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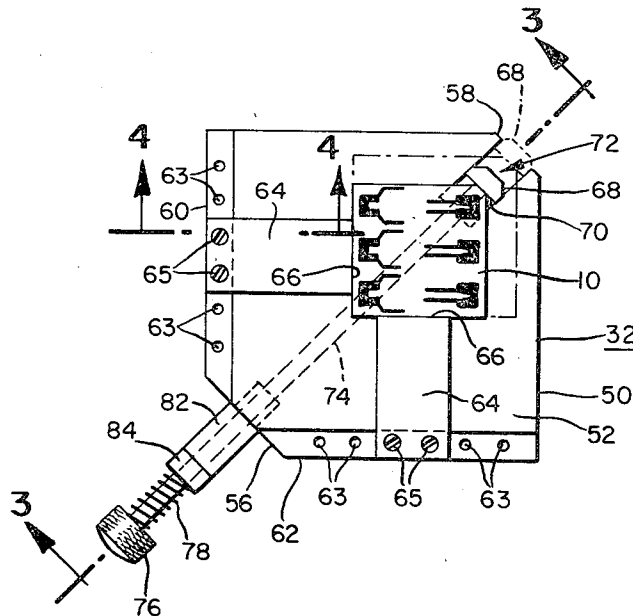
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[54] **ABRADING APPARATUS**
1 Claim, 6 Drawing Figs.

[52] U.S. Cl. 51/8,
51/217, 269/112, 269/254
[51] Int. Cl. B24b 41/06
[50] Field of Search 51/217, 217
(A), 217 (L), 217 (O), 217 (P), 217 (R), 8;
269/112, 254, 303, 304, 305, 306, 317

ABSTRACT: Abrading apparatus is provided with an improved workpiece holder including a plate on which is mounted structure having diverging edge portions and a spring-biased member for clamping the workpiece therebetween.



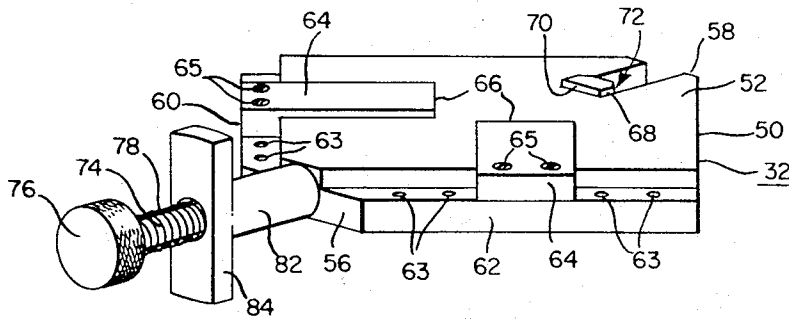


Fig. 1

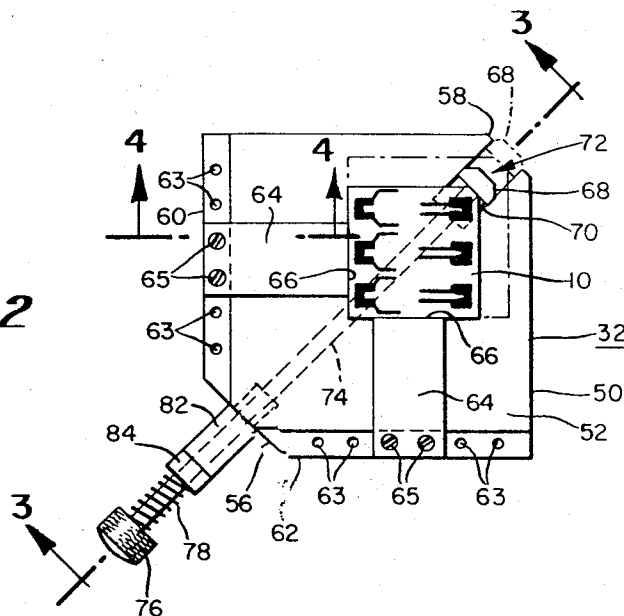


Fig. 2

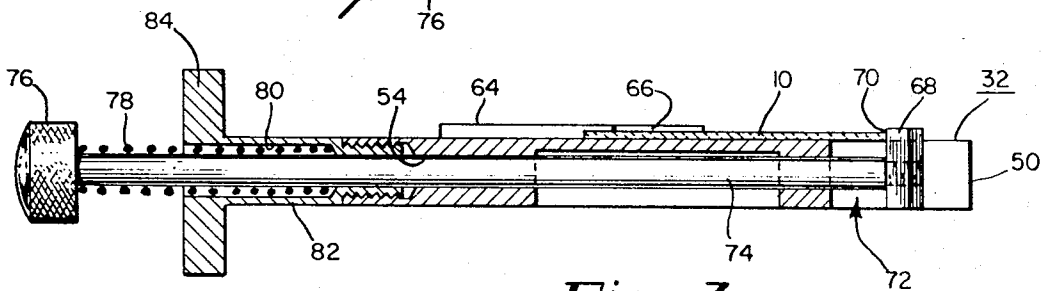


Fig. 3

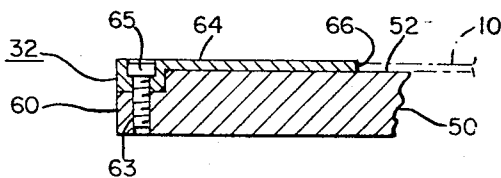


Fig. 4

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ABRADING APPARATUS

This invention relates to abrading apparatus, and more particularly to an improved workpiece holder therefor.

Abrading apparatus is now in use for trimming resistors printed transversely across spaced conductors on a nonconductive substrate. The substrate is usually a thin, flat piece or chip which must be held securely in accurately positioned relation to a pressurized stream of airborne abrasive particles. With the printed surface of the substrate facing the abrasive stream, the stream traverses between the parallel conductors and reduces the width of the printed resistor connecting the conductors. The resistor is preferably reduced in width midway between the conductors until the desired value of electrical resistance is obtained.

With increasing use of the abrading apparatus for mass production of miniature circuits, a need has developed for a holding device which affords rapid and accurate loading of workpieces before trimming, as well as quick unloading after trimming. The present invention is directed to providing abrading apparatus having a holding device which fulfills the foregoing requirements.

According to the present invention the abrading apparatus includes a holding device comprising a flat plate to which a workpiece may be clamped between stationary structure and a spring-biased movable member, all mounted on the plate. The stationary structure may have diverging edge portions above the plate surface, and the movable member may travel in a path bisecting the angle of divergence between the edge portions. This arrangement provides stable, three-point contact between the workpiece and the holding device. Loading is facilitated by holding the movable member away from the stationary structure while inserting the workpiece between them, and then releasing the movable member into clamping engagement. Unloading involves movement similar to loading while sliding the trimmed workpiece off the plate surface. Optionally, both unloading and loading can be accomplished in sequence with the movable member retracted in order to further speed the process.

In the drawings:

FIG. 1 is an isometric view of the holding device;

FIG. 2 is a plan view of the holding device shown in FIG. 1, with a workpiece in clamped position;

FIG. 3 is an enlarged sectional view of the holding device, taken along line 3-3 of FIG. 2;

FIG. 4 is an enlarged and fragmentary sectional view of the holding device, taken along line 4-4 of FIG. 2;

FIG. 5 is a schematic illustration of apparatus to which the device is applied; and

FIG. 6 is a plan view of a miniature electrical resistor, shown greatly enlarged, of the type which can be trimmed abrasively while held in a device according to the present invention.

The invention is included in abrading apparatus which will be described with reference to FIGS. 5 and 6 as applied to the trimming of a thick-film resistor or other workpiece designated generally by the numeral 10, utilizing a high-velocity abrasive stream issuing from a nozzle 12. The latter is supplied through a supply conduit 14 by a mixing chamber 16 where dry, filtered, pressurized air at about 85 p.s.i. from a compressor 18 is uniformly mixed in the desired proportions with abrasive powder from a reservoir 20. By means of unique arrangement, more fully described in U.S. Pat. No. 3,344,524, a vibrator 22 is employed to apply vibrations to the chamber 16. This arrangement can produce an automatically replenished trickle about 3 to 5 grams per minute of aluminum oxide or other abrasive powder having an average particle size of 27 microns, from a reservoir 20 through a passageway (not shown) to the mixing chamber 16 for combining with the pressurized air.

The flow of airborne abrasive particles is initiated by the energization of a solenoid-operated pinch valve 24 in the upstream end of the supply conduit 14, that is, at the outlet of the mixing chamber 16. The nozzle 12 will have a restricted orifice, e.g. 0.018 inch diameter, of much smaller cross-sectional flow area than the supply conduit 14, and thus the entire

system is pressurized. In order to achieve uniform cutting action the apparatus is arranged to provide a uniform concentration of particles in a constant airstream issuing from the nozzle at about 40 to 80 p.s.i.

The supply conduit 14 may be a flexible hose of abrasion resistant material at the end of a length of rigid tubing, and it is preferred that the terminal or end portion adjacent the nozzle 12 be of rigid tubular construction so that it can serve as nozzle holder 26 capable of having its movements accurately controlled by a traversing mechanism 28 connected thereto by a rigidly constructed arm 30. The nozzle holder 26 is suitably journaled in the extended free end of the arm 30, in upright position above a holder 32 for the workpiece 10. The traversing mechanism 28 serves to move the nozzle 12 by its holder 26 transverse to the longitudinal extent of the holder, or into and out of the plane of the drawing illustrating the apparatus, whereby the abrasive stream is traversed along the length of the workpiece to cut or abrade along the line of travel. The traversing mechanism 28 responds to signals received via conductors 34 from a control 36 to move a controlled distance first in one direction and then usually in opposite or reverse direction upon completion of an abrading operation. The control 36 also sends energizing current through conductors 38 to the solenoid of pinch valve 24 to effect its closing upon completion of an abrading operation; but otherwise during abrasive trimming the pinch valve 24 is held open.

The workpiece 10 shown in FIG. 6 is an electrical resistor having a thick, electrically resistive film 40 printed on a correspondingly shaped substrate and having a pair of terminals 42 joined to opposed parallel edges thereof. As shown, the resistor 10 has been trimmed between the lines designated by the letters A and C. Phantom line B indicates the point at which a stop and reverse signal was issued from the control 36; and the trimmed area lying between lines B and C represents the amount of film 40 trimmed by overshooting during the 5 milliseconds of elapsed time between issuance of the signal and the actual point of stopping. Broken line D represents the point at which abrasive flow ceased during reverse movement of the nozzle, approximately 20 milliseconds following issuance of the stop signal at B. It can be seen that abrasive material continues to flow as the nozzle travels from B to C and then in reverse direction from C to D.

Referring again to FIG. 5, a pair of probes 44 are connected during trimming between terminals 42 and control 36 by conductors 48 so that the electrical resistance of the resistor 10 can be continuously monitored by the control 36 as work proceeds.

The vibrator 22 may be connected as shown to the control 36 by conductors 46. The concentration of abrasive particles in the abrasive jet can be set by adjusting the amplitude of vibrations applied to the mixing chamber in direct relation to the desired abrasive capability of the jet since the cutting action of the abrasive stream corresponds to the abrasive concentration.

The holder or holding device 32 will now be described in detail while referring to FIGS. 1 to 4.

The holder 32 is preferably of metal construction and includes a generally rectangular plate 50 having a broad flat upper surface 52. Below the upper surface 52 and parallel thereto is a bore 54 extending through the plate 50 from one corner 56 to a diagonally opposite corner 58. The corners 56 and 58 may be squared so that their edges are normal to the axis of the bore 54.

The edges 60 and 62 of the plate 50 adjacent the corner 56 are stepped and provided with a marginal series of threaded holes 63, as shown, to conveniently receive a pair of abutment elements 64 having an L-shaped cross section. The abutment elements 64 are secured to the plate 50 by screws 65 and together comprise stationary structure having diverging edge portions 66 above the plate surface. The workpiece 10 is clamped against the edge portions 66 by a movable member 68, the latter having a flat edge portion 70 which is also nor-

mal to the axis of the bore 54. The member 68 is movable above the plate surface in a guiding slot 72 that is in alignment with the bore 54 by means of a rod 74. The rod 74 is slidably received in the bore 54 and connected to a handle 76. The member 68 is movable between and beyond its positions indicated in FIG. 2 by both broken and solid lines.

The member 68 is biased toward the abutment elements 64, in a path between them, by means of a spring 78. The spring 78 is received in a counterbore 80 of a tubular fitting 82. The fitting is secured by threads to the plate 50 at corner 56 and provides an extension of the bore 54. The spring 78 is interposed between the handle 76 and the plate 50 to bias the member 68 as described. Further provided is a finger grip 84 on the fitting 82 for convenient manual working of the handle 76, as with a thumb, in the manner of a plunger.

The edge portions 66 of the abutment elements 64 diverge at a right angular inclination to one another while facing in directions generally parallel to the top plate surface 52. The angular inclination is not restricted to a right angle, and it may be in the range of between an acute and an obtuse angular inclination suitable for receiving the workpiece 10. As shown, a right angular inclination is preferred since it conforms to the usual rectangular edge configuration of the workpiece 10, thereby ensuring proper positioning of each similar workpiece in the holder.

If desired, one corner of the workpiece 10 may be squared with the facing edge 70 of the movable member 68 in order to reduce the chances of malpositioning the workpiece. The arrangement provides for stable and secure three-point contact between the workpiece 10 and its clamping means.

The holder 32 of the present invention can accommodate workpieces of various sizes without modification, since the movable member 68 is retractable against its yielding spring bias within a wide range, providing more than ample clearance for insertion of the workpiece 10. With the contacting edges of the workpiece 10 and the abutment elements 64 in smooth condition there is little frictional resistance to relative sliding motion. Consequently, the workpiece 10 readily slides to desired position, after insertion loosely between the abutment

elements 64 and the member 68, as thumb pressure on the handle 76 is reduced and the biasing force of the spring 78 urges the workpiece to position through the member 68.

Although the invention has been shown and described as if a single holder 32 were mounted on the base of the abrading apparatus, it is to be appreciated that the invention is not restricted as such.

I claim:

1. The combination with abrading apparatus of a holding device for flat-sided workpieces, wherein the abrading apparatus comprises means including a supply conduit and a nozzle at one end of the supply conduit for directing a high-velocity stream of abrasive particles to said workpiece, comprising:
 - a. a plate having a broad flat surface between the edges thereof, further provided with a bore beneath the surface of said plate and parallel thereto,
 - b. structure secured to said plate having edge portions disposed above said surface, said edge portions diverging at a right-angular inclination to one another and facing in directions generally parallel to said surface,
 - c. a member movable in a path directed between the edge portions of said structure, above said surface toward and away from said structure, for clamping said workpiece between the edge portions of said structure and said member,
 - d. said plate being provided with a slot extending with said bore in the direction of movement of said member for guiding the movement of said member therein,
 - e. a handle adjacent an edge of said plate, with said structure being disposed between said handle and said member,
 - f. a rod in said connecting said handle and said member, and
 - g. means including a spring interposed between said handle and said plate biasing said member toward said structure for clamping said workpiece, said biasing means yielding to movement of said member away from said structure for the insertion of a workpiece therebetween.

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,577,682 Dated May 4, 1971

Inventor(s) Walter Kulischenko

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

┌ In column 1, line 65, "of" should be inserted after "trickle". ┐

In claim 1, column 4, line 33, "bore" should be inserted before "connecting".

Signed and sealed this 24th day of August 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents