Feb. 10, 1970 G. K. CARGO 3,494,137

FLUID-OPERATED PUMP AND REFRIGERANT SYSTEM CONTAINING THE SAME

Filed June 12, 1968 2 Sheets-Sheet 1

FIG. 1.

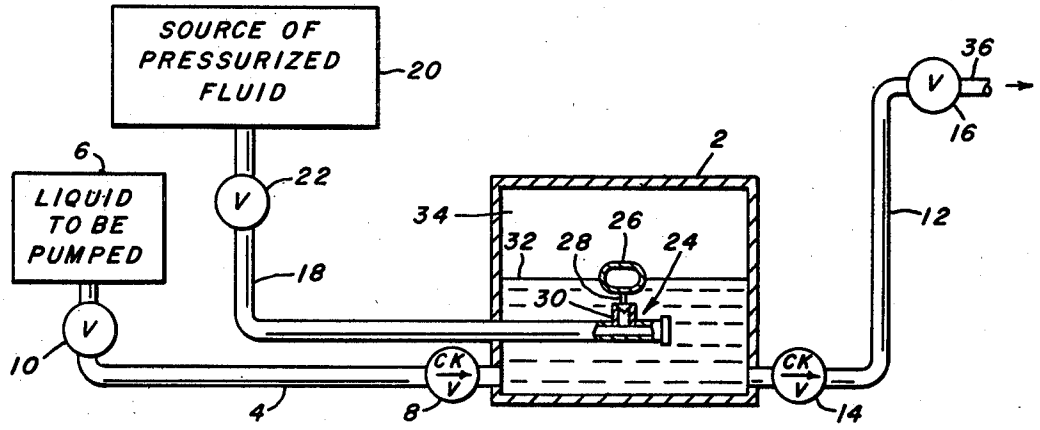
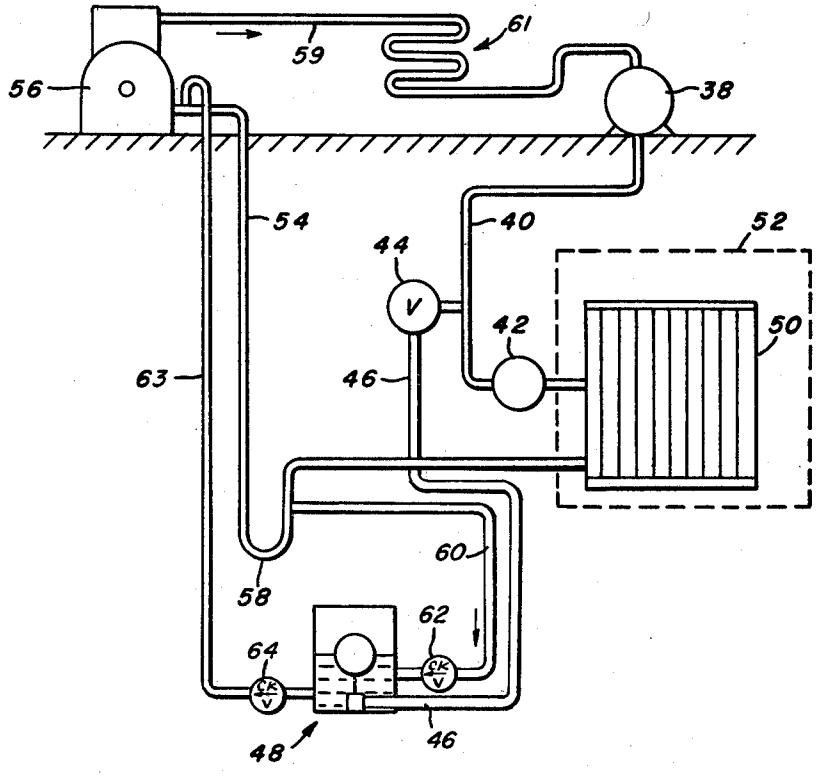


FIG. 2.



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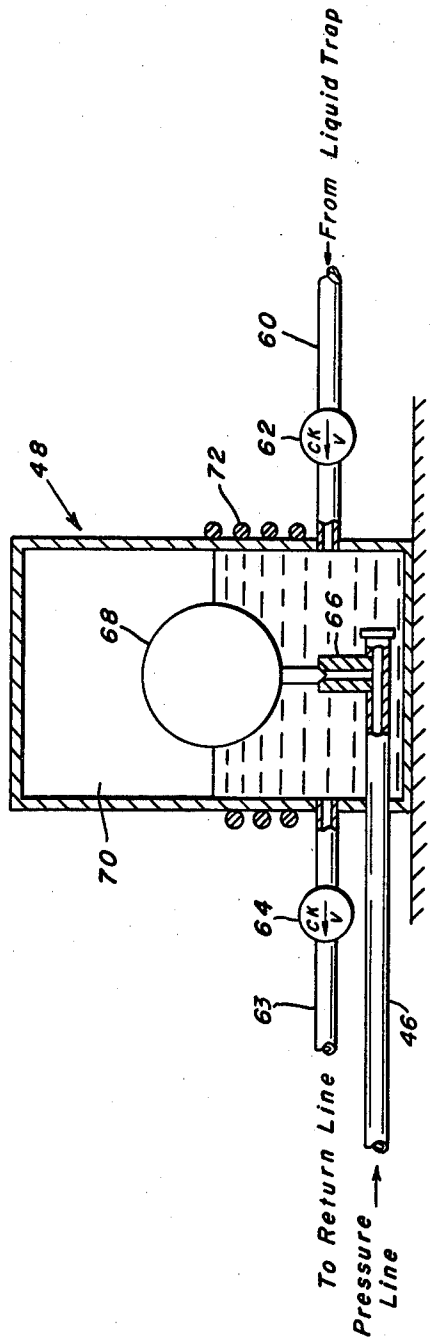
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FLUID-OPERATED PUMP AND REFRIGERANT SYSTEM CONTAINING THE SAME

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FIG. 3.



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FLUID-OPERATED PUMP AND REFRIGERANT SYSTEM CONTAINING THE SAME

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U.S. Cl. 62—84 9 Claims

ABSTRACT OF THE DISCLOSURE

Disclosed is a novel kind of pump, operated by means of pressurized fluid admitted to a closed chamber through a valve responsive to the level in the chamber of a liquid to be pumped. Such a pump is simple in construction, versatile in its uses, and not dependent upon a source of electrical power. Also disclosed is the use of such a pump, together with a refrigeration system in which dichlorodifluoromethane is recirculated between an evaporator and a compressor, to return to the compressor the lubricant taken up by the dichlorodifluoromethane in passing therethrough and condensing in the bottom of the coils of the evaporator.

BACKGROUND OF THE INVENTION

Field of the invention

This invention relates to pumps for liquid, and in particular to a recirculating refrigeration system containing a pump for liquid of the novel kind taught herein.

Description of the prior art

Refrigeration systems are known, in which a fluid refrigerant passes through an expansion valve into an evaporator member contained within the space to be cooled, thereby vaporizing and withdrawing heat from such space, with the gases issuing from the evaporator member then being led to a compressor and compressed to high pressure, so that upon being cooled they are condensed to form a liquid that may again be used in the evaporator. Various refrigerant substances are known, including dichlorodifluoromethane, which is also known as Freon. Other fluorinated methanes and ethanes are also sometimes called by the same name. These are advantageous because of their high heat of vaporization, relatively low toxicity, low freezing point, etc. It is known, however, that such refrigerants possess considerable affinity for lubricants of the kind that are used in compressors of such refrigeration systems. The compressed refrigerant gases contain such lubricant, which is soluble in the liquid refrigerant as it enters the evaporator. In the evaporator, the refrigerant gasifies and cools, so that some of the lubricant becomes insoluble and condenses out in the bottoms of the evaporator coils. It has been customary to collect the lubricant from the evaporator into a trap and return it to the compressor by means of a pump using a small electrical motor.

Pumps are known in which liquid is conveyed away from a pump chamber by the action of compressed gas trapped within the chamber. One example is the common force pump used with windmill-operated water-pumping systems. The windmill causes reciprocation of a member that forces water through a check valve into a chamber, the top of which contains air that is thereby compressed. The outlet line leading from the chamber is normally closed with a valve, and when that valve is opened, the compressed air forces water through the outlet line.

It is known, moreover, that the level of liquid in a chamber can be controlled by means of a system comprising a float having associated therewith a valve. In the most common example, the carburetor of an internal-

combustion engine, gasoline is maintained in a predetermined level in a carburetor chamber by having the float operate to open the valve, admitting additional gasoline to the chamber from the fuel line, whenever the liquid level in the carburetor chamber drops below the predetermined level.

BRIEF SUMMARY OF THE INVENTION

In one aspect, the invention relates to a pump comprising a closed chamber to which there is admitted liquid to be pumped through a line containing a check valve that closes against further ingress of liquid through said line whenever the pressure in said chamber reaches a value sufficiently high, with the chamber also having a liquid outlet line for liquid to be pumped containing a check valve that prevents the return to the chamber of liquid that has passed therethrough. The pump further comprises a source of fluid under pressure and a line admitting such fluid to the chamber, this line having a valve responsive to the liquid level in the chamber, such that whenever the liquid level rises above a predetermined location, fluid is admitted to the chamber, to create pressure therein and drive the liquid to be pumped into the liquid exit line. Preferably, the fluid used is the same as or miscible with the liquid to be pumped, and if desired, means are provided for heating the liquid to be pumped, to prevent it from solidifying.

In accordance with a further aspect of the invention, use is made of such a pump in order to return to the compressor of a refrigeration system comprising, in addition to the compressor, an evaporator, the lubricant picked up by the refrigerant gases passing through the compressor and becoming condensed as liquid during the gasification of the refrigerant in the coils of the evaporator. Refrigerant from the high-pressure side of the system is conveniently used as the source of fluid under pressure.

DESCRIPTION OF THE DRAWINGS

A complete understanding of the invention may be obtained from the foregoing and following description thereof, taken together with the appended drawings, in which:

FIGURE 1 is a schematic diagram of a pump in accordance with the present invention;

FIG. 2 is a schematic diagram of the refrigeration system comprising the novel pump as indicated in FIG. 1; and

FIG. 3 is a detailed view of the pump shown in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The novel pump of the invention comprises a closed chamber **2**, into which there is led through a line **4** from a suitable source **6** the liquid to be pumped. The line **4** contains a check valve **8** that prevents liquid from leaving the chamber **2** through the line **4**, and it also contains, preferably, an additional valve **10**.

There is also a liquid exit line **12** that communicates with the chamber **2** and contains a check valve **14** that serves to prevent liquid from returning to the chamber **2**, once that it has passed through the valve **14**. The line **12** also contains, preferably, an additional valve **16**.

Also entering the chamber **2** is a line **18** leading from a suitable source **20** of pressurized fluid and containing, if desired, a valve **22**. Within the chamber **2**, there is an additional valve **24**, in the nature of, for example, a needle valve and comprising a float **26** that is attached to a projection **28**, which, in turn, cooperates with a portion **30** of the line **18** to provide valved inlet of fluid from the source **20**. The action is such that whenever the level **32** of the liquid in the chamber **2** rises, the float **26** causes the projection **28** to rise, admitting fluid

from the source **20** to the chamber **2** and building up in the space **34** a pressure sufficient to cause liquid to be forced through the valve **14** and out the exit line **12**.

It will be understood that it is desirable for the pressurized fluid to be the same as, or thoroughly miscible with, the liquid to be pumped. In that way, there are avoided problems that would arise if the fluid from the source **20** were a gas that would condense to a liquid not miscible with the liquid **6**, including the problems associated with dealing with a liquid in the exit line **12** having two distinct, immiscible phases. Thus, the liquid to be pumped from the source **6** may be water, and the pressurized fluid from the source **20** may be steam, or, as will hereinafter be described in greater detail, the liquid to be pumped from the source **6** may be lubricant, and the fluid to be pumped from the source **20** may comprise liquid or gaseous high-pressure refrigerant gas, such as dichlorodifluoromethane or other refrigerant material comprising a fluorinated alkane having 1 to 2 carbon atoms.

The exact mode of the operation of the novel pump of the invention will depend upon a number of variables. Depending upon the nature of the fluid and liquid concerned and the values chosen for the above-mentioned variables, the flow of liquid in the exit line may be reasonably steady, mildly pulsed, distinctly pulsed but with high frequency, or distinctly pulsed with low frequency. The above-mentioned variables include the following: the pressure of the pressurized fluid used, the diameter of the line **18**, the size of the opening in the valve **24**, the vertical range of movement of the float **26** in passing from fully open to fully closed, the pressure or head of liquid from the source **6** in the line **4**, the pressure drop in the check valve **8**, the diameter of the line **4**, the valume of the chamber **2**, the diameter of the exit line **12**, and the vertical distance between the level **32** and the point of delivery of the liquid being pumped, indicated on the drawings at **36**.

For example, if the pressurized fluid from the source **20** is at a value too high, it is conceivable that whenever the valve **24** opens, the chamber **2** will be emptied and fluid will be forced out the exit line **12**. On the other hand, if the pressure of fluid in the source **20** is too low, no pumping action will be obtained, since the head of liquid in the line **12** will be sufficient to counteract such pressure of the fluid from the source **20**. With values of fluid pressure somewhat more intermediate, the rate of pumping may be somewhat faster or slower than is desired, or, in the event that a relatively steady flow is desired in the line **12**, the flow may be too uneven.

Similar variations in performance attend changes in others of the variable mentioned above, and for the most part, the nature of these will be apparent to those skilled in the art.

OPERATION OF THE PUMP

The pump means described above may be operated in following manner. First, the chamber **2** is filled with liquid to be pumped from the source **6** in a suitable manner. This may be done, for example, by opening the valve **16** and the valve **10**, and drawing a vacuum at the point of delivery **36** so as to bring into the chamber **2** a suitable quantity of liquid from the source **6**, and preferably enough to raise the float **26** to such a position that the valve **24** is open, the valve **22** being at this time closed.

Then, the valve **22** is opened end, as a result, fluid from the source **20** is admitted to the space **34**, causing pressure to be built up therein and causing the check valve **8** to close and the valve **14** to be driven open, so that liquid leaves the chamber **2** through the line **12**. Thereafter, as the pressurized gas in the space **34** forces the liquid level **32** downward, the valve **24** is closed and, provided that the pressure of the liquid to be pumped from the source **6** is sufficiently high, cyclic operation of the pump results.

If the pressures of the liquid from the source **6** and the fluid from the source **20** are properly balanced, and/or the valve **24** is sufficiently slow-acting, it is conceivable that there will result in the line **12** a reasonably steady flow of liquid. When this happens, the check valve **8** is in a semiclosed position and the check valve **14** is in a slightly more open one, so that there is a relatviely slight but effective differential of pressure in the two lines **4** and **12**, so that liquid enters the chamber **2** from the one and leaves the chamber **2** through the other.

According to an alternative method of starting the operation of the pump, the valve **10** is closed and the valves **16** and **22** are opened, so that the chamber **2** is filled with a condensable gas, e.g., steam. Then, the valves **22** and **16** are closed, and the gas in the chamber **2** is permitted to condense, creating a vacuum therein. Upon opening of the valve **10**, liquid from the source **6** is drawn into the chamber **2**.

ADVANTAGES OF PUMP OF THE INVENTION

The invention provides, as can be seen, a pump for liquid that does not require manual effort or the use of any electrical motors. It is of relatively simple construction, and is easy to construct, install and maintain. It is not limited to raising liquid by an amount corresponding to a head of one atmosphere. As will be explained below, the structure is particularly suitable for use in connection with refrigeration machinery in which a refrigerant is recirculated between a high-pressure side and a low-pressure side, or in other machinery where a source of high-pressure fluid is available. By a suitable choice of values for the above-mentioned variables, different modes of operation are possible, increasing the versatility of the pump of the invention.

REFRIGERATION APPARATUS OF THE INVENTION

Reference will now be had to FIG. 2, which shows schematically refrigeration apparatus embodying the pump as described above. Starting with the liquid tank **38**, refrigerant liquid under high pressure is drawn through the line **40** toward an expansion valve **42**. Through a valve **44** and a line **46**, some of the refrigerant liquid is drawn toward a pump **48**, which may be as described above, the high-pressure refrigerant liquid serving the purpose of the fluid from the source **20**. Most of the refrigerant liquid, however, passes through the expansion valve **42** into the evaporator **50** contained within the region **52** within which a cooling effect is to be obtained. In so doing, the high-pressure refrigerant liquid is permitted to expand and gasify, thereby becoming a great deal cooler, though not so cold as to liquefy or freeze. Expanded, low-pressure refrigerant gas withdrawn from the evaporator **50** through a line **54** communicates with a compressor **56** and contains a trap **58**. The compressor **56** increases the pressure of the refrigerant gas, which leaves the compressor **56** through a line **59**, passing through a condenser **61**, which may, if desired, be water-cooled, and thence to the liquid storage tank **38**.

In passing through the compressor **56**, the refrigerant gases tend to pick up the lubricant used therein. Although dichlorodifluoromethane is for many purposes an admirable refrigerant material, it possesses an affinity for lubricant of the kind used in such compressors. The lubricant material remains dissolved or suspended in the refrigerant until the refrigerant reaches the evaporator **50**, where the lubricant taken up by the refrigerant gases tends to condense out and gather in the bottoms of the coils of the evaporator **50** or, where such is provided, a trap such as the trap **58**.

It is important that the lubricant be removed from the evaporator **50**, since it tends to decrease the pressure drop that can be obtained therein and therefore the refrigeration capacity of the system. Moreover, with some systems involving the production of low temperatures that

may cause lubricants to solidify, permitting the lubricant to remain in the evaporator **50** can cause the refrigeration system to stop operating.

From FIGS. 2 and 3, it will be seen that the present invention, in its refrigeration-system aspect, comprises a use of a pump system as shown in FIG. 1, wherein there is provided a line **60** containing a check valve **62** that corresponds to the line **4** containing the check valve **8**. Similarly, the line **46** corresponds to the line **18** of FIG. 1, and the line **63** and check valve **64** correspond to line **12** and check valve **14**, respectively. There is a valve **66**, corresponding to the valve **24**, operated by means of a float **68**, corresponding to the float **26**.

If desired, as is frequently necessary with refrigeration systems intended to operate at a low temperature, such that the lubricant would solidify, it is desirable to provide the chamber **70**, corresponding to the chamber **2**, with heating coils **72**, shown schematically in FIG. 3. By means of the line **63**, lubricant fluid is returned to the compressor **56**.

The operation of the refrigeration system described in detail above will be apparent to those skilled in the art from the above description.

While I have shown and described herein certain embodiments of my invention, I intend to cover as well any change or modification therein which may be made without departing from its spirit and scope.

I claim as my invention:

1. Refrigeration apparatus comprising, in combination:

a pump for liquid comprising,

a puressure-tight chamber,

a first line entering said chamber for conveying thereto a liquid in such quantity, as needed, as to create in said chamber a predetermined liquid level, said first line containing check-valve means for preventing outflow of liquid from said chamber through said first line,

a second line entering said chamber for conveying thereto a fluid that is under pressure and is capable of generating in the space in said chamber above liquid level an absolute pressure exceeding one atmosphere,

means for sensing the liquid level of said chamber,

valve means associated with said second line and responsive to said liquid level sensing means for admitting fluid to said chamber through said second line whenever said liquid level exceeds a predetermined value less than said predetermined liquid level, and

a third line leaving said chamber for conveying pumped liquid therefrom, said third line containing check-valve means for preventing inflow of liquid from said third line into said chamber,

apparatus comprising a compressor for increasing the pressure of expanded refrigerant material in the gaseous state,

a condenser for liquefying the refrigerant material compressed by said compressor,

an evaporator having at its inlet an expansion valve and situated within a space to be cooled,

a first conduit for leading liquefied refrigerant material under high pressure to said expansion valve,

a second conduit for returning to said compressor expanded refrigerant material in the gaseous state issuing from said evaporator, said second conduit containing a trap for collecting liquid lubricant material that enters said refrigerant material in its passage through said compressor and becomes condensed as liquid in said evaporator,

said first line of said pump being connected to said trap.

said second line of said pump being connected to said first conduit, and

said third line of said pump being connected to said second conduit.

2. A pump for liquid comprising, in combination,

a pressure-tight chamber,

a first line entering said chamber for conveying thereto a liquid in such quantity, as needed, as to create in said chamber a predetermined liquid level, said first line containing check-valve means for preventing outflow of liquid from said chamber through said first line,

a second line entering said chamber for conveying thereto a fluid that is under pressure and is capable of generating in the space in said chamber above said liquid level an absolute pressure exceeding one atmosphere,

means for sensing the liquid level of said chamber comprising a float situated within said chamber,

valve means associated with said second line and responsive to said liquid level sensing means for admitting fluid to said chamber through said second line whenever said liquid level exceeds a predetermined value less than said predetermined liquid level, said valve means comprising a needle valve in said second line through said fluid that is under pressure passes, said needle valve being situated in a portion of said second line within said chamber, and

a third line leaving said chamber for conveying pumped liquid therefrom, said third line containing check-valve means for preventing inflow of liquid from said line into said chamber.

3. Refrigeration apparatus comprising the combination of a pump as defined in claim **2** with:

apparatus comprising a compressor for increasing the pressure of expanded refrigerant material in the gaseous state,

a condenser for liquefying the refrigerant material compressed by said compressor,

an evaporator having at its inlet an expansion valve and situated within a space to be cooled,

a first conduit for leading liquefied refrigerant material under high pressure to said expansion valve,

a second conduit for returning to said compressor expanded refrigerant material in the gaseous state issuing from said evaporator, said second conduit containing a trap for collecting liquid lubricant material that enters said refrigerant material in its passage said compressor and becomes condensed as liquid in said evaporator,

said first line of said pump being connected to said trap,

said second line of said pump being connected to said first conduit, and

said third line of said pump being connected to said second conduit.

4. Refrigeration apparatus as defined in claim **3**, said apparatus being suited for low-temperature operation and further comprising means for heating said lubricant in said chamber to maintain said lubricant in a liquid state.

5. In the operation of a refrigeration system using recirculating refrigerant material consisting essentially of at least one fluorinated alkane having 1 to 2 carbon atoms and comprising

a compressor for increasing the pressure of expanded refrigerant material in the gaseous state,

a condenser for liquefying the refrigerant material compressed by said compressor,

an evaporator having at its inlet an expansion valve situated within a space to be cooled,

a first conduit for leading liquefied refrigerant material under high pressure to said expansion valve, and

a second conduit for returning to said compressor expanded refrigerant material in the gaseous state issuing from said evaporator, said second conduit containing a trap for collecting liquid lubricant material that enters said refrigerant material in its passage through said compressor becomes condensed as liquid in said evaporator,

the method of returning said liquid lubricant material

to said compressor which comprises providing a pump for liquid comprising, in combination,

a pressure-tight chamber,

a first line entering said chamber for conveying thereto a liquid in such quantity, as needed, as to create in said chamber a predetermined liquid level, said first line containing check-valve means for preventing outflow of liquid from said chamber through said first line,

a second line entering said chamber for conveying thereto a fluid that is under pressure and is capable of generating in the space in said chamber above said liquid level an absolute pressure exceeding one atmosphere,

means for sensing the liquid level in said chamber,

valve means associated with said second line and responsive to said liquid-level-sensing means for admitting fluid to said chamber through said second line whenever said liquid level exceeds a predetermined value less than said predetermined liquid level, and

a third line leaving said chamber for conveying pump liquid therefrom, said third line containing check-valve means for preventing inflow of liquid from said third line into said chamber,

delivering said lubricant material contained in said trap to said pump through said first line,

delivering high-pressure refrigerant material from said first conduit to said pump through said second line, and

by the operation of said pump, delivering liquid lubricant material through said third line to said second conduit.

6. A method as defined in claim **5**, characterized in that said refrigerant material consists essentially of dichlorodifluoromethane.

7. A method as defined in claim **5**, further characterized in that said liquid-level-sensing means comprises a float situated within said chamber and said valve means responsive to said liquid-level sensing means comprises a needle valve in a portion of said second line within said chamber.

8. A method as defined in claim **7**, characterized in that said refrigerant material consists essentially of dichlorodifluoromethane.

9. A method as defined in claim **8**, further characterized by the step of heating said lubricant material in said chamber to maintain said lubricant material in a liquid state.

References Cited

UNITED STATES PATENTS

1,060,594	5/1913	Griffiths	103—248
1,157,491	10/1915	Anderson	103—248
1,544,916	7/1925	Judeman	103—248
2,366,955	1/1945	Burggrabe	103—248
2,665,557	1/1954	Dodson	62—193
3,079,763	3/1963	Schneider	62—84
3,081,604	3/1963	Namisniak	62—84
3,274,796	9/1966	Kocher	62—84
3,283,532	11/1966	Kocher	62—84

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U.S. Cl. X.R.

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