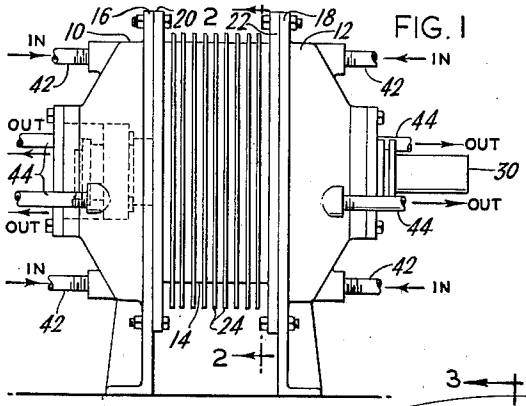
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AIR PUMP

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FIG. 1



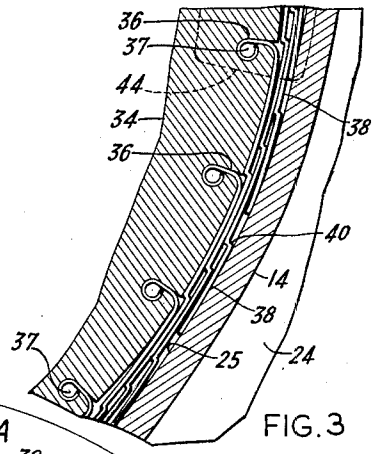
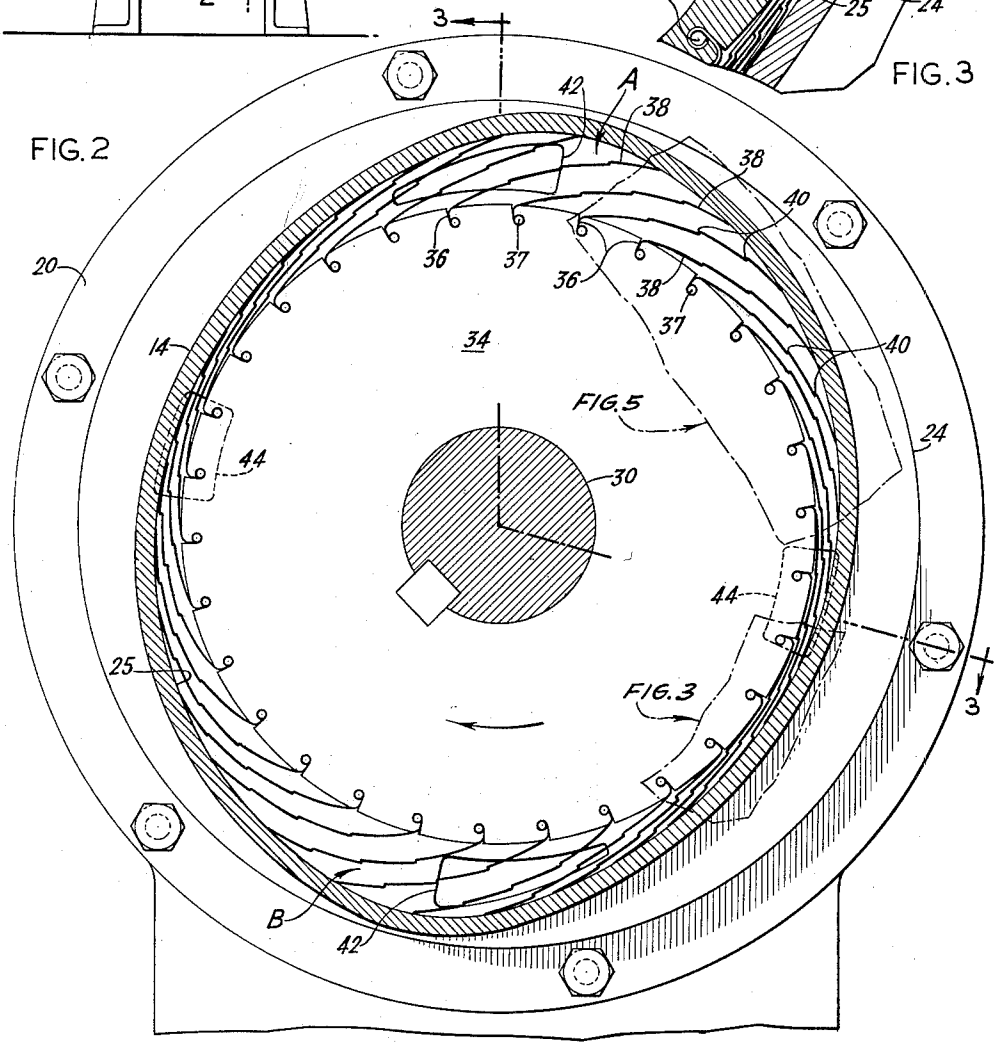




FIG. 3

FIG. 2




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FIG. 4

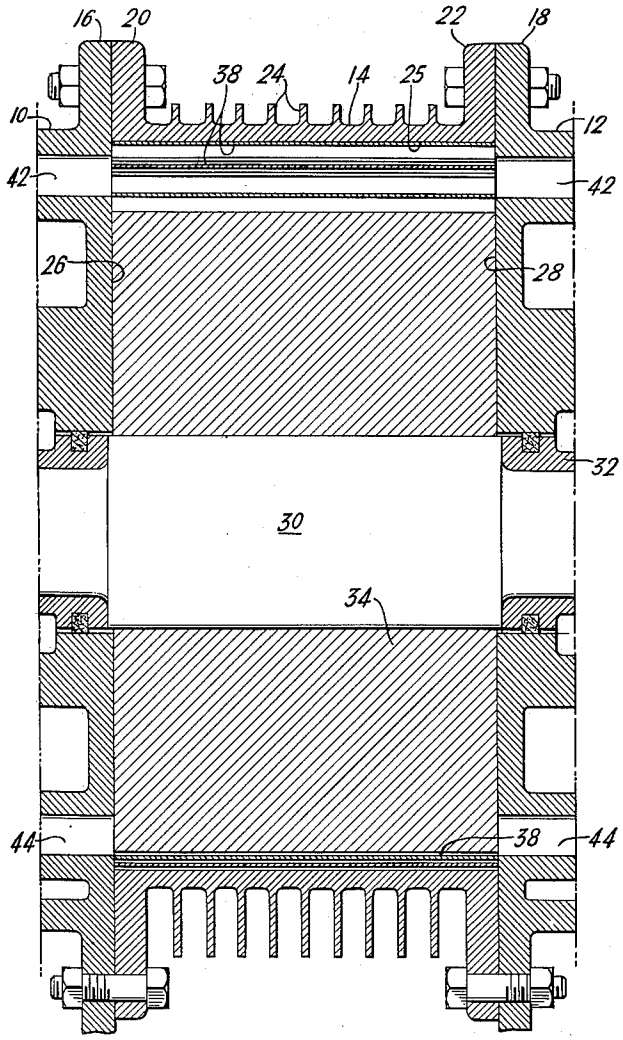
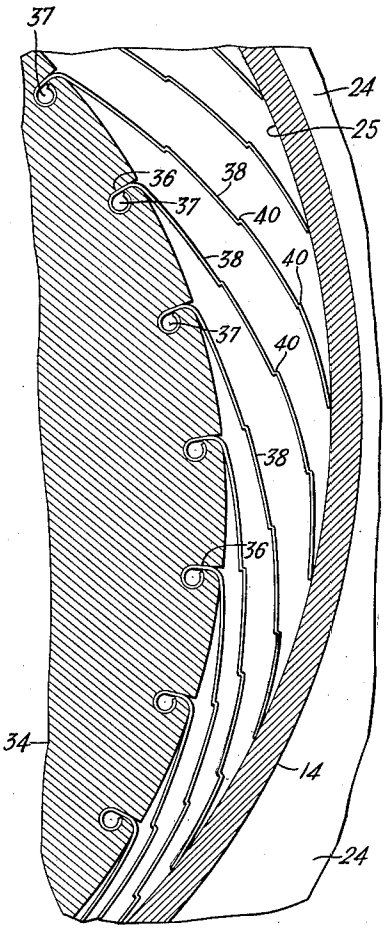



FIG. 5



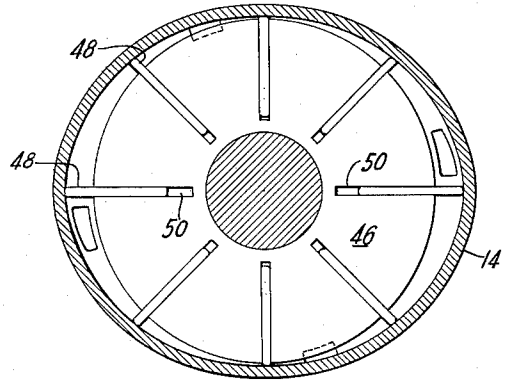




FIG. 6

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# AIR PUMP

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6 Claims. (Cl. 230—154)

The present invention relates generally to pumps for gaseous fluids and more particularly to a high-speed rotary pump characterized by a rotor with extensible vanes rotatably mounted in an irregularly-shaped axially symmetrical housing.

One object of this invention is to provide a rotary pump having a rotor with extensible vanes with balancing means to permit high-speed rotation thereof.

An additional object of the invention is to provide a rotary pump having two or more compression chambers located symmetrically around a central rotor permitting multiple simultaneous compressing action during rotation of the rotor.

A further object of the invention is to provide a rotary pump which is adaptable to multiple-stage compression.

Another object of the invention is to provide a rotary pump which may be used as a vacuum pump, compressor, or with a reverse flow of high pressure gas such as steam, as a motor.

A still further object of this invention is to provide a rotary pump permitting the use on a rotor of a large number of thin extensible vanes to minimize the pressure differential effect on the vanes particularly when a high degree of compression is desired.

Another object is to provide a rotary pump having extensible flexible vanes which when mounted in overlapping relation on a cylindrical rotor may be folded against the rotor to produce a cylindrical outer surface.

The present invention, in realizing these and other objects, consists of a cylindrical rotor to which are attached thin flexible vanes of spring steel or similar material. The rotor and vanes are rotatably mounted in a casing which in a preferred embodiment is of a modified elliptical shape. In rotation the vanes are folded back against the rotor by contact with the narrower portions of the casing, but extend radially at an acute angle with the rotor in the direction of travel when passing into the broader chamber area of the casing. The springy character of the vane material holds the vanes in continual sealing contact with the inner casing surface. Gas inlet and outlet openings are located in the ends of the casing to admit gas when the vanes are in an open position and to exhaust it as the vanes reach a closed position at the narrowest portions of the casing. The rotor is driven by a motor of suitable size and in operation the vanes of the rotor scoop the gas entering the chambers from the inlet openings. As the vanes are forced closer to the rotor by the elliptical shape of the casing the gas is compressed into a smaller volume and emerges from the vanes through the exhaust openings at a higher pressure predetermined by the design of the pump.

Additional objects and advantages of the invention will be more readily apparent from the following detailed discussion of embodiments thereof when taken together with the accompanying drawings in which:

FIG. 1 is a side elevational view of an embodiment of the invention;

FIG. 2 is a fragmentary sectional view taken along the line 2—2 of FIG. 1;

FIG. 3 is an enlarged sectional view of the outlined area designated FIG. 3 in FIG. 2;

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 2;

FIG. 5 is an enlarged sectional view of the outlined area designated FIG. 5 in FIG. 2; and

FIG. 6 is a sectional axial view of a modified embodiment of the invention showing a modified rotor and vane assembly mounted in the elliptical casing of the embodiment illustrated in FIGS. 1–5.



Referring to FIG. 1 of the drawings, the present invention includes end housing members 10 and 12 which enclose the ends of a casing 14 and are attached thereto by machined flanges 16 and 18 bolted to similarly machined flanges 20 and 22 of the casing. The flange joints may be sealed by use of O-rings, by machined interacting tongues and grooves on the flange faces or other suitable method. The casing may have fins 24 to expedite the dissipation of heat created by gas compression.

The casing has a modified elliptical cross section as shown in FIG. 2. The importance of this shape will be explained with the discussion of the operation of the pump. The interior casing surface 25 is machined and highly polished.

The interior walls 26 and 28 of the end housing members 10 and 12 are machined to the same high finish as the casing inner surface and the flange contact surface and are in the same plane as the flange surfaces, being continuations thereof as shown in FIG. 4. The end housing members are apertured to permit insertion of a shaft 30 supported on bearings 32 located so as to provide concentric rotation of the shaft within the quasi-elliptical casing 14. An end of the shaft is connected to a motor of appropriate power and speed, not shown in the drawings.

A cylindrical rotor 34 is keyed to the shaft as indicated in FIG. 2 and is axially dimensioned and machined to provide a close-fitting relation with the end housing interior walls 26 and 28 while permitting free rotation of the shaft and rotor. Longitudinally-extending slots 36 are cut radially into the surface of the rotor at uniform intervals ending in cylindrical terminals 37 as shown in FIGS. 2, 3, and 5 to provide mounting means for the rotor vanes 38. The vane mounting edges are annularly formed to coact with the terminals 37 thus anchoring the vanes to the rotor. The vanes are of spring steel or other elastically deformable material to allow bending of the vanes radially inward against the rotor and to insure continual spring-loaded contact of the vanes and the inner casing surface 25. In the embodiment shown in FIGS. 1–5, the vanes are of such length as to overlap the several preceding vanes. Outwardly-directed axially extending steps 40 of the vanes allow an overlapping nesting of the vanes which results in a smooth cylindrical outer vane surface when the vanes are folded against the rotor. The significance of this will be developed below. The length of the vanes and the vane-guiding presence of the inner casing surface 25 cause the vanes to extend from the rotor at an acute angle with the rotor in the direction of rotation.

Intake and outlet ports 42 and 44 are provided in the end housing members 10 and 12 as shown in FIGS. 1, 2, and 4. There are two inlet and two outlet ports in each end housing member corresponding with and located axially across from the similar ports in the opposing end housing member. Thus the inlet and outlet functions are accomplished through both end walls simultaneously. The location of the ports with respect to the quasi-elliptical shaped casing will be considered in conjunction with the operation of the pump.

It is shown in FIG. 2 and in greater detail in FIG. 3 that the area of minimum diameter of the casing 14 forces the vanes into an overlapping contact with the rotor and adjoining vanes. In the area of maximum casing diameter the lobe portions of the elliptical casing form two crescent-shaped chambers designated A and B in FIG. 2 into which the vanes extend radially from the rotor, the springy vane material biasing the outer vane edges against the inner casing surface as shown in FIGS. 2 and 5. Accordingly, the vanes pass through two con-

stricted areas during each revolution and are folded tightly between the rotor and the casing wall. To minimize friction the vanes are designed with steps as described above and thus present a smooth annular bearing surface to coact with the casing. The two unconstricted chamber portions of each cycle permit the vanes to open radially. Thus on rotation of the shaft, the vanes continuously open and close, completing this action twice during each revolution.

The inlet ports **42** are located so as to supply gas to the vanes as they are opening and until they reach their fully open position as shown in FIG. 2. The outlet ports **44** are placed so as to exhaust the compressed gases just before the vanes reach the fully closed position. Since the vanes close in touching contact, the outlet port must continue into the fully closed vane zone to permit escape of the last traces of gas from the vanes. Figs. 2 and 3 indicate the positions of the outlet ports.

On rotation of the shaft, the vanes pass out of the narrow casing areas into the inlet port areas where the evacuated pockets between the vanes are filled with air. The air is carried between the vanes around the end of the approximately elliptical casing and as the vanes approach the narrow area of the casing and start to close, the volume of the gas within the vanes is decreased and the pressure is proportionately increased. The compressing action of the vanes is continued until the outlet opening is reached. There the gas is discharged and the vanes are completely closed and cleared of any gas. This cycle is carried on simultaneously on each side of the rotor; thus each vane participates in two compression phases during a single rotation of the shaft.

The cross-sectional shape of the casing **14** is not a true ellipse as can be seen in FIG. 2. The casing outline includes a slight outward bulge in the vicinity of each inlet port which is smoothly blended into the casing design. This shape has considerable functional importance, particularly when high compression pressures are desired. Since the vanes used in the preferred embodiment are extremely thin, the pressure differential on each vane must be kept low to prevent distortion of the vanes. One solution is to provide a large number of vanes, thus insuring a small pressure difference of gases in adjoining vane compartments during compression since a number of blades will be engaged in the compression phase at one time. Assuming the over-all pressure increase produced by the pump to be constant, the pressure acting on each vane is directly dependent on the number of vanes engaged in compression. Thus, if the shape of the casing can be varied to effectively increase the length of the actual compression chamber, more vanes will be engaged in compression and vane pressure will be proportionately decreased. This is the result produced in the present case by modifying the casing from a true elliptical shape. In the modified casing, instead of having the maximum diameter perpendicular to the minimum diameter as is the case in a true ellipse, the maximum and minimum diameters form an acute angle defining the inlet region of each chamber, and a complementary obtuse angle setting forth the compression areas. The length of the compression portion of the chamber, which is the circumferential distance from the point of maximum diameter to the point of minimum diameter, is thus proportionately increased in the modified elliptical casing. This allows more vanes to take part in the compression of gas at one time and decreases the pressure on each blade.

Although the purely elliptically shaped casing would be operative, the preferred embodiment of the invention utilizes the "bulged" elliptical shape. In either case the casing must be symmetrical to permit a blanced operation of the pump. The pump may be built to operate with three or more pumping chambers providing the casing is symmetrical. Previous to this invention, rotary pumps have been limited to slow speed operation and low pressure increases because of unbalanced rotors. Other pumps have utilized only one compression chamber, mounting the rotor eccentrically in a cylindrical casing. The present invention, by including at least two opposing compression chambers provides equal and opposite simultaneous vane action and thus results in continually balanced rotor despite changes in speed or load.

A variation of the preferred embodiment is shown in FIG. 6 wherein the modified elliptical casing **14** of the invention is shown in conjunction with a concentric rotor **46** having rigid extensible vanes **48** which are slidably mounted in radial slots **50** in the rotor. The compressing action is identical with that explained above in describing the preferred embodiment. The limited number of vanes practical to use in this embodiment increases the pressure on the individual vanes. However, the heavier vane construction absorbs the increased stress without distortion. The vanes are held in radial extension against the inner wall of the casing by centrifugal force acting on the slidable vanes. Since each vane has a corresponding vane located on the opposite side of the rotor acting identically in any rotor position, the rotor-vane assembly maintains a balanced condition at any speed of rotation and hence the embodiment, as likewise the preferred embodiment, may be operated at relatively high speeds.

The present invention while primarily intended for use as a gas compressor could also be used without modification as a vacuum pump by connecting the chamber to be evacuated to the inlet ports of the pump.

It would also be possible to utilize the pump of this invention as a multiple stage compressor by decreasing the volume of one of the chambers, although balancing difficulties may restrict such use to low-speed operation.

With little structural change the invention could also be adapted to use as a fluid motor, high pressure fluid being directed into the openings previously described as exhaust ports. Rotation would be in the opposite direction, and the ports described above as inlet ports could preferably be extended to the constricted area of the casing in order to permit substantially exhausting the vanes of fluid.

Manifestly minor changes in details of construction can be effected by those skilled in the art without departing from the spirit and the scope of the invention as defined in and limited solely by the appended claims.

I claim:

1. In a rotary fluid pump, an irregularly shaped closed casing, said casing having a smoothly-finished continuously curved interior surface, a rotor mounted in said casing, a plurality of vanes mounted on said rotor for rotation therewith with the free ends thereof in continuing sealing contact with the interior surface of said casing on rotation of said rotor, the outer periphery of said rotor and the interior surface of said casing defining therebetween a plurality of chambers, said vanes being elastically deformable vanes of a length exceeding the maximum radial width of said chamber, said vanes being elastically deformed by said casing into continuing biasing contact with said casing interior surface, each of said vanes being in overlapping relation with at least one preceding vane, and each of said vanes having at least one outwardly-directed axially-extending step thereon to provide clearance for a preceding overlapped vane when said vanes pass through the region of minimum casing diameter, fluid inlet and outlet means entering said casing and opening into said chambers, said vanes adapted to sweep fluid through said chambers and increasingly compress the fluid from entry in to exit from said chambers, said closed casing being of a modified elliptical shape wherein the maximum and minimum diameters of the casing form an acute angle defining the inlet region of each chamber, and a complementary obtuse angle setting forth the compression region such that the compression stroke of said vanes through said chambers is of greater angular duration than the intake stroke, thereby decreasing the pressure differential on each vane

and reducing the shock occurring in the compression region.

2. In a rotary fluid motor, an irregularly shaped closed casing, said casing having a smoothly-finished continuously curved interior surface, a rotor mounted in said casing, a plurality of vanes mounted on said rotor for rotation therewith with the free ends thereof in continuing sealing contact with the interior surface of said casing on rotation of said rotor, the outer periphery of said rotor and the interior surface of said casing defining therebetween a plurality of chambers, said vanes being elastically deformable vanes of a length exceeding the maximum radial width of said chambers, said vanes being elastically deformed by said casing into continuing biasing contact with said casing interior surface, each of said vanes being in overlapping relation with at least one preceding vane, and each of said vanes having at least one outwardly-directed axially-extending step thereon to provide clearance for a preceding overlapped vane when said vanes pass through the region of minimum casing diameter, fluid inlet and outlet means entering said casing and opening into said chambers, means for introducing a fluid under pressure into said fluid inlet into engagement with said vanes, whereby expansion of fluid acting against said vanes from entry in to exit from said chambers causes rotation of said rotor, said closed casing being of a modified elliptical shape wherein the maximum and minimum diameters of the casing form an obtuse angle defining the expansion region in each chamber, and a complementary acute angle setting forth the exhaust regions, thereby decreasing the pressure differential on each vane and reducing the shock occurring in the compression region.

3. A rotary fluid pump as claimed in claim 1, said vanes having a plurality of steps thereon, said vanes co-acting by means of steps thereon, and an area of said casing interior surface acting against said vanes whereby said vanes are deformed into contact with preceding vanes, the rotor and the casing interior surface, thereby substantially vacating the vanes of fluid as they pass by said area of the casing interior surface.

4. A rotary fluid motor as claimed in claim 2, said vanes having a plurality of steps thereon, said vanes co-acting by means of steps thereon, and an area of said casing interior surface acting against said vanes whereby said vanes are deformed into contact with preceding vanes, the rotor, and the casing interior surface, thereby substantially vacating the vanes of fluid as they pass by said area of the casing interior surface.

5. In a rotary fluid pump, an irregularly shaped closed casing, a rotor mounted in said casing, a plurality of radially extensible vanes mounted on said rotor for rotation therewith with the free ends thereof in continuing sealing contact with the interior surface of said casing on rotation of said rotor, the outer periphery of said rotor and the interior surface of said casing defining therebetween a plurality of chambers, fluid inlet and outlet means entering said casing and opening into said chambers, said vanes adapted to sweep fluid through said chambers and increasingly compress the fluid from entry in to exit from said chambers, said vanes being elastically deformable vanes having an unrestrained radial extension exceeding the maximum radial width of said chambers, said vanes being elastically deformable vanes of a length exceeding the maximum radial width of said chambers, said vanes being elastically deformed by said casing into continuing biasing contact with said casing interior surface, each of said vanes being in overlapping relation with at least one preceding vane, and each of said vanes having at least one outwardly-directed axially-extending step thereon to provide clearance for a preceding overlapped vane when said vanes pass through the region of minimum casing diameter.

6. A rotary fluid pump as claimed in claim 5, said vanes having a plurality of steps thereon, said vanes co-acting by means of steps thereon, and an area of said casing interior surface acting against said vanes whereby said vanes are deformed into contact with preceding vanes, the rotor, and the casing interior surface, thereby substantially vacating the vanes of fluid as they pass by said area of the casing interior surface.

**References Cited** in the file of this patent

UNITED STATES PATENTS

| | | |
|---|---|---|
| 559,324 | Dyer | Apr. 28, 1896 |
| 1,818,430 | Ricardo | Aug. 11, 1931 |
| 1,842,829 | Gregg | Jan. 26, 1932 |
| 2,435,279 | Hubacker | Feb. 3, 1948 |
| 2,487,685 | Young | Nov. 8, 1949 |
| 2,588,430 | Svenson | Mar. 11, 1952 |
| 2,781,729 | Johnson et al. | Feb. 19, 1957 |
| 2,791,185 | Bohnhoff et al. | May 7, 1957 |
| 2,829,599 | Jones | Apr. 8, 1958 |
| 3,016,184 | Hart | Jan. 9, 1962 |

FOREIGN PATENTS

| | | |
|---|---|---|
| 204,852 | Germany | Dec. 5, 1908 |
| 106,521 | Great Britain | May 22, 1917 |