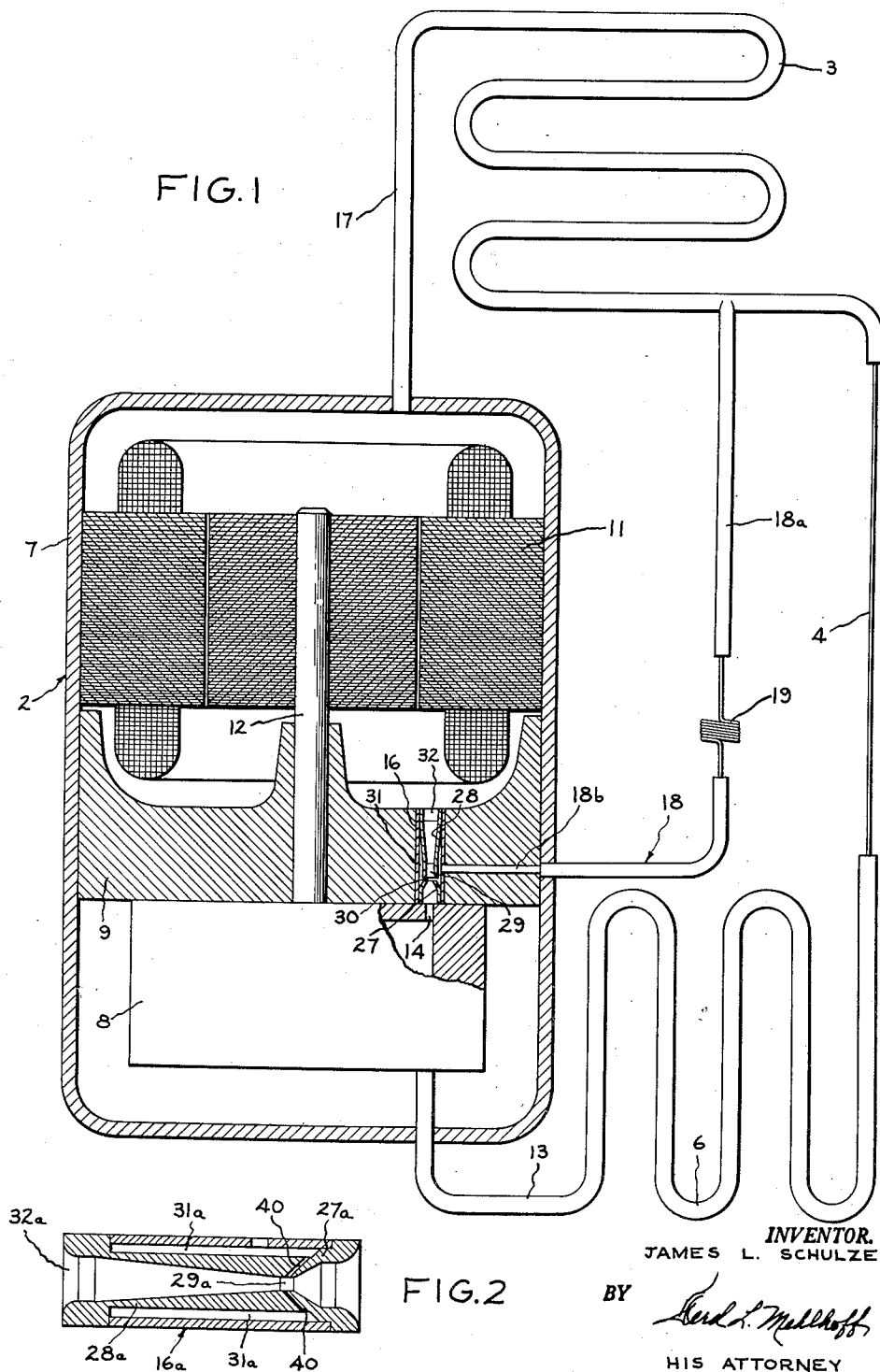


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MOTOR COOLING ARRANGEMENT FOR HERMETICALLY SEALED REFRIGERANT COMPRESSOR UNIT

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The present invention relates to a hermetically sealed motor-compressor unit and more particularly to an improved arrangement for cooling the motor of such a unit.

It is common practice in the field of refrigeration to mount both the refrigerant compressor and its drive motor within a hermetically sealed casing. In such an arrangement it is necessary to devise some means for cooling the drive motor in order to maintain its temperature within safe operating limits. One means employed for this purpose is to pass the high pressure discharge gas from the compressor unit over the compressor motor after this high pressure gas has been cooled to a low enough temperature to remove heat from the motor thereby maintaining the motor at a safe operating temperature. The heat removed from the motor is carried off by the gas and dissipated in the condenser of the refrigerating system. This is an efficient method of maintaining the motor at a proper operating temperature but requires that the high pressure discharge gas be pre-cooled before being passed into intimate contact with the motor. One means used for cooling the high pressure discharge gas involves the use of a superheat removal coil which is connected to the discharge outlet of the compressor unit and extends outside the hermetic casing into the outside ambient. The gas flows from the compressor into the superheat removal coil and is thereby cooled before being passed back into the case and over the motor. The incorporation of a superheat removal coil onto the hermetic casing creates a sealing problem and, in addition, creates a noise problem due to the intermittent discharge pulses of high pressure gas flowing through the coil which cause audible radiations that are also transmitted from the coil to supporting structures.

To obtain the advantages of discharge gas cooling of the motor while overcoming the disadvantages of a superheat removal coil, another method is used which incorporates the injection of condensed refrigerant from the refrigerating system into the hermetic casing where it mixes with the high pressure discharge gas to cool this gas and thereby cool the motor. However, in order to withdraw condensed refrigerant from the condenser into the compressor case, it is necessary to overcome the pressure drop in the system which occurs in the condenser and refrigerant tubing leading thereto. It is also desirable to provide some means for automatically increasing and decreasing the amount of condensed refrigerant being added to the case according to the load on the motor, which is normally relatively great when large quantities of gas are pumped and correspondingly less when lesser quantities of gas are pumped. It is, therefore, desirable that the means for supplying condensed refrigerant from the condenser of the system be automatically modulated to supply correspondingly greater or lesser amounts of condensed refrigerant according to the quantities of the gas being discharged from the compressor so that the amount of cooling will vary correspondingly with the

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varying loads on the compressor and thereby maintain the motor continuously at a safe operating temperature.

Accordingly, it is an object of the present invention to provide an improved arrangement for introducing condensed refrigerant into the discharge gas stream being directed into the casing for cooling the motor of a hermetically sealed motor compressor unit.

It is another object of the present invention to provide an improved means for overcoming the pressure drop in the condenser of the system in order to promote the flow of liquid refrigerant from the condenser into the high pressure refrigerant gas being directed into the hermetically sealed casing.

A more specific object of the present invention is to provide an improved means for pumping liquid refrigerant from the condenser which means automatically modulates the liquid refrigerant flow according to the quantity of refrigerant flowing through the discharge passage from the compressor unit into the hermetically sealed casing.

Further objects and advantages of the invention will become apparent as the following description proceeds and the features of novelty which characterize the invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In accordance with the present invention there is provided a hermetically sealed refrigerant compressor unit adapted to form part of a refrigerating system including a condenser for condensing the refrigerant compressed by the compressor unit and an evaporator for evaporating the condensed refrigerant. A discharge passage is provided between the compressor unit and the hermetic casing for directing high pressure discharge gas from the compressor directly into the casing. A portion of this passage takes the form of an aspirating means, such as a venturi or a jet pump, which creates a region of lower pressure in the high pressure gas stream flowing through the passage. A liquid refrigerant supply passage, communicating with a source of condensed refrigerant in the condenser, introduces liquid refrigerant into the low pressure region of the aspirating means. The low pressure region in the aspirating means provides the requisite pressure drop to promote flow of liquid refrigerant from the condenser into the low pressure region where it mixes with the high pressure gas flowing therethrough. In the preferred form, the system employs a restriction in the condensed refrigerant supply passage leading from the condenser for restricting the flow of refrigerant through the passage. Inasmuch as the quantity of condensed refrigerant flowing through the liquid supply passage depends on the pressure drop in the lower pressure region of the aspirator means which, in turn, depends on the quantity of refrigerant gas flowing therethrough, the flow of liquid refrigerant through the condensed refrigerant supply passage from the condenser is variable in accordance with the quantity of gas pumped by the compressor and, thus, in accordance with the approximate cooling requirements of the gas being pumped.

For a better understanding of the invention reference may be had to the accompanying drawings in which:

Fig. 1 is a somewhat schematic view, partially in section, of a refrigerating system incorporating the invention; and

Fig. 2 is a cross-sectional detailed view of a second type of aspirating means which takes the form of a venturi member.

Referring to the Fig. 1, there is shown a hermetically sealed refrigerant compressor 2 which forms part of a refrigerating system including a condenser 3, an expansion means in the form of a capillary 4, and an evaporator 6 all connected in refrigerant flow relationship. The compressor includes a hermetically sealed casing 7 having arranged in its lower portions a compressor unit 8

which is supported within the casing 7 by a main frame 9. Mounted above the main frame 9 is a compressor drive motor 11 which drives the compressor through a shaft 12 also supported in the main frame 9.

During operation of the compressor, low pressure refrigerant is withdrawn from the evaporator 6 through the suction line 13 which connects with the suction port (not shown) of the compressor unit 8. The refrigerant gas is compressed within the compressor unit to a relatively high pressure and temperature and is then discharged by the compressor through a suitable discharge passage leading directly into the hermetic casing. The discharge passage includes the discharge port 14 of the compressor unit which directs the high pressure discharge gas into an aspirating means or jet pump 16 positioned in the main frame 9 through which the hot discharge gases must pass prior to entering the hermetic case. After flowing upwardly over the motor 11, the high pressure gas is conducted out of the casing through the conduit 17 into the condenser 3 where the heat absorbed by the refrigerant in the other portions of the system is extracted. As the gas in the condenser is cooled, it condenses so that the refrigerant in the latter stages of the condenser is largely in liquid form.

In order to cool the discharge gas flowing from the compressor unit sufficiently to maintain the motor within safe operating temperatures, cooled liquid refrigerant from the condenser is introduced into this gas as it flows through the aspirating means. The aspirating means, shown in Fig. 1, takes the form of a jet pump 16 having a nozzle or gas accelerating section 27 and a diffuser or gas decelerating section 28. As the high pressure gas flows through the jet pump it drops in pressure in the nozzle section 27 where its velocity is increased. The gas pressure increases to approximately its original pressure as the velocity decreases in the diffuser section 28. In the throat 29 of the jet pump there is created a region of low pressure into which liquid or condensed refrigerant is syphoned through the circular orifice 30 from the cavity 31. The condensed refrigerant is then mixed with the high pressure gas flowing through the pump. Liquid refrigerant is introduced into the cavity 31 of the jet pump by means of a condensed refrigerant supply passage 18 which communicates with the cavity 31 and connects with a source of condensed refrigerant in the latter stages of the condenser. In a manner similar to that described above for the jet pump, the venturi-type aspirating means 26a, shown in Fig. 2, which contains the nozzle section 27a, diffuser section 28a, throat 29a, and cavity 31a can be employed to draw liquid refrigerant through a supply passage from the condenser where the condensed refrigerant is introduced into the gas stream through the orifices 40 leading into the throat 29a of the venturi member.

Referring to Fig. 1, the liquid refrigerant supply passage includes a conduit 18a that connects at one end with one of the latter coils of the condenser and, at the other end, connects with the passage 18b formed in the main frame 9. Passage 18b leads directly into the cavity 31 of the jet pump.

Liquid refrigerant flowing through the conduit 18a is restricted to some extent by a restricting means or capillary 19. The design of the restricting means or capillary 19 should permit enough condensed refrigerant to flow through the conduit 18a that will sufficiently cool the discharge gas but still limit the flow sufficiently to eliminate short circuiting of the evaporator and eventual collection of refrigerant in liquid form within the case. Obviously a capillary does not have to be used for this purpose. Other means such as a needle valve or other type of restriction could easily be substituted for this capillary. When the liquid refrigerant is introduced into the throat or low pressure region of the aspirating means, it encounters the hot discharge gases and is vaporized or flashed into gaseous form. The heat removed from the discharge

gas, in vaporizing the liquid refrigerant, reduces the temperature of the discharge gases and the violent reaction created by flashing the liquid into vaporous form completely mixes the gases so that the resultant gas mixture issuing from the passage is at a substantially uniform temperature and much cooler than the temperature of the original high pressure gas discharged from the compressor.

As was stated before, the high pressure gas flowing through the aspirating means is first dropped in pressure and then recovers approximately all of the pressure drop as it passes through the diffuser sections of the aspirator. In actual tests made on both types of aspirating means shown in Figs. 1 and 2, it was found possible to attain a pressure difference between the low pressure region 29 (29a in the embodiment of Fig. 2), and the outlet 32 of the passage of 10 pounds per square inch with a normal flow of refrigerant gas through the aspirating means. This is easily sufficient to overcome the pressure drop encountered in the case and the tubing through the condenser. That is, the pressure in the lower pressure region or the throat 29 (29a of the venturi-type aspirating means) is less than the pressure in the latter stages of the condenser and, therefore, causes considerable flow of liquid refrigerant through the supply passage 18 toward the aspirating means.

In operation, the jet pump 26 or venturi 26a act as modulating devices for supplying greater or lesser amounts of condensed refrigerant to cool the high pressure discharge gas according to the flow of gas through the discharge passage from the compressor unit. As the amount of liquid refrigerant flowing through the supply passage 18 depends to a great extent upon the pressure recovery experienced in the diffuser section from the throat to the outlet of the diffuser and, since the amount of pressure recovery in the jet pump or venturi is a function of the quantity of gas flowing therethrough, it is apparent that the amount of liquid refrigerant syphoned through the supply passage 18 depends on the quantity of discharge gas flowing through the discharge passage leading from the compressor unit. Thus, whenever the pressure of the suction gases is high, the amount of gas being pumped is, under normal conditions, also correspondingly greater and the cooling requirement, therefore, is correspondingly greater. However, the increased quantity of gas being pumped results in a greater flow of liquid refrigerant into the throat or low pressure region 29 (or 29a of the venturi) to supply the necessary cooling of the high temperature discharge gas. Conversely, whenever the suction pressure is low and the compressed discharge gas is at a relatively low temperature, the amount of gas being pumped through the discharge passage is correspondingly less, and consequently produces a correspondingly smaller pressure difference between the throat 29 and the outlet 32 of the jet pump or aspirating means, thereby resulting in a diminished flow through the conduit 18 and a lesser amount of cooling of the discharge gas. Thus, under normal conditions of operation, the aspirating means modulates the amount of cooling of the discharge gas from the compressor and automatically increases or decreases the cooling effect on this gas to maintain the motor within safe operating limits.

While, in the preferred embodiment of the invention, the aspirating means of the discharge passage is formed in the main frame 9, it does not necessarily have to be positioned or formed in this manner. It could, for example, be formed in a tube connected to the discharge port 14 of the compressor into which the discharge gas would flow prior to being delivered back into the hermetic case. In this manner the tube and aspirating means could be positioned on the outside of the casing. In this arrangement, the conduit 18a would lead directly into the cavity 31 rather than having a continuation of the passage formed in the main frame. The important thing is that the discharge gases feeding from the compressor be

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passed through a passage or coil having a portion thereof shaped in the form of an aspirating means, such as the above described jet pump or venturi, for producing a pressure drop in the discharge gas as it flows through the passage. This pressure drop is used to overcome the pressure drop encountered in the condenser of the system and actually siphons the condenser liquid refrigerant from the condenser.

It has been found desirable to add sufficient restricting means, such as the capillary 19, in the conduit 18 to limit the flow through this conduit when the flow of gas through the discharge passage is relatively small and, therefore, at a very low temperature. Under these low flow conditions, the discharge gas is generally at a temperature low enough to cool the motor without requiring additional cooling. Since the pressure drop in the throat 29 or 29a of the jet pump or venturi respectively is relatively small at these times, as compared to the pressure drop under most operating conditions, the restriction 19 in the conduit 18 can be designed to practically eliminate the liquid flow at these times.

By the present invention there has been provided a simple arrangement for mixing liquid refrigerant in the discharge gases issuing from the compressor unit for cooling the motor. Moreover this means is self-modulating in that the amount of liquid refrigerant introduced into the discharge gases is increased or decreased according to the flow of discharge gases and according to the normal cooling requirements of the discharge gas flowing from the compressor.

While in accordance with the patent statutes there has been described what at present is considered to be the preferred embodiment of the present invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, the aim of the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing housing said compressor, a motor in said casing for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a discharge passage leading from said compressor into said casing for conducting compressed refrigerant gas from said compressor into said casing for cooling said motor, said discharge passage including an aspirating means for creating a low pressure region in said discharge gas stream as it passes through said aspirating means, means for conducting high pressure gas from said casing into said condenser, a condensed refrigerant supply passage having one end connecting with said low pressure region of said aspirating means and the other end connecting with a source of condensed refrigerant in said condenser for introducing condensed refrigerant into said discharge passage so that said high pressure discharge gas flowing into said casing and over said motor is mixed with and cooled by said condensed refrigerant to maintain said motor temperature within safe operating conditions.

2. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing housing said compressor, a motor in said casing for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a discharge passage for conducting compressed refrigerant gas from the compressor into said casing for cooling said motor, said discharge passage including a jet pump having a throat of reduced cross sectional area for creating a low pressure region in said discharge gas as it passes through said throat, means for conducting high pressure gas from said casing

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into said condenser, a condensed refrigerant supply passage having one end connecting with said throat of said jet pump and the other end connecting with a source of condensed refrigerant in said condenser, said low pressure region in said throat of said jet pump causing condensed refrigerant to flow through said supply passage into said throat where said condensed refrigerant becomes mixed with said high pressure discharge gas flowing into said casing thereby cooling said high pressure discharge gas and maintaining said motor temperature within safe operating conditions.

3. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing housing said compressor, a motor in said casing for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a discharge passage for conducting compressed refrigerant gas from said compressor into said casing for cooling said motor, said discharge passage including a jet pump having a throat of reduced cross sectional area for creating a low pressure region in said discharge gas as it passes through said throat, means for conducting high pressure gas from said casing into said condenser, a condensed refrigerant supply passage having one end connecting with said throat of said jet pump and the other end connecting with a source of condensed refrigerant in said condenser, said supply passage having a restriction therein for limiting the flow of condensed refrigerant therethrough, said low pressure region in said throat of said jet pump causing condensed refrigerant to flow through said supply passage into said throat where said condensed refrigerant becomes mixed with said high pressure discharge gas flowing into said casing thereby cooling said high pressure discharge gas and maintaining said motor temperature within safe operating conditions.

4. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing housing said compressor, a motor in said casing for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a discharge passage for conducting compressed refrigerant gas from the compressor into said casing for cooling said motor, said discharge passage including a venturi member having a throat of reduced cross sectional area for creating a low pressure region in said discharge gas as it passes through said throat, means for conducting high pressure gas in said casing into said condenser, a condensed refrigerant supply passage having one end connecting with said throat of said venturi member and the other end connecting with a source of condensed refrigerant in said condenser, said low pressure region in said throat of said venturi member causing condensed refrigerant to flow through said supply passage into said throat where said condensed refrigerant becomes mixed with high pressure discharge gas flowing into said casing thereby cooling said high pressure gas and maintaining said motor temperature within safe operating conditions.

5. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing, a main frame mounted in said casing, a compressor unit mounted below said main frame and supported in said casing thereby, a motor in said casing mounted above said main frame, said motor having a drive shaft journaled in said main frame and extending into said compressor for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a high pressure gas discharge port in the upper portion of said compressor adjacent said main frame, an aspirating means formed in said main frame and communicating at one end with said discharge port of said compressor and at the other end with said casing, said aspirating means having a throat of reduced cross-sectional area for creating

a low pressure region in said discharge gas as it passes through said aspirating means, a condensed refrigerant supply passage having one end communicating with said throat of said aspirating means and the other end leading to a source of condensed refrigerant in said condenser so that said low pressure region in said discharge gas flowing through said aspirating means causes condensed refrigerant to flow through said supply passage into said throat of said aspirating means to cool said high pressure discharge gas prior to its discharge into said casing where it flows upwardly over said motor to maintain said motor temperature within safe operating conditions.

6. In a refrigeration system having a condenser, an evaporator, and a compressor, the combination comprising a hermetically sealed casing, a main frame mounted in said casing, a compressor unit mounted below said main frame and supported in said casing thereby, a motor in said casing mounted above said main frame, said motor having a drive shaft journaled in said main frame and extending into said compressor for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a high pressure gas discharge port in the upper portion of said compressor adjacent said main frame, a jet pump formed in said main frame and communicating with said discharge port of said compressor, said jet pump having a throat of reduced cross-sectional area for creating a low pressure region in said discharge gas as it passes through said jet pump, a condensed refrigerant supply passage having one end communicating with said throat of said jet pump and the other end leading to a source of condensed refrigerant in said condenser so that said low pressure region in said discharge gas flowing through said jet pump causes condensed refrigerant to flow through said supply passage into said throat of said jet pump to cool said high pressure discharge gas prior to discharge of said gas into said casing where it flows upwardly over said motor to maintain said motor temperature within said operating conditions.

7. In a refrigeration system having a condenser, an

evaporator, and a compressor, the combination comprising a hermetically sealed casing, a main frame mounted in said casing, a compressor unit mounted below said main frame and supported in said casing thereby, a motor in said casing mounted above said main frame, said motor having a drive shaft journaled in said main frame and extending into said compressor for driving said compressor, means for delivering low pressure refrigerant gas from said evaporator into said compressor, a high pressure gas discharge port in the upper portion of said compressor adjacent said main frame, an aspirating means formed in said main frame, said aspirating means having one end communicating with said discharge port of said compressor and the other end discharging into said casing, said aspirating means having a throat of reduced cross-sectional area for creating a low pressure region in said discharge gas as it passes through said aspirating means, a condensed refrigerant supply passage having one end connecting with said low pressure region of said aspirating means and the other end connecting with a source of condensed refrigerant in said condenser, said supply passage having a restriction therein for limiting the flow of condensed refrigerant therethrough, said low pressure region in said throat of said aspirating means causing condensed refrigerant to flow through said supply passage into said throat of said aspirating means to cool said high pressure discharge gas prior to its discharge into said casing where it flows upwardly over said motor to maintain said motor temperature within safe operating conditions.

References Cited in the file of this patent

UNITED STATES PATENTS

2,247,950	Kucher	July 1, 1941
2,510,887	Hanson	June 6, 1950
2,776,542	Cooper	Jan. 8, 1957
2,891,391	Kocker et al.	June 23, 1959
2,904,971	Kosfield	Sept. 22, 1959