June 28, 1966 R. J. HUSBAND ET AL 3,258,730

SWITCH BLOCK

Filed Oct. 22, 1963

FIG. 1

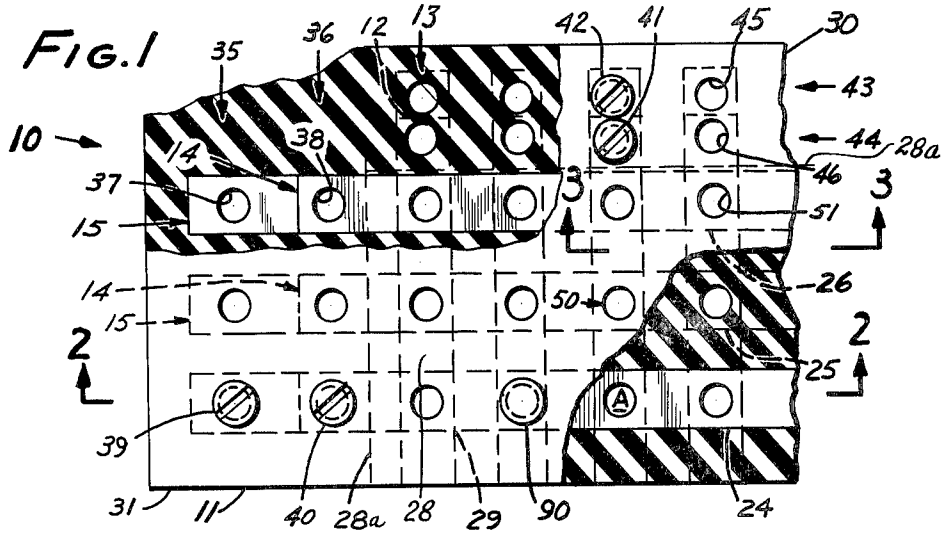


FIG. 2

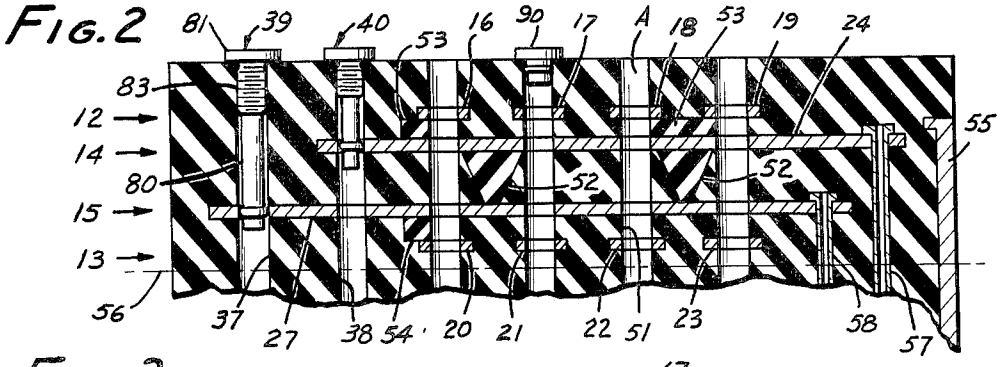


FIG. 3

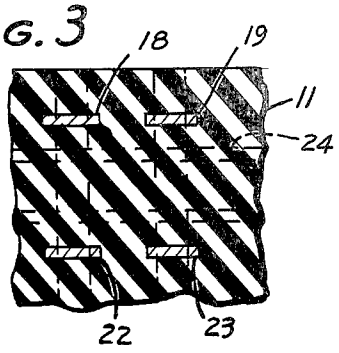


FIG. 4

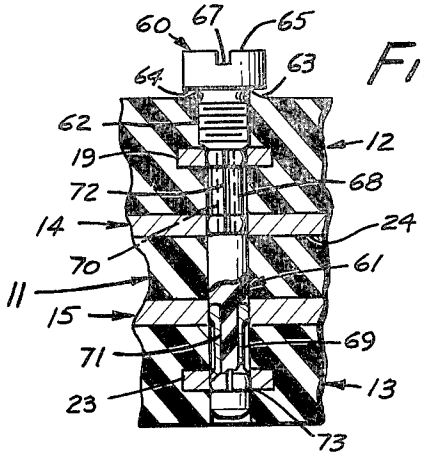
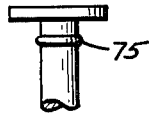


FIG. 5



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SWITCH BLOCK

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This invention relates to a switch block of the cross-bar type.

There is an outstanding requirement for a unitary switch block of the cross-bar type in which the block may be left exposed to the weather and in that circuit connections which are fully protected from the environment can readily be made by the simple insertion of pins. Such a switch block must be susceptible of ready and inexpensive construction and be resistant to environment. Furthermore, it is desirable for the switch block to occupy as little bulk as possible to achieve its function.

Previous efforts to produce such devices have failed, because temperature and weather changes destroyed the registration of the elements associated with the various holes, and the units also failed structurally, because the devices had to be built up in layers, which could not effectively be bonded together.

It is an object of this invention to provide a switch block which is unitary, non-layered, and therefore rugged, and which is readily manufactured.

It is another object of this invention to provide the combination of a switch block and a switch pin with an environmental seal that protects the switching junction from the elements.

A switch block according to this invention comprises an encapsulating body enclosing four ranks of spaced-apart conductive bars. The bars of each rank lie in a single respective plane, these planes and their respective bars being parallel to and spaced apart from each other. The bars of the first and seconds ranks are parallel to each other as are the bars of the third and fourth ranks. The bars of the third and fourth ranks are perpendicular to the bars of the first and second ranks in plan view. The bars of the first and second ranks overlay each other in plan view as do the bars of the third and fourth ranks. With this arrangement, the four ranks intersect each other in plan view at intersections which lie on a normal to any of the said planes, these intersections lying within a switching region. The ranks of bars extend beyond the switching region to respective access regions outside the switching region where wire access means is provided for each bar, whereby wire may be connected to any selected bar. Pin access holes are provided through the block and the bars at each intersection in order to provide access for interconnection between ranks at any selected intersection. Switch pin means is insertable in a selected pin access hole and adapted to interconnect a bar of the first and third ranks and a bar of the second and fourth ranks at a selected intersection.

According to a feature of this invention, the encapsulating body is unitary and bonded to the bars.

According to a preferred but optional feature of this invention, an environmental seal is provided between the switch pin and the pin access means.

According to still another preferred but optional feature, the four ranks of bars are doubled and corresponding ranks are interconnected by conductive connections

in order to use both sides of the switch block for operative purposes.

The above and other features of this invention will be fully understood from the following detailed description and the accompanying drawing in which:

FIG. 1 is a plan view, partly in cutaway cross-section, showing the presently preferred embodiment of the invention;

FIGS. 2 and 3 are cross-sections taken at lines **2—2** and **3—3**, respectively, of FIG. 1;

FIG. 4 is a cross-sectional view of a portion of FIG. 2, showing one embodiment of switch pin making its connections; and

FIG. 5 is a fragmentary side view of a pin useful in place of that shown in FIG. 4.

FIG. 1 illustrates the presently preferred embodiment of switch block **10** according to the invention. It includes an encapsulating body **11** which may readily be made of an epoxy compound which can be poured into a form where it solidifies around the objects it encapsulates. The presently preferred epoxy material is Epocast H2E–069, mod 3, sold by Furane Plastics Company, Los Angeles, California. This material has Shore hardness of about 74 Shore D at 74° F. Hardener 9010 sold by the same source is added to achieve this Shore hardness. The ratio of Epocast to the hardener is two to one by weight.

FIGS. 1 and 2 illustrates four ranks **12, 13, 14, 15** of conductive bars. These ranks lie in respective planes which are seen in edge view in FIG. 2, and in plan view in FIG. 1. The ranks and their planes are spaced apart from each other as can be seen in FIG. 2. As can also be seen in FIG. 2, rank **12** (hereinafter called the first rank) as all the other ranks, comprises a plurality of flat conductive bars which may conveniently be prepunched as will hereinafter be more fully discussed. It will be understood that the number of bars to be utilized herein is indeterminate and forms no part of the invention, though ordinarily there will be a plurality of bars in each rank. In first rank **12**, there are shown bars **16, 17, 18, 19**, while in rank **13** (hereinafter called the second rank), there are shown bars **20, 21, 22, 23.**

In rank **14** (hereinafter called the third rank), there are illustrated only three bars **24, 25, 26**, and in rank **15** (hereinafter called the fourth rank), there is illustrated only bar **27.**

It will be noted that the bars of the first and second rank overlay each other as viewed in plan in FIG. 1, as do the bars of the third and fourth rank. This creates a region outlined by dashed line **28***a* to be referred to herein as switching region **28** within which there is disposed a plurality of intersections of bars such as intersection **29.** The intersections of all of the bars as viewed in plan lie on lines which are normal to the plane of every rank.

The bars extend beyond the switching region into access regions **30, 31.** Access region **30** relates to the first and second ranks, and access region **31** relates to the third and fourth ranks. These are respective access regions where it is intended that wires of incoming and outgoing pairs be selectively connected to individual ones of the bars. The bars of the second and fourth ranks extend beyond the bars of first and third ranks, all respectively, to provide vertical access by connecting pins to all bars.

Wire access means **35, 36** are best shown in FIGS. 1 and 2. These means comprise holes **37, 38** extending into the block and passing through the respective bars of the

third and fourth ranks. As best shown in FIG. 2, holes **37** and **38** pass through bars **27** and **24** in order that terminal pins **39**, **40** may be inserted to make selective contact with the two bars.

In access region **31**, similar connections such as terminal pins **41**, **42** can be made to the bars of the first and second ranks, respectively. It will thereby be seen that it is possible to introduce cable pairs to selective members of two ranks and by selective interconnection of bars within the switching region to direct these to selected terminal pins. Wires are connected to the terminal pins. Terminal pins **41**, **42** are inserted in wire access means **43**, **44**, such as holes **45**, **46**.

Pin access means **50** comprises holes such as hole **51** which pierces the encapsulating body, and passes through all of the bars at the respective intersections. The hole's diameter is less than the bar width, so that metal is left to be contacted by means yet to be described. In the preferred embodiment of this invention, the bars are prepunched and aligned before encapsulation, so that drilling the pin access holes is a simple matter involving only the removal of plastic material. Little metal is removed. Furthermore, in mass production, with these holes predrilled in the bars, it is possible to set up the bar assembly with the holes in the metal entirely occupied by locating pins attached to the mold, pour the encapsulating material into the mold and around the assembled structure, and then remove the mold, thereby leaving the holes **51** already formed, and needing only minor, if any, cleanout. As can best be seen from FIG. 2, every hole **51** intersects one of the bars of every rank. Which bars are involved in circuit connections is determined by which of the intersections is selected. It is thereby possible to make any combination of connections between bars in the first and second ranks and bars in the third and fourth ranks, thereby making a fully useful cross-bar device.

In order to facilitate the assembly of this device, wedge-shaped spacers **52**, made of some insulating material such as Micarta, are placed between the third and fourth ranks, while flat spacers **53**, **54** are placed between the first and third and the second and fourth ranks, respectively, thereby spacing apart and holding well assembled the various bars so that they can readily be handled as a unit. As many or few of these spacers as desired may be used.

A U-shaped channel **55** (only half of which is shown) runs the length of the switch block at one edge which can readily be used for attachment purposes. For example, it can receive metal screws to attach it to other structure.

In order to reduce the bulk and double the utility of the device relative to devices of the same area, and with only a minor increase in thickness, the board may be "folded over," its mirror image with respect to FIG. 2 being formed below center line **56**. Conductive roll pins **57**, **58** interconnect respective, parallel, bars of a third and fourth rank on the opposite side of access **56**. A mirror image hole pattern is formed on the opposite side by continuing all holes through the block. In this, as in all other embodiments, the bars are substantially parallel to each other within switching region **28**. They may, of course, be otherwise formed outside this region but in the preferred embodiment shown they will be flat bars, parallel throughout their entire length. Holes **38** and **46** on the opposite side may also be continuations, by drilling through intervening bars, or may be formed separately. In this way, a device of indefinite length such as that of FIG. 2 can be doubled over to make both of its sides useful for switching purposes. It is not believed necessary to show the lower half of FIG. 2, it being understood that the construction below the center line is an exact mirror image of that which is shown above the center line.

Switching within the switching region is accomplished by use of switch pins **60**, the preferred embodiment of which is shown in FIG. 4. This switch pin includes a

non-conductive spindle **61** made of material which is preferably less pliable than that of the encapsulating block, but which may be made of generally similar material. The term "pliability" is used here in the sense of resilience because it is desired to have at least moderate spring back forces between the body so as to maintain the seal once it is made, and this is the sense of the "relative movement" of material to create a fluid-tight seal. As an example, the pin may be made of material having a Shore hardness of about 90, while the block may be made of a material having a Shore hardness of about 74. The result of this is that threads **62** on the pin can readily tap themselves into the body, and furthermore, in so doing, upset a small shoulder **63** which meets underside **64** of head **65** to make a seal at their face which excludes the outer environment. A driver slot **67** may be provided to aid in setting this pin.

A pair of conductive sleeves **68**, **69** are spaced apart from each other and located in grooves **70**, **71** of the pin. These sleeves have shoulders adapted to contact and interconnect the first and third ranks and the second and fourth ranks in the region in which they are located, and preferably each has a small slit **72**, **73** which renders the sleeve somewhat outwardly biased in order to make such a firm contact.

FIG. 5 illustrates that, instead of the use of threads, a pin for the use shown in FIG. 4 may have a bead **75** surrounding it, and a smooth shank. The bead has an outer diameter greater than that of the hole into which it is to be inserted. This pin may be pressed into the hole, and the bead will make the environmental seal, and also will exert a retaining force which will hold the pin in place. Of course, the bead may also be used on a threaded pin. There are thus provided two pin types suitable for use in any place where pins are needed: a first wherein threads are used, and the block material is upset to form a seal; and, a second where no threads are provided, and a bead makes the seal and a friction grip as well. The thread in the one embodiment and the bead in the other both form environmental seal means which will provide a fluid-tight seal between the pin and the body. The bead is a single example of an interference fit which caused relative movement of material to create a fluid-tight seal. The term "friction fit" is often used synonymously with the term "interference fit."

Pins **39**, **40** suitable for use with the wire access means are shown in FIG. 2. They are of different length so as to reach only the bar with which they are to make contact. They are identical except for length. Pin **39**, for example, has a shank **80** with a slotted head **81** at one end. The shank and integral bead will be made of material harder than the encapsulating body, for example, of brass, so that it will indent itself into the body.

Threads **83** on the shank cut into the body to engage it. Spaced from the head is a springy contactor which extends laterally beyond the shank, but which is in firm electrical connection with it. This is located on the shank where it will contact the respective bar, it and the shank thereby connecting the bar to the head, to which a wire may be connected.

In order to provide complete environmental protection, holes in which pins for connections are not inserted should be closed by plugs such as plug **90** (FIGS. 1 and 2) which may be similar to either set of pins, but preferably to that of FIG. 5 to avoid cutting threads in the block in advance of need. Only one of these plugs is shown, it being contemplated that one will be used in each hole. However, to illustrate them all would only render the drawings less illustrative of the other features of the invention.

It is further contemplated to plate the bars at the holes. This can conveniently be done with an initial disposition of electroless nickel, followed by a deposition of electroless gold, which plate improves the contact, and which will not plate onto the plastic, only onto the brass, when properly accomplished.

The method of construction of this device should be evident from the foregoing. By the use of the roll pins and spacers, the bars may readily be assembled as a free body and may be inserted in a mold. Thereafter the mold may be filled with the encapsulating material and after it is set, the respective holes may be formed and the device is ready for use.

Should more expensive tooling be desired, it is then possible to provide pins for each of the access means and pin access means assembling the construction on these pins, and then pouring the encapsulating body, thereafter cleaning up the holes as necessary. Either construction will work, one involving greater initial expense but less labor than the other. In either event, the construction is one of extreme ruggedness and wide utility.

One of the principal reasons for failure of prior art devices is their attempt to build such structures in laminar form. The laminations would tend to separate and, should the thermal coefficients of expansion differ greatly, the holes in the bars and spacing material no longer align when the temperature changes, and the device is useless. In this device, the encapsulating material selected is one which *bonds* to the bars. In this way, registration is maintained whatever the temperature, because the device is unitary and has a composite coefficient of expansion. In the embodiment described above, the expoxy does bond to the brass bars. The process of casting the device in a single piece entirely does away with lamination problems.

The bars and encapsulating material preferably have substantially equal thermal coefficients of expansion.

As to the illustrated use, members of a wire pair connected to pins **39** and **40** are connected to bars **27** and **24**, respectively. Assuming a pin **60** to be inserted in the hole at junction A, bars **27** and **24** will thereby be connected to bars **22** and **18**, which are, in turn, connected to pins **41** and **42**, respectively. Insertion of pins **60** into any intersection would connect different sets of bars, and pins would be appropriately located in the access regions.

The beads, or the thread-caused upset as shown in FIG. 4, give a reliable environmental seal to the inside elements and their joints.

The access means is shown in the present embodiment as being holes, but it will be recognized that instead it could be other means such as different types of recesses or of protruding portions of individual bars adapted to receive wire contacts.

This device is not limited in utility to cross-bar switching of pairs. It is also useful as a circuit board for all purposes where cross-bar switching between circuits is desired.

This invention is not to be limited by the embodiments shown in the drawings and described in the description which are given by way of example and not of limitation, but only in accordance with the scope of the appended claims.

We claim:

1. In combination: a switch block comprising an encapsulating body, four ranks of spaced-apart conductive bars inside said body, the bars of each rank lying in a single respective plane, the planes being parallel to and spaced apart from each other, the bars of the first and second ranks being parallel to each other, the bars of the third and fourth ranks being parallel to each other, and perpendicular to the bars of the first and second ranks in plan view, the bars of the first and second ranks overlaying each other in plan view, and the bars of the third and fourth ranks overlaying each other in plan view, whereby the four ranks intersect each other in plan view at intersections which lie on a normal to any of the said planes, said intersections lying within a switching region, said first and second, and third and fourth ranks of bars extending beyond the switching region to respective access regions outside the switching region, wire access means to each bar at the access region whereby a wire may be connected to any selected bar, a pin access means through the block and the bars at each intersection to provide access for interconnection between ranks at any selected intersection; and switch pin means insertable in said pin access means adapted to interconnect a bar of the first and third ranks and a bar of the second and fourth ranks at a selected intersection, the body encapsulating the bars and being continuous and free of discontinuities within its own structure; and seal means for forming an environmental seal between the switch pin means and the pin access means.

2. A combination according to claim **1** in which the thermal coefficients of expansion of the body material and of the bars are substantially equal.

3. A combination according to claim **1** in which the material of the block is bonded to the bars to render the block an integral structure.

4. A combination according to claim **1** in which the switch pins bear external threads which are harder than the material of the body so as to cut into the body for attachment purposes.

5. A combination according to claim **1** in which the ranks and pin access means are duplicated at opposite surfaces of the switch block, at least one set of parallel ranks being interconnected to a respective set in the duplication, whereby the switching function is doubled over the same gross area.

6. A combination according to claim **1** in which the seal means comprises a peripheral thread on the switch pin means adapted to displace material of the block so as to form a fluid-tight joint.

7. A combination according to claim **1** in which the seal means comprises a peripheral surface on the pin adapted to make an interference fit with the block to form a fluid-tight seal.

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