This invention in general relates to plugboard assemblies for electrical accounting machines, computers, and the like and more particularly to an electrical contact assembly which provides circuit connections between fixed and movable plugboards of a plugboard assembly. For purpose of illustration the invention will be set forth in the present specification in association with plugboards and related parts such as are found in electrical accounting machines.

It has become the prevailing practice to provide in electrical accounting machines of the perforated record controlled type a fixed panel on which are arranged a multiplicity of electrical contacts in rows and columns, certain of the contacts being connected to the sensing elements or brushes of the machine and the remainder providing terminals for the leads connected to the instrumentalties that perform the operative functions of the machine under control of perforated records. A control panel connected with the fixed panel to provide through the electrical contacts the desired circuit connection pattern between the sensing elements and the instrumentalties to be operated in accordance with the predetermined pattern. To this end the control panel is provided with removable plugs or pin contacts which are adapted to engage and couple the corresponding contacts on the fixed panel. Commonly, the control panel and its contacts are removable as a unit from the plugboard assembly, whereby a separate control panel may be furnished for each arrangement desired.

Generally the control panel is carried by a frame which may be pivotally connected to the fixed panel, pivotal movement of the frame bringing the panels into operative relationship. To distribute evenly the contact pressure throughout the assembly in order to prevent warping of the control panel, it is preferred that the panels, or plugboards, first be brought to a parallel position with the two sets of contacts being in an overlapping equally spaced relationship. Subsequent movement of the movable or control panel along the fixed panel causes the contacts to engage simultaneously and effects even distribution of contact pressure. A mechanism for producing the movement of the panels, as described, is disclosed in my co-pending application, Serial No. 411,969, filed February 23, 1954, now Patent No. 2,927,295, dated March 1, 1960. The present invention is here described in a form suitable for incorporation in other apparatus in my co-pending application but other forms will readily occur to others skilled in this and related arts.

To render such a plugboard assembly practical, good electrical contact between the panels must be assured. It has been found, however, that merely bringing the control panel plugs into engagement with the fixed panel terminals may fail to give optimum performance due, among other causes, to contact failure resulting from the accumulation thereon of dust and films and by corrosion and pitting of the contact surfaces.

Accordingly, it is an object of the present invention to provide a contact assembly for plugboards which assures a clean and positive electrical contact between the contact elements.

Another object is to provide in a contact assembly for plugboards a contact member which effects an ultimate engagement with a mating contact plug at a freshly wiped point on the plug.

A further object is to provide a contact assembly for plugboards wherein the relative movement of the contact carriers is amplified as translated into wiping action between the contacts.

Still another object is to provide in a plugboard assembly a self-locking contact assembly tending to maintain the plugboards in interconnected relationship.

A still further object of the present invention is to provide in a plugboard assembly a spring contact which is simple to insert and to lock in position in the associated contact carrier.

Still another object of the present invention is to provide in a plugboard assembly a spring contact of a durable single-piece construction.

Other objects and attainments of the present invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which:

Figure 1 is a side view of a plugboard assembly partly broken away to illustrate the mounting of the contact assembly of the present invention;

Figure 2 is a partial front view in elevation of the plugboard assembly with certain parts being broken away as indicated in Figure 3 from A to E to illustrate the details of mounting the contact assembly;

Figure 3 is a detailed fragmentary view of the plugboard assembly illustrating the contact assembly in contacting relationship;

Figure 4 is a plan view of a spring contact for the fixed plugboard of the assembly;

Figure 5 is a side view of the spring contact shown in Figure 4;

Figure 6 is a plan view of the contact portion of the spring contact member of Figures 4 and 5;

Figure 7 is an end view of the spring contact member of Figures 4 and 5 illustrating the relationship of the contact portion to the spring portion thereof;

Figure 8 is a diagrammatic view of the contact assembly illustrating the movement of the contact elements during operation of the plugboard assembly;

Figure 9 is a perspective view of another embodiment of the contact portion of the spring contact member;

Figure 10 is a diagrammatic view illustrating the movement of the cooperating plug contact and the contact portion illustrated in Figure 9;

Figure 11 is a side view of a spring contact member including the contact portion shown in Figure 9;

Figures 12 and 13 are perspective views of other embodiments of the contact portion of the spring contact member;

Figure 14 is a diagrammatic view illustrating the movement of the cooperating plug contact with the contact portions shown in Figures 12 and 13;

Figure 15 is a perspective view of another embodiment of the contact portion of the spring contact member;

Figure 16 is a diagrammatic view illustrating the relationship of the cooperating contact pin and the contact portion of Figure 15 during the connective movement of the plugboard assembly;

Figures 17 and 18 are perspective views of other embodiments of the contact portion of the spring contact member.

Referring now to Figure 1, there is illustrated the plugboard assembly which includes a movable plugboard 1 shown loosely pivoted at 2 to a fixed plugboard 3 adapted to be rigidly affixed by bolts 4 to the frame of an elec-
A mechanism (not shown) of a type known in the art is provided to swing movable plugboard 1 about pivot 2 from the open position as shown to a position parallel fixed plugboard 3 and then lift or move plugboard 1 upwardly along the fixed plugboard by a predetermined amount. Such means form no part of the present invention and hence are omitted for purposes of clarity, an example of a suitable mechanism being shown and described in my aforesaid patent.

Fixed plugboard 3 is provided, as shown in Figure 2, with a base panel 6 having a plurality of apertures 5 arranged in rows and columns which are adapted to receive and support in position a like number of contact elements 7, some of which are coupled to the sensing elements of the machine while others are coupled to the various instrumentalities that perform the operative functions. Conventionally, movable plugboard 1 is provided with a removable panel 9 having a plurality of apertures 11 corresponding to apertures 5, in which contact plugs or pins 13 are adapted to be mounted, pins 13 being arranged to engage corresponding such an arrangement 7 as shown in Figure 3, when the plugboard assembly is moved to its closed or interconnected position. Apertures 5 on panel 6 of the fixed plugboard are intercepted by longitudinal grooves 15 for a purpose to be explained hereinafter.

Pin 13 is preferably in the form of a plug or jack and includes a barrel 14 which is detachably secured to plugboard 1 within apertures 11 by any suitable means known in the art. For example, a friction fit of barrel 14 within apertures 11 will suffice, however, it is preferred that the plug be of the form shown and described in my pending application, Serial No. 418,413, filed March 24, 1954, now Patent No. 2,903,670, dated September 8, 1959. A ferrule 16 integral with barrel 14 provides a means for electrically and mechanically connecting lead 17 to the pin of plug 13. The contact portion of pin 13 cooperates, in a manner hereinafter described, with a corresponding contact member 7 to effect electrical continuity between lead 17 and the lead 18 which is terminated in contact member 7, as in Figure 3.

As the movable plugboard is swung inwardly toward to a position parallel to the fixed board, contact pin 13 is initially disposed in overlapping spaced relationship with respect to contact member 7. Upon further operation of the plugboard mechanism, the movable board is slidably moved along the fixed plugboard such that each pin 13 engages the corresponding contact member 7 to accomplish the desired electrical connections. Contact members 7 are contemplated to include spring means which, upon deflection by the moving contact pin 13, eventually produces a predetermined contact pressure between the elements. To this end each contact member 7 includes, as shown in Figures 4 through 7, a spring portion 19 which characteristically is constrained to deflect in a plane perpendicular to the movement of the pin about a bending axis parallel to the movement of the pin. Typically a leaf spring will afford the characteristics desired in spring portion 19. With such an arrangement, to be described in detail, of the pin and of the contact surface of member 7 may be had that enhances the electrical quality of the contact between the elements by removing or scraping away any accumulation of foreign matter which might interfere with the making of a clean contact.

Generally designated at 20 in Figure 4 is the means by which contact member 7 is mounted and retained within the apertures of the fixed board in a manner such that the plane of spring portion 19 is maintained substantially in the desired position parallel to the path of pin movement. An indentation 21, struck up from a peripheral portion at the base of spring 19 leaving shoulders 25, provides the link integrally connecting mounting 20 with the remainder of the contact member. Shoulders 25 are adapted to fit within grooves 15 in abutting relationship with the face of the plugboard in order to maintain spring 19 in a fixed plane on a face of the plugboard 3. Stabilizing the forward end of mounting means 20 within aperture 11 is a generally cylindrical member 23 having a diameter closely approximating the aperture diameter. Protruding from the rearward face of plugboard 3 is a semi-cylindrical portion 27 extending from the side edges of which are wings 29. The forward edges of wings 29 facing the plugboard are curved so that upon spreading wings 29 outwardly, such edges will engage the plugboard in a camming action to draw shoulders 25 into tight engagement with the forward face of the plugboard, thus securely anchoring contact member 7.

Intermediate cylindrical portion 23 and extension 27 there is provided a tapering socket or receptacle 31 adapted to receive a mating taper pin 33 which is affixed to the electrical conductor or lead 18.

At the free end of spring 19 there is provided a contact portion or tab 35 through which electrical contact is had with pin 13. In the form of contact member 7, shown in Figures 4 through 7, tab 35 is a substantially flat extension of spring 19 but with the plane thereof set at an angle with respect to the plane of spring 19 as best shown in Figure 7. The relationship of corresponding apertures 5 and 11 is such that, upon mounting contact member 7 on the fixed board, the leading side of pin 13 should be disposed in the path of movement of pin 13. A relatively narrow contact surface 37 is provided on tab 35 in the form of a bead or rib facing the path of movement of pin 13 as best shown in Figure 8, the specific form and character of the contact surface to be described in detail hereinafter.

As thus arranged pin 13 will initially engage contact rib 37 near the leading side of tab 35, the relationship of the elements being diagrammatically illustrated by the dotted lines in Figure 8. As pin 13 continues to move upwardly, it will ride along contact surface 37 causing tab 35, under constraint of spring 19, to move perpendicularly to the line of pin movement, as indicated by the arrow, ultimately to reach the final point of contact indicated by full lines in Figure 8.

It will be observed from Figure 8 that the path of pin movement and a line segment representing the motion of tab 35 are the legs of a right triangle, the hypotenuse of which is a line segment representing the actual path of contact between the elements.

Accordingly, the upward movement of the pin as translated into wiping action along the contact rib 37 is amplified since the pin wipes along a contact path greater in length than the distance it has traveled. This amplification augments the tendency of the wiping action to free rib 37 of any accumulated foreign matter. With the tab 35 being set at an angle of 45° to the plane of spring portion 19 the greatest amplification is attained and presents a large target area for the pin while not unduly increasing the force required to deflect the spring.

To assure, however, good electrical contact with the pin, contact rib 37 is arranged so that during the upward motion of the pin, a predetermined length of the pin is first wiped and then rewiped or recontacted within the wiped length to result in a final contact on the pin at a freshly wiped point. To this end a first portion 37a of rib 37 is inclined downwardly toward the base of the contact member 7 and away from the direction of movement of the pin and a second portion 37b is inclined substantially opposite to the inclination of portion 37a, a rib 37 thus having a generally V-shaped configuration with the apex of the V pointing in a direction along the length and toward the base of the contact member 7. It should be apparent, however, that rib 37 is susceptible of taking a variety of forms for effect recontacting the pin within the wiped length. Typically, the final point of contact on pin 13 may be approximately midway of the prewiped path, in which case, the V-shape of rib 37 is
formed by rib 37b having an inclination the same as portion 37a but of a length half as long, or alternatively, the legs of the V may be substantially of the same length but with portion 37b being inclined at an angle half as great as portion 37a. In general, however, assuming that a line representing the direction of pin movement together with another line substantially perpendicular thereto and representing the direction of spring deflection define a plane, such lines being shown as arrows in Figure 8, then inclination of rib 37 in such plane with respect to the line of pin movement, as afforded by the angular set of contact portion 35, provides a cam-like arrangement for deflection of spring 19. Inclination of rib portion 37a out of the aforesaid plane effects the desired prewiping action, recontacting of the pin within its prewiper length being accomplished by fixing the final contact point on rib portion 37e equidistant from said plane with an intermediate point or rib portion 37f.

In operation, as the pin 7 first engages contact tab 35, as shown in dotted lines in Figure 8, the contact point will fall near the leading end of rib portion 37a. As the pin moves upwardly, the point of contact will be shifted toward the back end of rib portion 37a in accordance with the inclination of rib 37 until the apex of the V is reached. Further upward movement of the pin causes the point of contact to retract the prewiped path in accordance with the inclination of rib portion 37b until the final point of contact is reached, near the rear side edge of the contact tab 35, within the limits of the prewiped length of the pin.

In the embodiment of my invention shown in Figures 9 to 11, by imparting a ramp-like configuration to the contact rib, the camming action for deflection spring portion 19 may be obtained within the design of the contact rib alone. Thus, as best shown in Figure 11, contact portion 39 is substantially a flat coplanar extension of spring portion 41 with contact rib 43 progressively increasing in elevation above the plane of spring portion 41 from its forward point 43a to its terminal point 43b. With contact rib 43 having a generally V-shaped configuration, the operation, as indicated in the action diagram, Figure 10, will be substantially the same as has been described in connection with the embodiment of my invention shown in Figures 4 through 8. Accordingly, spring portion 41 will be deflected increasing in height as the pin 13 rides upwardly along the contact rib 43.

In the form of my invention shown in Figure 9, full contact pressure is not reached until final contact has been made as the entire length of the contact rib is ramped to provide for spring deflection, hence the prewiping action is had at a reduced pressure between the elements.

In the embodiment shown in Figure 12 the cleaning power of the prewiping action is enhanced by ramping only the initial portion 45a of contact rib 45 whereby once the pin has traversed ramp 45a, as may be seen in the action diagram, Figure 14, full contact pressure will be had and applied to the greater part of the prewiped length of the pin.

In a simplified form of my invention the contact rib may be formed merely by turning down the end 49 of contact portion 51 as in Figure 13. Preferably, the end surface of portion 49 is utilized as the contact rib so as to provide a contact path of a width at least equal to the stock thickness. Hence, end 49 is substantially at an angle of 90° with respect to the plane of contact portion 51 and spring portion 53.

In the embodiments of my invention thus far described once the pin has passed beyond the apex of the V-shaped rib the force required to deflect the spring decreases since the point of contact is at a greater distance from the point at which the spring was deflected. Accordingly, when the plugboard assembly is to be disconnected, the pin retraces its path back along the contact rib which requires the point of contact to once again move toward the apex of the V and nearer to the anchoring point of the spring. Thus, until the apex is reached, an increase in force is necessary to retract the pin along the contact rib whereby to open the plugboard assembly, hence a self-locking action is had. A more positive self-locking action may be obtained by progressively decreasing the height of the rewiping portion of the contact rib of the form generally shown in Figure 9. Thus, in the embodiment shown in Figure 15, rewiping portion 55a of rib 55 progressively increases in height above the plane of contact portion 57 until the apex of the V is reached, thereafter a progressive but attenuated decrease in height is imparted to rewiping portion 55b. As thus constructed, the force necessary to move pin 13 along rib portion 55a gradually increases until the apex is reached, whereupon continued movement of the pin results in a slight relaxation of spring tension due to both the increase in distance from the anchoring point of the spring to rib portion 55b and the decrease in height of the rib. In order to disengage the contact assembly there is now required an increase in deflection of the spring, to the left in the action diagram, Figure 16, against an increasing resistance from the point contact once again approaches the anchoring point.

In Figure 17 a simplified version of the contact rib is shown. In this form a ramped contact rib 59 extends diagonally across the breadth of contact portion 61 and is effective to wipe clean a path along which the pin 13, the wiping action being amplified both by the rear and the apparent increase in length of the contact rib.

In the embodiments of my invention thus far described, it will be apparent that the contact member may be formed from sheet metal stock by blanking and forming techniques well-known in the art, the simplicity of fabrication of the part and by low cost production methods.

Figure 18 illustrates a more simplified form wherein contact member 7 is fabricated from wire. In this embodiment two wire legs 63, which may be staked to the plugboard in any suitable manner, comprise the spring portion, the wire ends being joined by a bight portion turned back at an angle of approximately 90° with one leg 65 of the turned back portion being longer than the other leg 66 so as to impart the desired ramp to rib 67 and to incline the rib with respect to the direction of movement of the contact pin.

Sufficient contact pressure is, of course, essential to provide a good electrical contact. In the contact assembly of the present invention a contact pressure in the range of 6 to 8 ounces is effective for most applications. Obviously the degree of contact pressure may be controlled by varying such factors as stock thickness, the type of metal employed and the degree to which the rib is ramped. For those forms of my invention illustrated in Figures 9 through 18, it is especially preferred that relatively thin stock be utilized so as to require a high deflection to produce the 6 to 8 ounces of pressure. This, in turn, requires a fairly high ramp for the contact rib whereby the target area to be struck by movement of the contact pin is large, lending to a less critical arrangement of the contact springs 7 on the face of the plugboard in relation to the mounting of contact pins 13 on the movable plugboard.

In the specification and accompanying drawings I have shown and described a preferred embodiment of my invention and suggested various modifications thereof, but it will be recognized by those skilled in the art that many other modifications may be made without departing from the spirit of the invention. For example, there are many other configurations of the contact rib and those shown which will achieve a prewiping of a path along the contact pin with a subsequent recontacting of the pin within the prewiped path. Accordingly, it is to
be understood that the embodiments shown are not intended to be exhaustive nor limiting of the invention but on the contrary are given for purposes of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it and adapt it in various forms, such as may be best suited to the conditions of a particular use.

I claim:

1. An electrical contact member comprising an elongated leaf spring portion, means at one end of said spring portion for mounting said member on a supporting base, and a contact portion at the other end of said spring portion engageable by a mating contact pin adapted to be disposed substantially parallel to said member and moved in a plane parallel to the plane of said spring portion, rib means on said contact portion providing a narrow contact surface adapted for sliding engagement with the pin, at least the initial portion of said rib means being inclined to the plane of pin movement to provide a ramp for guiding the pin onto said contact surface and deflecting said spring portion, said rib means including a first wiping portion inclined along the length of said member for wiping along a predetermined length of said pin and a second terminal portion having an inclination in the opposite direction from that of said first portion for recontacting the pin within the wiped predetermined length.

2. An electrical contact member comprising an elongated leaf spring portion, means at one end of said spring portion for mounting said member on a supporting base, the other end of said spring portion having an extension to form a contact portion engageable by a mating contact pin adapted to be disposed substantially parallel and moved in a plane parallel to the plane of said spring portion, rib-like means forming a V on one side and extending substantially the width of said contact portion with the apex of the V approximately at the longitudinal center of said member, said rib means providing a narrow contact surface adapted for sliding engagement with the pin, at least the initial portion of said rib means being inclined to the plane of pin movement to provide a ramp for guiding the pin onto said contact surface and deflecting said spring portion, at least a portion of said rib means being inclined along the length of said member to effect a wiping along the pin upon movement in sliding contact with said surface.

3. An electrical contact member substantially as set forth in claim 2, wherein said contact portion is substantially planar and the legs of the V progressively decrease in height above the plane of said contact portion from the apex of the V.

4. An electrical contact member comprising an elongated leaf spring portion, means at one end of said spring portion for mounting said member on a supporting base, and a substantially flat contact portion integrally extending from the other end of said spring portion engageable by a mating contact pin adapted to be disposed substantially parallel to said member and moved in a plane parallel to the plane of said spring portion, the plane of said contact portion being set at an acute angle relative to the plane and about the length of said spring portion, rib means providing a narrow contact surface substantially to a uniform elevation above the plane of and extending substantially across said contact portion and adapted for sliding engagement with the pin, at least a portion of said rib means being inclined along the length of said member to effect a wiping along the pin upon movement in sliding contact with said surface.

5. An electrical contact member comprising an elongated leaf spring portion, means at one end of said spring portion for mounting said member on a supporting base, and a substantially flat contact portion integrally extending from the other end of said spring portion engageable by a mating contact pin adapted to be disposed substantially parallel to said member and moved in a plane parallel to the plane of said spring portion, the plane of said contact portion being set at an acute angle relative to the plane and about the length of said spring portion, rib means providing a narrow contact surface substantially to a uniform elevation above the plane of and extending substantially across said contact portion and adapted for sliding engagement with the pin, at least a portion of said rib means being inclined along the length of said member to effect a wiping along the pin upon movement in sliding contact with said surface.

6. An electrical contact member comprising an elongated leaf spring portion, means at one end of said
terminal portion angularly disposed relative to said first portion for recontacting said cylindrical surface at an intermediate point within the wiped portion thereof.

11. An electrical contact member comprising an elongated leaf spring portion, means at one end of said spring portion for mounting said member on a supporting base, the other end of said spring portion having an extension to form a contact portion engageable by a mating contact pin disposed substantially parallel to said member and moved in a plane parallel to the plane of said spring portion, rib-like means projecting from a face and extending the width of said contact portion to provide a narrow contact surface which is smoothly rounded for sliding and wiping engagement across a length of the pin, said rib-like means having an initial portion and an intermediate portion and a terminal portion, at least said initial portion being inclined to the plane of pin movement to provide a ramp for guiding the pin onto said contact surface and deflecting said spring portion, at least said intermediate portion being inclined along the length of said member to effect a wiping along the pin upon movement in sliding contact with said surface, said contact portion being substantially planar with said rib-like means progressively increasing in height above the plane of said contact portion all along its entire length across the width of said contact portion.

12. A contact member as set forth in claim 11 wherein the terminal portion of said rib-like means provides a narrow contact surface extending along a line at an angle to and intersecting the line of said intermediate portion.

References Cited in the file of this patent

UNITED STATES PATENTS

<table>
<thead>
<tr>
<th>Number</th>
<th>Inventor</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,213,632</td>
<td>Hammond</td>
<td>Jan. 23, 1917</td>
</tr>
<tr>
<td>1,359,585</td>
<td>Fitzgerald</td>
<td>Nov. 23, 1920</td>
</tr>
<tr>
<td>1,808,555</td>
<td>Ishimaru</td>
<td>June 2, 1931</td>
</tr>
<tr>
<td>2,120,396</td>
<td>Domaleski</td>
<td>June 14, 1938</td>
</tr>
<tr>
<td>2,401,430</td>
<td>Lake</td>
<td>June 4, 1946</td>
</tr>
<tr>
<td>2,594,748</td>
<td>Earl</td>
<td>Apr. 29, 1952</td>
</tr>
<tr>
<td>2,738,486</td>
<td>Wadsworth</td>
<td>Mar. 13, 1956</td>
</tr>
<tr>
<td>2,816,275</td>
<td>Hammell</td>
<td>Dec. 10, 1957</td>
</tr>
</tbody>
</table>