

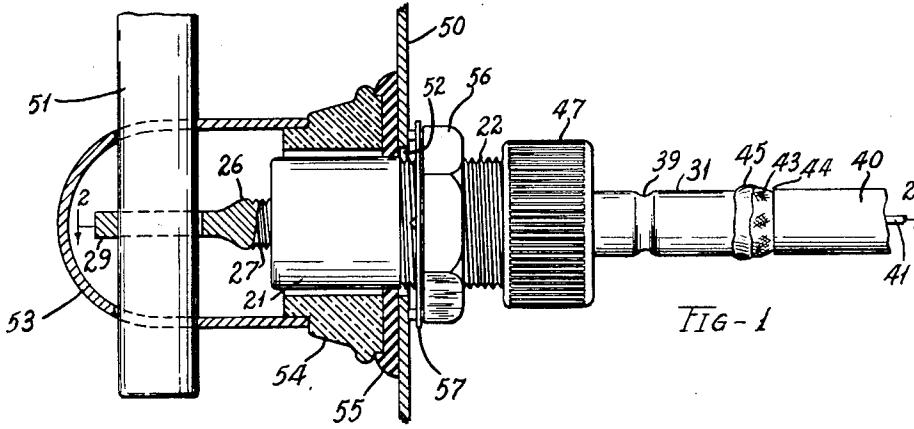
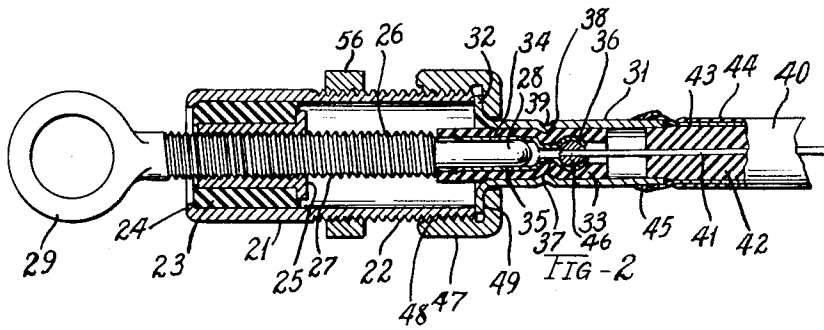
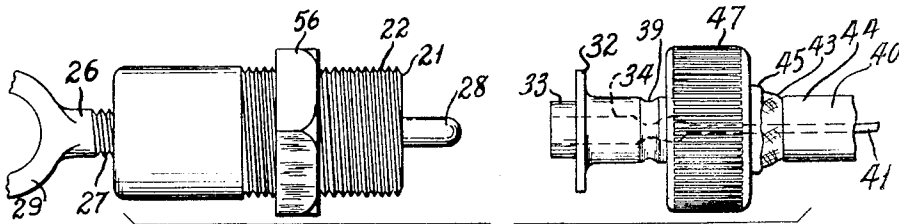
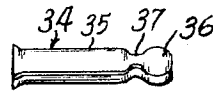
May 8, 1951

M. R. FRIEDBERG ET AL

2,552,313

GROOVED CONNECTOR TERMINAL FOR SHIELDED CABLE

Filed March 27, 1946



INVENTOR
MILTON R. FRIEDBERG
THEODORE R. FINKE
BY *Ely & Foye*
ATTORNEYS

UNITED STATES PATENT OFFICE

2,552,313

GROOVED CONNECTOR TERMINAL FOR
SHIELDED CABLE

Milton R. Friedberg, Cleveland, and Theodore R. Finke, Euclid, Ohio, assignors, by mesne assignments, to The Gabriel Company, Cleveland, Ohio, a corporation of Ohio

Application March 27, 1946, Serial No. 657,438

7 Claims. (Cl. 174—19)

1

This invention relates to electrical connectors and means for making them, and more particularly to an electrical connector comprises cooperating pin and socket-bearing members and means for locking said members together, and to a method of making the socket-bearing member.

For convenience, the invention will be discussed with reference to a connector employed in an automobile radio antenna mounting to connect the antenna to a lead-in cable extending to the radio set. Connectors embodying the invention are particularly advantageous for such purpose; however, connectors embodying the invention may be used for other purposes.

The problems involved in mounting an automobile radio antenna on an automobile and connecting it to the lead-in cable are by no means simple of solution. The antenna must be firmly mounted to extend wholly or in part outside of the automobile body and yet be insulated from the automobile, but must make good electrical connection with a radio-frequency conductor within a shielded lead-in cable grounded to the automobile body. The electrical connector connecting the antenna and lead-in cable should embody means for shielding the radio-frequency current-conducting element in the connector, and such shielding means of the conductor should be electrically connected to the shielding means on the lead-in cable and be grounded therethrough to the body of the automobile. The antenna mounting and electrical connector should be inexpensive, mechanically strong and positive, and be capable of being readily and cheaply installed by a relatively unskilled mechanic, but yet should provide a neat appearance. The fastening members of the connector and mounting must be within the automobile to prevent theft of the antenna. Particular advantages are provided if the connector is such that the lead-in cable can be readily connected and disconnected for the purposes of installation, repair or replacement of parts.

The means for mounting an automobile radio antenna and associated connector for making an electrical connection between the lead-in cable and antenna, heretofore employed, have not been as satisfactory as desired in all the above respects. If they satisfactorily performed the functions of mounting the antenna and making a shielded electrical connection between the antenna and lead-in cable, they usually were relatively expensive and difficult to install and did not provide a readily detachable connection to

2

the lead-in cable. If they were less expensive or more easily installed, they usually did not provide a satisfactory mounting of the antenna on the car body or make a satisfactory shielded connection to the lead-in cable, or present a neat appearance.

It is an object of this invention to provide an electrical connector which may be employed in automobile antenna mounting and which may connect the antenna to the lead-in cable to the radio set, which connector satisfies the requirements outlined above and is free of the disadvantages of prior connectors for such purposes.

It is another object of the present invention to provide an electrical connector, which is simple, strong, and inexpensive in construction, comprising cooperating pin and socket-bearing members which may be readily connected and locked together to form a good electrical connection but which may be readily disconnected and separated.

It is another object of this invention to provide such a connector which, when assembled, provides a continuous metallic shield surrounding radio-frequency conducting elements therein.

It is another object of this invention to provide such an electrical connector in which one of the cooperating members comprises a pin-receiving socket, a surrounding insulating sleeve, and an outer metallic sleeve all held together and located relative to each other by cooperating interfitting grooved portions in said socket, insulating sleeve, and metallic sleeve.

It is a further object of this invention to provide a method of making such socket-bearing member of such a connector.

These and other objects and advantages of the invention will be apparent from the following description of a preferred embodiment of the invention, in connection with the accompanying drawing, and from the appended claims. In the appended drawing:

Fig. 1 is a side elevation to an enlarged scale of a preferred connector embodying the invention, forming part of means for mounting an automobile antenna on an automobile body, and serving to provide an electrical connection between the antenna and a lead-in cable, parts being broken away to show the mounting cap and insulating bushings for the antenna;

Fig. 2 is a plan sectional elevational through the assembled connector alone of Fig. 1, from line 2—2 of Fig. 1;

Fig. 3 is a plan elevation showing the exterior

of the two cooperating members of the connector in disassembled relation; and

Fig. 4 is an elevation of the socket member employed in the illustrated connector.

In the drawing, in which like reference numerals refer to like parts throughout, the electrical connector as a whole comprises a pin-bearing member and a cooperating socket-bearing member.

As shown to advantage in Figs. 2 and 3, the pin bearing member comprises a metal sleeve member 21 having an exterior thread 22 extending from the inner end, adjacent the socket bearing member, for a substantial distance toward the other or outer end of sleeve member 21. The sleeve member 21 has firmly mounted therein adjacent its outer end an insulating bushing 23. Bushing 23 may be mounted in sleeve member 21 by being pressed therein; the outer edge of sleeve member 21 is shown as bent inwardly to form an annular lip 24 to aid in locating the bushing 23 in place in sleeve member 21. An internally threaded sleeve 25 which may be formed of metal and which may be flanged as shown, is firmly mounted in said insulating bushing 23, as by having been pressed therein. A bolt 26 is threaded in sleeve 25. The illustrated bolt 26 comprises an intermediate threaded portion 27, a smooth pin portion 28 at one end, and a ring or eye portion 29 at the other end; the length of said bolt 26 is such that the ring portion 29 projects a substantial distance from the outer end of sleeve member 21 and the pin portion 28 projects a substantial distance from the inner end of said sleeve member 21.

The socket bearing member of the connector comprises an exterior metal sleeve member 31 provided with a radial flange 32. The inner surface of flange 32 is adapted to abut against the inner end of said sleeve member 21. Said sleeve member 31 has firmly mounted therein an insulating bushing 33, which projects from the inner end of said sleeve member 31. A metal socket member 34, preferably split longitudinally, is firmly mounted in said insulating bushing 33. As shown in Figs. 2 and 4, said socket member comprises a tubular portion 35, an open-ended ball-portion 36 at one end, and an intermediate annularly grooved portion 37. The opening of the tubular portion 35 is slightly flared to permit easy insertion of the pin 28, the diameter of the pin 28 being slightly greater than the normal inner diameter of the split tubular portion 35 to insure a tight fit of the pin 28 and tube 35 when the connector is assembled. The insulating bushing 33 has formed therein an annular grooved portion 38 which interfits with the grooved portion 37 of the socket 34, and sleeve member 31 has formed therein an annular grooved portion 39 which interfits with the grooved portion 38 of bushing 33. Consequently the socket 34, bushing 33, and sleeve member 31 are locked together by their inter-fitting grooved portions.

An electrical conductor, taking the form of a shielded lead-in cable 40 in the illustrated embodiment, is connected to said sleeve member 31 at its outer end. The illustrated cable 40 comprises a conductor wire 41 which is surrounded by a layer 42 of suitable insulating material. A braided metal shielding sheath 43 surrounds said insulation, and is covered with a protective layer 44 of rubber, plastic, or the like. In the illustrated embodiment, the metal sheath 43 of

the cable is fixed to the end of the sleeve member 31, by solder 45, and the conductor wire 41 extends into the ball portion 36 of socket member 34, where it is held by solder 46.

A nut 47, having an internal thread 48 adapted to fit thread 22 of sleeve member 21 and an internal shoulder 49 adapted to bear against the outer surface of flange 32, is slidably mounted on sleeve member 31.

The socket member 34 is the key element of the socket bearing member and is preferably preformed by rolling a thin sheet or metal stamping into the form shown in Fig. 4. In order to provide good electrical conductivity, the formed socket 34 is then preferably given a thin plating of silver. (The cooperating pin 28 is likewise preferably silver plated.) In order to permit the socket to be rapidly connected to a conductor wire 41, the preformed socket 34 is provided with a mass of solder 46 in the ball portion 36, an axial opening being formed in the solder which otherwise fills the ball 36.

In the embodiment shown, the socket bearing member is assembled and the sleeve 31, bushing 33, and socket 34 are interlocked when the sleeve 31 is connected to the end of the cable 40. First, a length of the radio-frequency signal conductor 41 is either pulled out of the cable 40, or the end of the cable is stripped to provide a protruding length of conductor 41. The end of the conductor 41 is then inserted in the axial opening in the solder 46 within the ball 36. A firm mechanical and good electrical connection is then quickly made between the conductor 41 and the socket 34 by a more or less instantaneous application to the ball 36 of a flame or soldering iron which is hot enough to melt the solder 46 within the ball, thereby establishing a fused joint between the wire 41 and the socket 34.

After the socket 34 and wire 41 are connected, the socket 34 is pressed into the bushing 33, which, at that stage, is a short tube having no annular groove 38. The bushing 33 is made of polystyrene, for example, or like material having high dielectric strength as well as good mechanical strength, toughness, and formability. The sleeve 31, carrying the shouldered nut 47, is then slid over the bushing 33; the sleeve 31 likewise has no annular groove 39 at that stage. With the concentric socket 34, bushing 33 and sleeve 31 arranged in the desired longitudinal position relative to each other, the assembled members are quickly and simply but positively interlocked by pinching the sleeve 31 with grooving rolls to form the annular groove 39 therein in radial alignment with the groove 37 of the socket 34. Formation of the groove 37 in the sleeve 31 simultaneously forms the groove 38 in the bushing 33, forcing the grooved portion thereof into the groove 37 of the socket 34 to interlock the elements of the socket bearing member. The connection of the sleeve 31 to the cable 40 is then completed by soldering a stripped end of the braided sheath 43 over the outer end of the sleeve 31. By inserting into the sleeve 31 that portion of the cable insulation which had been covered by the portion of the sheath which is soldered to the sleeve, the internal conductor 41 is maintained in a coaxial relationship with both the braided sheath 43 and the sleeve 31, thereby relieving the conductor 41 from mechanical stress while maintaining minimum impedance at the connection of the sleeve 31 and the cable 40.

The sleeve 31 may also be conveniently formed

and attached to the cable 40 by a slightly different procedure by obtaining a cable comprised, initially, of just the layer 42 taking the form of a tube of dielectric plastic material, the braided shielding sheath 43 and its protective outer covering 44. In this alternate procedure, one end of a desired length of such cable is stripped of the shielding sheath 43 back a distance equal to about the length of the bushing 33 and the shielding is bared of its outer covering 44 a short distance farther back. The end of hollow tube 42 so stripped is then counter-bored to a depth slightly greater than the length of the socket 34. An end of a bare conductor 41 is then inserted into the ball end of the socket 34 and soldered thereto, the length of the bare conductor being somewhat greater than the length of hollow cable selected. The other end of the length of bare conductor 41 is then inserted in the counter-bored end of the hollow cable and threaded through the tube 42 until the socket 34 is seated in the counter-bored portion, which counter-bored portion thus constitutes a bushing portion 33 integral with the insulation 42. The sleeve member 31, carrying the nut 47, is then slipped over the bared, counter-bored end of the tube 42 until it overlaps or is overlapped by the bared end of the shielding 43. The sleeve 31 is then suitably pinched to provide the groove 39, simultaneously forming the groove 38 in the bushing portion 33 interfitting the groove 37 in the socket 34. The connection of the socket bearing member to the cable 40 is then completed by soldering the sleeve 31 to the bared portion of the shielding sheath 43.

In assembling the electrical connector as a whole, the pin portion 28 of bolt 26 is inserted into the socket 34, the bolt 26 being so located in sleeve 25 that when this is done the inner surface of flange 32 of sleeve 31 abuts the inner end of sleeve member 21 of the pin bearing member. When the socket 34 is of the split tube type and has an inner diameter slightly smaller than the pin 28, as preferred, insertion of the pin 28 causes the tubular portion 35 to expand slightly, causing the flared opening to bite into the bushing 33 and thus further fix the socket 34 in the bushing 33. In addition to insuring a tight mechanical fit of the pin 28 and socket 34, the split in the tubular portion 35 also insures good electrical connection; a slight scratching of the surface of the pin 28 is caused by the edges of the split in the tubular portion 35 as the pin 28 is inserted. The nut 47 is then threaded onto the thread 22 of sleeve 21 until the internal shoulder 49 of nut 46 bears against the outer surface of flange 32, thus locking together the pin bearing and socket bearing members of the electrical connector. The elements of conducting radio-frequency signal current, comprising the wire 41, the socket 34, and the portion of bolt 26 in sleeve member 21 are thus wholly shielded; it is to be noted that these conducting elements are coaxially located with respect to the shielding elements throughout the length of the connector, thus providing minimum impedance.

In the antenna mounting assembly shown in Fig. 1, a portion of a sheet metal automobile body is indicated by the reference numeral 50. Located outside of the body is a portion of the antenna, having a conductive surface, indicated by the reference numeral 51. The outer end of sleeve member 21 of the connector projects through an opening 52 in the body portion 50. The antenna 51 passes through and contacts the

interior of the ring portion 29 of bolt 26. A cap 53, having oppositely disposed openings through which antenna 51 passes, surrounds the projecting portion of bolt 26 and bears against an insulating bushing 54. Bushing 54 is formed of ceramic material, hard rubber or the like. It bears against an elastic pad 55, formed of rubber or the like, which bears against and conforms to the curvature of the outer surface of body 50. A nut 56, threaded on the exterior thread 22 of sleeve member 21, presses a lock washer 57 against the interior surface of body portion 50. The lock washer 57 is of the type having points which bite through any nonconductive coating on the interior of body portion 50 and make electrical contact therewith, thus grounding the shielding portions of the connector and cable 40.

The antenna 51 is thus firmly mounted in position because it is pulled by ring portion 29 of bolt 26, against the walls of the openings through cap 53. Cap 53 is thus pressed against the bushing 54 which in turn presses the pad 55 against the outer surface of body portion 50. The bolt 26, being threaded in member 25 of the connector, is drawn inwardly of body member 50 by the nut 56 which presses the lock washer 57 against the inner surface of the body member 50.

The connector is thus also firmly mounted on the body member 50. The socket bearing member of the connector, attached to the end of lead-in cable 40, may be readily connected and locked to the pin bearing member, or disconnected therefrom, in the manner described above. Contact of the pin portion 28 with the interior of socket 34 provides a good electrical connection, and the lock nut 47 holds the members of the connector together and maintains such good electrical connection despite shocks and vibrations incident to the operation of the automobile.

In the illustrated connector, the interfitting grooved portions in the sleeve member 31, the insulating bushing 33, and the socket 34 locate these members longitudinally of each other; this prevents sliding of these members relative to each other even though a longitudinal stress is applied thereto, as by the cable 40. The annular lip 24 on sleeve member 21 and the flange on sleeve 25 prevent the bushing 23 and sleeve 25 from pulling out of sleeve member 21 under the stress caused by bolt 26.

The present invention thus provides an electrical connector comprising a pin-bearing member and a socket-bearing member, which members may be readily assembled and firmly locked together to provide good electrical connection, and which may be readily unlocked and disassembled. These members of the connector, particularly the socket-bearing member, are of simple, strong construction and may be easily manufactured. The connector when assembled provides a continuous grounded metallic shield surrounding, but insulated from, the radio-frequency conductive elements in the connector; said shield mechanically protects and electrically shields the conductive elements. The connector of the invention advantageously may be employed for electrically connecting an automobile radio antenna to a lead-in cable connected to a radio set in the automobile, and when so employed may form part of means for mounting the antenna on the automobile. Such mounting means firmly holding the antenna in place, are simple and inexpensive in construction, and may be readily installed on the automobile by a relatively un-

skilled mechanic. The fastening member, the nut 56, is located inside the car, thereby preventing theft.

It is apparent that various modifications may be made in the illustrated embodiment, and that other embodiments of the invention may be devised, and that connectors embodying the invention may be employed for other purposes than that discussed above, without departing from the spirit of the invention. For example, the bolt 26 need not necessarily be provided with the ring portion 29 at its outer end, but may be provided with other means for making a connection to an electrical conductor. It is apparent that the present invention is not limited to the preferred embodiment disclosed, but is limited only by the scope of the appended claims.

What is claimed is:

1. An electrical connector for connecting a shielded cable comprising a first cooperating connector member comprising a shielding metal sleeve member, an insulating member coaxially mounted in said sleeve member, an inner sleeve in said insulating member and a conductive element coaxially threaded in said inner sleeve member and formed at one end thereof with a pin; a second cooperating connector member comprising a socket adapted to receive said pin of said conductive element in said first cooperating connector member, a bushing formed of insulating material and coaxially surrounding said socket, and a metal sleeve member coaxially surrounding said bushing, and annular grooved portions in said socket, bushing, and sleeve member which interfit and locate said parts relative to each other; and means for detachably connecting said sleeve members of the first and second connector members to provide a continuous coaxial shield for said conductive elements.

2. An electrical connector comprising a first cooperating connector member comprising a metal sleeve member having thereon an exterior thread extending to its inner end; an insulating member mounted in said sleeve member, an inner sleeve in said insulating member, and a conductive element threaded in said inner sleeve and having a pin at the end thereof adjacent the inner end of said sleeve member; and a second cooperating connector member comprising a socket adapted to receive said pin of said conductive element in said first connector member, a bushing formed of insulating material and surrounding said socket, a metal sleeve member surrounding said bushing and having at its inner end a flange adapted to abut the inner end of said sleeve member of said first connector member, and an internally threaded nut mounted on said sleeve member of said second connector member and adapted to be threaded onto the exterior thread of said first connector member to hold said flange against the end of said sleeve member of said first connector member, said socket, bushing and sleeve member of said second connector member having annular grooved portions which interfit and locate said parts relative to each other.

3. An automobile antenna mounting and connector for connecting the antenna to a lead-in cable comprising a first connector member, an externally threaded first sleeve, a bolt within said first sleeve, means for connecting one end of said bolt mechanically and electrically to an antenna, means for engaging an antenna and adapted to bear against the outer portion of a car body adjacent an opening through which said bolt ex-

tends, said antenna engaging means being comprised of at least one element for insulating the antenna from the car body, a body nut on said first sleeve member, and means within said first sleeve centering and insulating said bolt within said first sleeve and holding said bolt longitudinally with respect to said sleeve when said body nut is tightened against the inside of a car body to draw the antenna and antenna engaging means against the outside of the car body by means of tension exerted on said bolt connected to the antenna, and a second connector element connected to a shielded lead-in cable having a central radio-frequency conductor comprising a socket connected to the conductor, a second sleeve connected at one end to the shield of the lead-in cable, a flange on the other end of said shield substantially equal to the diameter of said first sleeve, and insulating bushing centering said socket within said second sleeve, said second sleeve, bushing and socket having interfitting grooved portions, and a nut for engaging said flange and threadable on said first sleeve, said socket being located longitudinally with said flange so that when said flange is seated co-axially against said first sleeve, said pin portion on said bolt will be received in said socket.

4. A method of manufacturing a member of an electrical connector comprising a conductive element adapted to make a detachable electrical connection with a cooperating element, an insulating bushing surrounding said conductive element, and a metal sleeve member surrounding said bushing; which method comprises forming an assembly in which a conductive element having an annular groove is positioned in a tubular insulating bushing and said bushing is positioned in a metal sleeve member in proper longitudinal relation, and pressing an annular grooved portion in the wall of said sleeve member to form an interfitting grooved portion in said bushing which fits into the groove in said conductive element.

5. A method of manufacturing a member of an electrical connector comprising a conductive socket having an electrical connector attached thereto and adapted to make a detachable electrical connection with a cooperating element, an insulating bushing surrounding said socket, and a metal sleeve surrounding said bushing; which method comprises forming an assembly in which a conductive socket having an annular groove therein and having an electrical connector attached to one end is positioned in a tubular insulating bushing and said bushing is positioned in a metal sleeve in proper longitudinal relation, and pressing an annular grooved portion in the wall of said sleeve member to form an interfitting grooved portion in the wall of said bushing which fits into the groove in said socket.

6. An electrical connector comprising a first cooperating connector member comprising an outer metal sleeve having thereon adjacent one of its ends exterior threads, an insulating member mounted in said outer sleeve and adjacent the other end of the latter, an inner sleeve mounted in said insulating member and internally threaded, and a conductive exteriorly threaded element screwed in said inner sleeve and having a pin at the end thereof adjacent to the said one end of said outer sleeve; and a second cooperating connector member comprising a socket adapted to receive said pin of said conductive element in said first connector member, a bushing formed of insulating material and surrounding said socket, a metal sleeve surrounding said bush-

9

ing and abutting the said one end of said outer sleeve of said first connector member, means carried by said metal sleeve of said second connector member and cooperating with the threads of said outer sleeve of said first connector member to interconnect said connector members, said socket, bushing and metal sleeve of said second connector member having annular grooved portions which interfit and locate said parts relative to each other.

7. An electrical connector comprising a first cooperating connector member comprising an outer metal sleeve having thereon adjacent one end exterior threads, the other end of said outer sleeve being inwardly flanged, an insulating member mounted in said outer sleeve and engaging said flange, an inner sleeve mounted in said insulating member and provided with a threaded bore, and a conductive element exteriorly threaded and screwed into the threaded bore of said inner sleeve and having at one end a pin projecting beyond said one end of said outer sleeve; and a second cooperating connector member comprising a socket adapted to receive said pin of said conductive element in said first connector member, a bushing formed of insulating material and surrounding said socket, said socket and said bushing being of such length as to extend into the outer sleeve of said first connector

10

member, a metal sleeve surrounding said bushing and adapted to abut at said one end of said outer sleeve of said first connector member, means carried by said metal sleeve and cooperating with the threads on said one end of said outer sleeve to interconnect the connector members, said socket, bushing and metal sleeve of said second connector member having cooperating inter-fitting deformed portions which locate said parts relative to each other.

MILTON R. FRIEDBERG.
THEODORE R. FINKE.

REFERENCES CITED

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

UNITED STATES PATENTS

Number	Name	Date
20 1,318,728	Conrad -----	Oct. 14, 1919
2,173,668	Smith -----	Sept. 19, 1939
2,200,888	Mace -----	May 14, 1940
2,234,737	Mace -----	Mar. 11, 1941
2,335,041	Bruno -----	Nov. 23, 1943
25 2,366,634	Ludwig -----	Jan. 2, 1945

FOREIGN PATENTS

Number	Country	Date
556,548	Great Britain -----	Oct. 11, 1943