

PATENT SPECIFICATION

(11)

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489 281

(21) Application No. 10366/75 (22) Filed 12 March 1975 (19)

(23) Complete Specification filed 12 March 1976

(44) Complete Specification published 19 Oct. 1977

(51) INT. CL.⁸ H01R 13/46,

(52) Index at acceptance

H2E 19 3A12 3A4A 3A5 3A6C 3B6 3C2C 3C2D 3C2E
3D3 3E16

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(54) ELECTRICAL CONNECTOR ELEMENT

(71) We, THE POST OFFICE, a British body corporate established by Statute, of 23 Howland Street, London, W1P 6HQ, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to electrical connectors. The invention is particularly concerned with an electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange and also extends to a terminating and testing unit incorporating a plurality of such elements.

A characteristic requirement of the design of such units is that while providing ready access to conductors for testing purposes, the units should be as compact as possible; this latter requirement is important because of the very large number of conductors terminating at a telecommunications exchange.

British Patent Specification No. 1,241,488 describes a break-jack assembly for an automatic telephone exchange main distribution frame. The assembly has an insulating housing divided into a number of separate compartments in each of which a pair of contact springs are located. The contact springs are normally in electrical contact connecting the lines to the exchange equipment but on insertion of a suitable insulating plug between a pair of contact springs, the latter are forced apart; the insulating plug is also provided with a pair of conducting tabs which, on insertion of the plug, engage respective contact springs between the springs and the walls of the housing. This connection provides a line testing facility. The contact springs are also provided with terminals extending out of the insulating housing for connection to an external lead. The insulating housing is made up of two components secured together after installation of the contact springs.

This break jack assembly suffers the dis-

advantage of being of complex design and the provision of a separate compartment for each pair of spring contacts considerably increases the area required to house the contacts.

It is an object of the invention to provide an improved electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange which is economical in its use of space.

According to the invention there is provided an electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange, said element comprising a strip of insulating material having first and second conducting member locating slots in respective opposite faces thereof, a first conducting member located in said first slot and having a tag connection portion projecting from one edge of the strip, a second conducting member located in said second slot and having a tag connection portion projecting from said one edge, said slots communicating in a recess formed in the other edge of the strip in which recess contact portions on said members interengage and provide a socket connection facility.

A terminating and testing unit made up of a number of such elements placed side by side enables a greater packing density of conductors to be achieved than in prior art terminating and testing units. An example of a packing density achievable by the use of the invention is 10,000 lines (conductor pairs) in 3.15 square metres.

Said contact portion of said first conducting member can include an anvil portion and said second conducting member can have a spring portion tensioned between the anvil portion of said first conducting member and a side wall of said second slot.

Said anvil portion of said first conducting member can abut a corresponding portion of said strip but said contact portion of said second conducting member can be

resiliently biased to a location spaced from its corresponding portion of said strip.

Interengagement of the contact portions can take place at a location within the recess spaced from the location of the socket connection facility within the recess.

Said projecting portion of one of said conducting members can project further from said one edge than said projecting portion of the other conducting member.

Said further projecting portion of said conducting member can have an insulating collar over a part of its length.

Said collar can be tapered away from the body of the strip.

Said further projecting portion can be provided with notches to facilitate tag connection.

Said first conducting member can be generally crank shaped.

Said conducting members can be made of strip metal and can be positioned edgewise in said first and second slots.

Said conducting members can be composed of tin coated nickel/silver alloy.

Said element can have a plurality of said first and second conducting members, said members providing a plurality of said tag connection portions spaced along said one edge of said strip and a plurality of said socket connection facilities spaced along the other edge of the strip.

A wall of said strip defining said recess can be provided with teeth projecting into the socket to cooperate with a plug member to resist withdrawal of said plug member.

According to another aspect of the invention there is provided a cable terminating and testing unit suitable for use in a telephone exchange, said unit comprising a plurality of electrical connector elements, each element being as defined above clamped together side-by-side to form a block having tag connection portions arranged over one face and socket connection facilities arranged over the opposite face.

At the interfaces between adjacent elements in the unit, respective slots in the adjacent faces can be offset from one another to prevent the conducting members located in said respective slots from conducting at said interfaces.

Said projecting portions of said other conducting members can be located between respective aligned collars of adjacent elements to leave a plurality of passageways between adjacent rows of aligned collars.

Said strips can be recessed along the paths of said passageways to form a plurality of channels.

Said elements can be clamped between a pair of end plates, one of said end plates having an edge portion projecting outwardly from said one block face, which edge por-

tion has holes therein aligned with said passageways.

Certain illustrative embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:

Figure 1 is a perspective view of part of an element according to the invention;

Figures 2 and 3 are elevations from opposite sides of the element of Figure 1 drawn to a smaller scale;

Figure 4 is a bottom elevation of the element;

Figures 5 and 6 are elevations from opposite faces of the element;

Figures 7 and 8 are sectional views on the lines VII—VII and VIII—VIII respectively of Figure 2;

Figures 9 and 10 are perspective views from opposite faces of part of a cable terminating and testing unit incorporating a plurality of the elements of Figures 1 to 8.

Figures 11 and 12 show conducting members forming part of the element;

Figure 13 shows a fanning strip forming part of the terminating and testing unit;

Figures 2 to 8 and Figure 13 being drawn to a smaller scale than Figures 1 and 9—12;

Figures 14 and 15 are elevations of part of another element according to the invention from opposite sides of the element;

Figure 16 is an enlarged end elevation of the element of Figures 14 and 15;

Figure 17A is an enlarged plan view of a plug suitable for use with the element of Figures 14 to 16;

Figure 17B is an enlarged elevation view of the plug; and

Figure 18 is a schematic illustration of a modified form of the plug inserted into the element of Figures 14 to 16.

Referring to Figures 1 to 8 in detail there is shown an element 1 for a terminating and testing unit suitable for use in a telecommunication exchange, the element generally comprising a rigid plastics strip 2, a plurality of conducting members 3 of one type and a plurality of conducting members 4 of another type, one of each type of the conducting member being shown detached from the element 1 in Figures 11 and 12. The conducting members are composed of springy metal, preferably tin-coated nickel/silver alloy. The conducting members 3 and 4 are located in respective slots 5 and 6 which are formed during heat moulding of the strip, or subsequently by machining, in respective faces 7 and 8.

Each of the slots 5 has a housing portion 9 of greater width than the rest of the slot 9a; the housing portions house curved parts 10 of the respective conducting members 3. Each of the curved parts 10 bears on one side against a surface 11 of the housing portion 9 and on the other side against an

anvil portion 12 of an adjacent one of the conducting members 4. The parts 10 are sprung against their respective housing portions.

5 The anvil portion 12 of each conducting member 4 is integral with a neck portion 13 which, as shown in Figure 8 is located in a portion of the associated slot 6 of increased depth. In the region of each anvil portion 10 12, the associated slots 5 and 6 communicate and jaws 14 and 15 on the associated conducting members 3 and 4 bear against one another.

15 The strip 2 is so shaped at 16 as to allow movement of the jaw 14 away from the jaw 15 when an object is pushed between the jaws, the spring portion 10 ensuring that the object will be gripped by the jaws.

20 The conducting members 3 and 4 have at their other ends, portions 16a and 17 respectively which project from the edge of the strip 2. The portions 17 project further from the strip edge than the portions 16a and each is surrounded on three sides along an inner part by an insulating block 18 formed 25 integrally with the strip 2. The portion 17 is formed with notches 19 whose use will be explained with reference to the description of the operation of the element 1.

30 Referring to Figures 9 and 10, there is shown a part of a cable terminating and testing unit which includes several (for example, ten) of the elements 1 described with reference to Figures 1 to 8. Part of two 35 elements can be seen in Figure 10 and part of three in Figure 9.

40 The back plate 23 shown in Figure 13, as well as performing a clamping function, also serves, in use, as a fanning strip; ie a strip having holes through and by which individual conductors or sets of conductors are led from a cable to chosen locations, in this case the projecting portions (or tags) 16a 45 and 17. The back plate or fanning strip 23 has a series of holes 27 and 28 extending through it. The series of holes is arranged down the side of the plate with a spacing such that in the assembled condition as shown schematically in Figure 13, each horizontal 50 set of holes 27 and 28 is aligned with the row of spaces between the respective horizontal rows of blocks 18. As can be seen from Fig. 9, the projecting portions 16a are located between respective aligned collars of adjacent elements to leave a series 55 of horizontal passages 29 available for laying in conductors or sets of conductors after they have been led through the holes 27 and 28.

60 The installation and operation of a single terminating and testing unit will now be described with particular reference to a telephone exchange. A cable, (not shown), is 65 led into the exchange and the conductor pairs of the cable are split into groups. Each

group is led through one of the smaller holes 27 (Fig. 13) and laid along a passage 29. Individual conductors of the group are then led upwardly to respective ones of the upwardly adjacent row of tags 16a where they are terminated using, for example, a known wire wrapping technique.

The top as shown in Figures 11 and 13 (and the bottom (not shown)) of each element 1 is formed with an end portion 20 75 which provides a guideway 21 in which a screw-threaded tie member 22 is located. Each tie member extends from a back plate 23 (shown in Figure 13) to a front plate 24, the elements being securely clamped between 80 the two plates by the tie members. The guideway 21 allows extraction of individual elements 1 when the tie member ends are partially unscrewed.

85 As can be seen from Figure 2, the array of slots 5 in the face 7 of an element are offset vertically with respect to the array of slots 6 in the opposite face 8. Since the elements 1 are all identical, when they are clamped together to form the regular block 90 structure, part of which is shown in Figs. 9 and 10, the conducting member 3 at the surface 7 of any one element 1 will not come into electrical contact with the conductor member 4 at the surface 8 of the next adjacent element. In order to guard 95 further against electrical contact between the members they are formed with feet 26 which are flush with the respective faces 7 and 8 when the members 3 and 4 are properly 100 located. When adjacent elements 1 are clamped together, the feet 26 of the respective members serve to maintain the main body of each conducting member spaced 105 from the interface between elements. The feet on members 3 are offset from the feet on members 4 so that the foot on a member 3 cannot touch the foot of an adjacent member 4.

110 Groups of jumpers, i.e. wires connecting different parts of the exchange, to the cable conductors, are led through respective ones of the larger holes 28 in the fanning strip, the jumper groups being laid over the groups 115 of conductor pairs. Individual ones of the jumpers are led upwardly to respective ones of the upwardly adjacent row of tags 17, which extend further from the unit face 120 than the tags 16a, the jumpers being terminated at the notches 19 by, for example, a known soldering technique.

Electrical connections between adjacent jumpers and conductor tags, for example tags A and B in Fig. 9 are produced by 125 interengagement between adjacent jaws 14 and 15, for example the jaws A₁ and B₁ of Fig. 10.

Access to the circuits for testing or other purposes is obtained by pressing a laminated break plug blade (not shown) into the socket 130

formed by an adjacent pair of jaws 14 and 15. The blade has a pair of conducting faces flanking an insulating leaf, the conducting surfaces being connected to one another through a test circuit.

In fact, to test a telephone circuit it will be necessary to test a circuit including a pair of conductors which will, for example, be terminated at the horizontally aligned tags A and C (Fig. 9). To ensure that a test probe cannot be used to connect one leg of one telephone circuit to one leg of another telephone circuit, spacer members 30 are located in grooves 31 in such a position that a probe of preformed shape having a pair of plug blades can be inserted only in horizontally aligned sockets which form a pair. For example, in Figure 10 the probe could be inserted in sockets A₁, B₁ and C₁, D₁ but the spacer 30 would prevent insertion in C₁, D₁ and the socket (not shown) to the left, in Figure 10, of C₁, D₁.

Figures 14 to 16 show another form of element embodying the invention which, as can be seen from the drawings, is similar to the element shown in Figure 1, but which includes a number of modifications. The description of the construction and operation of the second element will therefore be confined largely to the substance of the modifications incorporated in the element of Figures 14 to 16.

Referring first to Figures 14 and 15, an element 32 for a terminating and testing unit comprises a rigid strip 33, a plurality of conducting members 34 of one type and a plurality of conducting members 35 of another type. The conducting members 34 and 35 are of the same outline when seen in plan view as the shape of conducting members 3 and 4 respectively as shown in Figures 11 and 12. However as can be seen in Figures 14 and 15 the conducting members 34 and 35 are of a different shape, when seen in elevation, at the ends where they contact each other. The conducting member 35 has a substantially flat anvil portion 36 which abuts a correspondingly flat part of the strip 33. The conducting member 34 has a generally 's' shaped end portion one end of the 's' being in contact with the member 35 and the remaining part of the 's' defining, in combination with the anvil part of the member 35 a pair of jaws forming a socket into which a plug can be inserted. The conducting member 34 is so shaped that when located in the strip 33, it is resiliently biased into contact with the member 35 by spring tension in the conducting member 34. The strip 33 is so formed in the region 37 as to allow movement of the jaw on the member 34 away from the member 35.

A further modification incorporated in the element 32 is the provision of a toothed

section 38 on a wall of the strip 33. As can be seen most clearly in Figure 16 the toothed section is provided to one side of the conducting members and constitutes one wall of an open recess 39. This recess, which is not present in the element shown in Figure 1, is provided to receive a correspondingly toothed portion of a plug 43.

The socket engaging portion of the plug 43 is shown in Figures 17A and 17B. As can be seen in the drawings the plug has a central toothed portion 44 which is inserted into the recess 39 when a connection is made. The plug and recess are dimensioned so that the plug can be fitted therein without the teeth engaging; however if leads to the plug 43 are accidentally pulled so that the plug assumes a downwardly slanted position, the teeth on the plug and recess interengage to prevent unwanted removal of the plug. On each side of the toothed portion 44 there is a break plug blade 45 composed of an insulating leaf 46 flanked on each side by conducting surfaces 47.

Referring again to Figures 14 and 15, the ends of the conducting members 34 and 35 distant from the jaws are of the same shape as in the first embodiment. An insulating collar 40 integral with the strip 33 is provided around three sides of the conducting member 35 and as shown in the drawings this collar is tapered away from the body of the strip. Between adjacent collars 40 there are recesses 41 provided in the strip 33; the purpose of these recesses will be described later.

The elements 32 can be secured together side by side in the same way as the elements 1 of the previously described embodiment. In one particular example ten elements are secured together, each element having twenty sockets. The top (not shown) and bottom of each of the elements 32 is provided with a guideway 42 in which a screw threaded tie member is secured as before between a back plate and a front plate.

The element 32 is not provided with grooves to locate spacer members between adjacent elements as is the element of Figure 1; instead a second type of element is inserted between neighbouring elements 32; this second type of element is very similar to the element 32 but it is not provided with a recess 39 to receive the toothed part of the plug 43. Consequently, when the elements are clamped together side by side with the two types of elements alternating, the plug 43 can only be inserted with the left hand blade (as seen in Figure 17A) in the element 32 of the first type (so that the toothed part 44 of the plug is located within this same element). Thus the plug 43 can only be inserted into adjacent pairs of sockets and not adjacent unpaired sockets; it should be noted that the plug cannot be

inverted since the toothed part 44 would be unable to fit the recess 39 in the element 32.

When the elements 32 are secured together as just described the recesses 41 on adjacent elements will be aligned so that a plurality of channels are formed between the tags on conducting members 34 and 35. As in the first described embodiment the back plate can also serve as a fanning strip and conductors or sets of conductors can pass through holes in the fanning strip and along the channels formed by the recesses 41.

The operation and installation of the terminating and testing unit will be generally the same as for the previously described unit and will not therefore be described again; however the mechanism of insertion of a plug into a socket is somewhat different owing to the different shape of the conducting members and this will now be described.

The jaws of the conducting members prior to insertion of the plug 43 have a separation slightly less than the depth of the plug. Upon insertion of the plug 43 into the socket, the jaws of the conducting members 34, 35 are forced further apart so that the conducting members break contact with each other and make contact with respective faces of a break plug blade 45. Thus in the arrangement just described considerably less bending of the conducting member 34 is incurred than in the element shown in Figure 1; consequently the conducting member 34 is exposed to correspondingly less severe stresses.

While two specific embodiments of the invention have been described it will be clear that many modifications of the embodiments can be made and some of these will be described below.

As has already been described the slots in the plastics strip can be formed by heat moulding of the strip or subsequently by machining. It may be convenient, particularly in the case where the slots in the plastics strip are moulded, to reduce the amount of plastics material in each strip. In this case the faces 7 and 8 (and the corresponding faces in the element 32) can be subject to substantial coring, as is usual in the manufacture of moulded articles. In this case the problem of differential contraction of the strip during cooling is substantially eliminated and the flow of the material in the mould is improved. The coring provides the further advantage of economy of material. As a result of the coring, the side walls of the slots abutting the conductors may be discontinuous, and they may be formed as a number of separated portions for locating the conducting members.

As an alternative to or in addition to the

provision of interlocking teeth to retain the plug 43 in the unit, a small rounded pip 48 can be provided protruding from the upper contact surfaces 47 of the plug so that when the plug is fully inserted into a pair of sockets the pips advance into the socket just beyond the narrowest separation of the conducting members 34, 35 to the position illustrated schematically in Figure 18. In this position the plug is secured in the socket and is also prevented from rotating substantially in the horizontal plane.

WHAT WE CLAIM IS:—

1. An electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange, said element comprising a strip of insulating material having first and second conducting member locating slots in respective opposite faces thereof, a first conducting member located in said first slot and having a tag connection portion projecting from one edge of the strip, a second conducting member located in said second slot and having a tag connection portion projecting from said one edge, said slots communicating in a recess formed in the other edge of the strip in which recess contact portions on said members interengage and provide a socket connection facility.
2. An element as claimed in claim 1 in which said contact portion of said first connecting member includes an anvil portion and said second conducting member has a spring portion tensioned between the anvil portion of said first conducting member and a side wall of said second slot.
3. An element as claimed in claim 2 in which said anvil portion of said first conducting member abuts a corresponding portion of said strip but said contact portion of said second conducting member is resiliently biased to a location spaced from its corresponding portion of said strip.
4. An element as claimed in any preceding claim, in which interengagement of the contact portions takes place at a location within the recess spaced from the location of the socket connection facility within the recess.
5. An element as claimed in any preceding claim in which said projecting portion of one of said conducting members projects further from said one edge than said projecting portion of the other conducting member.
6. An element as claimed in claim 5 in which said further projecting portion of said conducting member has an insulating collar over a part of its length.
7. An element as claimed in claim 6 in which said collar is tapered away from the body of the strip.
8. An element as claimed in any preceding



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inverted since the toothed part 44 would be unable to fit the recess 39 in the element 32.

5 When the elements 32 are secured together as just described the recesses 41 on adjacent elements will be aligned so that a plurality of channels are formed between the tags on conducting members 34 and 35. As in the first described embodiment the back plate can also serve as a fanning strip and conductors or sets of conductors can pass through holes in the fanning strip and along the channels formed by the recesses 41.

15 The operation and installation of the terminating and testing unit will be generally the same as for the previously described unit and will not therefore be described again; however the mechanism of insertion of a plug into a socket is somewhat different owing to the different shape of the conducting members and this will now be described.

20 The jaws of the conducting members prior to insertion of the plug 43 have a separation slightly less than the depth of the plug. Upon insertion of the plug 43 into the socket, the jaws of the conducting members 34, 35 are forced further apart so that the conducting members break contact with each other and make contact with respective faces of a break plug blade 45. Thus in the arrangement just described considerably less bending of the conducting member 34 is incurred than in the element shown in Figure 1; consequently the conducting member 34 is exposed to correspondingly less severe stresses.

40 While two specific embodiments of the invention have been described it will be clear that many modifications of the embodiments can be made and some of these will be described below.

45 As has already been described the slots in the plastics strip can be formed by heat moulding of the strip or subsequently by machining. It may be convenient, particularly in the case where the slots in the plastics strip are moulded, to reduce the amount of plastics material in each strip. In this case the faces 7 and 8 (and the corresponding faces in the element 32) can be subject to substantial coring, as is usual in the manufacture of moulded articles. In this case the problem of differential contraction of the strip during cooling is substantially eliminated and the flow of the material in the mould is improved. The coring provides the further advantage of economy of material. As a result of the coring, the side walls of the slots abutting the conductors may be discontinuous, and they may be formed as a number of separated portions for locating the conducting members.

65 As an alternative to or in addition to the

provision of interlocking teeth to retain the plug 43 in the unit, a small rounded pip 48 can be provided protruding from the upper contact surfaces 47 of the plug so that when the plug is fully inserted into a pair of sockets the pips advance into the socket just beyond the narrowest separation of the conducting members 34, 35 to the position illustrated schematically in Figure 18. In this position the plug is secured in the socket and is also prevented from rotating substantially in the horizontal plane.

WHAT WE CLAIM IS:—

1. An electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange, said element comprising a strip of insulating material having first and second conducting member locating slots in respective opposite faces thereof, a first conducting member located in said first slot and having a tag connection portion projecting from one edge of the strip, a second conducting member located in said second slot and having a tag connection portion projecting from said one edge, said slots communicating in a recess formed in the other edge of the strip in which recess contact portions on said members interengage and provide a socket connection facility.

2. An element as claimed in claim 1 in which said contact portion of said first connecting member includes an anvil portion and said second conducting member has a spring portion tensioned between the anvil portion of said first conducting member and a side wall of said second slot.

3. An element as claimed in claim 2 in which said anvil portion of said first conducting member abuts a corresponding portion of said strip but said contact portion of said second conducting member is resiliently biased to a location spaced from its corresponding portion of said strip.

4. An element as claimed in any preceding claim, in which interengagement of the contact portions takes place at a location within the recess spaced from the location of the socket connection facility within the recess.

5. An element as claimed in any preceding claim in which said projecting portion of one of said conducting members projects further from said one edge than said projecting portion of the other conducting member.

6. An element as claimed in claim 5 in which said further projecting portion of said conducting member has an insulating collar over a part of its length.

7. An element as claimed in claim 6 in which said collar is tapered away from the body of the strip.

8. An element as claimed in any preceding

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ing claim in which said further projecting portion is provided with notches to facilitate tag connection.

- 5 9. An element as claimed in any preceding claim in which said first conducting member is generally crank shaped.

- 10 10. An element as claimed in any preceding claims in which said conducting members are made of strip metal and are positioned edgewise in said first and second slots.

- 15 11. An element as claimed in any preceding claim in which said conducting members are composed of tin coated nickel/silver alloy.

- 20 12. An element as claimed in any preceding claim in which said element has a plurality of said first and second conducting members, said members providing a plurality of said tag connection portions spaced along said one edge of said strip and a plurality of said socket connection facilities spaced along the other edge of the strip.

- 25 13. An element as claimed in any preceding claim in which a wall of said strip defining said recess is provided with teeth projecting into the socket to cooperate with a plug member to resist withdrawal of said plug member.

- 30 14. An electrical connector element for a terminating and testing unit suitable for use in a telecommunications exchange, the element being substantially as herein described with reference to and as illustrated by Figures 1 to 8, 11 and 12 or by Figures 14, 15 and 16 of the accompanying drawings.

- 35 15. A cable terminating and testing unit suitable for use in a telephone exchange, said unit comprising a plurality of electrical connector elements, each element being as claimed in any preceding claim clamped to-

gether side-by-side to form a block having tag connection portions arranged over one face and socket connection facilities arranged over the opposite face. 45

16. A unit as claimed in claim 15 in which at the interfaces between adjacent elements in the unit, respective slots in the adjacent faces are offset from one another to prevent the conducting members located in said respective slots from conducting at said interfaces. 50

17. A unit as claimed in claim 15 or 16 when dependent upon claim 6 in which said projecting portions of said other conducting members are located between respective aligned collars of adjacent elements to leave a plurality of passageways between adjacent rows of aligned collars. 55 60

18. A unit as claimed in claim 17 in which said strips are recessed along the paths of said passageways to form a plurality of channels. 65

19. A unit as claimed in any of claims 15 to 18 in which said elements are clamped between a pair of end plates, one of said end plates having an edge portion projecting outwardly from said one block face, which edge portion has holes therein aligned with said passageways. 70

20. A cable terminating and testing unit suitable for use in a telephone exchange, the unit being substantially as herein described with reference to and as illustrated by Figures 1 to 13 of the accompanying drawings or as modified substantially as herein described with reference to and as illustrated by Figures 14 to 16 of the accompanying drawings. 75 80

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