May 5, 1964 W. E. MARIETTA 3,131,643

ENGINE

Filed Oct. 25, 1962 3 Sheets-Sheet 1

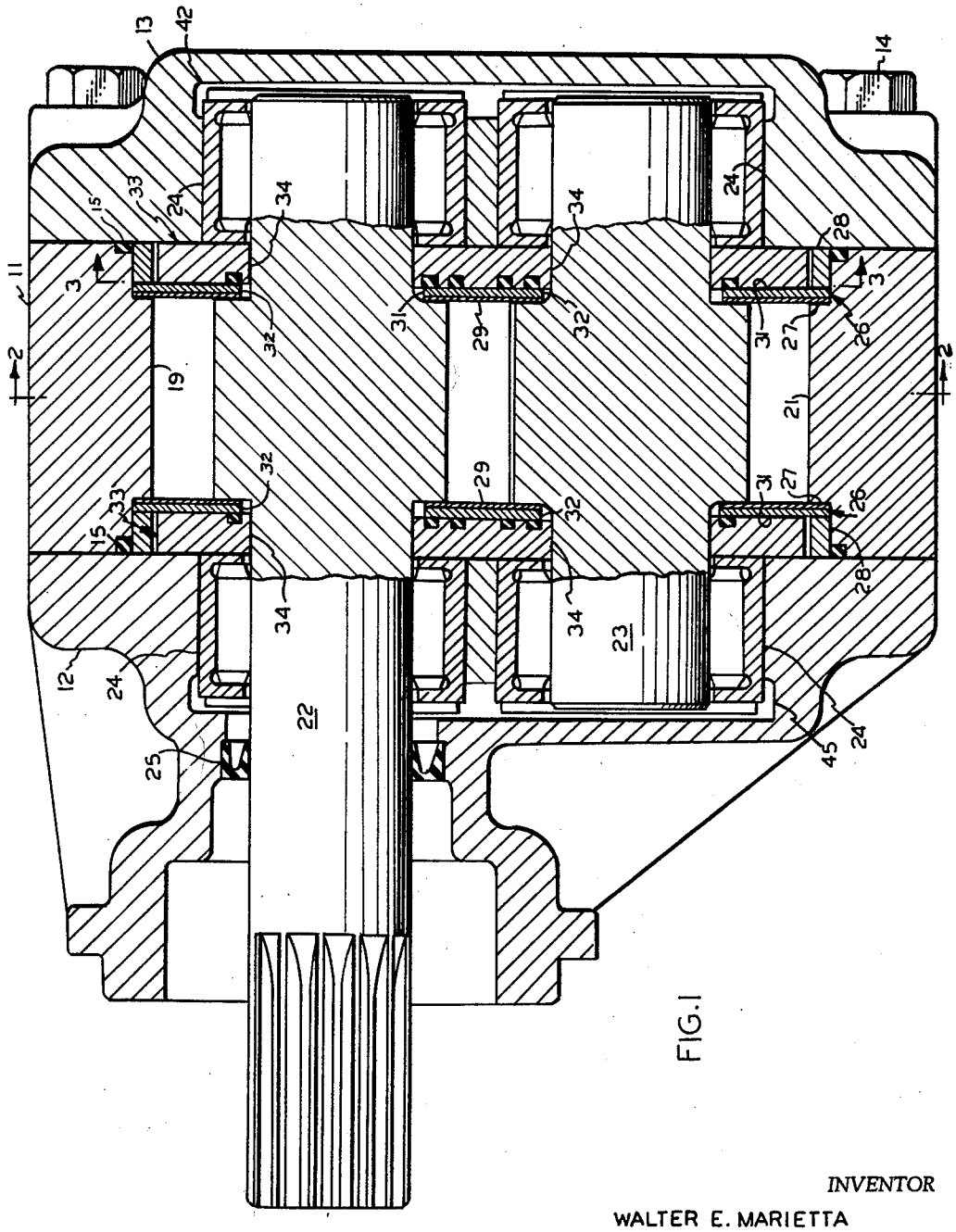


FIG. 1

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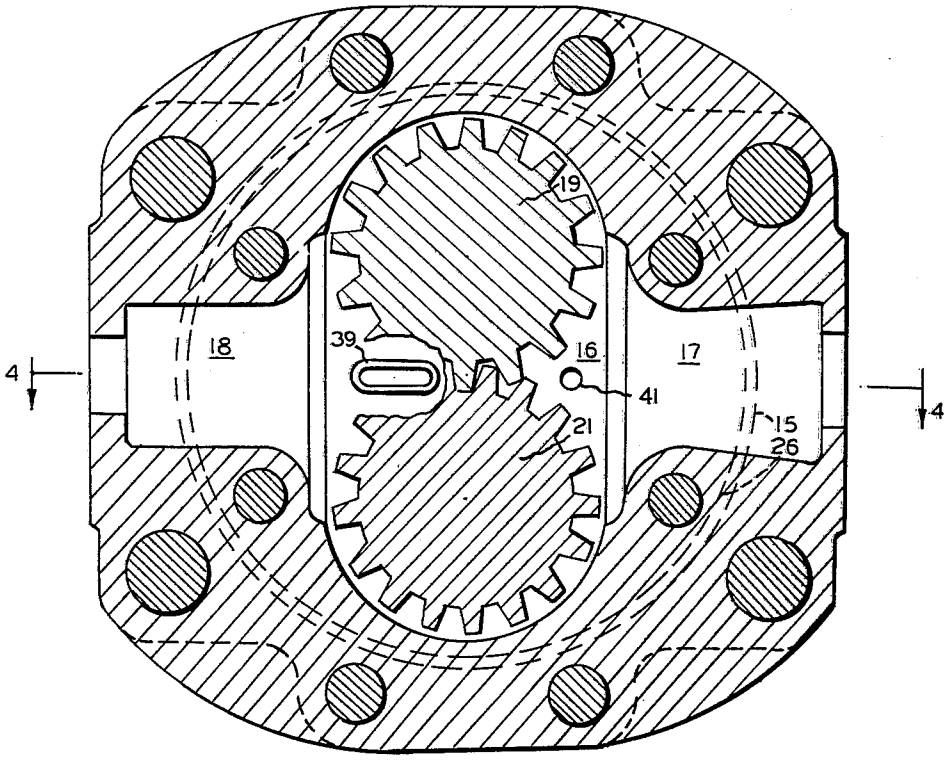


FIG. 2

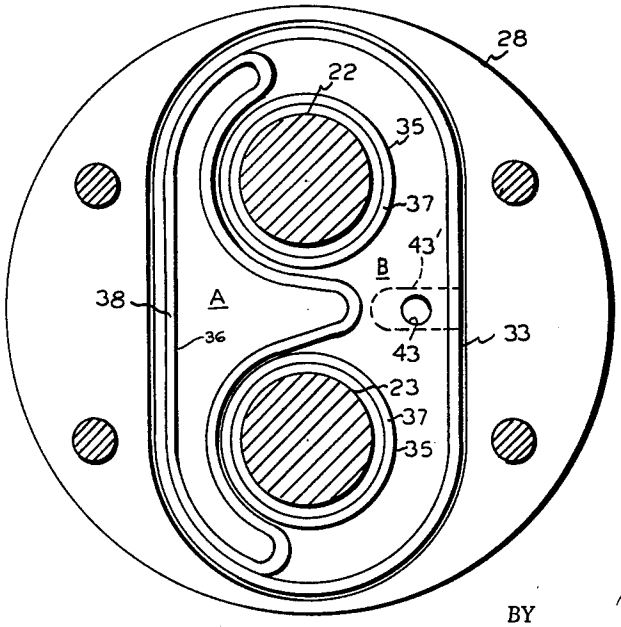


FIG. 3

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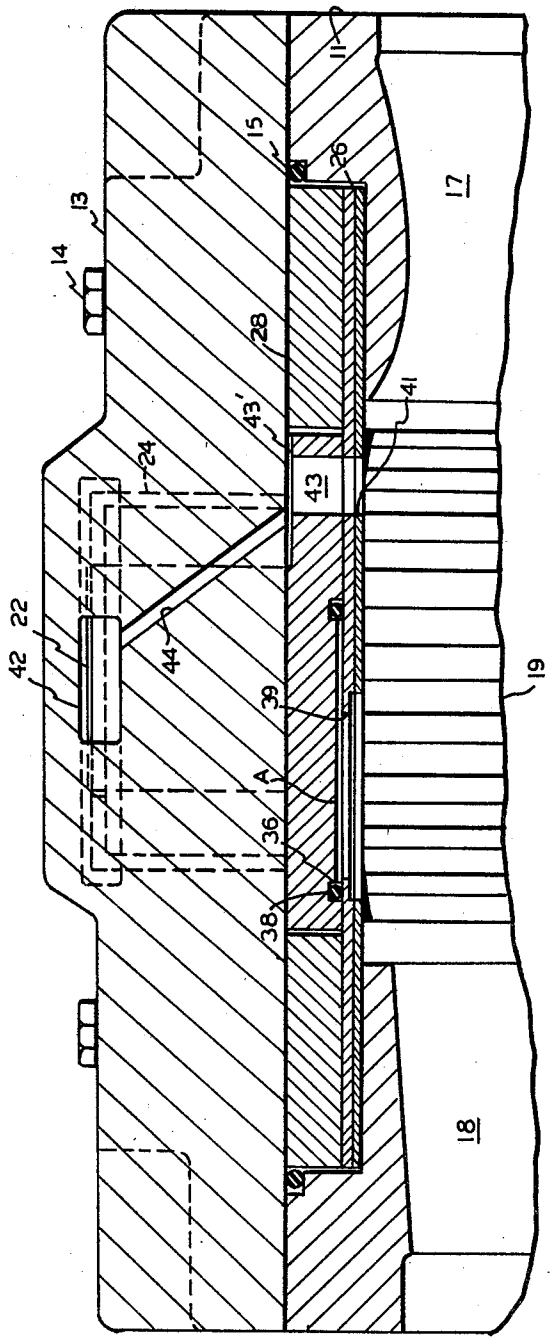


FIG. 4

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ENGINE

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4 Claims. (Cl. 103—126)

This invention relates to hydraulic engines, and more particularly to engines of the gear type. The term "engine" is used herein in a generic sense and it will be understood that it includes fluid pressure pumps as well as motors.

Prior engines of this type frequently include a deflectable wear plate which is clamped around its outer periphery and which is disposed adjacent one side face of the meshing gears. The gears are carried on shafts which project from the working cavity through bores in the wear plate and are journaled in bearings supported by the housing and located behind the wear plate. The pressure in the working cavity, which varies from a maximum on the high pressure side to a minimum on the low pressure side, tends to deflect the wear plate outward away from the side faces of the gears, and, therefore, in the normal case the engine includes means for developing an oppositely directed force on the rear face of the wear plate that deflects the plate inward toward the gears so that an effective seal is maintained. This last mentioned means usually takes the form of elastic sealing members that are confined between the rear face of the wear plate and the housing and which define at least two reaction areas on this face. One of these reaction areas is located on the low pressure side of the engine and is subjected to the pressure in that side of the working cavity, and another of the areas is located on the high pressure side and is subjected to the pressure in that side of the working cavity. With this arrangement, the forces acting on the opposed faces of the wear plate in the regions of the high and low pressure sides of the working cavity are balanced and undue wear of the wear plate is prevented. The high pressure reaction area usually extends some distance around the circumference of the gears toward the low pressure side of the cavity so that in the region between these two sides this area develops a force that exceeds slightly the outward directed force developed by the pressure gradient in the working cavity. As a result, the wear plate is deflected slightly inward in this region and forms a running seal with the side faces of the gears. In some cases, the rear face of the wear plate is divided into other reaction areas that are subjected to pressures intermediate the pressures in the high and low pressure sides of the working cavity, but in all cases the intent is to produce a controlled amount of wear plate deflection in the zone between the high and low pressure sides of the engine.

While this prior construction is generally satisfactory for low pressure engines, i.e., those operating at pressures below about 1500 p.s.i., it presents some problems in engines intended for use in the pressure range of 1500 p.s.i. to 3000 p.s.i. As the operating pressure is increased, the radial loads on the gears also increase, thus necessitating the use of rather large roller or other anti-friction bearings for the gear shafts. Since these bearings are located directly behind the wear plate they subtract from the area on the rear face of that plate that may be used for deflection control. It has been found that in high pressure engines this condition makes it very difficult, if not impossible, to obtain the desired degree of deflection control. Furthermore, since these wear plates are clamped between detachable sections of the engine housing, it is imperative, in order to insure ease of assembly and freedom from binding, that the bores through which the gear-carrying shafts project form a rather loose fit with the shafts. As a result, the rather large clearance spaces between the bores and the shafts define rather large leakage paths through which fluid may escape from the working cavity. This leakage not only reduces the efficiency of the engine, but also can affect the type of deflection control scheme selected for the wear plate. If the high pressure reaction area on the rear face of the wear plate is enclosed by the elastic seals and the low pressure area communicates with the clearance space between the shafts and the bores in the wear plate, then, since the low pressure area is directly connected with the low pressure side of the engine, a direct by-pass path is established between the high and low pressure sides of the engine and efficiency suffers. On the other hand, if it is the low pressure area that is sealed off and the high pressure area that communicates with the clearance space, efficiency is improved but adequate deflection control is difficult to obtain. Furthermore, in this case, the inner end of the drive shaft is subjected to high pressure which develops a longitudinally directed force of considerable magnitude. Because of this, it sometimes is necessary to provide a thrust bearing for the drive shaft.

The object of this invention is to provide a high pressure engine of the gear type which is free of the disadvantages of the prior engines mentioned above. In accordance with this invention, the engine includes a seal plate that is interposed between the back face of the wear plate and the housing and which contains bores through which the gear-carrying shafts extend. The seal plate is not clamped but is free to move in a direction parallel with the side faces of the gears. Because of this, the bores in this plate can be dimensioned to form a close running fit with the shafts and thereby define an effective seal for these shafts. The elastic sealing members that define the reaction areas on the rear face of the wear plate are mounted in grooves formed in the seal plate, and since the diameter of each shaft bore in this plate is much less than the diameter of the roller bearing, the invention affords a greater area that can be used to achieve wear plate deflection control. In the preferred embodiment of the invention, the high pressure area on the rear face of the wear plate is enclosed and the balance of this face is subjected to the pressure in the low pressure side of the engine. This arrangement affords more freedom in controlling wear plate deflection while at the same time minimizing leakage. Furthermore, when the wear plate and seal plate are installed at the end of the working cavity adjacent the inner end of the drive shaft, this arrangement affords a convenient way to vent this end of the shaft. As a result, the preferred engine requires no thrust bearing for the drive shaft.

The preferred embodiment of the invention is described herein in detail with references to the accompanying drawings in which:

FIG. 1 is an axial sectional view of a hydraulic gear pump incorporating the invention.

FIG. 2 is a sectional view, on a reduced scale, taken on line 2—2 of FIG. 1.

FIG. 3 is a sectional view, on a reduced scale, taken on line 3—3 of FIG. 1.

FIG. 4 is an enlarged sectional view taken on line 4—4 of FIG. 2.

As shown in the drawings, the pump comprises a three-part casing including a central housing **11**, an adapter **12** and a cover **13** which are held together by bolts **14**. A pair of elastic O-rings **15**, seated in shallow counterbores formed in housing **11**, seal the joints between the casing sections. Housing **11** is formed with a pumping cavity **16** that communicates with the inlet and discharge passages **17** and **18**, respectively, and which contains a pair of meshing gears **19** and **21**. The gears **19** and **21** are formed in one piece with the shafts **22** and **23**, respec-

tively, which are journaled in roller bearings 24 supported in adapter 12 and cover 13. The drive shaft 22 projects from the casing through adapter 12 and is provided with a low pressure seal 25.

The end walls of pumping cavity 16 are defined by a pair of identical circular wear plates 26 which are seated in counterbores formed in housing 11 and which are clamped around their outer peripheries between shoulders 27 and spacer rings 28 when the casing sections are joined. The wear plates 26 are of laminated construction and comprise a bronze facing 29 which is bonded to a steel backing 31. Each wear plate is provided with a pair of bores 32 through which the shafts 22 and 23 project and these bores are large enough to preclude binding between the shafts and the wear plates as a result of tolerance accumulations during manufacture.

The inner periphery of each spacer ring 28 defines a generally oval opening in which is positioned a similarly shaped seal plate 33. The seal plates 33 are slightly thinner (on the order of .0005" to .001" thinner) than the spacer rings 28 and their outer peripheries are spaced inward from the inner peripheries of the rings. Therefore, when the pump is assembled, these seal plates are not clamped but are free to shift in a plane parallel with the side faces of the gears. The seal plates 33 are formed with bores 34 through which the gear shafts 22 and 23 extend, and the radial clearance between the bores 34 and the gear shafts is small (on the order of .001") so that the restriction to fluid flow through each clearance space is very high. Therefore, this close-running fit between each shaft and its bore constitutes a seal that, for all practical purposes, prevents leakage from the pumping chamber 16 along the shafts. Since the seal plates 33 are free to shift, they take up positions dictated by the shafts 22 and 23 when the pump is assembled and binding is avoided.

The front face of each seal plate 33 contains a pair of circular grooves 35, one of which is coaxial with each bore 34, and an irregularly shaped groove 36 which overlies the pumping chamber 16 on the high pressure side, i.e., on the side communicating with discharge passage 18. Each of the grooves 35 contains an elastic sealing ring 37, and a similar ring 38 is mounted in the groove 36. These rings 37 and 38 are compressed between the wear plate 26 and the seal plate 33 when the pump is assembled and define high and low pressure spaces A and B between the wear plate and the seal plate. The high pressure space A is connected with the discharge side of pumping cavity 16 through an oval opening 39 formed in wear plate 26, and an opening 41 formed in the wear plate connects the low pressure space B with the inlet side of the pumping cavity. In accordance with the normal practice in this art, the size of space A is so selected that the pressure force developed on the rear face of the wear plate is slightly larger than the force developed on the front face of the wear plate by the pressure gradient in the pumping cavity. Because of this, the wear plates will be deflected inward into sealing engagement with the side faces of the gears when the pump is running.

The low pressure space B is also connected (see FIG. 4) with the cored chamber 42 in cover 13 through a bore 43 formed in seal plate 33 and a passage 44 formed in cover 13 so that the right end of drive shaft 22, as viewed in FIG. 1, is vented to the pump inlet 17. A passage (not shown) similar to passage 44 but formed in adapter 12 connects the cored chamber 45 with the low pressure space B at the rear of the left hand wear plate 26 in FIG. 1 so that the left end of shaft 23 and the space to the right of seal 25 also are vented to inlet passage 17. A shallow passage 43' formed in the rear face of each seal plate 33 and extending inward from its outer periphery drains the clearance space between the seal plate and the inner periphery of spacer ring 28.

It will be apparent now that the close running fits between shafts 22 and 23 and the bores 34 in seal plates 33 effectively minimize leakage from pumping chamber 16 along the outer peripheries of the shafts. The small amount of fluid which does pass through the clearance spaces collects in cored chambers 42 and 45 from which it is returned to inlet passage 17 via passage 44, and its counterpart in adapter 12, bores 43 and openings 41. Since the right end of drive shaft 22 is vented, a thrust bearing need not be provided. It also will be apparent that the diameter of each bore 34 is considerably smaller than the outside diameter of the roller bearings 24 and that, therefore, the annular zone on the rear face of the wear plate between these two diameters is available for deflection control.

As stated previously, the drawings and description relate only to the preferred embodiment of the invention. Since many changes can be made in the structure of this embodiment without departing from the inventive concept, the following claims should provide the sole measure of the scope of the invention.

What I claim is:

1. An engine comprising

(*a*) a housing containing a working cavity having a pair of transverse end walls and high and low pressure connections;

(*b*) a pair of meshing gears positioned within the cavity and carried by shafts whose opposite ends project from said cavity;

(*c*) bearing means supported in the housing for journaling the opposite ends of the shafts;

(*d*) a thin deflectable wear plate clamped around its outer periphery in the housing and positioned adjacent one side face of the gears so that its front face defines one of said transverse end walls, the wear plate being formed with bores through which the shafts project, the housing being formed to provide a space adjacent the rear face of the wear plate that is aligned with and has substantially the same cross-sectional size and shape as the working cavity;

(*e*) a seal plate separate from the wear plate and positioned in said space, the seal plate being formed with bores of smaller diameter than the outside diameter of the bearing means through which the shafts extend;

(*f*) sealing means confined between the seal plate and the rear face of the wear plate and defining wear plate deflection-control areas on the rear face of the wear plate; and

(*g*) means for pressurizing and venting selected ones of said deflection-control areas.

2. The engine defined in claim 1 in which

(*a*) the bores in the seal plate form a close running fit with the shafts and thereby define effective fluid seals for the shafts; and

(*b*) the width of the seal plate measured in the direction of the shaft axes is slightly less than the width of said space and the outer periphery of the seal plate is spaced inward from that portion of the housing that encloses said space, whereby the seal plate is free to shift in a plane substantially parallel with the side faces of the gears.

3. The engine defined in claim 1 including

(*a*) a second deflectable wear plate clamped around its outer periphery in the housing and positioned adjacent the other side face of the gears so that its front face defines the other of said transverse end walls, the second wear plate being formed with bores through which the shafts project, the housing being formed to provide a second space adjacent the rear face of the second wear plate that is aligned with and has substantially the same cross-sectional size and shape as the working cavity;

(*b*) a second seal plate positioned in said second space and formed with bores through which the shafts extend;

(*c*) sealing means confined between the second seal

plate and the second wear plate and defining wear plate deflection-control areas on the rear face of the second wear plate; and

(*d*) means for pressurizing and venting selected ones of said deflection-control areas on the rear face of the second wear plate.

4. A fluid pressure engine comprising

(*a*) a casing including a central housing that encircles an open ended working cavity, a cover attached to the central housing adjacent one end of the working cavity, and an adapter connected to the central housing adjacent the other end of the working cavity;

(*b*) high and low pressure passages connected with the working cavity at diametrically opposed positions;

(*c*) a pair of meshing gears positioned in the working cavity and carried by shafts whose opposite ends project into the adapter and the cover, one of the shafts projecting from the casing through the adapter;

(*d*) four bearings, two mounted in the cover and two mounted in the adapter, for journaling opposite ends of the two shafts;

(*e*) a pair of thin deflectable wear plates, one being clamped around its outer periphery between the housing and the cover and the other being clamped around its outer periphery between the housing and the adapter, the front faces of the two wear plates defining transverse end walls which close the working cavity and each plate being formed with a pair of bores through which the shafts extend, the cover and the adapter each being formed to provide a space adjacent the rear face of the associated wear plate that is aligned with and has substantially the same cross-sectional size and shape as the working cavity;

(*f*) a pair of seal plates, one positioned in said space in the cover and the other being positioned in said space in the adapter, each of the plates being formed

with a pair of bores of smaller diameter than the outside diameter of the bearings through which the shafts extend and which form a close running fit with the shafts, the bores and shafts defining seals which inhibit leakage from the working cavity along the shafts, the seal plates being slightly smaller than the spaces which receive them so that the plates are free to move in directions substantially parallel with the side faces of the gears;

(*g*) sealing means carried by each seal plate and confined between each of these plates and the adjacent wear plate, the sealing means enclosing on the rear face of each wear plate a reaction area located mainly on the high pressure side of the engine;

(*h*) a first opening through each wear plate on the high pressure side of the engine for connecting said reaction area with the working cavity;

(*i*) a second opening through each wear plate on the low pressure side of the engine for connecting that portion of the rear face of the wear plate outside said enclosed reaction area with the working cavity; and

(*j*) means including the second opening in each wear plate for venting the ends of the shafts within the casing to the low pressure passage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,702,509	Garnier	Feb. 22, 1955
2,707,441	Drennen	May 3, 1955
2,772,638	Nagely	Dec. 4, 1956
2,809,592	Miller et al.	Oct. 15, 1957
2,816,512	Murray	Dec. 17, 1957
2,923,248	Hodgson	Feb. 2, 1960
2,932,254	Booth et al.	Apr. 12, 1960
3,050,010	Thrap et al.	Aug. 21, 1962
3,073,251	Weigert	Jan. 15, 1963