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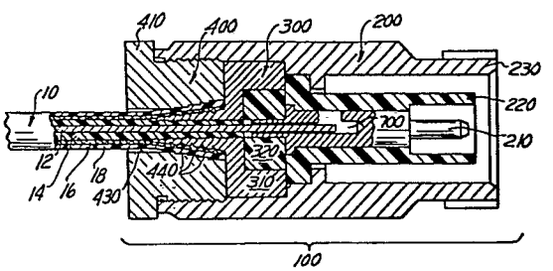
(54) Electrical connector having an electrical termination for a coaxial cable and method of assembling said electrical connector and its termination with a coaxial cable.

(57) Electrical connector having an electrical termination for a coaxial cable including a rotatable clamp member (300) terminating a "square-cut" end of the coaxial cable (10) which is of the type having a central conductor (12) separated from a braid conductor (16) by a dielectric core (14), and having a jacket (18) around the braid conductor (16), the clamp member (300) including a tapered frusto-conical clamp body (310) having a central passage sized to receive the dielectric core (14) therethrough, and thread-like portions having respectively an advancing helical groove of like sense and pitch being disposed on both the tapered outer surface and on the central passage wall of the clamp body (310) and simultaneously coacting with the braid conductor (16) and the dielectric core (14) to improve the resistance to undesirable axial movement of the clamp member (300) away from the cable (10) and high frequency impedance matching.

FIG. I



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Electrical connector having an electrical termination for a coaxial cable and method of assembling said electrical connector and its termination with a coaxial cable

This invention relates to an electrical connector having an electrical termination for a coaxial cable, in which: said coaxial cable includes a dielectric core, a braid outer conductor and an external jacket which are square-cut, and a central conductor extending forward of the square-cut; said electrical connector includes a forward contact body, the electrical termination which is disposed within the forward contact body, and a rear nut assembling the electrical termination to the forward contact body; and said electrical termination includes an electrical conductive clamp body having a forward face and a rear face, a tapered frusto-conical portion having an external helical groove provided with raised edge portions for progressively engaging the braid conductor, and a central passage extending between the forward face and the rear face for receiving the dielectric core.

Many approaches have been suggested for electrically terminating and or securing an electrical connector to a coaxial-type electrical cable.

Some approaches have required that the cable be prepared by removing forward portions of the outer jacket, the braid, the dielectric core insulator layer, and the central conductor in progressively longer lengths (i.e., describing a "stepped" arrangement) prior to insertion thereof into an electrical connector. Such a "stepped" arrangement of the conductor is undesirable in that it requires additional time and effort by the user and provides a chance that the preparation would not be properly done. Such an arrangement is shown in U.S. Patents 3,054,981; 3,107,135; 3,209,287; 3,264,602;and 3,634,815.

Another approach provides a clamp member with a frusto-conical shape that is pushed axially inward over the central conductor and within the jacket and braid. When the cable jacket is thick or made of a heavy, non-yielding material, inward movement of the clamp member can be resisted

and the clamp pushed axially outward. Such an approach is suggested in U.S. Patent No. 3,373,243.

When the clamp member is not fully engaged with the braid and/or the central conductor, a poor electrical connection is made. Undesirable resistance can develop between the braid and the clamp. High frequency impedance mismatch can develop if an air gap is formed between the clamp member and the central conductor. Provision of ribbed grooves have not been entirely satisfactory in that a crimping process usually is required to form a tight fitment between the clamp and the cable.

Other solutions to poor electrical termination problems have been suggested respectively in European Patent Application No. 80 400458.8 and in U.S. Patent No. 3,110,756. While variously providing mechanical securement and electrical terminations, each separate connection approach did not coact to provide both a reliable electrical termination having a secure positional fitment between a connector member and the cable, as well as a termination having high frequency impedance matching.

The present invention overcomes the disadvantages and limitations of the prior art arrangements by providing an electrical connector having an electrical termination for a coaxial cable, in which: said coaxial cable includes a dielectric core, a braid outer conductor and an external jacket which are square-cut, and a central conductor extending forward of the square-cut; said electrical connector includes a forward contact body, the electrical termination which is disposed within the forward contact body, and a rear nut assembling the electrical termination to the forward contact body; and said electrical termination includes an electrical conductive clamp body having a forward face and a rear face, a tapered frusto-conical portion having an external helical groove provided with raised edge portions for progressively engaging the braid conductor, and a central passage extending between the forward face and the rear face for receiving the dielectric core and provided with an internal helical groove having raised edge portions for progressively engaging the dielectric core, the external and internal helical

grooves being of like sense such that after the dielectric core is received in the central passage and the clamp body is rotated about the coaxial cable, the raised edge portions coact to progressively engage the dielectric core and the braid conductor to secure and to electrically connect the coaxial cable to the clamp body, the internal helical groove substantially eliminating any separation between the dielectric core and the central passage to improve high frequency impedance matching.

The electrical connector of the present invention is advantageous in that:

it uses a "square cut" cable termination in which the jacket, braid conductor and dielectric core are cut to a uniform length (i.e., in a single cut for cable preparation), such a square cut termination being an easy and quick one to accomplish in preparation of the cable and saving on labor costs;

it is compatible with any type of jacket and does not require the slitting of the jacket, maintaining the cables's integrity and thus increasing the life of the cable and the termination;

it improves the resistance to undesirable axial movement of the clamp member away from the cable;

it improves high frequency impedance matching;

it uses only three separate pieces of relatively large size to be handled conveniently, the use of a minimum number of pieces reducing the chance of inadvertent loss of a part during packaging or assembly; and

the clamp body is merely rotated to draw it into progressive engagement with the coaxial cable, such an engagement minimizing possible damage to the cable.

One way of carrying out the invention is described in detail below with reference to the drawings which illustrate one specific embodiment, in which:

FIGURE 1 is a cross sectional view of an electrical connector assembly having an electrical termination for a square-cut coaxial cable;

FIGURE 2 is an enlarged side view of a clamp member used in the connector assembly of FIGURE 1 showing an external

helical threaded portion;

FIGURE 3 is a cross sectional view of the clamp member looking along the lines III-III of FIGURE 2 and showing a central passage having an internal wall provided with an helical threaded portion and an axial slot;

FIGURE 4 is an end view of the clamp member looking along lines IV-IV of FIGURE 3;

FIGURE 5 shows the clamp member of the present invention partially inserted over the coaxial cable with and both helical threaded portions coacting and respectively in engagement with the cable braid and the dielectric core insulation; and

FIGURE 6 is a cross sectional view of the coaxial cable and clamp member of FIGURE 4 when the clamp member is in complete engagement within the coaxial cable and held in place therewith by the coacting helical threaded portions.

FIGURE 1 shows a cross sectional view of an electrical termination between a coaxial cable 10 and an electrical connector assembly 100 according to the present invention.

The coaxial cable 10 includes a core of dielectric material 14 disposed between a central conductor 12 and an outer braid conductor 16. A protective outer jacket 18 surrounds the conductors and the dielectric core. The outer jacket 18 and the dielectric core 14 are both made of electrically insulating materials to electrically isolate the conductors 12 and 16 from each other and from the environment.

The electrical connector assembly 100, in the embodiment shown, includes three components which are supplied and handled as separate pieces: a forward body 200, an internal clamp member 300 and a rear nut 400. The forward body 200 includes electrically insulating material 220 and an internal thread at the rear end thereof for coupling to the nut 400. An outer electrical contact 230 is disposed outside the insulating material 220 and is electrically isolated from a central contact 210 upon assembly. When the connector 100 is attached to the cable 10, the central contact 210 is electrically coupled to the central conductor 12 of the cable 10 and the outer contact 230 is electrically coupled to the braid conductor 16 of the cable 10.

The nut 400 may be of the type described in U.S. Patent No. 3,373,243 and includes a rear portion 410 adapted to be grasped during installation and an external screw threaded portion located forward of the rear portion 410 for engaging the internal thread of the body to secure the connector assembly 100 together. The nut 400 further includes a central aperture 430 through which the cable 10 extends and steps 440 which provide the central aperture 430 in the forward region with increasingly larger diameters. When used in conjunction with the clamp member 300 of the present design and as described later, the steps 440 enable the assembled connector 100 to captivate the jacket 18 and the braid conductor 16 and thereby to retain the cable 10 therein to provide increased resistance to axial decoupling forces applied on the cable. Captivation of the cable jacket 18 and the braid conductor 16 occurs between the steps 440 and a frusto-conical surface of the clamp member 300.

The clamp member 300 includes an electrically conductive clamp body 310, an insulator body 320 and a central mating contact 210. Preferably and in accord with the present invention the insulator body 320 includes a central bore 321 (Fig.5) which is large enough to receive only the central conductor 12 therein. The insulator body 320 fits within an undercut portion 312 (Fig.3) extending rearwardly from the front end of the conductive clamp body 310. The insulator body 320 electrically isolates the exposed portion of the central conductor 12 of the cable 10 and the contact 210 from the conductive clamp body 310. The insulator body 320 is retained within the undercut portion 312 by one of many known expedients (e.g., adhesively bonded or interference fit).

A portion of solder 700 would be provided between the central conductor 12 and the rearward end of the central contact 210 to complete an electrical interconnection between cable and connector.

FIGURE 2 is an enlarged view of the clamp body 310 of the present invention showing the external surface of the clamp body 310. The clamp body 310 has a constant diameter forward portion 313 and a tapered frusto-conical rear portion 314, rear portion 314 extending from the forward portion 313

rearwardly and having forward end 314b of greater diameter than a rear end 314a.

A helical groove or threaded portion 500 having raised edge portions and undercuts spirals progressively rearward around the frusto-conical rear portion 314 making several revolutions between the ends 314a and 314b.

FIGURE 3 is a cross sectional view of the clamp body 310 without the insulator body 320 and shows the undercut portion 312 for receiving the insulator body 320.

Preferably and in accord with the present invention, the clamp body 310 of the clamp member 300 includes a central passage 311 extending between a forward face 316 and a rear face 317. The central passage 311 is sized large enough to receive the layer of insulation formed by the dielectric core 14 of the cable 10. The internal wall 315 of the central passage 311 is provided with a helical groove or threaded portion 600 having raised edge portions and adjacent undercuts that spirals progressively rearward around the passage, making several revolutions. The sense of each respective threaded portion or helical groove 500 or 600 would be identical. That is, both grooves would be left-handed or both would be right handed. It has been found that for the external threaded portion 500 a continuous spiral of right-handed buttress-type thread of 40 pitch having a depth of 0.127 mm works to advantage. Although left-handed threads could be substituted and used to advantage in the present design, these threads would be unconventional and more difficult to install manually inasmuch as an operator is accustomed to install a screw member with right handed threads. The threaded portion 600 on the central passage wall 315 could be of the same type (i.e., buttress) as on the clamp body 310 or, more advantageously, V-shaped. Each V-shaped tooth would act to bite sharply into the core of dielectric material 14.

Further, a pair of axially extended grooves 318 (Figs. 3 and 4) disposed at substantially diametrically opposite portions of the central passage wall 315 could be provided if desired to receive any scraps of insulative material as a result of the sharp teeth of the threaded portion 600 biting into the cable insulation.

In FIGURE 5, the cable 10 has been prepared in a

manner which is referred to in the industry as a "square-cut" end wherein the central conductor 12 is exposed to extend forwardly of the rest of the cable (outer jacket 18, braid conductor 16 and dielectric core 14), these other portions being cut-off square and at a position rearwardly of the exposed end of conductor 12.

The tapered frusto-conical portion 314 of the clamp body 310 is pressed between the dielectric core 14 and the braid conductor 16, urging the braid conductor 16 and the outer jacket 18 slightly radially outward.

At the stage shown in FIGURE 5, the helical grooves 500 and 600 begin to coact to threadably engage with the braid conductor 16 and the dielectric core 14. Because the braid conductor 16 is also being urged radially inward by the surrounding jacket 18, the braid conductor 16 is partially urged into the groove 500.

As the clamp member 300 is rotated in the direction of helical grooves 500, 600, the raised edge portions of groove 500 coact with the braid conductor 16 to draw the clamp body 310 inwardly in the nature of a screw being drawn into wood as it rotates. Continued rotation of the clamp member 300 causes additional threads of groove 500 to engage the braid 16 and secures the clamp and cable 10 together by the groove 500 against unwanted axial movement out of the cable 10 because the braid conductor 16 is engaged by the groove 500.

Further, and in coaction with the external groove 500, rotation of the clamp member 300 causes the raised edge portions of the interior V-shaped teeth of groove 600 to bite into the dielectric core 14, thereby eliminating the slight air gap circumposing the dielectric core 14 that otherwise would exist if the dielectric core 14 were to be slidably slipped within the central passage 311 in a clearance fit. At extremely high frequencies (e.g. 18 gigahertz) an air gap defined by the central passage 311 can develop an impedance mismatch from the typically desired 50 ohms. Since 10 gigahertz corresponds to approximately 1 wave length with respect to passage 311 and inasmuch as any impedance mismatch of length 1/20 wavelength (i.e. at 0.5 gigahertz)

begins to adversely effect performance of the transmission line as measured by VSWR, this mismatch must be reduced to tolerable limits. Accordingly, the length of groove 600 in the central passage 311 serves to eliminate both this air gap as well as to provide increased resistance to unwanted axial withdrawal.

FIGURE 6 shows the clamp member 300 when the clamp body 310 is fully engaged with cable 10. The braid conductor 16 and the outer jacket 18 extend forwardly on the clamp body 310 over the enlarged forward portion 313 thereof, fully covering the tapering frusto-conical portion 314, with the helical groove 500 being embedded along its length within the braid conductor 16. The dielectric core 14 is well forward within the clamp body 310 and in the central passage 311 thereof with the helical groove 600 bitingly engaged along its length within the dielectric core 14 to eliminate any air layer thereabout.

While other types of grooves could be used, the grooves of the type shown in FIGURE 6 are believed the preferred embodiment as they can be formed quite easily on automatic screw machines. Of course, the grooves could be formed using other techniques.

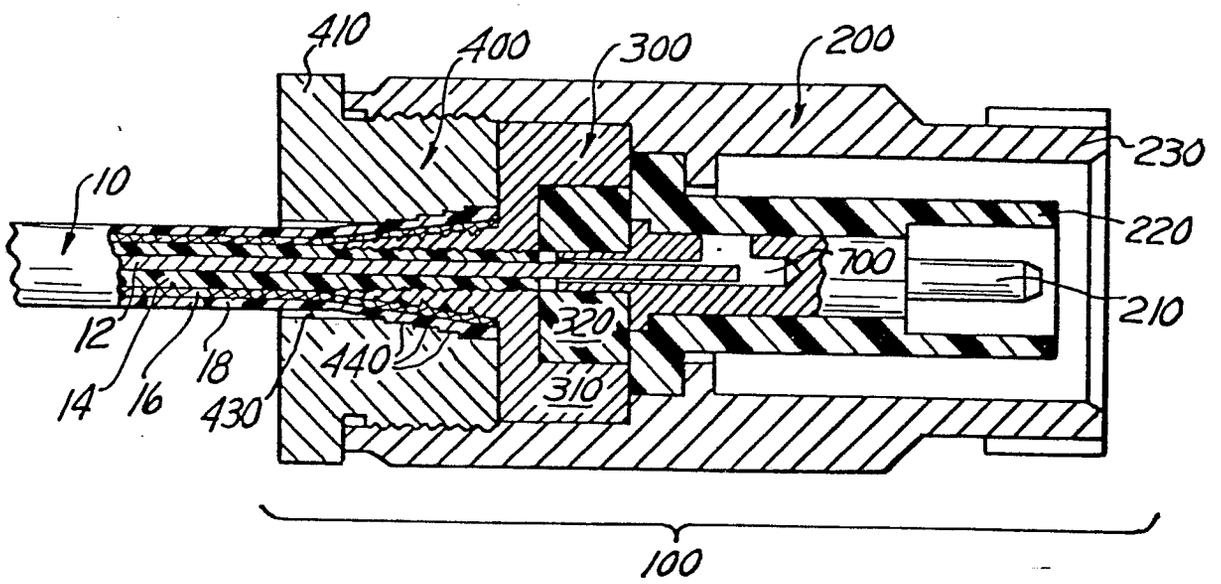
Claims:

1. Electrical connector having an electrical termination for a coaxial cable; said coaxial cable (10) including a dielectric core (14), a braid outer conductor (16), an external jacket (18) which are square-cut and a central conductor (12) extending forward of the square-cut; said electrical connector (100) including a forward contact body (200), the electrical termination (300) which is disposed within the forward contact body (200) and a rear nut (400) assembling the electrical termination (300) to the forward contact body (200); and said electrical termination (300) including an electrically conductive clamp body (310) having a forward face (316) and a rear face (317), a tapered frustoconical portion (314) having an external helical groove (500) provided with raised edge portions for progressively engaging the braid conductor (16), and a central passage (311) extending between the forward face (316) and the rear face (317) for receiving the dielectric core (14); characterized in that the central passage (311) is provided with an internal helical groove (600) having raised edge portions for progressively engaging the dielectric core (14), the external and internal helical grooves (500,600) being of like sense such that after the dielectric core (14) is received in the central passage (311) and the clamp body (310) is rotated about the coaxial cable (10), the raised edge portions coact to progressively engage the dielectric core (14) and the braid conductor (16) to secure and to electrically connect the coaxial cable (10) to the clamp body (310), the internal helical groove (600) substantially eliminating any separation between the dielectric core (14) and the central passage (311) to improve high frequency impedance matching.

2. Electrical connector as claimed in Claim 1, characterized in that the central passage (311) includes a pair of axially extended grooves (318), said axial grooves (318) being disposed at substantially diametrical opposite portions of the wall (315) of the central passage (311) to receive insulating material scraps as a result of biting engagement by the internal helical groove (600).

3. The method of assembling the electrical connector and its electrical termination according to Claim 1 with the coaxial cable, characterized by the steps of: cutting the external jacket (18), the braid conductor (16) and the dielectric core (14) of the coaxial cable (10) perpendicular to the axis thereof in a substantially uniform length, shorter than the central conductor (12) to provide the square cut; slipping the rear nut (400) over the coaxial cable (10); inserting the central conductor (12) in the central passage (311) such that the frusto-conical portion (314) faces the braid conductor (16) and the central passage (311) faces the dielectric core (14); rotating the clamp body (310) to progressively engage the raised edge portions of the external and internal helical grooves (500,600) with the braid conductor (16) and the dielectric core (14) to prevent removal of the clamp body (310) from the coaxial cable (10) and to reduce high frequency impedance mismatch caused by separation between the dielectric core (14) and the clamp body (310); and assembling the rear nut (400) and the forward contact body (200) over the electrical termination (300) to complete the electrical contact and captivate the clamp body (310) therebetween.

FIG. 1



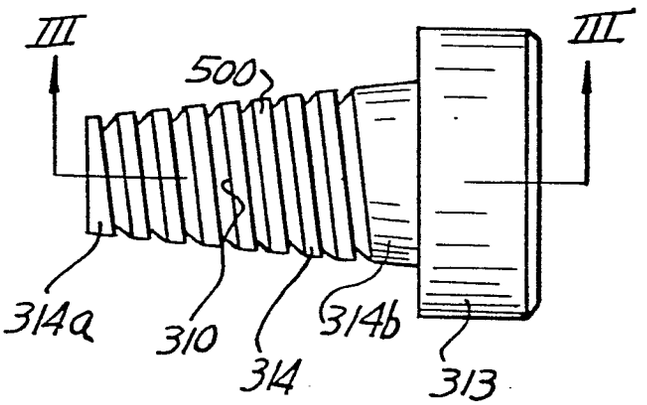


FIG. 2

FIG. 3

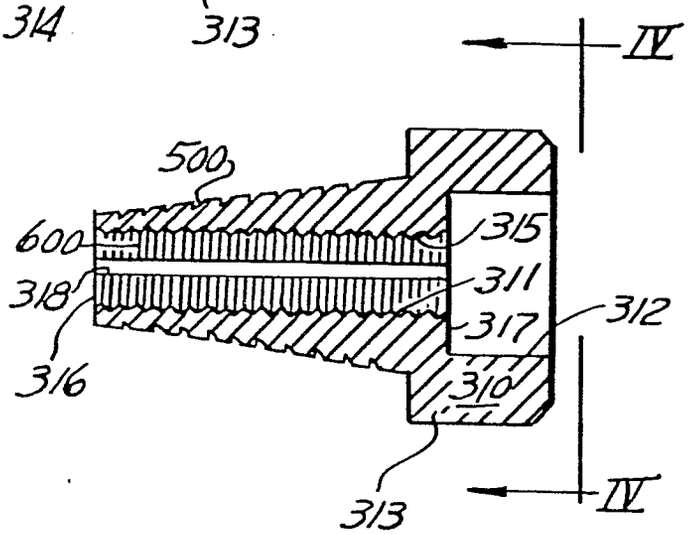


FIG. 4

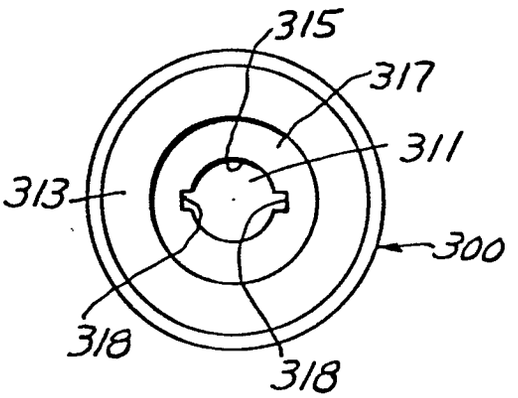


FIG. 5

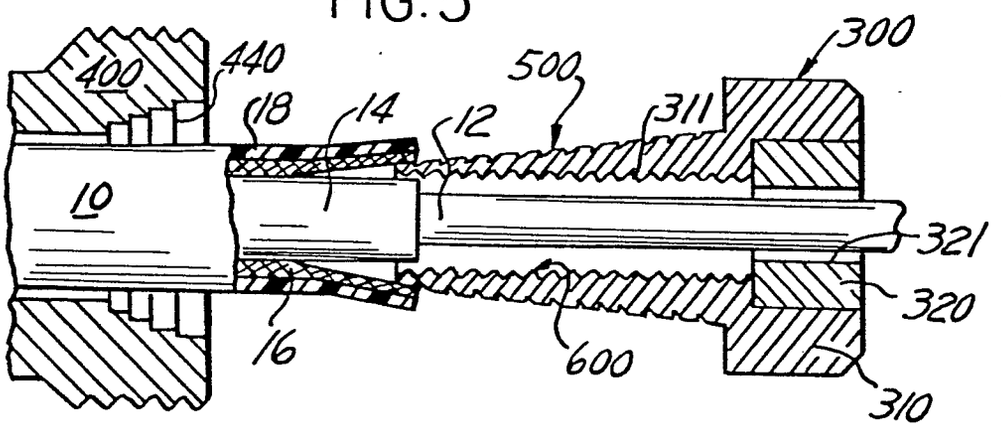
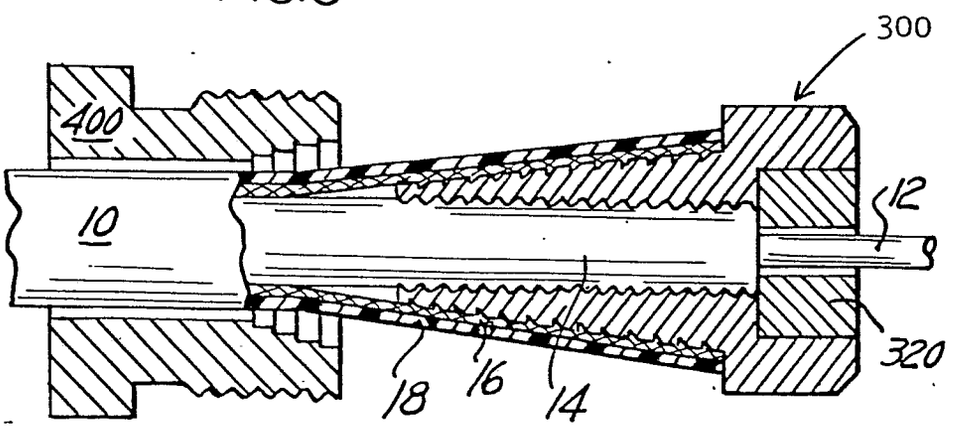


FIG. 6



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European Patent Office

Application number

EP 81 40 0732

EUROPEAN SEARCH REPORT

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
	DE - A - 2 628 490 (SIEMENS) * Page 7; paragraph 3; figures *	1
A	FR - A - 2 164 172 (SPINNER) * Page 5, lines 6-11; figure 8 *	1
A	DE - B - 1 075 699 (W. SIHN) * Column 2, lines 20-52; figures *	1
A	GB - A - 1 186 138 (KINGS ELECTRONICS) * Page 2, lines 42-53; figures *	1
P,D	EP - A - 0 020 188 (BENDIX) * Figures *	1
A,D	US - A - 3 110 756 (W.E. GENUNG et al.) * Figures *	1
A	US - A - 3 255 795 (Y. GINSBURG) * Column 2, lines 58-60; figures *	2

CLASSIFICATION OF THE APPLICATION (Int. Cl.³)

H 01 R 17/12

TECHNICAL FIELDS SEARCHED (Int. Cl.³)

H 01 R 17/12
- 9/05
F 16 B 37/00

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

X The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	11-09-1981	RAMBOER

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