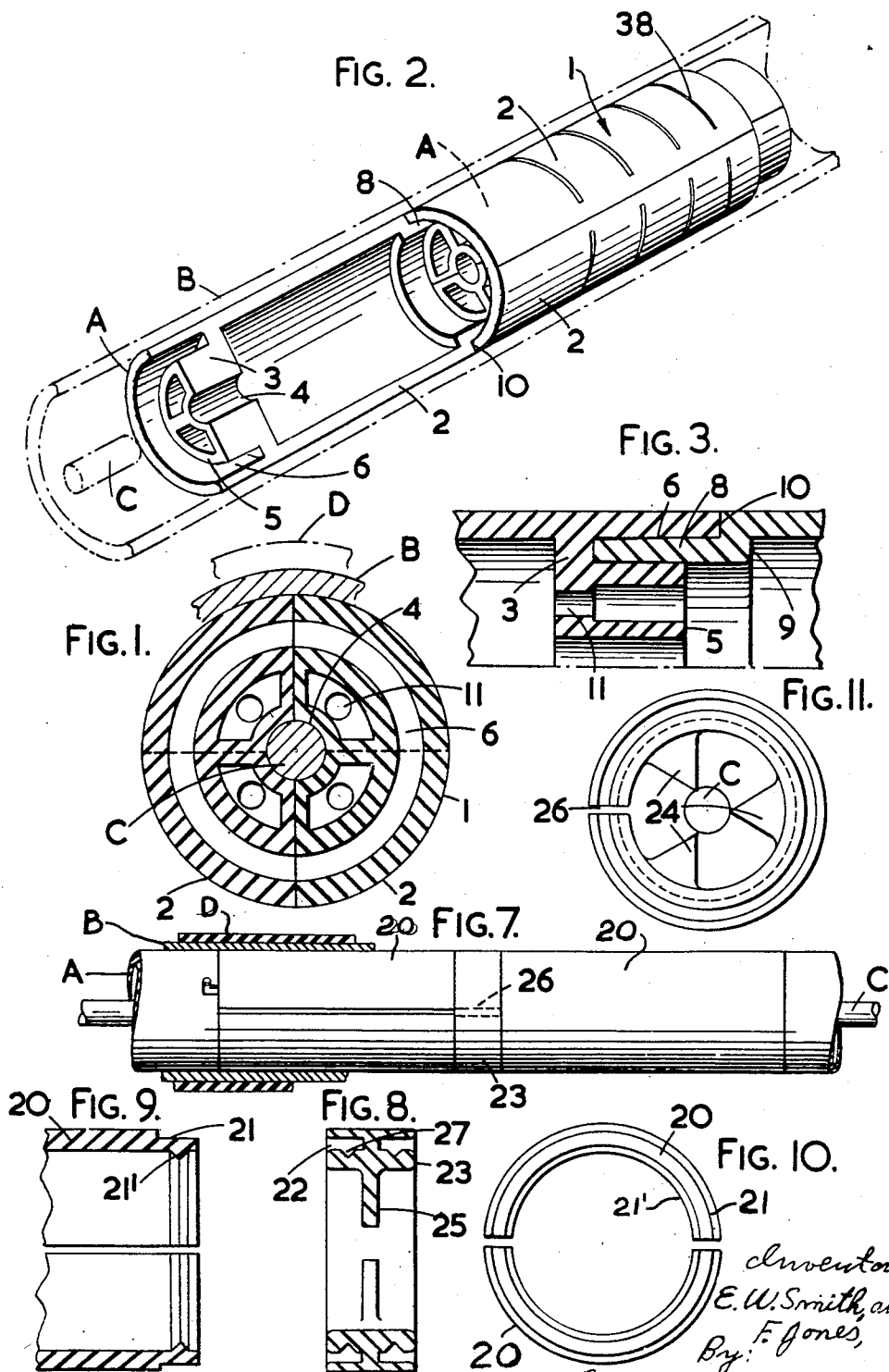


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2,648,719

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Aug. 11, 1953

E. W. SMITH ET AL
CONCENTRIC ELECTRIC CABLE WITH
INTERLOCKING TUBULAR SUPPORTS

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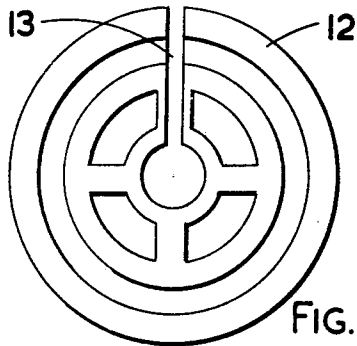


FIG. 4.

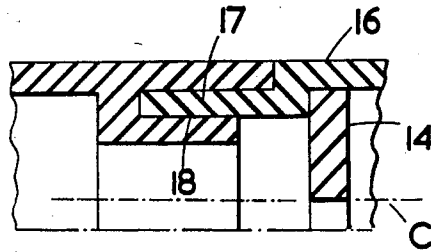


FIG. 5.

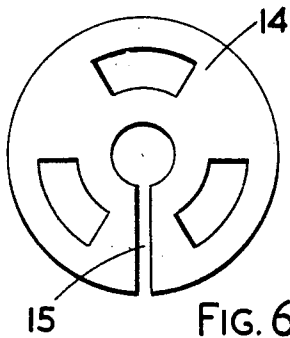


FIG. 6.

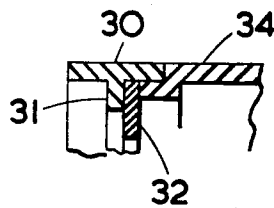


FIG. 15.

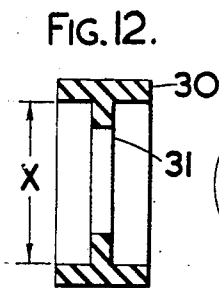


FIG. 12.

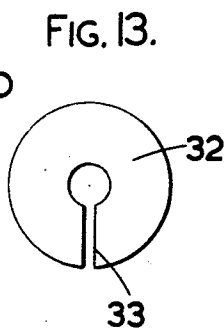


FIG. 13.

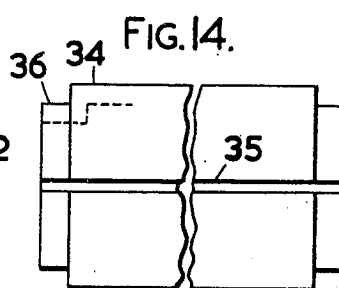


FIG. 14.

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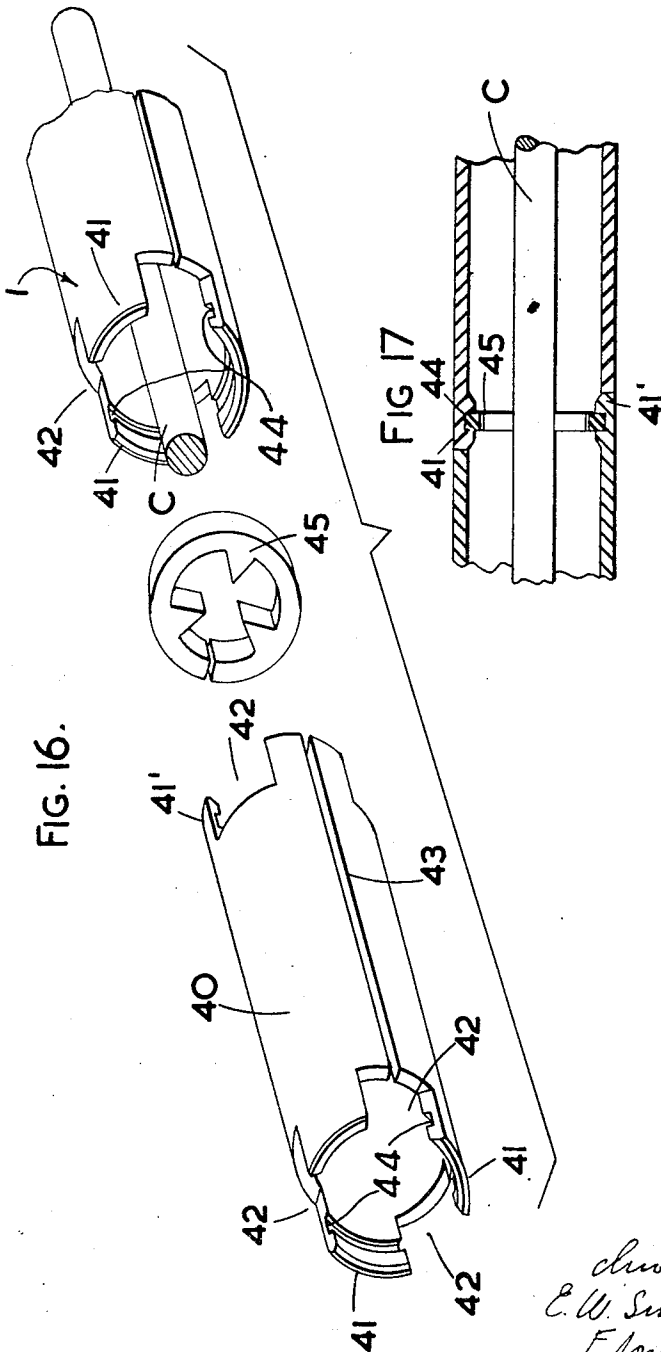
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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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CONCENTRIC ELECTRIC CABLE WITH
INTERLOCKING TUBULAR SUPPORTS

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9 Claims. (Cl. 174-28)

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This invention relates to electric cables and more particularly to electric cables for the transmission of high frequency energy in which a central conductor is insulated from a concentric outer conductor or screen by spacing means so arranged as to include a maximum amount of air as dielectric.

The normal processes of manufacture of such cables involve the extrusion over the spacing means, e. g. disc members which are slotted to fit on the central conductor, of a tube of dielectric material to provide a base on to which the outer conductor may be applied. It is found, however, that it is difficult to extrude this tube with sufficient accuracy to ensure that uniformity which is essential for the transmission of very high frequencies. It has therefore been proposed to make the initial diameter of the dielectric tube in excess of that required and to shave off the outer surface so as to produce an accurately machined dielectric boundary. This expedient has not proved successful, however, because the inside of the dielectric tube cannot be so treated and retains the non-uniformity associated with extrusion processes.

In another type of spacing member, it has been proposed to employ elongated tubular elements of elastic material characterized by thin walls to reduce dielectric losses and two end walls, the latter having slots to fit the central conductor and the elements being arranged at short distances apart and held in position by their inherent springiness.

In contradistinction to this latter type of spacer, the present invention aims at providing an air-space insulation which possesses great uniformity, being continuous throughout the cable length, and which presents an accurately finished outer surface so as to allow of accurate positioning of the conductors relative to one another: furthermore, whilst retaining the maximum amount of air as a dielectric, a high degree of uniformity of the cable insulation, mechanically and electrically, is ensured.

According to the invention, in an electric cable suitable for transmission of high frequency energy and having an inner and outer conductor separated by air space insulation, the insulation is built up from a series of interlocking tubular elements or complementary channel elements of dielectric material, capable when assembled of forming a continuous or substantially continuous tube so that when threaded or otherwise placed upon the inner conductor there is obtained a core structure of smooth surface and of uniform diameter throughout the length of the insulation, said structure by reason of the inherent flexibility of the dielectric permitting of bending of the cable as a whole.

The tubular or channel elements at their ends

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may be of male tongue and female groove construction so as to give a positive interlock in axial and/or diametral directions, each recess having at least two spaced walls, and the tongues each having at least two spaced faces respectively engaging two spaced recess walls of an adjacent tubular element. Contiguous end portions of adjacent tubular elements preferably are of substantially the same radius so that the dielectric support provided by the tubular elements is substantially uninterruptedly of uniform radius. Preferably, each tubular or channel element is provided with radial partitions or projections for the purpose of centering and locating the inner conductor. The walls of the recesses and the faces of the tongues preferably are substantially straight in a direction parallel to the common axis of adjacent tubular elements so that the co-operating tongues and grooves provide a joint between contiguous ends of adjacent tubular elements which resists substantial relative angular misalignment of adjacent tubular elements. The partitions may be formed by independent disc pieces, over which the tubular elements fit. With this construction, it may in some cases be more expedient to employ a tubular construction of element with a radial slot so that it can be sprung over the central conductor. Other and similar forms of the invention will be described with reference to the drawings.

The elements are preferably manufactured by the injection moulding of polymerised ethylene, alone or admixed with other materials such as polyisobutylene, a method which permits great dimensional accuracy and a high degree of uniformity in manufacture.

The invention is illustrated in the accompanying drawings in which Figure 1 is a transverse sectional view of a high frequency cable having air space insulation in accordance with one embodiment of the invention. Figure 2 is a perspective view showing the manner of assembly of the spacing elements on the central conductor. Figure 3 is a part sectional view on an enlarged scale showing a joint between adjacent elements. Figure 4 is an end view of an alternative construction of spacing element.

Figure 5 is a part longitudinal sectional view of air space insulation built up with still another construction of spacing element while Figure 6 is a separate view showing one of the wall discs used in conjunction therewith. Figure 7 is a part elevation of a cable having air space insulation built up of tubular elements co-operating with locking rings which function also as spacers. Figure 8 is a longitudinal section view of one of the locking rings while Figures 9 and 10 are respectively a part longitudinal section and an end view showing two such semi-cylindrical elements separately. Figure 11 is an end

view of the locking ring located on the conductor. Figures 12 to 14 are views illustrating another embodiment of the invention, Figure 12 being a longitudinal section of a ring while Figures 13 and 14 are respectively a face view and end-on perspective view of a spacing disc and tubular element. Figure 15 is a part sectional view showing the completed assembly. Figure 16 is an exploded perspective view showing another design of spacing element wherein the elements are both adapted to have interlocking engagement with a common spacing and locking ring, Figure 17 being a longitudinal section showing a joint when assembled.

Referring to the drawings, C indicates generally a central conductor and B the outer conductor spaced apart by air space insulation denoted generally by A. D is part of the sheath surrounding the outer conductor.

The air space insulation of this invention is built up of a series of tubular elements applied to the central conductor C in end to end contact and fixedly connected to each other so as to provide a continuous tubular sheath as represented at A, Figure 1.

In the arrangement shown in Figures 1 to 3 it is built up of complementary channel elements 2 provided at one end with an end wall part 3 integral with the part 2 and having a central groove 4 for centering and locating the centre conductor.

The elements 2 interlock with one another by means of a tongue and groove construction. Figures 1 to 3 show a construction in which the tongues and grooves extend in an axial direction. For this purpose the partition wall 3 is formed with an extension 5 forming an annular recess 6 to receive a corresponding tongue 8 on the contiguous end of the adjacent element. This tongue, it will be noted, is provided by an internal shoulder 9 and at the root of the tongue is an external shoulder 10 against which abuts the end of an adjacent element.

It will thus be seen that the elements 2 which are semi-cylindrical have a lip of reduced outer diameter provided by the tongue 8 to engage a recess 6 in the opposite end of an adjacent element, location of the central conductor being by means of an integral partition wall.

In order to facilitate assembly, the lip or reduced portion although substantially straight, may be tapered slightly or the annular recess may be flat.

The interior wall 3 for each element is suitably recessed or cut away to provide the minimum amount of solid dielectric compatible with mechanical strength. This steps assists in obtaining a low dielectric constant in the cable insulation, and also ensures a minimum of distortion during the moulding process. At the bottom of each recess and extending through the transverse wall a small hole or holes 11 may be provided through the cable for drying purposes, the use of an inert gas or the maintenance of the gas in the cable under pressure.

In manufacturing the cable a pair of semi-cylindrical elements is placed over the centre conductor. A second pair with its joint rotated through 90° (see Figure 1) is then placed over the conductor and its annular reduced portion mated with the recess of the first pair of elements. This operation is repeated until sufficient length of core has been manufactured.

Referring now to Figure 4 there is shown an alternative embodiment in which the cylindrical

elements instead of being made in two separate co-operating halves, are of one-piece construction providing a cylinder 12, and are split longitudinally as at 13 on one side only of the centre line so that they can be sprung over the centre conductor and then be locked by peripheral engagement with adjacent elements.

Referring now to Figures 5 and 6 instead of the conductor centralising walls 3 being constructed integrally with the tubular elements 2, the air space insulation may be built up of a series of disc parts 14 having radial slots 15 to permit them to be sprung on to the central conductor after which two semi-cylindrical elements 16 are applied over the disc to interlock with adjacent elements. The interlock between adjacent elements may be obtained by means of a lip 17 at one end engaging an annular recess 18 in the opposite end, similar to the arrangement described in Figures 1, 2, and 3.

Referring now to Figures 7 to 11 the air space insulation is built up of pairs of semi-cylindrical elements 20 of simple semi-cylindrical channel form having reduced ends 21 for engagement with annular grooves 22 in double-ended interlocking rings 23 which serve as spacing elements. The rings 23 are formed with at least three internal radial fingers 24 for locating the inner conductor and whose inner ends 25 are located on a circle substantially equal to the diameter of the inner conductor. Each ring 23 has a peripheral slot 26 (see Figure 11) to enable the fingers 24 to be sprung into engagement with the central conductor as in Figure 11, after which the elements 20 are inserted in the recesses 22. In order to provide a greater degree of interlock between the rings 23 and elements 20, the latter are preferably as shown and provided with an internal rib 21' for engagement with a similar V-groove 27 in the ring 23.

In manufacturing the cable a pair of semi-cylindrical components 20 is placed over the centre conductor. These are now locked in position by means of a locking ring 23, which is slipped on to the central conductor and then pushed into engagement with the reduced ends 21 of the components 20. A second pair with their joints rotated through 90° (see Fig. 7) is then placed over the conductor and their reduced ends 21 mated with the annular groove 22 in the opposite end of the ring 23 holding the first pair of elements. This operation is repeated until sufficient length of core has been manufactured.

Referring now to Figures 12 to 14 in a modification of this later embodiment, a number of junction rings 30 of dielectric material are threaded on to the conductor, the rings being of such internal diameter x as to accommodate spacing discs 32 which are slotted as at 33 to receive the conductor. Each ring 30 preferably has an internal flange 31 against which the disc 32 will abut. One ring is pushed towards the end of the conductor and a radially slotted disc 32 is sprung on to the conductor and pushed into the ring. A unit consisting of a cylindrical tube 34 slotted longitudinally on one side as at 35 and with its ends 36 reduced in overall diameter is then sprung over the conductor and pushed into one end of the ring to lock the disc against said flange. Another ring 30 is then moved into position to co-operate with this unit and the operations described are repeated until the desired length of cable has been built up.

Means may be provided for positively locking

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succeeding elements to one another, for example bayonet joints indicated in Figure 7 may be formed integrally in their co-operating ends. Additionally, to reduce the amount of solid dielectric employed, the main walls of the tubular elements may be perforated or otherwise cut away. To increase the flexibility of the cable circumferentially, slots 38 (see Figures 2 and 16) may be provided in each element, terminating at such a distance from the longitudinal edges of the latter as is consistent with the required mechanical strength, the width and number of these slots being variable according to the bending radius required.

Figures 16 and 17 show a modification of the arrangement of Figures 8 and 9 comprising tubular elements 40 provided at their ends with projecting tongues 41, 41' of which there may be three as shown equidistantly spaced to provide recesses 42 to receive the tongues 41, 41' on an adjacent element. At their ends the elements 40, which are slotted longitudinally as at 43, are formed with internal circumferential locking grooves 44 to receive a spacing ring 45 of similar construction to that shown in Figure 11. In use the spacing discs 45 are threaded or sprung into position on the inner conductor C after which the elements 40 having been similarly assembled on the conductor are pushed into locking engagement with each other by causing the tongues 41 on one end to enter the recesses 42, between the tongues 41' on an adjacent element so that the tubular elements interengage circumferentially and also interlock with the spacing rings 45. The tongues 41, 41' may be of increased thickness to accommodate the grooves 44 as shown in Figure 17.

What we claim is:

1. In an electric cable of the character described, the combination of an inner conductor, a series of solid disc-like spacing members mounted on and contacting said inner conductor, tubular elements supported by said spacing members in interlocking end to end contact, the ends of each of said tubular elements being formed to provide a plurality of substantially identical symmetrically arranged tongues separated by corresponding recesses to provide circumferential interlocking, and an outer conductor supported by the continuous insulation sheath formed by said tubular elements.

2. In an electric cable of the character described, the combination of an inner conductor, a series of disc-like spacing members mounted on the inner conductor, tubular elements supported by the spacing members in end to end contact, male and female connecting portions on the tubular elements and an outer conductor supported by the continuous insulation sheath formed by the tubular elements, said tubular elements having correspondingly spaced tongues and recesses at opposite ends so that when assembled the tubular elements interlock circumferentially, and having internal grooves to engage the perimeters of the disc-like spacing members.

3. In an electric cable of the character described, the combination of an inner conductor, a series of disc-like spacing members mounted on the inner conductor, tubular elements supported by the spacing members in end to end contact, male and female connecting portions on the tubular elements and an outer conductor supported by the continuous insulation sheath formed by the tubular elements, said tubular elements having correspondingly spaced tongues

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and recesses at opposite ends so that when assembled the tubular elements interlock circumferentially, said tongues being formed with grooves to engage the perimeters of the disc-like spacing members.

4. An electric cable of the character described comprising an inner conductor, an outer conductor coaxial therewith, a substantially continuous dielectric support for said outer conductor, said support comprising a plurality of tubular elements interlocked at their ends by complementary male tongues and female recesses which extend parallel to the common axis thereof, said recesses each having at least two spaced straight walls extending parallel to said common axis of said tubular elements and said tongues each having at least two spaced straight faces extending parallel to said common axis of said tubular elements respectively engaging the two spaced recess walls of an adjacent tubular element to provide a joint between contiguous ends of adjacent tubular elements which resists substantial relative angular misalignment of adjacent tubular elements. Outermost surfaces of contiguous end portions of adjacent tubular elements being of substantially the same radius whereby said dielectric support is substantially uninterrupted in the form of a continuous wall of uniform radius throughout its length, and means spacing said support from said inner conductor.

5. An electric cable of the character described as set forth in claim 4 in which said tubular elements have a longitudinally extending slot to enable said elements to be applied laterally to the inner conductor.

6. An electric cable of the character described and as set forth in claim 4 in which said spaced walls of said recesses are concentric with each other and with said conductors, and are spaced radially from each other.

7. An electric cable of the character described and as set forth in claim 4 in which said means spacing said support from said inner conductor comprises parts integral with said tubular elements respectively.

8. An electric cable of the character described and as set forth in claim 4 in which said spaced walls of said recesses are substantially parallel to each other and to said conductors and extend substantially parallel to the axis of said tubular elements and said conductors.

9. An electric cable of the character described and as set forth in claim 4 in which said means spacing said support from said inner conductor comprises separate parts surrounding said inner conductor and fitting within said tubular elements respectively.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
535,084	Stillwell et al. -----	Mar. 5, 1895
2,169,108	Meybauer -----	Aug. 8, 1939
2,257,259	Inoue -----	Sept. 30, 1941
2,451,413	Robinson -----	Oct. 12, 1948
2,470,631	McClellan -----	May 17, 1949

FOREIGN PATENTS

Number	Country	Date
433,711	Great Britain -----	Aug. 15, 1935
568,343	France -----	Dec. 20, 1923
754,322	France -----	Aug. 28, 1933
807,149	France -----	Oct. 12, 1936