May 19, 1953 T. J. DUNSHEATH 2,639,355

ELECTRICAL CONTACT

Filed May 25, 1951 2 Sheets-Sheet 1

Fig. 1

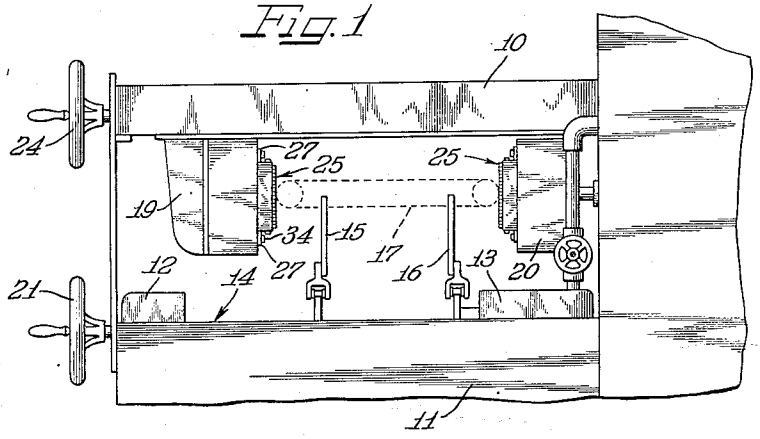


Fig. 2

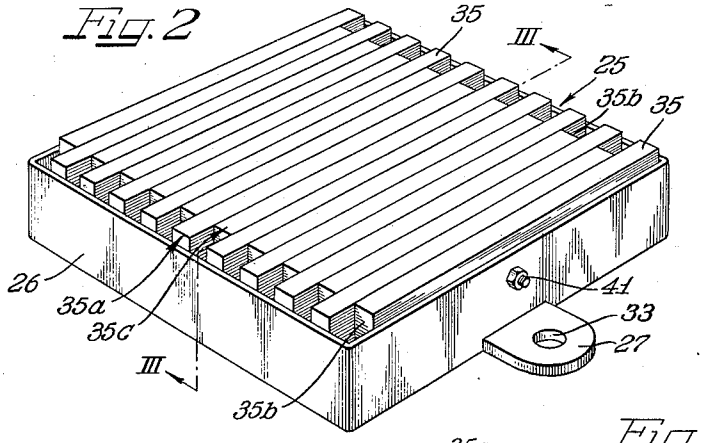


Fig. 3

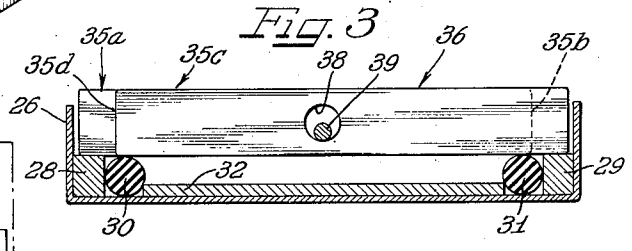
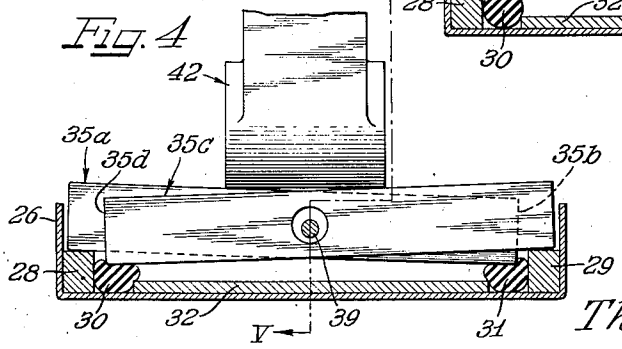


Fig. 4



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ELECTRICAL CONTACT

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Fig. 5

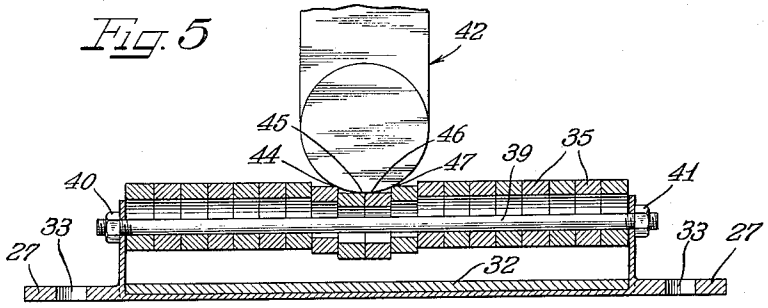


Fig. 6

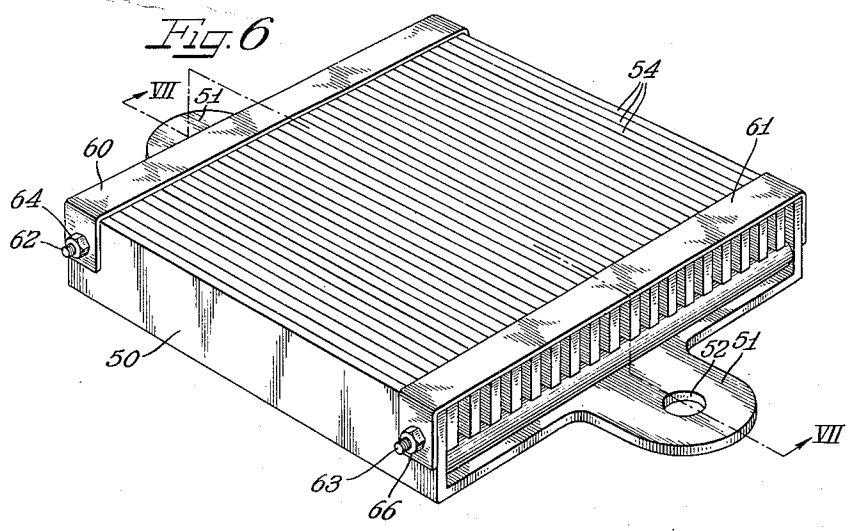
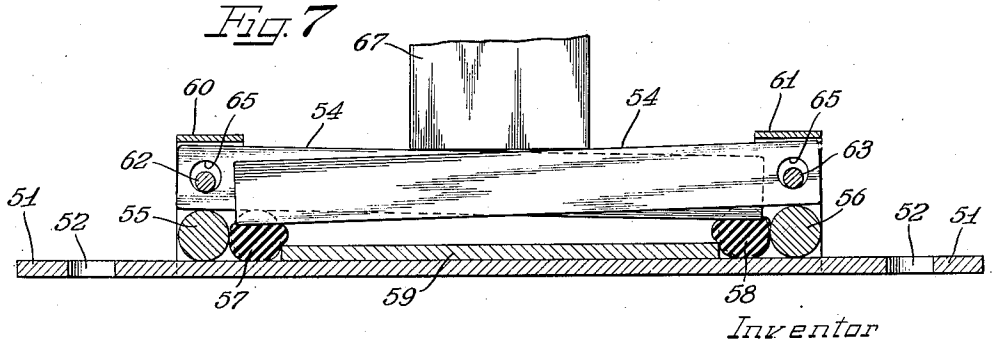


Fig. 7



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UNITED STATES PATENT OFFICE

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ELECTRICAL CONTACT

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7 Claims. (Cl. 200—166)

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The present invention relates to electrical contacts, particularly for use where high current carrying capacity contacts are required.

The contacts of the present invention will find use in a variety of fields, but in particular are extremely useful in machines designed to detect flaws in metallic test pieces. In this type of machine, a test sample is inspected for flaws by supporting the element to be tested between a pair of electrical contact elements, applying a thin layer of ferromagnetic particles, preferably in the form of a suspension in oil, over the test piece and then passing a high amperage current through the test piece. The applied current sets up a magnetic field about the test piece, and the ferromagnetic particles become clustered at any surface flaws or fissures present in the article. After termination of the current flow, the presence of such flaws or fissures can be determined in the test piece by a visual observation, as the clustered ferromagnetic particles around a flaw or other defect will be of sufficient size to be readily noticeable.

It has been conventional practice in machines of this nature to place the piece to be tested between a pair of electrical contacting heads consisting of contact pads or plates mounted on air cylinder rods, with the air cylinders being operated to clamp the piece. The electrical current is then passed through the piece for approximately one-half second by the operation of a relay in the electrical circuit of the machine. The current intensities in the test piece present during the application of the current are quite high, being on the order of 1,000 amps. for a test piece having a diameter of one inch. Because of the extremely high current densities, there is definite danger of burning the test piece at the point where the contact is made, particularly for parts having irregular end surfaces. This burning presents a very serious problem, particularly where finished parts are being inspected, as the current mars the finish of the parts. In addition, excessive heating of the test piece even for short intervals of time is sometimes sufficient to change the hardness of the test piece in localized areas. Where the contact elements are made of copper, a further problem is presented, because the copper may enter the grain structure of the steel or other metal being tested, and cause copper embrittlement of the piece being tested.

In addition to other requirements, the contact elements must be sufficiently rugged to have an extended life. Many inspecting machines of the type described operate at rates as high as 1,800

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test pieces per hour, and the replacement of contacts in such machines is undesirable from the standpoint of delays necessitated by shutting down the equipment to replace the contacts.

In general, machines of the nature described have employed either lead plates or copper braid pads with a backing member of synthetic rubber as contact elements. Lead plates have the advantage that they do not ordinarily burn the test piece, since the lead melts and conforms to the surface of the piece being tested. However, lead plates have a short useful life, and are objectionable because there is a tendency to splatter molten lead away from the contacts, and endanger the safety of the operator.

While copper braid contact pads have a longer life than lead plates, they also have the disadvantage of having a greater tendency to burn the piece being tested. In addition, as the copper braids wear out, fine copper wires broken from the braid are deposited in the tank used to drain the suspension of ferromagnetic particles and cause clogging.

To overcome the disadvantages of the lead plates and copper braid pads which have previously been employed as contacts in machines of this nature, three requirements must be met. First, the amount of heat generated at the point of contact between the contact element and test piece must be reduced. Since the current cannot be reduced without a reduction in the effectiveness of the inspecting process, the contact resistance must necessarily be lowered. Secondly, the heat generated at the contact area must be spread over a large area, or distributed over several points rather than at a localized small area to prevent intense concentration of the heat evolved. Third, the contact elements themselves should have sufficient thermal capacity and conductivity to draw heat away rapidly from the point of contact.

In order to obtain low contact resistance between the electrical contacts and the test piece, several requirements should be met. In the first instance, the contact material itself should have a low electrical resistance. Also, the contact pressure between the test piece and the contact elements should be high. If possible, the contact should incorporate a wiping action. In addition, the metal from which the contact is made should not form a non-conducting oxide.

For the efficient removal of heat from the areas of contact, the contact elements should have a high thermal conductivity and a large mass. Finally, the design of the contact units

must be such as to hold the test pieces firmly during testing.

The present invention provides an electrical contact assembly which meets all of the foregoing requirments. Essentially, the contacts of the present invention consist of a plurality of elongated, relatively thin electrically conductive members in interleaving relationship. The test piece to be inspected is supported rigidly between a pair of the contact elements, the engagement being such as to provide numerous contact points for the passage of current, so that there is no tendency to build up heat along a very small area of the test piece. The arrangement of the individually displaceable conducting elements is such that the surface of the contact element can accommodate test pieces of various shapes and sizes. Furthermore, the mass of each of the conducting elements is relatively large, thus aiding in dissipation of heat.

An object of the present invention is to provide an improved electrical contact assembly for supporting a test piece and energizing the same with a high amperage current.

Another object of the present invention is to provide an electrical contact consisting of a plurality of individually displaceable conducting elements which are displaced by pressure of the work piece to provide spaced areas of heat dissipation.

Another object of the present invention is to provide an electrical contact element having a high degree of thermal capacity and conductivity and a low contact resistance when used in conjunction with a test piece.

Still another object of the present invention is to provide a compact electrical contact for use in flaw detection apparatus.

A further description of the present invention will be made in connection with the attached sheets of drawings in which:

Figure 1 is a fragmentary view, with parts in elevation, of the magnetizing station of a flaw detecting apparatus;

Figure 2 is a perspective view of a contact element embodying the principles of the present invention;

Figure 3 is a cross-sectional view taken substantially along the line III—III of Figure 2;

Figure 4 is a cross-sectional view similar to Figure 3, and illustrating the deflection of the conducting members of the contact by a test piece during flow of current through the contact element and the test piece;

Figure 5 is a cross-sectional view of the contact element in operative engagement with a test piece, this view being taken substantially along the line V—V of Figure 4;

Figure 6 is a perspective view of a modified contact member also within the scope of the present invention; and

Figure 7 is a cross-sectional view taken substantially along the line VII—VII of Figure 6 illustrating the deflection of the conducting elements during the testing operation.

As shown on the drawings:

Figure 1 illustrates a portion of a flaw detecting apparatus in which the contact elements of the present invention will be particularly useful. This apparatus includes a pair of horizontally extending frame members 10 and 11, and a pair of horizontally extending guide members 12 and 13. Between the guide members 12 and 13 is a traveling conveyor belt 14. Supported for movement with the conveyor belt 14 are a pair of work supporting arms 15 and 16 suitably notched to receive a test piece 17 which is illustrated in dotted outline in the view of Figure 1.

A housing 19 is supported by the upper frame member 10, and a second housing 20 is also supported in the assembly in fixed position with respect to the traveling work carrying arms 15 and 16.

Movement of the work carrying arms 15 and 16 into proper alignment with the housings 19 and 20 may be made by rotation of a hand wheel 21 which is operatively engaged with the conveyor system 14.

One of the housings, such as housing 19 of Figure 1, is suitably supported for lateral movement with respect to the other housing 20, as by means of a jack screw. Adjustment of the position of the housing 19 with respect to the housing 20, to adjust for various sizes of test pieces, is made by rotation of a hand wheel 24.

The present invention is primarily concerned with the contact elements associated with the housings 19 and 20. These contact elements have been indicated generally at numeral 25 in Figure 1, and, in most installations, will be substantially identical.

As shown in Figure 2, the contact element 25 includes a generally box-like enclosure 26 made of brass or similar electrically conductive material. Disposed at opposite ends of the enclosure 26 are a pair of extensions 27 each having an aperture 33 to permit mounting of the assembly 25, within the housing 19 or 20 by means of bolts 34 (Figure 1).

As shown in Figures 3 and 4, included within the box-like enclosure 26 are a pair of elongated contact blocks 28 and 29, rectangular in cross-section, in parallel spaced relationship along opposite corners of the enclosure 26. Associated with each of the contact blocks 28 and 29, and co-extensive therewith, are a pair of generally cylindrical resilient members 30 and 31, which may be suitably composed of a synthetic rubber material such as Neoprene. A metallic spacer element 32, co-extensive with both the support blocks 28 and 29 and the resilient members 30 and 31 separates the resilient members 30 and 31 and compresses them slightly.

The conducting elements included within the contact element 25 are in the form of generally elongated rectangular elements of a good heat and current carrying material such as hard drawn copper. Other suitable materials from which the conducting elements may be prepared include beryllium copper alloys containing about 98.3% copper, 1.4% cobalt, and 0.3% beryllium; cadmium bronze containing 98.6% copper, 0.8% cadmium, and 0.6% tin; and Phosphor bronze containing 96% copper, 3.75% tin, and 0.25% phosphorous.

The arrangement of the electrically conducting leaves 35 is best illustrated in Figures 2 and 3. As shown in these drawings, the individual leaves 35 are arranged in interleaving relationship throughout the length of the enclosure 26. As shown in Figure 3, one end portion of a particular leaf 35*a* is supported by and in electrical contact with the support block 28. The opposite end of the leaf 35*a*, indicated at 35*b*, is supported by the slightly compressed resilient member 31. The leaf next adjacent to the leaf 35*a*, identified in Figure 3 at 35*c*, is supported at one end on the opposite support block 29, and has its opposite free end 35*d* resting on the opposite resilient member 30. By this arrangement, the leaves 35 pre-

sent a substantially flat contacting surface 36 along the entire length of the contact element 25.

The leaves 35 are prevented from falling out of the enclosure 26 by providing a slightly off-center aperture 38 in each of the leaves 35. Upon placing the leaves 35 in the interleaving relationship shown in Figure 2, the apertures 38 are in registry with each other, to receive a relatively small diameter bolt 39 therethrough. The bolt 39 is threaded at both ends and rigidly secured to the end walls of the enclosure 26 by means of a pair of nuts 40 and 41. The relationship of the rod 39 and the individual leaves 35 is best illustrated in Figure 5 of the drawings. The rod 39 and the nuts 40 and 41 hold the leaves 35 with sufficient pressure to prevent lateral movement of the leaves 35, but still provide sufficient working clearance to allow independent pivotal movement of the leaves 35 about the support blocks 28 and 29.

The engagement between the contact assembly and a test piece is illustrated in Figures 4 and 5. As shown in these drawings, as a test piece 42 is engaged between a pair of opposed contact elements 25, the contacting leaf elements are individually deflected. For example, as shown in Figure 4, the leaf 35*a* is pivoted about the end portions supported on the support block 28 so that its free end 35*b* compresses and deforms the resilient member 31. In the same way, the leaf 35*c* pivots about the point of contact between one end of the leaf 35*c* and the contact block 29, so that its free end 35*d* compresses the opposite resilient member 30. The number of leaves 35 which are engaged by a given work piece will, of course, depend upon the width of the individual leaves 35 and the dimensions of the test piece 42. However, as best seen in Figures 4 and 5, the test piece 42, is engaged by the leaves 35 in a series of spaced contact points, generally indicated at numerals 44, 45, 46 and 47 of Figure 5 so that the heat evolved upon application of current from the energizing means (not shown) in the housings 19 and 20 will be more effectively dissipated. As the test piece 42 is removed, the natural resiliency of the resilient members 30 and 31 urges the individual leaves 35 back into their initial alignment, determined by engagement of the apertures 38 with the rod 39.

In the embodiment of the invention illustrated in Figures 6 and 7, the means for retaining the leaves within the enclosure are different from that illustrated in previous figures. As shown in Figure 6, this modified form of the invention consists of a contact element comprising a box-like enclosure 50 composed of brass or other electrically conductive material, with a pair of integral extensions 51 extending from opposite sides thereof. Each of the extensions 51 is provided with an aperture 52 for receiving a bolt or other securing means to enable the contact element to be secured within the housing of the testing machine.

As in the case of the previously described embodiment, the contact element of Figures 6 and 7 contains a plurality of elongated conducting leaves or blades 54 disposed in interleaving relationship between the end walls of the box-like enclosure 50.

As illustrated in Figure 7, the contact structure also includes a pair of oppositely disposed cylindrical supports 55 and 56, and a pair of substantially cylindrical resilient members 57 and 58 in abutting contact therewith. A spacer 59 urges the resilient members 57 and 58 into abutting contact with the supports 55 and 56, with resulting slight deformation of the resilient members 57 and 58.

The leaves 54 are prevented from falling out of the enclosure 50 by means of a pair of retaining strips 60 and 61, the retaining strips being held in position by means of a pair of bolts 62 and 63 and their associated nuts 64 and 66.

Instead of providing each of the leaves 54 with a slightly off-center aperture as in the case of the previously described embodiment, the leaves 64 of the contact of Figures 6 and 7 are provided with apertures 65 at an end portion of the individual leaves. When the leaves are aligned in interleaving relationship, that is, with an end portion of one leaf 54 being supported on the cylindrical support member 56, and its other end support on the resilient member 57, and the next adjoining leaf 54 having its apertured end supported by the support member 55 at its free end by the resilient member 58, the apertures 65 are in registry to receive the securing bolts 62 and 63 therethrough, as illustrated in Figure 7. This construction has the advantage that the individual leaves are stronger, since the apertures are not punched from the center of the individual leaves, but in an end portion. However, this embodiment is not as useful as the previously described embodiment for testing of large test specimens, such as large, flat plates, because of the presence of the overlying contact strips 60 and 61.

The device illustrated in Figures 6 and 7 operates in the same manner as the device shown in Figures 1 to 5. As the test piece 67 is pressed against the contact, several of the leaf elements 54 are deflected downwardly, the number of leaf elements being deflected depending upon the width of the individual leaves and the width of the test member 67 being tested. The engagement of the test pieces 67 with the leaves 54 is such that a plurality of contact points is established between the end surface of the test piece 67 and the contacting surfaces of the individual leaves 54. Upon removal of the test piece 67, the natural resiliency of the resilient members 57 and 58 is sufficient to urge the ends of the depressed leaves 54 outwardly so that they present a flat contacting surface.

From the foregoing, it will be appreciated that the contact of the present invention has several distinct advantages over previously used high current carrying electrical contacts. The individually deflectible leaf elements of the contact assembly provide a plurality of contact points when engaged by a test piece, to minimize the danger of excessive heat concentration, while still holding the test piece rigidly. It will also be observed that as a test piece is clamped between the testing heads, a slight wiping action occurs as the individual leaves are deflected into a V-shape. This wiping action is important in establishing the low contact resistance between the contact element and the surface of the test piece.

In actual trials, the contact elements of the present invention have been shown to be far superior to previously employed contact elements using copper braid contacts. In test runs involving the testing of automobile connecting rods, currents of 3000 amperes could be passed into the test part without burning of the piece. This current value is about twice that possible when using copper braided contact elements. Furthermore, the contacts of the present invention have a longer useful life than either the lead plate or

copper braid type of contacts previously used in testing machines of this nature.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. An electrical contact comprising an electrically conductive support, a pair of electrically conductive contact elements in spaced parallel relation along said support, a plurality of elongated conducting elements bridging the space between said contact elements, said conducting elements being arranged with an end portion of one of said conducting elements supported on one of said contact elements, and an end portion of the next adjacent conducting element being supported on the other of said contact elements.

2. An electrical contact comprising a support, a pair of electrically conductive contact elements in spaced parallel relationship along said support, a pair of resiliently deformable members in spaced parallel relation along said support, a plurality of elongated conducting elements, said conducting elements being arranged with an end portion of one of said conducting elements supported on one of said contact elements, and the other end of said conducting elements being supported on one of said resiliently deformable members, and the next adjacent conducting element having one end portion supported on the other of said contact elements, and its other end portion supported on the other of said resiliently deformable members.

3. An electrical contact comprising an electrically conductive support, a pair of electrically conductive contact elements disposed in spaced parallel relationship along the support, a resiliently deformable member associated with each of said contact elements, a spacer urging each of said resiliently deformable members into abutting contact with its associated contact element, and a plurality of elongated conducting elements in interleaving engagement, said conducting elements being supported along said support by said contact elements and said resiliently deformable members.

4. An electrical contact comprising an electrically conductive support, a pair of spaced contact elements along said support, a plurality of elongated electrically conductive members disposed along said support in interleaving relationship, with portions of said conductive elements being supported by said contact elements, means associated with said support defining a pivotal axis transverse to said elongated electrically conductive members, and resilient means supporting

portions of said electrically conductive members, said interleaving electrically conductive members defining a relatively flat surface, said spaced contact defining a pivotal axis for each of said electrically conductive members.

5. An electrical contact comprising an electrically conductive support, a pair of spaced contact elements disposed in parallel relationship along said support, a plurality of elongated apertured electrically conductive members disposed along said support in interleaving relationship with portions of said conductive members being supported by said contact elements, resilient means supporting other portions of said electrically conductive members, said interleaving electrically conductive members defining a relatively flat surface, and a rod secured to said support and extending through the apertures of said electrically conductive members.

6. An electrical contact comprising an electrically conductive support, a pair of parallel spaced contact elements in spaced alignment along said support, a plurality of elongated electrically conductive members, each of said electrically conductive members having apertured end portions supported on and in electrical contact with one of said contact elements, said electrically conductive elements being arranged in interleaving relationship along said contact elements, and a pair of rods secured to said support and extending through the apertures in said electrically conductive members.

7. An electrical contact assembly comprising electrically conductive elements in interleaved arrangement with the corresponding ends of alternate elements extending into substantial alignment beyond the ends of adjacent elements, a rigid conductive member supporting each set of extended ends to leave the other ends unsupported, means yieldingly supporting said other ends to bring the working surfaces of said elements into substantially the same plane, and means having a lost motion connection with all of said elements providing limited independent movement of each of said yieldably supported ends when a work piece is brought into pressure contact with a portion of said working surfaces intermediate said rigid members.

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