

PATENT SPECIFICATION

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(54) PROCESS AND APPARATUS FOR PREPARATION OF ELECTRONIC COMPONENTS WEB CARRIER

(71) We, TOKYO DENKI KAGUKA KOGYO KABUSHIKI KAISHA a Japanese Body Corporate, of 13-1, Nihonbashi 1-chome, Chuo-Ku, Tokyo-to, Japan, formerly of 14-6, Uchikanda 2-Chome, Chiyoda-Ku, Tokyo-to, Japan, do hereby declare the invention for which we pray that a Patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:-

The present invention relates to a process and an apparatus for the preparation of an electronic component-bearing web carrier comprising a plurality of electronic components, such as condensers, arranged and held in a line.

We have previously proposed an electronic component web carrier comprising a great number of electronic components of the parallel lead type, such as condensers, arranged at equal intervals on a long support band, by which manufacture, storage, transportation and automatic insertion of these electronic components can be facilitated. An embodiment of such an electronic component web carrier is illustrated in Figure 1.

In Figure 1 an electronic component 70 such as a condenser comprises an electronic element 71 and two parallel lead wires 9'. A plurality of electronic components 70 are attached to a long support band 11 by means of an adhesive tape 86 to form a web carrier 75. Reference numerals 101 designate openings in the band for use for positioning and transportation thereof. When electronic components 70 are inserted in a printed circuit board by using an automatic inserting machine, respective electronic components must be separated from the web carrier 75. According to one conventional method, the lead wires are cut along line A-A in Figure 1, and electronic components are taken out and fed to the inserting machine. However, if the accuracy of spacing between two parallel lead wires maintained at the time of manufacture is low, then at the time when the electronic components have been cut and separated, the space between lead wires is very variable. This is important because the lead wires 9' of the separated electronic component

70 are inserted into holes formed on a printed circuit board 77 by the automatic inserting machine as shown in Figure 2, and the ends of the lead wires are cut along line B-B and bent as shown in Figure 3. The printed circuit board 77 is gripped between the thus bent portions and stoppers 100 formed in advance on parts of the lead wires 9' by deforming processing. Thus, insertion and attachment of the electronic component is completed. Clearly, in order to facilitate the above insertion operation, a high dimensional accuracy should be maintained with respect to the space between lead wires 9'. However, according to the conventional method, since it is difficult to maintain a high accuracy, the insertion operation cannot be performed smoothly, and, each time the insertion is not carried out satisfactorily, the operation of the inserting machine has to be stopped and removal of the defective component or other measure effected. Therefore, automation and speed of the operation of inserting electronic components into printed circuit board cannot be attained.

In accordance with a first aspect of the present invention, there is provided a process for the preparation of an electronic component web carrier including the steps of:

forming a U-shaped wire having a pair of arms extending parallel to each other to constitute lead wires;

continuously feeding a support band during the entire process;

feeding said U-shaped wire onto said support band;

fixing said U-shaped wire firmly to said support band by means of an adhesive tape with a predetermined spacing between said parallel lead wires of said U-shaped wire, and connecting an electronic component element at the free ends of said parallel lead wires.

According to a further aspect of the present invention there is provided an apparatus for the preparation of an electronic components web carrier comprising support band feeding means for continuously feeding a support band during the entire preparation;

wire forming means for forming from a con-

tinuous wire a U-shaped wire having a pair of arms extending parallel to each other to constitute lead wires, said wire forming means including feeding means for feeding the formed U-shaped wire onto said support band;

fixing means for fixing said U-shaped wire on said support band by means of an adhesive tape;

dimension-controlling means for ensuring a predetermined spacing between said parallel wires of said U-shaped wire during fixing of said wire on said support band, and

synchronizing means for synchronizing the feed of said U-shaped wire with the feed of said support band.

Embodiments of the apparatus of the present invention will now be described by way of example only, by reference to Figures 4 to 24 of the accompanying drawings, in which:

Figure 4 is a plan view of a preparation apparatus;

Figure 5 is a front view showing a swinging mechanism for the synchronizing apparatus;

Figure 6 is a plan view showing a power transmission mechanism;

Figure 7 is a front view showing a support band feed roll;

Figure 8 is a front view illustrating a support band feed device;

Figure 9 is a front view showing a device for feeding the wire by a predetermined constant length;

Figure 10 is a plan view showing the top end portion of a wire forming and feeding device;

Figure 11 is a side view showing the section taken along the line I—I of Figure 4;

Figure 12 is a plan view showing a state where the wire is formed to have a U-shaped shape;

Figure 13 is a plan view showing a state where the formed wire is pushed out;

Figure 14 is a front view of the state illustrated in Figure 13;

Figure 15 is a plan view illustrating a state where lead wires are controlled by tools;

Figure 16 is a front view of the state illustrated in Figure 15;

Figure 17 is a front view showing a section taken along line II—II of Figure 13;

Figure 18 is a sectional front view showing a state where adhesive tape is pressed by a roller;

Figure 19 is a plan view showing the state illustrated in Figure 18, and also showing formation of crossing portions and stoppers in lead wires;

Figure 20 is a sectional front view illustrating a state where tools are raised again;

Figure 21 is a plan view of the state illustrated in Figure 20;

Figure 22 is a plan view showing another embodiment of a tool device;

Figure 23 is a front view showing a section taken along line III—III of Figure 22 and

Figure 24 is a front view showing a section

taken along line IV—IV of Figure 22.

Referring firstly to Figure 4, a feed roll 2 having a support band 11 wound thereon and a spool 4 having a continuous wire 6 wound thereon, are each rotatably mounted on a machine body 1, and a wire-straightening means 5, a device 7 for feeding the wire by a predetermined constant length, a wire cutter 8 and a wire-forming and-feeding device 3 are disposed in series away from the spool 4. A support band guide rail 10 and a formed wire-fixing rail 13 for fixing the wire to the support band 11 are disposed in series away from the feed roll 2. Further away and also in series, a support band feed device 14 is disposed to impart a feeding action to the support band 11 continuously without stoppage. The wire-straightening means 5, the predetermined length wire feed device 7, the cutter 8, the wire-forming and-feeding device 3, the rails 10 and 13 and a dimension-controlling tool device 79 constitute a synchronizing apparatus 22, and are mounted on a swinging stand 22a to perform feeding of the formed wire and feeding of the support band synchronously with each other. A reciprocal movement is given to the synchronizing apparatus 22 at a speed relative to the speed of the continuously fed support band 11 such that during the forward movement of one reciprocal movement of the synchronizing apparatus 22, the relative speed of the apparatus 22 and the band 11 is arranged to be zero. This reciprocal movement is produced by a crank movement (see Figures 5 and 6). In Figures 5 and 6 rotation transmitted to a driving shaft 61 from a motor 64 is converted to a reciprocal movement of a connecting rod 25 by connecting rods 26' and 26, and a reciprocal movement of the synchronizing apparatus 22 on the swinging stand 22a is thus obtained. This reciprocal movement is arranged so that it is in harmony with the transportation direction and feed speed of the support band 11.

Referring again to Figure 4, the wire 6 is cut into predetermined lengths of wire 9 by the cutter 8 of which is formed into a U-shaped starting lead wire (Figure 10) and fed into the wire-fixing rail 13 by the wire-forming and-feeding device 3. The lead wire is deformed at a part in the vicinity of the top end by a mould tool 68 (Figure 11) while the space between the lead wires is controlled by the dimension-controlling tool device 79. The formed wire 9' is arranged on the support band 11 in synchronization with the feed speed of the support band 11 (Figure 12), and simultaneously, an adhesive tape 86 is pressed to the formed wire 9' by a roller 94 (Figure 14) of the tool device 79 so that the formed wire 9' is attached to the support band 11. During one cycle of formation of the wire by the wire-forming and-feeding device 3, the synchronizing apparatus 22 completes one reciprocal movement, and thus, formed wires 9' are equidistantly arranged on the support band 11.

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A frame rod 23 is mounted on the feed roll 2 as shown in Figure 7 so that the wound support band 11 is precisely fed out, and the taken-out support band 11 is introduced to the support band guide rail 10 (in Figure 4, the support band 11 is not illustrated after the entrance of the rail so that the illustrated structure can easily be seen). After the formed wire 9' on the formed wire-fixing rail 13 has been attached to the support band 11 by the adhesive tape, transportation holes are formed on the support band 11 through the adhesive tape by a perforating device 12 before it arrives at the support band device 14. This perforating device 12 forms holes at predetermined pitches on the support band 11 synchronously with the driving of the support band feed device 14, for example, by using punching means making a reciprocal movement in the vertical direction. Various devices are known in the art for this purpose, and hence, detailed illustration of the perforating device 12 is omitted.

In the foregoing embodiment, the perforating device 12 is synchronized with the support band feed device 14 so that holes are formed at precisely positioned intervals in the longitudinal direction and along the transverse midpoint of the support band equidistantly between lead wires of adjacent electronic components, as shown in Figure 1. If one hole is thus formed between two adjacent electronic components on the support band 11, the operation of inserting the electronic components of the resulting web carrier one by one into a printed circuit board by an automatic inserting machine can be markedly facilitated.

The support band feed device 14 comprises, as shown in Figure 8, a feeding member 15 such as an endless chain arranged about wheels 29, such as sprockets, one of which is mounted on a rotary shaft 30 connected to a driving shaft 59. The feeding member is provided with a click member 31 comprising a plurality of projections spaced longitudinally on the feeding member. Each projection of the click member 31 is arranged to engage with a hole formed on the support band 11 by the perforating device 12 so as to feed out the support band 11 and guide the support band 11 to a take-out rail 21 through the cutting device 17 (Figure 4).

The continuous wire 6 wound on the spool 4 is arranged so that it can readily be guided to the straightening means 5 by a reel 16 separately disposed (Figure 4). By means of the device 7 for feeding a predetermined length of wire (Figure 9), a predetermined length of the continuous wire is pulled out; and when the wire 6 is fed to the wire forming and feeding device 3, it is cut by the cutter 8 and supported by a wire holding mechanism 34 (Figure 10).

The wire-straightening means 5 may have a structure in which a plurality of rollers are alternately arranged so that the wire 6 is

passed through these rollers and is repeatedly curved, whereby the wire 6 is straightened. Such mechanisms are customarily used and well known in the art. Accordingly, detailed illustration of this mechanism will be omitted.

Any suitable mechanisms can be used in the present invention as the cutter 8, and hence, detailed illustration of the cutter 8 will be omitted as well.

The wire holding mechanism 34 includes wire supporting members 34a and 34a' each having a horizontal U-shaped groove as shown in Figures 10 and 17, and the continuous wire 6 is introduced in this U-shaped groove. Both the ends of the cut wire 9 from the cutter 8 are held at a predetermined position by said wire supporting members 34a and 34a' of the wire holding mechanism 34.

The straightening means 5, predetermined length wire feed device 7 and cutter 8 are disposed in a line on the swinging stand 22a of the synchronizing apparatus 22, and the wire holding mechanism 34 is also disposed on this wire and the wire-forming and-feeding device 3 is arranged to undergo reciprocal movement in a guide 80 on the synchronizing apparatus 22 in a direction at right angles to the supported wire 9. The rail 10 for guiding the support band 11 and the rail 13 for fixing the formed wire 9' on the support band 11 are disposed in series, parallel to a path of travel of the wire 6, and the support band feed device 14 is mounted on the machine body 1 in series with the rails 10 and 13 on the machine body 1.

The wire forming and feeding device 3 includes the wire holding mechanism 34 and outer and inner moulds 32 and 33 as the wire-curving means for forming the wire 9 cut in the predetermined length to have a U-figured shape. The device 3 further includes a transporting member 24 for feeding the formed wire 9' to the rail 13 on which the support band 11 is present. For this feeding and transportation, there may be used a mechanical system including a crank 42 as shown in Figure 11 or, alternatively, a known driving mechanism utilizing air pressure or hydraulic pressure.

In Figure 4, reference numeral 18 designates a connecting rod, reference numeral 19 designates a cutter for cutting the support band 11 to a predetermined length and reference numeral 20 designates a spring. In Figure 5, reference numerals 25, 26 and 26' designate connecting rods for driving the synchronizing apparatus 22, reference numeral 27 designates a supporting stand for the connecting rod 26 and reference numeral 28 designates a guide for guiding the reciprocal movement of the synchronizing apparatus 22. In Figure 10, reference numeral 35 designates the forming face of the mould 32, namely a concavely grooved bottom face formed on the outer mould 32. In Figure 9, reference numeral 36 designates a press feed roll of the device 7 for feeding the wire by a predetermined constant length, refer-

ence numeral 37 designates an adjustment screw, reference numeral 38 designates a pressure-adjusting spring, and reference numerals 39 and 40 designate roll-supporting stands.

5 In Figures 6 and 11, reference numeral 41 designates a main driving shaft acting as a driving power-transmitter for the operation of feeding the formed wire 9' toward the support band 11, the operation of swinging the synchronizing
10 apparatus 22 and the operation of reciprocal movement of the wire-feeding and-forming device 3. Reference numeral 42 designates a crank plate, reference numerals 43 and 44 designate gears, reference numeral 45 designates a cam, reference numeral 46 designates a cam lever, reference numeral 47 designates a striker, reference numeral 48 designates a crank lever, reference numerals 49 to 52 designate connecting levers, reference numeral 50 designates a pin (Figure 4), reference numeral 51 designates a supporting plate, reference numeral 53 designates an anchoring pin, reference numerals 54 and 55 designate pivoting pins, reference numeral 56 designates a crank pin, reference numeral 57
25 designates a pusher, reference numeral 58 designates a supporting stand, reference numeral 59 designates a driving shaft, reference numeral 60 designates a roller, reference numeral 61 designates a driving shaft, reference numeral 62 designates a crank plate, reference numerals 63 and 63' designate bevel gears, and reference numeral 64 designates a motor as the driving source.

35 As shown in Figures 10, 11 and 17, the outer mould 32 makes a reciprocal movement integrally with the wire-forming and-feeding device 3, and the inner mould 33 is supported on a bracket 81 on a guide 80 by a pin 67 so that it can freely swing and the inner mould 33
40 is operated in the vertical direction by means of a cylinder 82. As shown in Figures 11 and 17, the transporting member 24 is moved in the U-shaped groove of the outer mould 32 by a cylinder 83 disposed below the wire-forming and-feeding device 3.

45 As shown in Figure 14, the dimension-controlling tool device 79 is supported by a bracket 84 attached to the formed wire-fixing rail 13, and this tool device 79 comprises a reel
50 87 of an adhesive tape 86 rotatably supported by a pin 85, a bell crank 89 supported by a pin 88 so that it can swing, a piston-and-cylinder 90 for swinging the bell crank 89, two dimension-controlling tools 91 and 92 attached to the
55 outer end of the bell crank 89, and a resilient roller 94 disposed between both the tools 91 and 92 and supported rotatably by a pin 93. Each of the tools 91 and 92 has a substantially E-shaped shape, and as shown in Figure 15, the
60 tools 91 and 92 are located outside the support band 11. The thickness of the tool 91 disposed on the side of the terminal end of the formed wire 9' to be placed on the support band 11 is larger than the thickness of the tool 92 disposed
65 on the side of the U-shaped portion of the

formed wire 9'. Each tool has two grooves arranged so that when the tools 91 and 92 are brought down through the bell crank 89 by the piston-and-cylinder 90, each of the parallel lead wires of the formed U-shaped lead wire located on the support band 11 is inserted into each of the grooves and a predetermined spacing can be maintained at a high accuracy between the parallel lead wires. When the piston-and-cylinder 90 is operated, the tools 91 and 92 are brought down while holding the formed wire 9' and the wire 9' is attached to the support band 11.

As shown in Figure 11, a mould member 68 is disposed adjacent the formed wire-fixing rail 13 and it is operated by operating the striker 47 in the vertical direction. As shown in Figure 19, bending moulds 95 and 96, supporting mould 97 and pressing moulds 98 and 99 are disposed in the upper portion of the mould member 68, and this mould member 68 is arranged so that when the striker 47 is pushed upwardly, the supporting mould 97 is first raised in the vertical direction and intruded between two lead wires of the formed wire 9', the curving moulds 95 and 96 are then moved in the horizontal direction in parallel to the axes of the lead wires to come close to the lead wires, the top end portions of the lead wires are gripped between the bending moulds 95 and 96 and the supporting mould 97 to effect deformation for forming a crossing portion, and simultaneously the pressing moulds 98 and 99 grip the lead wires from the right and left sides together with the supporting mould 97 to effect deformation of the wire for forming a stopper portion 100 therein.

The functions of the apparatus having the above-mentioned structure will now be described.

The continuous wire 6 wound on the spool 4 is taken out through the reel 16 by the device 7 for feeding the wire by a predetermined constant length, and is then straightened by rollers of the wire-straightening means 5 and fed to the wire holding mechanism 34 through the cutter 8 by the feed device 7. When the predetermined constant length of the wire 6 is fed, it is cut by the cutter 8 into lengths of cut wire 9. Then, by the above-mentioned crank mechanism, the wire-forming and-feeding device 3 is forwarded toward the formed wire-fixing rail 13, and therefore, the outer mould 32 is advanced together with the transporting member 24. On the other hand, since the inner mould 33 is not moved in the horizontal direction, while the central portion of the wire 9 is kept stationary, both the ends of the wire 9 are guided by the grooved bottom face 35 of the outer mould 32 and bent to form a U-figures shape. Thus, there is formed the formed wire 9' constituting the lead wire and in the final stage of the moulding step, the U-shaped bent portion is gripped between the transporting member 24 and the inner mould 33 as shown in Figure 12.

Then, the piston-and cylinder 82 (see Figure 11) is operated to move the inner mould 33 out of the way, and the piston-and cylinder 83 (see Figure 11) moves the transporting member 24 toward the outer end of the outer mould 32 and the thus-formed wire 9' is located on the support band 11 in a direction transverse to the longitudinal direction of the support band 11 as shown in Figure 13.

The support band 11 is continuously moved to the right in Figures 13 and 14 by the support band feed device 14, but for a certain period from the moment in the cycle shown in Figure 13 where the formed wire 9' is located on the support band 11, there is no relative movement between the support band 11 and the formed wire 9', formed wire-fixing rail 13, tool device 79 and mould member 68, because of the reciprocal movement of the synchronizing apparatus 22.

In this state, the piston-and-cylinder 90 is operated to bring down the tools 91 and 92 and the two lead wires of the formed wire 9' are intruded in the grooves of the tools, whereby the space between the two lead wires can be controlled to a predetermined dimension precisely as shown in Figures 15 and 16. Then, the piston-and-cylinder 90 is further operated, and the tools 91 and 92 are further brought down but the space is still controlled as described above. Finally, the roller 94 presses the adhesive tape 86 to the support band 11 as shown in Figure 18, and during this pressing operation, the formed wire 9' is gripped in the support band 11 and attached thereto. Simultaneously, by the action of the cam 45 (see Figure 11), the striker 47 (see Figure 11) is pushed upwardly to operate the mould member 68, and a crossing portion is formed on the terminals of the lead wires of the formed wire 9' by means of the bending moulds 95 and 96, supporting mould 97 and pressing moulds 98 and 99 and also a stopper portion 100 is formed.

Then, the piston-and-cylinder 90 is operated to raise the tools 91 and 92 and the roller 94, and the synchronizing apparatus 22 begins the return movement and a relative movement is caused between the synchronizing apparatus 22 and the formed wire 9' attached to the support band 11 as shown in Figure 20.

As the above steps are repeated, formed wires are equidistantly attached onto the support band 11 by the adhesive tape 86. Then, the support band 11 is fed to subsequent steps by the support band feed device 14 (see Figures 1 and 8) having the click member 31, after holes 101 shown in Figure 21 have been formed on the support band through the adhesive tape by the perforating device 12 as described hereinbefore. At subsequent steps, according to the known method, while the support band is being transported by the feed device 14 or travelling on an extension of a take-out rail 21, electronic component elements 71 are gripped,

soldered or coated on the crossing portions, and the lead wires are cut along line P-P as shown in Figure 21, and the capacitance or resistance is measured. Thus, an electronic component web carrier as shown in Figure 1 is obtained. The so-obtained electronic component web carrier is wound to a predetermined length on a winding reel or core and it is cut by cutter 19 according to need.

Preferred examples of the support band 11 and adhesive tape 86 used in the embodiment mentioned above will now be described.

The width of the adhesive tape 86 is narrower than the width of support band 11 for several reasons. First, exact positioning of tape 86 onto support band 11 in the direction of width is not critical so long as the adhesive surface of tape 86 is not exposed outside supporting band 11. If the adhesive extends beyond support band 11 or the lower surface of the web carrier, problems will result during winding the web carrier 75 on a core or a reel as mentioned above. Further, this embodiment facilitates measurement of electric characteristics of the finished products such as capacitance, resistance and the like. A contact element can be butted to part of the lead wires that extend outwardly from the edge of adhesive tape 86, but remain on support band 11, whereby the support band 11 acts as a support for measuring means and prevents the lead wires from being deformed or broken accidentally.

The series of electronic components 70 as a whole are heavier than support band 11. In order to feed electronic components 70 into an automatic printed circuit board inserting machine and have them inserted into the board precisely, the support band 11 and electronic components 70 must be free from deformation such as elongation and twisting. In addition, since the support band 11 and electronic components 70 are to be wound on a core or a reel, the support band 11 is preferably flexible in the direction of winding in addition to satisfying the above-mentioned requirements.

Once the formed lead wires 9' of electronic components 70 are fixed onto the support band 11 by the adhesive tape 86, the components must not entangle themselves, which will result in breakage during the winding operation onto a core or a reel, or during the transportation of the components. These requirements are accomplished by controlling the relationship between the thickness of the support band 11 and that of the adhesive tape 86. The ratio (B/T) of thickness of the support band 11 to that of the adhesive tape 86 in conjunction with a suitable material for the support band 11 permits the electronic components web carrier 75 to be transferred or fed under extremely exacting conditions and inserted automatically into a printed circuit board in an extremely smooth manner. Ranges of thickness ratios are set forth below.

The support band 11 is made of a relatively flexible material as most typically exemplified by paper tape, such as, Japanese paper, kraft-liner paper having regenerated kraft paper as its surface layer, and board-like thick paper of a large cushioning action containing a polymeric material such as nylon, foamed styrol, etc., as a hollow material. Since kraft-liner paper is of a sulphuric acid-type pulp, it may cause chemical reaction between the lead wires of electronic components. Hence, the surface layer of the kraft-liner paper, that is to say, the contacting surface with the lead wires, is covered with regenerated kraft paper. In order to impart to the support band 11 a suitable tensile property in the longitudinal direction, it is preferred to use such paper in which linear fibrous elements of metallic fibers or non-metallic fibers are woven into the Japanese paper or synthetic paper in the longitudinal direction of the paper.

When Japanese paper or synthetic paper having a small flexibility in the direction of thickness is used for the support band 11, the ratio of band thickness to adhesive tape thickness (B/T) is preferably within the range of 1.5 to 5, and more preferably within the range of 2.5 to 3.5. When the support band 11 is made of board-like thick paper of large cushioning type, the ratio (B/T) is preferably within the range of 5 to 15, and more preferably within the range of 7.5 to 12.5.

When support band 11 is made of the above-mentioned materials, elongation, twisting and deformation in the longitudinal direction can be controlled or compensated for, so that the resulting electronic components web carrier 75 can be positioned with precise dimensional accuracy and be wound on a core or a reel easily and securely. When the thickness ratio is maintained within the ranges of the example, taping and fitting of electronic components 70 to the support band 11 are stable and precise. In addition, the accuracy in positioning between each electronic component is markedly improved. The above-mentioned example provides components supported with precise equal spacing which improves the insertion reliability of an automatic printed circuit board inserting machine. It also permits a stable high speed operation of the inserting machine.

In the present invention having the above-mentioned structure and function, since the formed wire 9' is fixed and attached to the support band 11 in the state where the spacing between the parallel lead wires is precisely controlled to a predetermined dimension by the tools 91 and 92, the accuracy of this distance or spacing between the parallel lead wires can be maintained during the step of forming an electronic components web carrier and a high accuracy is kept also in the resulting web carrier. More specifically, even when the web carrier undergoes deformation as indicated by a two-dot chain line on the left hand side of

Figure 1 by an external force during storage or transportation, since the part fixed by the adhesive tape 86 is not moved, the precise spacing of the lead wires in the zone C close to the edge of the support band 86 can easily be maintained. Since in the finished web carrier the spacing or distance between the lead wires can be maintained very precisely, also the lead wire spacing in the respective cut-out and separated electronic components can easily be precisely maintained, insertion of them into a printed circuit board can be performed very smoothly without trouble and with high speed and effective automatic insertion is possible.

Further, even when crossing portions on the top ends of lead wires or stopper portions are formed by deforming processing, since the space between the lead wires is controlled by the tools 91 and 92, reduction of the dimensional accuracy by the deforming processing can be effectively prevented.

In lead wires, the zone C shown in Figure 1, that is, the base portion of the lead wires 9' projecting from the edge of the support band 11 on the side of the electronic component element 71, is a most important portion. Accordingly, for example, as shown in Figure 10, the thickness of the tool 91 is made larger than that of the tool 92 so that the controlling effect is prominently exerted. The tool 92 need not always be used.

When a pair of tools 91 and 92 are used, it is not essential that both the tools should have an E-shaped shape, and, for example, especially good results can be obtained when both the tools 91 and 92 are arranged so that, as shown in Figures 22 to 24, the tool 92 controls the maximum outer dimension of lead wires and the tool 91 controls the minimum inner dimension. More specifically, when the formed wire 9' formed to have a U-shaped shape by the inner mould 32 and outer mould 33 is pushed outwardly of the outer mould 32 by the transporting member 24 and is released from restraint, both the leg portions of the formed wire 9' are slightly expanded by the spring-back action and the spacing between lead wires is made inaccurate. The tools 91 and 92 are disposed so as to prevent this undesirable phenomenon from taking place. Expansion of the lead wires is controlled by the tool 92 to tend to decrease the spacing between the top ends of the lead wires to less than the predetermined value, but this tendency is eliminated by the tool 91 controlling the minimum inner dimension. When the tool device having the above structure is adopted, the lead wires are urged closely to the tool 91 and therefore, the spacing can be controlled most precisely in the portion of the lead wires where the precision is most required in the finished electronic components web carrier, that is, at the top ends of the lead wires in the finished carrier corresponding to the portion with which the tool 91 falls

provides a very characteristic process and apparatus for the preparation of electronic component web carriers, which has a very high practical utility.

5 WHAT WE CLAIM IS:-

1. A process for the preparation of an electronic component web carrier including the steps of:

- 10 forming a U-shaped wire having a pair of arms extending parallel to each other to constitute lead wires;
continuously feeding a support band during the entire process;
feeding said U-shaped wire onto said support band;

15 fixing said U-shaped wire firmly to said in contact in Figure 22. Accordingly, the quality of the finished product can be improved.

- 20 In the foregoing embodiments, the respective members are operated by mechanical power transmission systems or cylinders using air or hydraulic pressure. In the present invention, hydraulic pressure systems may be used instead of the mechanical systems shown specifically, or on the contrary, mechanical systems may be used instead of the fluid pressure mechanisms shown specifically. Electrical systems may also be used.

- 30 In the present invention, it is possible to produce an electronic components web carrier having a series of electronic components, in each of which a highly precise spacing is maintained between the parallel lead wires. Furthermore, when the so-prepared electronic components web carrier is employed, automatic insertion of electronic components into a printed circuit board can be performed very smoothly without any trouble. Accordingly, the present invention support band by means of an adhesive tape with a predetermined spacing between said parallel lead wires of said U-shaped wire, and connecting an electronic component element at the free ends of said parallel lead wires.

- 45 2. A process according to claim 1, wherein said U-shaped wire is arranged on said support band such that a closed loop of the U-shaped lead wire projects beyond an edge of said support band.

- 50 3. A process according to claim 1 or 2, wherein control of the spacing is effected by means of dimension-controlling tools.

4. A process according to any preceding claim, wherein the feed of said support band is effected at a predetermined speed, and the feed of said U-shaped wire is effected at a speed synchronous with the feed speed of said support band.

- 55 5. A process according to claim 2 and claim 3 when dependent thereupon, wherein the spacing control is effected upon portions of the U-shaped wire projecting beyond both edges of said support band.

- 60 6. A process according to claim 5, wherein the outer maximum dimension between said parallel lead wire is controlled at an edge of

the band including the loop of said U-shaped wire and the inner minimum dimension between said parallel lead wires is controlled at the other edge of the band.

7. A process according to any preceding claim, further comprises the step of subjecting the free end portions of said parallel lead wires to deforming processing while controlling the spacing between said parallel lead wires.

8. A process according to claim 7, wherein the deforming processing is cross-bending processing.

9. A process according to claim 7 or 8, wherein the deforming processing is stopper-forming processing.

10. A process for the preparation of an electronic components web carrier, substantially as hereinbefore described with reference to Figures 4 to 21 or as modified by reference to Figures 22 to 24 of the accompanying drawings.

11. An electronic components web carrier, when produced by a process as claimed in any preceding claim.

12. An apparatus for the preparation of an electronic components web carrier comprising support band feeding means for continuously feeding a support band during the entire preparation;

- wire forming means for forming from a continuous wire a U-shape wire having a pair of arms extending parallel to each other to constitute lead wires, said wire forming means including feeding means for feeding the formed U-shaped wire onto said support band;

- fixing means for fixing said U-shaped wire on said support band by means of an adhesive tape;

- dimension-controlling means for ensuring a predetermined spacing between said parallel lead wires of said U-shaped wire during fixing of said wire on said support band, and

- synchronizing means for synchronizing the feed of said U-shaped wire with the feed of said support band.

13. Apparatus according to claim 12, wherein said wire forming means includes a spool having a continuous wire wound thereon, wire-straightening means for straightening the wire, means for feeding a predetermined length, of wire, a cutter for cutting the wire to said length, wire holding means for holding both ends of the wire cut by said cutter, and wire-curving means for forming the wire into U-shaped lead wire.

14. Apparatus according to claim 12 or 13, wherein said fixing means includes a reel having a continuous adhesive tape wound thereon and a rotatable roller for pressing said adhesive tape onto the support band so as to adhere it thereto.

15. Apparatus according to any one of claims 12 to 14, wherein said dimension-controlling means includes a bell crank, a piston-and-cylinder for swinging said bell crank, and

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provides a very characteristic process and apparatus for the preparation of electronic component web carriers, which has a very high practical utility.

5 WHAT WE CLAIM IS:—

1. A process for the preparation of an electronic component web carrier including the steps of:

- 10 forming a U-shaped wire having a pair of arms extending parallel to each other to constitute lead wires;
- continuously feeding a support band during the entire process;
- 15 feeding said U-shaped wire onto said support band;

fixing said U-shaped wire firmly to said in contact in Figure 22. Accordingly, the quality of the finished product can be improved.

- 20 In the foregoing embodiments, the respective members are operated by mechanical power transmission systems or cylinders using air or hydraulic pressure. In the present invention, hydraulic pressure systems may be used instead of the mechanical systems shown specifically, or on the contrary, mechanical systems may be used instead of the fluid pressure mechanisms shown specifically. Electrical systems may also be used.

In the present invention, it is possible to produce an electronic components web carrier having a series of electronic components, in each of which a highly precise spacing is maintained between the parallel lead wires. Furthermore, when the so-prepared electronic components web carrier is employed, automatic insertion of electronic components into a printed circuit board can be performed very smoothly without any trouble. Accordingly, the present invention support band by means of an adhesive tape with a predetermined spacing between said parallel lead wires of said U-shaped wire, and connecting an electronic component element at the free ends of said parallel lead wires.

- 2. A process according to claim 1, wherein said U-shaped wire is arranged on said support band such that a closed loop of the U-shaped lead wire projects beyond an edge of said support band.

- 3. A process according to claim 1 or 2, wherein control of the spacing is effected by means of dimension-controlling tools.

- 4. A process according to any preceding claim, wherein the feed of said support band is effected at a predetermined speed, and the feed of said U-shaped wire is effected at a speed synchronous with the feed speed of said support band.

- 5. A process according to claim 2 and claim 3 when dependent thereupon, wherein the spacing control is effected upon portions of the U-shaped wire projecting beyond both edges of said support band.

- 6. A process according to claim 5, wherein the outer maximum dimension between said parallel lead wire is controlled at an edge of

the band including the loop of said U-shaped wire and the inner minimum dimension between said parallel lead wires is controlled at the other edge of the band.

- 7. A process according to any preceding claim, further comprises the step of subjecting the free end portions of said parallel lead wires to deforming processing while controlling the spacing between said parallel lead wires.

- 8. A process according to claim 7, wherein the deforming processing is cross-bending processing.

- 9. A process according to claim 7 or 8, wherein the deforming processing is stopper-forming processing.

- 10. A process for the preparation of an electronic components web carrier, substantially as hereinbefore described with reference to Figures 4 to 21 or as modified by reference to Figures 22 to 24 of the accompanying drawings.

- 11. An electronic components web carrier, when produced by a process as claimed in any preceding claim.

- 12. An apparatus for the preparation of an electronic components web carrier comprising support band feeding means for continuously feeding a support band during the entire preparation;

wire forming means for forming from a continuous wire a U-shape wire having a pair of arms extending parallel to each other to constitute lead wires, said wire forming means including feeding means for feeding the formed U-shaped wire onto said support band;

fixing means for fixing said U-shaped wire on said support band by means of an adhesive tape;

dimension-controlling means for ensuring a predetermined spacing between said parallel lead wires of said U-shaped wire during fixing of said wire on said support band, and

synchronizing means for synchronizing the feed of said U-shaped wire with the feed of said support band.

- 13. Apparatus according to claim 12, wherein said wire forming means includes a spool having a continuous wire wound thereon, wire-straightening means for straightening the wire, means for feeding a predetermined length, of wire, a cutter for cutting the wire to said length, wire holding means for holding both ends of the wire cut by said cutter, and wire-curving means for forming the wire into U-shaped lead wire.

- 14. Apparatus according to claim 12 or 13, wherein said fixing means includes a reel having a continuous adhesive tape wound thereon and a rotatable roller for pressing said adhesive tape onto the support band so as to adhere it thereto.

- 15. Apparatus according to any one of claims 12 to 14, wherein said dimension-controlling means includes a bell crank, a piston-and-cylinder for swinging said bell crank, and



(13)

at least one dimension-controlling tool attached to one end of the bell crank.

16. Apparatus according to any one of claims 12 to 14, wherein said synchronizing means include a swinging stand capable of moving reciprocatively, in the direction of feed of the support band, the wire forming means, the wire feeding means and the dimension-controlling means being mounted on said swinging stand, so that motion of the means mounted on the swinging stand relative to the support band can be eliminated.

17. Apparatus according to any one of claims 12 to 14, further comprising perforating means for forming holes at predetermined intervals on the support band.

18. Apparatus according to any one of claims 12 to 17, further comprising deforming processing means having a plurality of mould elements for shaping terminal portions of said parallel lead wires.

19. Apparatus according to claim 13, wherein said wire-curving means includes an outer movable mould element and inner mould element.

20. Apparatus according to claim 15, wherein said dimension-controlling tool has two grooves arranged so that when the tool is actuated via the bell crank by means of the piston-and-cylinder, parallel lead wires of the

U-shaped lead wire located on the support band are inserted into said grooves and a predetermined distance is maintained between the parallel lead wires.

21. Apparatus according to claim 15, wherein a pair of dimension-controlling tools are provided, arranged so that one of them controls an outer maximum dimension between said parallel lead wires and the other controls an inner minimum dimension between said parallel lead wires.

22. An apparatus for the preparation of an electronic components web carrier, substantially as hereinbefore described with reference to Figures 4 to 21 or as modified by reference to Figures 22 to 24 of the accompanying drawings.

23. An electronic components web carrier when produced by means of an apparatus as claimed in any of claims 12 to 22.

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