

- [54] **MINIATURE TANDEM SPRING CLIPS**
 [75] Inventors: **Ray R. Scoville**, LaCanada; **Ralph R. Wells**, Van Nuys, both of Calif.
 [73] Assignee: **Vector Electronic Company**, Sylmar, Calif.
 [22] Filed: **July 23, 1971**
 [21] Appl. No.: **165,567**

- [52] U.S. Cl. **339/18 C**, 339/17 C, 339/198 S, 339/262 R
 [51] Int. Cl. **H01r 13/12**, H01r 13/20, H01r 29/00
 [58] Field of Search.....339/17, 18, 19, 21, 339/198, 217, 252, 253, 255, 256, 258, 262

[56] **References Cited**

UNITED STATES PATENTS

2,813,257	11/1957	Cornell, Jr.	339/262 X
3,078,596	2/1963	Sweeton	339/18 R
1,678,082	7/1928	Rottenburg.....	339/262 R
2,424,986	8/1947	Hubbell et al.	339/198 S
1,665,446	4/1928	Conrad.....	339/258 F X
3,085,177	4/1963	Thompson	339/18 R X
2,534,881	12/1950	Schroeder.....	339/95 R
2,431,999	12/1947	Englehardt.....	339/198 S

FOREIGN PATENTS OR APPLICATIONS

1,427,747	1/1966	France	339/258 F
445,841	6/1927	Germany	339/262 R

Primary Examiner—Marvin A. Champion
Assistant Examiner—Terrell P. Lewis
Attorney—William D. Hall

[57] **ABSTRACT**

A miniature electrical terminal adapted for use in breadboarding experimental circuits utilizing various electrical components, including dual-in-line-package integrated circuits, comprises a bifurcated metallic spring clip adapted to receive an electrical connector between the bifurcations thereof, and cooperating with a U-shaped resilient metallic shell covering the clip and having the sides of the shell connected to the tines of the clip to increase the wire diameter handling range of the composite terminal by a ratio of about 1 to 3 with provision for contactor insertion from both top and bottom. Multiple connection points are achieved by providing strips of inter-connected spring clips which are covered by a common shell; and such strips can be used individually as patch blocks for assembling any desired circuit, or can be mounted on or between perforated boards. Strips of the terminal can be disposed closely adjacent one another, in insulated relation, to provide a ground bus and a voltage strip closely adjacent to, or between, groups of other terminal strips adapted to receive electrical components and connections.

16 Claims, 20 Drawing Figures

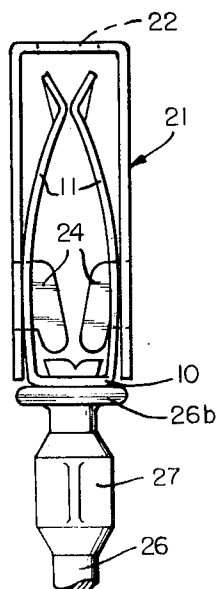


FIG. 1A.

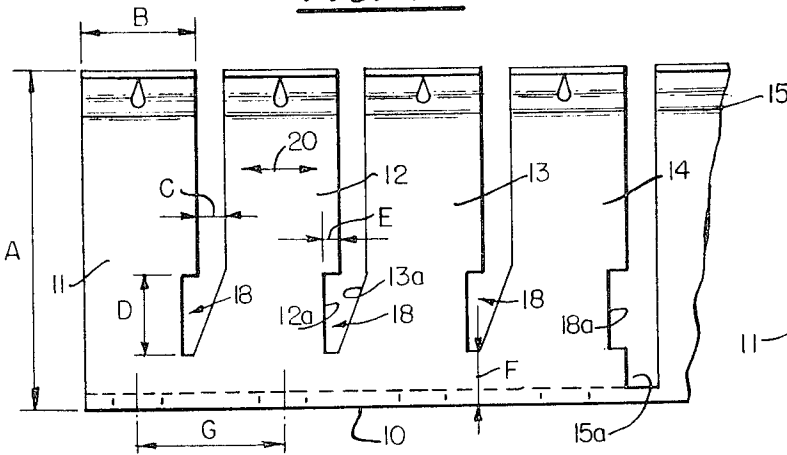


FIG. 1B.

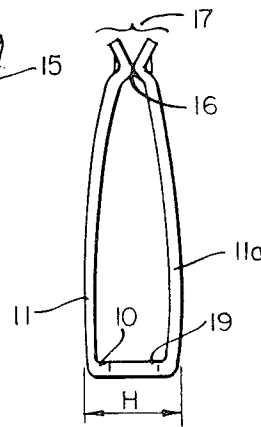


FIG. 1C.

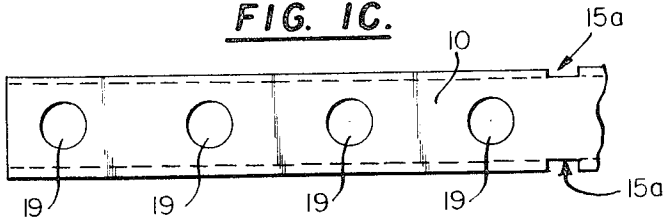


FIG. 2A.

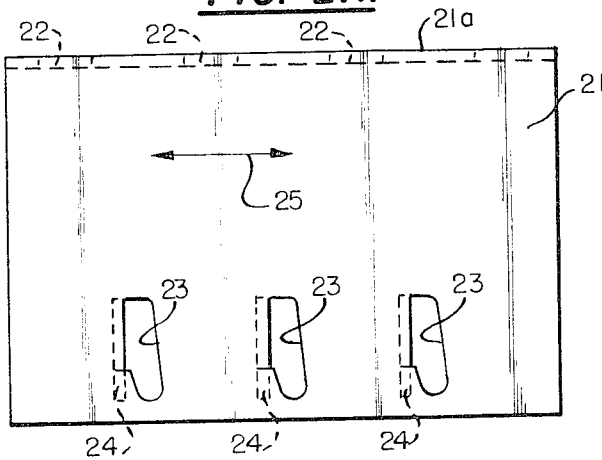


FIG. 2B.

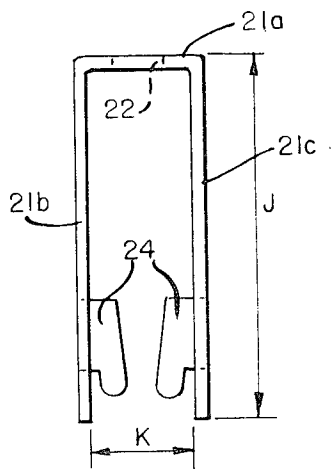


FIG. 4A.

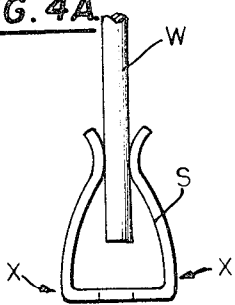
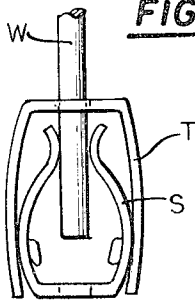


FIG. 4B.



INVENTORS

Ray R. Scoville
Ralph R. Wells

BY

ATTORNEY

FIG. 3A.

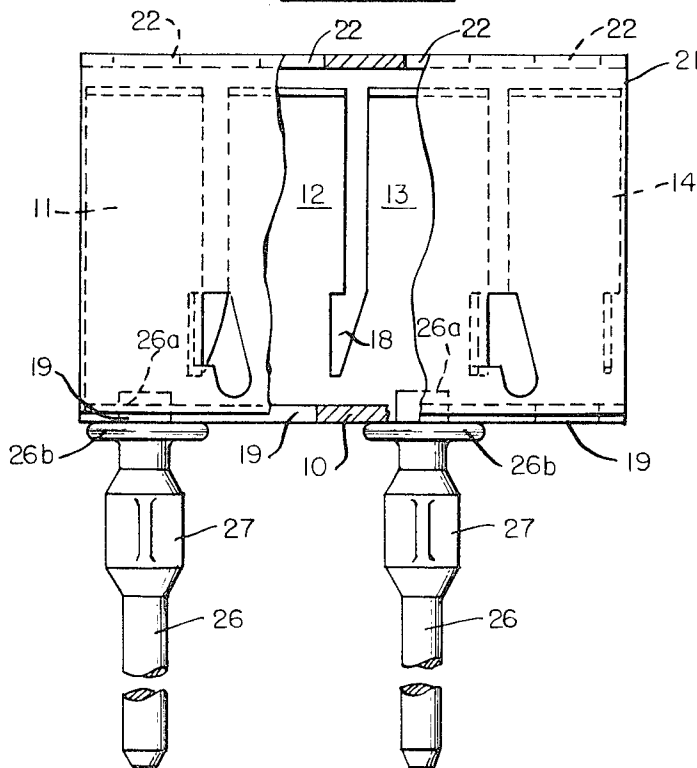


FIG. 3B.

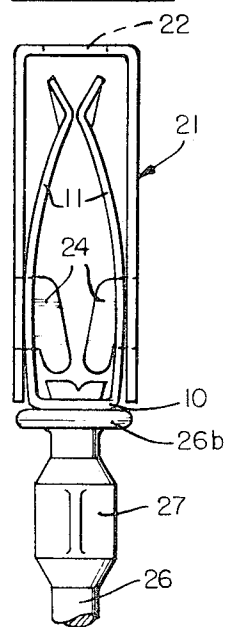


FIG. 5A.

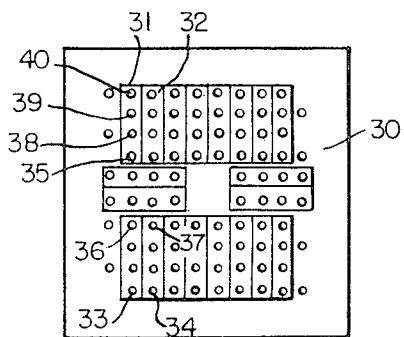


FIG. 5B.

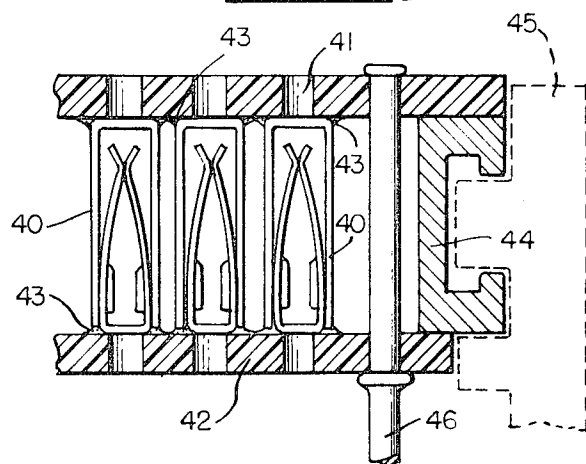
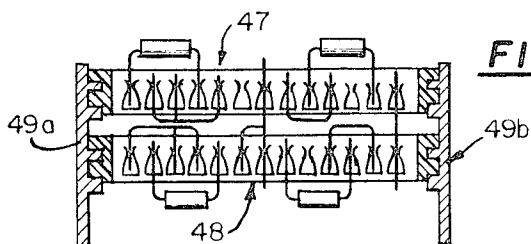


FIG. 5C.



INVENTORS

Ray R. Scoville
Ralph R. Wells

BY

[Signature]

ATTORNEY

FIG. 6A.

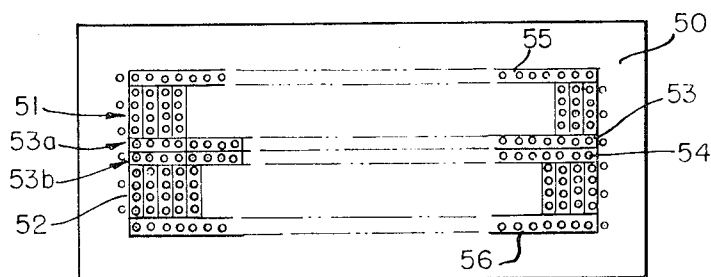


FIG. 6B.

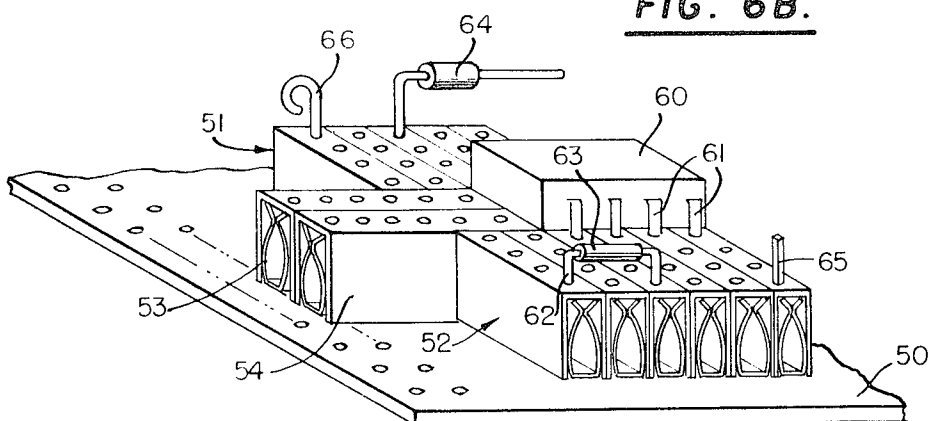


FIG. 8.

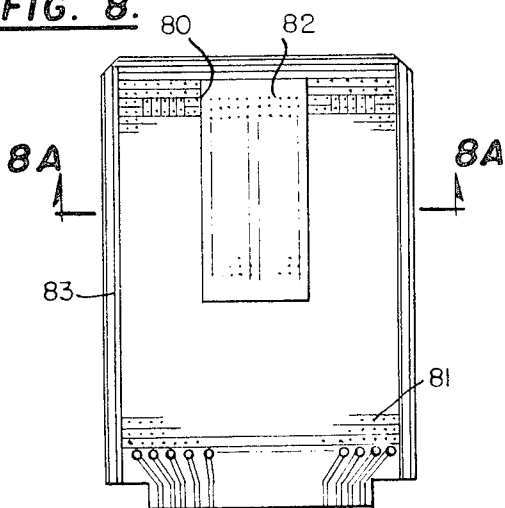


FIG. 7.

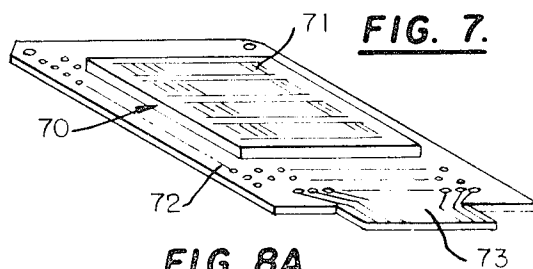
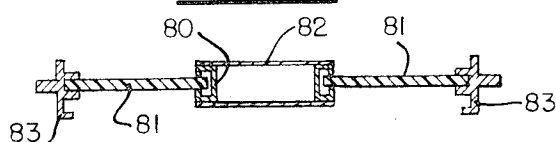


FIG. 8A.



INVENTORS

Ray R. Scoville
Ralph R. Wells

BY

ATTORNEY

FIG. 9A.

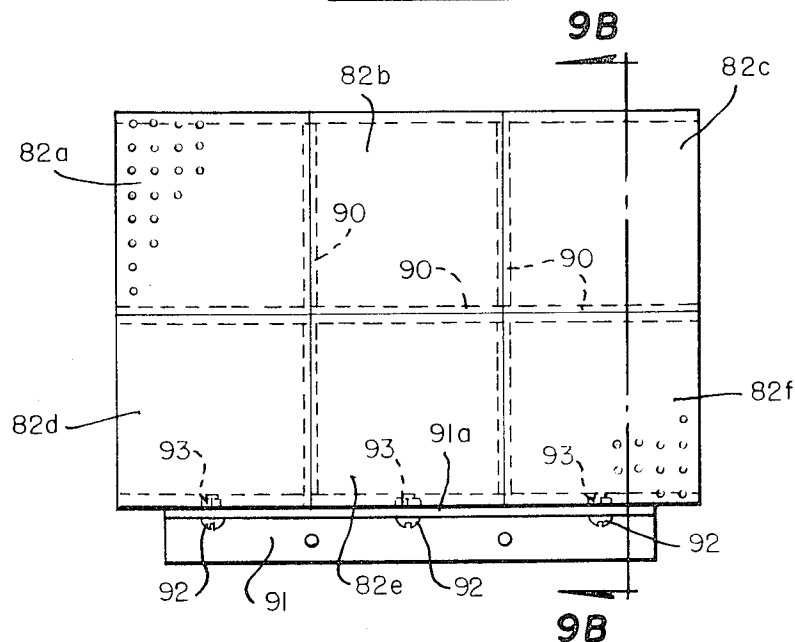


FIG. 9B.

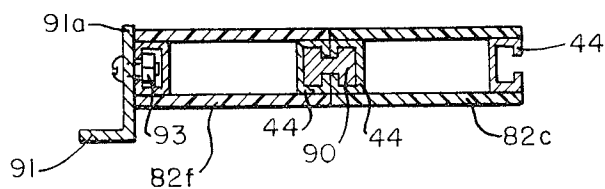
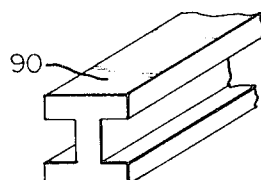


FIG. 9C.



INVENTOR

Ray R. Scoville
Ralph R. Wells

BY

ATTORNEY

MINIATURE TANDEM SPRING CLIPS

BACKGROUND OF THE INVENTION

Over the years, a wide variety of electrical terminals have been suggested for use in fabricating electrical circuits, breadboarding such circuits, or otherwise interconnecting electrical components to one another. The terminal structures suggested heretofore, however, have for the most part been useless in fabricating electrical assemblies employing integrated circuits. Standard dual in-line package (D.I.P.) integrated circuits comprise components having two parallel lines of tabs emergent therefrom, the tabs being spaced 0.1 inches from one another in each line, with the lines of tabs usually being 0.3 inches apart; and other forms of packaging employed in integrated circuits, e.g., "flat-pack" arrangements, have leads which are only 0.05 inches apart, and all in the same plane. Conventional terminals, designed for use in connection with very much larger electrical components, are incapable of use with integrated circuits having the small dimensions specified.

Satisfactory terminals cannot be achieved simply by reducing the size of known larger terminals. The final terminal to be used must not only have dimensions consistent with those of the integrated circuits with which they are to cooperate, but they must also be able to receive wire leads having diameters of a considerable range, e.g., 0.008 inches to 0.036 inches, without damaging the terminal or exceeding its elastic limit. A mere reduction in size of known terminals is simultaneously accompanied by a reduction in the strength, resiliency, and elastic limit of the terminal; and, as a result, such reduced size terminals are incapable, as a practical matter, of accommodating the wire size range in question when the center to center spacing of the terminals is limited to 0.1 inches. Further, any terminals used, for example, to fabricate a prototype of a two-sided printed circuit board (by the connection of integrated circuits and related components to opposing sides of the board by means of such terminals), must give a good approximation of the distributed inductances and capacitances which will be realized when the prototype is converted into a final printed circuit; and such parameter approximation requires that special attention be given to the terminals employed. The topological design of such a two-sided board requires that wires, which will eventually be replaced by etched foil, do not cross each other on the same side of the board. Terminal constructions which have only top entry cannot be used to solve such problems of parts location and conductor routing.

Some suggestions have been made heretofore for terminal constructions which can be used in environments of the general type contemplated by this invention. For example, so-called "breadboard terminal strips" are presently manufactured by AP Inc. of Painesville, Ohio. The AP terminals take the form of molded plastic boxes provided with partitions forming a large plurality of cubicles each of which receives a single spring clip. The top of the box is perforated to permit wires to be inserted through said boxtop into the individual cubicles and between the tines of the springs therein. The resultant structure is accordingly of the "top entry" type, i.e., leads can be inserted only through the top of the box; and this represents a distinct disadvantage when circuits are to be fabricated which require both

top and bottom entry to the terminal. Since plastic webs are required to contain the terminals, to mount the strips, and to support the top, it is infeasible to provide two-sided terminal density on the 0.100 centers required by modern circuit board layouts. Moreover, the use of a thermoplastic molded material to support the spring clips in place imposes a severe limitation on the types of circuits which can be fabricated, and on the environments in which they can be used, e.g., the use of soldering techniques may result in melting or deformation of the plastic structure, and similar such melting or deformation may occur if the final circuit is exposed to high temperatures in use.

The present invention is entitled to obviate all of the foregoing difficulties.

SUMMARY OF THE INVENTION

The present invention is directed to a novel terminal structure adapted for use with integrated circuits and with a wide variety of electrical components and wire leads having wire diameters extending over a comparatively large range of sizes. The terminal is adapted to receive wire leads from either its top or bottom ends, thereby greatly increasing the versatility of the terminal in fabricating circuits; and in receiving wire leads, the terminal exhibits a "closed entry" feature, i.e., the wire lead is actually inserted through a punched hole, thereby preventing damage to the lead, or faulty contact, due to lateral stresses resulting from "crow bar" action of the lead.

Each individual terminal is fabricated of two basic parts, i.e., a bifurcated spring clip, and a resilient U-shaped shell which is hooked onto the clip in covering relation thereto. In addition, mounting pins may be affixed to the base of the spring clip to permit attachment thereof to an electronic circuit board. The base of the clip includes a punched hole which achieves the aforementioned closed-entry feature at the bottom of the terminal; and the top (or cross portion) of the covering shell includes a similar punched hole to achieve the closed-entry feature at the top of the terminal. The sides of the U-shaped shell are attached to the resilient tines of the spring-clip at a position adjacent the bottom portion of the spring clip; and this interconnected relationship between the two parts of the clip results in a "piggy-back" action wherein the spring clip and its associated shell cooperate with one another when a lead is inserted into the terminal, to assure proper contact to a wide range of wire diameter sizes without exceeding the elastic limit of the composite structure.

The spring clips themselves are fabricated in strips, wherein any desired number of adjacent pairs of tines desired connected to a common base structure. Such a strip of spring clips is in turn covered by a single U-shaped shell attached to the strip adjacent each of the pairs of tines in the strip. Multi-point terminals constructed in accordance with the present invention, and using four interconnected spring clips covered by a common shell, are termed "quads;" and such quads have particular utility in the fabrication of various types of circuits, as will be described. A larger number of spring clips associated with a covering shell can be used as a ground bus or voltage strip. Quads may be employed as patch blocks for assembling any desired circuit. They may also be soldered to a line or pad on an etched circuit board or mounted (e.g., adhesively) on or between perforated circuit boards alone, or in asso-

ciation with elongated terminal strips providing grounding and power facilities, to permit the simulation of a wide variety of two-sided circuits exhibiting a good approximation of the locations of parts and interconnections, together with the associated inductances and capacitances which will be produced in the final printed circuit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1A is an enlarged side view of a spring clip of the type employed in a terminal constructed in accordance with the present invention;

FIG. 1B is an end view of the structure shown in FIG. 1A;

FIG. 1C is a bottom view of the structure shown in FIG. 1A;

FIG. 2A is an enlarged side view of a hook-on shell of the type employed with the spring clip of FIG. 1A;

FIG. 2B is an end view of the structure shown in FIG. 2A;

FIG. 3A is an enlarged side view of an assembled spring clip and hook-on shell constructed in accordance with the present invention, and associated with mounting pins for attaching the same to a circuit board;

FIG. 3B is an end view of the structure shown in FIG. 3A;

FIGS. 4A and 4B diagrammatically illustrate the "piggy-back" action achieved by the arrangement of FIGS. 3A and 3B;

FIG. 5A is a diagrammatic view of a plurality of quads mounted on a perforated board or on a printed circuit board;

FIG. 5B is an enlarged partial side view of a structure utilizing quads of the type shown in FIG. 3A, but without quad pins and held between two perforated boards with adhesive;

FIG. 5C is a side view of a plurality of units, of the type shown in FIG. 5B, mounted on top of each other to simulate multi-layer printed circuits;

FIG. 6A is a view similar to that of FIG. 5A showing another arrangement of terminals constructed in accordance with the present invention;

FIG. 6B is an enlarged perspective view of a portion of the circuit shown in FIG. 6A;

FIG. 7 shows another arrangement constructed in accordance with the present invention wherein the terminals are mounted on a printed circuit plug board;

FIG. 8 illustrates a modification of the arrangement of FIG. 7;

FIG. 8A is a cross-section taken on line 8A—8A of FIG. 8; and

FIGS. 9A, 9B and 9C illustrate another way of joining a plurality of units to one another.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1A, 1B, and 1C illustrate, in enlarged form, a typical spring clip structure forming a portion of the novel terminal of the present invention. This portion of the structure is fabricated in strips consisting of a large number of spring clips which can be subdivided into clip sections of any desired number of springs. More particularly, the spring clip strip comprises a generally rectangular base or bottom portion 10 having pairs of elongated resilient tines 11, 12, 13, 14, 15, etc., integral with the opposing edges of the bottom portion 10. As is best shown in FIG. 1B, wherein the pair of tines 11,

11a are depicted in relation to bottom portion 10, the tines extend transversely to the bottom portion of the clip and converge toward one another into firm, but resiliently separable, engagement at a position such as 16 located in relatively widely spaced relation to the bottom portion 10 of the clip. The tines are flared outwardly, as at 17, above the contact position 16 so as to provide guide portions adapted to receive a wire or other conductor and to direct the same between the spaced resilient tines 11, 11a. Any wire or conductor, so inserted, is grasped firmly on its opposing sides, by the resilient tines, in the region of contact position 16.

The actual tine arrangement depicted in FIG. 1A corresponds to that of a "quad" structure, i.e., four sets of resilient tines 11-14 are connected to a common base or bottom structure 10. The vertical edges of adjacent tines are spaced from one another, (e.g., dimension C) to assure that each set of tines operates as an individual spring clip upon reception of a wire or conductor therebetween. In addition, one of the vertical edges of each tine is directed rearwardly as at 12a, and the facing vertical edge of the adjacent tine is inclined as at 13a, to provide notches 18 on both sides of the spring clips between adjacent tines thereof. As will appear hereinafter, these notches 18 are designed to receive ears 24 projecting inwardly from the sides of the resilient shell (FIGS. 2A and 2B) forming another portion of the terminal, to lock the spring clip and shell to one another thereby to achieve a "piggy-back" action (FIG. 4B). The ears 24 also provide separation between units, and operate to "guide" wires upwardly as they are inserted from the bottom of each unit.

As illustrated by the numeral 15 in FIGS. 1A and 1C, more than four pairs of tines can be attached to the same base portion. However, since quads (i.e., units having four sets of tines) form a particularly desirable arrangement, the edge configuration of the spring clip strip is preferably cut away, as at 15a, and is provided with a special notch 18a, in the region after every fourth pair of tines. This configuration permits the user to easily break an elongated strip into quads or strips of other length if he so desires.

The bottom portion 10 is provided with a plurality of punched holes 19, one for each pair of tines in the spring clip. This permits conductors to be inserted via the bottom of the clip, between the clip tines and through the contact position 16 thereof; and also provides the previously described closed-entry feature at the bottom of the clip. By reason of this arrangement, therefore, wires or connectors may be inserted into the top or bottom end of the clip. It is generally not desirable for wires to be inserted both from the top and from the bottom in the same spring clip. However, some types of bus bars, jumpers and I.C.'s are fabricated from thin sheet metal, and these can be accommodated both ways. A bare wire can pass through from top to bottom simulating a "plated-thru" connection, or an insulated "magnet wire" can be used to duplicate a top-to-bottom connection without contact with adjacent terminals. Non-conducting pins may be inserted to provide mechanical support and location of parts without electrical connection. The mechanical grip furnished by both top and bottom holes in combination with the tines cannot be equaled by other configurations.

The spring clip representation of FIGS. 1A through 1C is very much larger than the actual spring clip. In order that this may be more clearly understood, various

dimensions have been designated A-H respectively in FIGS. 1A and 1B, and typical dimensions for the actual spring clip can be as follows: A is 0.232 inches; B is 0.082 inches; C is 0.018 inches; D is 0.055 inches; E is 0.01 inches; F is 0.035 inches; G is 0.1 inches (the normal spacing between tabs in D.I.P. integrated circuits); and H is 0.068 inches. The overall clip may be fabricated of phosphor bronze, tin plated material, with the direction of the grain of the phosphor bronze material being indicated by arrow 20.

FIGS. 2A and 2B illustrate an outer shell which is intended to be placed over the spring clip construction already described, as will be discussed subsequently in reference to FIGS. 3 and 4. The shell 21 is substantially U-shaped in cross section and includes a generally planar top 21a formed integrally with a pair of spaced generally parallel resilient sides 21b and 21c. The top 21a of the shell is punched on 0.1 inch centers to provide a plurality of holes 22 adapted to provide closed entry access of conductors through the top of the shell when the shell 21 is placed over the spring clip strip of FIG. 1A. The sides 21b and 21c of the shell are cut in an eared configuration, as at 23, with the cut portions being bent inwardly to provide depending inwardly projecting ears 24 adapted to be inserted, respectively, into the aforementioned notches 18 in the spring clip (FIG. 1A). The positions of ears 24 are so selected, in relation to the positions of notches 18 in the spring clip, that, when the parts are assembled, the holes 22 in the top of shell 21 overlie the flared portion 17 of each pair of tines (e.g., 11, 11a) to permit a closed entry top access for conductors.

The shell of FIG. 2 is fabricated of brass or other metal and has a height J of 0.251 inches (i.e., greater than the height A of the spring clip so that the top 21a of the shell overlies the top of the spring clip, but in spaced relation thereto), and has an interior width K of 0.07 inches (very slightly larger than the width H of the spring clip). The outermost surface of shell 21 is coated with an insulating material, e.g., with an insulating tape (not shown), thereby permitting quads or terminal strips to be placed directly adjacent to one another without shorting the spring clips of one such terminal to the spring clips of an adjacent terminal. The direction of the material grain in the shell 21 is represented by arrow 25.

FIGS. 3A and 3B depict a completely assembled terminal of the quad type, resulting from the placement of shell 21 over the spring clip of FIG. 1. As the shell 21 is pushed downwardly over the spring clip tines, the shell actually snaps into place. The ears 24 enter notches 18 and, when the shell is completely in place, depend to a position below the lowermost edges of notches 18 to firmly attach the shell 21 to its associated spring clip while simultaneously aligning top entry holes 22 relative to the spring clip tines with which they are associated.

The composite spring clip/shell arrangement can, if desired, be associated with mounting pins attached to the base 10 of the spring clip strip. Such mounting pins, which may be metallic or, alternatively, non-conductive, are depicted at 26 and, as illustrated, are placed in alternate ones (or even more widely spaced ones) of the bottom entry apertures 19. Each pin includes an internally projecting portion 26a; and after this portion has been inserted through a selected hole 19, with integral collar 26b of the pin firmly pressed

against the underside of spring clip base 10, the portion 26a may be swaged over (as illustrated in FIG. 3B) to lock the mounting pin in place. The mounting pins 26 are optional, but are highly desirable when quads or terminal strips of the present invention are to be mounted on one side only of perforated circuit boards. If the quads are to be mounted on a larger matrix of mini-terminals (e.g., such as shown in FIG. 6B), the use of non-conducting pins allows mechanical attachment without electrical contact. In such arrangements, the pins 26, extending through spaced holes in the circuit board, hold the terminals on the board and, simultaneously, align the various top and bottom entry apertures 22 and 19 with respect to the holes in the circuit board. Moreover, if a metallic mounting pin is used, it can be used to provide electrical connections, and can also serve as a test point or as a solder terminal. The mounting pins 26 are preferably provided with bulges 27 which cause the pins to "snap" into the holes on an associated perforated plastic circuit board, i.e., the bulges deform the board hole edges slightly during entry of the pins 26, with the board then being firmly held in place between each bulge 27 and the bottom surfaces of mounting pin collars 26b.

The interconnected configuration of the spring clips and covering shell is highly desirable since the spring and shell deflect together in a complementary fashion, the so-called "piggy-back" action referred to earlier, to increase the range of wire sizes which may be received without exceeding the elastic limit of the composite terminal. Referring to FIG. 4A (which is exaggerated, and somewhat distorted, for explanatory purposes) it will be seen that, if a spring clip S is used alone, insertion of a wire W tends to cause the tines of the spring clip to deflect in such fashion that the stress is concentrated substantially entirely at the points X, at the junction between the tines and base of the spring clip. Because of this consideration the range of wire sizes which can be accommodated without exceeding the elastic limit of the spring S is limited; and in practice, using only spring clips (of the general type already described in reference to FIG. 1), that limited range of wire sizes is substantially 0.015 inches to 0.025 inches in diameter. If a hole is provided between the points X, to provide entry from the bottom (as illustrated in FIG. 4A), approximately 35 percent of the metal is removed in the region of maximum bending moment arm. With such a hole provided in the bottom of the spring clip, the range of wire sizes which can be accommodated, without exceeding the elastic limit of the spring, drops to 0.015 - 0.019 inches.

When a shell T is hooked onto the spring 8, however, as illustrated in FIG. 4B, the stresses or loads resulting from insertion of a wire W are progressively shared by both the spring S and the shell T. If one observes the action of the composite structure upon insertion of a wire W, it will be seen that the inner spring S first deflects outward. The dimensions at the bottom of the composite spring/shell arrangement are prevented from changing to any significant extent and, instead, engagement between the tines of the spring and the inner sides of the shell causes a bulging or "bellying out" of the shell sides. By this action, stresses tend to be distributed throughout the length of the spring tines and along the sides of the shell, rather than being concentrated at the points X of FIG. 4A. A hole may be readily provided in the bottom of the spring, between

points X, since the critical bending loads have been replaced by simple tension stresses. With such an arrangement, it has been found that wire sizes in the range 0.008 inches to 0.036 inches can easily be accommodated with good contact pressure, without any damage to the terminal, and without exceeding the elastic limit of the spring tines; and when the wire is subsequently removed from the composite arrangement, the tines spring back together into firm contact at position 16 (FIG. 1B).

Miniature terminal quads constructed in accordance with the present invention can be mounted on, or between, perforated circuit boards to provide a structure which is very useful in the breadboarding of prototype circuits. One such arrangement is shown in FIG. 5A, wherein quads alone are used in association with substantially square circuit boards. A typical board 30 may have a first plurality of quads 31, 32 etc. mounted side by side in a first linear array, with adjacent quads being insulated from one another by the insulating coating on the exterior of each quad shell; and a second plurality of quads 33, 34 etc. may be mounted in a second linear array parallel to, but spaced from the first array. The innermost holes in the facing arrays, e.g., holes 35 and 36, are spaced from one another by 0.3 inches, or as required, whereas adjacent holes in each array, e.g., holes 36 and 37, are spaced from one another by 0.1 inches. These hole spacing dimensions correspond to the spacing between tabs in a conventional D.I.P. integrated circuit; and, as a result, such a circuit can be plugged into the innermost lines of holes in the two arrays with the circuit itself bridging the space between the arrays. The arrangement described, therefore, provides a socket-like device for a standard D.I.P. unit; and when such a unit is plugged into the structure shown in FIG. 5A, each tab of the D.I.P. unit is provided with three additional plug-in points for other circuit components, i.e., a tab inserted into hole 35 is electrically connected to the spring clips associated with holes 38, 39 and 40 of quad 31 so that other electrical components can be connected to said tab through the other holes of the same quad.

Third and fourth arrays of parallel quads may be disposed in the space between said first and second linear arrays, as illustrated in FIG. 5A. By the arrangement shown, an inner facing set of twelve, electrically independent, contacts results. These can be used to connect integrated circuit packages of the round (TO-5) type, which have from six to 12 pins each, providing three other connecting points for each central contact. If desired, adapter wafers are available to shift leads from the round to the rectangular configuration. This makes a very versatile unit which will mount either the dual-in-line type or the round type of integrated circuit package having leads in a small circle (about 0.25 inch diameter).

It will be appreciated that the arrangement of FIG. 5A can actually take the form of a plurality of quads similar to those already described in reference to FIG. 3A, mounted on a single circuit board 30 by means of mounting pins such as 26, or mounted by means of eyelets or by soldering to printed circuit copper pads, or adhesively affixed to the board. Another version of this same structure, however, contemplates that quads or terminal strips be mounted between a pair of circuit boards to provide a "sandwich" construction. Such an arrangement is shown in FIG. 5B wherein quads 40 are

mounted between two perforated circuit boards 41 and 42 with the top and bottom entry holes of each quad being aligned with corresponding holes in said circuit boards. The quads may be held in place by means of an adhesive such as in indicated at 43, which may be of the "hot melt" type. Such an adhesive may be spread across the interior of the boards by a roller-coater; and after the quads have been assembled into place (using mounting pins for alignment purposes), the assembly is clamped and then heated to cause the adhesive to flow and form a good bond between the quads and boards without clogging up the holes of the boards or quads.

Slotted extruded pieces 44 surround the unit on four sides, and are bonded to the inner surfaces of the top and bottom perforated plates 41 and 42. One of the two perforated plates (the bottom one in FIG. 5B) is about 0.1 inch shorter in width on each side than the other. This is to permit sliding the unit into a standard card guide, shown in broken line at 45. The arrangement also permits mounting two or more units side by side or end to end to make larger assemblies.

Alternatively, units can be stacked one over the other as shown in FIG. 5C. This latter arrangement has a special advantage in that multi-layer circuits can be simulated for prototyping. Thus, two units 47, 48 can be mounted in end support guides 49a, 49b. Each of the two units can carry components such as the dual-in-line or TO-5 type, or other, and interconnections can be made on each face of each unit and also by running long pins straight through where needed from one unit to the underlying unit, thus providing a very large number of interconnect possibilities, just as with the usual multilayer process. The use of this type of "breadboard" for a multilayer device is most valuable; experimental changes can easily be made and, when satisfactory, the resulting connection pattern can be copied almost exactly for the ultimate device.

As illustrated in FIG. 5B, the extruded side pieces 44 may have outwardly facing 'T' slots in which mounting nuts, bars, or strips can be carried. This permits several units to be joined along their sides for making larger arrays (see FIG. 9). Mounting pin-rivets such as 46 can be employed for holding the assembly of FIG. 5B aligned with other perforated circuit boards, or to serve as "feet" for the unit.

Another arrangement employing quads and terminal strips constructed in accordance with the present invention is shown in FIGS. 6A and 6B. As illustrated in FIG. 6A, the perforated circuit board 50 employed may be rectangular, rather than square. Quads may be mounted in a first linear array 51 along the board, and in a second linear array 52 spaced from array 51 by the spacing already discussed in reference to FIG. 5A. The space between arrays 51 and 52 can be left open or, alternatively, two elongated terminal strips 53 and 54, constructed in accordance with the present invention, can be disposed in side by side relation between quad array 51, 52. One such strip, e.g., 53, can be used as a ground bus, and the other such strip, e.g., 54, can be used as a voltage strip. Alternatively, quads 53a and 53b could be used so that round type I.C. units might be mounted, as previously described in reference to FIG. 5A.

The space between arrays 51 and 52 of FIG. 6A is the usual location of power busses in printed circuit layouts since digital I.C.'s usually have more than one pin connected to such busses. Other designs, such as the afore-

mentioned AP construction, require the use of this space for mechanical supports, thereby precluding a realistic approach to topological design of supply lines, or any other connections which run perpendicular to the short terminal assemblies. FIG. 6A shows that every intersection on a standard 0.100 by 0.100 grid pattern can be provided with a terminal, and can interconnect to adjacent terminals in a wide variety of practical configurations.

Still other terminal strips can be placed in very close proximity to the quad arrays, as illustrated by terminal strips 55 and 56 which extend parallel to strips 53 and 54, but along the outer edges of the quad arrays. When an arrangement of the type illustrated in FIG. 6A is used to breadboard a prototype circuit, the close proximity between the quads and associated ground and voltage strips, as well as the possibility of disposing such buses and strips between quads, tends to assure that any interconnection lines which may be employed in some final printed circuit are closely and accurately represented in the breadboard model, and that a good approximation of the physical layout of components and interconnecting wiring of the final scale model is achieved in the breadboard prototype. Moreover, since either components and/or connections can be placed on both sides of the assembly, an excellent simulation of a two-sided printed circuit with "thru hole connections" can be made. Circuits so constructed can be readily tested out, and, when found satisfactory, the arrangement can be copied directly for a corresponding printed circuit.

FIG. 6B depicts a portion of the terminal arrangement discussed in reference to FIG. 6A, and illustrates some of the ways in which the assembly may be used to breadboard a prototype circuit. Elements 50-54 shown in FIG. 6B correspond to like elements already discussed in reference to FIG. 6A. An integrated circuit 60 of the D.I.P. type is provided with tabs 61 which may be plugged into quad array 52 (and with similar such tabs on the other side of circuit 60 which are plugged into quad array 51). The several quads are, of course, insulated from one another and from the strips 53 and 54 (which are also insulated from one another) by reason of the insulating coating on the exterior of each quad and terminal strip.

If it is desired to connect the terminals of one quad with those of another quad normally insulated therefrom, a U-shaped wire strap or jumper, preferably (but not necessarily) provided with insulation 63 on its cross-portion, can be plugged between quads as illustrated. Similar such jumpers can, of course, be used in association with ground and voltage strips 53, 54 to energize, or ground, any selected terminal 61 of the circuit 60.

Electrical components 64 (such as resistors, capacitors, transistors, diodes, etc.) can be connected to any tab of the circuit 60 by inserting the component lead into one of the quad holes associated with that tab. Alternatively, a 0.025 square "wrap-around" pin, such as 65 may be inserted through the holes in a quad to permit external connections to be made thereto simply by wrapping a wire lead around the pin 65. Probe wires 66, having a looped end, as illustrated, may be inserted into any desired holes to permit easy connection of meters or other types of measuring or monitoring equipment to appropriate electrical points in the prototype circuit.

Another arrangement finding considerable utility is illustrated in FIG. 7. In this particular arrangement, a plurality of quads, generally designated 70, may be mounted between an upper circuit board 71 and a lower circuit board 72, e.g., in a configuration similar to that already described in reference to FIG. 5B. In the FIG. 7 arrangement, the lower board 72 is dimensionally larger than board 71 so that its edges project beyond the edges of board 71 on all sides to permit the edges of board 72 to be received in a standard printed circuit card guide. One end of the board 72 is provided with a standard printed circuit terminal arrangement 73 adapted to be plugged into an appropriate receptacle associated with such a card guide. This arrangement accordingly permits a prototype printed circuit to be mounted in the same structure which will eventually receive the final printed circuit.

FIGS. 8 and 8A show an alternative form of FIG. 7 in which a FIG. 5B type structure is mounted into a plug board instead of on it. This is made possible by cutting an opening 80 into the plug board 81 so that a FIG. 5B type unit 82 can slide into place, the T-slots of its periphery fitting the aperture in the board. To strengthen the whole assembly, an aluminum frame 83 (known as Vector "Kardej") is placed around three sides of the plug board.

In addition to mounting units above one another as shown in FIG. 5C, the units can be joined along their sides to make a larger array of any desired dimensions. This type of arrangement is shown in FIGS. 9A, 9B and 9C. In these latter figures, a plurality of units 82a-82f inclusive (each of which corresponds to unit 82 already described in reference to FIG. 8) are disposed in closely adjacent, coplanar relation to one another with their respective "T" slots facing one another. An extruded connector 90 (FIG. 9C) having an "I" shaped cross section, and dimensioned to fit the "T" slots in the facing extruded side pieces 44, can be slid into said facing "T" slots in both horizontal and vertical directions (See FIGS. 9A and 9B) to firmly join units 82a-82f to one another. The assembled array can be attached to a mounting bracket 91 having a flange 91a through which screw members 92 pass; and said screw members thread engage nuts 93 which are retained in the aligned "T" slots forming an external edge of the assembled array.

While we have thus described preferred embodiments of the present invention, many variations will be suggested to those skilled in the art. It must therefore be understood that the foregoing description is intended to be illustrative only, and not limitative of the present invention; and all such variations and modifications as are in accord with the principles described are meant to fall within the scope of the appended claims.

Having thus described our invention, we claim:

1. An electrical terminal comprising a metallic spring clip having a bottom portion of elongated rectangular configuration and a plurality of pairs of elongated resilient tines integral with opposing edges of said bottom portion and disposed in spaced relation to one another along the direction of extension of said bottom portion, said tines extending transversely to said bottom portion with the tines in each pair converging toward one another into resiliently separable engagement with one another at a position spaced from said bottom portion, a unitary metallic shell covering all of said pairs of tines, said shell having a U-shaped cross section and

having a generally planar base portion overlying the ends of said tines remote from said spring clip bottom portion and extending in a direction generally parallel to said spring clip bottom portion, said base portion of said shell including a plurality of first apertures overlying the separably engaged ends of said tines respectively to permit a conductor to pass through said base portion and between said tines via one of said apertures, the bottom portion of said spring clip including a plurality of further apertures in alignment with said first apertures respectively to permit a conductor to pass through said bottom portion and between said tines via one of said further apertures, said U-shaped shell including a pair of spaced generally parallel resilient sides integral with opposing edges of said base portion and extending from said base portion toward the bottom portion of said spring clip at positions outward of said tines respectively, and means for attaching the resilient sides of said shell to the resilient tines of said spring clip at positions adjacent said spring clip bottom portion, whereby said tines and the attached sides of said shell deflect resiliently as a unit when a conductor is inserted between said tines.

2. The terminal of claim 1 including an insulating coating covering the exterior of said shell.

3. The terminal of claim 1 wherein said shell includes a plurality of inwardly directed ears which are snapped into notches located between adjacent pairs of said tines for effecting said attachment of said shell to said spring clip.

4. The terminal of claim 1 including at least one mounting pin attached to said terminal via one of said further apertures in the bottom portion of said spring clip.

5. The terminal of claim 4 including a perforated circuit board, said mounting pin being inserted through one of the perforations in said board to mount said terminal on said board with the board perforations in alignment with said first and further apertures.

6. The terminal of claim 5 wherein said mounting pin is provided with a bulged portion for snapping said pin into its associated board perforation.

7. The structure of claim 1 including a pair of perforated circuit boards disposed respectively in parallel relation to one another across the base portion of said shell and the bottom portion of said spring clip respectively, the perforations in said pair of boards being

aligned with one another and with said first and further apertures in said terminal.

8. The structure of claim 7 wherein the top and bottom ends of said terminal are adhesively secured respectively to the inner facing sides of said pair of boards.

9. The structure of claim 7 wherein one of said circuit boards is dimensionally larger than the other of said boards to provide outwardly extending edges adapted to be inserted in a printed circuit card guide.

10. The structure of claim 9 wherein said larger one of said boards includes an outwardly extending printed circuit plug at one edge thereof.

11. The structure of claim 7 including a first plurality of said terminals disposed side-by-side to one another between said pair of boards, a second plurality of said terminals disposed side-by-side to one another between said pair of boards in spaced relation to said first plurality of terminals, and at least one further plurality of said terminals disposed between and closely adjacent to both said first and second pluralities of terminals.

12. The structure of claim 7 including at least one spacer member extending transversely between said pair of boards adjacent the edges of said boards.

13. The structure of claim 7 including a plurality of extruded spacer members extending between said pair of boards around the periphery of said boards, each of said spacer members being formed, in cross section, with a T-shaped slot the leg of which opens outwardly into the outermost periphery of its associated spacer member.

14. The structure of claim 13 wherein a plurality of units constructed in accordance with claim 15 are disposed in side by side relation to one another with their respective pairs of boards substantially coplanar, and a connector member of I-shaped cross section disposed within the facing T-shaped slots of said units for joining said units to one another.

15. The structure of claim 13 including at least one nut disposed within said T-shaped slot, and a screw member in thread engagement with said nut extending outwardly of said T-shaped slot.

16. The structure of claim 15 including a mounting bracket attached to said structure by means of said screw and nut.

* * * * *

50

55

60

65