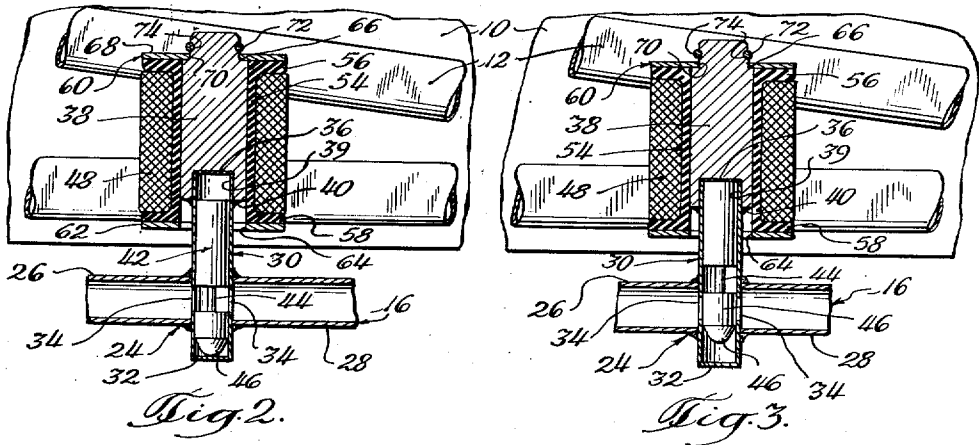
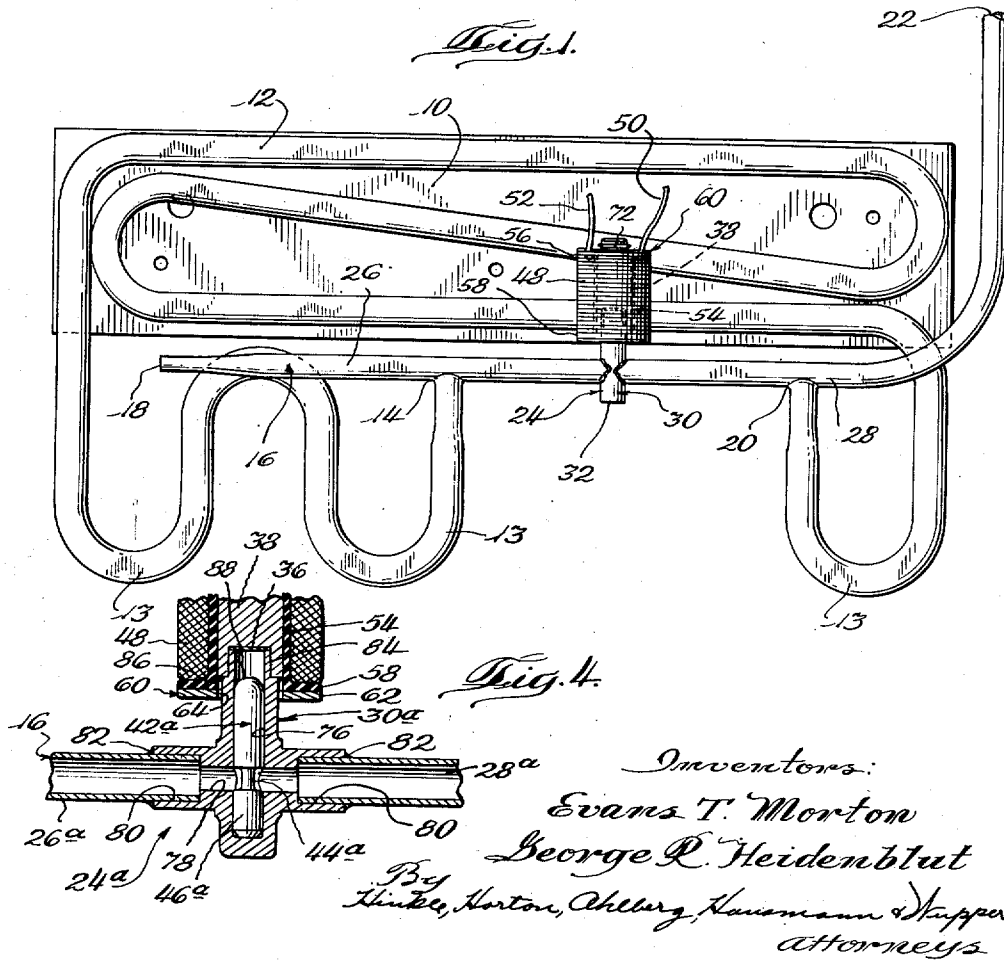


2,601,549

2 SHEETS--SHEET 1



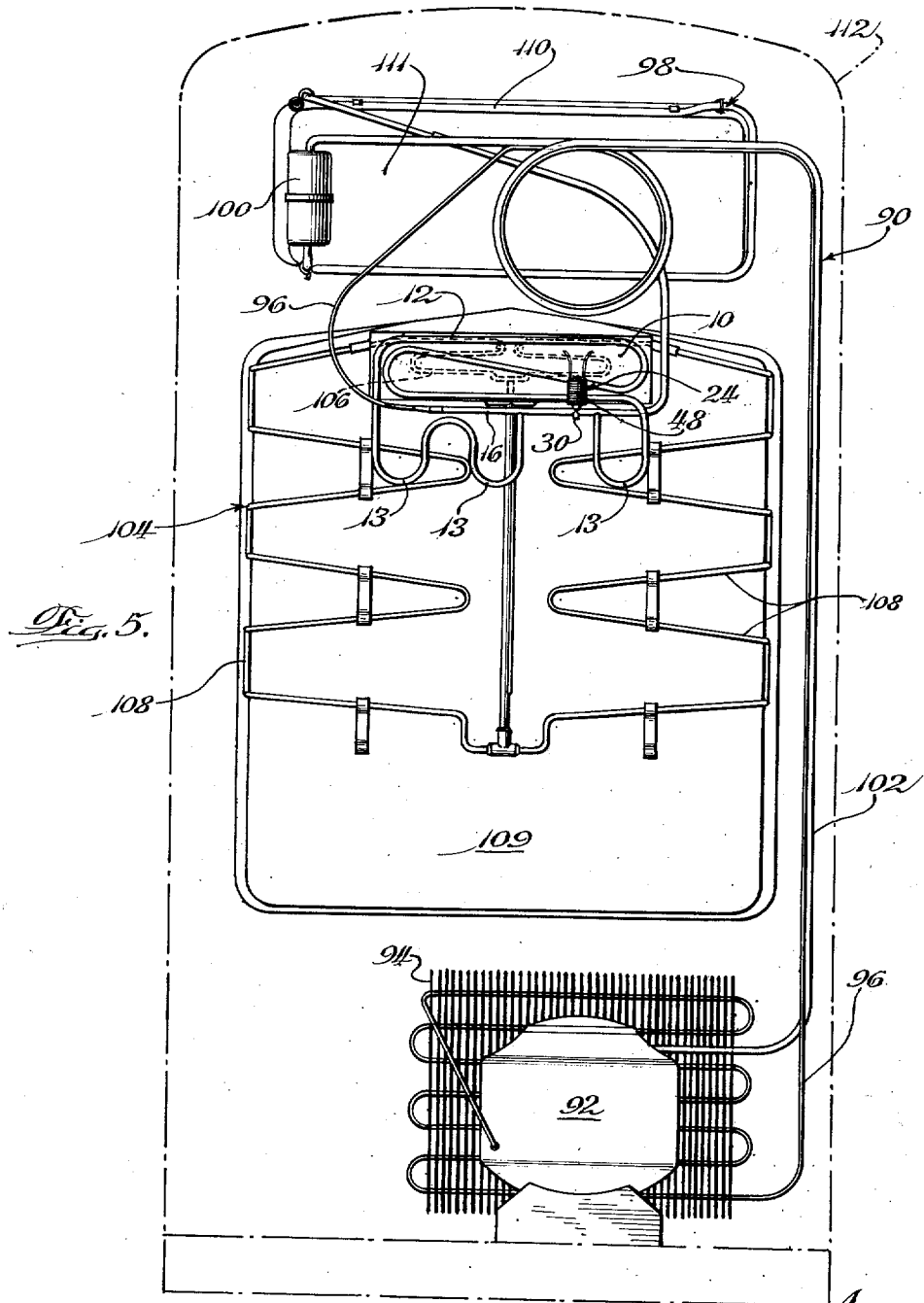
June 24, 1952

E. T. MORTON ET AL
RESTRICTING VALVE

2,601,549

Filed Jan. 2, 1947

2 SHEETS—SHEET 2



Inventor:
Evan T. Morton
By Hinkle, Horton, Ahlberg & Hupper
Attorneys

UNITED STATES PATENT OFFICE

2,601,549

RESTRICTING VALVE

Evans T. Morton, Chicago, and George R. Heidenblut, Des Plaines, Ill., assignors to Admiral Corporation, Chicago, Ill., a corporation of Delaware

Application January 2, 1947, Serial No. 719,670

3 Claims. (Cl. 62-8)

1

The present invention relates to restricting valves and in particular to a novel restricting valve adapted to be placed in a refrigerant circulating system to restrict the flow of refrigerant through the circuit or through a particular portion of the circuit.

It is the principal object of the present invention to provide a novel solenoid operated flow restricting valve, to be inserted in a refrigerant circulating system, which incorporates a minimum of moving parts and which will be moved to open or closed positions as desired regardless of flow and pressure conditions existing in the circuit.

It is a further object to provide a novel solenoid operated valve which can readily be changed from the open to closed condition or from the closed to open condition without sticking.

It is a further object to provide an improved type of restricting valve for use in a refrigerant circulating system which will not become frozen in either the open or the closed position.

It is still another object to provide a novel solenoid operated restricting valve which is simple in construction, is economical to manufacture and has a long life.

Other objects and advantages will become apparent from the following description taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is an elevational view of a portion of one type of refrigerant circulating system incorporating the restricting valve of this invention;

Fig. 2 is an enlarged medial cross sectional view with the valve in open position;

Fig. 3 is a view similar to Fig. 2, but illustrating the valve in closed position;

Fig. 4 is a fragmentary medial cross sectional view of a modified construction of the valve; and

Fig. 5 is a rear elevational view, somewhat schematic in form, of a typical installation incorporating the restricting valve of this invention and showing the refrigerator cabinet in phantom outline.

The valve of the present invention is particularly adapted to be used in a refrigerant circulating system such as that shown in the co-pending application of Evans T. Morton, Serial No. 720,080, filed January 3, 1947, now Patent No. 2,586,853, for an invention entitled "Multiple Temperature Refrigerator." Specifically, a two temperature refrigerator is described in that application and is cooled by a primary-secondary type of refrigeration system which is somewhat schematically illustrated in Fig. 5. The system has a

2

primary refrigerant circulating circuit 90 which includes a compressor 92, condenser 94, capillary tube 96, evaporator 98, accumulator 100 and suction tube 102; it also has a secondary circuit 104 including a condenser 106 and an evaporator 108 which is in contact with a liner 109 forming the large, moist cold food storage compartment. The primary evaporator is divided into two portions, one portion 110 being in contact with a frost chest liner 111 and the other portion 12 being permanently secured to a so called "contact plate" 10. This latter portion effects the transfer of heat between the secondary condenser, which is secured to a similar contact plate, and the primary evaporator and is the portion illustrated in detail in Fig. 1. The two contact plates are removably secured together so that the primary refrigeration system may be removed from the cabinet, indicated by the dot-dash lines and the reference character 112.

In this type of refrigerator, it is frequently desirable to cool the frost chest without cooling the secondary condenser 106, and at other times to cool the secondary condenser 106. The refrigerator is provided with separate and independent thermostatic controls (not shown) which may be responsive to the respective compartment temperatures or to the temperatures of the refrigerant associated with the compartments and circulating in the primary and secondary systems. The thermostat associated with the frost chest 111 controls the operation of the compressor 92, while that associated with the warmer compartment 109 controls the cooling conditions in respect of the secondary condenser 106. In order that the secondary condenser 106 may be cooled independently of the frost chest 111, the primary system incorporates the two separate evaporator portions 12 and 110. These portions are so arranged that they may be connected in series or that one of them—that which cools the secondary condenser—may be by-passed. The by-pass is provided with a controllable restriction which, in the refrigerator under discussion, is the restricting valve of the present invention, this valve being in either the closed or open position as set by the warmer compartment thermostatic control.

In other types of primary-secondary refrigerating systems, two primary evaporators may be arranged in parallel or partially in parallel and partially in series. Regardless of what type of primary system is used, it is desirable to control the flow of refrigerant through the different evaporator portions in such manner that the

proper temperature conditions are maintained in the storage compartments.

In order that this control over the flow of refrigerant be had, it is necessary only to increase the obstruction or resistance to the flow of refrigerant in one portion of the evaporator to a point where it is greater than the obstruction or resistance to flow of refrigerant in the alternate portion of the evaporator as the liquid refrigerant will flow through that portion where the resistance is the smallest. By alternating the resistance the refrigerant can be made to flow through the proper evaporator portions according to the cooling requirements of the refrigerator compartments.

It is not necessary that an absolute shutting off of the coils of a particular section or portion of the evaporator be made but merely that it require more pressure to send refrigerant through the one portion of the evaporator than through the portion that is to be used for a particular cooling. By properly placing the restricting valve of the present invention in the refrigerant circulating tubing, the desired control over the flow of refrigerant through the different portions of the evaporator may be obtained.

While the invention is described with particular reference to the primary-secondary system of the aforesaid application of Evans T. Morton, Serial No. 720,080 and illustrated in Fig. 5, nevertheless it is to be understood that the principles of balancing pressures and resistance to flow may be applied to other types of refrigerating systems and the restricting valve of the present invention may be used in such systems. The illustration, therefore, is merely indicative of one use of the invention and is not to be considered as being limitative.

Referring now to Figs. 1 to 3, the primary contact plate 10 normally in contact and heat exchange relationship with the similar plate secured to the secondary condenser 106, has the primary evaporator coil 12, soldered, brazed or welded to the face thereof to provide a good thermal connection. The inlet end of the coil 12 is connected at 14 to a tube 16 the end 18 of which is in turn connected to the capillary tube 96 of the primary refrigerant circulating system. The outlet end of the coil 12 is connected at 20 to the tube 16. Suitable refrigerant traps 13 are provided in the coil 12 to increase the resistance to the flow of refrigerant therethrough thereby preventing such flow when the resistance to flow through the tube 16 is less than that through the coil 12. The reference character 22 indicates the end of the tube 16 which is connected to that portion 110 of the primary evaporator which is in contact with the frost chest liner 111. A refrigerant flow controlling restricting valve 24 is placed in the tube 16 intermediate the junctions 14 and 20.

The tube 16 is formed in two sections, 26 and 28, and is made of a non-magnetic material such as copper, which possesses the further advantageous characteristic of noncorrosiveness. The tubes 26 and 28 are silver soldered to a vertically disposed tubular valve body 30, preferably made of brass, which is closed at its bottom 32 and open at the top. Below its vertical center the valve body is provided with a pair of diametrically-opposed openings 34 which are in communication with the tubes 26 and 28. At its upper end the valve body 30 is closed by a very thin brass plate 36 which is retained in position by a solenoid core 38 formed of a magnetic material such

as iron or steel. The core 38 is recessed at 39 to fit over the upper end of the valve body to which it is silver soldered at 40.

A valve plunger 42 formed of a magnetic material reciprocates vertically within the valve body 30. Neither the plunger 42 nor the core 38 are permanent magnets nor made of material which may be permanently magnetized by ordinary household current customarily supplied at 110-120 volts. The valve body 42 is provided with an intermediate portion 44 of considerably reduced diameter and with a rounded head portion 46. When the plunger 42 is at the bottom of the valve body 30 the reduced portion 44 is opposite the openings 34 and the valve is open; but when the valve body 42 is in its raised position (Fig. 3), the portion 46 is opposite the openings 34 and the valve is closed.

The plunger 42 has an outside diameter slightly smaller than the inside diameter of the tubular valve body 30 so that the plunger will reciprocate freely and will not stick in either its raised or lowered position. Since the plunger face area at the top of the reduced portion 44 is equal to that at the bottom thereof, the effective fluid pressure exerted on the faces of the reduced portion is zero, and the plunger will reciprocate in the valve body independently of the pressure of the refrigerant or of its rate of flow. In practice it has been found that an annular clearance of .015 inch between the plunger and the valve body gives very satisfactory performance and actually does not completely cut off the flow of refrigerant from the tube 26 to the tube 28 when the valve is in its closed position. When the valve is closed the path of least resistance is through the coil 12. However, with the reduction in pressure at the junction of the capillary tube and the tube 16 the refrigerant commences boiling and a small amount of vapor or gas is formed. By causing the gas to bubble out of the liquid refrigerant in the tube 16 it will pass the restricting valve 24 without carrying an appreciable amount of liquid refrigerant with it. This gas separation means is illustrated and described in the copending application of Evans T. Morton, Ser. No. 720,080.

A solenoid coil 48 provided with leads 50 and 52 is mounted around the core 38. The coil 48 is wound upon a suitable spool 54 flanged at 56 and 58 and made of an electrical insulating material. The solenoid core 38 is cylindrical, and the spool has a complementary cylindrical opening. A U-shaped shield or retainer 60 removably holds the solenoid coil 48 in place on the core. The retainer 60 is provided with a bottom flange 62 having an opening 64 which is only slightly larger than the outside diameter of the core 38 and slips readily thereover. Adjacent its upper end the core 38 is provided with a shoulder 66 on which an upper flange 68 of the retainer 60 is seated, the diameter of opening 70 in the top flange being smaller than the major outside diameter of the core 38. A hairpin shaped retaining spring 72 is engaged in a notch 74 in the upper end of the core 38 above the flange 68 to prevent inadvertent removal or dislodging of the coil 48 from the core 38.

The solenoid coil 48 is removable from the valve and the core 38 because it is desirable to have the primary refrigerant circulating system 90 removable from the cabinet. Since the valve 24 is a permanent component of the primary system it is likewise removed. Usually it will be unnecessary to remove the solenoid coil 48 from the refrigerator cabinet, and, therefore, it is

5

desirable that the coil be removable from the valve body.

In the typical refrigerating system shown in Fig. 5 the solenoid coil 48 is energized and deenergized according to temperature conditions in the warmer or food storage compartment 109 of the refrigerator. When this temperature rises above a desired value, the circuit including the solenoid coil 48 is energized and the plunger 42 is moved upwardly to the position shown in Fig. 3 to increase the amount of resistance to the flow of refrigerant through the tube 16 so that it is greater than the resistance of the coil 12, thereby causing the refrigerant to flow through the evaporator coil 12 which is secured to the face of the contact plate 10. When sufficient cooling of the secondary refrigerant circulating system 104 has taken place and the temperature in the food storage compartment has dropped sufficiently, the circuit to the solenoid coil 48 will be broken and the plunger 42 will drop by gravity to the bottom of the valve body 30, bringing the portion 44 of the plunger opposite the openings 34 to restore communication between the tubes 26 and 28. With the valve 24 open the evaporator coil 12 will be by-passed because the liquid refrigerant in the traps 13 builds up sufficient resistance to prevent flow therethrough provided a parallel path having a lower resistance is open; this low resistance path is through the tube 16 and valve 24.

The brass plate 36 placed between the upper end of the plunger 42 and the adjacent lower face of the core 38 prevents the establishment of a holding magnetic circuit through the plunger 42 and the core 38 based upon residual magnetism, so that when the magnetic circuit built up by the coil 48 collapses, the plunger 42 will drop by gravity to the bottom of the valve body. It is, of course, important that the valve 24 be mounted so that the plunger 42 will be returned to its rest or normal position by gravity.

A modified type of valve 24a which operates on the same principle as the valve illustrated in Figs. 1 to 3 is shown in Fig. 4. This valve comprises a valve body 30a having the general form of a cross and made of a brass forging or extrusion. A vertical bore or cylinder 76 is drilled therein but not through it, so that the bottom of the cylinder is closed. A plunger 42a is mounted for vertical reciprocation within the bore or cylinder 76 in the same manner as the plunger 42 is mounted within the tubular valve body 30. A bore 78 perpendicular to the cylinder 76 is drilled through the cross arms of the valve body 30a and is provided with counter-bores 80 into which sections 26a and 28a of the refrigerator tubing 16 are inserted. The tubing portions 26a and 28a are silver-soldered or brazed to the valve body 30a at 82.

The upper open end of the valve body 30a is capped by the iron core 38 and the brass plate 36 is interposed between the solenoid core 38 and the upper edge of the valve body 30a. In order to accommodate and locate the core 38, the outside wall of the vertically extending portion of the valve body 30a is turned down at 84, and the core 38 is soldered or brazed thereto at 86.

The plunger 42a is somewhat different from the plunger 42 in that it has a reduced portion 44a of greater section. However, the clearance between the reduced portion 44a and vertical cylinder 76 is not less than the cross-sectional area of the bore 78 so that when the valve is in open position it presents no greater resistance to the

6

flow of refrigerant than does the bore 78. The valve plunger has a rounded top 88 for engagement with the brass washer 36 to make the valve less noisy when held in closed position by the solenoid. The rounded head 88 presents a single pointed contact with the plate 36, whereas the flat headed valve plunger 42 illustrated in Figs. 1 to 3 presents a plane surface. At times the plane surface is not even or a small bit of metal projects outwardly therefrom, which causes the valve plunger 42 to chatter as it is held in the raised or closed position by the energized solenoid coil 38.

The operation of the modified form of restriction valve 24a as shown in Fig. 4 is identical with that of Figs. 1 to 3 and need not be repeated.

Both illustrated embodiments of the invention disclose the valve to be open when the plunger is in the rest or normal position; it is obvious that with a minor rearrangement the valve can be changed so that it will be open when the plunger is raised and the solenoid coil energized.

While a preferred embodiment of the invention has been described, it will be apparent to those skilled in the art that numerous modifications may be made therein without departing from the spirit and scope of the present invention, which, therefore, is intended to be limited only by the scope of the appended claims.

What is claimed as new and desired to be secured by United States Letters Patent is:

1. In a refrigerant circulating system, tubing forming alternative paths for refrigerant flow, one of said paths normally presenting less resistance to refrigerant flow than the other path, a restriction in the low resistance path, said restriction comprising a normally open valve including in combination, a valve body, a pair of diametrically opposed openings in said valve body communicating with the tubing, a plunger reciprocable in said valve body, said plunger having a portion substantially but not completely filling the cross sectional area of said valve body adjacent said openings so as to provide a capillary-like space between said plunger and said valve body when the valve is closed substantially to prevent the flow of liquid refrigerant therethrough but to permit the free flow of gaseous refrigerant therethrough, said plunger having a second portion of reduced cross sectional area adjacent said openings when the valve is open, and means associated with said plunger for moving said plunger in only one direction, said plunger returning to its first position by gravity.

2. In a refrigerant circulating system, tubing forming alternative paths for refrigerant flow, one of said paths normally presenting less resistance to refrigerant flow than the other path, a restriction in the low resistance path, said restriction comprising a normally open valve including in combination, a valve body, a pair of openings in said valve body communicating with the tubing, a plunger reciprocable in said valve body, said plunger having a portion substantially but not completely filling the cross sectional area of said valve body adjacent said openings so as to provide a capillary-like space between said plunger and said valve body when the valve is closed substantially to prevent the flow of liquid refrigerant therethrough but to permit the free flow of gaseous refrigerant therethrough, said plunger having a second portion of reduced cross sectional area adjacent said openings when the valve is open, and a solenoid coil associated with said plunger for moving said plunger in only one

direction, said plunger returning to its first position by gravity.

3. In a refrigerant circulating system, tubing forming an evaporator, said evaporator being formed to have a high resistance to refrigerant flow, a by-pass around said evaporator normally presenting less resistance to refrigerant flow than said evaporator, a restriction in the low resistance path, said restriction comprising a normally open valve including in combination, a valve body, a pair of diametrically opposed openings in said valve body communicating with said tubing, a plunger reciprocable in said valve body, said plunger having a portion substantially but not completely filling the cross sectional area of said valve body adjacent said openings so as to provide a capillary-like space between said plunger and said valve body when the valve is closed substantially to prevent the flow of liquid refrigerant therethrough but to permit the free flow of gaseous refrigerant therethrough, said plunger having a second portion of reduced cross sectional area adjacent said openings when the valve is open, and a solenoid coil associated with

said plunger for moving said plunger in only one direction, said plunger returning to its first position by gravity.

EVANS T. MORTON.
GEORGE R. HEIDENBLUT.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
Re. 12,710	Kramer	Oct. 29, 1907
563,879	Paul	July 14, 1896
811,064	Hughes	Jan. 30, 1906
1,140,623	Simmien	May 25, 1915
1,271,670	Conrad	July 9, 1918
1,523,112	FitzGerald	Jan. 13, 1925
2,374,895	Ray	May 1, 1945
2,519,578	Jiminez	Aug. 22, 1950

FOREIGN PATENTS

Number	Country	Date
214,451	Great Britain	Apr. 24, 1924