

- [54] **APPARATUS FOR POSITIONING AN END OF A BENDABLE WIRE-LIKE ARTICLE AT A PREDETERMINED LOCATION ON ANOTHER ARTICLE**
- [75] Inventors: **James Woodrow Hammond**, Camp Hill; **Eugene Phillip Loomis**, Harrisburg, both of Pa.
- [73] Assignee: **AMP Incorporated**, Harrisburg, Pa.
- [22] Filed: **June 7, 1973**
- [21] Appl. No.: **367,916**
- [52] U.S. Cl. **29/203 P, 29/203 DT, 29/628**
- [51] Int. Cl. **H01r**
- [58] Field of Search **29/203 R, 203 D, 203 HC, 29/628, 203 S, 203 P, 203 J, 203 DT; 72/413, 416, 421, 452, 456**

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Primary Examiner—C. W. Lanham
 Assistant Examiner—James R. Duzan
 Attorney, Agent, or Firm—William J. Keating; Jay L. Seitchik; Frederick W. Raring

[57] **ABSTRACT**
 During each operating cycle of an automatic lead making machine, one of a plurality of spaced-apart grippers on a conveyor, which holds a bendable elec-

trical lead wire having an electrical terminal crimped on its end, positions the wire on a ramp located between the gripper and a pair of bonding tools at an assembly station of the machine and locates the terminated end of the wire in the vicinity of an open cavity of one housing part of an unassembled insulating housing having a pair of hingedly, pivotally connected housing parts, which housing is located generally between the bonding tools at the assembly station. A top surface of the ramp, on which the wire is positioned, is stationarily located in an elevated position adjacent to, and above, the one housing part of the housing. With the wire being stationarily held by the one gripper and so positioned on the ramp, the terminated end of the wire is placed in the housing cavity by an article positioning mechanism located between the ramp and the bonding tools. The article positioning mechanism has a pair of fingers which are pivotal toward and away from each other about separate, spaced-apart axes between open and closed positions. Each finger has a wire engaging surface on its free end. The surfaces are arranged respectively on the free ends of the fingers so as to overlap each other during the final stage of pivotal movement of the fingers toward each other and to their closed position. During the initial stage of pivotal movement of the fingers toward each other, the wire engaging surface of one of the fingers will engage one side of the wire and move the wire end into a spaced-above relationship to the housing cavity at which position the other surface of the other finger also engages the wire at the opposite side thereof. Then, as the fingers are pivotally moved toward each other during the final stage of their movement toward their closed position which causes overlapping of their respective surfaces above the wire, the progressively-increasing overlapping of the surfaces moves the wire downwardly and bends the wire between its terminated end and the ramp such that the terminated end of the wire is positively placed into the housing cavity.

9 Claims, 31 Drawing Figures

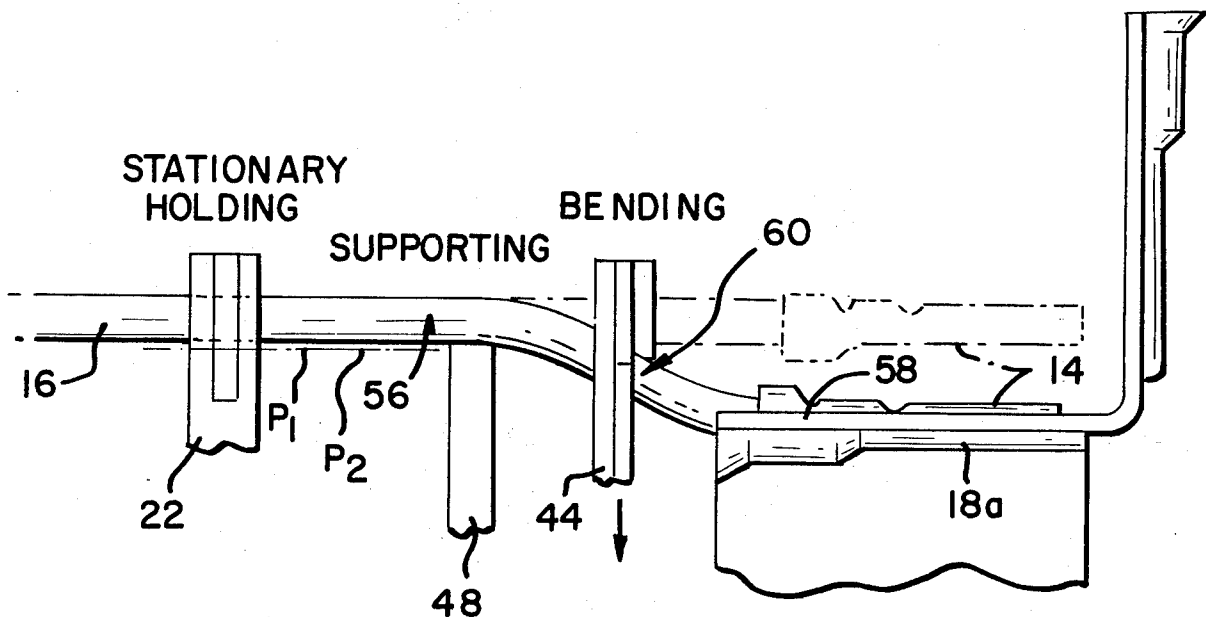
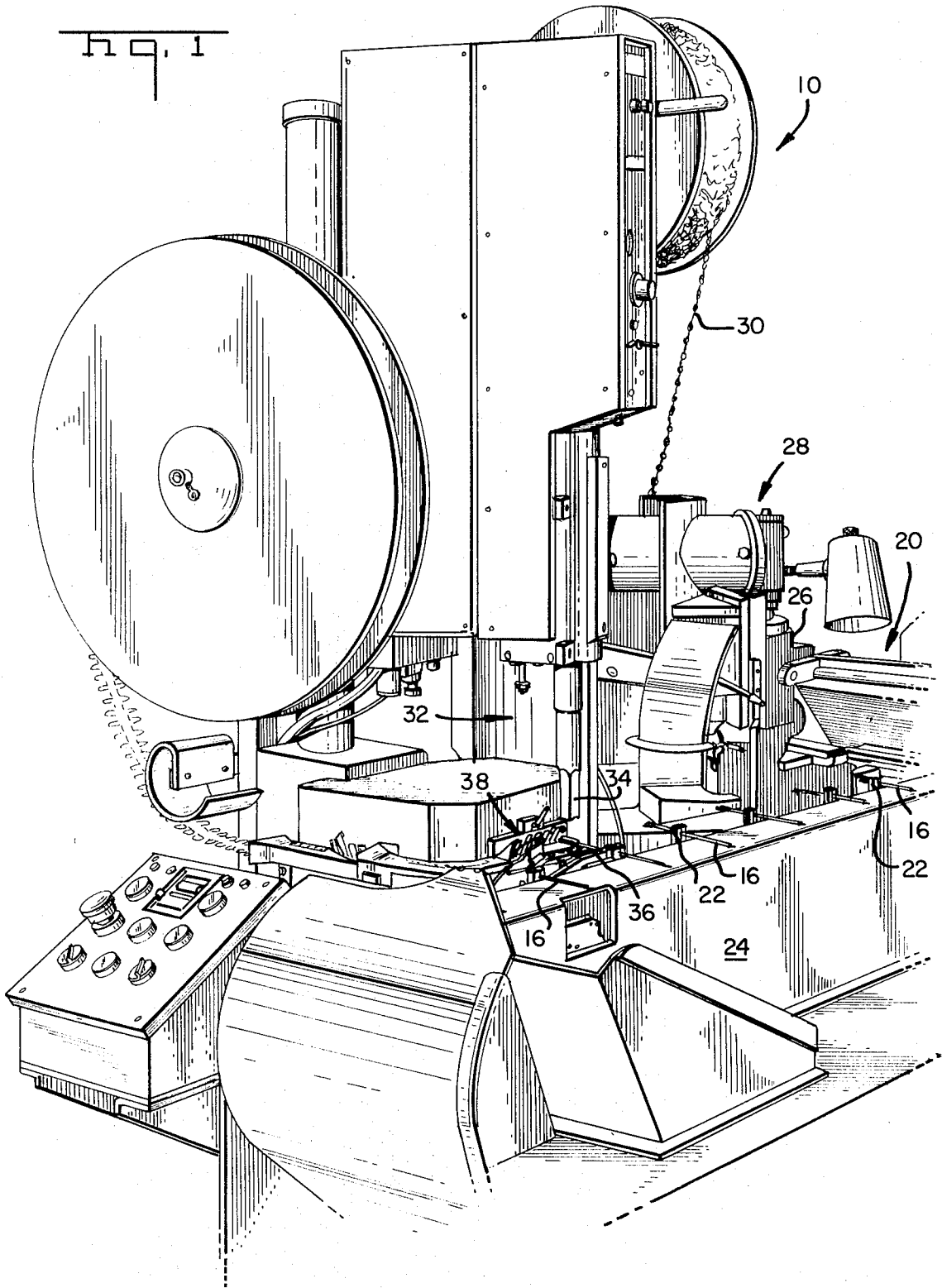
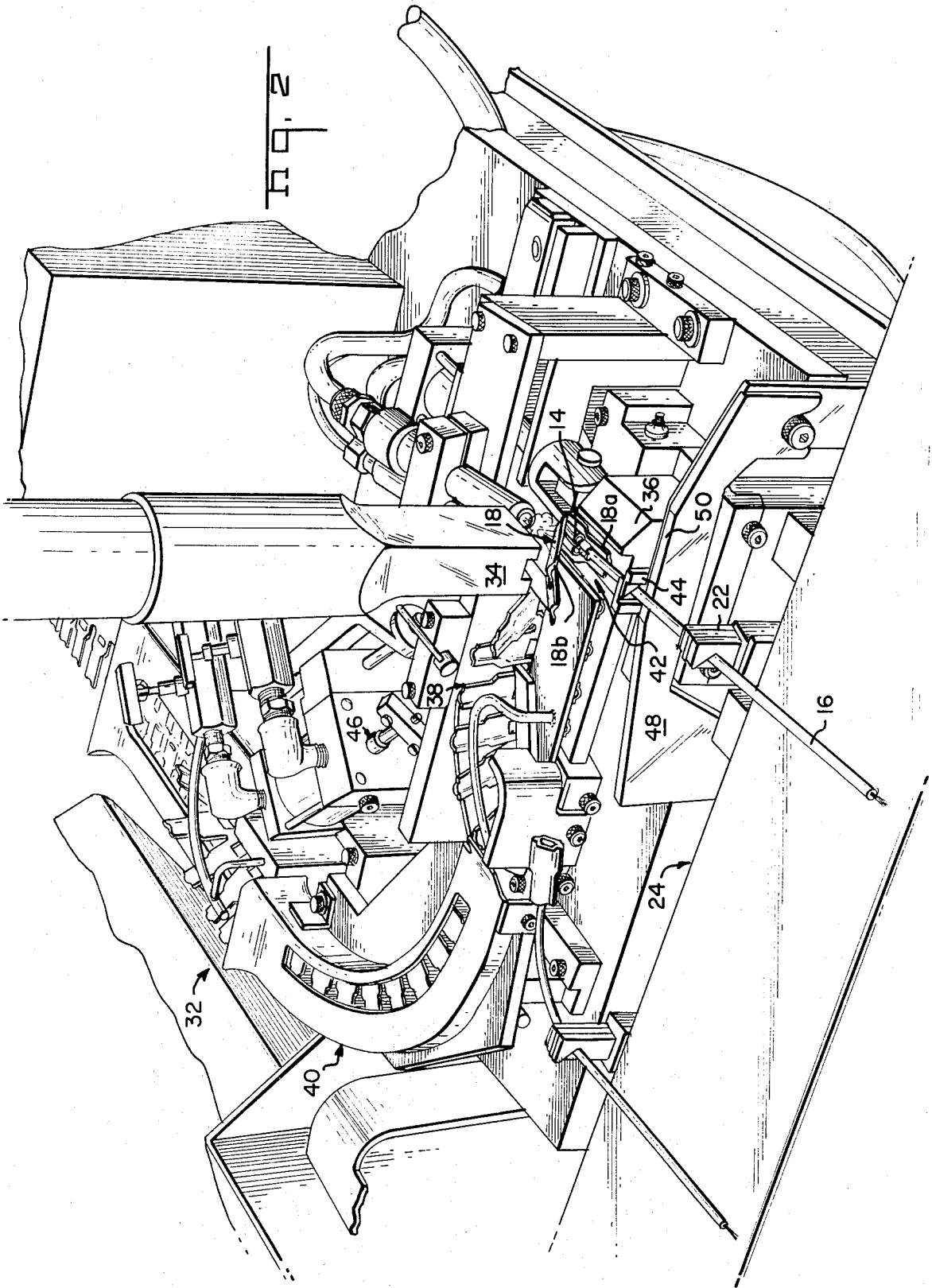


Fig. 1





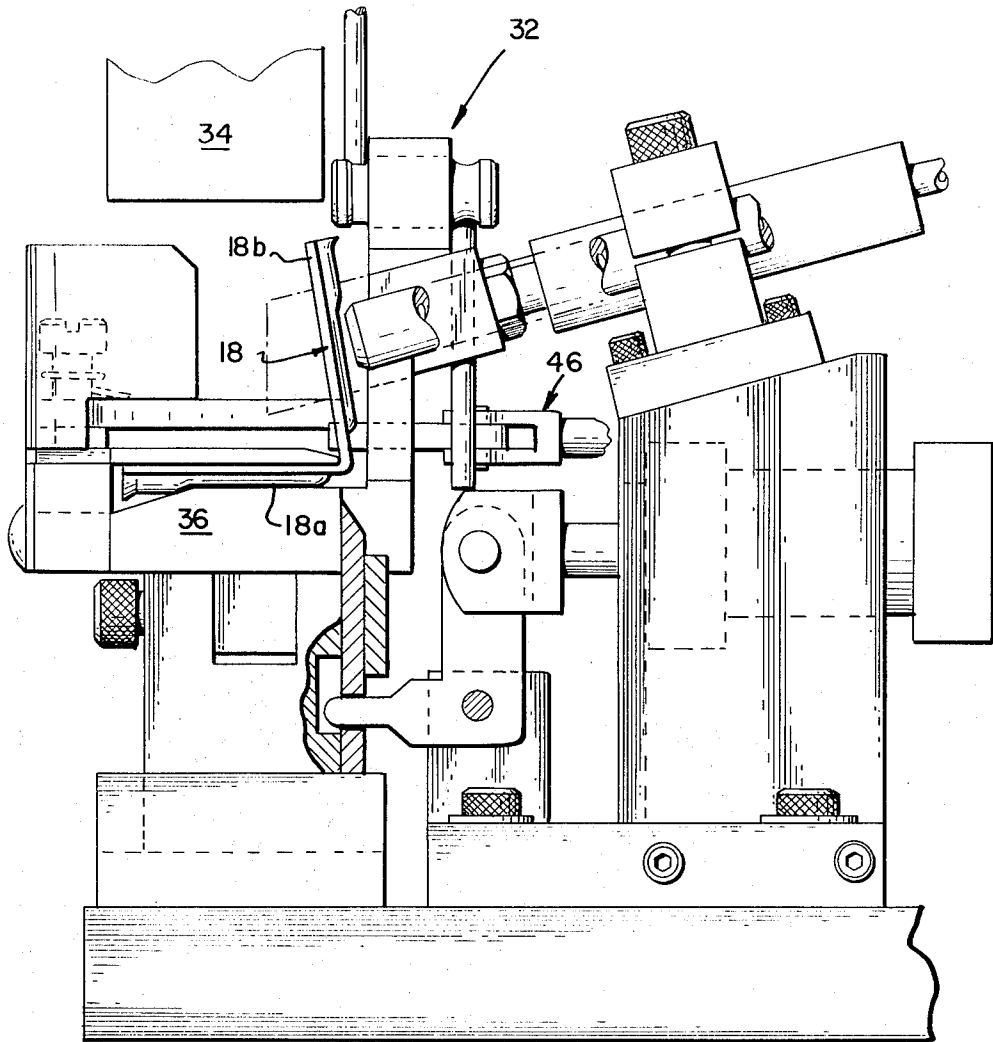
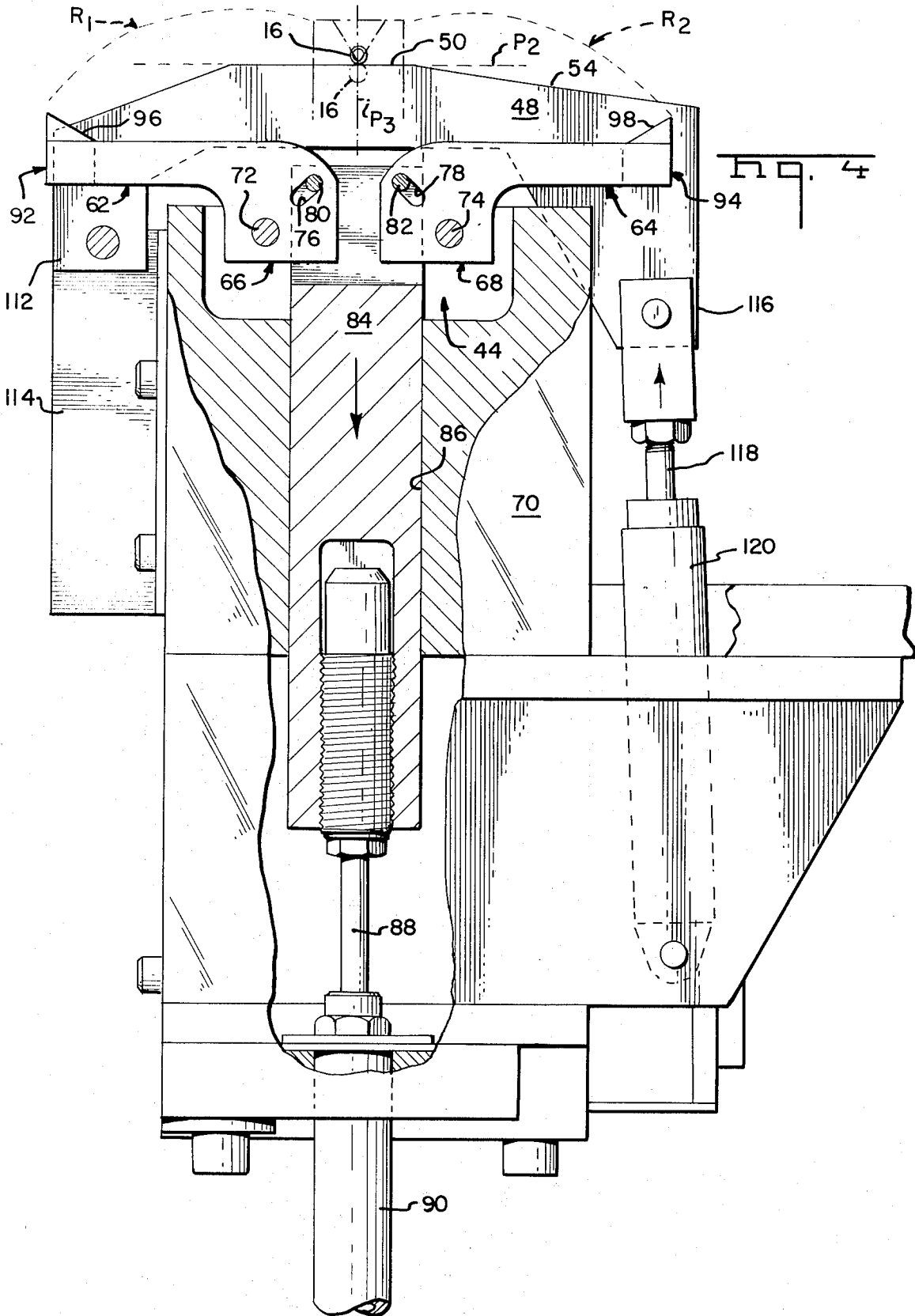
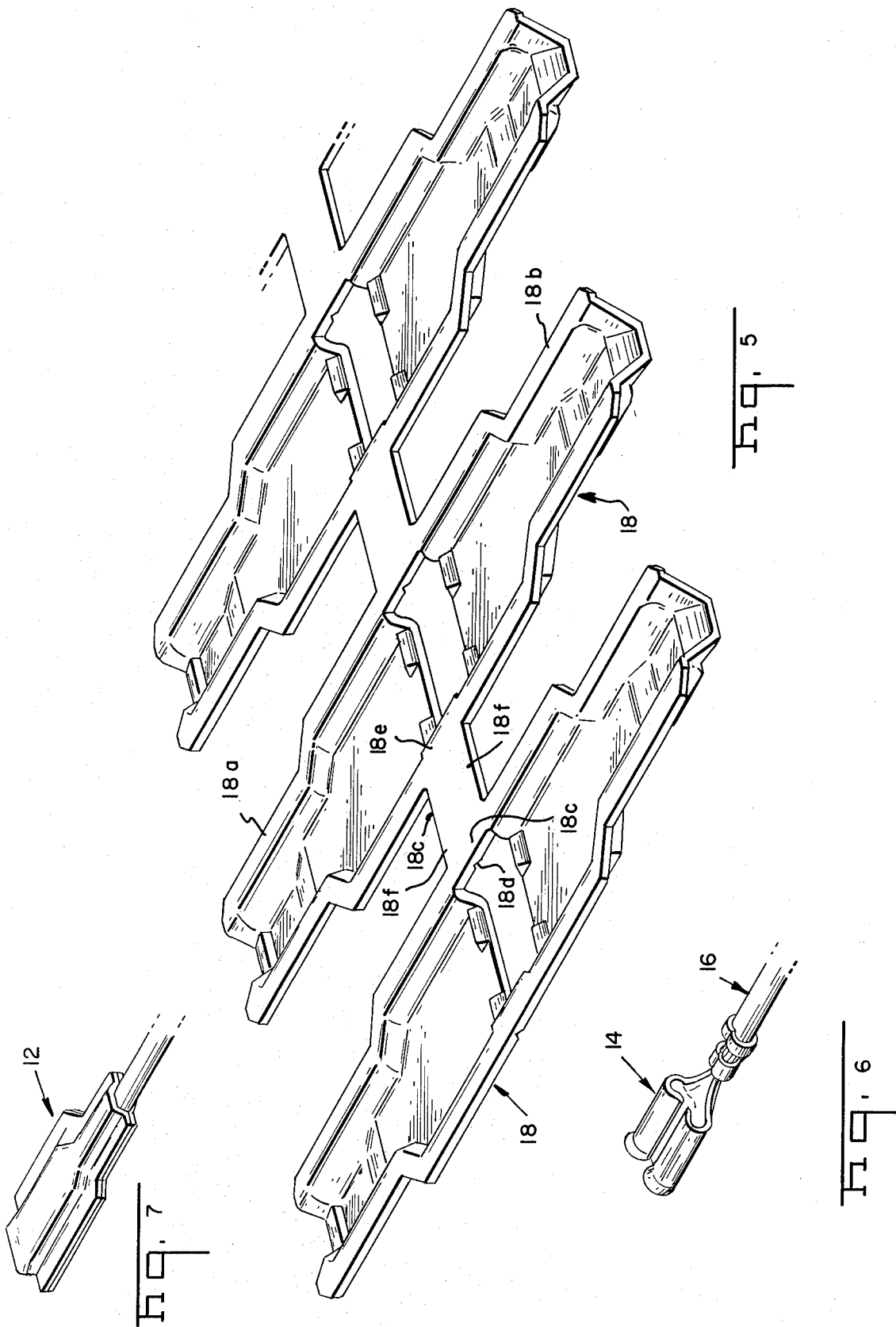
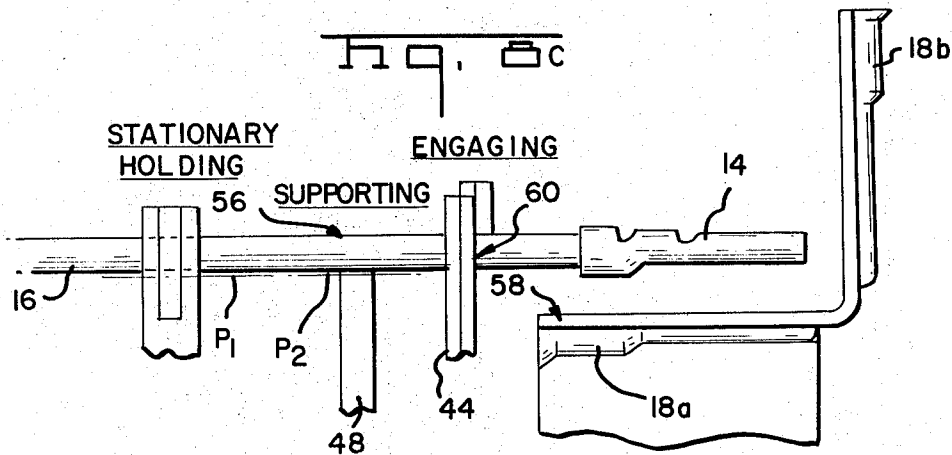
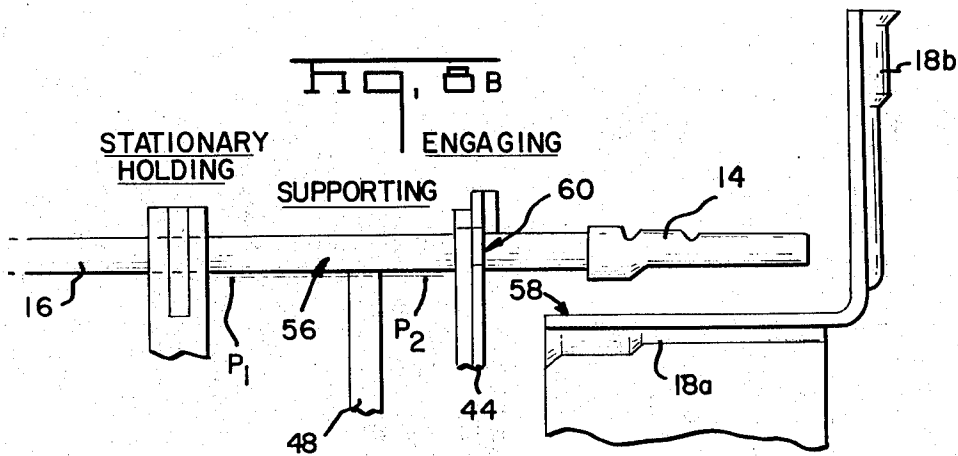
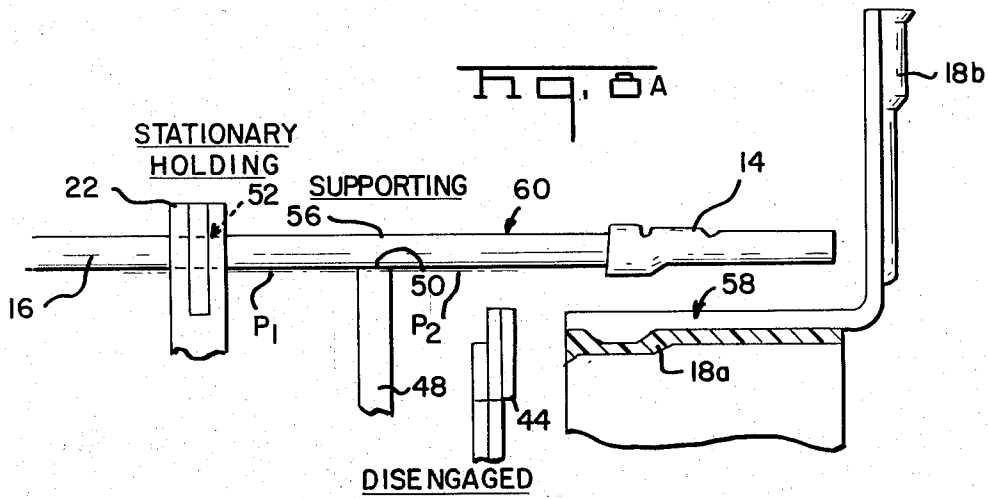
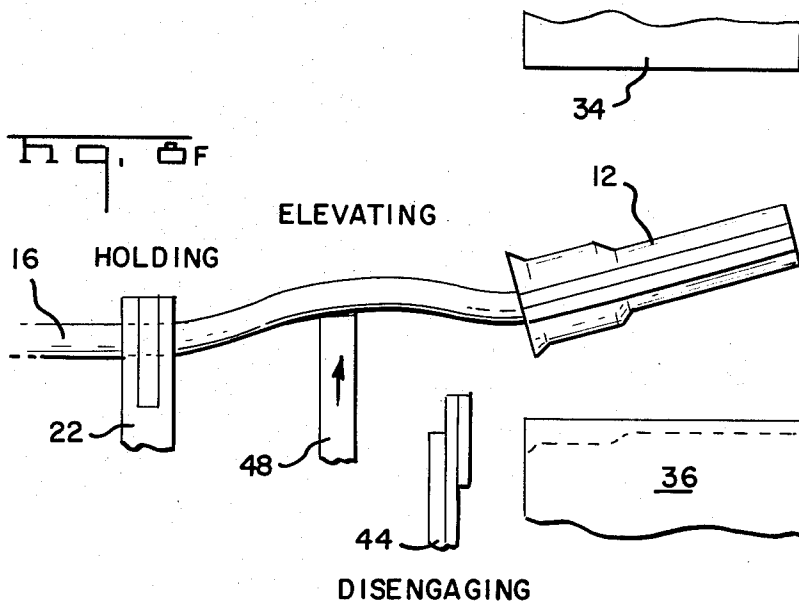
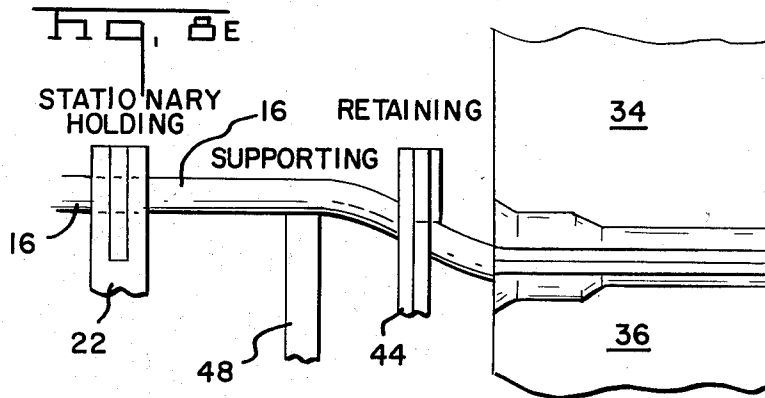
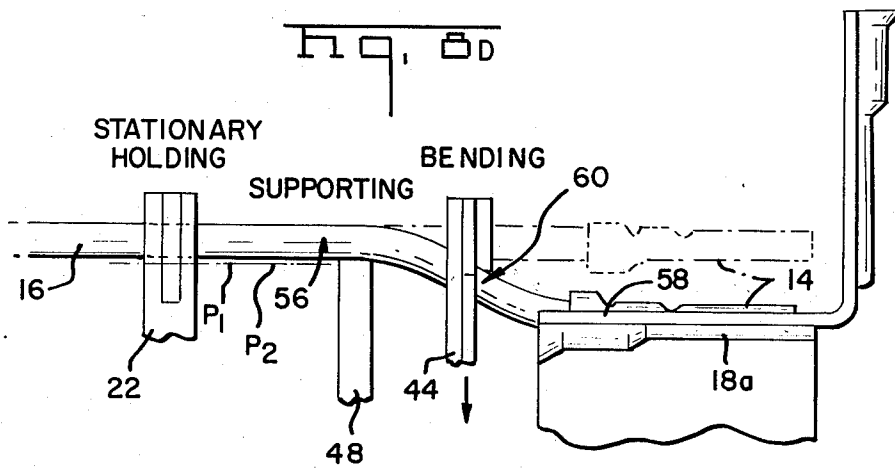


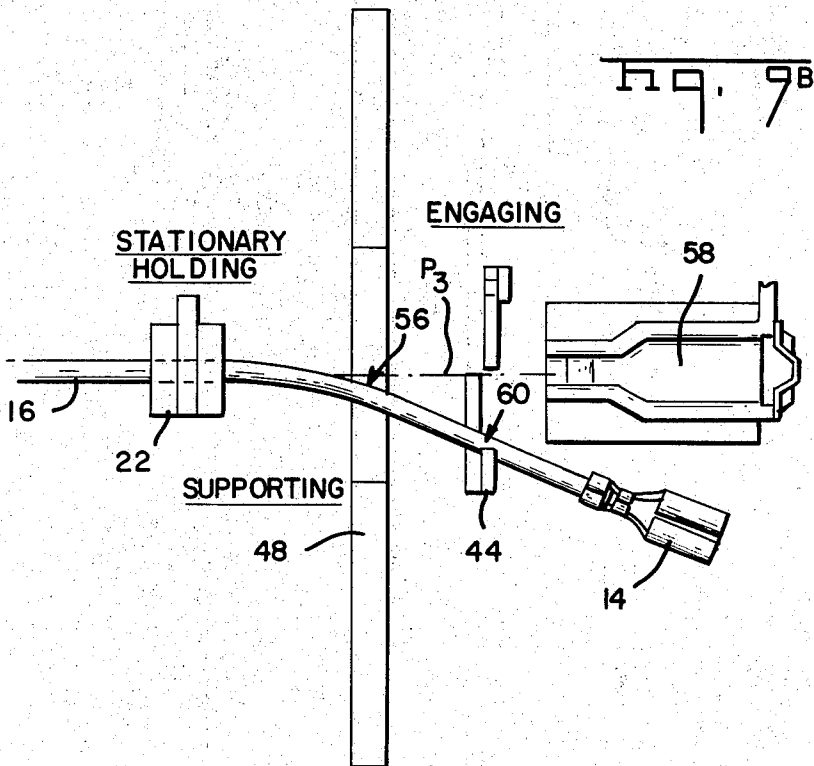
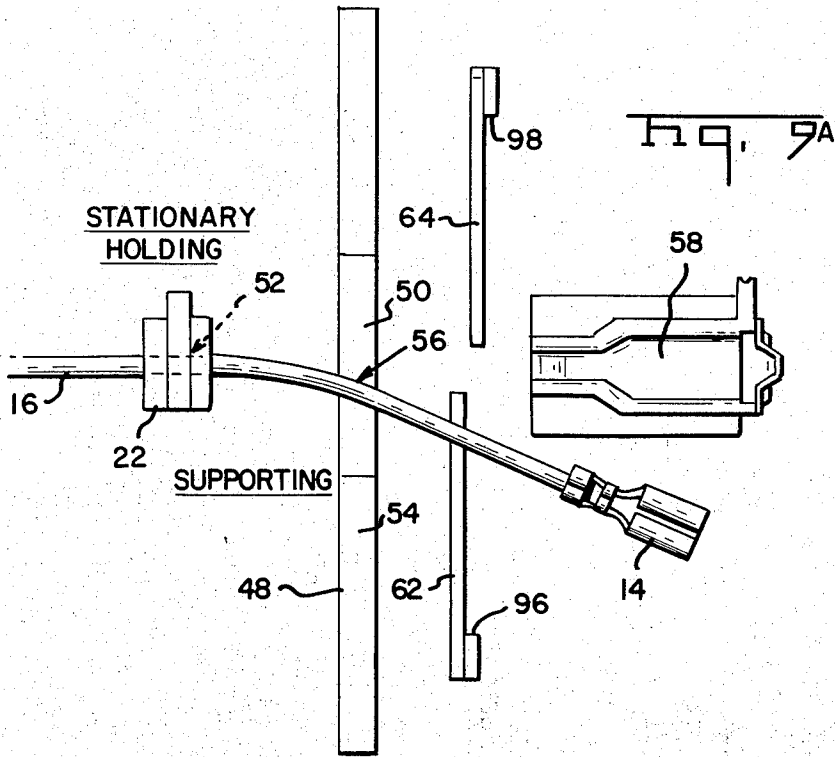
Fig. 3











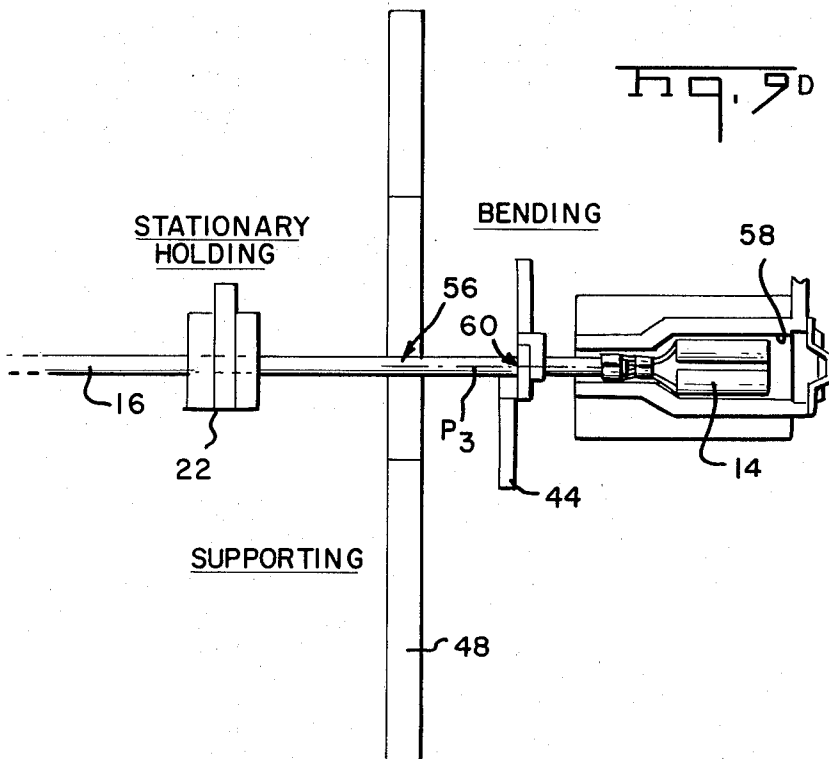
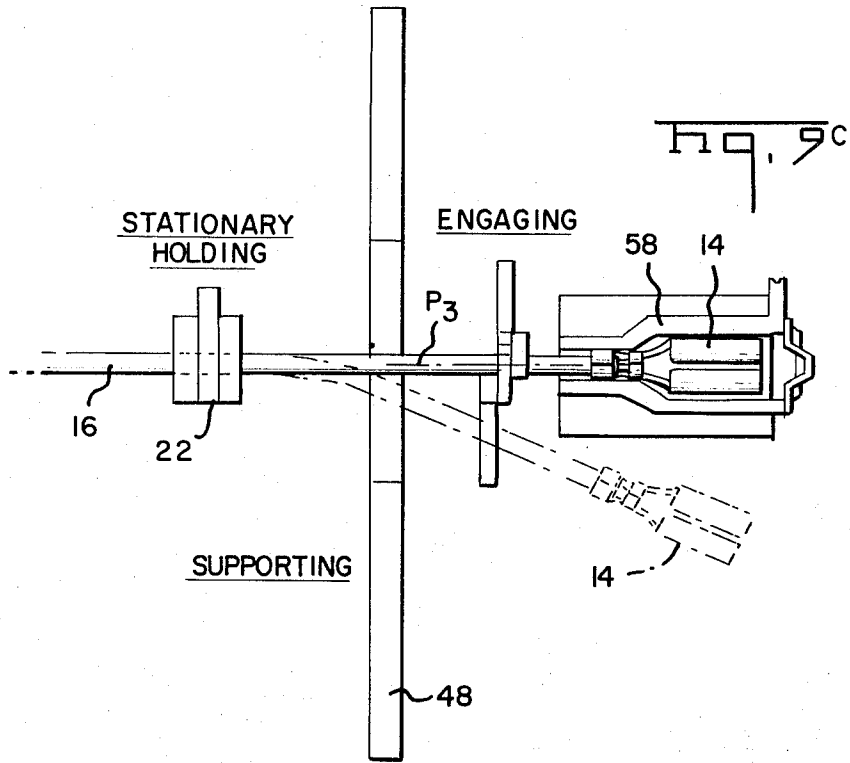


Fig. 10A

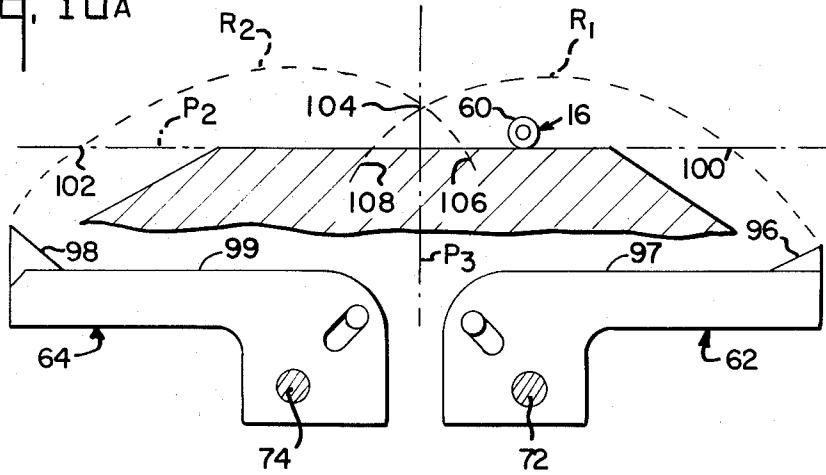


Fig. 10B

ENGAGING

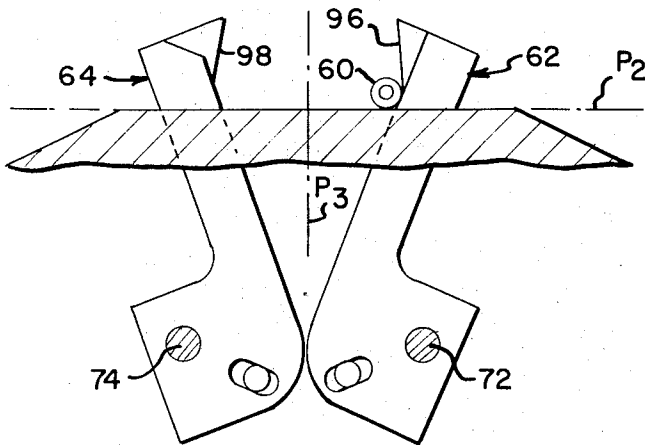
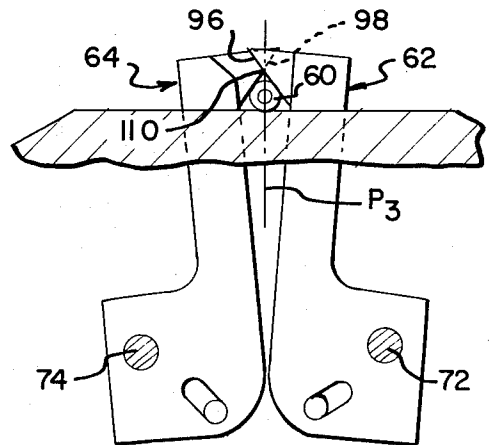


Fig. 10c

ENGAGING



BENDING

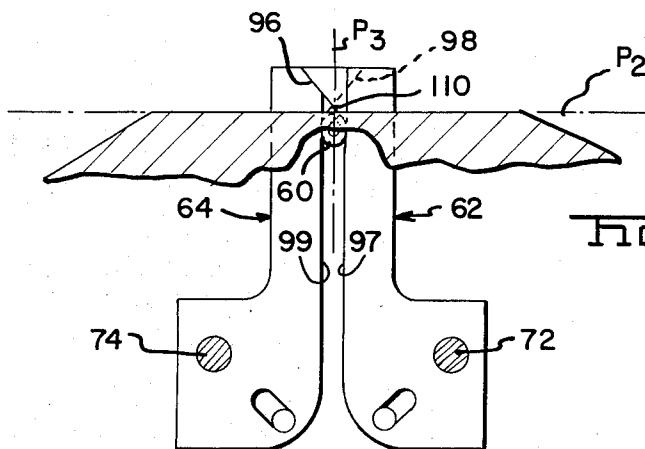
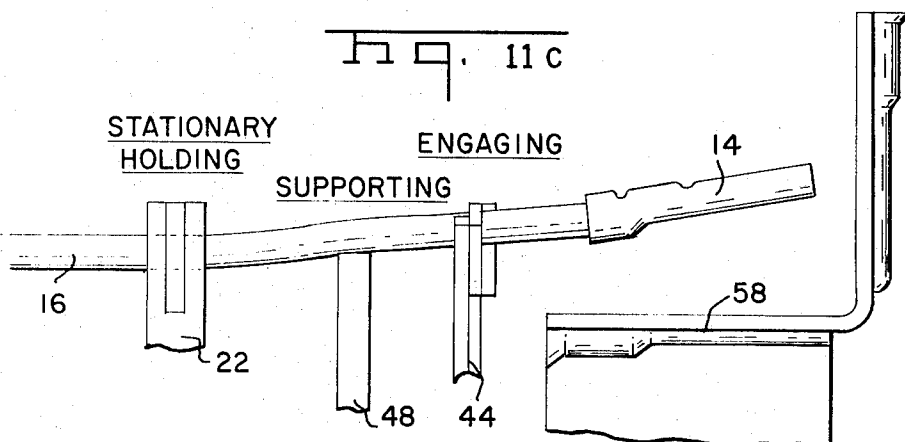
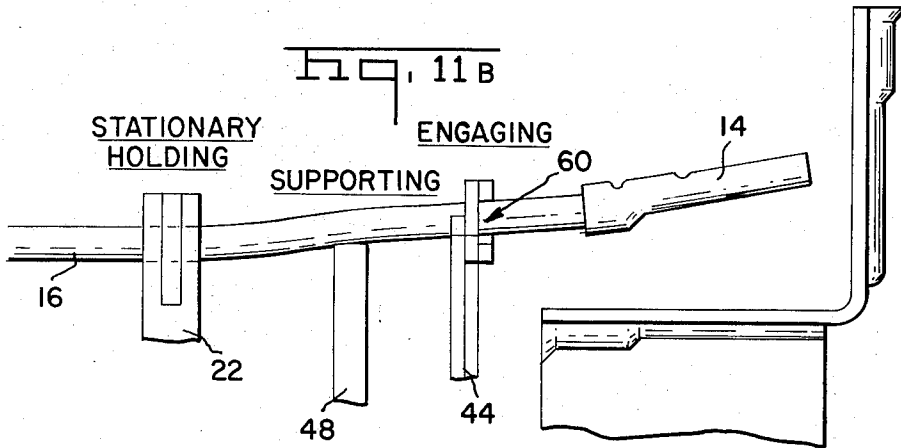
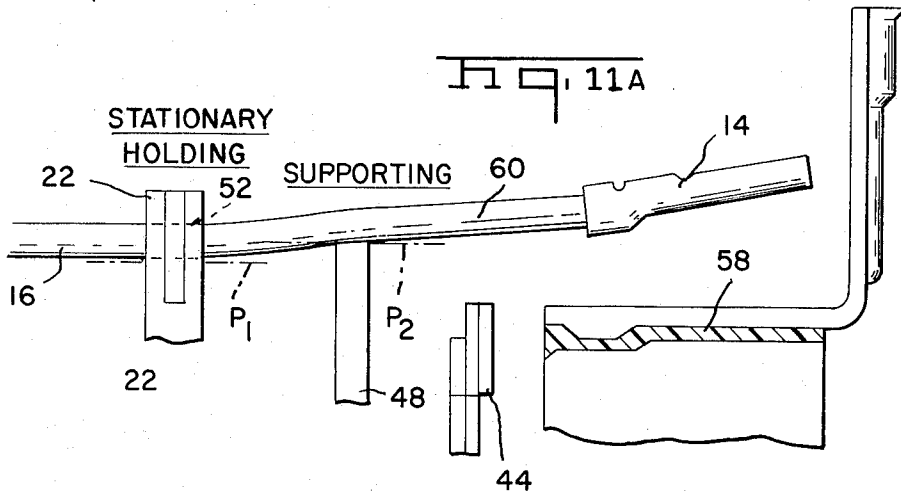
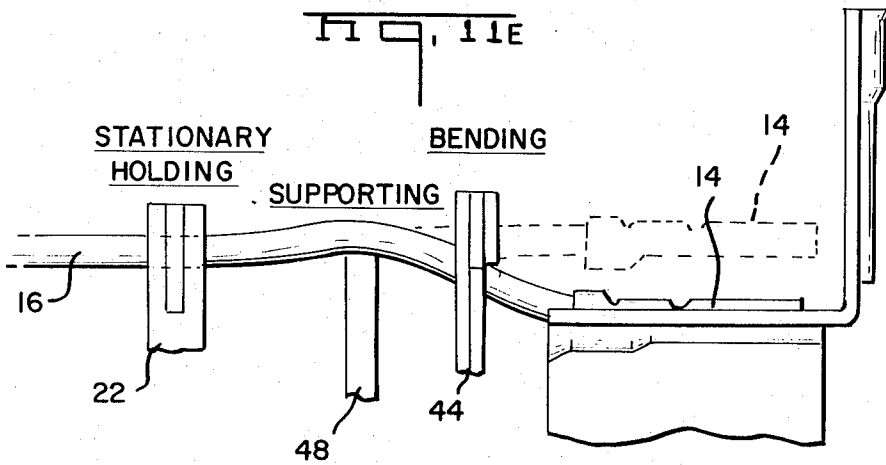
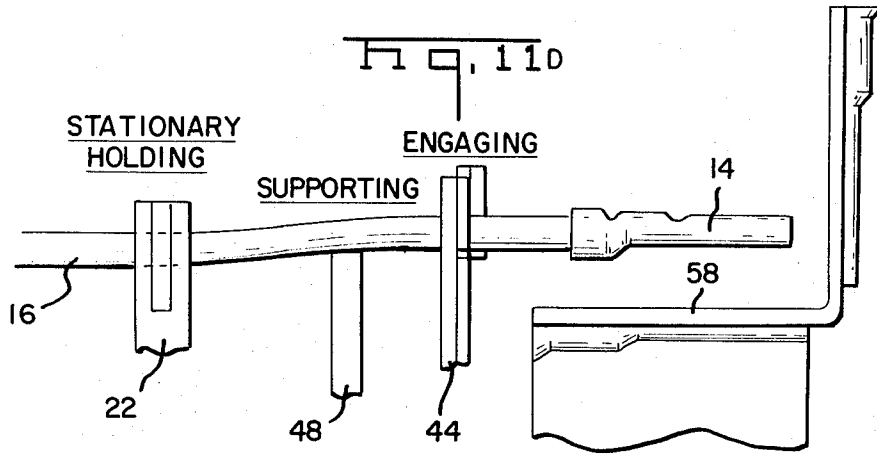



Fig. 10D





16 —  — 60

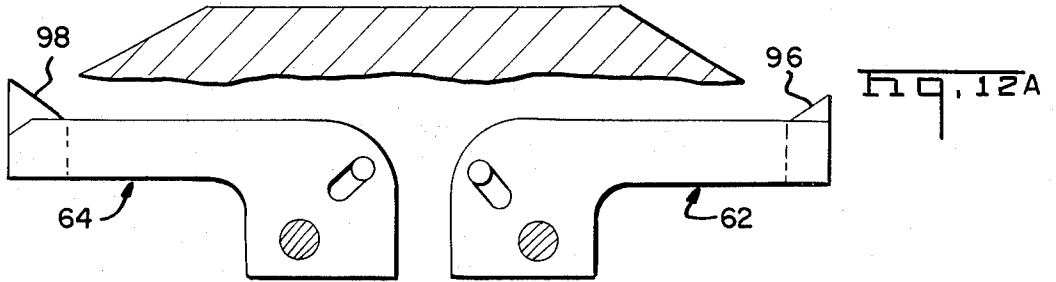


Fig. 12A

ENGAGING

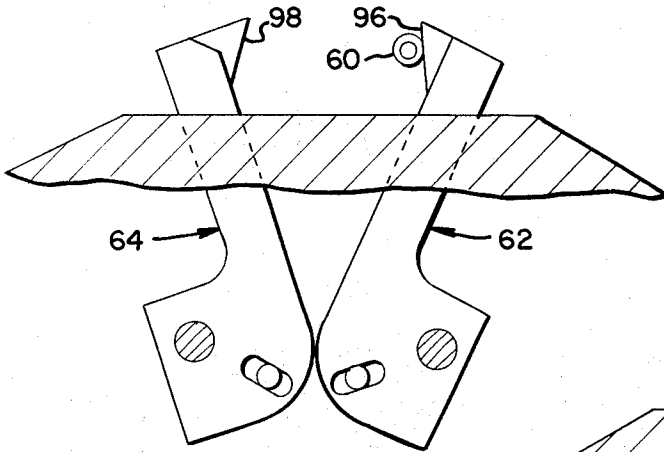


Fig. 12B

ENGAGING

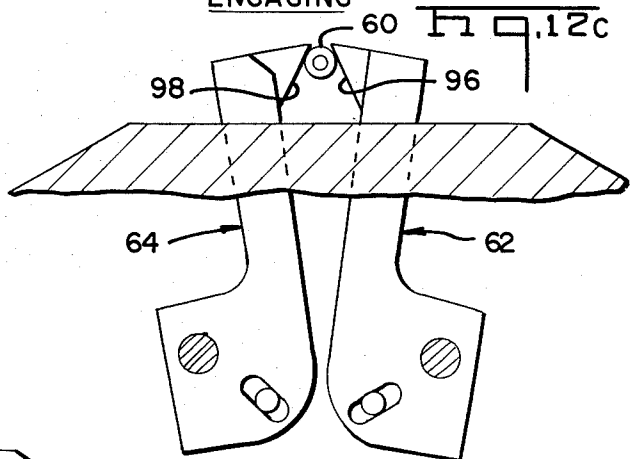
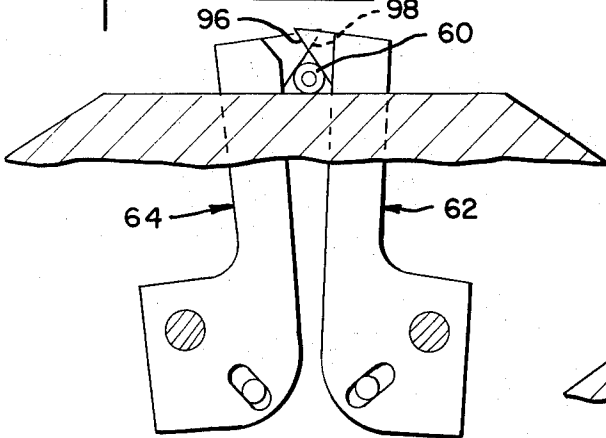


Fig. 12C

Fig. 12D

ENGAGING



BENDING

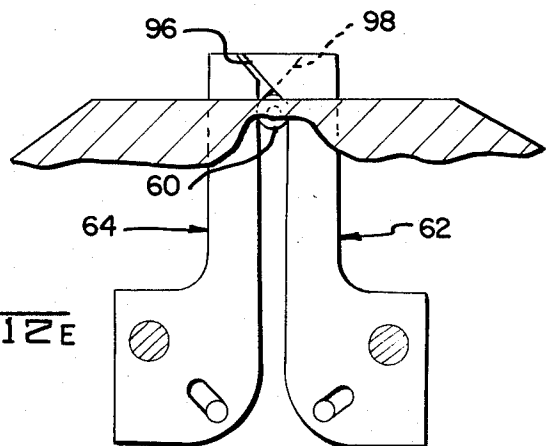


Fig. 12E

APPARATUS FOR POSITIONING AN END OF A BENDABLE WIRE-LIKE ARTICLE AT A PREDETERMINED LOCATION ON ANOTHER ARTICLE

CROSS REFERENCES TO RELATED APPLICATIONS

Reference is hereby made to the following copending U.S. applications dealing with related subject matter and assigned to the assignee of the present invention.

1. "Housings For Electrical Connecting Devices And Methods Of Assembling Housings To Connecting Devices" by James Pritulsky et al, U.S. Ser. No. 255,666, filed May 18, 1972, and now abandoned.

2. "Method And Apparatus For Disposing Unassembled Insulating Housings In A Predetermined Position For Facilitating Placement Of Articles Such As Electrical Connecting Devices Within Said Housings" by Phillip Eugene Loomis et al, U.S. Ser. No. 367,908 filed June 7, 1973 now U.S. Pat. No. 3834016.

3. "Method And Apparatus For Successively Positioning Unassembled Insulating Housings At An Assembly Station Between Assembly Tools For successive Assembly Of Said Housings To Articles Such As Electrical Connecting Devices" by Phillip Eugene Loomis et al, U.S. Ser. No. 368,159, filed June 8, 1973.

BACKGROUND OF THE INVENTION

1. Field Of The Invention

The present invention relates generally to an automatic lead making machine which, in succession, cuts as individual insulated electrical conductor lead wire to a desired length, strips the insulation from both ends of the conductor wire, applies an electrical terminal to one of the electrically-bared ends of the conductor wire, such as a receptacle-type of terminal, and applies an insulating housing to the terminated end around the terminal and an adjacent portion of the insulation of the conductor wire to provide a highly satisfactory insulated electrical connecting device, such as a post-insulated, pre-terminated, receptacle-type of electrical connecting device, at high production rates.

More particularly, the present invention is concerned with apparatus for positioning an end of a bendable wire-like article, such as the stripped end of the above-mentioned insulated electrical conductor wire having the receptacle-type of electrical terminal crimped thereon, at a predetermined location on another article, such as in an open cavity of a housing part of an unassembled insulating housing, which apparatus when incorporated into the above-mentioned automatic machine facilitates the production of the above-mentioned highly satisfactory electrical connecting device at high rates by the automatic machine.

2. Description Of the Prior Art

One commonly used type of electrical terminal is a receptacle having a ferrule portion which is crimped onto a conductor wire. The receptacle is adapted to receive a generally rectangular tab on a mating conductor to which the wire is to be connected. Terminals of this general type are often used in appliance and automotive wiring for the reason that they accept a standard type of rectangular tab which is widely used in industry. Under some circumstances, it is desirable to insulate terminals of this type, particularly, where a shock hazard or the danger of a short circuit exists.

Terminals of this type are relatively inexpensive so that the means used for insulating the terminals and the cost of applying the insulating means to the terminals must also be relatively low.

5 In the manner of insulating terminals of this type, one common practice has been to utilize an insulating housing having two hingedly connected housing parts.

Various methods have been proposed and utilized heretofore in the application of the aforementioned type of insulating housing to the receptacle type of terminal crimped on the end of the conductor wire.

One general method is disclosed and illustrated in U.S. Pat. Nos. 3,380,140 and 3,416,212 and involves the progressive, partial folding of one of the two 15 hingedly connected and mateable housing parts of the insulating housing toward the other, placing the terminated end of the wire having the receptacle-type of terminal crimped thereon into the partially folded housing, and then completing the closing and assembly of the housing parts together about the terminated end of the wire. As disclosed in the aforementioned patents, the housings to be applied by this method were manufactured in a succession wherein the housings are disposed in a side-by-side relationship and connected at 20 one end to a common carrier strip or tape with the two housing parts of each housing being disposed in an open position in which the housing parts are displaced approximately 180° apart.

In copending patent application, U.S. Ser. No. 255,666, cross-reference being made thereto hereinabove, there is disclosed a succession of insulating housings in the form of a continuous strip of housings in spaced-apart, side-by-side relationship where adjacent housings in the strip between the two housing 35 parts thereof are connected to each other by a central connecting strip which functions as a hinge between the two housing parts and also interconnects corresponding housing parts of adjacent housings so that the leading housing of the strip can be assembled to the terminated end of the conductor wire. The method of applying the housings as disclosed by the aforementioned application involves fully closing together the respective two housing parts of each of the housings prior to arrival of the housing at the assembly station and then 40 allowing the housing parts of the leading housing to slightly open at the assembly station whereupon the terminated end of the conductor wire is placed between the housing parts and after which the housing parts are assembled together about the terminated end of the wire.

The apparatus disclosed by the aforementioned patent application for carrying out the disclosed method is believed to be satisfactory for its intended purpose, that being as a semi-automatic bench type of applicator in that the terminated ends of conductor wires are intended to be hand fed by an operator along a front end approach path into and between the slightly open housing parts of the leading housing at the assembly station. Particularly, the step of pre-closing the housing parts of each housing prior to its arrival at the assembly station is advantageous in that the plastic material forming the hinge, by having a resiliently deformable character which tends to resist the closing action, may more assuredly be folded about a desired bend axis, such as defined by a V-shaped notch in the underside of the material, at the assembly station if the natural resiliency of the material in the area of this axis is weak-

ened by manipulative steps occurring prior to arrival of the housing at the assembly station, which steps may advantageously be more precisely controlled along the path of advancement of the succession of housings than at the assembly station. Also, the apparatus applies housings at reasonable production costs since it is capable of making from 1,500 2,000 housing applications per hour.

However, the required hand feeding of the terminated ends of the conductor wires to the applicator appears to inherently limit the possibility of achieving any further increases in production rates above this range and thus limits the possibility of further reductions in the cost of applying the housings. Further, the slightly open position of the two housing parts of the leading housing at the assembly station, wherein one housing part is disposed between the assembly tools and in a generally transverse relationship to the path of movement of the tools and the other housing part is disposed obliquely across the path of movement of the tools and at an approximately 30° to 45° angular displacement from the one housing part, while providing the housing parts in a desirable final position, between the assembly tools and across the path of movement of the tools, for the subsequent assembly step, substantially limits the choices between possible approach paths along which the terminated wire may be fed to one choice, that being the front end feed path disclosed in the aforementioned patent application. Furthermore, difficulty will be encountered in trying to design apparatus which will automatically feed the terminated ends of the wires between the housing parts, when the housing parts are in their slightly open position, irrespective of the direction of feed relative to the housing, at production rates above the aforementioned range.

The aforementioned limitations and difficulties of the semi-automatic bench type of applicator apparatus disclosed by the aforementioned patent application are substantially overcome by the automatic lead making machine disclosed in the instant application. The automatic nature of the subject machine, and the substantially higher production rates achieved thereby, are, in part, accomplished by its incorporation of the method and apparatus of the present invention. The invention disclosed by the second and third copending patent applications cross-referenced above, and filed concurrently with the instant application, each relate to method and apparatus incorporated into the disclosed automatic lead making machine which further contribute to the automatic nature of the machine and the substantially higher production rates achieved thereby.

OBJECTS AND SUMMARY OF THE INVENTION

An object of the present invention, therefore, is to provide apparatus to position the end of a bendable wire-like article, such as an end of an electrical connecting device which preferably is a conductor wire having a receptacle-type of electrical terminal crimped thereon, at a predetermined location relative to another article, such as within an open cavity of a housing part of an unassembled insulating housing located at the assembly station of the aforementioned automatic machine in a manner which facilitates the automatic application of the housing to the terminal at high rates of production by the automatic machine, such as in the region of 3,000 applications per hour.

Another object of the invention is to provide apparatus which precisely controls the positioning of the terminal relative to the open cavity of the housing part and thereby insures a more positive and accurate placement of the terminal within the cavity.

These and other objects of the invention are achieved in a preferred embodiment thereof wherein apparatus is incorporated into the aforementioned automatic lead making machine to position the end of the bendable wire-like article at a predetermined location relative to another article. The wire-like article is stationarily held at a first section thereof, located remote from its end, by one of a plurality of grippers on a conveyor mechanism of the machine. A second section of the wire-like article is supported on a top surface of a ramp located between the one gripper and the assembly station of the machine. The top surface of the ramp supports the second station of the wire-like article in a first horizontal plane which is spaced above the predetermined location in such a manner that the end of the wire-like article will be positioned in a spaced-above relationship relative to the predetermined location. After the wire-like article has been positioned in the aforementioned relationships, a third section is engaged by an article positioning mechanism located between the second section and the end of the wire-like article to position its third section in a vertical plane which is generally aligned in a transverse relationship to the first horizontal plane to position its end in vertical alignment above said predetermined location. After the third section and the end of the wire-like article have been engaged and so positioned by the article positioning mechanism, the article positioning mechanism next moves the third section of the wire-like article downwardly within the vertical plane relative to its second section to the predetermined location, which is below the first plane, so as to bend the wire-like article between its second section and its end.

In the aforementioned manner of positioning the end of the wire-like article the second section of the wire-like article is supported substantially nearer to its end than its first section. This provides more precise control of its end during displacement thereof by focusing the bending of the wire-like article within a shorter extent thereof, and thereby insures a more positive and accurate placement of its end than would be provided and insured if the bending of the wire-like article should be allowed to occur over a longer extent thereof such being between its end and its first section and more remote from its end.

Other objects and attainments of the invention will become apparent to those skilled in the art upon a reading of the following detailed description when taken in conjunction with the drawings in which there is shown and described an illustrative embodiment of the invention; it is to be understood, however, that this embodiment is not intended to be exhaustive nor limiting of the invention but is given for purpose of illustration in order that others skilled in the art may fully understand the invention and the principles thereof and the manner of applying it in practical use so that they may modify it in various forms, each as may be best suited to the condition of a particular use.

BRIEF DESCRIPTION OF THE DRAWINGS

In the course of the following detailed description reference will be frequently made to the attached drawings in which:

FIG. 1 is a perspective view of an automatic lead making machine, for terminating an electrical connecting device, such as a receptacle-type of terminal, to a pre-cut and pre-stripped conductor wire and then for applying an insulating housing to the connecting device, into which the apparatus of the present invention has been incorporated;

FIG. 2 is a perspective view, on an enlarged scale, of the portion of the automatic machine of FIG. 1 incorporating the present invention, illustrating the preferred form of the apparatus of the invention for positioning the terminated end of the conductor wire within the cavity of the one housing part of the leading housing of the succession of housings;

FIG. 3 is an enlarged, fragmentary end view of the portion of the automatic machine shown in FIG. 2, also illustrating the leading housing of the succession of housings in the desired predetermined position prior to placement of the terminated end of the conductor wire within the housing;

FIG. 4 is an elevational view, on a further enlarged scale than that of FIG. 2, taken along line 4-4 of FIG. 2 showing the ramp and the article positioning mechanism of the automatic machine;

FIG. 5 is a perspective view, on an enlarged scale, of the preferred form of the unassembled housings in the succession thereof;

FIG. 6 is a perspective view, on an enlarged scale, of a receptacle-type of electrical terminal crimped on an electrically-bared end of an insulated electrical conductor lead wire to which one of the housings of FIG. 5 is to be assembled;

FIG. 7 is a perspective view, on an enlarged scale, of the terminated lead wire of FIG. 6 having an individual insulating housing assembled thereto;

FIGS. 8A through 8D are side elevational schematic views of various components of the apparatus of the invention showing the positions of the components in relation to each other, to the conductor wire, and to one housing part of one of the insulating housings of FIG. 5, at consecutive stages during positioning of the terminated end of the conductor wire of FIG. 6 within the open cavity of one housing part of the one unassembled housing;

FIGS. 8E and 8F are elevational schematic views of the various components of the apparatus showing the positions of the components in relation to each other at consecutive stages during positioning of the terminated end of the conductor wire for subsequent removal thereof;

FIGS. 9A through 9D are top plane schematic views of the components of the apparatus at the same consecutive stages as shown in FIGS. 8A through 8D;

FIGS. 10A through 10D are front elevational schematic views of only the article positioning mechanism and the ramp of the apparatus, as seen looking toward the housing, showing the positions of these components in relation to each other and to the conductor wire at the same consecutive stages as shown in FIGS. 8A through 8D with the wire being shown as a cross-section thereof taken at the article positioning mechanism;

FIGS. 11A through 11E are side elevational schematic views of the components of the apparatus showing the positions of the components in relation to each other, to the conductor wire, and to one housing part of one of the insulating housing, at consecutive stages during positioning of the terminated end of the conductor wire within the open cavity of the one housing part of the one unassembled housing, where the conductor wire is being supported by the ramp in a plane spaced above that plane in which the wire is being stationarily held by the gripper such that the wire has an initial inclined disposition, while in FIGS. 8A through 8D the ramp and the gripper respectively support and hold the wire in substantially the same plane, that being in a generally horizontal disposition; and

FIGS. 12A through 12E are front elevational schematic views of only the article positioning mechanism and the ramp of the apparatus, as seen looking toward the housing, showing the positions of these components in relation to each other and to the conductor wire at the same consecutive stages as shown in FIGS. 11A through 11E with the wire being shown as a cross-section thereof taken at the article positioning mechanism.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now in greater detail to the various figures of the drawings wherein like reference characters refer to like parts, there is shown at 10 in FIG. 1 an automatic lead making machine which incorporates the preferred form of the apparatus of the present invention.

During each operating cycle of the machine 10, an insulated electrical connecting device 12 (see FIG. 7) is produced having an electrical terminal 14, for example, a receptacle-type of terminal, crimped on an electrically-bared end of an insulated electrical conductor lead wire 16 (see FIG. 6) and an individual insulating housing 18 (see FIG. 5) assembled to the terminated end of the wire 16 about the terminal 14 and an adjacent portion of the insulated conductor wire 16.

Each of the housings 18 are comprised by a pair of housing parts 18a, 18b, made of deformable, bondable plastic material, which are preferably complementarily shaped to accept the profile of the terminal 14 therebetween when the parts 18a, 18b are closed about the terminal 14. Further, each of the housings 18 are interconnected together to form a succession of housings 18 by a deformable web 18c having a notch 18d formed in its longitudinal mid-line. The notch 18d defines a bendline within the web 18c about which the parts 18a, 18b will hingedly and pivotally move with respect to each other. Each of the webs 18c, in the preferred form shown in FIG. 5, includes end portions 18e which each respectively interconnect complementary pair of housing parts 18a, 18b of individual housings 18. Further, each of the webs 18c includes side portions 18f which merge with each of the end portions 18e of adjacent housings 18, and are preferably, but do not necessarily need to be, connected to each other along the notch 18d. The side portions could be separate from each other along the notch 18d. Alternatively, side portions 18f could be formed so as to interconnect corresponding housing parts 18a, 18b of adjacent housings 18 at respective locations disposed anywhere outwardly toward the free ends of the housing parts 18a, 18b so as

not to merge with each of the end portions **18e** of adjacent housings **18**, but instead directly with the adjacent corresponding housing parts themselves. A more detailed description of the housings **18** is set forth in aforementioned copending patent application, U.S. Ser. No. 255,666, which description is incorporated herein by reference thereto.

In the machine **10**, the initial steps toward the production of the connecting device **12** are taken by conventional apparatus located at a first station, generally designated **20** (only partially shown in outline form in FIG. 1). This apparatus is of a type which is operative, during each operating cycle of the machine **10**, to feed wire from an endless source such as a reel, to cut the lead wire **16** to a desired length from the leading end of the endlessly fed wire, and to strip insulation from the trailing end of the lead wire and from the leading end of the fed wire. A detailed description of an apparatus which suitably performs the above-described operations is set forth in U.S. Pat. Nos. 2,680,394, and 2,929,284. Also, a suitable commercially available apparatus is known as the Artos CS9AT.

The conductor wire **16** produced during each operating cycle of the machine **10** by the apparatus at the first station **10** is delivered to one of the spaced apart wire grippers **22** of a conveyor, generally designated **24**. The conveyor **24**, being of the type disclosed in U.S. Pat. No. 3,583,055, advances leftwardly on its upperside as viewed in FIG. 1 so that, also during each operating cycle of the machine **10**, the trailing electrically-bared end of one of the conductor wires **16** gripped in one of the grippers **22** is presented to a conventional crimping press **26** located at a second station, generally designated **28**. The crimping press **26** shown in FIG. 1, which performs the next step toward the production of the connecting device **12**, is of a type disclosed in U.S. Pat. No. 3,343,398.

The advancement of conveyor **24** is arrested once during each operating cycle of the machine **10**. Each advancement of conveyor **24**, which precedes its arrest, brings one of the conductor wires **16** to the second station **28**. During each period arrest of conveyor **24**, the bared end of the one of the conductor wires **16**, located at the station **28**, is positioned between a crimping die and an anvil of the press **26** by any suitable means such as, for example, a pair of positioning jaws as disclosed in U.S. Pat. No. 3,583,055. At approximately the same time, suitable feed apparatus associated with the press **26** positions a leading terminal **14** of an endless interconnected chain of terminals **30** on the anvil of the press **26** beneath the bared end of conductor wire **16**. Then, the crimping die of the press **26** is actuated to crimp the terminal **14** to the end of the conductor wire **16**.

The operations performed at the first and second stations **20**, **28**, and by the conveyor **24**, of the machine **10** need not be described in any more detail than that set forth hereinabove since, as stated above, the respective apparatuses carrying out these operations are conventional equipment and well known to those skilled in the art. Further, various patents have been cited which disclose apparatuses suitable to perform the operations described hereinabove at the desired high production rates. The operations performed at the first and second stations **20**, **28** form no part of the present invention which will be described in detail hereinbelow.

One of the conductor wires **16** now with terminal **14** crimped thereon is advanced to a third and final station of machine **10**, an assembly station generally designated **32**, where one of the insulating housings **18** will be assembled about the terminal **14**.

Therefore, the final steps toward the production of the insulated connecting device **12** of FIG. 7 are taken at the assembly station **32** during periods of arrest of both the conveyor **24** and the housing succession, which arrest periods occur substantially concurrently. During these concurrent arrest periods, the method and apparatus of the instant invention, and the methods and apparatuses of the inventions disclosed by the second and third copending patent applications cross-referenced above, together operate to position the housing parts **18a**, **18b** of the leading housing **18** and the terminal **14** in the relationship shown in FIG. 2 which relationship facilitates subsequent assembly of the leading housing **18** about the terminal **14**.

The method and apparatus of the invention disclosed in detail by the second copending patent application cross-referenced above, which disclosure is incorporated herein by reference thereto, achieves the initial disposing of the housing parts **18a**, **18b** of each housing **18** in a leading group, generally designated **38** in FIG. 2, of the housings in the succession thereof at an approximately 90° angular displacement with respect to each other by utilizing a guide track **40** which defines a predetermined path having an end, generally designated **42**, disposed proximate to an article positioning mechanism **44** and the pair of bonding tools **34**, **36** and by utilizing a feeding mechanism **46** which intermittently advances the succession of housings **18** along the guide track path. The housing parts **18a**, **18b** of each housing **18** are manipulated in a particular manner by the guide track **40** as the housing succession is advanced therealong by the feeding mechanism **46**, as described in the aforementioned second cross-referenced copending patent application, to disposed the leading housing **18** of the group **38** at the beginning of each arrest period in the path of the bonding tools **34**, **36** with the one housing part **18a** disposed between the tools **34**, **36** in a generally horizontal relationship to the vertical path of the tools and the other housing part **18b** disposed at an approximately vertical relationship to the one housing part **18a** (see FIG. 3).

In such relationship, sufficient clearance is provided between the housing parts for placement of one of the terminals **14** on the one housing part **18a**, next during each arrest period, without contact with, or interference from, the other housing part **18b** by the method and apparatus of the instant invention which will now be described in detail.

As stated hereinabove, an article positioning mechanism **44**, as shown in FIG. 2 and in more detail in FIG. 4, is disposed proximate to the guide track path end **42**. The mechanism **44** is also disposed adjacent to, and between, the bonding tools **34**, **36** and a ramp **48**. The ramp **48** is disposed adjacent to the conveyor **24** and between the conveyor **24** and the article positioning mechanism **44**.

During each arrest of the conveyor **24**, one of its grippers **22** is positioned adjacent to, but spaced from, a generally horizontal top surface **50** of the ramp **48**. Each of the grippers **22** is a conventional device being of the type disclosed in aforementioned U.S. Pat. No. 3,583,055. As the conveyor **24** moves one of the grip-

pers 22 into the area of the assembly station 32 and toward the arrest position of the one gripper 22 at the station 32 a first section 52 of, the wire 16 is held by the first supporting means or gripper 22, the first section 52 being located remote from the free end of the wire 16 having the terminal 14 crimped thereon, and a second section 56 of the wire rides up a side inclined surface 54 of the ramp 48 and onto the top generally horizontal surface 50 of the ramp 48 which extends across the length of the wire. When the arrest position of the gripper 22 is reached, the second section 56 of the wire is supported on second support means which is the top surface 50 of the ramp 48. The second section 56 is located between the first section 52 and the free or terminated end of the wire 16. Frictional forces imposed on the wire 16 as it rides up the inclined surface 54 of the ramp 48 may cause it to extend from the gripper 22 in the arcuate manner shown in FIG. 9A when the gripper 22 reaches its arrest position.

Referring to FIG. 8A, the gripper 22 preferably holds the wire 16 at its first section 52 in a generally horizontal plane P_1 which is spaced above a location on the one housing part 18a, such being an open cavity 58 defined therein, onto which the terminal 14 on the wire 16 is to be placed. The top surface 50 of the ramp 48 supports the wire 16 at its second section 56 in another generally horizontal plane P_2 which is spaced above the cavity 58 through a displacement which in this Figure is equal to the displacement through which the plane P_1 is spaced above the cavity 58. This insures that the terminal 14 on the end of the wire 16 will be positioned in a spaced-above relationship to the cavity 58 as illustrated in FIG. 8A. (It may be desirable to have the displacement of plane P_2 greater than the displacement of plane P_1 , particularly if the predetermined location is relatively high with respect to plane P_1 .) With the wire 16 held and supported in the aforementioned manner respectively by the gripper 22 and the surface 50 of ramp 48, the article positioning means 44 first engages the wire 16 at a third section thereof, generally designated 60 in FIG. 9B, located between, and spaced from, the second section 56 and the terminated end of the wire 16 to position its third section 60 in a generally vertical plane P_3 which is generally aligned in a perpendicular relationship to the planes P_1 , P_2 and to position the terminal 14 on the end of the wire 16 in vertical alignment with the cavity 58 with the terminal 14 remaining in a position spaced above the cavity 58 (see FIGS. 8C and 9C). Then, the article positioning mechanism 44 moves the third section 60 of the wire 16 downwardly within the plane P_3 so as to bend the wire 16 between its second section 56 and the terminal 14 on its end and thereby displace the terminal 14 from its position aligned and spaced above the cavity 58 to a desired predetermined location which may be within the cavity 58 of the one housing part 18a (see FIGS. 8D and 9D).

In the aforementioned manner of positioning the terminal 14 on the end of wire 16 in the cavity 58 of the one housing part 18a, the supporting of the wire 16 in plane P_2 at its second section 56, in being substantially nearer to its end (terminal 14) and to the cavity 58 than is its first section 52 where the wire 16 is being stationarily held in plane P_1 , provides more precise control of its end during displacement thereof from the position aligned and spaced above the cavity 58 to the desired position in the cavity 58 by focusing the bending of the

wire 16 within a shorter extend thereof such being between its end and its second section 56 and nearer to its end, and thereby insures a more positive and accurate placement of the terminal 14 in the cavity 58, in the moving of its third section 60 within the plane P_3 than would be provided and insured if the bending of the wire 16 should be allowed to occur over a longer extend thereof such being, for example, between its end and its first section 52 and more remote from its end.

Referring now to FIG. 4, the article positioning mechanism 44 is comprised by a pair of opposed members or fingers 62, 64. The fingers 62, 64 at a respective first end portions, generally designated 66, 68, are pivotally mounted on a block member 70 of the machine 10 for pivotal movement about respective separate axes 72, 74 which are located at respective positions spaced below the plane P_2 of the top surface 50 of the ramp 48 and spaced from, and on opposing sides of the plane P_3 within which the third section 60 of the wire 16 is to be moved. Thus, the axes 72, 74 extend to either side of the predetermined location. The fingers 62, 64 also at their respective first end portions 66, 68 have respective slots 76, 78 which respectively receive interconnecting means or studs 80, 82. The studs 80, 82, are part of the moving means, the moving means also including slide member 84, piston rod 88, and a cylinder 90. The studs 80, 82 are fixed to an end of the slide member 84, which is reciprocally mounted within a central bore 86 in the block member 70. An opposite end of the slide member 84 is linked to the end of piston rod 88 which extends from a pneumatic piston cylinder 90 appropriately mounted on the machine 10. During each operating cycle of the machine 10 and during the arrest of the conveyor 24, the piston rod 88 retracts the slide member 84 linked thereto which pivotally moves the fingers 62, 64, via their linkage to the slide member 84 by studs 80, 82, from an initial spaced apart or open position, shown in full lines in FIG. 4 through an intermediate overlapping position to their closed final operative position partially shown in dotted lines in FIG. 4. The fingers 62, 64 at respective second end portions, generally designated 92, 94, such being free ends of the fingers 62, 64, have respective surfaces 96, 98 which move along respective separate paths of revolution R_1 , R_2 about the respective separate axes 72, 74 when the fingers 62, 64 are pivotally moved about their respective separate axes 72, 74 by the movement of the slide member 84 within bore 86. The inclined surfaces 96, 98 extend away from principle surfaces 97, 99 of fingers 62, 64 at obtuse angles.

Referring to FIGS. 10A through 10D, the respective separate paths R_1 , R_2 intersect with the horizontal plane P_2 at respective separate first locations 100, 102 spaced remote from, and on opposing sides of, the vertical plane P_3 . Further, the respective separate paths R_1 , R_2 cross each other at a location 104 spaced above the horizontal plane P_2 and within the vertical plane P_3 . Still further, the respective separate paths R_1 , R_2 intersect again with the horizontal plane P_2 at respective separate second location 106, 108 spaced from, and adjacent to, the vertical plane P_3 and on opposing sides of the vertical plane P_3 but in a relationship opposite to the relationship between the respective separate first locations 100, 102 and the opposing sides of the vertical plane P_3 .

If the wire 16 extends from the gripper 22 in the arcuate manner as illustrated in FIG. 9A, pivotal movement of the fingers 62, 64 about their respective separate axes 72, 74 from their open spaced apart position (FIG. 10A) through an overlapping position (FIG. 10C) to their final operative or closed position will initially bring the surface 96 or 98 of the one finger into engagement with a side of the wire 16 at its third section 60 (FIGS. 8B, 9B and 10B). As pivotal movement of the fingers 62, 64, continues, the one finger pushes the third section 60 of the wire 16 ahead of it and into alignment with the vertical plane P_3 and the surface 98 on the other finger 64 comes into engagement with an opposite side of the wire 16 at its third section 60 substantially as the wire 16 reaches alignment within the vertical plane P_3 (FIGS. 8C, 9C and 10C). The respective surfaces 96, 98 of the fingers 62, 64 are now overlapping and positioned respectively adjacent to the location 104 at which the respective separate paths R_1 , R_2 cross each other. The surfaces 96, 98 now define an inverted V-shaped surface. Also, the terminal 14 on the end of the wire 16 has accordingly been pushed into vertical alignment with the cavity 58 of the one housing part 18a, as shown clearly in FIG. 9C but still remaining in a position spaced above the cavity 58. As pivotal movement of the fingers 62, 64 further continues, until they reach their final operative or closed position the surfaces 96, 98 progressively overlap each other in a scissoring-type of relation until the fingers 62, 64 reach their closed position (FIG. 10D), and, a leading line of intersection 110 between the progressively overlapping surfaces 96, 98 is formed above the third section 60 of the wire 16 within the vertical plane P_3 and progressively moves in a direction generally toward below the horizontal plane P_2 with the surfaces 96, 98 on either side of the intersection line 110 coating together to push the third section 60 of the wire 16 within the vertical plane P_3 and in the direction generally toward below the horizontal plane P_2 (FIG. 10D) so as to bend the wire 16 between its second section 56 and the terminal 14 on its end and thereby displace the terminal 14 from its position aligned and spaced above the cavity 58 to the desired position within the cavity 58 (FIGS. 8D and 9D). As can be seen from FIG. 10D the opposed surfaces 96, 98 still define an inverted V-shaped surface. When the fingers 62, 64 are in their final operative position the principle surfaces contact opposed sides of the wire-like article 16.

After the fingers 62, 64 have been pivoted to their closed position and the terminal 14 placed in the cavity 58 of the one housing part 18a as illustrated in FIG. 8D, the fingers 62, 64 are retained in their closed position in order to maintain the terminal 14 in the cavity 58 during positioning of the other housing part 18b of the leading housing 18 obliquely across the path of relative movement of the ultrasonic bonding tools (FIG. 2) according to the method and apparatus disclosed in detail by the third copending patent application cross-referenced above, which disclosure is incorporated herein by reference thereto and further during assembly of the housing parts 18a, 18b about the terminal 14 as described in detail in the aforementioned copending patent application, U.S. Ser. No. 255,666, which description is incorporated herein by reference thereto.

After the assembly operation is completed and during the remaining portion of the period of arrest of both the conveyor 24 and the housing succession, first the

fingers 62, 64 are pivotally moved back to their initial open full line position shown in FIG. 4 by longitudinal movement of the slide member 84 toward the fingers 62, 64 as caused by extension of the piston rod 88 out of the cylinder 90. Next, the ramp 48 which is pivotally coupled at one end 112 to a bracket 114 on the frame of the machine 10 and is linked at the opposite end 116 to an end of a piston rod 118 of another pneumatic cylinder 120 (see FIG. 4) is pivotally moved in a direction generally toward above the horizontal plane P_1 to elevate the insulated connecting device 12 on the wire 16 to a position which is clear of the bonding tools 34, 36 (FIG. 8F). When the device 12 reaches such position, advancement of the conveyor is initiated and the device 12 is removed from the assembly station 32 and subsequently removed from the gripper 22.

In FIGS. 11A through 11E and 12A through 12E, which illustrate the same operative steps of the article positioning mechanism 44 as explained hereinbefore and illustrated in FIGS. 8A through 8D and 10A through 10D, the wire 16 initially supported by ramp 48 in plane P_2 which is spaced above plane P_1 where the wire 16 is held by the gripper 22 such that the wire has an initial inclined disposition, while in FIGS. 8A through 8D plane P_2 of the ramp 48 and plane P_1 of the gripper 22 are substantially common. Therefore, the third section 60 of the wire 16 will initially be disposed above plane P_2 as shown in FIG. 12A. However, the arcuate paths of revolution R_1 , R_2 of the fingers 62, 64, as readily apparent in FIGS. 12A through 12C, are designed to allow the surfaces 96, 98 to gather the wire 16 at its third section 60 when in such elevated disposition and place the terminal 14 into the cavity 58 in essentially the same manner and with the same precision as was explained hereinbefore in reference to FIGS. 10A through 10D.

It is thought that the invention and many of its attendant advantages will be understood from the foregoing description and it will be apparent that various changes may be made in the form, construction and arrangement of the apparatus described and that changes may be made in the steps of the method described and their order of accomplishment without departing from the spirit and scope of the invention or sacrificing all of its material advantages, the form hereinbefore described being merely a preferred or exemplary embodiment thereof.

What is claimed is:

- Apparatus for displacing the free end of a bendable wire-like article to a predetermined location relative to another article; said apparatus comprising:
 - first and second spaced apart means for supporting spaced apart first and second portions of said wire-like article, said first and second spaced apart portions of the wire-like article being remote from its free end, said free end being disposed above said predetermined location when said wire-like article is supported only by said first and second means; and
 - positioning means for engaging and moving a third section of said wire-like article to displace its free end to said predetermined location, said third section being located between and located away from said second section and said free end of the wire-like article, said positioning means including opposed members movable from an initial spaced apart position through an overlapping position to a

final operative position, and means operative to move said opposed members towards and away from each other, the parts being so arranged and constructed that the third section of said wire-like article is initially engaged and moved into a position in vertical alignment with said predetermined location as said opposed members are moved from their spaced apart position to their overlapping position, continued movement of said opposed members from their overlapping position to their final operative position moving said third section downwardly to cause the free end to be placed downwardly to said predetermined location.

2. The apparatus set forth in claim 1 wherein said first means for supporting the first portion of said wire-like article is gripper means carried by a conveyor.

3. The apparatus as set forth in claim 1 wherein said second means for supporting a second spaced apart portion of the wire-like article is a generally horizontal support surface which extends across the length of the wire-like article.

4. Apparatus for displacing the free end of a bendable wire-like article to a predetermined location relative to another article; said apparatus comprising: gripping means for stationarily holding a first section of said wire-like article remote from said free end;

generally horizontal support surface means extending across the length of the wire-like article for supporting a second section of said wire-like article, said second section being located between and spaced away from said first section and said free end of said wire-like article, said free end being disposed above said predetermined location when said wire-like article is engaged only by said gripping means and said support surface means; and positioning means for engaging and moving a third section of said wire-like article to displace said free end to said predetermined location, said third section being located between and spaced away from said second section and said free end of said wire-like article, said positioning means including opposed surface means movable from a spaced apart position through an overlapping position to a final operative position, said opposed surface means defining an inverted V-shaped surface when in their overlapping and final operative po-

sitions, and means operative to move said opposed surface means towards and away from each other, said third section of said wire-like article being initially engaged and moved into a position in vertical alignment with said predetermined location as said opposed surface means are moved from their spaced apart position to the overlapping position, and continued movement of said opposed surface means from their overlapping position to their final operative position moving said third section downwardly to cause said free end to be displaced downwardly to said predetermined location.

5. The apparatus set forth in claim 4 in which said opposed surface means are opposed surfaces formed on a pair of fingers pivoted about spaced apart axes which extend to either side of said predetermined locations.

6. The apparatus set forth in claim 5 wherein each of said fingers is provided with a principle surface and an inclined surface which extend away from the principle surface at an obtuse angle, said inclined surfaces defining said inverted V-shaped surface when said fingers are in an overlapping position, the parts being so arranged and constructed that the final operative position is achieved when said principle surfaces contact opposed sides of wire-like article.

7. The apparatus set forth in claim 5 wherein said axes are supported by a block member having a vertically extending bore between said axes, and wherein the means operative to move said opposed surface means towards and away from each other is a slide member reciprocal in said bore of said block member and means interconnecting said slide member with said fingers.

8. The apparatus set forth in claim 7 wherein the means interconnecting the slide member with said fingers are spaced apart studs received within elongated apertures in said fingers, said spaced apart studs being carried by said slide members.

9. The apparatus set forth in claim 7 wherein said slide member is mounted on one end of a piston rod, and further characterized by the provision of a pneumatic piston cylinder operable to reciprocate said piston rod.

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