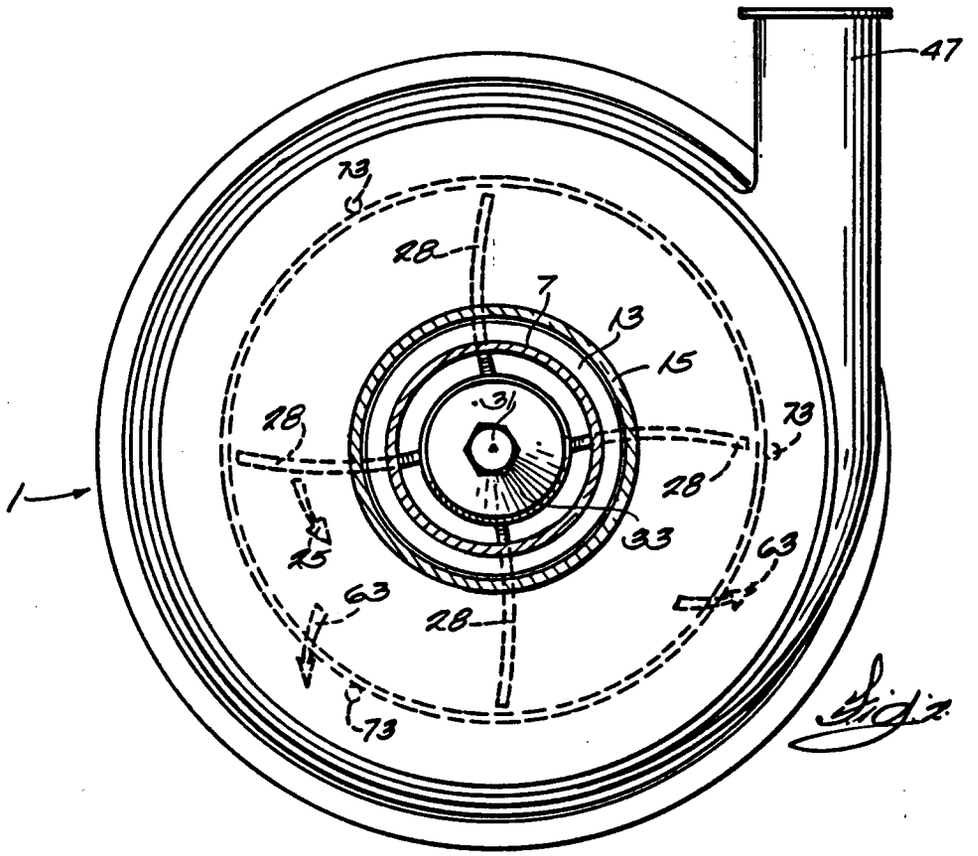
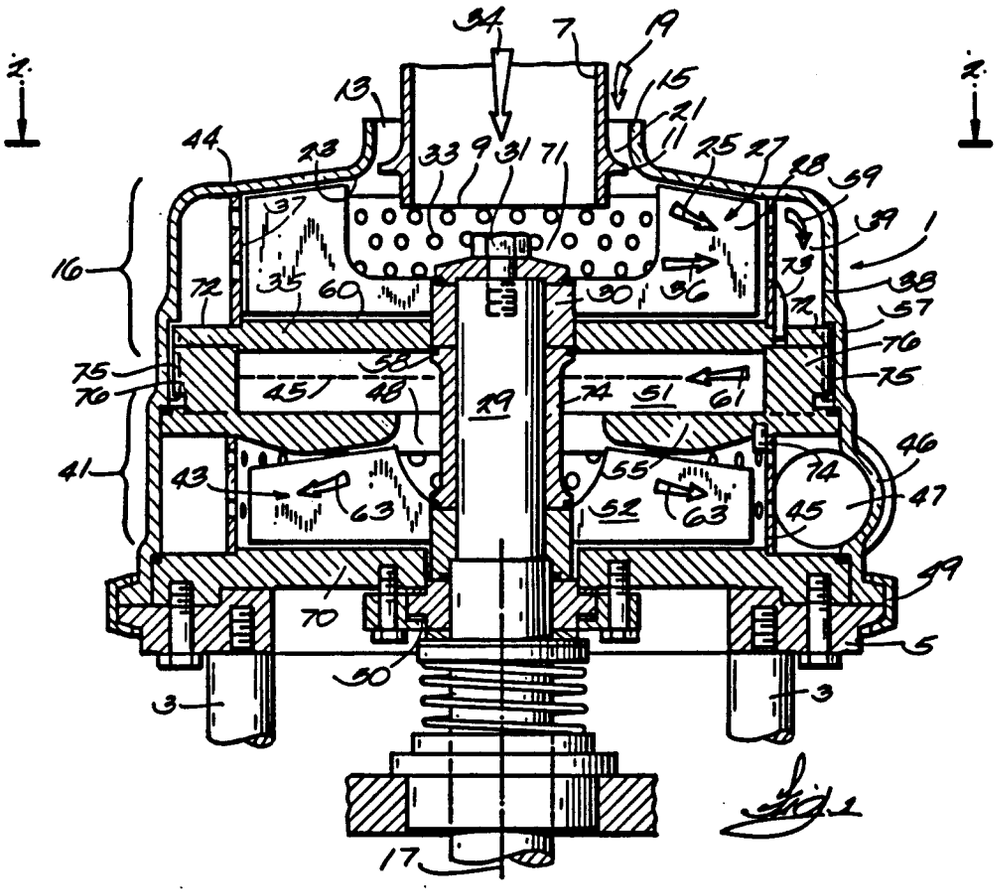

47
73
28
7
13
15
31
28
73
1
28
25
63
33
63
28
73

Fig. 2


34
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11
25
27
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38
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48
19
74
51
61
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47
59
70
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3
50
3
17

Fig. 1

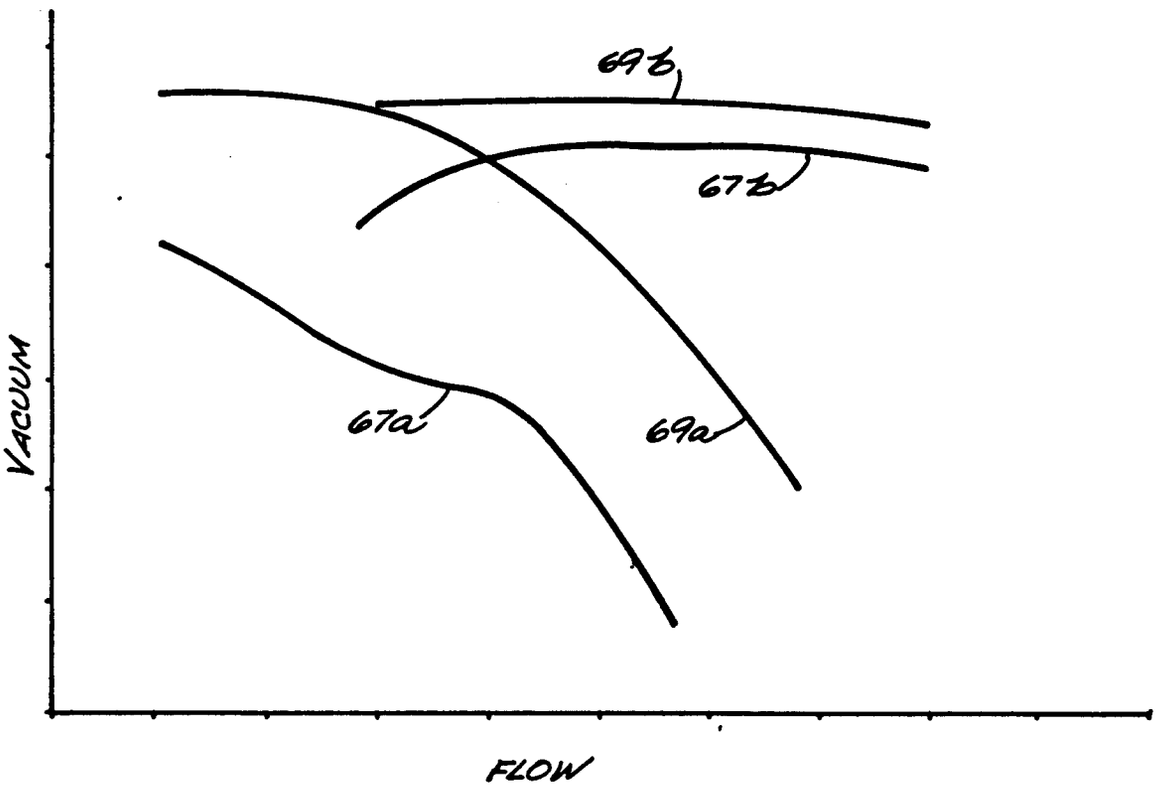


Fig. 3