

Nov. 24, 1959

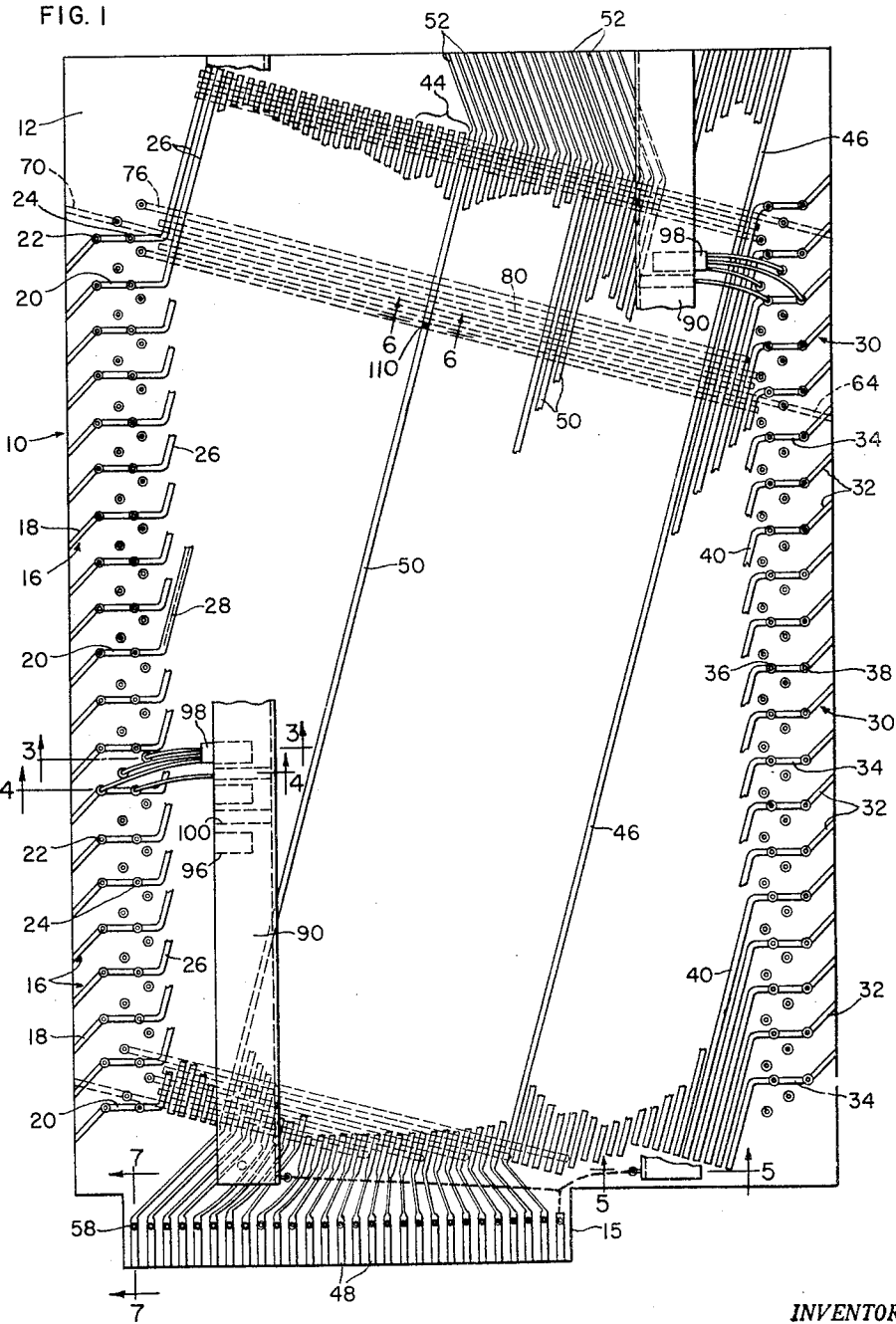
F. A. HILL ET AL

2,914,706

GENERAL PURPOSE CONNECTOR CARD

Filed March 5, 1956

4 Sheets-Sheet 1



INVENTORS
FRANK A. HILL
A.J. PANKRATZ
BY
Thodore H. Sanguine
ATTORNEY

Nov. 24, 1959

F. A. HILL ET AL

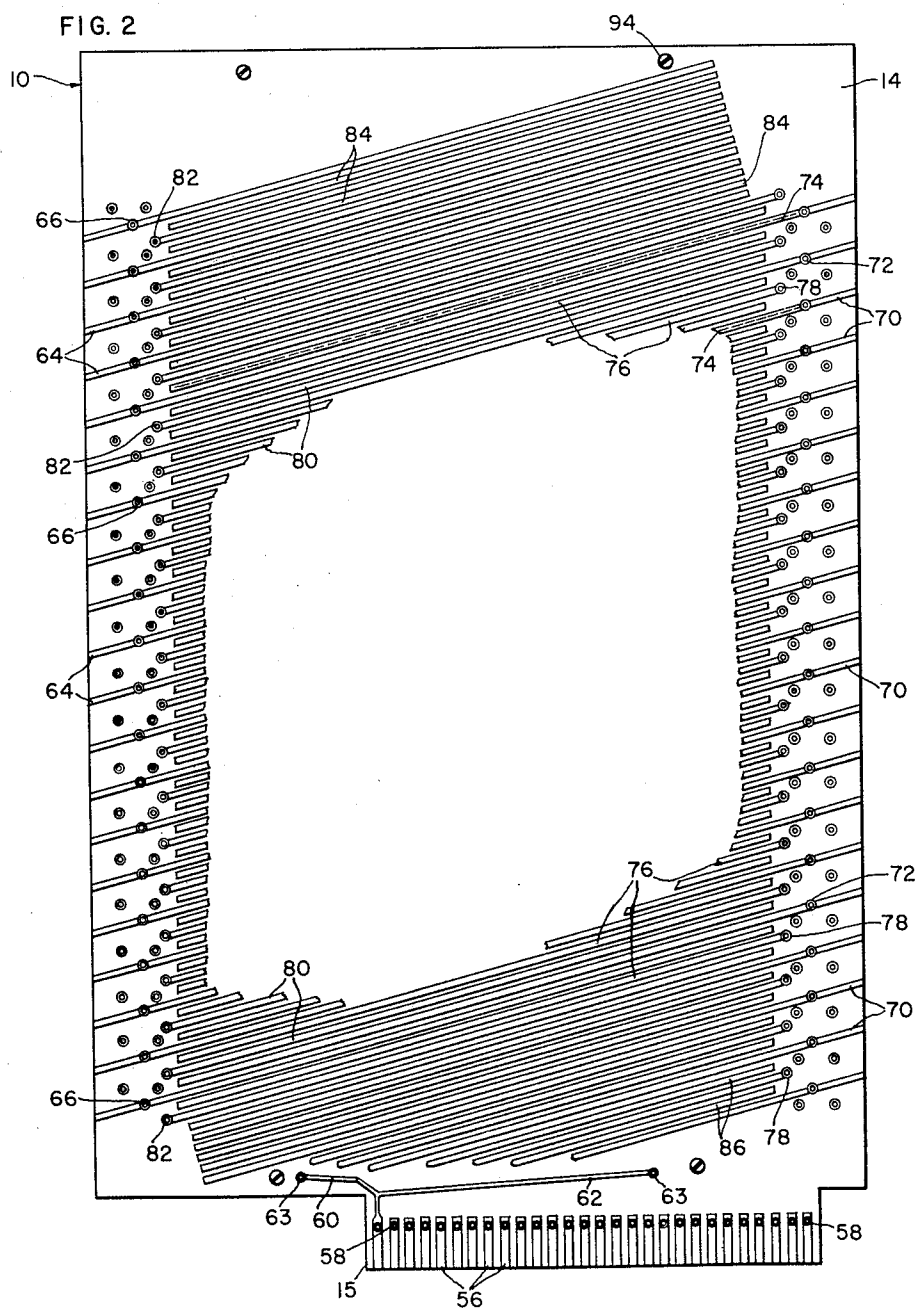
2,914,706

GENERAL PURPOSE CONNECTOR CARD

Filed March 5, 1956

4 Sheets-Sheet 2

FIG. 2



INVENTORS

FRANK A. HILL

A. J. PANKRATZ

BY

Theodore H. Lassaragne

ATTORNEY

Nov. 24, 1959

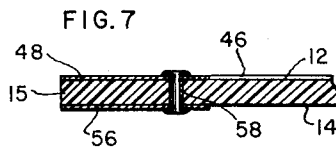
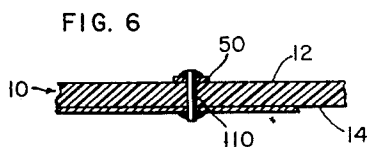
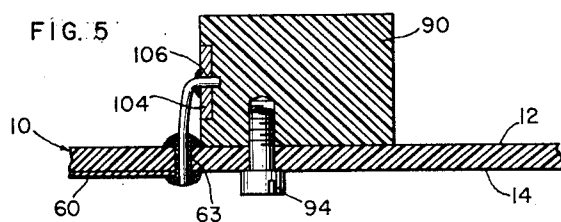
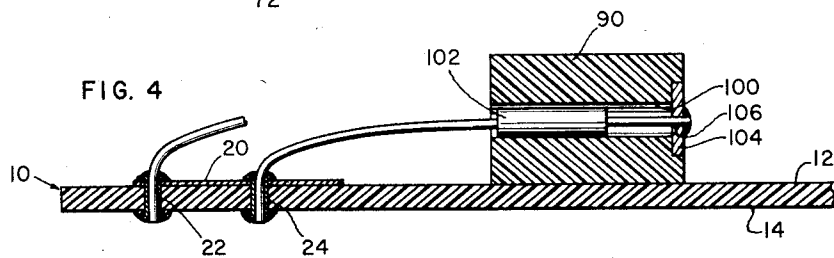
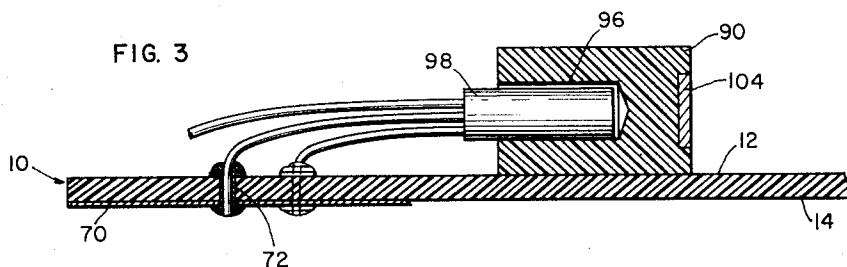
F. A. HILL ET AL

2,914,706

GENERAL PURPOSE CONNECTOR CARD

Filed March 5, 1956

4 Sheets-Sheet 3



INVENTORS
FRANK A. HILL
A. J. PANKRATZ
BY
Theodore H. Lasegne
ATTORNEY

Nov. 24, 1959

F. A. HILL ET AL

2,914,706

GENERAL PURPOSE CONNECTOR CARD

Filed March 5, 1956

4 Sheets-Sheet 4

FIG. 8

TRANSISTOR STATION NUMBER	COLLECTOR AVAILABLE TO EMITTER AND BASE NUMBER	BASE AND EMITER AVAILABLE FROM COLLECTOR NUMBER
1	2-40	1
2	3-40	1-2 21-40
3	4-40	1-3 21-40
4	5-40	1-4 21-39
5	6-39	
6	7-38	1-5 21-38
7	8-37	1-6 21-37
8	9-36	1-7 21-36
9	10-35	1-8 21-35
10	11-34	1-9 21-34
11	12-33	1-10 21-33
12	13-32	1-11 21-32
13	14-31	1-12 21-31
14	15-30	1-13 21-30
15	16-29	1-14 21-29
16	17-28	1-15 21-28
17	18-27	1-16 21-27
18	19-26	1-17 21-26
19	20-25	1-18 21-25
20	21-24	1-19 21-24
21	1-20 22-40	1-20
22	1-20 23-40	1-21
23	1-20 24-40	1-22
24	1-20 25-40	1-23
25	1-19 26-40	1-24
26	1-18 27-40	1-25
27	1-17 28-40	1-26
28	1-16 29-40	1-27
29	1-15 30-40	1-28
30	1-14 31-40	1-29
31	1-13 32-40	1-30
32	1-12 33-40	1-31
33	1-11 34-40	1-32
34	1-10 35-40	1-33
35	1-9 36-40	1-34
36	1-8 37-40	1-35
37	1-7 38-40	1-36
38	1-6 39-40	1-37
39	1-5 40	1-38
40	1-4	1-39

INVENTORS

FRANK A. HILL

A. J. PANKRATZ

BY

Herbert H. Pennington

ATTORNEY

1

2,914,706

GENERAL PURPOSE CONNECTOR CARD

Frank A. Hill, Van Nuys, and A. J. Pankratz, Glendale, Calif., assignors to Librascope, Incorporated, Glendale, Calif., a corporation of California

Application March 5, 1956, Serial No. 569,341

8 Claims. (Cl. 317—101)

This invention relates to a connector card for providing connections between a plurality of different semi-conductors and more particularly to a connector card adapted to obtain a simple construction of various types of transistor circuits.

In recent years, transistors have been adapted for use in a different number of circuits. The transistors have certain advantages when used in these circuits. One advantage results from the small size of the transistors. Other advantages result from the low power dissipation in the transistors and from the stable operating characteristics of the transistors over long periods of time.

Since transistors have been adapted for use in a wide variety of circuits, it is now possible to build complex equipment in which transistors entirely replace such components as vacuum tubes. In such complex equipment, it is desirable to have mountings known as "cards" on which the transistors and other components such as resistances may be carried. It is also desirable that the cards be so constructed as to permit different circuits to be formed by relatively simple connections made within various standard types of connector cards. These connect the transistors and other components in various patterns to form various types of circuits.

By using standard connector cards, the over-all design of complex equipment is simplified, at least from the standpoint of packaging the equipment. Furthermore, the costs of constructing and maintaining such equipment is minimized. Various attempts have been made to construct such a universal connector card but these attempts have not been altogether successful.

This invention provides a connector card for obtaining the desirable features described. The connector card has a pair of faces separated from each other by a relatively short distance. A first plurality of conductive leads extends along one face of the card to provide connections to elements corresponding to the collectors of a plurality of transistors. A second plurality of conductive leads extends along the second face of the card in transverse relationship to the first plurality of conductive leads. The second plurality of leads provides connections for elements corresponding to the bases and emitters of the different transistors.

By passing conductive pins through the card at particular positions to provide communications between the particular leads on one face of the card and certain leads on the other face of the card, the collector of each transistor can be electrically connected to the bases and emitters of the different collectors. The pattern of connections between the collector of each transistor and the bases and emitters of the other transistors is dependent upon the particular circuit being built.

The connector card constituting this invention is especially adapted to be used with circuits employing directly coupled transistors. In such circuits, various transistors are directly connected to each other without any inclusion of impedances between the elements of the different transistors. Since the elements in the different transis-

2

tors can be directly connected, the connections can be made by driving pins through the card to provide communications between the leads on one face and certain leads on the other face.

In the drawings:

Figure 1 is a top plan view illustrating the construction of a connector card constituting one embodiment of this invention and further illustrating the disposition of a plurality of conductive leads disposed on one face of the card;

Figure 2 is a bottom plan view illustrating the disposition of a plurality of leads on a second face of the card parallel to the first face;

Figure 3 is an enlarged fragmentary sectional view substantially on the line 3—3 of Figure 1 and further illustrates the construction of the connector card shown in Figures 1 and 2 and the manner in which electrical interconnections are made to various components including transistors;

Figure 4 is an enlarged fragmentary sectional view substantially on the line 4—4 of Figure 1 and illustrates in further detail the manner in which electrical connections are made between the connector card and certain components such as resistances;

Figure 5 is an enlarged fragmentary sectional view substantially on the line 5—5 of Figure 1 and illustrates in further detail the manner in which voltage is applied to various components including resistances;

Figure 6 is an enlarged fragmentary sectional view substantially on the line 6—6 of Figure 1 and illustrates a particular electrical connection between one of the conductive leads shown in Figure 1 and one of the conductive leads shown in Figure 2;

Figure 7 is an enlarged fragmentary sectional view substantially on the line 7—7 of Figure 1 and illustrates in further detail the construction of certain leads for making electrical connections to sources external to the connector card constituting this invention; and

Figure 8 is a chart showing the various connections possible from the different leads shown in Figures 1 to 7, inclusive.

In the embodiment of the invention shown in the drawings, a connector card generally indicated at 10 is adapted to be formed from a suitable insulating material such as a plastic material made from Epoxy Glass. The connector card 10 may be provided with a pair of parallel flat faces 12 (Figure 1) and 14 (Figure 2) separated from each other by a relatively thin width such as approximately $\frac{1}{16}$ inch. The faces 12 and 14 may have a rectangular configuration and may have suitable dimensions such as approximately 9 inches by 6 inches. As will be described in detail subsequently, the configurations of the faces 12 and 14 may also be trapezoidal instead of rectangular, or may be any other suitable configuration. A tab 15 extends downwardly from the bottom end of the card 10. The tab 15 (Figures 1 and 2) may have a rectangular configuration with dimensions of approximately $\frac{1}{2}$ inch by 3 inches.

A first plurality of leads 16 (Figure 1) are etched or printed on the face 12 of the card 10. The leads 16 are preferably formed so as to be substantially flush with the face 12 of the card. The leads 16 may be formed from a suitable material such as platinum which is highly conductive and which has good properties of resistivity to wear. The leads 16 may be provided with a suitable width such as approximately $\frac{1}{16}$ inch. Each of the leads 16 may start from a position substantially flush with the left edge of the card 10. The leads 16 may then extend from this flush relationship inwardly from the left edge of the card and upwardly toward the upper edge of the card 10 in Figure 1 so as to form an angle of substantially 45° with the left and upper edges of the card. The leads

16 may extend in this manner for distances of approximately $\frac{3}{8}$ inch to form portions 18. The portions 18 may be separated from one another by distances of approximately $\frac{1}{4}$ inch. By way of illustration, approximately twenty lead portions 18 may be formed in this manner.

The leads 16 extend from the inward ends of the portions 18 to form portions 20. The portions 20 may be substantially parallel to the upper and lower edges of the card 10 in Figure 1 and may have a length of approximately $\frac{3}{8}$ inch. As may be best seen in Figures 1 and 4, a pair of eyelets 22 and 24 extend through holes in the card 10 in contact with each of the portions 20 of the leads 16.

The eyelets 22 and 24 may be made from a suitable conductive material. Each of the eyelets 22 and 24 may be provided with a cylindrical portion and with a pair of flange portions which extend for a short distance along the faces 12 and 14 of the eyelet to maintain the rivet in fixed position on the card 10. The eyelets 22 contact the portions 20 of the leads 16 at their position of contiguity with the lead portions 18. The eyelets 24 contact the lead portions 20 at a position interior to the eyelets 22 and near the interior end of the lead portions.

The leads 16 extend obliquely from the portions 20 toward the upper edge of the card in Figure 1 to form portions 26. The leads 16 extend upwardly at a suitable angle such as approximately 60 degrees with respect to the upper and lower edges of the card 10 in Figure 1. The lead portions 26 may be separated from one another by a suitable distance such as approximately $\frac{1}{32}$ inch. The lead portions 26 may extend upwardly to a position near the upper edge of the card 10 in Figure 1. Instead of extending obliquely upwardly in a manner similar to that shown in Figure 1, the lead portions 26 may extend vertically if the left and right edges of the card 10 in Figure 1 are not substantially perpendicular to the upper and lower edges of the card in Figure 1.

Certain of the lead portions 26 may have their continuity partially interrupted at spaced positions as at 28. The width of these interruptions is not as great as the width of the lead portions 26 so as not to interrupt the conductivity of the lead portions along their complete lengths. The interruptions may occur in every nth number of interruptions such as in every 10th interruption. The purpose of the interruptions is to simplify the procedure of counting the lead portions to determine which of the particular lead portions 26 is to be chosen at any instant. This is especially important when a plurality of lead portions 26 such as twenty lead portions are used as in the particular embodiment being described and shown in the drawings.

A plurality of leads 30 are formed on the face 12 in a manner similar to the leads 16. The leads 30 extend from the right edge of the face 12 in Figure 1 instead of from the left edge of the face as has been described above for the leads 16. The leads 30 are provided with first portions 32 corresponding to the portions 18 and with second portions 34 corresponding to the portions 20. Pairs of eyelets 36 and 38 extend through the card 10 to contact each of the lead portions 34. The eyelets 36 and 38 contact the lead portions 34 at positions corresponding to the positions in which the eyelets 22 and 24 contact the lead portions 20. Lead portions 40 extend downwardly from the lead portions 34 at an oblique angle with respect to the edges of the card 10 and in substantially parallel relationship to the lead portions 26. Interruptions may be provided in every nth number of lead portions 40 in a manner similar to the interruptions 28 in the lead portions 26.

In addition to the leads 16 and 30, certain other leads are formed on the face 12 of the card 10 as by etching or printing. These leads include a plurality of leads 44 disposed in contiguous relationship to the leads 16. The leads 44 extend in substantially parallel relationship

along the face 12 to positions somewhat near the upper and lower edges of the card 10. For example, five leads 44 may be formed on the face 12. These leads are included to perform supplementary functions, as will be described in detail subsequently.

A plurality of leads 46 are also disposed in contiguous and parallel relationship to the leads 40 to perform supplementary functions. For example, eight leads 46 may be included in the plurality. The leads 46 extend at their upper ends to a position contiguous to the upper edge of the card 10 in Figure 1. At their lower ends, the leads 46 flare outwardly from one another to establish electrical continuity with certain leads 48 extending upwardly in parallel relationship to one another from the bottom edge of the tab 15. The leads 48 may be formed from platinum coated with a suitable material such as solder.

A plurality of leads 50 are disposed between and in substantially parallel relationship to the leads 44 throughout most of their length. For example, approximately twenty leads 50 may be included in the plurality. The portions of the leads 50 parallel to the leads 44 and 46 extend in a direction from the lower left corner toward the upper right corner of the card 10 in Figure 1. At their upper end, the leads 50 are bent sharply at one position to extend toward the upper left corner of the card 10 in Figure 1, as indicated at 52 in Figure 1. The portions 52 have a relatively thin width and are substantially parallel to one another. At their lower ends, the leads 50 flare outwardly from one another to meet particular ones of the leads 48 extending upwardly from the bottom edge of the tab 15.

A plurality of leads 56 (Figure 2) extend upwardly along the tab 15 from the bottom edge of the tab. The leads 56 are disposed on the face 14 in substantially parallel relationship to one another. The leads 56 correspond in position on the face 14 to the disposition of the leads 48 on the face 12. The leads 56 may be formed from platinum coated with solder in a manner similar to that described above. A hole extends through the card 10 between each of the leads 48 and 56. A conductive eyelet 58 extends through each of the holes to provide an electrical communication between the paired leads 48 and 56.

The lead 56 at the left of the card 10 in Figure 2 communicates with first and second leads 60 and 62 on the face 12. The lead 60 extends toward the left in Figure 2 for a distance of approximately $\frac{1}{2}$ inch and the lead 62 extends toward the right for a distance of approximately $3\frac{1}{4}$ inches. The leads 60 and 62 are included so that electrical connections can be made from the leads to introduce a suitable voltage to the circuitry formed by the leads on the connector card 10 and associated components including transistors and resistances. The introduction of direct voltage from the leads 60 and 62 to the various components can be made by wires which extend through holes 63 in the card 10.

A plurality of leads 64 extend along the face 14 from the left edge of the card 10 in Figure 2. Approximately twenty leads 64 may be included in the plurality. The leads 64 are disposed in substantially parallel relationship to one another and are separated from one another by distances of approximately $\frac{3}{8}$ inch. The leads 64 extend upwardly toward the right in Figure 2 at a relatively shallow angle such as approximately 15 degrees with respect to the upper and lower edges of the card in Figure 2. The leads 64 on the face 14 are substantially perpendicular to the leads 16, 30, 44, 46 and 50 on the face 12. Each of the leads 64 on the face 14 is disposed in intersecting relationship to a plurality of the leads 16, 30, 44, 46 and 50 on the face 12 but is separated from these leads by the thickness of the card 10.

A hole is provided in the card 10 in intersecting relationship to each of the leads 64 at a distance of approximately $\frac{3}{8}$ inch from the left edge of the card in Figure 2. A conductive eyelet 66 extends through each of the holes

in the leads 64 and has flange portions which engage the faces 12 and 14 to hold the eyelet in fixed position within the hole. Each eyelet 66 meets the face 12 at a position removed from the leads on the face by a sufficient distance such as approximately $\frac{1}{16}$ inch so as to be electrically insulated from the leads on the face.

In like manner, a plurality of leads 70 extend along the face 14 from the right edge of the card 10 in Figure 2. Approximately twenty leads may be included in the plurality. The leads 70 are disposed in substantially parallel relationship to the leads 64 and are separated from one another by approximately $\frac{3}{8}$ inch. The leads 70 are disposed in alternate relationship with the leads 64 and are separated from the adjacent leads 64 by approximately $\frac{3}{32}$ inch.

Eyelets 72 extend through the card 10 in intersecting relationship with the leads 70 at a position on the leads corresponding to the position of the eyelets 66 with respect to the leads 64. Alternate ones of the leads 70 may be partially interrupted as at 74 in a manner similar to that described above for the interruptions 28 in the lead portions 26. The interruptions 74 are provided to facilitate the identification of each lead on the face 14 of the card 10.

A plurality of leads 76 are disposed on the face 14 of the card 10 in substantially parallel relationship to the leads 64 and 70. Each of the leads 76 is disposed between a different pair of the leads 64 and 70 and is positioned a relatively short distance such as approximately $\frac{1}{16}$ inch from its adjacent lead 64. The leads 76 extend to a position approximately $\frac{3}{8}$ inch away from the left edge of the card in Figure 2 and to a position approximately $\frac{1}{2}$ inch away from the right edge of the card in that figure. Eyelets 78 extend through the card 10 and contact the leads 76 at the right end of the leads. The eyelets 78 contact the face 10 at positions separated from any of the leads 16, 30, 44, 46 and 50.

Leads 80 extend along the face 12 of the card 10 in substantially parallel relationship to the leads 64, 70 and 76. The leads 80 are disposed between and in spaced relationship to the leads 70 and 76. The leads 80 extend to a position approximately $\frac{1}{2}$ inch away from the left edge of the card 10 in Figure 2 and to a position approximately $\frac{3}{8}$ inch away from the right edge of the card in that figure. Eyelets 82 are disposed on the card 10 in contact with the leads 80 at the left end of the leads in Figure 2. The eyelets 82 contact the face 12 at positions separated from any of the leads 16, 30, 44, 46 and 50.

Certain other leads are also included on the face 14 in addition to the leads 64, 70, 76 and 80. These leads include leads 84 disposed in parallel relationship between successive pairs of the leads 64 and 80 near the top of the card 10 in Figure 2. The leads 84 extend to a position approximately $\frac{5}{8}$ inch from the left edge of the card in Figure 2 and to a position in the order of approximately $\frac{3}{4}$ to $1\frac{1}{4}$ inches from the right edge of the card in that figure. In like manner, leads 86 are disposed in parallel relationship between successive pairs of the leads 70 and 76 near the bottom of the card 10 in Figure 2. The leads 86 have a sufficient length to be separated from the right end of the card 10 in Figure 2 by a distance of approximately $\frac{5}{8}$ inch. The leads 86 are separated from the left end of the card 10 in Figure 2 by a considerable distance such as a distance in the order of several inches.

A pair of retainers 90 (Figures 1, 3, 4 and 5) are suitably attached as by screws 94 to the face 12 of the card 10. Each of the retainers 90 is made from a preferably non-conductive material such as a methyl methacrylate polymer designated commercially by the trade name of "Lucite." Each of the retainers 90 may have a width of approximately $\frac{1}{2}$ inch, a vertical length of approximately 9 inches and a depth of approximately $\frac{3}{8}$ inch. The retainers 90 are disposed in parallel relationship to

the left and right edges of the card 10 in Figure 1 and may be respectively separated from the left and right edges of the card 10 by a distance of approximately $1\frac{1}{2}$ inches.

Sockets 96 (Figures 1 and 3) are provided along the vertical length of each of the retainers 90 at spaced intervals such as approximately $\frac{3}{8}$ inch. The sockets 96 may be provided with an annular configuration having a suitable diameter such as approximately $\frac{5}{32}$ inch. The sockets 96 extend for a suitable distance such as approximately $\frac{3}{8}$ inch in the lateral direction in Figure 1.

The sockets 96 may extend laterally toward the right from the left edge of the left retainer 90 in Figure 1 and toward the left from the right edge of the right retainer. The sockets 96 are adapted to hold semi-conductors such as transistors 98 such as those shown in Figure 1. Each of the transistors 98 may be provided with elements corresponding to an emitter, a base and a collector.

Sockets 100 (Figures 1 and 4) are also provided in the retainers 90 in alternate relationship with the sockets 96. The sockets 100 extend laterally across the full widths of the retainers 90 and preferably have an annular configuration with a diameter of approximately $\frac{5}{32}$ inch. The sockets 100 are adapted to hold components which may be connected to the transistors 98. For example, resistances 102 may be supported within the sockets 100 in a manner similar to that shown in Figure 4.

Conductive bus bars 104 (Figures 3, 4 and 5) are supported within grooves in the retainers 90. The bus bars may be made from suitable material such as brass having a thickness of approximately $\frac{1}{32}$ inch and having a depth of approximately $\frac{5}{32}$ inch. The bus bars 104 extend along the complete lengths of the retainers 90 in the vertical direction in Figure 1. The bus bars 104 are disposed in flush relationship with the side surfaces of the retainers 90, the particular side surface on the retainers 90 being the ones closest to each other.

The bus bars 104 are adapted to receive voltage such as a direct voltage from a suitable source for introduction to the resistances 102 and to certain of the leads on the connector card 10. Electrical connections are made from the leads 60 and 62 (best seen in Figure 5) to the bus bars 104 by wires extending through the eyelets 63 so that voltage can be applied to the bus bars. Holes 106 are provided in the bus bars 104 so that wires from the resistances 102 may be passed through the holes and soldered to the bus bars as shown in Figure 4.

The connector card shown in the drawings and described above is adapted to be used with semi-conductors such as the transistors 98 to form different types of electrical circuits in accordance with the particular connections made in the circuits. Each of the transistors 98 includes elements equivalent to an emitter, a base and a collector. Because of the particular manner in which each transistor 98 is made, the emitter and collector of the transistor are provided with excesses of charged particles of the same polarity. The base of each transistor 98 has an excess of charged particles with a polarity opposite to the excess of charged particles in the emitter and the collector of the transistor. For example, in a PNP type of transistor, the emitter and collector of the transistor have an excess of positively charged particles or "holes" and the base has an excess of electrons.

In a PNP type of transistor, the charged particles of positive polarity in the emitter of the transistor are attracted toward the base of the transistor when a negative voltage of sufficient amplitude is applied to the base relative to the voltage on the emitter. The charged particles of positive polarity continue past the base of the transistor toward the collector when the base exerts a sufficient attractive force on the charged particles to impart a considerable velocity to the particles. The charged particles are particularly attracted to the collector when a negative voltage is applied to the col-

lector to impose an additional attractive force on the charged particles.

As will be seen from the discussion in the previous paragraphs, the voltage between the base and the emitter controls the initiation of any flow of current through the transistor. For this reason, the base and emitter of each transistor serve as the input elements to the transistor. Since the current through the transistor flows to the collector, the collector generally serves as the output element of the transistor.

Because of the fact that voltages cannot be generally introduced to input elements from other input elements, emitters and bases of transistors are connected directly together only a relatively few times. In like manner, collectors of transistors do not connect directly to collectors of other transistors since output elements do not introduce voltages to other output elements. In order to apply voltages from output elements to input elements, collectors of transistors are generally connected to emitters and bases.

As has been previously described and as may be best seen in Figures 1 and 4, the transistors 98 are supported within the sockets 96 in the retainers 90. The collectors of the transistors 98 supported by one of the retainers 90 are connected to the leads 16. The collectors are connected to the leads 16 by disposing the collector wires in the eyelets 22 and applying solder to the eyelets to fill the eyelets and maintain the collector wires fixedly positioned within the eyelets. In like manner, the collectors of the transistors 98 supported by the second retainer 90 are connected to the leads 30. Since there are twenty leads 16 and twenty leads 30 in the embodiment constituting this invention and since there are twenty sockets in each of the retainers 90, the collectors of as many as forty transistors can be connected to the leads 16 and 30.

In like manner, the bases of the transistors 98 are connected to the leads 64 and 70 by disposing the wires from the bases in the eyelets 66 and 72 and applying solder to the eyelets. This may be best seen in Figure 3. The emitters of the transistors 98 are connected in a similar manner to the leads 76 and 80 by disposing the wires from the emitters in the eyelets 78 and 82 and applying solder to the eyelets. In this way, connections are alternately made to the bases and emitters of successive transistors. The connections are made alternately at the left side of the card in Figure 2 and at the other times at the right side of the card.

Since the leads 64 and 70 and the leads 76 and 80 are disposed in intersecting relationship to the leads 16 and 30, connections may be made from the collector of each transistor 98 to the emitters and bases of a plurality of transistors. A plurality of such connections may be made since each of the leads 16 and 30 on the face 12 crosses a plurality of the leads 64, 70, 76 and 80 on the face 14. The connections from the leads 16 and 30 to the leads 64, 70, 76 and 80 are made by driving conductive rivets 110 (Figures 1 and 6) or pins through the card to provide an electrical communication between the leads. In this way, the apparatus constituting this invention provides simple and easy connections from the collectors to the bases and emitters of the transistors 98.

Because of physical limitations in the disposition of the leads 16 and 30 and of the leads 64, 70, 76 and 80, the base and emitter of each transistor 98 cannot be directly connected through these leads to the collector of every other transistor. However, connections can be made from the leads 16 and 30 to the auxiliary leads 84 and 86 which are respectively disposed on the face 14 near the top and bottom of the card in Figure 2. Connections can be made from the leads 16 and 30 to the leads 84 and 86 by passing rivets similar to the rivets 110 through the cards to provide an electrical communication between the leads. Auxiliary connections can also be made from the leads 64, 70, 76 and 80 to the leads 44 on the face 12 to produce an increase flexibility

in the electrical coupling from the collectors to the bases and emitters of the different transistors 98.

In addition to the connections described above, certain other connection are generally necessary to complete the formation of electrical circuits. For example, in most circuits connections are made from the collectors and bases of transistors to first terminals of various resistances. Such connections can be easily made on the card 10 since the resistances 102 are disposed within the sockets 100 in the retainers 90. The connections are made in a manner similar to that shown in Figure 4. As shown in Figure 4, wires from the resistances 102 extend into the eyelets 24 to provide electrical connections to the collectors of the different transistors 98. The wires from the resistances 102 may also extend into the eyelets 66, 72, 78 and 82 (Figure 2) to provide electrical connections to the bases and emitters of the different transistors 98.

Just as the first terminals of the resistances 102 are connected to the various elements in the different transistors, the second terminals of the resistances generally have voltage applied to them. This is especially true when the transistors and the resistances are included in circuits in which the transistors are directly coupled to one another. Transistors are directly coupled to one another when elements in first transistors are directly connected to elements in second transistors without the inclusion of any impedances such as resistances between the various elements.

Voltage is applied to the resistances 102 by passing the wires from the resistances through the holes 106 in the bus bars 104 and soldering the wires to the bus bars. A typical connection between a wire from one of the resistances 102 and one of the bus bars 104 is shown in Figure 4. By providing such connections, electrical continuity is established through elements including the left lead 56 in Figure 2 and the right lead 48 in Figure 1, the leads 60 and 62 in Figure 2 and the bus bars 104 to the resistances 102. Since the left lead 56 in Figure 2 is adapted to receive voltage from an external source (not shown), voltage can be easily applied to any of the resistances 102. The left lead 56 is adapted to receive voltage from an external source since the tab 15 holding the lead is adapted to fit within a standard 28-position receptacle (not shown). Such a receptacle is normally used in electrical equipment and especially with circuitry printed on cards to provide input and output connections to the circuitry printed on the cards.

Generally certain input signals are applied to the electrical circuitry formed on the card 10. The characteristics of the input signals applied to the circuitry are dependent upon the type of operation being performed by the circuitry. The input signals can be applied through the leads 48 and 56 since these leads are disposed on the tab 15 and the tab is positioned in a standard receptacle (not shown) as described above. In like manner, output voltages from the circuitry formed on the card 10 can be applied to certain of the leads 48 and 56 for introduction to different terminals of the standard receptacle.

As described previously, corresponding pairs of leads 48 and 56 communicate with each other through the eyelets 58. Although the leads 48 would be sufficient to provide electrical connections, the leads 56 are included to insure that the proper input signals are obtained from different terminals in the standard receptacle. Both the leads 48 and 56 are also included to insure that the voltages at proper positions in the card 10 are introduced to different terminals in the standard receptacle. The leads 46 and 50 communicate with the leads 48 and extend to the top of the card 10 in Figure 1 in a manner similar to that described above so as to facilitate checks which it may be desired to make as to the various input and output voltages.

Generally only the emitters and bases of transistors

are connected to receive the input voltages. Such connections can be easily made by driving rivets or pins through the card 10 to provide a communication between the leads 46 and 50 on the face 12 and the leads 64, 70, 76 and 80 on the face 14. As previously described, the leads 46 and 50 communicate electrically with the leads 48 and 56 on the tab 15.

It should be appreciated that the parameters described above for the card 10 are only by way of illustration. However, it is believed that the parameters described above offer good possibilities of cross connections between the various leads so as to offer an optimum flexibility in the different combinations of connections and so as to offer such optimum flexibility in a minimum area.

In connecting the various transistors to form circuits on the card 10, the ground connection is preferably placed at the lowest possible level on the card 10 as seen in Figures 1 and 2. When two or more transistors are connected in a series relationship, the transistors are placed at successive vertical levels of the card 10 in Figures 1 and 2 in accordance with the voltages applied to the different transistors in the series circuit. Similarly, when a first group of transistors introduces input signals to a second group of transistors, the first group of transistors should be placed at a lower level on the card 10 in Figures 1 and 2 than the second group of transistors. Transistors in parallel should be connected as closely as possible on the card from a vertical standpoint but it is immaterial as to the vertical order in which the transistors are placed.

Figure 8 illustrates the connections possible between the various leads shown in Figures 1 to 7, inclusive, and described fully above. The first column in Figure 8 indicates by number the different transistor stations. The count is made by starting at the upper right corner of Figure 1 and counting downwardly to the bottom right corner. As will be seen, twenty transistors 98 can be supported by the right retainer 90 in Figure 1 and twenty collector leads 30 are provided at the right side of the face 12. The count then proceeds upwardly along the left side of the card 10 in Figure 1. The count proceeds from "21" to "40," inclusive, since twenty transistors 98 can be supported by the left retainer 90 and twenty collector leads 16 are provided at the left side of the face 12 in Figure 1.

The second column indicates the connections which can be made from each of the collector leads 16 and 30 to the leads 64, 70, 76 and 80 common to the bases and emitters of the different transistors. As will be seen, connections can be made from certain of the collector leads to the emitters and bases of practically all of the transistors 98. For example, connections can be made from transistor "1" or from transistor "21" to the emitter and base of every other transistor. For this reason, transistors "1" and "21" have optimum suitability as output transistors. The number of connections available from the collector of each transistor decreases progressively as the number of the transistor decreases from "1" to "20," inclusive, and as the number of the transistor decreases from "21" to "40," inclusive.

The third column in Figure 8 indicates the connections which can be made from the base and emitter of each transistor 98 to the collectors of the other transistors. As will be seen, more of these connections can be made for certain transistors than for other transistors. For example, the base and emitter of transistor "40" can be connected to the collector of every other transistor supported by the retainers 90. For this reason, transistor "40" has optimum suitability as an input transistor. On the other extreme, the base and emitter of transistor "1" cannot be connected to the collector of any other transistor. It will be seen that generally the transistors which have optimum suitability as input transistors have minimum suitability as output transistors and vice versa.

It should be noted that transistors are used to perform two basic types of functions. For example, the two transistors used in a flip-flop apply voltages to successive stages to control the operation of these stages. In such stages as a flip-flop, the collectors of the two transistors in the flip-flop must be accessible to the transistors in the successive stages having their operation controlled by the flip-flop. Since certain stations on the card 10 are primarily suitable as output stations as described above, the transistors of such stages as flip-flops should preferably be disposed at these stations. For example, the transistors of such stages should preferably be disposed at stations "1" and "21."

Certain other transistors such as those used in logical networks have signals applied to them from other stages. Because of this, the bases and emitters of such logic transistors must be accessible to the transistors of the stages feeding signals to the logic transistors. Since certain stations on the card 10 are primarily suitable as input stations, transistors used for such purposes as logical networks should preferably be disposed at these stations. For example, such transistors should preferably be disposed at stations "39" and "40."

We claim:

1. In combination for providing electrical connections between a plurality of electrical components including semiconductors having bases, emitters and collectors and including impedance members, a card having first and second faces and made from electrically insulating material, a first plurality of parallel conductive strips extending in a first direction along the first face of the card to provide connections for the collectors of the semiconductors, a second plurality of parallel conductive strips extending in a second direction transverse to the first mentioned strips and along the second face of the card to provide connections for the emitters and bases of the semiconductors, pins extending through the card to couple electrically the strips on one face with particular ones of the strips on the other face in a pattern dependent upon the electrical circuitry to be produced, an insulating retainer disposed on the card and extending along the first face of the card in intersecting relationship to the conductive strips in the first and second pluralities, the retainer being provided with sockets to support the electrical components, a bus bar supported on the retainer and extending along the retainer past the sockets, and electrical connections coupled electrically to the bus bar and to particular components supported in the sockets for supplying electrical energy to these components.

2. The combination as set forth in claim 1 in which a tab is disposed at one end of the card to provide input and output connections to the card and in which a third plurality of conductive strips extend in the first direction along the first face of the cards and terminate at spaced positions along the tab to provide input and output connections to the different components.

3. In combination for providing electrical connections between a plurality of electrical components including semiconductors having bases, emitters and collectors and including impedance members, a nonconductive card having first and second faces with peripheries defined by a plurality of edges, a first plurality of conductive strips extending in a first direction along the first face of the card from a first pair of opposite edges on the card and obliquely relative to the edges to provide electrical connections for the collectors of the semiconductors, a second plurality of conductive strips extending along the second face of the card from the first pair of opposite edges on the card and in a second direction transverse to the first direction to provide electrical connections for the emitters and bases of the semiconductors, at least one insulating retainer extending along one face of the card in intersecting relationship with the conductive strips on that face and in transverse relationship with the conducting

strips on the other face, there being sockets in the non-conductive retainer for holding the semiconductors and the impedance members, a plurality of conductive pins extending through certain selected conductive strips and the card to provide electrical connections between particular ones of the first and second conductive strips for an electrical coupling from the collector of each semiconductor to the bases and emitters of different semiconductors and to particular ones of the impedance members, means disposed on the retainer for introducing electrical energy to different ones of the components supported on the retainer, and electrical connections extending from the energy means to particular ones of the components to obtain a supply of energy to the components.

4. The combination set forth in claim 3 in which the energy means includes a bus bar extending along the retainer for connection to the electrical components.

5. In combination for providing electrical connections between a plurality of electrical components including semiconductors having bases, emitters, collectors and including impedance members, an electrically insulating card having first and second faces, a first plurality of conductive strips having first portions extending obliquely in a first direction along a first face of the card and having second portions extending to positions near the edges of the card for connections to the collectors of the semiconductors, a second plurality of conductive strips having first portions extending obliquely along the second face of the card in a direction transverse to the first direction and having second portions extending to positions near the edges of the card for connections to the bases and emitters of the semiconductors, at least one insulating retainer extending along the card in transverse relationship to the strips in the first and second pluralities and having sockets for holding the semiconductors and the impedance members for connections to the conductive strips in the first and second pluralities, a bus bar extending along the retainer for electrical coupling to the components in the retainer to introduce electrical energy to the components, a plurality of conductive pins extending through certain selected conductive strips and the card at positions coupling the strips in the first and second pluralities to provide connections between the various elements in the different semiconductors in a pattern dependent upon the circuit intended for use, and electrical connections extending from the bus bar to particular ones of the components to introduce electrical energy from the bus bar to the components.

6. In combination for providing electrical connections between a plurality of electrical components including semiconductors having emitters, bases and collectors and including impedance members, an electrically insulating card having first and second faces, a first plurality of conductive strips extending in a first direction along one face of the card from a first pair of opposite edges on the card to provide electrical connections to the collectors of the semiconductors, a second plurality of conductive strips extending along the second face of the card from the first pair of opposite edges on the card and in a direction trans-

verse to the first direction to provide electrical connections to the emitters and bases of the semiconductors, a plurality of conductive pins extending through certain selected conductive strips and the card at particular positions on the cards and in intersecting relationship with the strips in the first and second pluralities to provide electrical connections between the collectors of particular semiconductors and the emitters and bases of different semiconductors in a pattern dependent upon the particular circuitry to be produced, at least one electrically insulating retainer supported on the card and extending along the card in a direction corresponding to that defined by the first pair of opposite edges on the card to support the components and to provide for an electrical coupling between the components and the conductive strips in the different pluralities, and means associated with the retainer for providing electrical connections between the impedance members and the semiconductors and for introducing voltage to the impedance members.

7. The combination set forth in claim 6 in which the retainer is provided with sockets extending outwardly toward a first one of the edges in the first pair to support the impedance members and in which the connecting means associated with the retainer is a bus bar extending along the retainer at the inner end of the retainer and in which electrical connections extend from the bus bar to the impedance members supported in the sockets of the retainer.

8. The combination set forth in claim 7 in which a second electrically insulating retainer extends along the card in spaced relationship to the first retainer and in transverse relationship to the strips in the first and second pluralities and in which the second retainer has sockets for holding the semiconductors and the impedance members for connections to the conductive strips in the first and second pluralities and in which the sockets in the first and second retainers extend outwardly toward opposite ones of the first pair of opposite edges on the card and in which a second bus bar extends along the second retainer for electrical coupling to the components in the retainer to introduce electrical energy to the components and in which the first and second bus bars are supported on the walls of the first and second retainers closest to each other and in which electrical connections extend from the second bus bar to the impedance members supported in the sockets of the second retainer and in which the conductive strips in the first and second pluralities extend in oblique directions relative to the first pair of opposite edges on the card.

References Cited in the file of this patent

UNITED STATES PATENTS

2,066,511	Arlt	Jan. 5, 1937
2,586,854	Myers	Feb. 26, 1952
2,599,710	Hathaway	June 10, 1952
2,634,310	Eisler	Apr. 7, 1953
2,693,584	Pifer	Nov. 2, 1954
2,701,346	Powell	Feb. 1, 1955

OTHER REFERENCES

Stamped Wiring, Electronics, June 1947.