

Sept. 13, 1966

L. E. LAWRENCE

3,272,949

BIFURCATED PARALLEL CONTACTS FOR RELAY

Filed Aug. 14, 1964

3 Sheets-Sheet 1

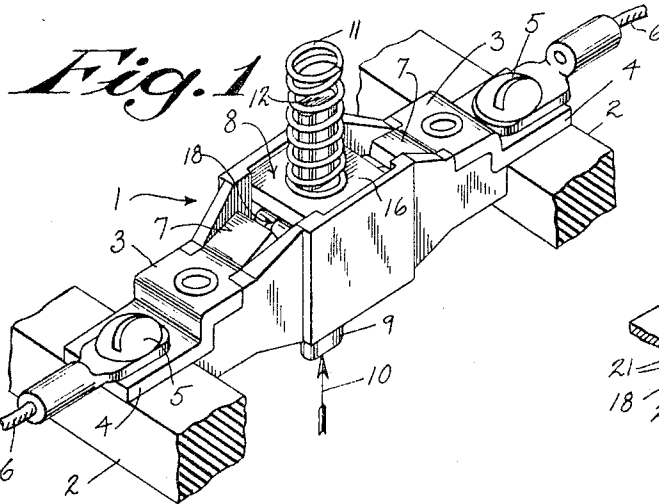


Fig. 2

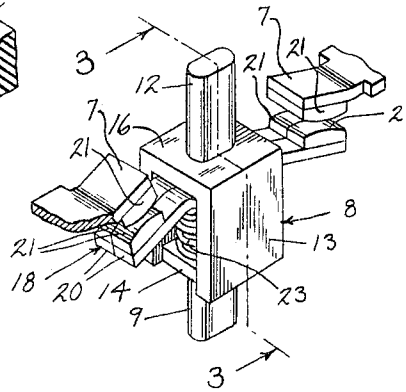


Fig. 3

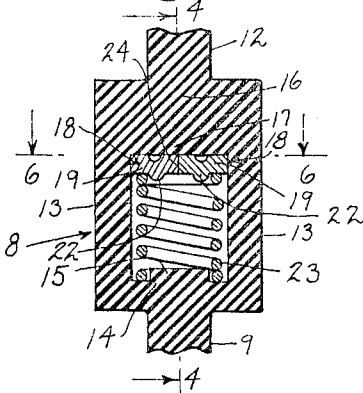


Fig. 4

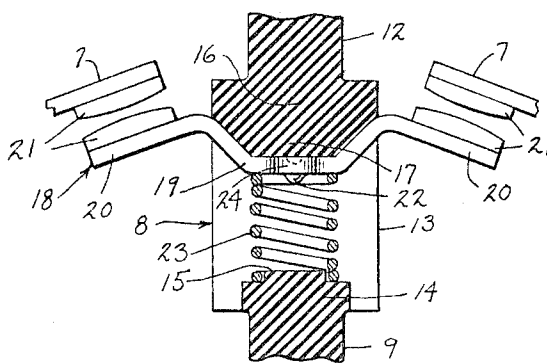


Fig. 5

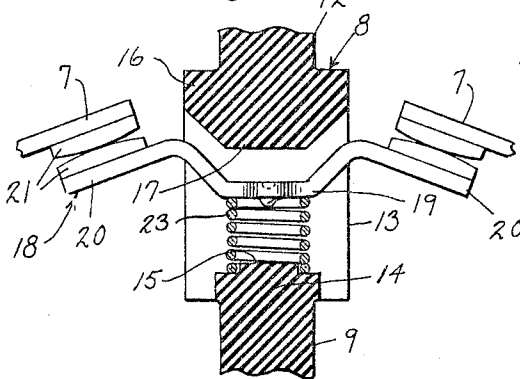
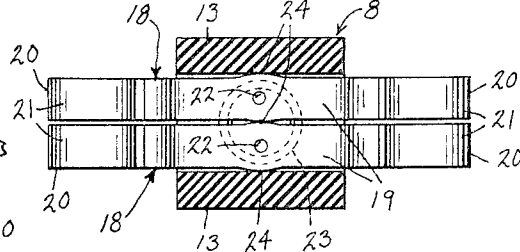


Fig. 6



INVENTOR
LELAND E. LAWRENCE

BY *Arthur H. Nidel*

ATTORNEY

Sept. 13, 1966

L. E. LAWRENCE

3,272,949

BIFURCATED PARALLEL CONTACTS FOR RELAY

Filed Aug. 14, 1964

5 Sheets-Sheet 2

Fig. 7

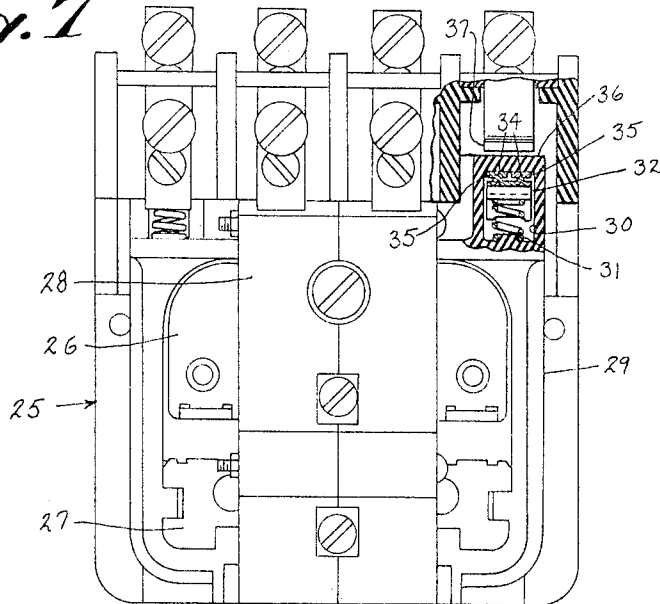


Fig. 8

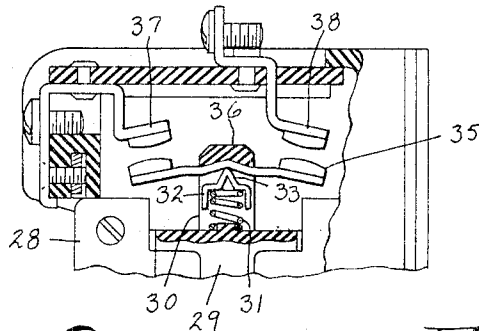


Fig. 9

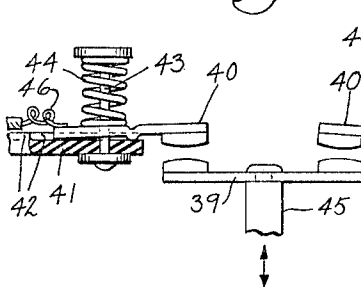
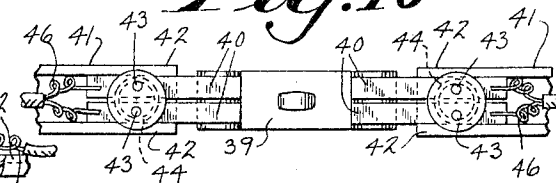


Fig. 10



INVENTOR
LELAND E. LAWRENCE

BY *Arthur H. Hidel*

ATTORNEY

Sept. 13, 1966

L. E. LAWRENCE

3,272,949

BIFURCATED PARALLEL CONTACTS FOR RELAY

Filed Aug. 14, 1964

3 Sheets-Sheet 3

Fig. 11

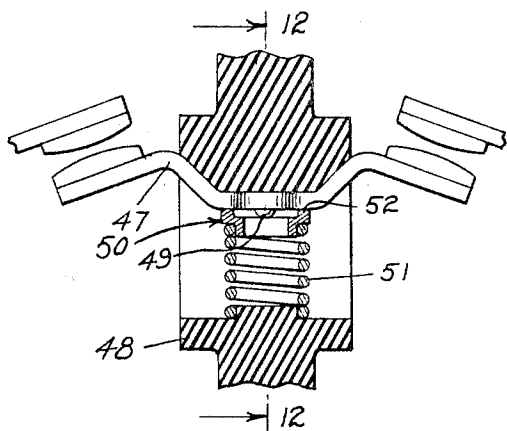


Fig. 12

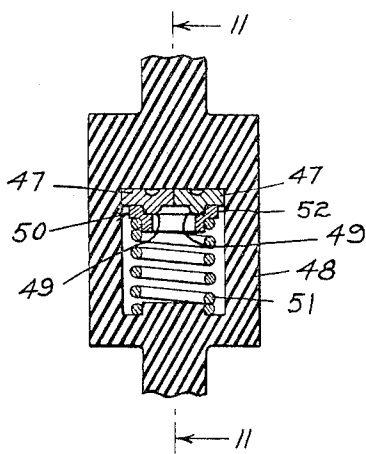
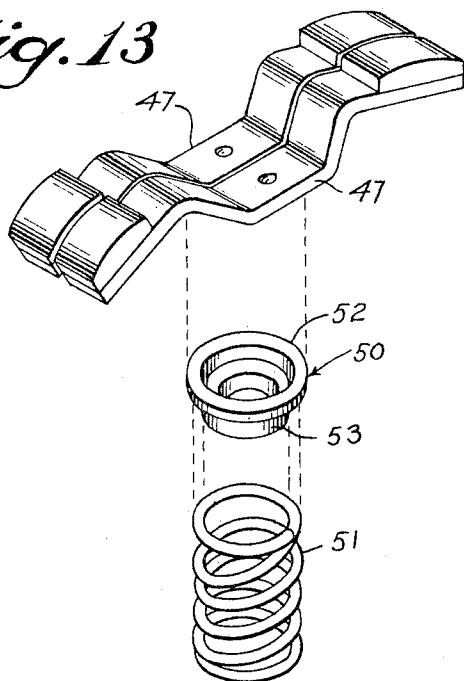


Fig. 13



INVENTOR
LELAND E. LAWRENCE

BY

Arthur H. Sidel

ATTORNEY

1

3,272,949
BIFURCATED PARALLEL CONTACTS FOR RELAY
Leland E. Lawrence, Wauwatosa, Wis., assignor to Allen-Bradley Company, Milwaukee, Wis., a corporation of Wisconsin

Filed Aug. 14, 1964, Ser. No. 390,271
6 Claims. (Cl. 200-166)

This invention relates to contacts for relays and the like which provide highly reliable contact closure through the provision of separate, parallel contacts for a common pole of a circuit, and this application is a continuation-in-part of application Serial No. 355,264 filed March 27, 1964, now abandoned.

In many relay applications circuits are established by the closing of relay contacts before electrical energy is fed to the circuit. The voltages that are then applied to the circuits, subsequent to the establishing of the circuits, are often of a low order of value, and if minute particles, such as grit or dust, are lodged between a pair of relay contacts that have been actuated to closed position current flow will not occur if such particles obstruct engagement of the contact surfaces. Hence, the reliability of relays used under such conditions is frequently not sufficient for satisfactory operation, particularly where there are numerous relays in a circuit and frequent switching takes place. This problem is not as prevalent in the switching of live circuits, or in circuits handling higher voltages, where arcing can readily establish continuity between contacts, and minute particles no longer function as effective barriers to current flow. The situations in which the problem predominates, in which voltages are applied after switching, are commonly referred to as either dry switching or cold circuit applications.

It has been proposed to bifurcate the movable contacts of a relay to solve the problem. In such approach the finger of the movable contact which engages the stationary contact is split, to present two movable contacts, and if one contact fails to properly engage the stationary contact by reason of the presence of foreign particles the other, in all probability, will establish a circuit. However, in such a construction the split fingers of a movable contact must be resilient, and this presents additional problems. When initial contact engagement is made contact pressure will be very slight, and this pressure will continue to be slight until considerable travel of the contact actuator takes place in order to load the resilient contact finger by a bending of the finger. For a relay that is versatile for use in both circuits that are energized at the time of contact make and break, as well as in dry switching applications, such a delayed build up of contact pressure during closure, and also the reverse decay of contact pressure upon circuit interruption, cannot be tolerated. Also, the excessive stroke necessary for flexing a resilient contact is not compatible with many electro-magnet designs that are particularly desirable for use in industrial type relays.

Another disadvantage of the foregoing approach is that relatively long fingers are required for the contacts, in order to have the necessary resilience. Also, a very thin contact finger is required if its length is shortened for compact construction, and such thin fingers may not have the current capacity for the types of relays under consideration.

The present invention provides a very high reliability of contact closure for dry switching in which a preferred form has a spanner type of movable contact which bridges between a pair of stationary contacts. This movable contact is divided into two separate, mutually exclusive, contacts which lie side by side and form two parallel

2

electrical paths between stationary contacts which they both engage. These stationary contacts, one at each end of the twin movable contacts, constitute a single electrical pole. The twin movable contacts may be stiff and for practical purposes non-resilient. They can also be short, and no increased overtravel is necessary for the contact actuator, as in the instance of resilient contact members.

In the invention, each separate movable contact is free to seat with the stationary contacts, as in normal relays having a single movable contact for each pole. The two side by side movable contacts are not connected or joined, as in the prior suggested constructions discussed above, and the probability of failure to satisfactorily close in a dry switching operation is inversely proportional to the square of the probability for a single movable contact. Hence, a very reliable relay is attained by the invention.

It is still another object of the invention to provide a control relay having a very high degree of reliability of contact closure in dry switching operations.

It is another object of this invention to provide a relay having a split contact that presents parallel electrical paths for a single pole.

It is another object of the invention to provide separate movable contacts for engaging a single stationary contact which may be stiff and substantially non-resilient.

It is still another object of the invention to provide a contact structure for use in relays that may be employed in cold circuit applications having a plurality of freely floating contacts for each pole of the relay to insure reliability of contact closure.

It is still another object of this invention to eliminate the disruption that small particles such as grit and dust can create in the setting up of relay circuits.

Another object of the invention is to provide a split contact comprising two side by side contacts that provide parallel electrical paths between their ends and which also are electrically connected to one another at a point along their respective lengths whereby current can be shunted from one contact to the other. The electrical shunt comprises a low resistance material upon which the two contacts are seated. A spring urges the seat and contacts into engagement, and in such engagement the individual contacts remain separate from one another to allow freedom of alignment.

In the following description the foregoing and other objects and advantages will become apparent. In the description reference is made to the accompanying drawings, which form a part hereof and show by way of illustration and not of limitation specific embodiments in which the invention may reside. The embodiments are described in terms to enable those skilled in the art to practice the invention, and for a determination of the scope of the invention reference is made to the claims at the end of this specification.

In the drawings:

FIG. 1 is a view in perspective of a contact module embodying the invention which comprises a single pole usable in a relay like that shown in co-pending application Serial No. 333,596, filed December 26, 1963, for Electromagnetic Relay. Such relay constitutes an industrial control relay as may be used in control circuits for numerous applications, both in dry circuit and energized circuit environments. Similar contact modules are also shown in detail in co-pending application Serial No. 333,283, filed December 26, 1963 for Contact Module. Only that part of a relay is shown in FIG. 1 that is necessary for an understanding and explanation of the present invention,

FIG. 2 is a view in perspective of the contacts and a contact actuator employed in the apparatus of FIG. 1,

FIG. 3 is a view in section of the movable contact and

contact actuator of FIG. 2, viewed through a vertical plane as designated in FIG. 2,

FIG. 4 is a view in section taken on the plane 4—4 indicated in FIG. 3,

FIG. 5 is a view in section also taken on the plane 4—4, but with the contacts in closed position,

FIG. 6 is a view in section taken on the plane 6—6 indicated in FIG. 3,

FIG. 7 is a view of another form in which the invention may reside, and in this instance the contact structure is shown as a part of a complete electromagnetic relay,

FIG. 8 is a fragmentary side view of the relay of FIG. 7 with parts broken away and in section to show the invention,

FIG. 9 is a side view of a further embodiment of the invention in which stationary contacts are split to provide parallel electrical paths for a single electrical pole.

FIG. 10 is a top view of the embodiment of FIG. 9,

FIG. 11 is a view in section of another form of the invention in which a pair of movable side by side contacts rest on a seat of low resistance material,

FIG. 12 is a view in section of the form of the invention shown in FIG. 11 viewed through the plane 12—12 indicated in FIG. 11, and

FIG. 13 is an exploded view in perspective of the movable contacts and contact seat of FIGS. 11 and 12.

Referring now to FIG. 1, a contact housing 1 is mounted on supports 2, which can be a part of a relay structure as illustrated in said co-pending application Serial No. 333,596, and there is shown here merely by way of illustration sufficient environment for a description of the invention. A terminal strip 3 is secured at each end of the housing 1 which has an outer mounting end 4 that receives a terminal screw 5 which is threadedly engaged in the associated mounting support 2. Each terminal screw 5 also connects a suitable circuit lead 6 with the associated terminal strip 3, and each terminal strip 3 includes a stationary contact end 7 which extends into the housing 1. The stationary contact ends 7 are spaced from one another, and are set at an angle oblique to a line running between the stationary contacts, as is particularly shown in FIGS. 2, 4 and 5.

The contact housing 1 mounts a vertically movable contact actuator 8, shown in perspective in FIG. 2, that is guided in its vertical movement by appropriate bearing surfaces in the housing 1. The actuator 8 functions to move movable contacts toward and away from the stationary contacts 7. For actuation of the contact actuator 8 a suitable electromagnetic actuator, not shown in the drawings, is provided, which will engage the bottom stem 9 as illustrated by the arrow 10 in FIG. 1. For a complete description of such an electromagnetic actuator and its cooperation with the contact structure being described reference is again made to said co-pending applications. There is also provided a return spring 11 encircling the upper stem 12 of the actuator 8, such return spring 11 urges the actuator 8 downwardly, so as to return the same when the electromagnetic actuator is retracted, and again reference is made to said co-pending applications for a detailed description of these parts which do not form a part of the present invention.

Referring now to the central portion of the contact actuator 8, it is comprised of a pair of oppositely spaced side walls 13, a bottom 14 that includes a small spring orientating boss 15, and a top 16. As particularly shown in FIGS. 4 and 5, the top 16 has a chamfered seat 17 that protrudes downwardly beneath the top 16, and this seat 17 together with the side walls 13 and the bottom 14 define a contact cage with a central opening that extends through the actuator 8 in a direction substantially paralleling a line extending between the stationary contacts 7.

Inserted within the opening is a pair of twin movable contact spanners 18 which bridge between the stationary contacts 7 to make and break contact therewith in response to vertical movement of the contact actuator.

Each of the movable contact spanners 18 has a mid-

portion 19 that has a saddle like shape conforming with the chamfered seat 17 of the top wall 16 of the contact cage. From its mid-portion 19 each spanner 18 extends into outer ends 20 that overhang beyond the contact cage and are aligned with the stationary contacts 7, as shown in FIGS. 2, 4 and 5. Each outer end 20 is obliquely disposed to roughly parallel the oblique disposition of the associated stationary contact 7, and suitable contact buttons 21 are applied to each outer end 20 and to each stationary contact 7 for making and breaking engagement with one another. As particularly shown in FIGS. 3—6, each movable contact spanner 18 has a small downwardly extending boss 22 formed at its center that fits within a spiral type bias spring 23. The bias spring 23 has its lower end seated over and concentric with the boss 15, and its upper end encircles both of the small bosses 22, to thereby keep the movable contact spanners orientated with one another and the bias spring 23. In forming the bosses 22 the central or mid-portion 19 of each movable contact spanner 18 has its crosswise dimension slightly expanded, as seen in FIG. 6, to develop a slight enlargement 24. These enlargements 24 provide a fairly snug fit with the side walls 13, and also slightly space the contact spanners 18 from one another along the major portions of their length, and so that they do not bind against one another.

When the contacts are in open position, as shown in FIG. 4, each of the twin movable contact spanners 18 is held by the bias spring 23 against the seat 17. The contact spanners 18 are then restricted from endwise movement, by virtue of the geometry of the seat 17 and the saddle-like mid-portions 19, and they are further restrained from sidewise movement by virtue of the close fit between the side walls 13 forming a part of the contact cage. The close encirclement of the bias spring 23 about the two bosses 22 will aid in retaining the position of the spring 23 with respect to the twin contact spanners 18. When the contacts are moved into engagement, by an upward motion of the contact actuator 8, the striking of the contact buttons 21 will arrest upward travel of the contact spanners 18. The contact actuator 8 will move upward to compress the bias spring 23, and to free the contact spanners 18 from engagement with the seat 17. Since the bias spring 23 is at all times in a state of pre-compression, sufficient contact pressure is immediately obtained upon contact engagement, and as the spring 23 is further compressed this pressure increases. Also, as the actuator 8 rises to the position shown in FIG. 5 each of the twin contact spanners 18 floats freely to allow firm engagement with each of the stationary contacts 7. Neither contact spanner 18 interferes with the making of contact engagement of the other, as could be the case in the instance of a contact which is simply bifurcated to have two contact fingers that have to move in unison with one another by reason of an integral connection between them. In the present invention, the twin contact spanners 18 are separate, and mutually exclusive, insofar as relates to their freedom to properly align and make engagement with the stationary contacts 7. Further, each contact spanner 18 is formed as a separate piece and can be relatively stiff and non-deflectable. This allows for immediate establishment of effective contact pressure upon initial contact engagement.

When the contacts are in closed position, as seen in FIG. 5, the oblique arrangement of the stationary contacts 7 and the contact ends 20 of the spanners 18 precludes endwise shift of the movable contact members, and sidewise shift is precluded by continued close spacing within the side walls 13 of the cage. The close fit between the two bosses 22 and bias spring 23 also aids in keeping the parts properly oriented.

The invention provides parallel electrical paths through the twin contact spanners 18 which engage a single sta-

5

tionary contact 7 at each end. The stationary contacts 7 thus comprise a single electrical pole, and in the circuit of this pole a pair of independent contact engagements are provided to have parallel paths which can establish electrical connection independent of one another. Thus, if a small particle might lodge between any two mating contact buttons 21, so that electrical continuity cannot be established upon a closing of the contacts, the parallel path of the other contact spanner 18 will in all probability set up a closed circuit. The resulting reliability in establishing a circuit greatly enhances the use of relays in switching operations for the control of machine tools and the like, particularly in dry switching in which the circuit is unenergized at the time of setting up the contacts and the subsequent voltages applied are quite small. This reliability of operation is achieved within the same space as formerly used for single contacts, and the expense of manufacture is not increased, while obtaining decidedly greater reliability in relay operation.

Referring now to FIGS. 7 and 8, there is shown an embodiment in which the contacts of the invention are a part of an electromagnetic relay 25. The relay 25 has a stationary magnetic yoke 26 and a vertically movable magnetic armature 27 mounted in a coil piece 28. The armature 27 translates a contact actuator 29 in a vertically reciprocable movement, and the actuator 29 includes a number of contact cages 30, one of which is shown in FIGS. 7 and 8. Each contact cage 30 mounts a bias spring 31 which has its upper end housed within a formed metal cap 32. The cap 32 has a peaked top 33, as seen in FIG. 8, with a pair of upwardly rising dimples 34, as seen in FIG. 7. Mounted on the peaked top 33 is a pair of movable contact spanners 35, each of which has a slight depression on its underside to mate with one of the dimples 34. The central portion of each contact spanner 35 is also hump shaped, as seen in FIG. 8, to mate with a similar configuration in the top 36 of the contact cage 30. Stationary contacts 37 and 38 are provided for each pair of twin movable contact spanners 35, and a set of stationary contacts 37, 38 provide a single pole for the relay 25.

The operation of the contacts in FIGS. 7 and 8 is similar to that described for the embodiment of FIGS. 1-6, and there is included in this particular embodiment an intermediary member, in the form of the cap 32, between the bias spring 31 and the twin contact spanners 35 which may increase the freedom of movement of the spanners 35, so that contact engagement is enhanced.

Another form of the invention is shown in FIGS. 9 and 10, wherein a movable contact spanner 39 is a unitary piece rigidly secured to an actuator 45 that moves upward and downward in response to a suitable source of movement. The stationary contacts at each end of the contact spanner 39 are split into two separate contacts 40, and each pair of stationary contacts 40 provide parallel electrical paths with the unitary movable contact spanner 39. Thus, there is a single electrical pole, as represented by the contact spanner 39, and a circuit through the pole can be established through either of parallel paths, as in the other embodiments described. The two stationary contacts 40, at an end of the contact assembly, each rest on a ledge 41 and are retained from sidewise shift by small longitudinal steps 42. Each stationary contact 40 is pierced by a pin 43 and a coil spring 44, that establishes contact bias, encircles each pair of pins 43. Pig-tails 46 make electrical connection with the stationary contacts 40, and as is apparent from this the operation of the assembly is similar to that of the prior embodiments described, except that the stationary contacts 40 have freedom of movement for developing contact pressures and for making proper alignment with the movable bridging contact 39.

A further embodiment of the invention is shown in FIGS. 11-13, wherein a pair of movable contact spanners

6

47 within an actuator 48 are each provided with a small downwardly extending boss 49 at the center of its underside. The spanners 47 are disposed on a circular contact seat 50, which in turn is secured to the top convolutions of a bias spring 51. The seat 50 is open through the center, has an upper ridge 52 that receives and holds captive the bosses 49, and has a bottom flange 53 that fits tightly within the spring 51.

The seat 50 has the function of serving as an electrical connection between the contact spanners 47 to act as a shunt to allow current to flow from one spanner 47 to the other. Thus, when one end of one spanner makes electrical contact with a stationary contact, and the opposite end of the other spanner 47 makes contact with another stationary contact a circuit is established through the seat 50, and for optimum conduction a low resistance material is employed for the seat 50. Copper base alloys and silver plated metals form satisfactory low resistance contact seats, and a silver plated brass has given fine results. By having a low resistance material, the contact resistance between the contact spanners and the seat is low and burning will not occur as in the instance where a high resistance material forms the seat. The seat forms an electrical shunt between the contact spanners 47, and the bias spring 51 working against the seat 50 provides the necessary pressure for adequate electrical engagement. This use of a low resistance material is particularly advantageous in the prolongation of the life of the contacts, for electrical erosion is minimized. Current flow from contact spanner to contact spanner may be quite prevalent, and in such instances a low resistance for a shunt, which does not restrict the freedom of physical movement of the contact spanners, is desirable.

The invention achieves the objective of greatly increasing reliability of contact closure in relay operations. It may take several forms, and in addition to the advantages previously discussed problems of contact bounce during closing movement of the actuator can be partially overcome through out of phase physical movements of the twin contacts. The circuit, then, may remain substantially closed during the brief interval in which bounce occurs. Another feature is the ability to shunt current flowing in one of the parallel contacts to the other. For example, in the embodiment of FIGS. 11-13 the seat 50 forms a shunt conductor between the movable contact spanners 47, and contact reliability is enhanced by thus providing a current path when one end of each spanner 47 is held open by foreign matter and these open ends are at opposite stationary contacts. The cap 32 can also function as a shunt in the embodiment of FIGS. 7 and 8. In conclusion, the invention particularly enhances dry switching, low voltage applications.

I claim:

1. In a contact assembly the combination comprising:
 - a supporting structure;
 - a pair of stationary contacts carried by said supporting structure that are spaced from one another with contact surfaces thereof disposed oblique to a line between the contacts;
 - a contact actuator movable in a path of action substantially normal to said line between said spaced stationary contacts, which actuator includes a contact receiving cage formed with two spaced side walls, a top and a bottom that define an opening through the actuator that substantially parallels said line between said spaced stationary contacts, the top of said cage having a seat with surfaces oblique to said line between stationary contacts;
 - guide means associated with said supporting structure and engageable with said contact actuator for confining movement thereof to said path of action;
 - a pair of stiff, substantially non-deflectable, separate contact spanners mounted in said cage opening of said contact actuator, each spanner having its opposite ends extending from the cage opening at an

- angle substantially matching the oblique orientation of said stationary contacts, a central portion with a curvature conforming to said seat of said contact actuator to restrain endwise movement of the spanner when in engagement with said seat, and further having a contact surface at each end for engagement with said stationary contacts, said contact spanners lying in side by side relation between the side walls of said contact cage and forming parallel electrical paths between said stationary contacts when in engagement therewith; and
- a coil spring interposed between said contact spanners and the bottom of said contact cage which urges each of said contact spanners toward said seat of said contact cage.
2. In a contact assembly the combination comprising:
- a supporting structure;
 - a pair of stationary contacts adjacent one another that are formed separately and are substantially non-bendable, each being mounted upon said supporting structure for yielding engagement with a movable contact;
 - a single movable contact for engagement and disengagement with said adjacent stationary contacts, the movable contact together with the stationary contacts constituting a single pole for the assembly;
- means associated with said supporting structure for moving said movable contact toward and from the stationary contacts;
- bias spring means urging said stationary contacts against said movable contact when in engagement therewith for parallel electrical paths with the movable contact of the single pole defined by the contacts; and
- an arresting surface against which said spring means urges said stationary contacts when disengaged from said movable contact.
3. In a contact assembly the combination comprising:
- a supporting structure;
 - a pair of stationary contacts borne by said supporting structure and spaced from one another to form an electrical pole;
 - a contact actuator associated with said supporting structure for guided movement;
 - a pair of separate movable contact spanners mounted by said actuator with their ends aligned for engagement with said spaced stationary contacts to thereby each bridge between the stationary contacts;
 - a contact spanner seat in engagement with both said contact spanners at a point along their lengths which constitutes an electrical shunt between said contact spanners.

4. An assembly as in claim 3, wherein said seat is of a low resistance metal from the group of copper alloys and silver plated metals.
5. An assembly as in claim 4, wherein a contact bias spring is carried by said actuator and has one end working against said seat to urge the seat against the contact spanners.
6. In a contact assembly the combination comprising:
- a supporting structure;
 - a pair of stationary contacts spaced from one another and mounted upon said supporting structure to form an electrical pole for the assembly;
 - a contact actuator movable in a path of action substantially normal to a line between said spaced stationary contacts which is guided in such movement by said supporting structure, said contact actuator including a contact receiving cage with a seat having surfaces oblique to said line between said spaced stationary contacts;
- means associated with said supporting structure for reciprocating said contact actuator in said path of action;
- a pair of movable contacts formed of two separate pieces mounted in said contact receiving cage for bridging engagement between said stationary contacts, said movable contacts lying in closely adjacent side by side relation within said cage and forming parallel electrical paths between said stationary contacts when in engagement therewith, each of said movable contacts having a saddle engageable with said oblique surfaces of said seat to preclude endwise shift of said movable contacts when said seat and saddles are in engagement;
- said contact receiving cage having side walls between which said movable contacts are closely held to preclude any substantial sidewise shift of said movable contacts; and
- a common bias spring means working against said pair of movable contacts.

References Cited by the Examiner

UNITED STATES PATENTS

1,238,667	8/1917	Halbleib et al.	200—166
1,399,492	12/1921	Krantz	200—166
3,200,225	8/1965	Lemke	200—166

ROBERT K. SCHAEFER, *Primary Examiner.*KATHLEEN H. CLAFFY, *Examiner.*H. O. JONES, *Assistant Examiner.*