

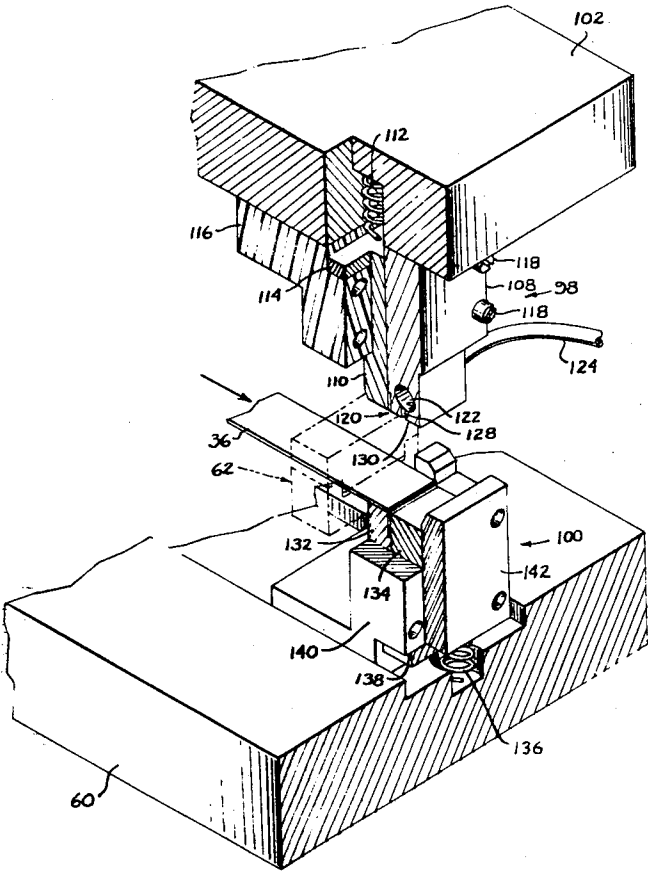
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[21] Appl. No. **801,114**
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[73] Assignee **Sylvania Electric Products Inc.**

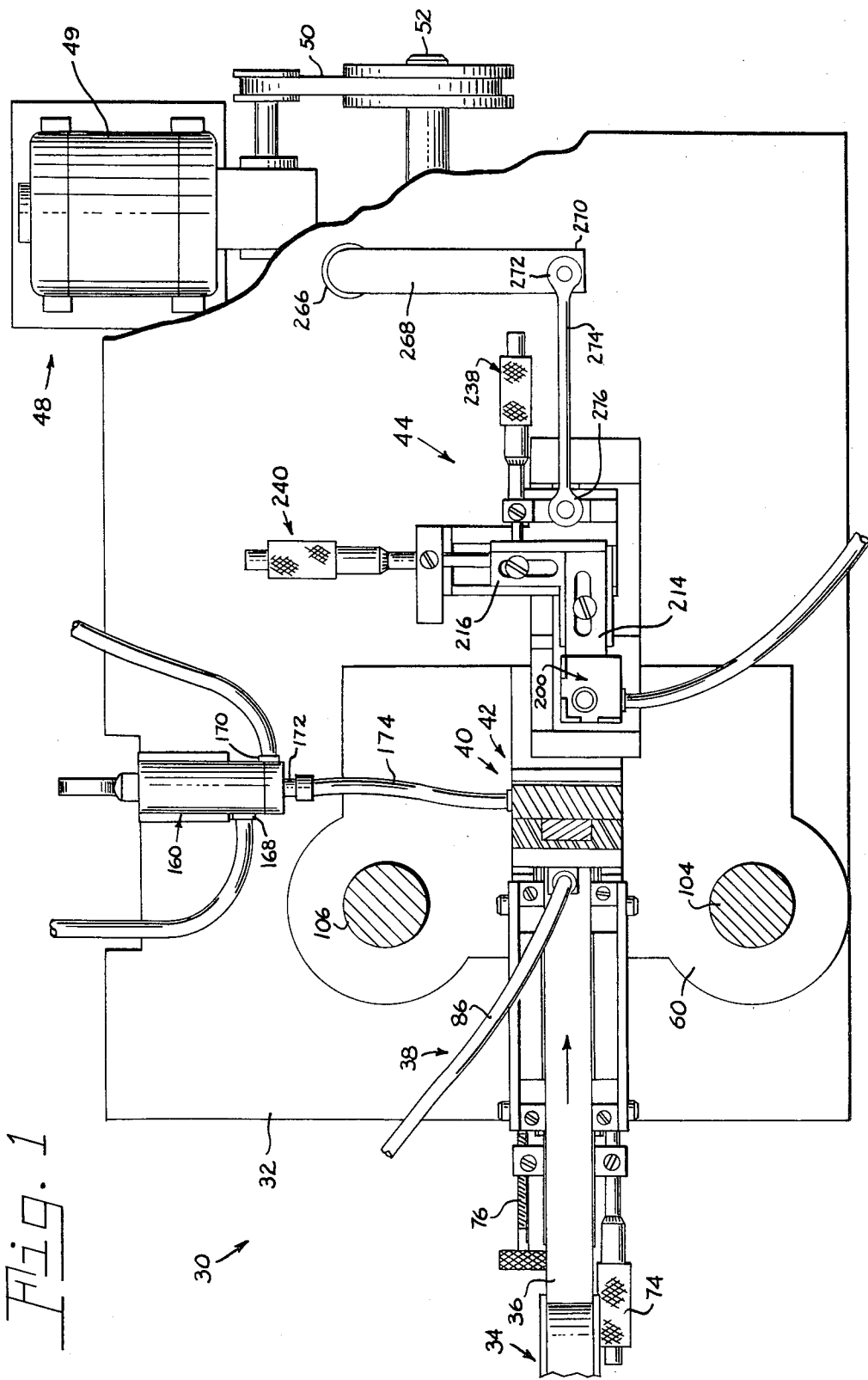
[54] **METHOD AND APPARATUS FOR CUTTING,
TRANSFERRING AND DEPOSITING SELF-
SUPPORTING STRIP MATERIAL**
1 Claim, 22 Drawing Figs.

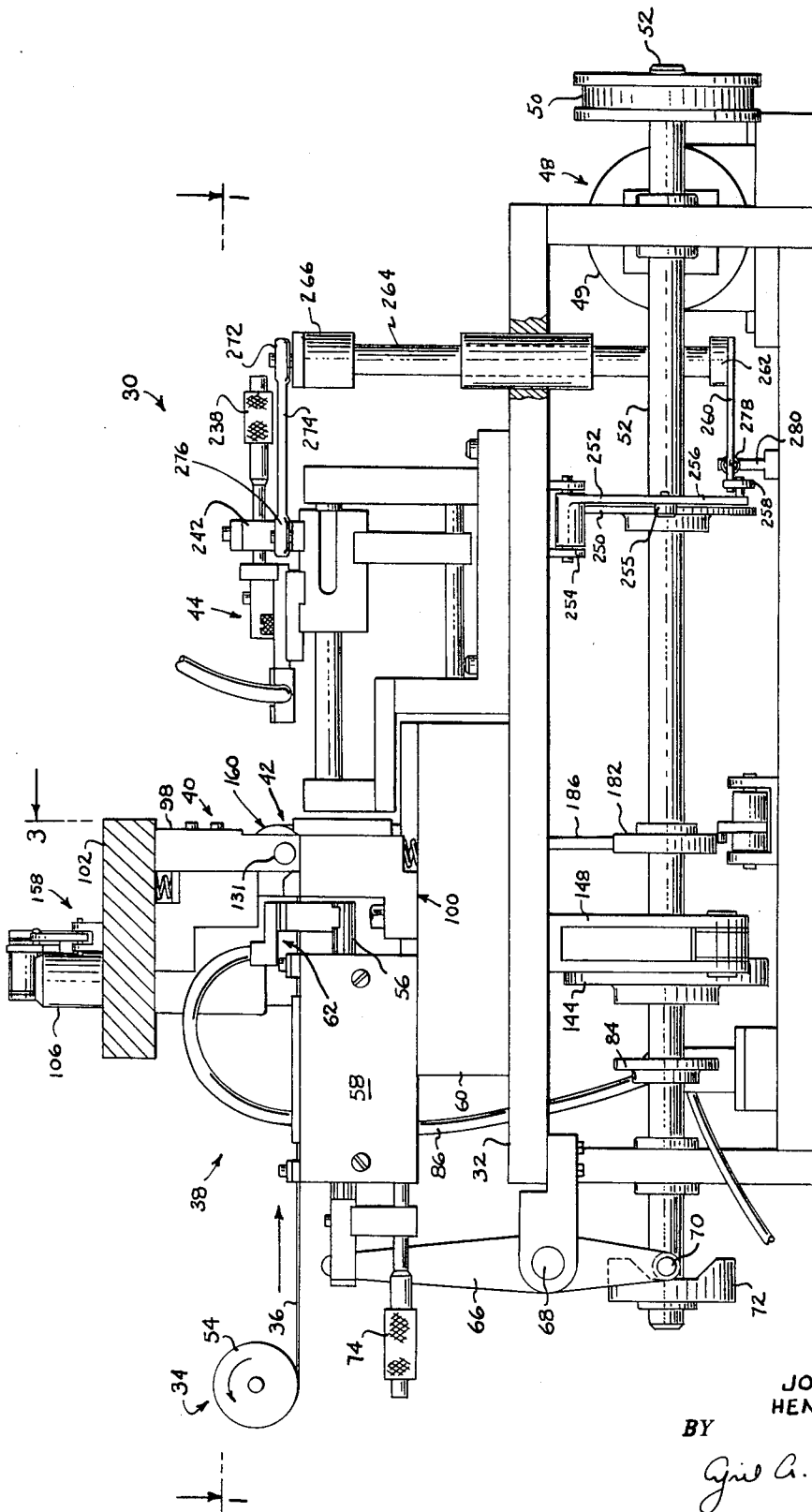
[52] U.S. Cl. **83/98,**
83/112, 83/152, 83/277, 83/282
[51] Int. Cl. **B26d 5/20,**
B26d 7/06
[50] Field of Search **83/152, 98,**
100, 277, 282, 112

[56] **References Cited**
UNITED STATES PATENTS
2,214,478 1940 Rosenthal 83/277 X
2,663,784 1953 Iversen 83/282 X
3,465,408 1969 Clark et al. 83/152
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ABSTRACT: Apparatus and method for performing the title functions with thick film resistor or capacitor material. The material is fed in discrete increments to a cutting head which severs selected portions and transports the same to a remote location where it is deposited across conductors formed on an insulating substrate.







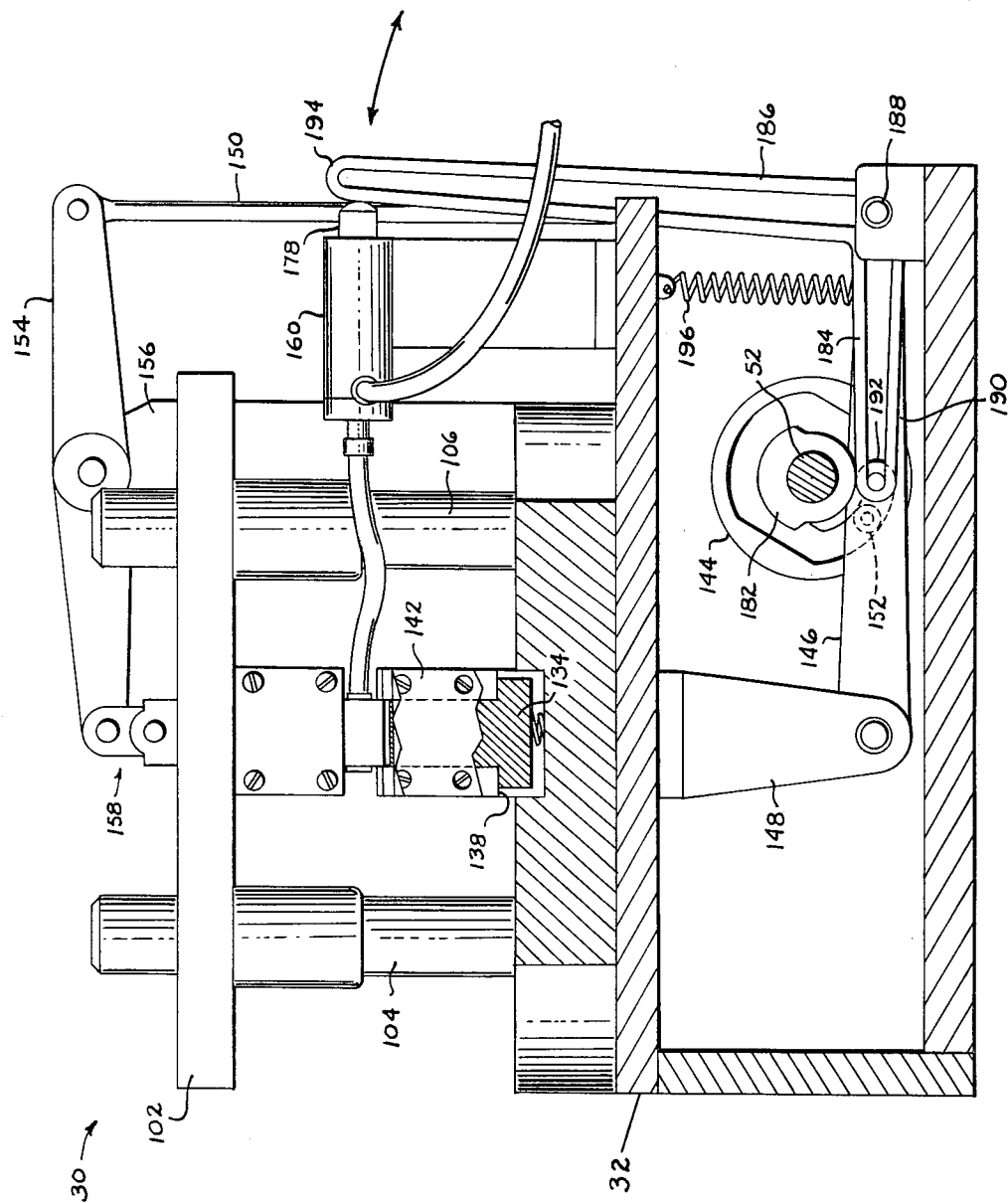


Fig. 3

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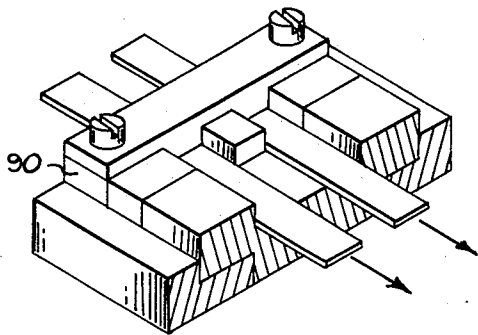


Fig. 5

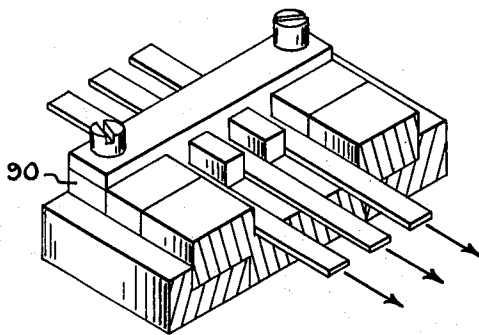


Fig. 6

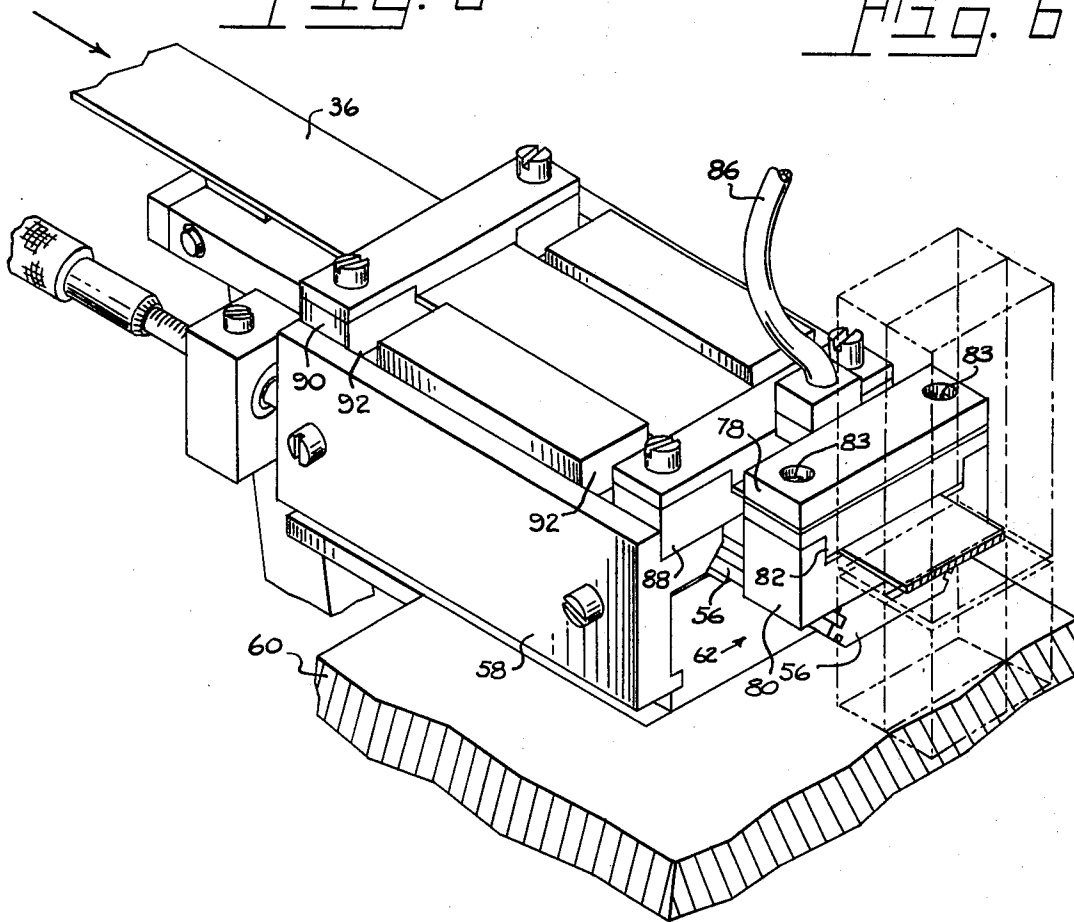


Fig. 4

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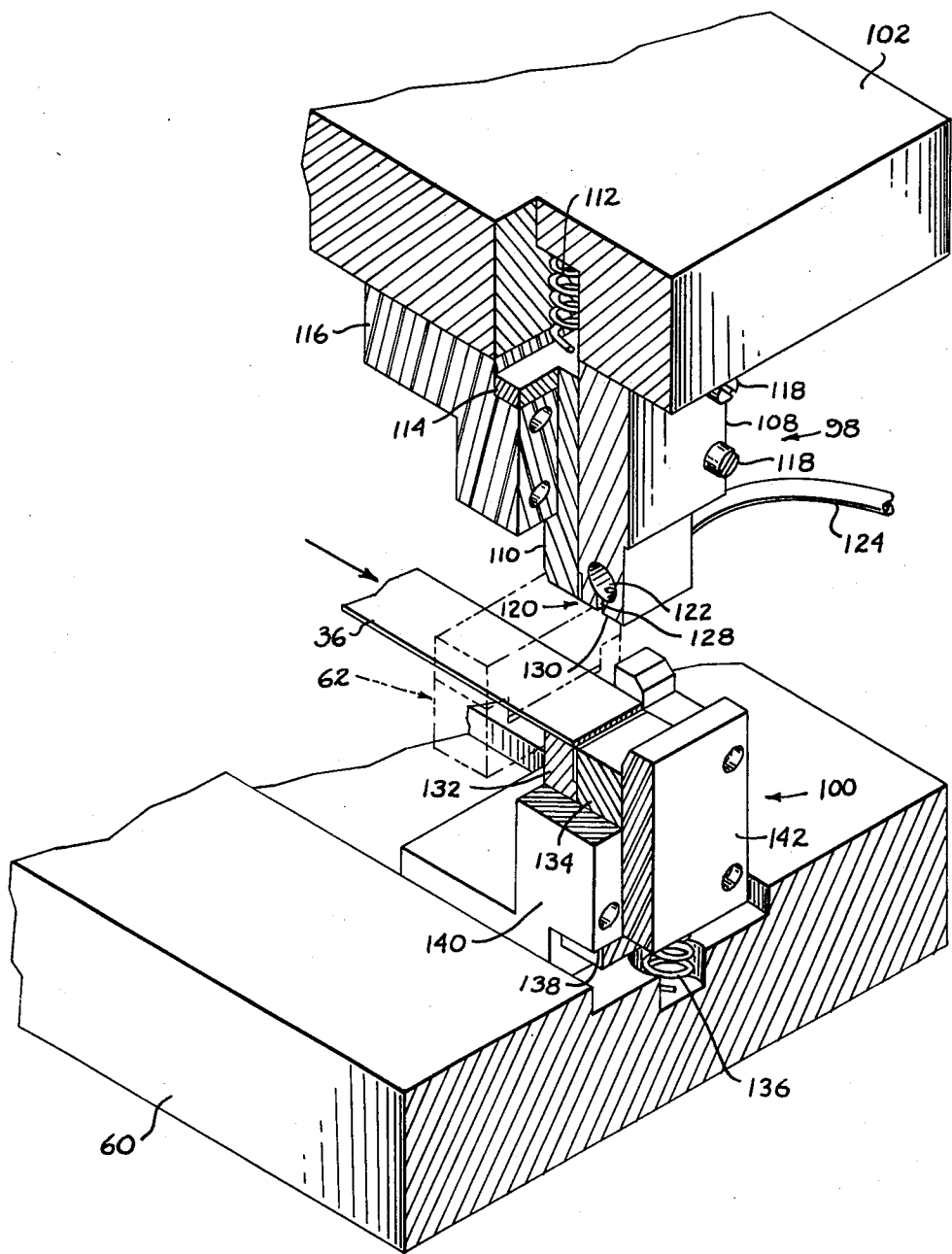
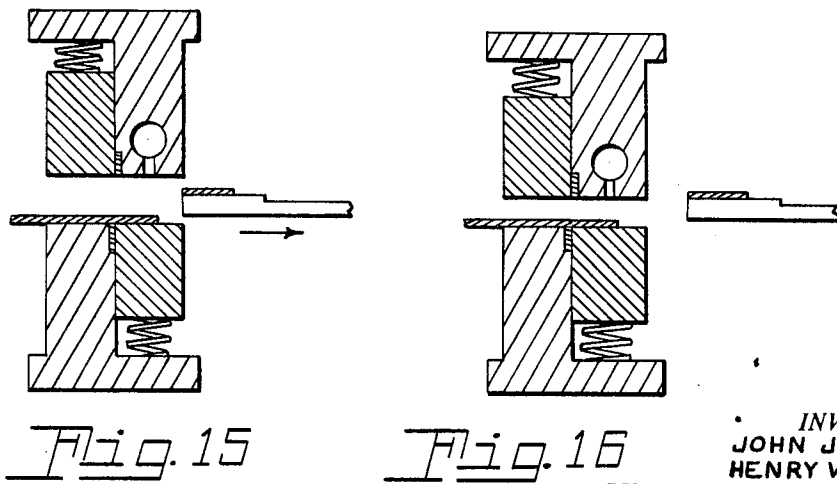
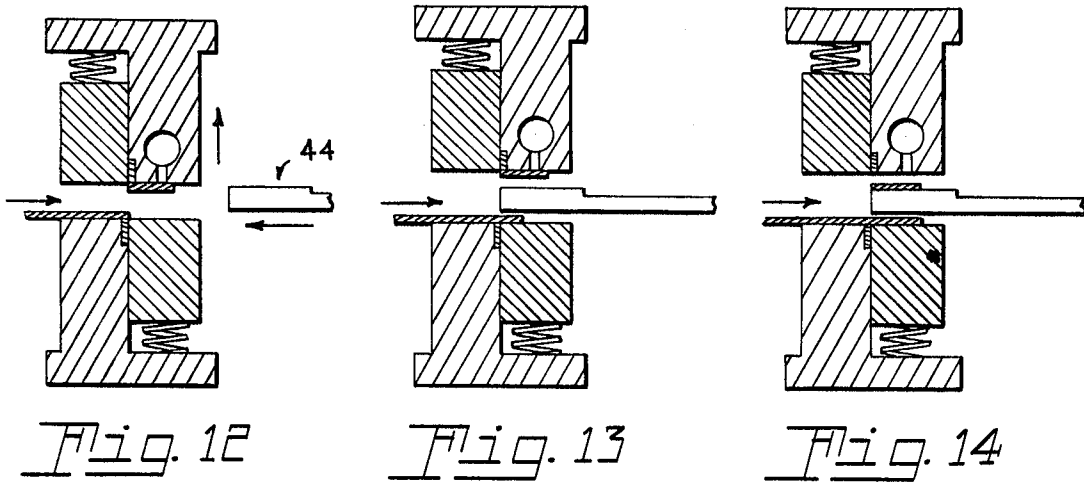
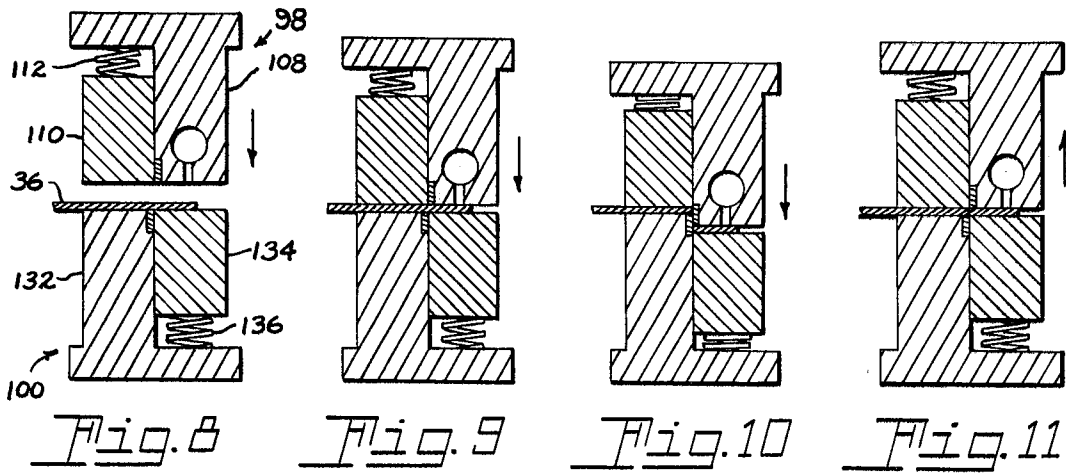


Fig. 7

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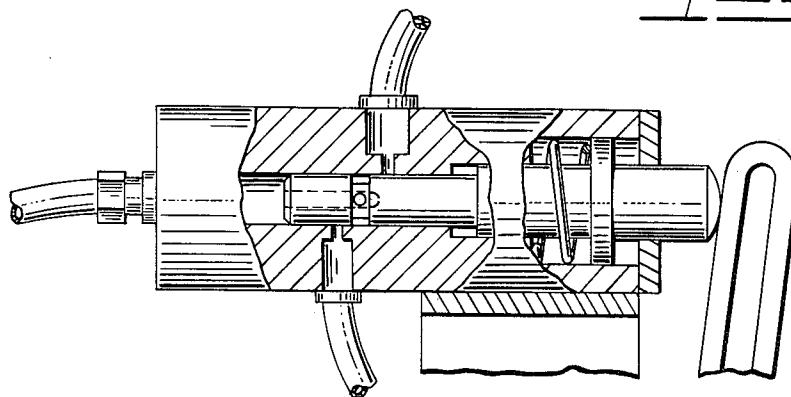
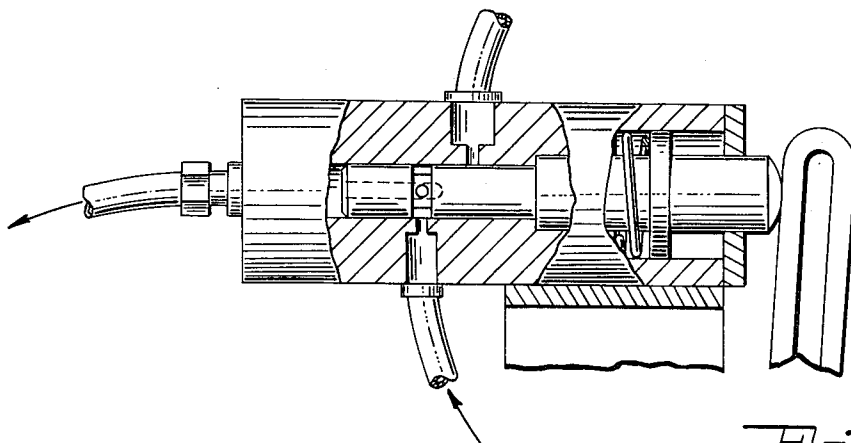
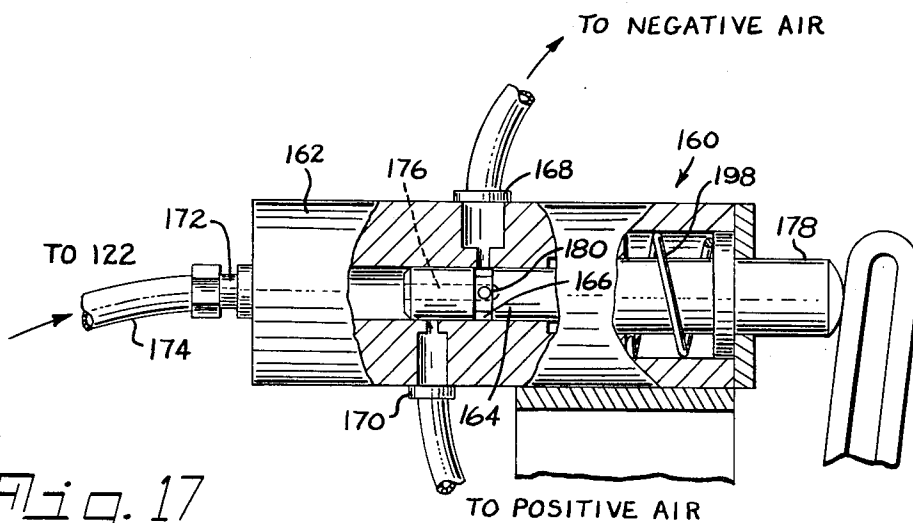
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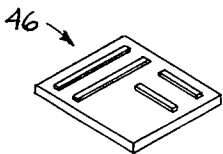
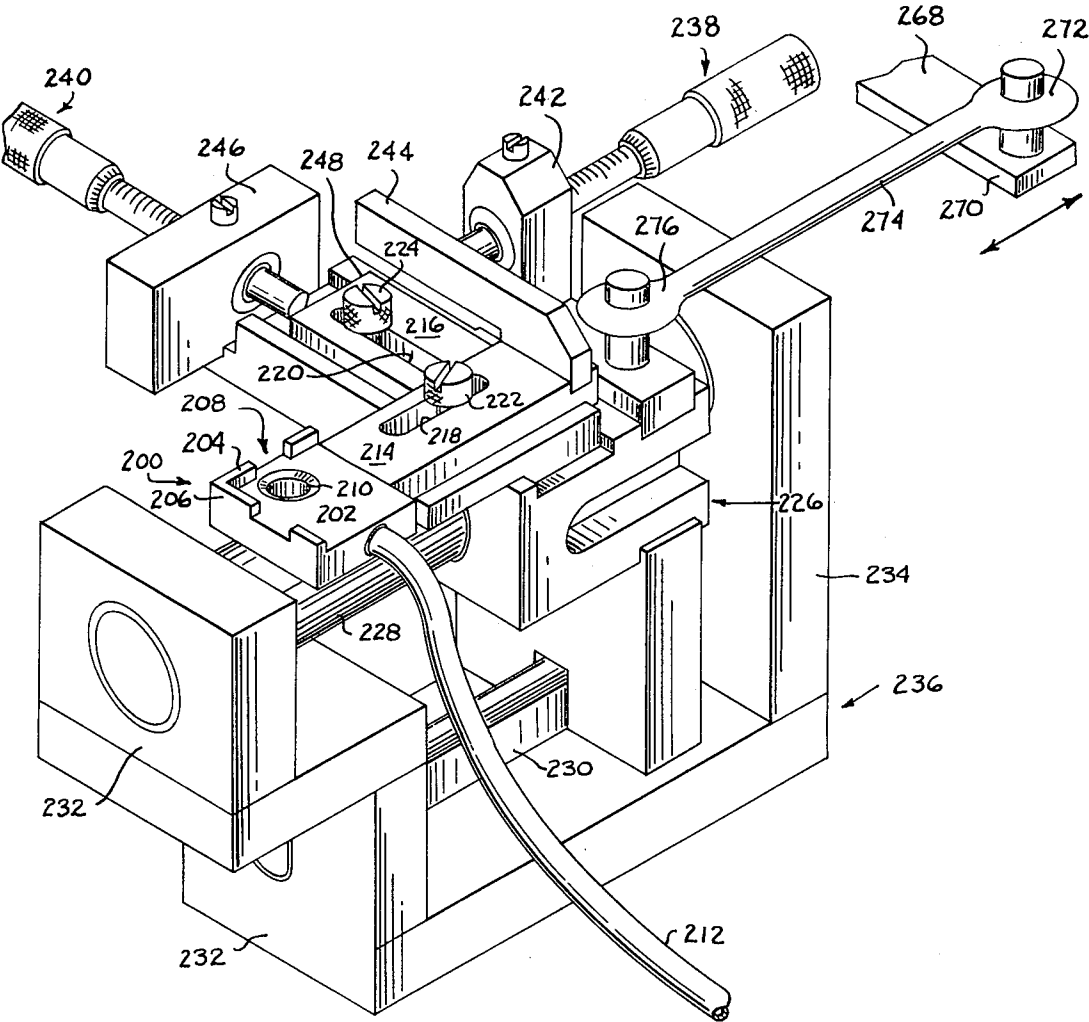


Fig. 20

Fig. 21

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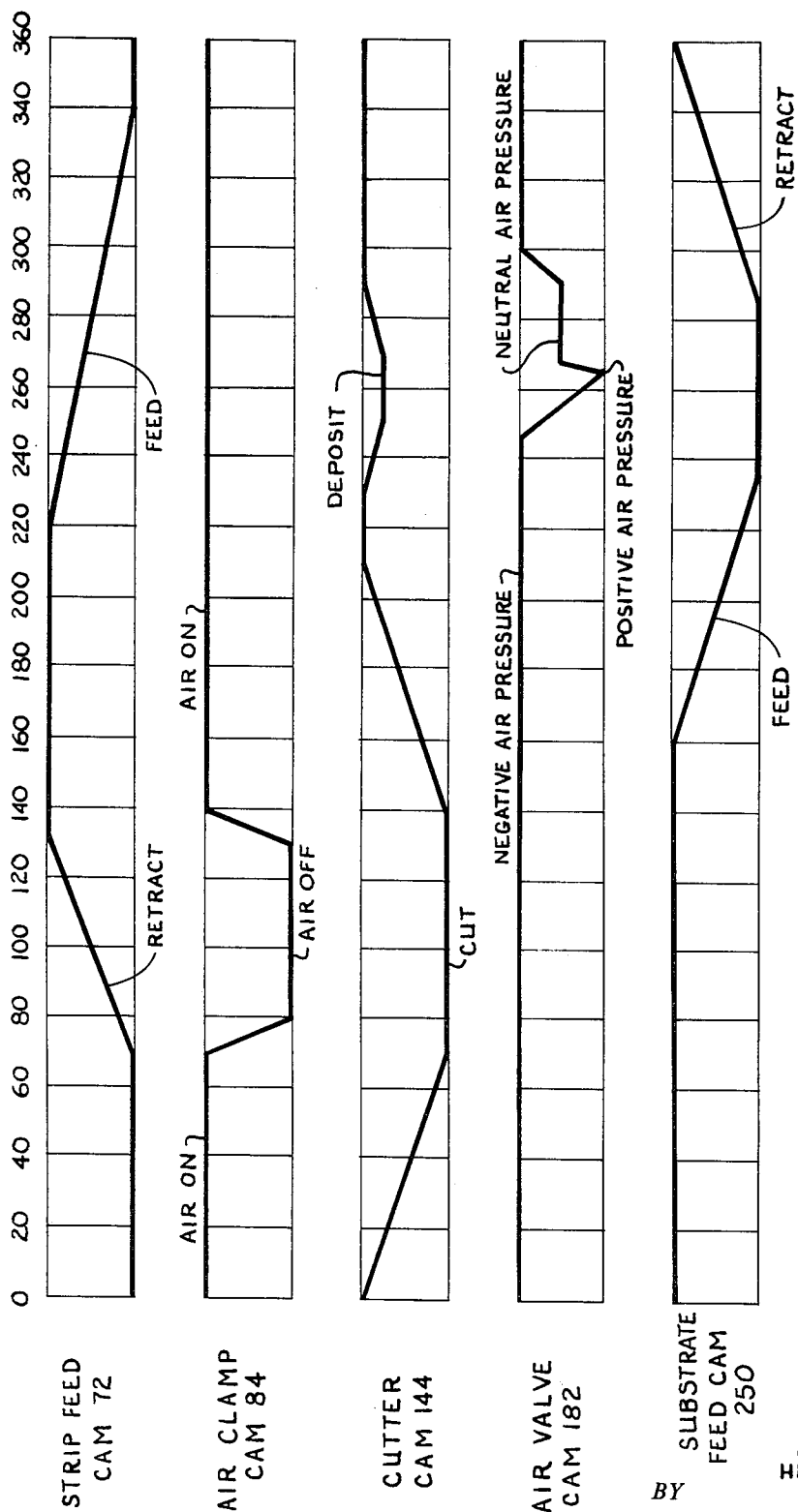


Fig. 22

BY
SUBSTRATE
FEED CAM
250

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METHOD AND APPARATUS FOR CUTTING, TRANSFERRING AND DEPOSITING SELF-SUPPORTING STRIP MATERIAL

BACKGROUND OF THE INVENTION

This invention relates to methods and to apparatus for handling self-supporting strip material and more particularly to methods and apparatus for cutting, transferring and then depositing self-supporting thick film electrical components such as resistors and capacitors.

The use of thick film electrical components materials is known in the electronic industry and has gained wide acceptance over the past few years in relation to the miniaturization of various electrical circuits. Generally, the prior art methods of applying thick film resistor materials have left much to be desired. The various techniques employed usually comprise suspending the resistor material in an organic binder and then silk-screening the resistor in the desired location upon an insulating substrate. The disadvantages of this technique stem from the lack of control of the amount of material being applied and thus the ultimate resistivity of the component. Other techniques utilized have been suspending the resistor material in an organic binder and by means of a brush simply painting the material in the desired location. This method has the same disadvantages as the silk-screening approach.

Some of these disadvantages have been obviated by a process of casting the thick film material in the form of a self-support strip material. This material is capable of extremely accurate controls as regards thickness and width, and thus the resistivity of a given segment of the material is far more accurately controllable than the prior art methods. However, disadvantages are also present with the current methods of utilizing the self-supporting thick film material. These are the ability to consistently cut the thick film material to accurate dimensions and the complexity involved in transferring the cut portion to a substrate. This, in the past, has been a hand operation and varied considerably depending upon the amount of skill of the operator.

OBJECTS AND SUMMARY OF THE INVENTION

It is therefore an object of the invention to obviate the above-cited disadvantages of the prior art.

It is another object of the invention to enhance the critical tolerances of thick film material.

Yet another object of the invention is to provide thick film material handling apparatus which is relatively inexpensive to operate.

It is a further object of the invention to provide apparatus and methods for feeding, cutting, transporting and depositing thick film material in a preselected location on a substrate automatically.

The above objects are carried out in one aspect of the invention in the provision of an apparatus for cutting, transferring and depositing self-supporting strip material which comprises generally a supply of the strip material and the means for advancing the strip material from the supply to a work station. Formed at the work station are cutting means for severing a selected portion of the strip. Transporting means are formed at the work station and associated with the cutting means for transporting the selected portion to a position remote from the work station for depositing the selected portion in a predetermined area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of one form of apparatus for utilizing the invention;

FIG. 2 is a front elevational view of the apparatus of FIG. 1;

FIG. 3 is a side elevational view partially in section taken along the line 3-3 of FIG. 2;

FIG. 4 is a partial perspective view of the strip-feeding means;

FIG. 5 is an alternate embodiment of strip-feeding means;

FIG. 6 is yet another alternate view of strip-feeding means;

FIG. 7 is a perspective view partially in section illustrating the cutting head of the apparatus;

FIGS. 8 thru 16 are diagrammatic sectional views illustrating the sequence of operation of the cutting head and the transfer mechanism;

FIGS. 17 thru 19 are elevational views partially in section illustrating the sequence of operation of the air control mechanism utilized with the invention;

FIG. 20 is a perspective view illustrating a method of substrate positioning and indexing;

FIG. 21 is a diagrammatic perspective view of one form of substrate which may be utilized with the invention; and

FIG. 22 is a cam chart illustrating the various sequence of operation of the distinct portions of the apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the above-described drawings.

Referring now to the drawings with greater particularity, there is shown in FIG. 1 an apparatus 30 for providing the functions of supplying, cutting, transporting and delivering a selected portion of strip material. Apparatus 30 comprises a base portion 32 having mounted thereon or adjacent thereto supply means 34 for strip 36, strip feeding means 38, strip cutting means 40, strip transporting means 42 and means 44 for carrying and indexing a substrate 46. Drive means 48 in the form of a motor connected by means of a drive belt 50 to a cam shaft 52 is also provided.

The strip supply for the strip material 36 is dependent upon the structure and material strength of the strip and may be, for example, a spool or reel 54 of the material. When the characteristics of the strip 36 are such that it is not suitable for rolling on a reel, then the strip may be in the form of elongated substantially flat sections, which may be supplied to the strip feed means in any suitable manner.

The strip feed mechanism 38, as shown in detail in FIGS. 1, 2 and 4, comprises a slide 56 mounted in a slideway 58 which in turn is mounted upon a supporting block 60. A selectively engageable advancing clamp 62 is mounted at one end of the slide 56. The opposite end of slide 56 is provided with slide moving means 64 which is formed for advancing said slide in a first direction and for retracting the slide in a second opposite direction. The slide advancing and retracting means comprises a lever arm 66 affixed at one end to slide 56 and having a pivot point 68 substantially intermediate the ends thereof and a cam follower 70 positioned at the other end thereof. The cam follower 70 engages a strip feed cam 72 which is mounted upon cam shaft 52. The amount of advance of the slide 56 is adjustable by means of a micrometer adjuster 74 and a locking screw 76. The selectively engageable strip advancing clamp 62 comprises upper and lower jaws 78 and 80 respectively. Lower jaw 80 is fixedly mounted upon slide 56. The upper jaw 78 through which strip 36 passes is journaled in a cutout portion 82 of lower jaw 80 and is slideable therein by means of aligning pins 83, which may be in the form of screws. The clamp 62 is air actuated and the actuation is controlled by means of a cam 84 which controls an air cylinder. A hose connection 86 is provided between the air cylinder and the clamp 62.

The strip 36 is guided from the supply 34 to clamp 62 by means of front and rear guides 88 and 90 respectively. The guide bars are mounted on the upper surface of slideway 58. Adjacent each of the guide bars is a slot 92 formed to accept an adapter for controlling the width and number of strips of tape being fed simultaneously. In FIG. 5 is shown a two-strip adapter 94 positioned in one of the slots 92. An identical adapter would be positioned in the other slot 92. In FIG. 6 is shown a three-strip adapter 96 positioned in one of the slots

92. With this arrangement three separate selected portions of strips may be cut and deposited simultaneously. While in each of the alternate embodiments shown the strips are all of equal width, it will be understood that this is exemplary only, and obviously the widths of the strips may be whatever is desired.

Referring now to FIG. 7, the cutting means 39 comprises a strip cutter 40 having upper and lower heads 98 and 100 respectively. The upper head 98 is mounted on the lower surface of a mounting plate 102 which, in turn, is reciprocatably mounted upon a pair of upright standards 104 and 106 (see FIGS. 1, 2 and 3). The lower head 100 is mounted upon the upper surface of supporting block 60.

Upper head 98 comprises a fixed member 108 and a tensioned movable member 110. The tension for member 110 may be provided by one or more springs 112 which urge member 110 downwardly against an appropriate stop 114 which may be formed in a first guide block 116 which is suitably slotted to accept member 110. The guide block 116 may be fixed to mounting plate 112. Fixed member 98 is mounted upon an appropriate surface of guide block 116 by means of bolts 118.

The lower portion of fixed member 108 contains strip transporting means 120. Means 120 comprises a horizontal air chamber 122 extending the length of member 108 which is connected by means of a hose 124 to a control valve 160 (FIGS. 17, 18 and 19). A plurality of apertures 128 connect the chamber 126 with the cutting face 130 which is formed on fixed member 108. An adjustable plug 131 (seen in FIG. 2) is also provided. Plug 131 fits snugly in chamber 122 and may be adjusted to control the number of apertures 128 through which air flows. The reason for this will be explained hereinafter.

Lower head 100 also comprises a fixed member 132 and a tensioned movable member 134. The tension for movable member 134 may be provided by one or more springs 136 which urge member 134 upwardly against an appropriate stop 138 which may be formed in a second guide block 140 which is suitably slotted to accept member 110. The second guide block 140 is fixed to support block 60. A cover plate 142 is fixed to guide block 140 and maintains the location of movable member 134 therein. The fixed and movable members of the upper and lower heads are so arranged that during contact of the heads the movable member 110 of upper head 98 contacts the fixed member 132 of lower head 100 and the fixed member 108 of upper head 98 contacts the movable member 134 of lower head 110. When contact between the heads is achieved, the fixed member 108 and movable member 134 cooperate to function as the strip cutting means 39 and the movable member 110 and fixed member 132 cooperate to function as a strip retaining clamp. During the operating cycle of the apparatus the strip retaining clamp formed by the head action cooperates with strip advancing clamp 62 to control the amount of strip material fed into the cutting means. This will be explained in more detail hereinafter.

The reciprocation of the upper head 98 is controlled through a cam 144 mounted on cam shaft 52 and suitable linkage. The linkage comprises a lever arm 146 pivotally mounted at one of its ends in a standard 148 and having a connecting rod 150 at its other end. A cam follower 152 is positioned intermediate the two ends of arm 146 for engagement with cam 144. The end of connecting rod 150 remote from arm 146 is pivotally fastened to a second lever arm 154 which is pivotally mounted substantially centrally of its length on a support 156. The end of second arm 154 remote from connecting rod 150 is fastened, through suitable linkage 158, to mounting plate 102.

The air supply to strip transporting means 120 is controlled by valve 160 (FIGS. 17-19) which will apply negative, positive, or neutral air to chamber 122. Valve 160 comprises a body 162 formed to accept a piston 164 having an air selection ring 166 formed thereabout. A vacuum source or supply of negative air is operatively connected to the body 162 by any suitable means such as a nipple 168. A source of positive air is also connected to the body 162 as by nipple 170. The two con-

nections must be spaced apart a given distance when measured along the longitudinal axis of the valve.

An outlet 172 is provided at one end of body 162. A hose 174 connects this outlet 172 to air chamber 122 of the strip transporting means 120. A longitudinally extending opening 176 is formed in one end of piston 164 and communicates with the air selection ring 166. The ring 166 is formed as a circumferential groove about piston 164. An end 178 of piston 164 projects outside of body 162 and connects to the operating mechanism for the valve.

When the piston is in the position shown in FIG. 17, it will be seen that air selection ring 166 communicates with the nipple 168 leading to the source of negative air. This negative air is applied to the chamber 122 via the aperture 180 in ring 166 to opening 176 in piston 164 and thence hose 174. When the piston 164 is in a more forward position, as in FIG. 18, it is the source of positive air through nipple 170 which is applied to air chamber 122. At the intermediate position, as in FIG. 19, the air selection ring 166 is not in communication with either nipple and the result is neutral air applied to air chamber 122. The reasons for this sequence of operation will be explained more fully hereinafter.

Valve 160 is controlled by cam 182 on cam shaft 52 and suitable connecting linkage. The linkage comprises a pair of substantially right-angled arms 184 and 186 pivotally mounted at their jointure 188. An end 190 of arm 184 is provided with a cam follower 192 for contacting cam 182. An end 194 of arm 186 contacts the end 178 of piston 164. Spring 196 is provided between arm 184 and base 32 to maintain cam follower 192 in contact with cam 182. A spring 198 is provided in valve body 162 for controlling the action of the piston.

The substrate carrier or holder 44 is adjustable in both an X direction and a Y direction so that a particular area of the substrate may be precisely located beneath the strip transporter 42 to receive the selected cut portion thereof. The carrier 44 comprises a nest 200 for the substrate 46 which nest is provided with a substantially flat surface 202 and at least portions of adjacent, upstanding sidewalls 204 and 206 on two sides of surface 202. Substrate holding means 208 is provided in nest 200 and may comprise an opening 210 in surface 202 which communicates via hose 212 to a vacuum source, not shown. The nest 200 is fixedly attached to a first adjustable slide 214 which is keyed in a second adjustable slide 216. The slide 214 is adjustable in an X direction (X being a direction parallel to the longitudinal axis of the machine or the direction in which cam shaft 52 extends, and Y being a direction transverse thereto) and the slide 216 is adjustable in a Y direction. Adjustment may be accomplished by means of appropriately extending slots 218 and 220 respectively and locking screws 222 and 224 respectively. The second slide 216 is keyed in a supporting block 226 which is mounted for movement in an X direction by means of dual guiding bars 228 and 230. The ends of bars 228 and 230 are journaled in upright, spaced apart, supporting walls 232 and 234 of fixed bracket 236. The positioning of slides 214 and 216 is accomplished by means of micrometer adjusters 238 and 240 respectively. Micrometer adjuster 238 is mounted in a suitable block 242 fixed to supporting block 226 and contacts an offset tongue 244 mounted on slide 214. Micrometer adjuster 240 is mounted in a suitable block 246 fixed to supporting block 226 and may directly contact the end 248 of slide 216.

The movement of the nest 200 is controlled by a cam 250 mounted on cam shaft 52 and suitable linkage. The linkage comprises a depending arm 252 mounted at one end for pivoting movement in a bracket 254 fixed to the bottom of machine base 32. A cam follower 255 is positioned intermediate the ends of arm 252. The other end 256 of arm 252 is attached to a first end of a transversely extending connecting link 258. The second end of link 258 is attached to the first end of a longitudinally extending bar 260 which as its second end fixedly attached to the base 262 of an upright rotatable rod 264. The upper end 266 of rod 264 projects through machine base 32 and has fixed thereto a transversely extending bar 268. The

free end 270 of bar 268 is attached to a first end 272 of a connecting link 274 which has its second end 276 attached to supporting block 226. Thus rises and falls on cam 250 are transmitted through the cam follower 255 to the end of arm 252, and translated into transverse movement of connecting link 258, longitudinal movement of bar 260, rotative movement of rod 264, transverse movement of bar 268, and longitudinal movement of link 274 which is attached to block 226. Cam follower 255 maintains its contact with cam 250 by means of a spring 278 fixed to bar 260 and a base mounted post 280.

For a better understanding of the operation of the invention a description of one cycle of operation is herewith rendered, with particular application to FIGS. 8—16 and the cam chart of FIG. 22.

To set up the machine a substrate 46 is placed in nest 200. Locking bolts 222 and 224 are loosened and the proper location of the substrate is established by the micrometer adjusters 238 and 240. This location of the substrate will, of course, depend upon where the conductors are and where the selected portion of the strip is to be placed. When this is established the locking bolts 222 and 224 are tightened to maintain this location.

Next, the proper width of strip to be cut is determined (the length is determined by the preformed strip being fed to the machine) and the proper amount of feed is set up by the micrometer adjuster 74 which cooperates with slide 58. When this is accomplished, locking screw 76 is moved into position and the micrometer adjuster 74 is backed off to avoid damage thereto.

To begin the cycle it will be assumed that a strip feed has already taken place and the equipment is in the position shown in FIG. 8 (the 0° mark on the cam chart of FIG. 22). The upper surface of substrate 46 is coated with an organic cement to hold the strip when it is placed in position. Mounting plate 102, carrying with it upper cutting head 98, begins to descend through the action of cam 144 and its associated linkage. At this time strip advance clamp 62 is energized and negative air is being applied to air chamber 122. The head 98 descends through the positions shown in FIGS. 9 and 10 with the movable member 110 of head 98 contacting the fixed member 132 of lower head 100 thus clamping the strip therebetween and forming the strip retaining clamp. While the strip retaining clamp is actuated, the air to strip advancing clamp 62 is turned off thereby releasing the same and the strip feed slide 58 is retracted to a new position by the action of cam 74 and its associated linkage. The distance of retraction by the slide 58 will be equal to the amount of strip material to be fed to the next cycle. The head 98 continues to descend and the fixed member 108 thereof depresses the movable member 134 of lower head 100, this action severing the selected portion of the strip. After completing its downward travel head 98 begins to rise. At this time clamp 62 is again energized so that at no time is the strip free of a clamping action. As head 98 rises it carries with it the selected cut portion of the strip, maintained against the cutting face 130 of fixed member 108 by virtue of the negative air being applied to the air chamber 122.

During the rise of head 98 the substrate 46 in nest 200 starts to be indexed under the head 98 (see FIG. 12). This action continues until the substrate is positioned under head 98. Shortly before the substrate reaches its final position, head 98 begins a partial descent to carry it to a level close to but not touching the substrate. Simultaneously cam 74 has begun the feed of a new segment of strip. As head 98 reaches its lower position and the substrate 46 is in its final position, air valve cam 182 actuates valve 160 and causes piston 164 to assume the position shown in FIG. 18. This position is assumed only

for a fraction of a second and allows a puff of positive air to blow the cut portion of the strip down onto the substrate. After the puff of air, cam 182 returns piston 164 to the intermediate or neutral air position shown in FIG. 19. The piston remains in the neutral position until head 98 has returned to its full up position, after which the negative air is again applied. The absence of negative air for this period of time is to prevent the occurrence of any organic cement being sucked from the substrate surface; a condition that could clog the apertures 128. After head 98 has returned to its up position, the substrate and its nest retract to their original position. During this time the strip feed has been completed. With the substrate retracted and the cut portion of strip in place, the substrate is removed from the nest and a new coated substrate placed therein and the cycle is ready to be repeated.

Thus, it will be seen that this invention obviates many of the disadvantages of the prior art. The resistivity or conductivity of the material is controlled by the accurate cutting of the selected portions of the strip. The location of the strip on the substrate is also controlled, thus reducing operator error. The apparatus is relatively inexpensive to produce and operate which reduces the cost of the finished product.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined by the appended claims.

We claim:

1. An apparatus for cutting, transferring and depositing self-supporting strip material comprising: a supply of said strip; means for advancing said strip from said supply to a work station, said advancing means comprising a slideway, a slide mounted operatively with said slideway, a selectively engageable strip advancing clamp mounted upon said slide for clamping said strip, guide means for said strip mounted upon said slideway, means for actuating said strip advancing clamp into clamping relationship with said strip; a strip retaining clamp and means for operating said strip retaining clamp in sequence with said strip advancing clamp, and means operable upon said slide for moving said slide in a first direction with said advancing clamp engaged and said retaining clamp disengaged and in a second direction with said retaining clamp engaged and said advancing clamp disengaged; cutting means at said work station for severing a selected portion of said strip, said cutting means comprising upper and lower heads each of which has a fixed member and a tensioned movable member, and means for providing relative contact achieving movement between said upper and lower heads, said fixed and movable members of said heads being so arranged that during said contact of said heads said movable member on said upper head contacts the fixed member of said lower head and said fixed member on said upper head contacts said movable member on said lower head; means associated with said cutting means for transporting said selected portion to a position remote from said work station, said transporting means comprising a plurality of apertures formed in the cutting face of said fixed member of said upper head and communicating with an air chamber formed therein, a valve for sequentially applying negative, positive and neutral air pressure to said chamber, means for connecting said valve to said chamber, means for operating said valve, and means connected to said valve supplying thereto positive and negative air pressure, said chamber being provided with adjustable means for regulating the air-flow among said plurality of apertures; and means for depositing said selected portion in a predetermined area.