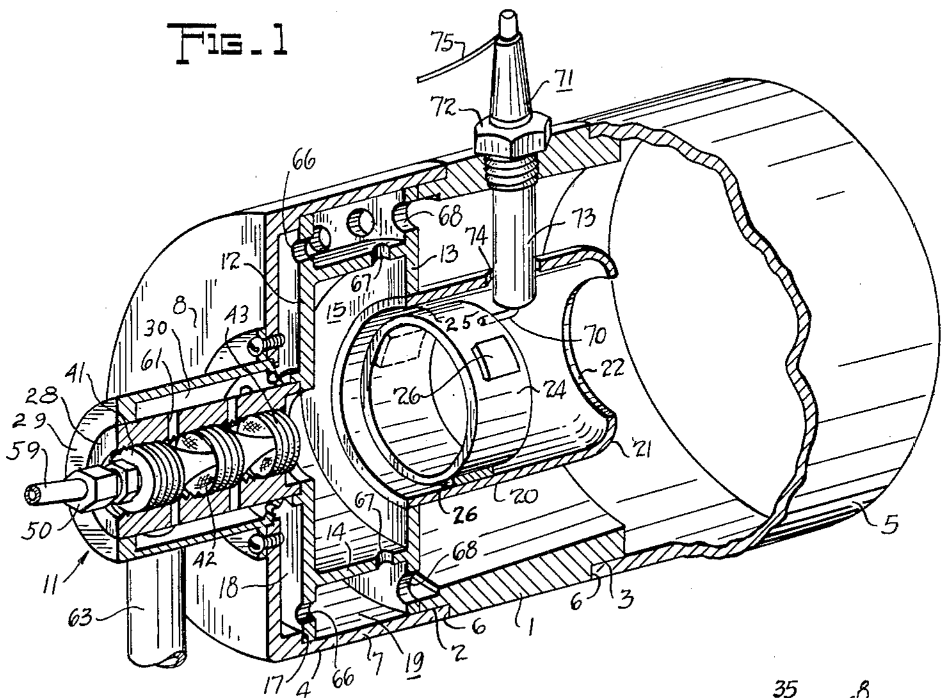
Dec. 25, 1962 R. H. HUNTER ETAL 3,070,150

LIQUID FUEL HEATER

Filed May 21, 1958

FIG. 1



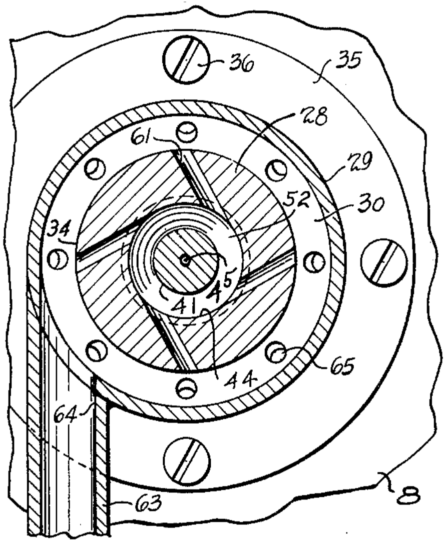


FIG. 3

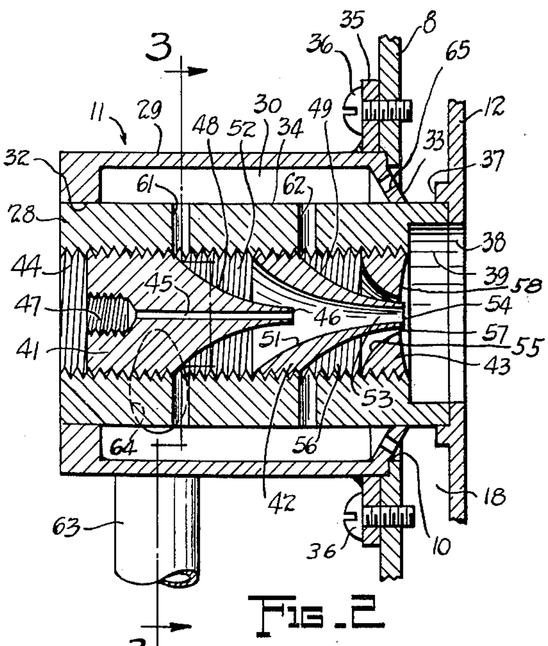


FIG. 2

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LIQUID FUEL HEATER

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This invention relates to heating devices, more particularly to atomizing oil burners of the type in which both combustion supporting air and liquid fuel oil are supplied to a nozzle system, the air being supplied under pressure to entrain the fuel for discharge from a common orifice in the form of a combustible spray mixture.

Oil burning heaters are frequently required to operate efficiently on oils of different types and viscosities, at different firing rates and under greatly varying climatic conditions. A number of burner designs have evolved as a result of attempts to provide systems capable of being fired at different rates and also capable of burning different oils without adjustment. One such burner is disclosed in copending application Serial No. 515,686 filed June 15, 1955 by Robert H. Hunter, one of the present applicants, and Ralph S. Damon, now United States Patent 2,876,763, dated March 10, 1959, owned by the assignee of the present application.

The principal object of the invention is to provide an improved oil heater of the character referred to, particularly a simplified arrangement for effecting complete and thorough mixing of the air and fuel oil over a wide air pressure range.

More specifically, the invention is concerned with confinement of the projected spray to maintain control of the resulting flame, minimize pulsations and vibrations and obtain high efficiency. Such control is another objective and is achieved by projecting the fuel-air spray across a cushion chamber and thence directly into one end of a hollow member in the form of a cylindrical open ended combustion tube suitably supported on the nozzle axis in concentric relation to the spray path. The receiving end of the combustion tube is spaced axially from the discharge orifice of the nozzle. Suitable walls, which desirably may constitute a supporting means for the combustion tube, define and enclose a cushion chamber which is of greater transverse dimension than the diameter of the combustion tube, the cushion chamber incorporating the space between the discharge orifice of the nozzle and the receiving end of the combustion tube. Suitable passages and ports are provided in the cushion chamber walls and support means to supply secondary air to the cushion chamber, preferably at its outer periphery, so that such secondary air mingles with or is drawn into the spray as the latter enters the combustion tube.

Another object of the invention is concerned with control over the recirculation of gases within a combustion tube such as described above. To this end a control ring comprising a cylindrical annulus is mounted within the combustion tube in coaxial relation. The external diameter of such control ring is less than that of the interior of the combustion tube and suitable spacers are interposed between the ring and the tube to support the latter in predetermined relation spaced from both ends of the tube. Gases tending to flow rearwardly in the combustion tube are thus afforded a confined passage through the space between the ring and the tube.

Other objects and advantages are concerned with certain structural features, combinations and arrangements of parts obtaining simplicity in design with attendant economy in manufacture. The invention is described with reference to a preferred embodiment representing the best known mode of practicing the invention. This embodiment is illustrated in the accompanying drawings forming a part of the specification.

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In the drawings:

FIG. 1 is a fragmentary isometric drawing partly in axial section and with parts broken away and removed showing the heating device of the present invention;

FIG. 2 is an enlarged fragmentary longitudinal section through the nozzle assembly of the device of FIG. 1; and

FIG. 3 is a transverse sectional details taken through the nozzle assembly substantially in the plane represented by the line **3—3** of FIG. 2.

The heating device of the present invention is essentially an oil burner and as such may be used in various conventional and well known ways. The hot gases and products of combustion can be conducted through a suitable heat exchanger to exhaust and thus used to heat air supplied to a building through such exchanger. In another application the hot gaseous products of combustion may be passed directly into a space to be heated such as a retort or kiln as employed in various processing industries. As an aid to the cold starting of an internal combustion engine the present heater may discharge directly into the intake manifold of such an engine.

The present heater comprises casing means which includes tubular shell **1**, housing **4** and extension tube **5**, all hollow circular sectioned components disposed in end to end relation and concentric to the main axis of the device. The shell **1** may take the form of a cylindrically shaped brass or iron casting. The ends of this shell have reduced diameter portions **2**, **3** that are respectively received telescopically one within one end of the housing **4** and the other within the rear end of the cylindrical extension tube **5** into which the products of combustion are discharged. The ends of the housing **4** and the extension tube **5** abut radial shoulders **6** on the shell **1**, thereby locating the parts in assembly, and are secured by suitable means such as drive screws, not shown.

The extension tube **5** may be secured to and open into, for example, the intake manifold of a diesel or other internal combustion engine. Thus the heater may be supported by such manifold to discharge hot gases and products of combustion into the manifold where they will comingle with and heat air moving into the cylinders of the engine. In another arrangement the extension tube **5** may be suitably supported and connected to a heat exchanger through which the hot gases and products of combustion of the heater are caused to flow in a conventional manner. In other arrangements the extension tube **5**, suitably lengthened and supported, may be made to discharge the hot gases and products of combustion into the interior of a kiln, retort or other space or device to be heated.

The housing **4** has a cylindrical wall **7** and, at the rear end of the later, an end closure wall **8** which is normal to the main axis and is formed with a central opening **10** (FIG. 2) closed by a nozzle structure **11**.

While it is feasible to ignite the fuel-air spray in an open combustion chamber such as provided by the housing **4**, shell **1** and extension tube **5** comprising the casing means, improved efficiency, and control and better heating is achieved by confining the spray within a hollow member in the form of a generally cylindrical combustion tube **20** open at both ends. The combustion tube is supported in coaxial relation to the path or trajectory of the fuel spray and is positioned with its receiving end spaced axially from the nozzle so as to provide an intervening cushion air chamber through which secondary air is fed to the spray and which has a modulating effect on the flame that minimizes pulsations and vibrations. To this end a specialized internal partitioning arrangement is provided within the housing **4**. A pair of axially spaced cross walls or partitions **12, 13**, each in the form of a circular ring, and a cylindrical inner wall **14**, extending between the cross walls, define a cushion chamber **15** across which the fuel-air spray from the nozzle **11** is projected. The housing **4** is desirably made as a casting of brass, aluminum, bronze or similar suitable metal. The cylindrical interior wall surface terminates at a radial shoulder **17** against which the outer periphery of the circular partition **12** is locatingly abutted in assembly. The shoulder **17** is spaced from the end closure wall **8** so that a narrow air chamber **18** is provided between the walls **8** and **12**.

The inner cylindrically shaped annular wall **14** is formed integrally with or at its rear end welded to the front face of the circular partition wall **12** so as to be supported by the latter in concentric relation to the outer wall **7** of the housing and to the main axis of the device. Since the wall **14** is of less external diameter than the internal diameter of the outer wall **7**, there is provided an annular air chamber **19** which surrounds the cushion chamber **15**.

The rear face of the circular partition **13** is engaged by the forward end of the inner annular wall **14**. The periphery of the other or front side of the partition **13** is disposed against the end of the casing shell **1**. Thus the partition **13** is held in place against axial movement. Both partitions **12** and **13** have circular peripheries of approximately the same diameter as the machined internal cylindrical surface of the housing wall **7** so that the parts are fixed in predetermined radial positions relative and concentric to the main axis of the device. Thus a circular centrally located axial opening through the partition **13** into the receiving end of the hollow member or combustion tube **20** is in the trajectory of the fuel-oil spray projected across the cushion chamber **15** from the nozzle assembly **11**.

The combustion tube **20** is mounted cantilever fashion on and supported solely by the circular partition **13** from which the tube projects forwardly through the center of the casing shell **1**. Its base or receiving end is received over the central opening of the partition and is welded or otherwise made fast thereto. The forward or discharge end of the combustion tube is formed with a circular inwardly directed curved radial flange **21** which defines circular discharge opening **22**.

Within and concentric to the combustion tube **20** and spaced axially from both of its ends is a flame controlling sleeve **24** symmetrical about the axis of the device. This sleeve comprises a cylindrical, radially thin metal member which has an external diameter less than the internal diameter of the combustion tube **20** in the provision of circumferentially extending clearance space **25** of greater axial than radial extent. The diameter of the clear opening through the sleeve is preferably greater than that of the discharge opening **22**. The control sleeve is centered in the combustion tube by a number of spacing blocks **26** distributed about the circumference of the sleeve and welded against the outside surface of the sleeve before the latter is slipped into the combustion tube. One or more of the spacing blocks are then welded to the combustion tube to secure the sleeve and tube in desired axial relationship.

The nozzle structure **11** is described and claimed in copending application for patent Serial Number 99,191, filed March 29, 1961. It comprises inner and outer tubular body members **28, 29** and plugs or orifice members **41, 42, 43**. The body members are disposed one within the other and are separated by an annular air chamber **30**. The ends of the chamber **30** are closed by inwardly directed circular flanges **32, 33** integrally formed on the outer member and which closely embrace cylindrical outer surface **34** of the inner member **28** at the ends of the latter. The body members **28, 29** are turned from brass or other suitable metal and the circular joints where the surface **34** of the inner member is embraced by the inner peripheries of the end flanges **32, 33** are sealed as by brazing.

An annular ring **35** surrounds and is brazed to the forward end of the outer member **29** adjacent the end flange **33** and is apertured at circumferentially spaced points to receive attaching screws **36** which are threaded into the end wall **8** of the main housing **4** to secure the nozzle assembly in place over the circular opening **10**.

The inner body member **28** is longer than the outer member **29**, projecting axially beyond the end flange **33** of the latter, across the narrow air chamber **18**, and being received within a shallow axial flange **37** on the partition **12**. A circular opening **38** in the partition **12** registers with a counterbore **39** in the end of the inner body member **28**, these openings constituting the outlet of the nozzle into the cushion chamber **15**.

The plugs or orifice members **41, 42** and **43** are disposed in alignment within the hollow interior of the tubular inner body member **28**. These members are each of circular cross section and are suitably held in axially spaced fixed relation coaxial to one another and to the tubular members **28, 29**. A convenient structural arrangement comprises external threads all of the same diameter on the circular sectioned members **41, 42, 43** and matching internal threads on the body member **28** throughout the entire length of its axial bore. The orifice plug thus may be screwed into desired positions in the bore of the body member.

The first orifice member **41** has an axial through passage **45** terminating at the forward end of the member in a discharge orifice **46**. At its rear end the member **41** is counterbored and tapped at **47** to receive threaded fitting **50** on the end of a fuel supply line **59**. Fuel oil, such as kerosene or gasoline, is contained in a suitable remote storage vessel or tank and supplied as by gravity flow to the passage **45** of the orifice member **41** through a suitable flow control system such as a constant level float bowl device (not shown) which has a needle valve actuated by a float to maintain a constant level in the bowl. The bowl of the constant level fuel control device is connected to the passage **45** through a short conduit such that the level in the bowl is substantially the same as or only slightly below the level of the orifice **46**.

The plug or orifice members are formed on their confronting ends with coaxial surfaces of revolution which shape the aspirating chambers of the nozzle. Thus the orifice members **41** and **42** are formed with external or outwardly facing concave tapering surfaces of revolutions **48, 49** which are concentric to the axis or path of fuel traveling through the nozzle device and approach such path tangentially. An internal or inwardly facing convexly curving tapered surface **51** on the orifice member **42** is disposed in axially spaced relation to the surface **48** of the orifice member **41**, providing between the orifice members **41, 42** a first aspirating or air chamber **52** which surrounds and is coaxial to the fuel path and progressively diminishes in cross-sectional area in the direction of fuel flow. The smoothly curving wall **51** of the chamber **52** blends tangentially into the wall of an axial passage portion **53** in the forward part of the orifice member **42**. The passage **53** terminates in a discharge orifice **54** spaced axially beyond or forward of the orifice **46**.

An internal conxely curved tapered surface **55** is formed on the orifice member **43** and faces rearwardly, confronting the tapered surface **49** of the second orifice member **42** in axially spaced relation, thus providing between the members **42, 43** a second air or aspirating chamber **56** which surrounds and is coaxial to the path of fuel advancing through the nozzle structure. The chamber **56** progressively decreases in diameter and cross-sectional area toward an annular axially directed orifice **57** defined by a circular wall opening in the forward end of the orifice member **43** and the smaller diameter circular end of the second orifice member **42** which projects slightly through and is concentric to such wall opening in the third orifice member 43. Front end face 58 of the orifice member 43 may be flat or, as shown, may be slightly dished or concave with the circular opening which defines the annular orifice 57 located at the bottom of the concavity.

A number of oblique passages 61, 62 are drilled or otherwise formed in the nozzle member 28 to place the annular air chamber 30 in communication with each of the tapering air chambers 52, 56 at the rear or large diameter ends of the latter.

Air is supplied to the annular chamber 30 from a suitable source such as a centrifugal blower or fan (not shown) at a pressure of from about 1 to about 30 or more inches of water, the exact pressure depending upon factors such as fuel oil viscosity and the desired rate of fuel consumption. The air pressure is increased to increase the rate or with higher viscosity fuel oil and is decreased to decrease the rate or with lower viscosity fuel oil. The air is conducted from the blower or other supply through suitable conduit means which includes a tubular conduit 63 brazed or otherwise secured to the outer member 29 of the nozzle structure. The conduit 63 is disposed so that air forced into the chamber 30 enters tangentially through opening 64 and flows about the inner nozzle member 28 in a clockwise direction as viewed in FIG. 3. The pressurized air thus introduced into the annular chamber is forced tangentially into the rear or closed ends of the tapering air chambers 52, 56 through the oblique passages 61, 62 so that the air rotates in the tapered chambers in the same direction it rotates in the outer chamber 30, but at a higher velocity resulting from the reduced cross-sectional area. The high velocity air thus traveling through the first air chamber 52 and approaching the fuel path tangentially, generally from left to right as viewed in FIG. 2, has an aspirating effect on the liquid fuel supply system, the reduced pressure which prevails in the chamber 52 and at the discharge orifice 46 results in fuel being drawn or projected into the chamber from such orifice. The projected fuel is comminuted and entrained in the high velocity air advancing helically and as a contracting cone into and through the axial passage 53 of the second orifice member 42 so that the mixture is projected from the orifice 54 as a fine spray into and across the cushion chamber 15.

The circular opening 10 in the end wall 8 of the main housing is larger than the external diameter of the inner body member 28 of the nozzle structure to allow air to flow into the air chamber 18 from the chamber 30 through a number of ports 65 formed in the flange 33. Preferably, the flange is canted to project through the wall opening 10 or the ports 65 are otherwise made oblique to direct the air outwardly. At circumferentially spaced points located radially outwardly of the annular wall 14 the partition 12 is formed with axial ports 66 which place the chamber 18 in communication with the annular chamber 19 to supply pressurized air to the latter. Radial ports 67 in the wall 14 and axial ports 68 in the wall 13 place the cushion chamber 15 and the interior of the shell 1 in communication with the annular chamber 19, the ports of each group being circumferentially spaced uniformly about the axis of the device. Thus air supplied under pressure to the annular chamber 30 in the nozzle structure through the supply tube or conduit 63 is distributed to a number of supply points along the path of the fuel-air spray and the flame. Pressurized air in the annular chamber 19 surrounding the cushion chamber, such air being supplied through the narrow chamber 18 and the ports 65 and 66 is introduced radially into the cushion chamber through the ports 67 at a number of points spaced circumferentially about such cushion chamber and is also supplied through the axial ports 68 to the annular space in the main shell 1 which surrounds the combustion tube 20.

The air introduced into the cushion chamber 15 through the ports 67 flows radially inward and mixes with the conical spray being projected continuously across the cushion chamber into the receiving end of the combustion tube 20 from the orifices 54, 57 of the nozzle assembly. The system thus provides a center rich fuel-air mixture conducive to efficient burning with minimum smoking and deposition of carbon to the metal parts of the burner.

Ignition of the fuel-air spray is effected by a high frequency electrical spark produced between center electrode 70 of a spark plug assembly 71 and one of the grounded metal parts such as the control sleeve 24 of the combustion tube assembly. In the arrangement shown, the spark plug assembly includes a threaded support sleeve 72 screwed into a tapped radial hole in the casing 1. The spark plug has an internal insulator or porcelain and an outside metal tube or sleeve 73 which extends radially across the annular chamber that surrounds the combustion tube 20 and projects into the interior of the latter through a hole 74, a suitable annular clearance separating the sleeve 73 from the metal of the combustion tube. The electrode 70 extends through the internal porcelain insulator which is inside the metal sleeve 73 and at its outer end the electrode is threaded and provided with nuts or other suitable connector means for attachment of a high tension electrical cable 75 by means of which the spark plug is connected to one of the terminals of a suitable source of high frequency electrical curent. The other terminal of the current source is grounded to the metal casing of the oil burner device so that, upon energization of the ignition system the desired spark is produced inside the tube 20.

Thus the present invention provides a compact, economical heater which incorporates a nozzle assembly operating on the aspirating principle and capable of atomizing fuel at a variable rate depending upon the pressure at which air is supplied through the tube 63. Since the entire air supply is furnished through the single tube, variation in the pressure of the air so supplied automatically varies the rate of air supply to the several air chambers of the burner and to the different points along the fuel, air and flame path.

Prior to entering the cylindrically shaped combustion zone within the combustion tube 20 the fuel-air spray travels across the cushion chamber 15 which is of larger cross-sectional area than the combustion zone and is symmetrical about the fuel path. At the discharge end of the combustion tube 20, the flange 21 constitutes a choke on the flame and promotes a limited recirculation of the outermost portions of the gases in the tube. These outermost portions of the gases thus traveling rearwardly toward the receiving end of the combustion tube pass through clearance 25 between the control sleeve 24 and the internal surface of the combustion tube for reentry into the main body of the flame substantially at the receiving end of the combustion tube.

In accordance with the patent statutes the principle of the present invention may be utilized in various ways, numerous modifications and alterations being contemplated, substitution of parts and changes in construction being resorted to as desired, it being understood that the embodiment shown in the drawings and described above is given merely for purposes of explanation and illustration without intending to limit the scope of the claims to the specific details disclosed.

What we claim and desire to secure by Letters Patent of the United States is:

1. In a liquid fuel burner, a casing having an annular wall forming a combustion chamber, nozzle means fixed relative to the casing and adapted to receive fuel and air and project them into the chamber along a predetermined axis, a hollow member having an open receiving end, means mounting the member within the casing with said open end facing and disposed in spaced aligned relation to the nozzle means and with the member generally symmetric relative to said axis, said member being dis-

posed to receive the projected fuel and air in its open end, with the interior of said member constituting an initial combustion zone, said hollow member being of smaller cross sectional area than and being separated from the casing by a surrounding annular clearance space, the casing being of greater length along said axis than the hollow member and having a combustion chamber portion beyond the member and continuous with the clearance space about the entire circumferential extent of the latter, means defining a cushion chamber including annular wall means surrounding the space between the nozzle means and the hollow member, said cushion chamber being of greater cross-sectional area than the interior of the hollow member and of greater dimension transverse to said axis than along said axis from the nozzle means to the open receiving end of the hollow member, air conducting means adapted to feed a first supply of air to the cushion chamber through the annular wall means at a plurality of points spaced circumferentially about the axis to flow first into the outer periphery of the cushion chamber and thence toward the center thereof, and said air conducting means feeding a second supply of air other than the air supplied to the cushion chamber to said annular clearance space to flow therein toward and into said combustion chamber portion in the same general axial direction as projected fuel and air.

2. In a burner as defined in claim 1 the hollow member being of metal and having on its other end an inturned flange of thin section defining a flame discharge orifice concentric with said axis and of less cross-sectional area than the combustion zone.

3. In a burner as defined in claim 1, a cylindrical sleeve of less axial length than diameter and also of less axial length than the hollow member, means supporting the sleeve within and in symmetrical spaced relation to the hollow member, and one end of the sleeve being closer to the receiving end of the hollow member than its other end is to the other end of the hollow member, said space between the hollow member and the sleeve constituting a return path over which gases circulating in the combustion zone flow toward the receiving end of the hollow member.

4. In a burner as defined in claim 1 said air conducting means comprising a portion of the casing surrounding the annular wall means in coaxial relation and separated therefrom by a second annular clearance space, said air conducting means also comprising a ring surrounding the receiving end of the hollow member and extending radially outward to the casing, said ring constituting a partition between the first mentioned and said second annular clearance spaces, and said ring being formed with openings communicating the said annular clearance spaces at circumferentially spaced points for supplying air to said first mentioned annular clearance space from the second clearance space.

References Cited in the file of this patent

UNITED STATES PATENTS

1,641,581	Egan	Sept. 6, 1927
1,826,776	Gunther	Oct. 13, 1931
1,869,897	Hymer	Aug. 2, 1932
1,989,421	Kerrick	Jan. 29, 1935
2,047,570	Wiltshire	July 14, 1936
2,050,577	Littleton	Aug. 11, 1936
2,240,161	Mueller	Apr. 29, 1941
2,623,786	Wille	Dec. 30, 1952
2,701,608	Johnson	Feb. 8, 1955
2,857,961	Brown	Oct. 28, 1958
2,867,270	Brozozowski	Jan. 6, 1959

FOREIGN PATENTS

1,111,865	France	Nov. 2, 1955
1,129,673	France	Sept. 10, 1956
1,157,143	France	Dec. 23, 1957