Sept. 24, 1963 F. W. WAHLIN 3,104,829

VANE UNIT FOR SPRAY NOZZLES

Filed May 17, 1962 3 Sheets-Sheet 1

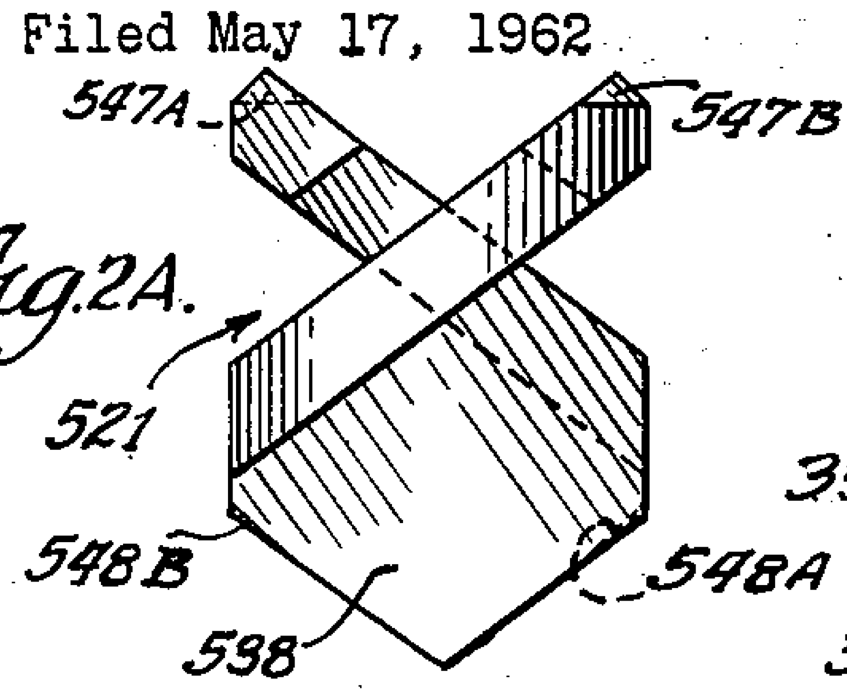


Fig. 2A.

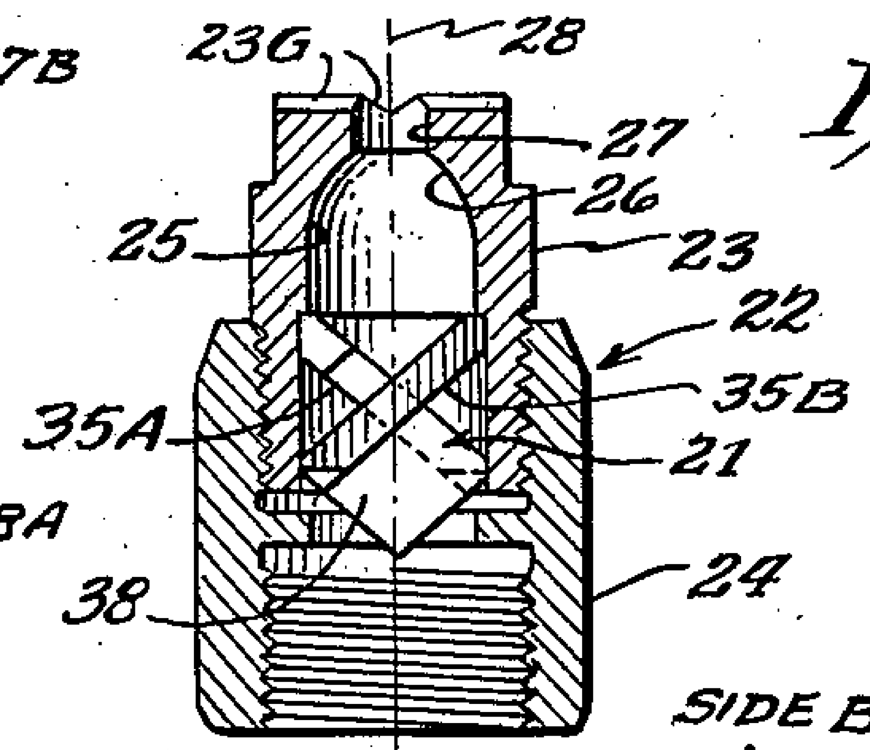


Fig. 1.

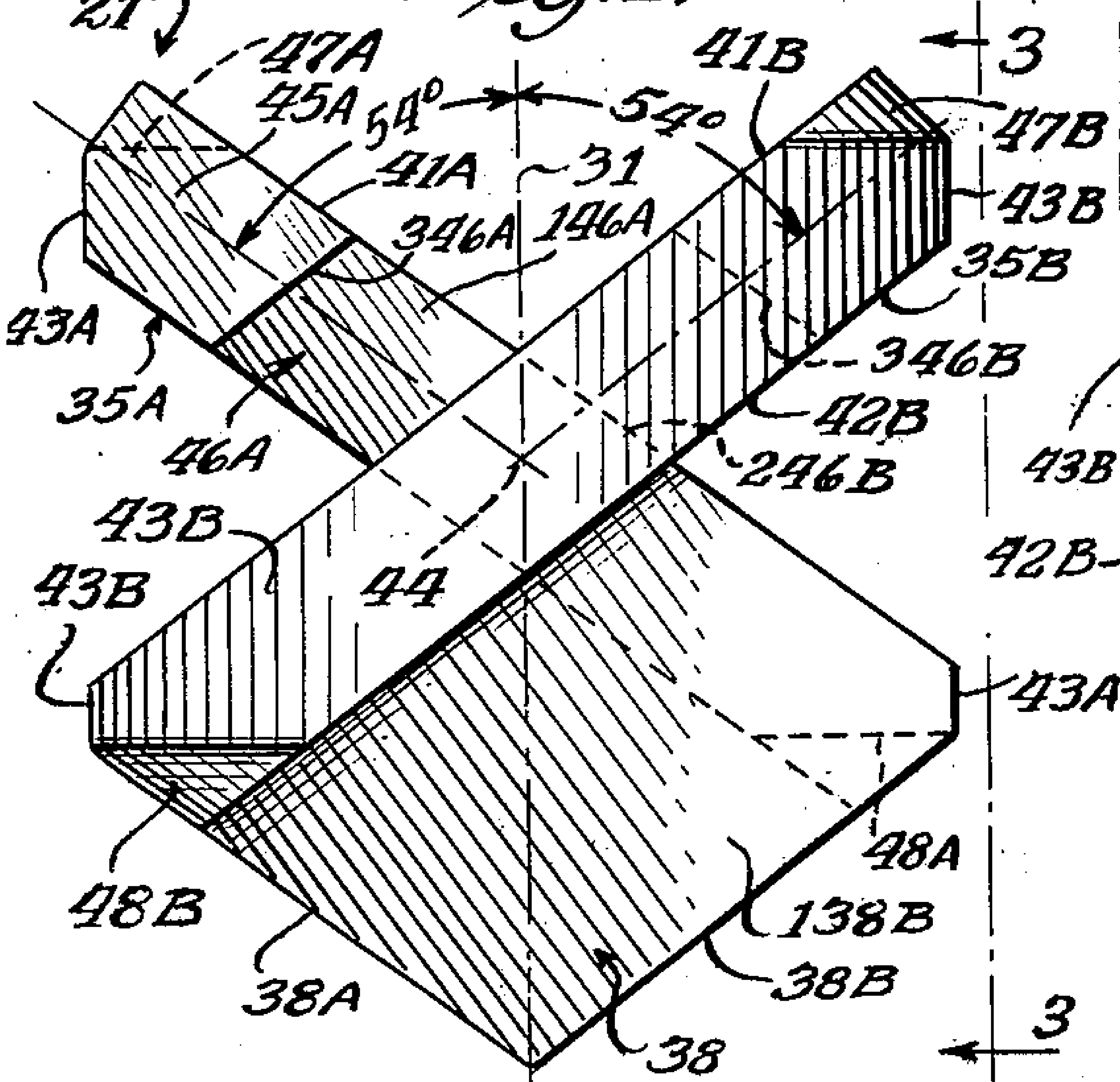


Fig. 2.

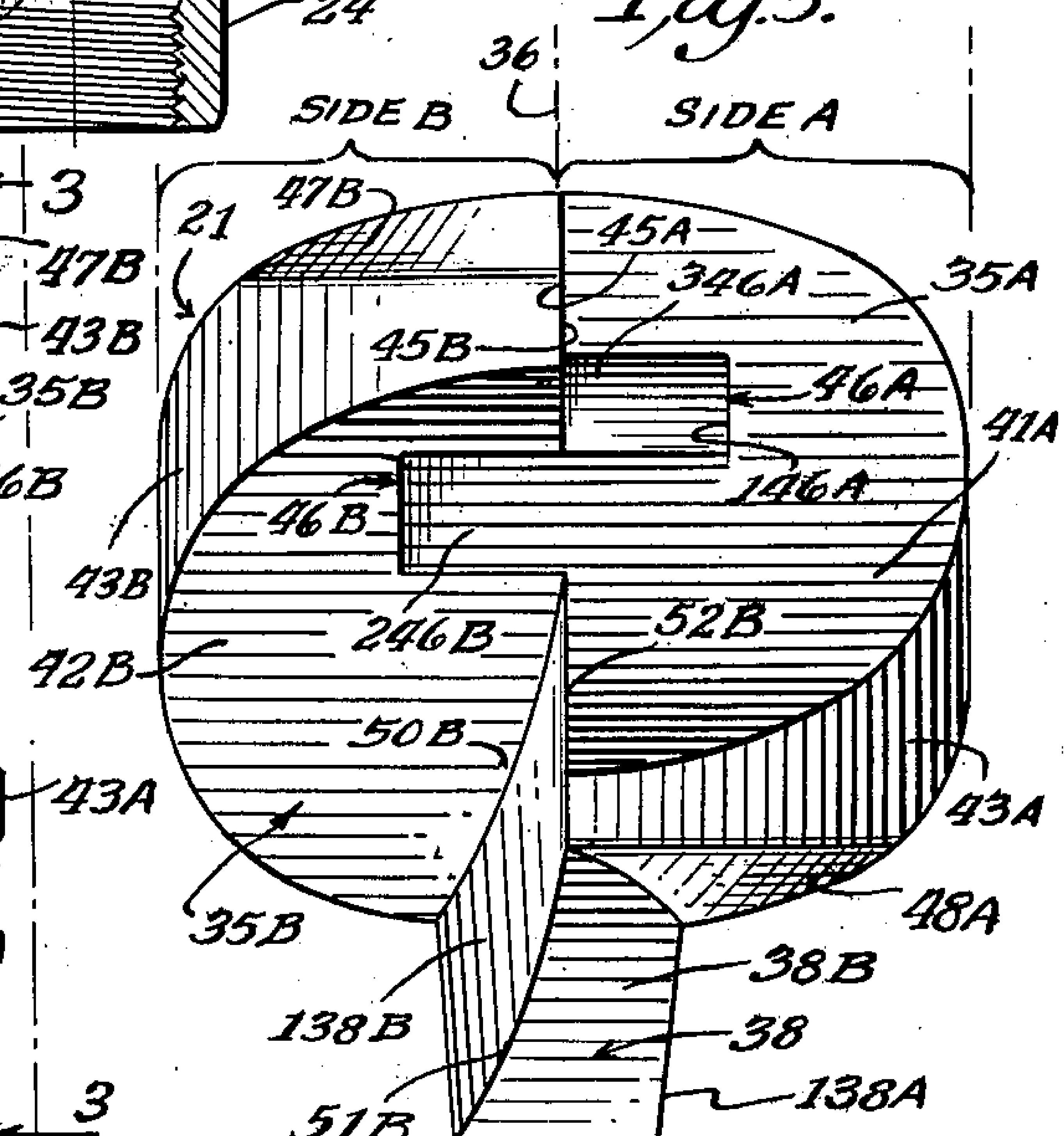


Fig. 3.

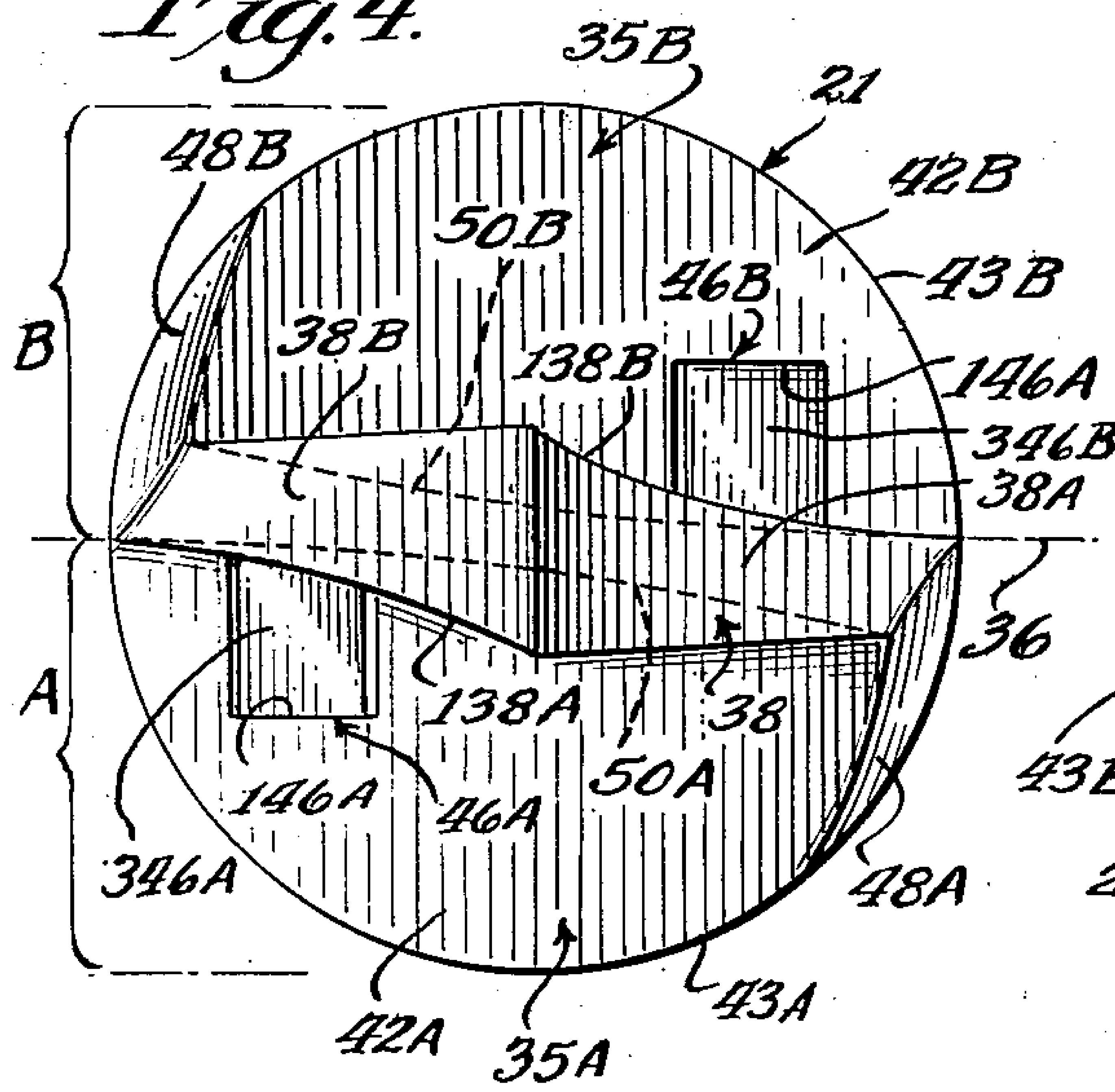


Fig. 4.

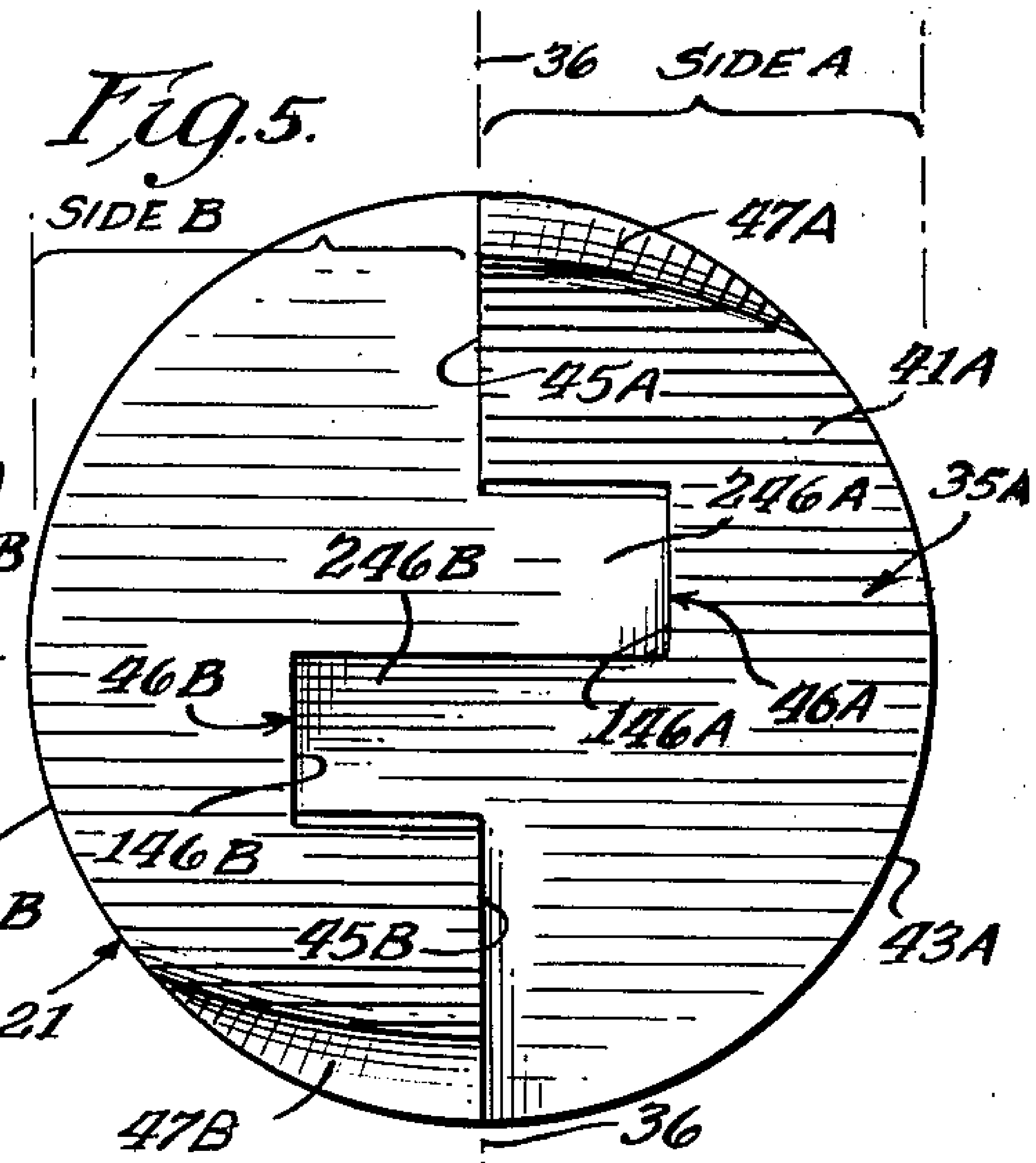


Fig. 5.

Inventor
Fred W. Wahlin
By Mann, Brown & McWilliams
Attys.

VANE UNIT FOR SPRAY NOZZLES

Filed May 17, 1962 3 Sheets-Sheet 2

Fig. 6.

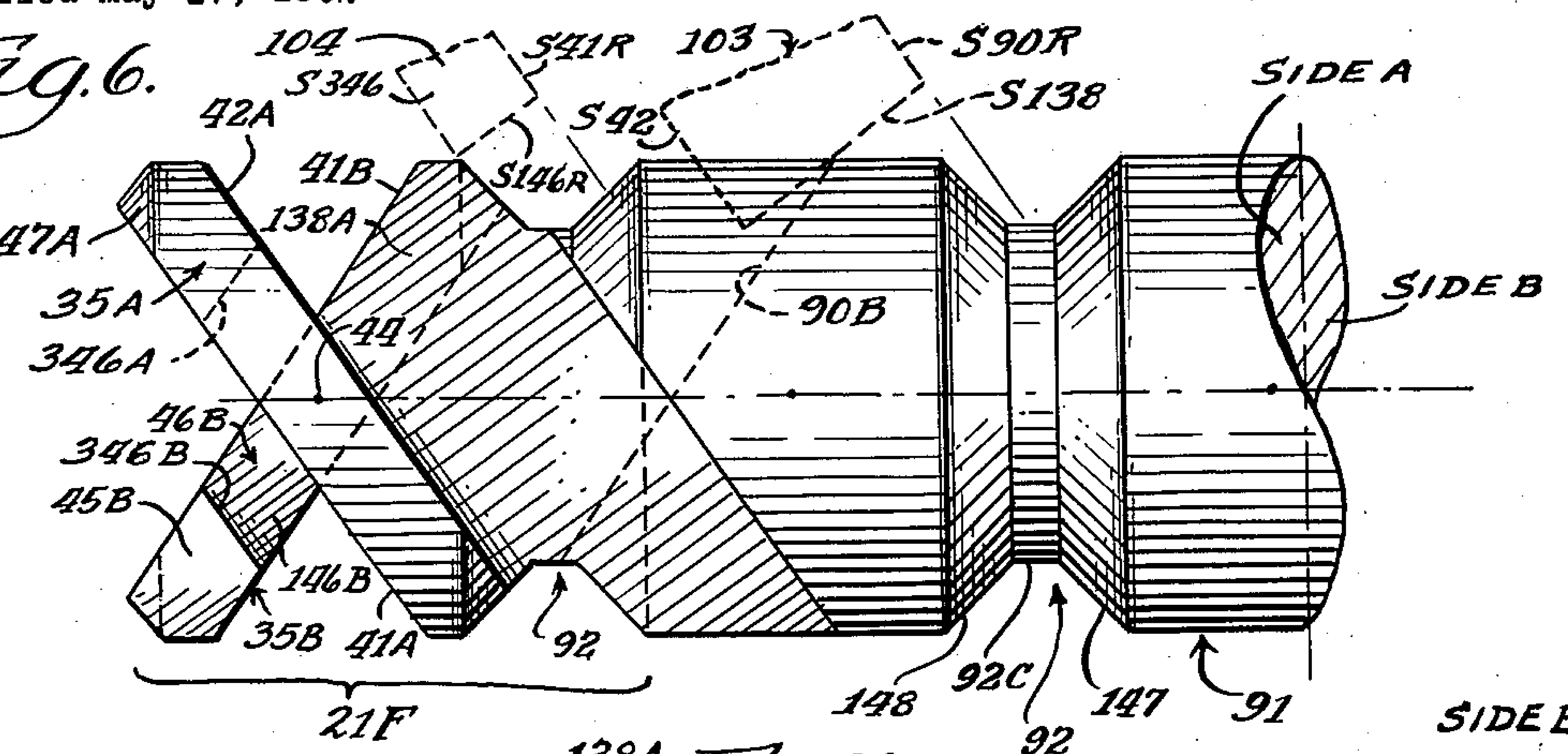


Fig. 7.

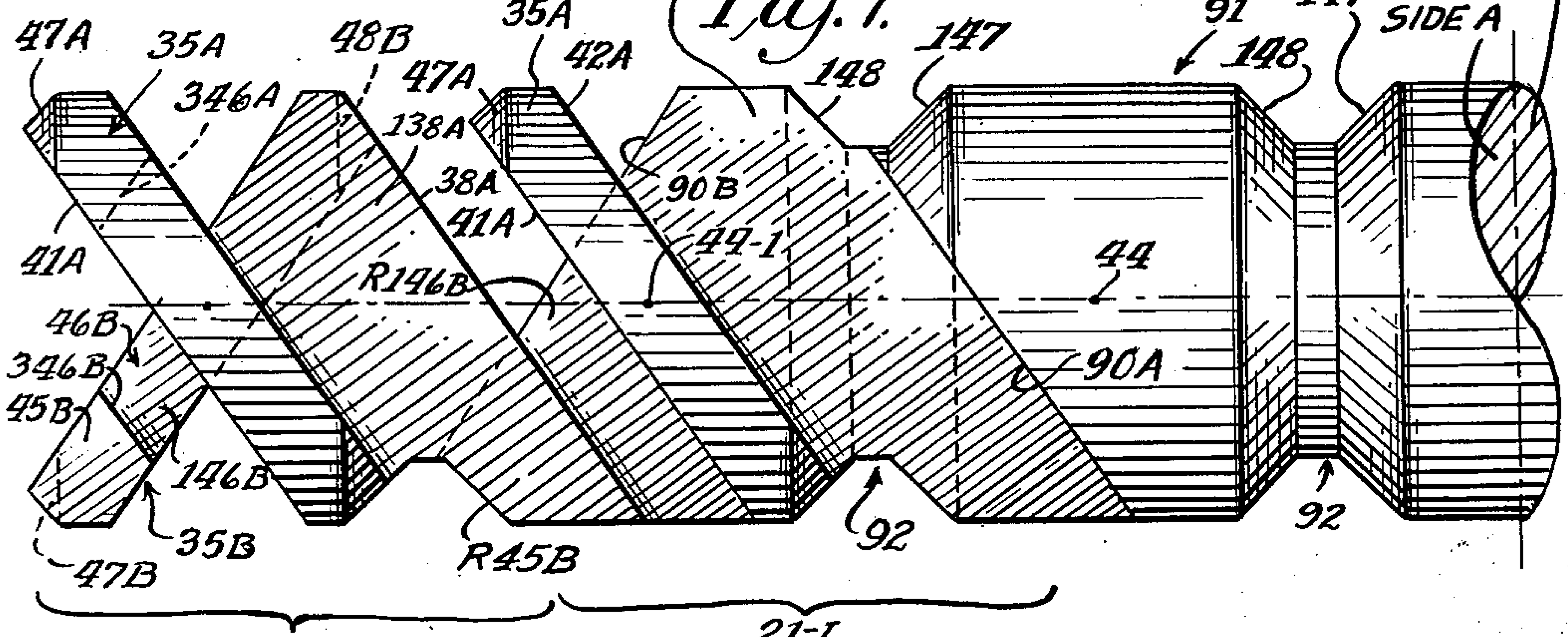


Fig. 8.

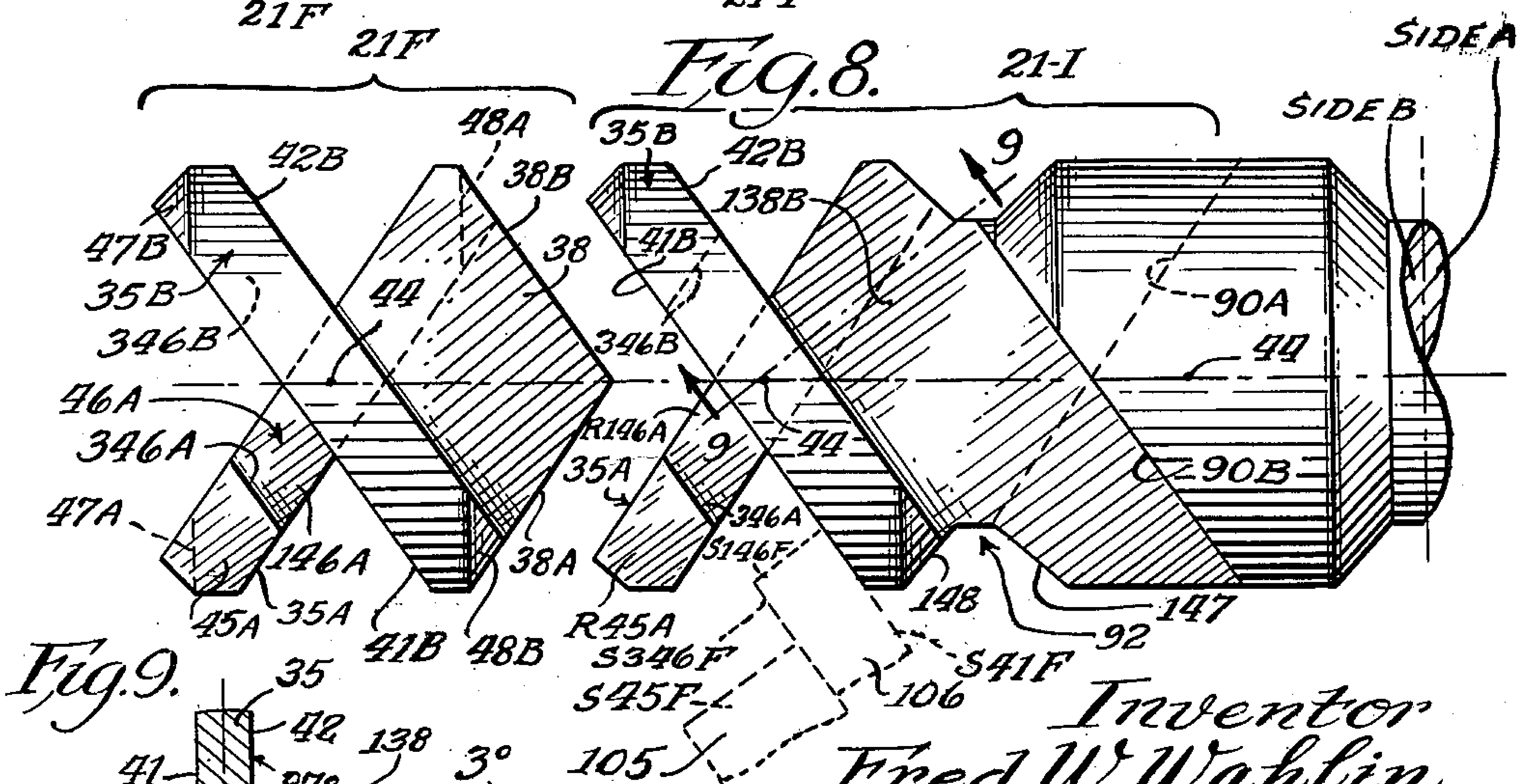
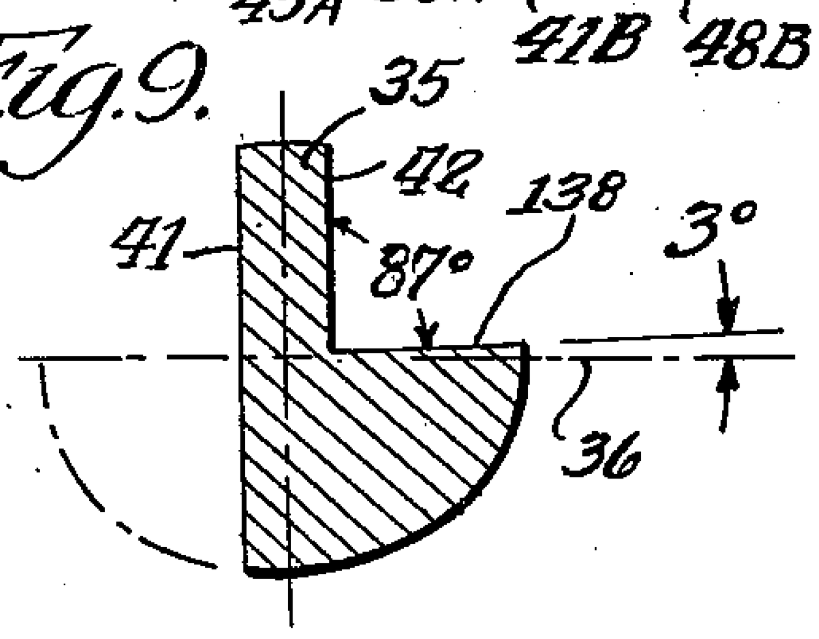


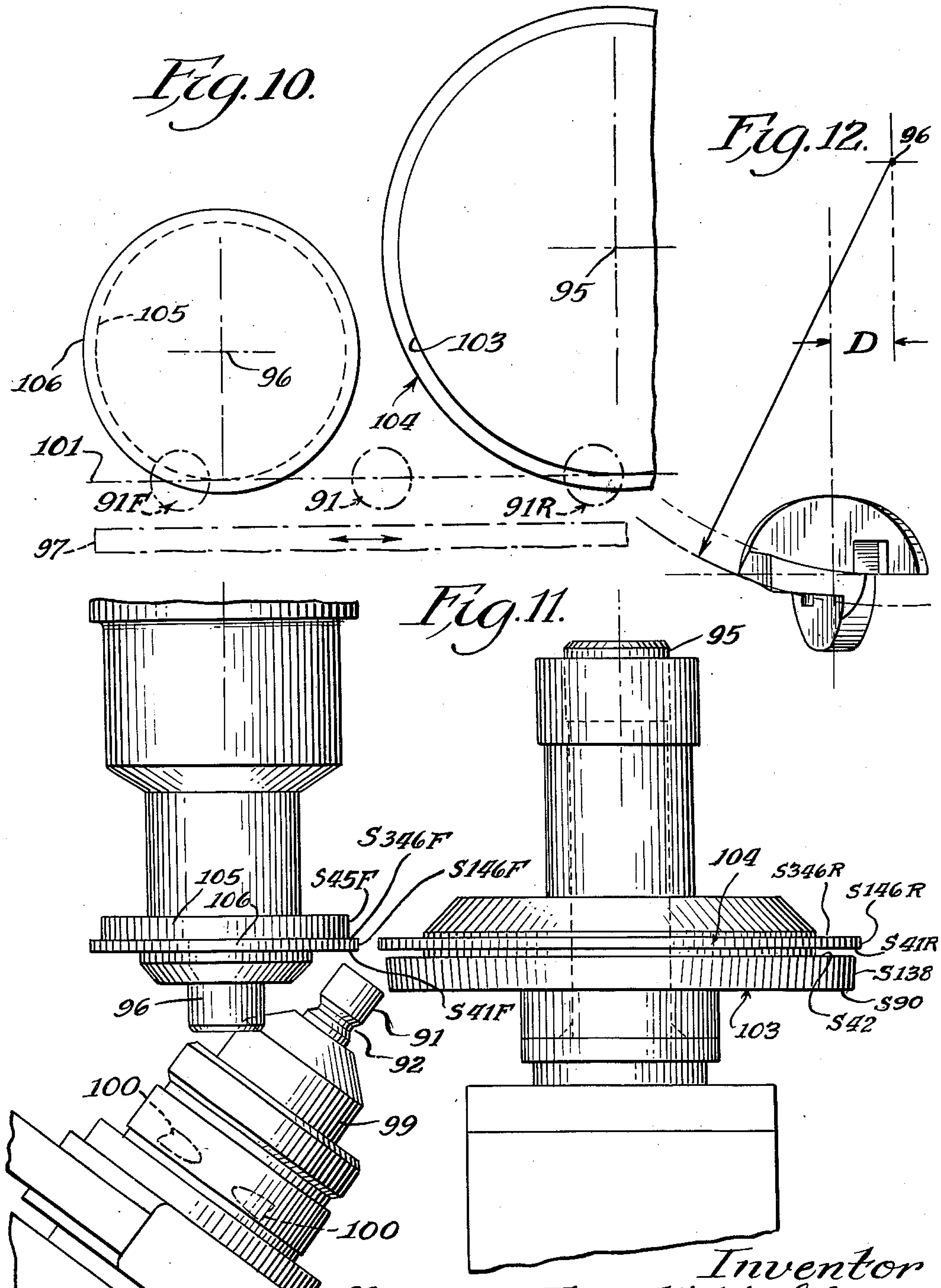
Fig. 9.



Inventor
Fred W. Wahlin
By Mann, Brown & McWilliams
Attys.

VANE UNIT FOR SPRAY NOZZLES

Filed May 17, 1962 3 Sheets-Sheet 3



Inventor
Fred W. Wahlin
By Mann, Brown & McWilliams.
Attys

United States Patent Office

3,104,829
Patented Sept. 24, 1963

1

3,104,829
VANE UNIT FOR SPRAY NOZZLES

Fred W. Wahlin, St. Charles, Ill., assignor to Spraying Systems Co., a corporation of Illinois

Filed May 17, 1962, Ser. No. 195,550
8 Claims. (Cl. 239—488)

This invention relates to vane units of the kind employed in solid cone spray nozzles to produce swirling movement and turbulence in the liquid as it advances toward the discharge orifice of the nozzle.

A vane unit of the general kind to which the present invention relates is shown in my prior Patent No. 2,305,210, patented December 15, 1942, and such vane units have been employed with great success in nozzles of varying sizes and designs. In use such a vane unit is located in a fixed position in the internal chamber of a spray nozzle with the longitudinal axis of the vane unit coinciding with the central axis of the nozzle orifice, and in order to assure uniformity of whirling motion and uniformity of turbulence in the water or other liquid as it passes from the vane unit to the nozzle orifice, it is necessary that the various vane surfaces be accurately formed and related to each other. It has long been recognized that excessive and objectionable costs were involved in producing and handling such vane units, in intially mounting the vane units in the nozzles, and thereafter in removing and replacing the vane units for cleaning or other purposes, and with particular relation to cost of manufacture of the vane units, one of the most important factors has been the care required in attaining uniformity and accuracy of form and relationship in the various surfaces of the vane unit.

In view of the foregoing it is the primary object of the present invention to provide a new and improved vane unit of the aforesaid character that may be handled and mounted in a simple and convenient manner, and which, by reason of its novel characteristics of shape and form, may be produced with greater accuracy and at a less cost than prior vane units of this general kind.

More specifically it is an object of this invention to provide a simple and effective method for producing vane units of the aforesaid character, and objects related to the foregoing are to enable all of the critical liquid-directing surfaces of such vane units to be formed and finished while the work piece remains in its original relation to a work holder; to enable the vane units to be made from continuous and relatively long lengths of rod stock; to provide such a rod with preformed locating surfaces for axially locating and advancing such rod stock; and to provide these locating surfaces in a form and relation such that portions of the locating surfaces function in imparting certain desirable characteristics of form in the completed vane units.

Other and further objects of the present invention will be apparent from the following description and claims, and are illustrated in the accompanying drawings, which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof, and what is now considered to be the best mode in which to apply these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the invention.

In the drawings:

FIG. 1 is a vertical sectional view of a spray nozzle utilizing the vane unit of the present invention;

FIG. 2 is a side elevational view showing the vane unit;

FIG. 2A is a view similar to FIG. 2 and showing a different embodiment of the vane unit;

FIG. 3 is a side elevational view taken from the line 3—3 of FIG. 2;

2

FIG. 4 is a bottom plan view of the structure shown in FIG. 2;

FIG. 5 is a top plan view of the structure shown in FIG. 3;

FIGS. 6, 7 and 8 are views showing the successive steps that are utilized in making the vane unit of FIG. 2;

FIG. 9 is a cross sectional view taken substantially along the line 9—9 of FIG. 8;

FIG. 10 is a schematic vertical elevation showing the milling machine setup utilized in making the vane unit;

FIG. 11 is a plan view of the structure shown in FIG. 10; and

FIG. 12 is an enlarged schematic portion of FIG. 10 illustrating further details of the method of making the vane unit.

For purposes of disclosure the invention is herein illustrated as embodied in a vane unit 21 that is adapted for use in a full cone spray nozzle such as the nozzle 22 shown in FIG. 1. The nozzle 22 is but one of many specific forms of nozzle in which the vane unit 21 may be used, and the nozzle 22 as herein shown comprises a main body 23 with a sleeve-like connecting body 24 threaded on its lower end. The main body 23 has central passage 25 tapered at its upper end at 26 to a smaller diameter discharge orifice 27 that is of cylindrical form. The orifice 27, the passage 25 and the intermediate tapered portion 26 are centered on a common axis 28, and within the lower end portion of the passage 25, the vane unit 21 is mounted in a fixed position with its longitudinal axis coinciding with the axis 28. The function of the vane unit 21 is to impart swirling movement to water or other liquid passing through the vane unit 21 toward the orifice 27 while at the same time imparting turbulence to the liquid so that the liquid will be discharged from the orifice 27 as a solid or full cone spray rather than as a hollow cone spray. Actually the resulting spray is modified in the nozzle shown herein, and in my aforesaid patent, so that as the liquid discharges from the orifice it assumes a non-circular spray pattern, but this is independent of the present invention, and so far as the present invention may be concerned the ultimate spray pattern may be square or round as may be desired. Such modifications of the spray pattern are attained by known means such as the end grooves 23G which produce a square spray pattern.

The vane unit 21 is shown at an enlarged scale and in considerable detail in FIGS. 2 to 5, and considered in general, has the parts or elements thereof defined in part by a number of the surfaces that fall in or constitute parts of a cylindrical surface so that the vane unit 21 has a longitudinal center line 31 indicated in FIGS. 2 and 3, and in end elevation has a cylindrical or circular outline as will be evident in FIGS. 4 and 5. This general form enables the vane unit 21 to be inserted endwise and with a sliding fit or a firm frictional fit, as desired, into the central passage 25 of a nozzle as shown in FIG. 1, with the longitudinal centerline 31 of the vane unit coinciding with the axis 28 of the nozzle.

Within the confines of this overall cylindrical boundary, the vane unit 21 has a pair of oppositely sloping vanes 35A and 35B which, in end elevation, appear to be semicircular as shown in FIGS. 4 and 5, and which are disposed on opposite sides of a center plane 36 that has been indicated in FIG. 5. This center plane 36 of course passes through the axis 31, and the vanes 35A and 35B are integrally joined at their midpoints and are precise duplicates except that they are reversed as to slope and as to some other physical features as will hereinafter become apparent. Because of this duplication, the parts of the vane unit 21 on opposite sides of the center plane 36 will be identified by the same reference characters with the suffix "A" or "B" added, and reference will be made to side A or side B of the unit as these portions or sides are disposed on opposite sides of the plane 36, as indicated in FIGS. 3, 4 and 5 of the drawings. The adjacent lower sides of the vanes 35A and 35B, below their connected midportions, are joined by a wall-like tab 38 through which the center plane 36 passes so that the parts of the tab 38 lie on both sides of the plane 36, and this tab 38 projects substantially below the lower portions of the vanes 35A and 35B and has a special tapered form that facilitates handling, mounting and dismounting of the vane unit 21 as will be described.

The vanes 35A and 35B are disposed at identical angles to the axis 31, and this angle is preferably about 54° as indicated in FIG. 2, and in the following description, the various surfaces of the vane 35A will be described specifically and corresponding surfaces of the vane 35B will be identified in each instance by the same reference character with the suffix B instead of the suffix A.

The vane 35A has flat or planar top and bottom surfaces 41A and 42A that are parallel and disposed at the aforesaid angle with respect to the axis 31 and which are perpendicular to the central plane 36. The outermost edges of the top and bottom surfaces 41A and 42A are connected primarily by a curved surface 43A that forms part of a cylindrical surface centered on the longitudinal axis 31 of the vane unit 21; and at the central plane 36, the middle portions of the vanes 35A and 35B are integrally joined in a diamond shaped area centered on a locating point 44 in the plane 36 as shown in FIG. 2. Below the aforesaid diamond shaped area the edges of the vanes 35A and 35B adjacent the center plane 36 are integrally connected to the tapered portions of the tab 38.

Above the aforesaid diamond shaped area the vane 35A has a flat surface 45A that lies in the plane 36, such surface 45A extending from the extreme end of the vane 35A for about half the distance to the aforesaid diamond shaped area, and the lower edge of the surface 45A is defined and terminated by a transverse groove 46A formed in the vane 35A. The transverse groove 46A extends parallel to the vane 35B, and is defined by a flat bottom surface 146A that is parallel to the surface 45A, a side surface 246A that constitutes a planar continuation of the surface 41B of the other vane 35B, and an opposite planar side surface 346A that is parallel to the surfaces 41B and 246B.

At the upper extremity of the vane 35A, where the intersection of the surfaces 41A, 43A and 45A, would otherwise form an extremely sharp corner, the vane 35A has a rounded surface 47A, and as will become apparent this surface 47A, and the corresponding rounded surface 47B on the vane 35B, are parts of a common surface of revolution centered on the longitudinal axis 31 of the vane unit 21. Similarly, in the vane unit 21 shown in FIGS. 2 to 5, the lowermost portions of the vanes 35A and 35B have rounded surfaces 48A and 48B formed thereon. Here again, the surfaces 48A and 48B constitute parts of a common surface of revolution centered on the axis 31. It should be noted at this point, however, that in the smaller sizes of vane units, where it is desirable to have the longitudinal extent of the tab 38 relatively large in relation to the diameter of the vane unit, the rounded surfaces 48A and 48B are not provided at the lower ends of the vanes 35A and 35B as will be explained. Such a smaller vane unit 521 is shown in FIG. 2A at a small scale but comparison of FIGS. 2 and 2A shows that the unit 521 has a relatively long tab 538 as compared with the tab 38 of FIG. 2. Such a longer tab 538 may be provided readily under the present method of production of the vane units, as will become apparent.

The downwardly projecting tab 38 is defined by a series of intersecting surfaces some of which are planar and others of which constitute portions of conical surfaces. Thus, the tab 38, when viewed in elevation as shown in FIG. 2, tapers downwardly to a point located on the longitudinal axis 31 of the vane unit 21, and this tapered form is defined by a pair of planar surfaces 38A and 38B. The surface 38A is parallel to the surfaces 41A and 42A, while the surface 38B is parallel to the surfaces 41B and 42B.

The opposite sides of the tab 38 are defined by parts of conical surfaces that are identical but oppositely related. Thus the side of the tab 38 that is located below the vane 35A is defined by such a surface 138A, while the side of the tab 38 that is located below the vane 35B is provided by such a surface 138B. The surface 138B intersects the surface 42B with an included angle of approximately 87°, as will be evident in FIG. 9, and to facilitate description, this intersection is defined in FIG. 3 as a curved line 50B while the intersection of the conical surface 138B with the planar surface 38B is defined by a curved edge or line 51B as indicated in FIG. 3. Further, the conical surface 138B intersects the surface 41A, as a straight line 52B, and at the edge of the surface 138B that is defined by the line 52B, the arcuate line 50B intersects the surface 41A at substantially the center plane 36. The arcuate line 50B, as it extends across the tab 38, diverges from the plane 36, as will be evident in FIGS. 3 and 4, and since the lines 50A and 50B diverge in opposite directions from the plane 36, as will be evident in FIG. 4, the tab 38 has substantial thickness in the areas where it is connected to the vanes 35A and 35B. This thickness is represented by the distance between dotted lines 50A and 50B in FIG. 4, and it will be noted that this thickness is less in the center portions of the tab 38 than at the edges thereof.

In contrast to the reduced thickness of the upper central portions of the tab 38, it will be observed in FIGS. 3 and 4 that the lower portions of the tab 38 become progressively thicker toward the lower central portions of the tab. This results from the use of an angle that is less than 90° between the surfaces 42B and 138B, and between the surfaces 42A and 138A.

The vane unit 21, as thus described, and as shown in FIGS. 1 to 5, may be produced rapidly, accurately and economically according to the present invention by a noval and advantageous method in which the individual vane units 21 are cut one by one from rod stock such as the elongated rod 91 shown in FIGS. 6 to 8 and 11. The rod 91 has a diameter corresponding to the diameter of the surfaces 43A and 43B, and may be of relatively long length so that a large number of vane units 21 may be produced therefrom. The rod 91 has a plurality of annular grooves 92 formed thereabout at spaced intervals longitudinally of the rod, and these grooves have sloping side walls 147 and 148 and a cylindrical bottom wall 92C. The sloping walls 147 and 148 of adjacent grooves 92 are spaced apart in such a distance that in a finished vane unit 21, parts of the walls or surfaces 147 and 148 may provide the surfaces 47 and 48 of the finished vane units 21. The width of the bottom wall 92C of the groove 92 is then made such that the spacing of the grooves 92 constitutes a measure of the length of rod 91 required to produce one vane unit 21. The grooves 92 may thus serve as locating means in advancing the rod 91 and holding the same in the desired longitudinal position during the forming or machining operations, as will be described.

The units 21 are produced by a series of milling operations that may be accomplished with a milling machine set-up of the kind shown in FIGS. 10 to 12 of the drawings. Thus, a pair of laterally spaced horizontal spindles 95 and 96 extend in parallel relation over and in perpendicular relation to the path of reciprocation of a work-supporting table 97; and on the table 97 an indexing fixture 98 having a through-chuck 99 and longitudinal positioning fingers 100. The axis of the chuck 99 is disposed in a horizontal plane and at an angle to the axes of the spindles 95 and 96 which is equal to the slope angle of the vanes 35 and 36.

The fixture 98 and the chuck 99 support the rod 91 so that in reciprocation of the table 97, the horizontal axis of the rod 91 moves in a horizontal plane 101 that is indicated in FIG. 10, and it will be noted that the spindles 95 and 96 are located at different distances above the plane 101 so that milling cutters of different diameters on the respective spindles may cooperate with the rod 91 in cutting and forming the same into vane units 21.

The spindle 95 carries filling cutters 103 and 104 of conventional construction that are of different diameters and which are spaced axially as will be explained. Thus the cutter 103 is intended primarily to form the conical surface 138 and the related lower vane surface 42, and accordingly, the cutter 103 has a side surface S42 that is remote from location of the fixture 98, as shown in FIG. 11, and this side surface S42 intersects with an outer conical surface S138 of the cutter at an included angle of 87°. The width of the conical face S138 of the cutter 103 is somewhat wider than required to form the surface 138 on the unit 21, and the opposite side of the cutter 103 is defined by a face S90.

The cutter 103 has a diameter that is determined in part by the diameter of the vane unit 21 and in part by the form and thickness to be given to the tab 38, and in the present instance, where the diameter of the vane unit 21 is to be 17/32 inch, the diameter of the cutter 103 is about three inches. This same general cutter diameter may be employed with other sizes of vane unit, but it should be noted that its relationship to the plane 101 must in such an instance be somewhat different as will be explained.

As herein shown the upward spacing of the spindle 95 is such that at the lower edge of the cutter 103 the corner defined by the intersection of the surfaces S42 and S138 is located just slightly below the plane 101, and the purpose of this relation will be explained hereinafter.

The cutter 104 is spaced from the face S42 in an amount equal to the distance between surfaces 41 and 42 of the vanes 35, and it has side surfaces S41R and S346R that are connected by an outer cylindrical surface S146R. The purpose of the cutter 104 is to form the surface 41 and to rough-cut the groove 46 in the vane unit 21, and as an incident to the foregoing, the cutter 104 also functions in the method of this invention to form the surfaces 38A and 38B in succession as a completed vane unit 21 is severed from the end of the rod 91. The radius of the surface S146R of the cutter 104 is larger than the raduis of the cutter 103 in an amount substantially equal to the final depth of the groove 46 that is to be rough milled by the cutter 104.

The spindle 96 has milling cutters 105 and 106 secured thereon in face to face relation, and the function of these cutters is to finish mill the faces 45 and the grooves 46 of the vane units 21. The cutter 105 has a cylindrical cutting face S45F, and the cutter 106 is of slightly larger diameter and has side faces S346F and S41F that are connected by an outer cylindrical cutting face S146F.

The radius of the cutter 105 is considerably smaller than that of the cutter 103, and the axis of the spindle 96 is therefore considerably lower than that of the spindle 95. The actual position of the spindle 96 is such that the lower portion of the surface S45F of the cutter 105 is in the plane 101, and the cutter 106 projects further downwardly in an amount equal to the depth of the groove 46 in the finished vane unit 21.

In FIGS. 6 to 8 a rod 91 is shown after completion of certain of the forming operations of the present method, and the differences in form as between the several views will now be described in relation to the method steps whereby the changes in form are produced. Thus in a broad sense, the rod 91 as shown in FIG. 6 has a substantially completed vane unit 21F still rigidly and integrally in place on its forward or left end, and this vane unit 21F is thus in condition to be severed from the rod 91. As will become apparent hereinafter, such severance of the vane unit 21F takes place as an incident to the initial or rough milling operations that are performed in connection with the next vane unit to be produced. Thus, after completion of the vane unit 21F to the form shown in FIG. 6, the rod 91 is advanced axially in the chuck 99, the rotative relation of the rod 91 being maintained so that the plane 36 of the vane unit 21F is maintained in the plane 101 indicated in FIG. 6. Such advancing of the rod 91 takes place while the table is in a centered position with the extended end of the rod 91 between and spaced from both sets of milling cutters as indicated by the dotted circle 91 in FIG. 10.

For descriptive purposes it will be assumed that when the rod has been thus shifted, the side A of the rod 91 and the side A of the vane unit 21F are located above the plane 101, and it will be noted that in FIGS. 6 to 8 of the sides A and B of the rod 91 have been indicated so as to clearly show the rotative or indexed relation of the rod 91.

When the rod 91 has thus been advanced endwise to its new position, it is related to the cutters 103 and 104 in the manner indicated diagrammatically in FIG. 6, and by moving the table 97 to the left to the extent indicated in FIG. 10 by the dotted circle 91R, the portion of the rod 91 adjacent the vane unit 21F is milled on its side A to the form shown in FIG. 7. Thus, comparing FIGS. 6 and 7, it will be clear that the cutters 103 and 104 have milled away portions of side A of the rod to form the vane 35A of the next vane unit 21–1, FIG. 7; to form the related conical surface 138A; and to partially form the groove 46B for the vane 35B. In such partial formation of the groove 46B for the vane 35B, the bottom surface of the milled cut is defined as an arcuate surface R146B which requires a finishing operation as will be described.

Further comparison of FIGS. 6 and 7 shows that the cutter 104 also acts to partially sever the unit 21F from the rod 91. Thus the lower tab surface 38A is formed.

The extent of the milling operations by the cutters 103 and 104 is carefully controlled by limiting the extent of right hand movement of the table 97; and this enables the form and thickness of the tab 38 to be controlled. Thus, with the cutters 103 and 104 are sized and located as above described, and in the formation of vane units of 17/32 inch diameter, the right hand stroke of the table 97 is terminated with the reference point 44–1, FIG. 7, at a distance D, FIG. 12 of 7/32 inch from the vertical center plane of the spindle 95. This locates the intersection of lines 50A and 52A, FIG. 3, substantially in the plane 36, with the line 50A and the conical surface 138A diverging gradually from the plane 36 to produce the desired form and thickness in the tab 38 that is to be formed on the unit 21–1.

When the foregoing milling step has been completed, so that the unit 21–1 has the form shown in FIG. 7, the rod 91 is indexed so that the side A thereof is in the upper position shown in FIG. 8. The table 97 is then moved to the right, FIG. 10, through the limited stroke described so the vane 35B, FIG. 8, is formed. In this operation the cutter 104 completes the cut-off operation, forming the surface 38B on the tab 38 of the unit 21F and allowing this completed vane unit to drop to suitable collecting means. The surfaces 41B, 42B, 138B, 90B, 346A, R45A and R146A are also formed by the action of the cutters 103 and 104, and the unit 21–1 is ready for cooperation with the cutters 105 and 106 to finish cut certain of the surfaces of the vanes 35A and 35B of the unit 21–1 of FIG. 8 to the relation shown in the unit 21F of FIG. 6.

Thus, with the rod 91 remaining in the same longitudinal and rotative position, the table 97 is operated through a stroke to the left, FIG. 10, till the index point 44–1 of the rod has moved beyond the vertical center plane of the spindle 96, and to a position such as that indicated at 91F in FIG. 10. As this is done, the milling cutters 105 and 106, which have the relative positions shown diagrammatically in FIG. 8, act to mill away the arcuate surfaces R45A and R146A, FIG. 8, and produce a flat surface 45A located in the plane 101, and to produce the bottom surface 146A of the groove 46A of the unit 21-1 in form shown in the unit 21F.

After the table 97 has been returned to its center position, the rod 91 is indexed to locate the side A thereof above the plane 101, while at the same time locating the side B below the plane 101 in position to have the finish milling operations performed thereon by the cutters 105 and 106. The table 97 is then moved to the left through a finish milling stroke as above described to similarly finish the surfaces 45B and 346B. The unit 21-1 then has the same form as that of the unit 21F of FIG. 6, and the rod 91 may again be advanced longitudinally to start the formation of a succeeding vane unit.

It will be recognized that any or all of the above described milling operations may be repeated as required to remove burrs or to attain the desired smoothness of the milled surfaces of the finished vane units.

Where smaller vane units 521 are to be made, the cutters 103 and 106 must be changed to conform with the depth and width of the grooves 46, and to conform with the distance required between the surfaces 42 and 90. In general, the vertical height of the spindles 95 and 96 is determined in the manner described hereinabove, but with respect to the spindle 95, the position is selected so that the lowermost portion of the cutter 103 is located below plane 101 in an amount equal to about one-sixth of the diameter of the unit 521 that is to be made. Then, in the rough milling operations, the right hand stroke of the table 97 is terminated when the dimension D, FIG. 12, is equal to about twice the diameter of the unit 521 that is being made. This causes the conical surface of the tab 538 to start substantially in the plane 36 and to diverge from this plane at a rate that insures proper thickness in the tab 538 of the finished vane unit.

It has been pointed out that the tab 538 of the unit 521 of FIG. 2A is relatively long, and this added length is attained by proportionally increasing the spacing of the locating grooves 92 of the rod 91 from which the units are made. Thus in making the units 21, the grooves 92 are spaced a distance equal to $^{18}/_{17}$ of the rod diameter, while in making the units 521, this spacing is equal to $^{11}/_{8}$ of the rod diameter. This relative increase appears as added length in the tab 38 or 538. Care must be taken of course to make sure that the cutter 103 has sufficient width to mill the added width in the conical surfaces of the tab 38 or 538; and in any case, the surfaces 41A and 41B are so related to the locating grooves 92 that the surfaces 47A and 47B are formed at the upper ends of the vanes as described. This results in portions of the other side 148 of the groove 92 appearing in the edges of the tab 538 adjacent to the angular lower edges of the tab 538.

From the foregoing description it will be apparent that the present invention simplifies and reduces the cost of producing accurately formed vane units for spray nozzles, and it will also be evident that the vane units produced under this invention embody an integral tab whereby the vane units may be easily handled in assembly and disassembly of nozzles. More specifically it will be apparent that accuracy and economy in the production of the vane units is attained by reason of the performance of all of the major forming operations while the unit is maintained in the same relation to the work holder, and further, that the successive formation of the vane units from a length of rod stock enables simplicity in the manufacturing operations while at the same time enabling preformed positioning grooves on the rod to serve in imparting certain desirable characteristics of form to the completed vane units.

Thus while a preferred embodiment of the invention has been illustrated herein, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appending claims.

I claim:

1. A vane unit of the character described comprising a unitary body having upper and lower ends and said body appearing generally cylindrical in end elevation and having a pair of vanes disposed on opposite sides of and perpendicular to a predetermined axial plane and with said vanes sloping equally in opposite directions at a substantial acute angle with respect to the axis of said body and being integrally joined in a diamond shaped area that is located in said plane and is centered on said axis, each of said vanes in the portions above said diamond shaped area having a groove formed therein adjacent and parallel to the other of the vanes, and a tab joining said vanes below said diamond shaped area and being of a thickness that increases toward the lower portions of the tab.

2. A vane unit as defined in claim 1 wherein said tab has its vertical central plane disposed at an angle to said predetermined plane and said planes intersect in said axis of said body.

3. A vane unit as defined in claim 1 wherein the increase of thickness in said tab is defined by partial conical surfaces on opposite sides of the tab.

4. A vane unit of the character described comprising a unitary body having upper and lower ends and said body appearing generally cylindrical in end elevation and having a pair of vanes disposed on opposite sides of and perpendicular to a predetermined axial plane and with said vanes sloping equally in opposite directions at a substantial acute angle with respect to the axis of said body and being integrally joined in a diamond shaped area that is located in said plane and is centered on said axis, each of said vanes in the portions above said diamond shaped area, each of said vanes having flat parallel top and bottom surfaces, and each of said vanes in the portions above the diamond shaped area having a flat side face disposed in said predetermined plane and said flat face having a groove formed therein adjacent and parallel to the other of the vanes with the side walls of each groove parallel to the top surface of the other groove and with the bottom surface of each groove parallel to said side face of the vane in which the groove is formed, and a tab joining said vanes below said diamond shaped area and being of a thickness that increases toward the lower portions of the tab, said tab having its lower edges defined by a pair of angularly related flat surfaces that are parallel to the respective bottom surfaces of the vanes.

5. A vane unit according to claim 4 wherein said increase in thickness of the tab is defined by identical but oppositely disposed partial conical surfaces on opposite faces of the tab.

6. A vane unit of the character described comprising a unitary body having upper and lower ends and said body appearing generally cylindrical in end elevation and having a pair of vanes disposed in opposite sides of and perpendicular to a predetermined axial plane and with said vanes sloping equally in opposite directions at a substantial acute angle with respect to the axis of said body and being integrally joined in a diamond shaped area that is located in said plane and is centered on said axis, each of said vanes in the portions above said diamond shaped area, each of said vanes in the portions above the diamond shaped area having a groove formed therein adjacent and parallel to the other of the vanes, and a tab joining said vanes below said diamond shaped area and defined at its lower end by flat surfaces parallel to and spaced from the lower surfaces of the respective vanes.

7. A vane unit as defined in claim 6 wherein said tab has its vertical central plane disposed at an angle to said predetermined plane and said planes intersect in said axis of said body.

8. A vane unit as defined in claim 6 wherein the in-

crease of thickness in said tab is defined by partial conical surfaces on opposite sides of the tab.

References Cited in the file of this patent

UNITED STATES PATENTS

1,282,176	Binks	Oct. 22, 1918
1,310,687	Binks	July 22, 1919

2,098,136	Dyckerhoff	Nov. 2, 1937
2,305,210	Wahlin	Dec. 15, 1942
2,410,261	Bradner	Oct. 29, 1946
2,416,296	Fields et al.	Feb. 27, 1947
2,435,605	Rowell	Feb. 10, 1948
2,999,648	Wahlin et al.	Sept. 12, 1961