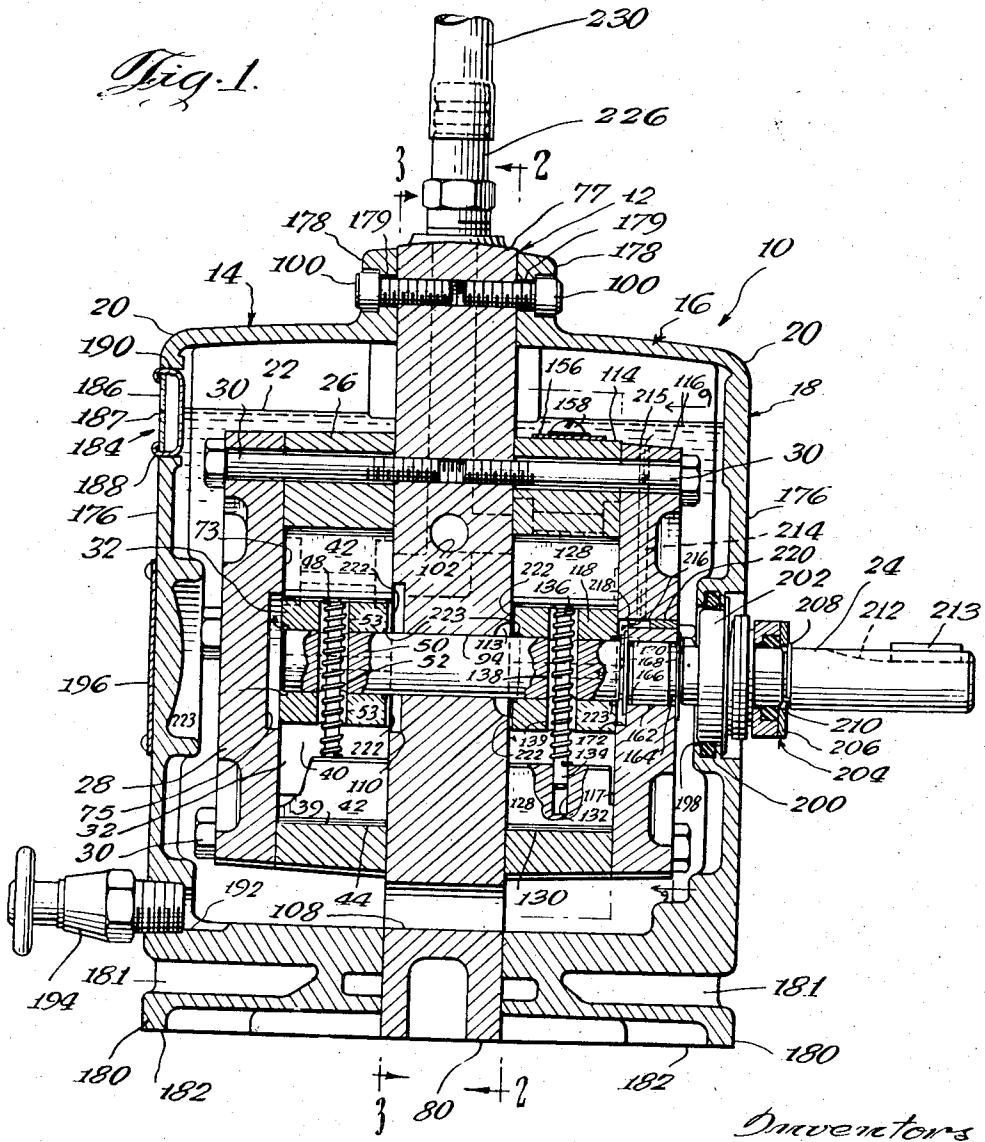
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VACUUM PUMP

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8 Sheets-Sheet 1

Fig. 1.



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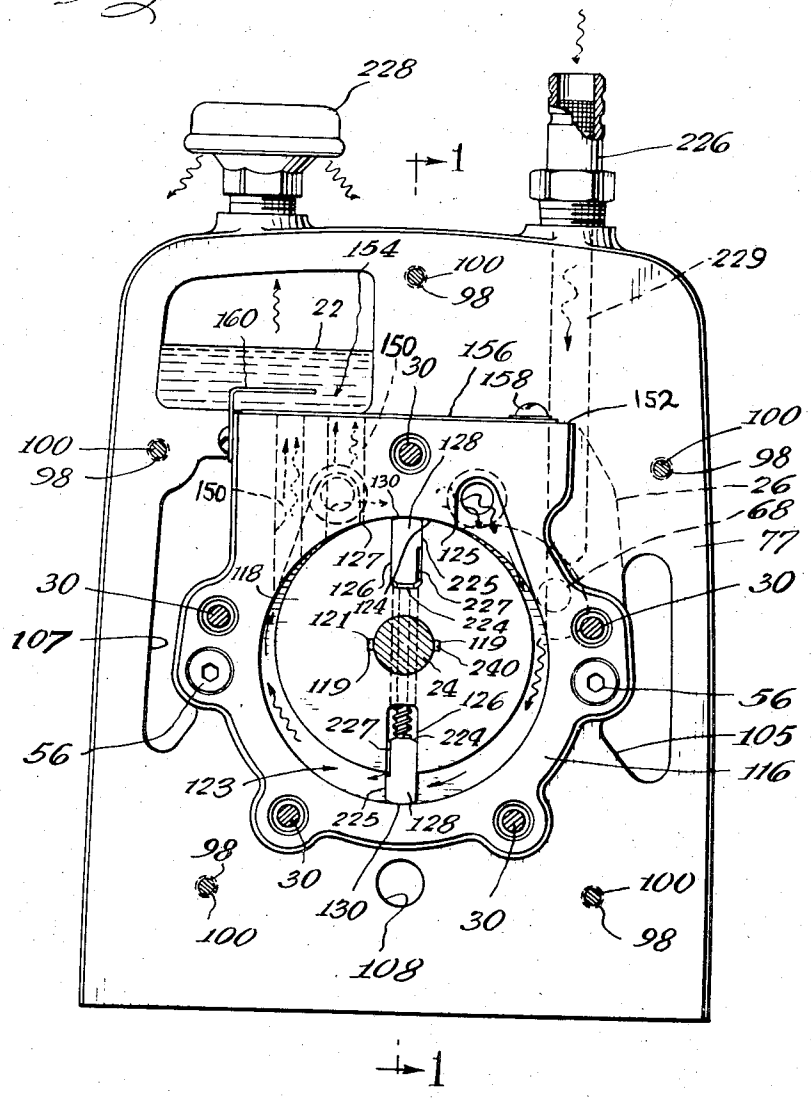
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8 Sheets-Sheet 2

Fig. 2.



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8 Sheets-Sheet 3

Fig. 4.

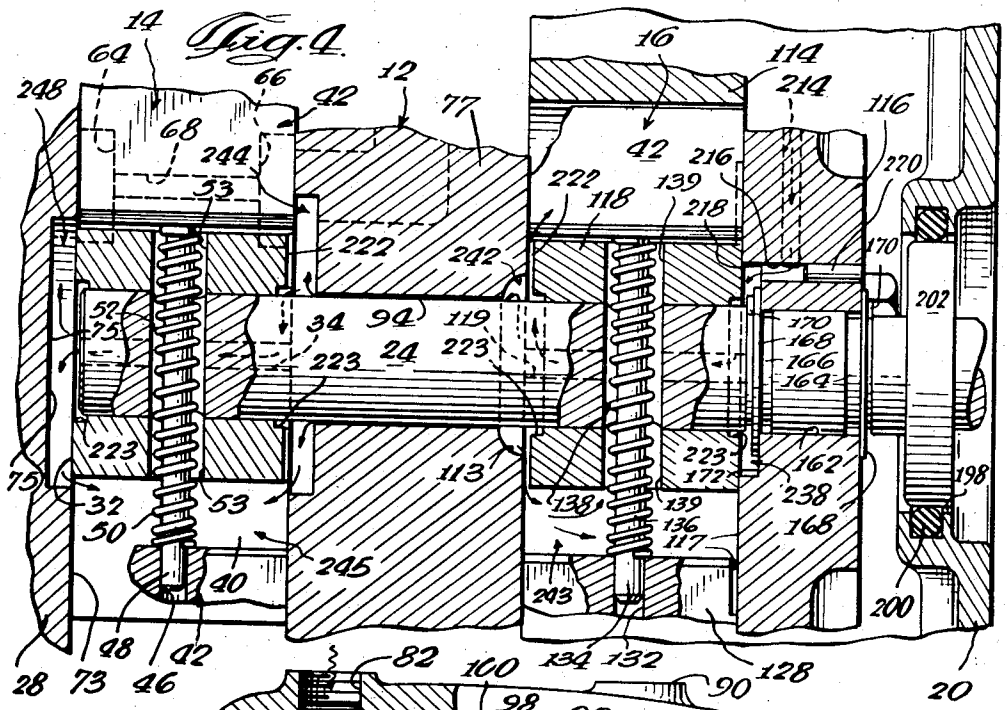


Fig. 3.

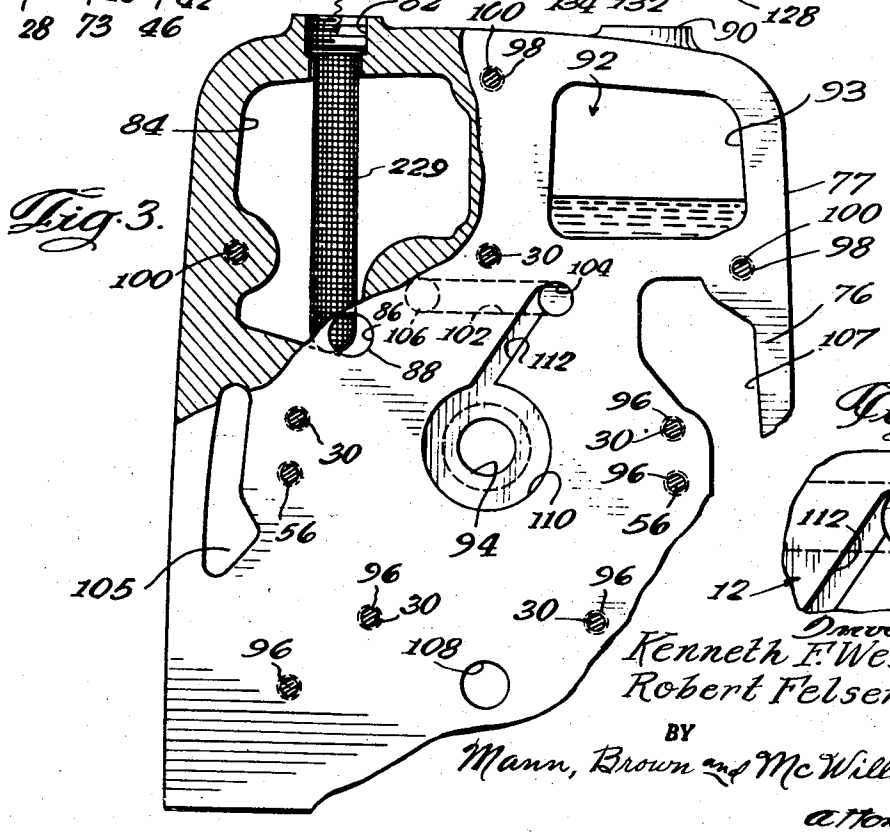


Fig. 3a.

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8 Sheets-Sheet 4

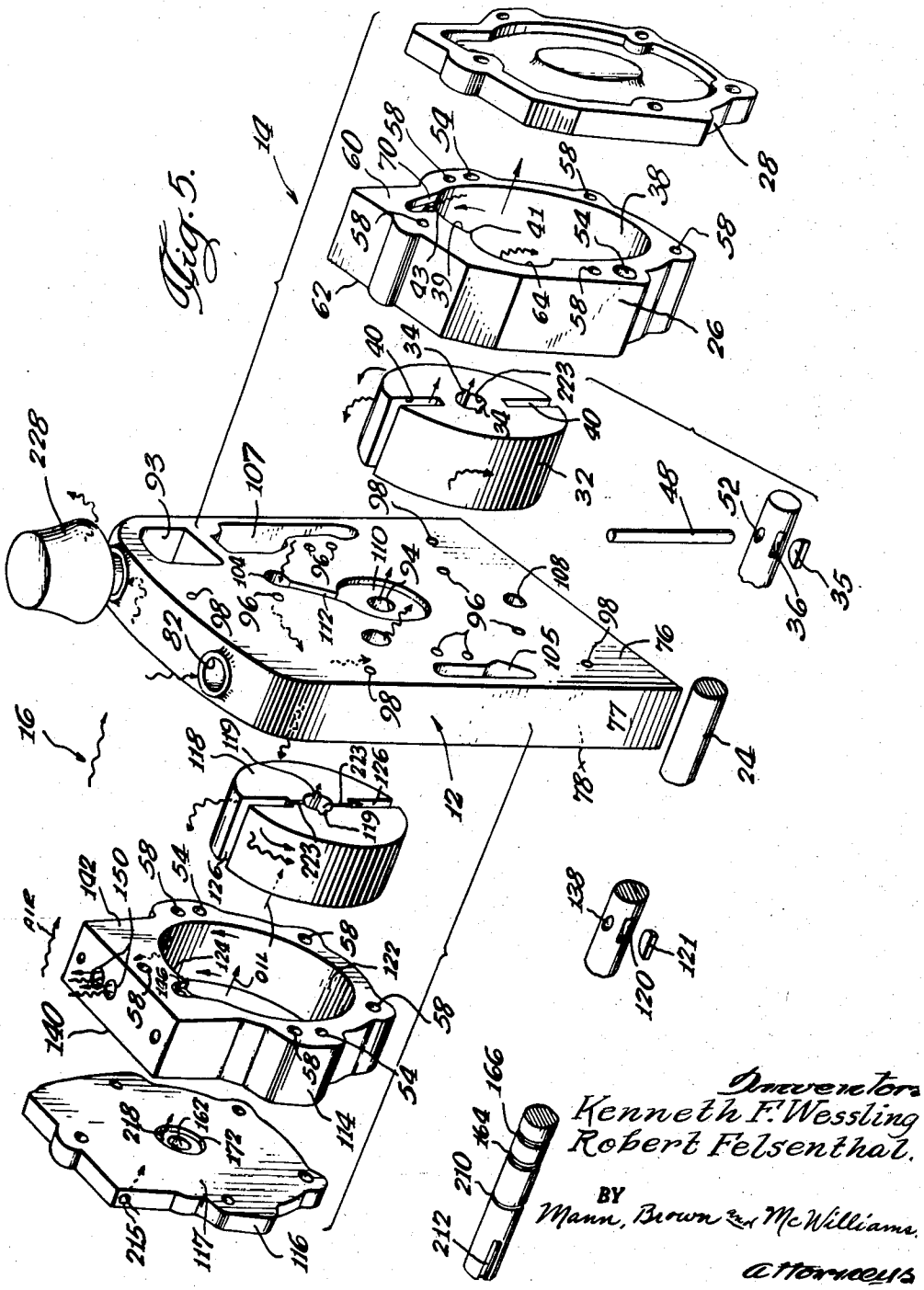


Fig. 5.

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March 17, 1959 K. F. WESSLING ET AL 2,877,947

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Filed Nov. 29, 1956 8 Sheets-Sheet 5

Fig. 6.

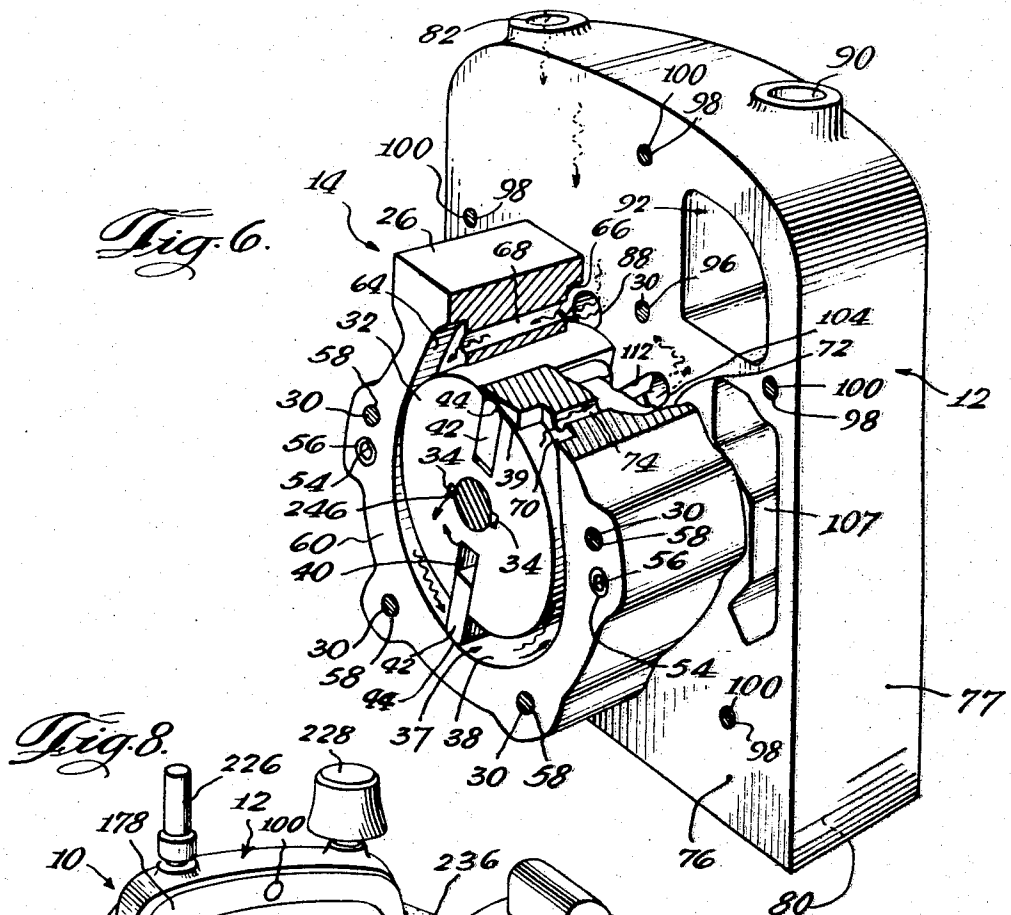


Fig. 8.

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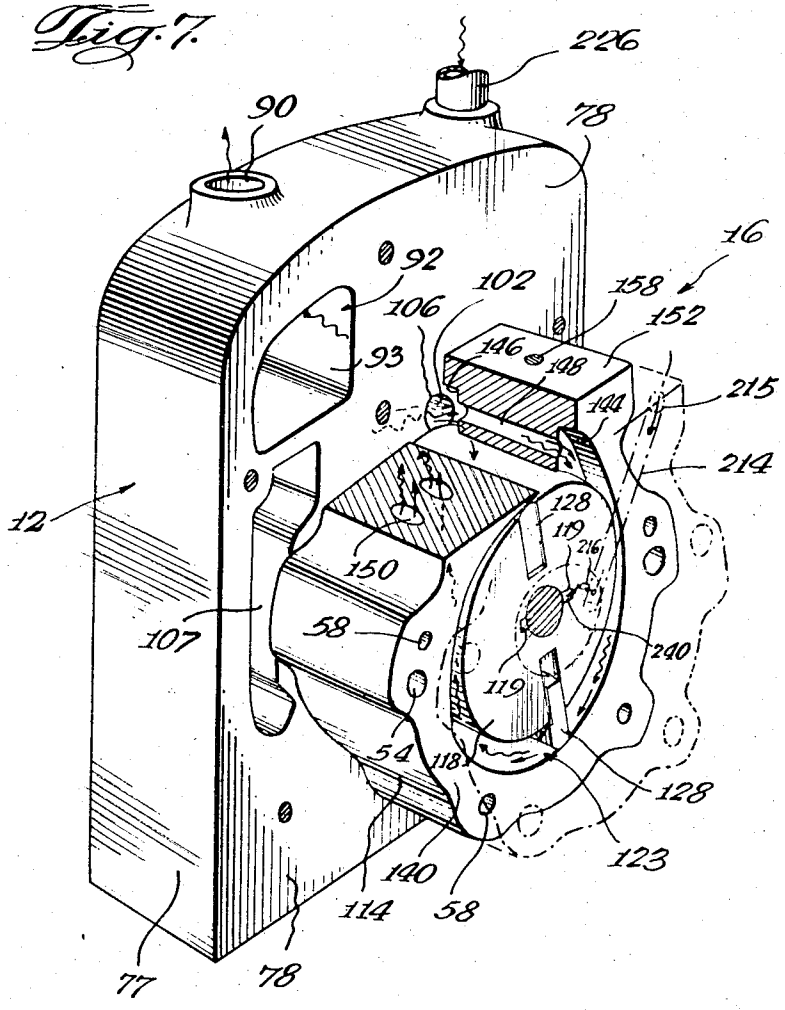
March 17, 1959 K. F. WESSLING ET AL 2,877,947

VACUUM PUMP

Filed Nov. 29, 1956

8 Sheets-Sheet 6

Fig. 7.



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March 17, 1959 K. F. WESSLING ET AL 2,877,947

VACUUM PUMP

Filed Nov. 29, 1956 8 Sheets-Sheet 7

Fig. 9.

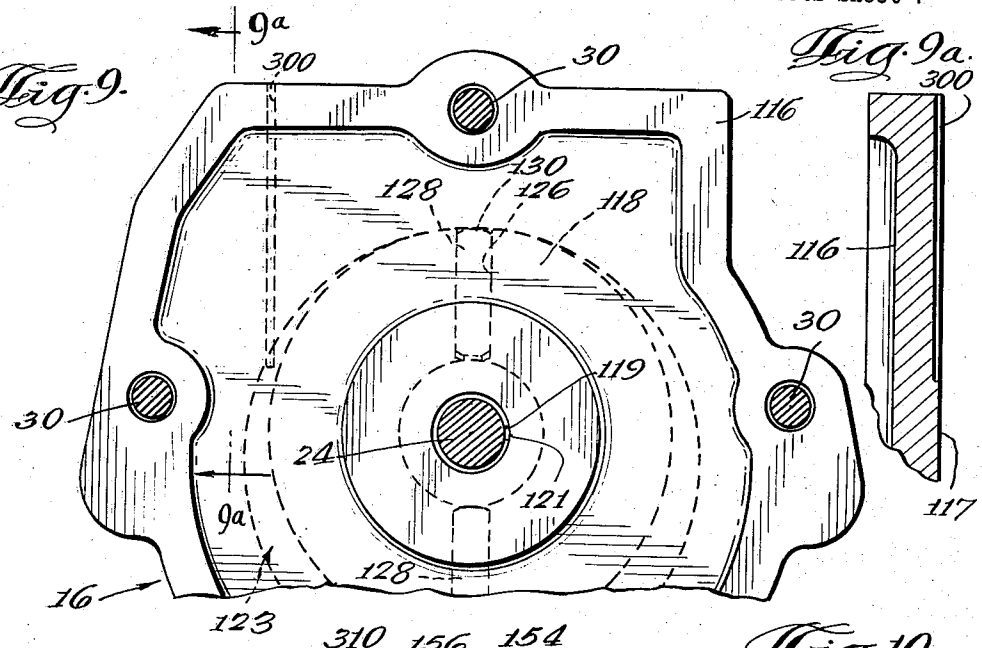
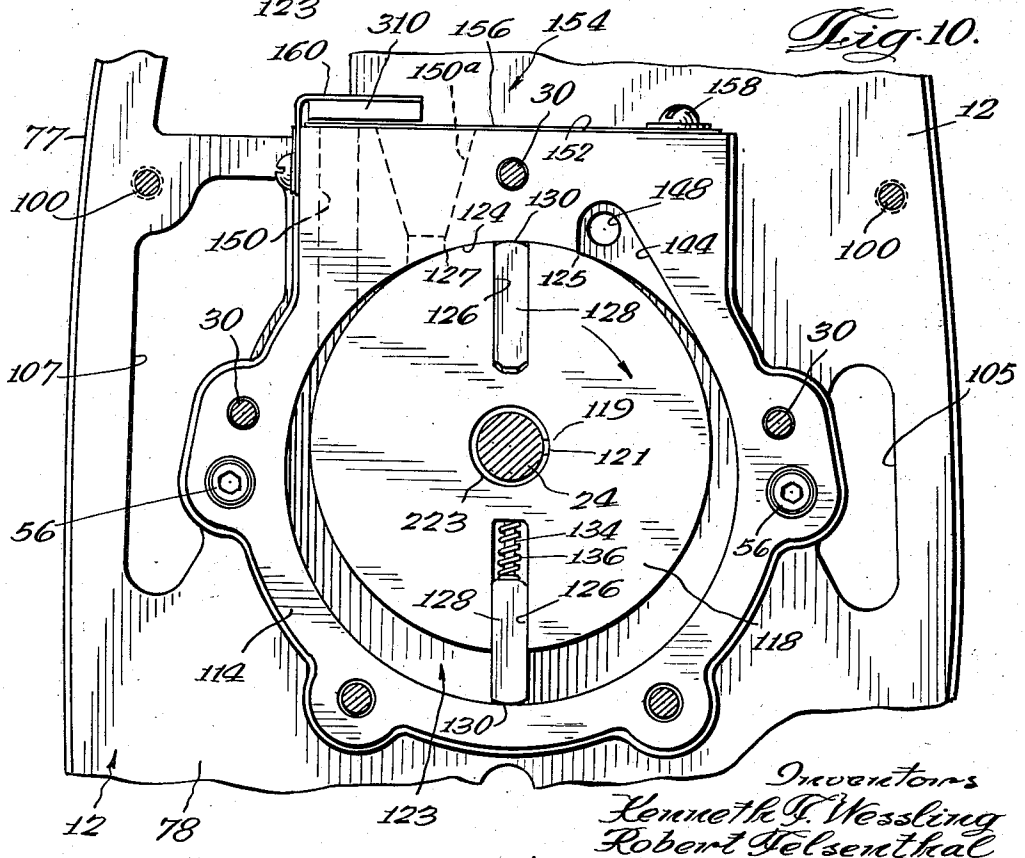


Fig. 9a.

Fig. 10.



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March 17, 1959 K. F. WESSLING ET AL 2,877,947

VACUUM PUMP

Filed Nov. 29, 1956 8 Sheets-Sheet 8

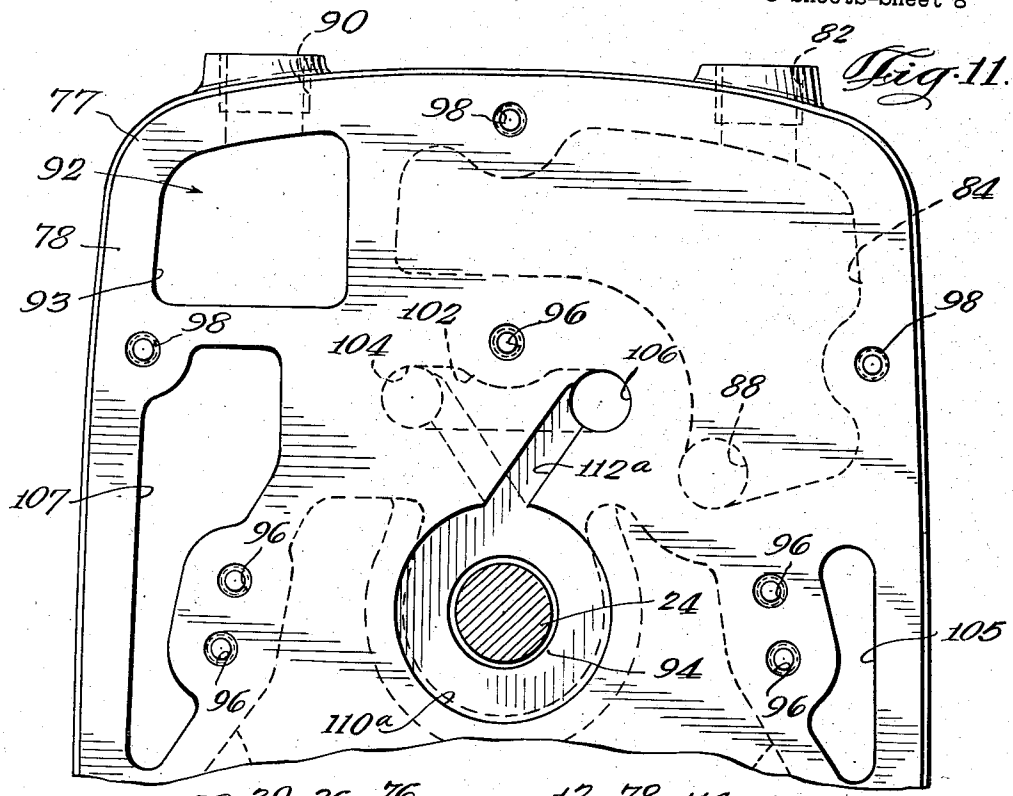


Fig. 11.

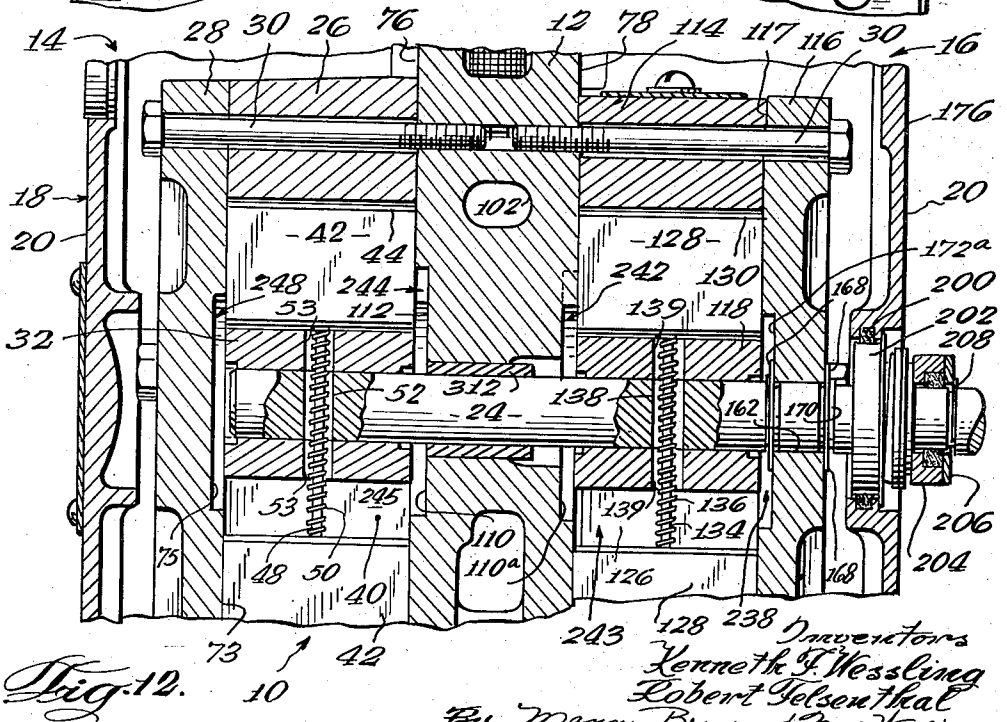


Fig. 12.

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Patented Mar. 17, 1959

2,877,947

VACUUM PUMP

Kenneth F. Wessling, Arlington Heights, and Robert Felsenthal, Chicago, Ill., assignors to Central Scientific Co., Chicago, Ill., a corporation of Illinois

Application November 29, 1956, Serial No. 625,161

1 Claim. (Cl. 230—153)

Our invention relates to a vacuum pump, and more particularly, to a rotary, oil sealed, two-stage, series connected pump utilizing the internal vane principle.

Copending application Serial No. 546,052, filed November 10, 1955, by Victor C. Garrison, Edward M. Nakaji, and Kenneth F. Wessling, and assigned to the assignee of our application, discloses a pump of this character. Our invention relates to, but is not limited to, improvements of the pump described in said copending application, and for purposes of facilitating the understanding of our improvements, much of the disclosure of said application is included herein.

Much work has been done by people active in this art to provide a vacuum pump that will pump down or reach its ultimate (that is, provide the rated vacuum) in a minimum of time. Our studies have revealed that this can be done on the pump described in said copending application by providing for better and quicker evacuation of the internal spaces within the pump and shortening the path that lubricating oil must travel through the pump. We have found that a substantial reduction in operating temperatures results when the principles of our invention are employed.

The principal objects of our invention are to improve the capability of the pump described in said copending application, as well as other similar pumps, to reach its ultimate, to reduce the time required to provide the rated vacuum, and to reduce the operating temperatures of the pump.

Another object of the invention is to provide a vacuum pump that runs quieter at low operating pressures than conventional pumps.

Other objects, uses, and advantages will be obvious or become apparent from a consideration of the following specification taken in conjunction with the accompanying drawings.

In the drawings:

Figure 1 is a vertical cross sectional view of the pump illustrated in said copending application, as viewed along line **1—1** of Figure 2;

Figure 2 is a vertical cross sectional view along line **2—2** of Figure1;

Figure 3 is a vertical cross sectional view along line **3—3** of Figure 1, with parts broken away for clarity of illustration;

Figure 3*a* is a fragmental view of one of the pump ports shown in Figure 3;

Figure 4 is an enlarged view of the pump shaft and adjacent structure shown in Figure 1;

Figure 5 is an exploded perspective view of the various elements comprising the embodiment of the pump shown in Figure 1;

Figure 6 is a diagrammatic perspective view of the main operating elements of the finishing stage of the pump shown in Figures 1 through 5, with parts broken away for clarity of illustration;

Figure 7 is a view similar to that of Figure 6, but illustrating the main operating elements of the roughing stage of the pump shown in Figures 1 through 5;

Figure 8 is a perspective view of the pump of Figures 1 through 7 as applied to a suitable pump mounting along with a motor for actuating same;

Figure 9 is a view illustrating one of our improvements in the pump shown in Figures 1 through 8, it being a sectional view equivalent to a section along line **9—9** of Figure 1, with the rotor, vanes, and pumping chamber of the roughing stage shown in dotted lines;

Figure 9*a* is a cross sectional view along line **9*a*—9*a*** of Figure 9;

Figure 10 is a view similar to that of Figure 2, but on a larger scale and with parts broken away, illustrating another improvement in the pump illustrated in Figures 1 through 8;

Figure 11 is a view similar to that of Figure 3, showing the roughing stage side of the plate shown in Figure 3, illustrating a further improvement; and

Figure 12 is a view similar to that of Figure 4, further illustrating our improvements in the pump shown in Figures 1 through 8.

But these drawings and the corresponding specific description are used for the purpose of disclosure because they conform to embodiments that have demonstrated their fitness for the purpose, and they are not intended to indicate the limits of the invention, which is susceptible of other embodiments.

Figures 1 through 8 illustrate the details of the pump described in said copending application.

The two-stage pump **10** shown in these figures generally comprises a center plate **12** (see Figures 1 and 5) having a finishing or intake stage **14** mounted on one side thereof, and a roughing or exhaust stage **16** mounted on the other side thereof. The two stages are enclosed by a casing **18** comprising a pair of dished housing plates **20** fixed to the center plate. The space enclosed by the casing is filled with lubricant, such as oil, to approximately the line indicated by reference numeral **22**. A shaft **24**, rotatably mounted in the center plate **12** and operatively connected to suitable power means, actuates the finishing stage **14** and the roughing stage **16**.

The specific components and features of pump **10** are fully described in said copending application, the disclosure of which is specifically incorporated herein by this reference. For convenience for referring to said copending application, Figures 1–8 of the present application bear the reference numerals employed in the specification of said copending application.

Our improvements

Tests have shown that the operation of the pump described in said copending application can be improved by reducing the path that the oil to be injected must take to reach roughing stage pumping chamber **123** and also by providing a positive way of evacuating spaces **238**, **242**, and **243**. Referring to Figures 1 and 4, it will be noted that the oil follows a relatively long path before it is injected into chamber **123** in the pump of said copending application. Moreover, it must pass through a number of constricted passageways, which we have found has the effect of raising the temperature of the oil as it passes through or between the internal surfaces of the pump. And, of course, evacuation of spaces **238**, **242**, and **243** and slots **119** is possible only through the passage provided by beveled roughing stage vanes **128** communicating with roughing stage pumping chamber **123** and this passage is in communication with pumping chamber **123** for only approximately 25 percent of a complete revolution of the roughing stage rotor.

In accordance with our invention, the oil to be injected into the roughing stage pumping chamber **123**

passes directly into this chamber from a port adjacent the surface of the oil bath through a single passageway. Referring to Figures 9 and 9*a*, which illustrate roughing stage end plate **116** as modified in accordance with our invention, the passages **214** and **216** are eliminated, and a slot **300** is formed in the surface **117** of this end plate. It will be noted that the slot **300** extends from the top of the end plate, which is positioned adjacent the surface **22** of the oil bath, down to the exhaust side of roughing stage pumping chamber **123**.

As each blade or vane **128** sweeps by the end of slot **300**, the instantaneous pressure adjacent the trailing face of the blade or vane becomes quite low. Atmospheric pressure acting on the oil bath forces a metered amount of oil through slot **300** into chamber **123**. Although some oil may initially be forced back out of slot **300** when the next succeeding blade sweeps by, at low operating pressures, which are arrived at in a short time, the pressure differential between the pressure in chamber **123** and atmospheric pressure is so great that back flow is impossible.

As in the case of the pump described in said copending application, a substantial amount of this extra oil is forced into the passages **150** by the next succeeding blade so that the oil tends to fill up these passages. Thus, each time a quantity of oil and air is forced into the passages, the strip **156** of valve **154** is lifted somewhat, to free the mixture of oil and air at the top of these passages.

Even though passages **214** and **216** have been eliminated, we have found that adequate oil reaches the finishing stage of the pump through the mounting for shaft **24**. Sufficient oil enters spaces **238**, **242**, **243**, **244**, **245**, and **248** through the relatively close clearances between the vanes, center plate, stators, and end plates for accomplishing the functions of the pump hereinbefore described. We have also found that extra slots **34** and **119** formed in the respective rotors may be eliminated as unnecessary (see Figures 9 and 10 illustrating the roughing stage side of the pump).

Since the long injection path employed by the pump described in said copending application is eliminated, the chamfer **227** of vane **128** is omitted, as indicated in Figure 10. Also, radially extending slots **222** have been eliminated as unnecessary since spaces **243** and **245** receive adequate lubricant from other sources.

A further improvement in accordance with our invention is indicated in Figures 11 and 12, wherein it will be observed that the roughing stage side of center plate **12** is formed with recess **110***a* and slot **112***a* that correspond to recess **110** and slot **112** of the finishing stage side, and thus the roughing stage side is formed similarly to the finishing stage side of the center plate. The recess **113** of the center plate is replaced by this recess **110***a*. Also, recess **172** is replaced by recess **172***a* having the same diameter as recess **110***a* so that spaces **238** and **242** will be in communication through the vane slots **126** of rotor **118**. The action of the vanes or blades **128** in cooperation with port **106** and slot **112***a* is similar to that described in connection with port **104** and slot **112**. However, the oil accumulating on the bottom of passage **102** proceeds outwardly of the passage **102** together with any air that is passing into the roughing stage of the pump.

This places spaces **238**, **242**, and **243** and the remaining slot **119** in positive communication with the pumping chamber **123** through slot **112***a* and slot **146** of the roughing stage stator, which insures fast evacuation of the former, since they are in communication with the intake side of the roughing stage during the entire revolution of said roughing stage rotor.

We have found that the oil injected into pumping chamber **123** directly from the oil bath need not be previously degassed, and even if it is not degassed, as in the illustrated embodiment, the operation of the pump is not adversely affected. This is because the portion of this oil that is carried to the intake side of roughing stage pumping chamber **123** is immediately degassed, and the portion of this oil which reaches spaces **238** and **242** is degassed through slot **112***a* (space **238** being connected to space **242** by the vane slots **126** of rotor **118**). This degassing occurs as the pressure adjacent the intake side of pump chamber **123** is quite low compared to the pressure adjacent shaft **24**.

We have also found it advantageous to enlarge chamber **84** to the size indicated in dotted lines in Figure 11, as this provides more space for containing oil in the event of back flow through the pump during periods of idleness.

Figure 10 illustrates a further improvement in accordance with the principles of our invention which substantially reduces the noise of operation of the pump shown in Figures 1 through 8. It will be noted that the passage **150** closer to the contact area between the stator **114** and the rotor **118** of the roughing stage is enlarged and is formed to taper outwardly as indicated at **150***a*. This arrangement gives the upper portion of the modified passage **150** a truncated conical configuration. In addition, the strip **156** of the flap valve has been made wider with respect to passages **150** (compare Figures 1 and 12).

We have found that the larger contact surface that the oil in modified passage **150** has with the flap valve strip **156** has the effect of deadening the usual noise of operation of this valve. We have also noticed that, at low operating pressures, the escaping gas seems to come from the larger hole. Probably, this is because the modified passage **150** is closely adjacent the contact point between the rotor and the stator.

As shown in Figure 10, a depending flange **310** may be secured to the center plate side of element **160**, which also aids in the deflection of oil during the initial pumping stages.

As also is shown in Figure 12, pump shaft **24** may be mounted in a suitable bushing, such as bushing **312**. The action of the lubricant passing in a thin film along the surface of shaft **24** from the roughing stage to the finishing stage of the pump is the same, however.

As indicated hereinbefore, these improvements have provided at least two important results. First of all, the reduction of both recovery time and pump down time is at least 50 percent. Also, we have achieved a substantial reduction in operating temperatures; tests have shown that temperatures of the oil bath are reduced approximately 10° centigrade. It may be added that pump down time is that time required for a cold or newly assembled pump to provide the rated vacuum, while recovery time is that time required for a warm pump to "return" to the rated vacuum of the pump.

The foregoing description and the drawings are given merely to explain and illustrate our invention and the invention is not to be limited thereto, except in so far as the appended claim is so limited, since those skilled in the art who have our disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

We claim:

In a vacuum pump comprising a center plate having a stator fixed to each side thereof, said stators each being formed with an internal rounded surface, a rotor eccentrically mounted within each stator and in contact with the respective rounded surfaces to provide a crescent shaped pumping chamber within each stator, said stators each being formed with inlet conduit means on the intake side thereof and outlet conduit means on the exhaust side thereof, a pump inlet passage formed in said center plate and leading to said inlet conduit means of one of said stators, said one stator and its rotor comprising a pump finishing stage, a pump outlet passage formed in said center plate leading from the outlet conduit means of the other of said stators, said other stator and its rotor

comprising the roughing stage of the pump, said center plate being formed with a crosswise passage connecting said outlet conduit means of said finishing stage stator with said inlet conduit means of said roughing stage stator, vane means carried by each of said rotors, said vane means comprising a pair of diametrically opposed, outwardly biased, sliding blades having the outer ends thereof in contact with the respective internal surfaces of said stators, each of said stators having an end plate secured to the outwardly facing side thereof, a shaft rotatably mounted in said center plate and extending outwardly of each side of said center plate, said rotors being keyed to the respective ends of said shaft, and means for supplying lubricant to the mounting for said shaft and to said vanes and rotors, the improvement wherein said center plate is formed with an annular recess on both the roughing and finishing stage sides thereof about said shaft, and conduit means extends between the annular recess and the end of said crosswise passage on each side of said center plate, said conduit means respectively merging into said ends of said crosswise passage at a point above the bottom of said crosswise passage.

References Cited in the file of this patent

UNITED STATES PATENTS

2,337,849	Dubrovin	Dec. 28, 1943

FOREIGN PATENTS

620,465	Germany	Oct. 22, 1935
678,962	Germany	July 26, 1939