Aug. 12, 1969 N. L. MOULIN 3,460,230

ELECTRICAL CONTACT ATTACHMENT APPARATUS

Filed April 3, 1967 4 Sheets-Sheet 1

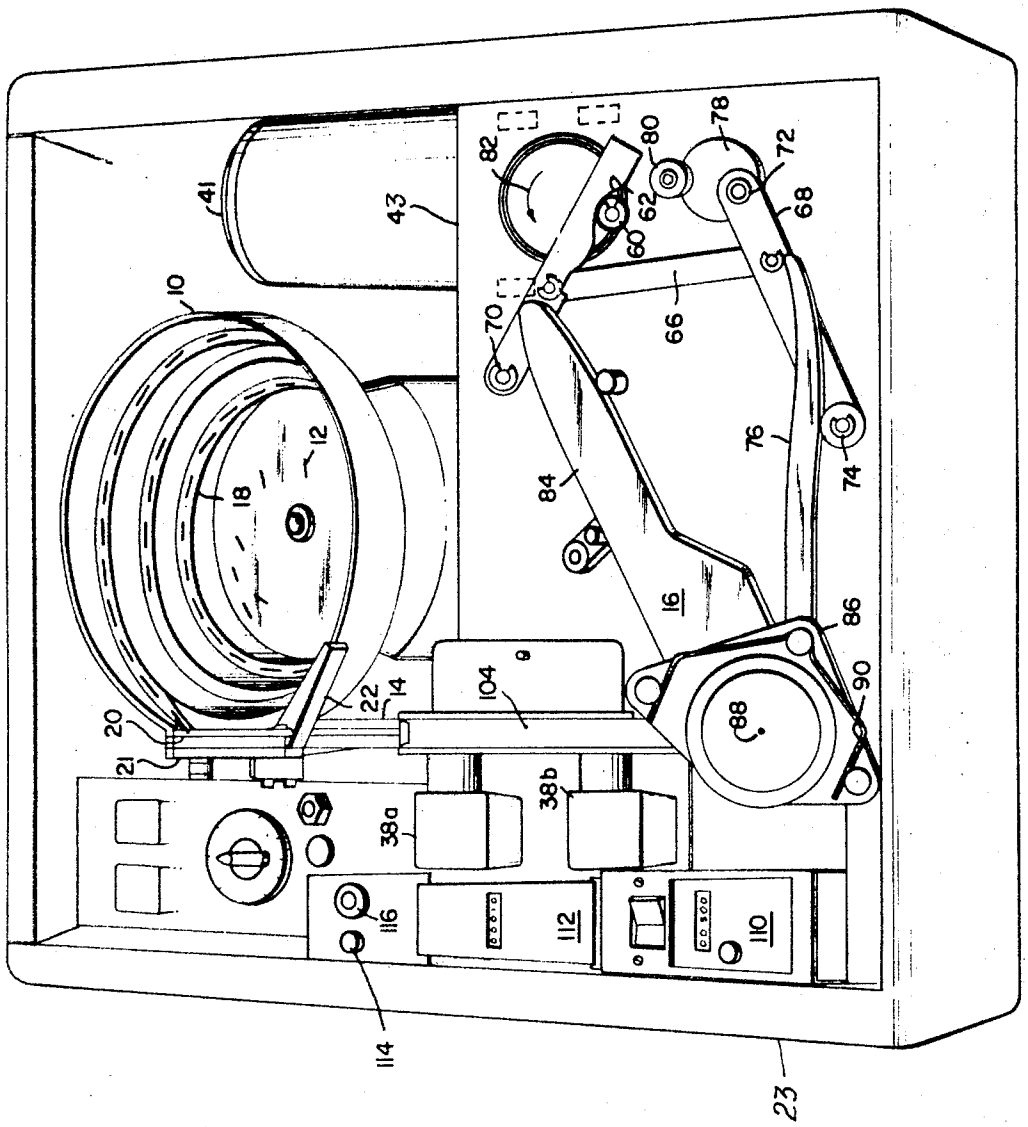

Fig. 1.

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ELECTRICAL CONTACT ATTACHMENT APPARATUS

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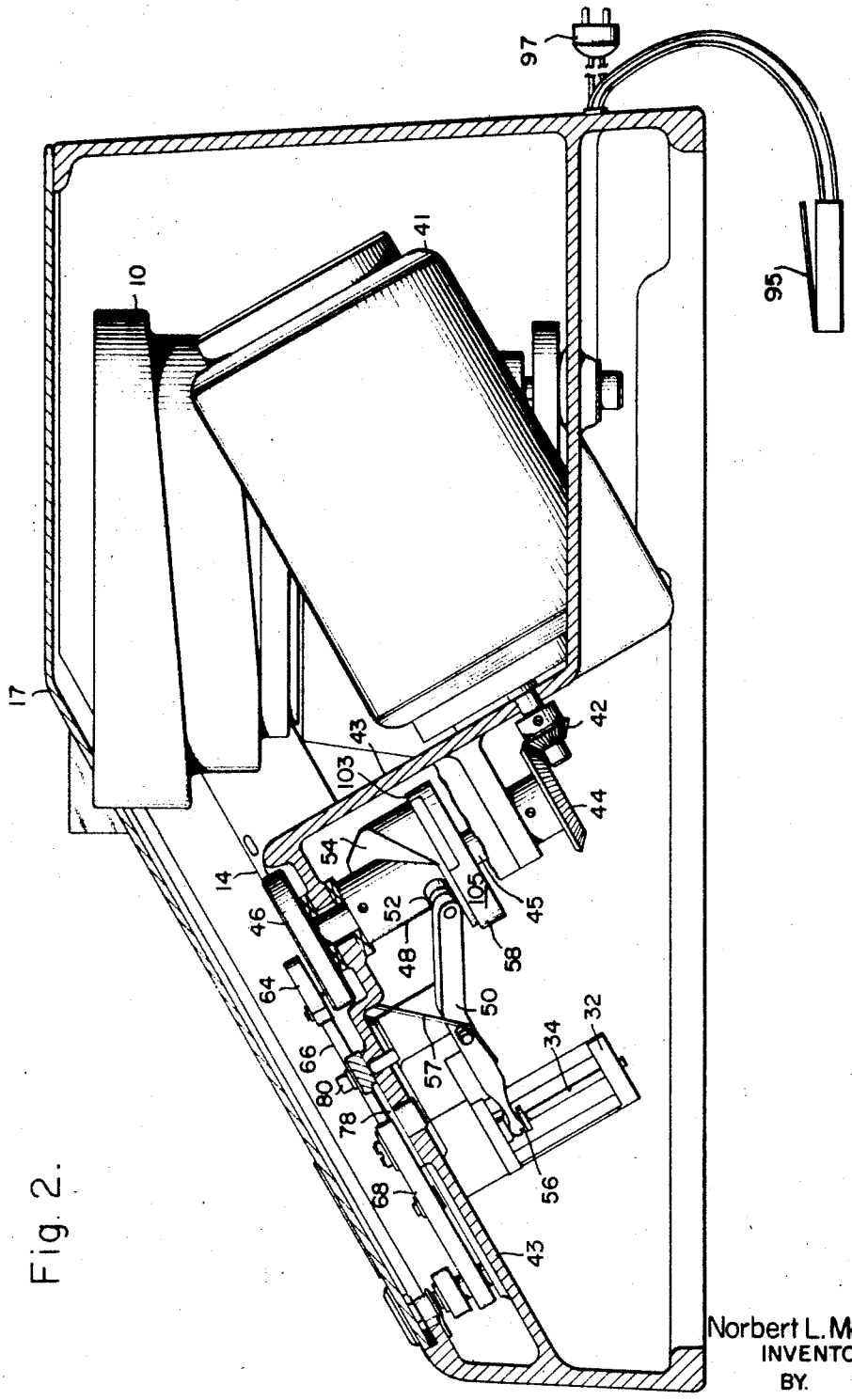

Fig. 2.

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Fig. 3.

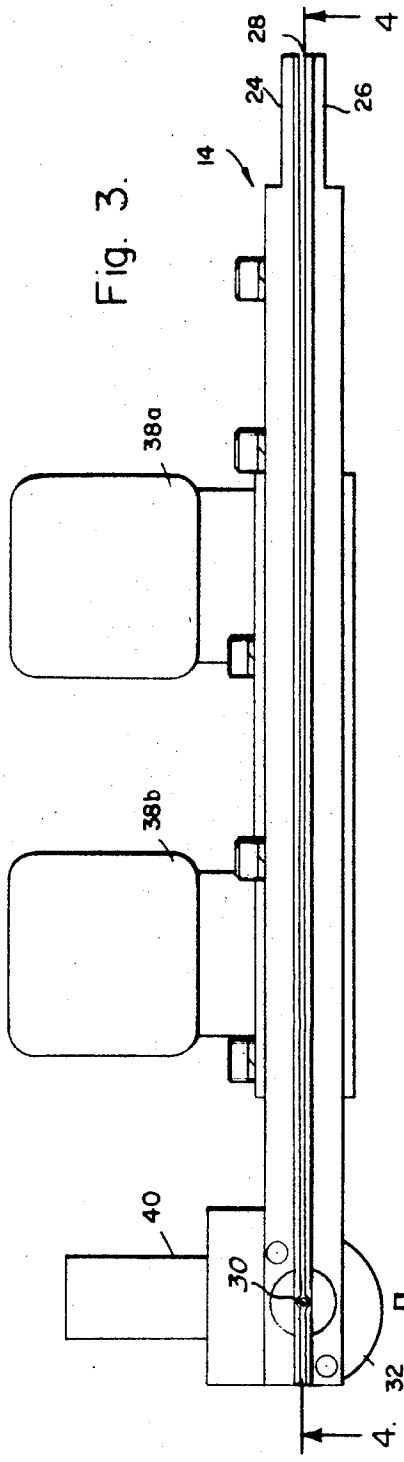
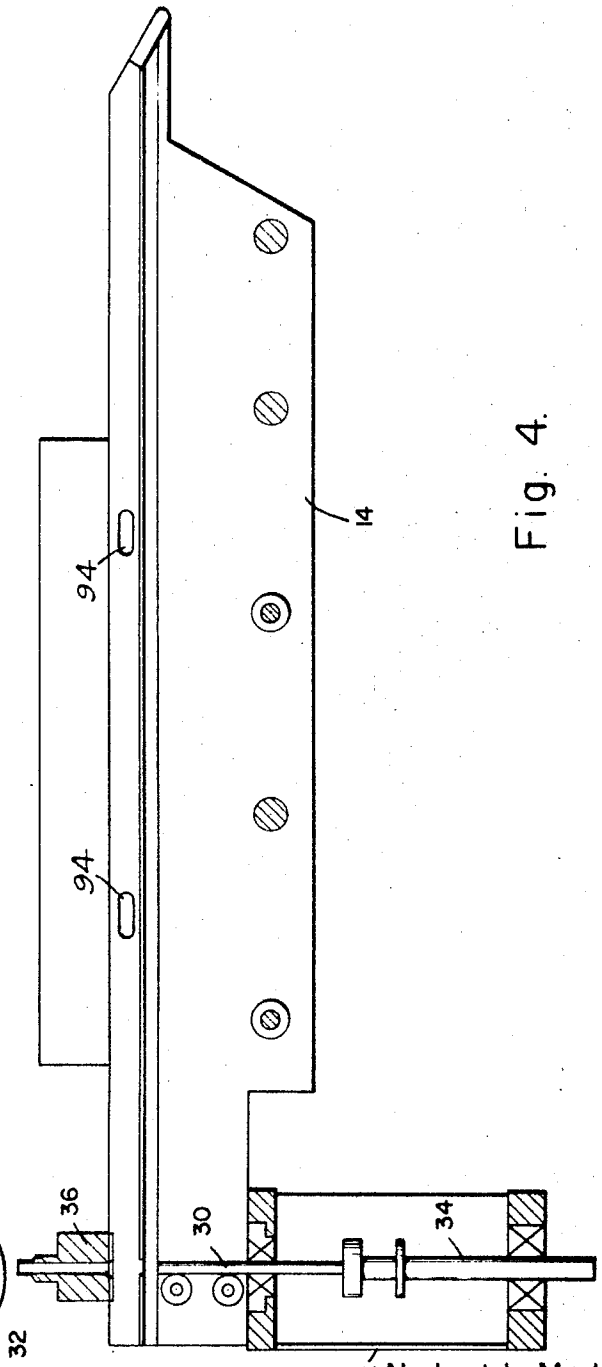


Fig. 4.



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ELECTRICAL CONTACT ATTACHMENT APPARATUS

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Fig. 5.

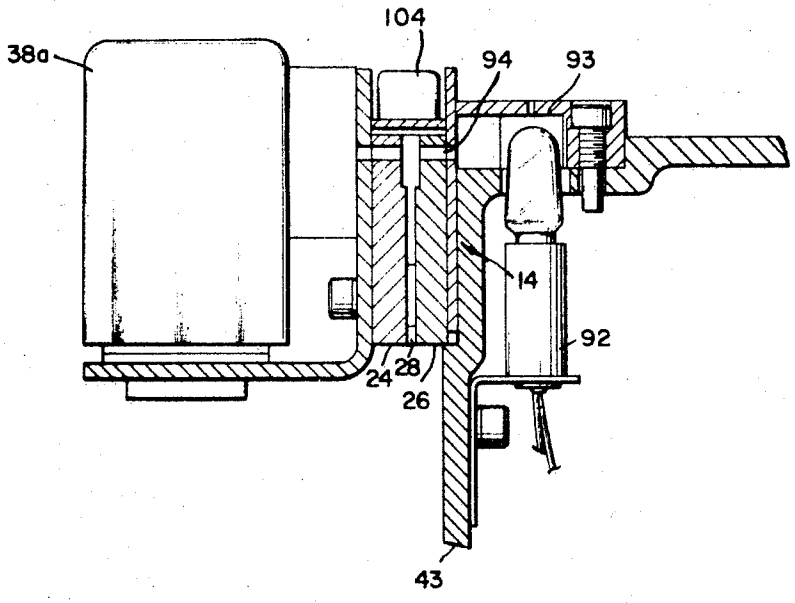
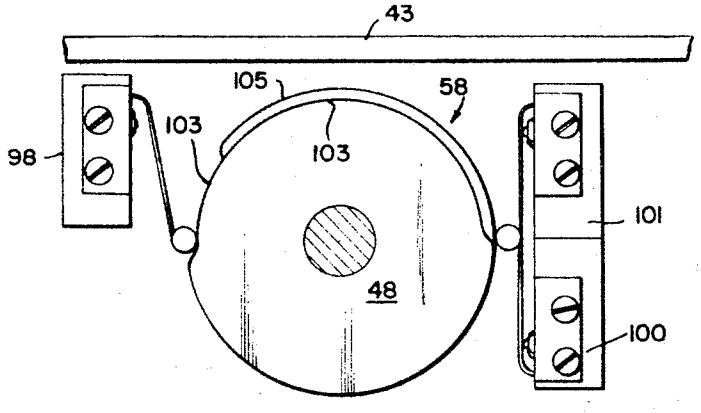


Fig. 6.



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3,460,230

ELECTRICAL CONTACT ATTACHMENT APPARATUS

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Int. Cl. B21d 37/00
U.S. Cl. 29—203 4 Claims

ABSTRACT OF THE DISCLOSURE

This disclosure describes an apparatus for semi-automatic crimping of electrical contacts to electrical conductors. The apparatus includes electro-mechanical elements which are controlled to operate a crimping tool to attach one electrical contact to a conductor during each cycle of operation of the machine. The cyclic control is achieved through a motor-driven cam driving a mechanical linkage for operating the crimping tool and an electrical timing mechanism for controlling the rotation of the motor.

This invention relates to an apparatus for attaching an electrical contact to the end of an electrical conductor and more particularly to a semi-automatic device for crimping electrical contacts to electrical conductors.

Complex electronic equipment requires many thousands and often tens of thousands of electrical conductors to inter-connect the various electrical components. Since many of these conductors are connected to connectors or terminal boards, a necessity has arisen for the development of fast operating, reliable equipment for attaching electrical connectors to such conductors. This attachment requirement becomes critical when the conductors and contacts are small in size because of the extreme difficulties in handling such conductors and using hand-operated devices for their attachment.

One method of attaching a small contact to an electrical conductor and perhaps for most operations, a preferred method, is to crimp the barrel of the contact so that it grips the metallic portion of an electrical conductor.

Therefore, it is an object of the present invention to provide an improved machine for semi-automatically attaching an electrical contact to an electrical conductor.

It is a further object of the present invention to provide a preferred embodiment wherein the barrel of the electrical contact is crimped to an electrical conductor in a semi-automatic fashion.

A still further object of the present invention is to provide in a semi-automatic contact crimping apparatus a control for maintaining a storage of electrical contacts. This control is operative only for a predetermined time interval sufficient to maintain the storage of such contacts at a predetermined level.

The above and other objects of this invention are accomplished in a preferred embodiment which comprises the general elements for storing a large number of electrical contacts and dispensing them into an orientation so that each may be automatically positioned to receive an electrical conductor and to be crimped thereto. This storage, positioning, and crimping operation is achieved through an electro-mechanical structure which comprises a vibratory hopper and track assembly, an electric motor and cam, and a crimping tool which is positioned to receive a contact from the track and to be activated by the motor and cam mechanism as part of the cyclic operation of the machine. A capacity level control is associated with the track assembly so that the vibratory hopper is activated only when it is necessary to bring the quantity

of the contact stored in the track assembly to a predetermined maximum number.

Other objects, features, and advantages of this invention will become apparent from reading the following detailed description of one embodiment of this invention and referring to the accompanying drawings in which:

FIGURE 1 is a plan view of an improved electrical contact attachment apparatus construction in accordance with the principles of the present invention and with the cover removed for clarity.

FIG. 2 is a side elevational view taken from the right side of the apparatus shown in FIG. 1. The mounting blocks for the control switches have been cut away to show the cam surfaces, and the crimping tool has been removed for clarity.

FIG. 3 is a plan view of the track assembly and the light sensitive switch members shown in FIG. 1 with the guide bushing shown in FIG. 4 removed for clarity of illustration.

FIG. 4 is a sectional view taken along the line 4—4 of FIG. 3 but showing the guide bushing attached to the track assembly and aligned with the slot.

FIG. 5 is a sectional view of the track assembly, one light sensitive switch member and the corresponding light source and mirror.

FIG. 6 is a schematic drawing showing the control switches and the cam surfaces of the cam mechanism.

Referring now to FIG. 1, the principles of the present invention are embodied in a preferred embodiment which includes the general structural elements of a feeder bowl or hopper **10** for storing or dispensing in a predetermined orientation, a plurality of relatively small elongated contacts **12**, such as a conventional crimp type removable contact. The hopper **10** is typically a vibrating device, such as a Model 5A–VFC manufactured by Automation Devices, Inc., Erie, Pa., and includes a helical ramp **18** around the periphery of the bowl. The use of such a device as this is conventional in the handling of small objects such as contacts since it can readily handle a small object in a predetermined orientation. As each contact **12** reaches the top of the ramp **18**, it drops into a groove **20** in a plate or platform **21**. The groove **20** is of a width and depth sufficient to permit each contact **12** to be oriented with the barrel thereof extending upwardly, or away from the groove **20**. Near the end of groove **20**, from that nearest the top of the ramp **18**, is a return tray **22**. The tray **22** receives misaligned or misoriented contacts and returns them to the hopper **10** through a slot (not shown) in the wall of the bowl.

A track member or guide device **14** is positioned near the hopper **10** at the end of the groove **20** with one end raised so that the contacts **12** may be dispensed from the hopper **10** into the track. Positioned near the other end of the track **14** is a crimping tool **16** such as a Model MS3191–4 manufactured by Daniels Manufacturing Corp., Pontiac, Mich. Thus, as the contacts **12** are dispensed from the hopper **10** they move down the track **14** under the force of gravity into a predetermined location relative to the crimping tool **16**. Associated with the crimping tool **16** is an electro-mechanical mechanism which positions each contact and operates the jaws of the crimping tool **16**. For convenience, these elements and components are packaged in a relatively compact enclosure **23** which includes a cover **17**, FIG. 2, along with appropriate indicators and control instrumentation to provide operative equipment.

In FIGS. 2, 3, and 4 is shown in detail the electro-mechanical mechanism utilized to develop the cyclic operation of the apparatus. Referring primarily to those figures, the track assembly **14** comprises an elongated structure having two halves **24**, **26** which are spaced a pre-

determined distance apart and are flanged to define a groove **28**. As the contacts are dispensed each is supported by the flanges with a portion of the contact below the flange in the groove **28**. Near one end of the track assembly **14** is a track relief or slot **30** of a diameter slightly larger than that of the electrical contact to be handled by the track. In association with the slot **30** is an escapement mechanism **32** carrying a bearing mounted plunger **34** movable in the slot **30** and in a guide bushing or member **36** attached to the track assembly **14** and aligned with the slot **30**. Secured to one side of the track assembly **14** are a pair of light sensitive switch members **38***a*, **38***b* and a solenoid plunger mechanism **40**. The light sensitive switch members function to control the actuation of the vibratory hopper **10** and will be described in more detail in relationship to a description of FIG. 5. The solenoid mechanism **40** functions to separate the contacts, to make sure that only one moves into the slot **30** at a time, and to assist the alignment of the contact **12**, in the slot **30**. This mechanism is timed as part of the sequence of each cycle; thus, as one of the contacts moves to the edge of the slot **30**, the solenoid is activated and a plunger (not shown) advances to separate and locate the contact from any adjacent contact to which it may have inadvertently become attached and to push it into the slot **30**.

An electric motor **41** is supported by a bulkhead **43** forming part of the structure of the housing **23** and includes a pinion gear **42** attached to its output shaft which drives a bevel gear **44**. The bevel gear **44** is attached to one end of a shaft **45** which contains at its other end a crank member **46** and intermediate thereof a cam member **48**. A connecting rod or rocker arm **50** is pivotally mounted to a spacer (not numbered) attached to the bulkhead **43** and at one end contains a roller **52** which rides in engagement with a first cam surface **54** of the cam member **48** and at the other end a U-shaped finger contact **56** which engages the plunger **34** of the escapement mechanism **32**. The connector rod **50** is spring-loaded by a spring **57** bearing against the bulkhead **43** so that after each cycle it returns to a predetermined starting position. The cam member **48** also contains a second cam surface **58** around the periphery of the member **48** near the end thereof opposite from that containing the first cam surface **54**.

Referring to FIG. 1, as well as FIG. 2, attached to the crank **46** is a roller bearing **60** which rides in a notch **62** in a first lever arm **64** of the crimp tool operating mechanism. The first lever arm **64** is pivotally attached to the bulkhead **43** at a point **70** and includes a connecting linkage **66** affixed to it as well as to a second pivotal lever arm **68**. The second lever arm **68** is pivotally indirectly attached to the bulkhead **43** at a point **72** and includes at the other end a roller **74** which is in engagement with one of the arms **76** of a crimping tool **16**. The point **72** of pivot of the second lever arm **68** is adjustable to accommodate different crimping tools with varying size arms by mounting the pivot point **72** on a disc **78** which is rotatable in a dent in the bulkhead **43** and once rotated is held securely by a lock nut **80**.

A counter-clockwise movement of the crank shaft, as shown by an arrow **82** (FIG. 1), causes the levers to move in such a fashion that the second lever arm **68** rotates clockwise; thus, moving the movable arm **76** of the crimp tool **16** toward a stationary arm **84** to radially move the jaws (not shown) of the crimping tool **16**. To facilitate the insertion of the end of the electrical conductor into the barrel end of the contact when it is positioned in the jaws of the crimping tool, a disked plate **86** having a central bore **88** is mounted on the top of the crimping tool **16** and secured by a bent spring **90**.

A desirable feature for any automatic or semi-automatic apparatus is to provide controls to deactivate parts of the apparatus when they are not needed. In the present invention the vibratory hopper **10** needs to be activated only when it is necessary to feed contacts in the track assembly **14**. One of the pair of light sensitive switch members **38***a* is used to deactivate the vibratory hopper **10** when a predetermined maximum number of contacts are stored in the track **14** and the other light sensitive switch member **38***b* is used to activate the hopper **10** when the number of contacts in the track is below a predetermined minimum number. Referring to FIGS. 1 and 5, this control is accomplished by mounting a light source **92**, such as a light bulb, on the other side of the track assembly **14** from each of the light sensitive members **38***a*, **38***b* which may be a conventional photo relay, such as a Model 8RCO1A, manufactured by Sigma Instruments, Inc., Braintree, Mass., and coupling the light energy to the photo relay by a mirror **93** and a chamber **94** extending across the track assembly **14**. When a contact is aligned with the chamber **94**, insufficient light falls upon the photo relay to deactivate it. Thus, when the track **14** contains contacts sufficient to align a contact with the chamber associated with the light sensitive member **38***a*, nearest the hopper **10**, the hopper will be deactivated; however, when sufficient contacts have been removed from the track so that one is not aligned with the chamber associated with light sensitive member **38***b*, nearest the tool, the vibratory hopper is again activated so that additional contacts can be dispensed and stored in the track **14**.

The apparatus is controlled so as it performs one crimping operation each time a foot switch or other control **95** is depressed or placed in an activating condition. Such control is accomplished through a conventional capacitor relay circuit (not shown) which is coupled between a source of electrical energy **97**, such as 110 volts AC, and the motor **41**. In FIG. 6 the control device is shown in a condition before the motor is activated, that is the foot switch is not activated. However, when the foot switch is activated in a conventional fashion a charged capacitor discharges to close a relay through a first normally closed limit switch **98** which is held closed by a first portion **103** of the second cam surface **58** of the cam member **48**. This locks the relay closed for approximately 180° of motor rotation at which time the relay opens. However, a second normally closed limit switch **100** is activated at a point approximately 165° from the starting position of the motor rotation and this operates the motor for the additional 195° rotation since both of the switches **98**, **100** are in parallel between the power source **97** and the motor **41** at which time the switch **100** opens stopping the motor. A slight overlap of motor control occurs, the first switch **98** controlling the motor relay from 0 to 179° of rotation with the second switch **100** closed starting at 166° and although the first switch **98** opens at 179°, the second switch **100** remains closed until one revolution is completed. At any time the foot switch is depressed, it may be released and the machine will complete one cycle or if the foot pedal remains depressed the machine will complete one cycle. A third limit switch **101** is operated by a second portion **105** of the cam surface **58** and is coupled in series between the power source **97** and the solenoid **40** to provide a pulse to the solenoid during every cycle of operation. Shown in dashed representation in FIG. 1, the limit switches are mounted on blocks (not numbered) on opposite sides of the second cam surface **58** at heights to enable each to be operated by the appropriate cam surrface with the second switch **100** and the third switch **101** on adjacent steps in the same block (not numbered).

As the machine makes one operation, it crimps a contact, ejects it, and positions a new contact for crimping. Starting with a contact in position for crimping, the following events takes place. The operator inserts the end of the conductor into the wire barrel of the contact beneath the aperture **88** and between the jaws of the crimping tool **16** and trips the foot switch **95**. The motor **41** starts powering the crank **46** and the first lever **64** where-

upon the second lever **68** draws the movable crimping arms **76** toward the fixed arm **84** which radially moves the jaws of the crimping tool **16** to crimp the contact on to the wire. As the crimping tool **16** is closing, the plunger **34** in the escapement mechanism **32** moves down by means of the connecting rod or rocker arm **50** and allows the next contact in the track assembly **14** to slide down into the slot **30** where the plunger **34** on its way up pushes this contact through the guide bushing **36**, ejecting the previously crimped contact out of the aperture **88** and locates the next contact in the proper position for crimping. To clarify this operation, the plunger **34** may not move down until the indentors or jaws (not shown) of the crimping tool **16** are applying pressure on the contact being crimped. When this occurs the plunger **34** moves down to pick up a new contact as the crimping tool **16** continues to close. As the plunger **34** reaches the bottom of its stroke, it pauses allowing time for one of the stored contacts in the track assembly **14** to fall into the slot **30** with the assistance of the solenoid and plunger **40** into a position where the plunger **34** picks it up on the upward stroke pushing it through the guide bushing **36**, ejecting the crimped contact out of the crimping head which has released the contact it has just crimped and positions the new contact for crimping. The timing for this operation is controlled by the contour and position of the first cam surface **54** and the second cam surface **58** of the cam member **48**.

To insure the reliability of the crimp and to prevent the user from having doubt of the machine's reliability, the crimping head in this present embodiment is a standard production hand crimp which includes a ratchet mechanism that insures a complete cycle before a contact can be released from the tool. The crimping machine powers this hand crimp tool; thus, any failure of the machine to complete a full cycle would prevent further operation of the machine and also prevent removal of a contact with an incomplete crimp.

To remove the crimping tool **16** from the machine, or to clean out the track assembly, or to purge the machine of contacts without crimping them, no tools are required. To remove crimping tool **16** or clean out the track assembly **14**, deflect wire spring **90** and remove guide plate **86**, the hand crimp may now be removed. Further access to the track assembly **14** can be obtained by removing the guide bushing **36** and a track cover **104**. To purge the machine of contacts without crimping them, an ejector spring can be provided adjacent to the slot **30** (not shown). Such a spring would not be accessible unless the crimping tool were removed so as to further insure that a person who might purge the machine to change contact size would be reminded to adjust the hand crimp tool to the correct setting for that specific contact.

Another feature the machine contains is a pair of conventional digital counters **110, 112**. One counter **110** can be set at any quantity of machine cycles and at that time, the predetermined counter turns off the machine and lights an indicator lamp **114** notifying the operator that the quality of the crimp must be verified and the other counter **112** can be used to indicate continuously the total number of cycles. Both of the counters **110, 112** may be powered through one of the limit switches or other pulsing element of the control circuit. To reset the counter and start the machine, a key **116** for the specific purpose is required. This allows the crimping quality of the machine to be checked every so many predetermined cycles. Due to the ease with which the hand crimp tool can be removed from the machine a quality assurance person could at the time the machine has reached the predetermined count, remove the hand crimp tool and replace it with a calibrated tool, reset the counter and production could continue in a matter of seconds while the removed hand crimp tool is recalibrated. The machine is capable of crimping most crimp type removable contacts by changing the track assembly, hopper, guide plate, and hand crimp tool.

While the basic principles of this invention have been herein illustrated, it will be appreciated by those skilled in the art that variations in the disclosed arrangement both as to its details and as to the organization of such details may be made without departing from the spirit and scope thereof. Accordingly, it is intended that the foregoing disclosure and the showings made in the drawings will be considered only as illustrative of the principles of the invention and not construed in a limiting sense.

What is claimed is:

1. An apparatus for attaching an electrical contact to an electrical conductor comprising:

a hopper containing a plurality of electrical contacts and adapted to dispense said contacts from a predetermined location on the periphery of the hopper and at a predetermined rate;

a track assembly cooperating with said hopper and positioned adjacent to said predetermined location for receiving said contacts in an in-line fashion and in a predetermined orientation as they are dispensed from said hopper and including at one end a slot;

said track being inclined with its higher end nearest said hopper so that said contacts move along said track under the force of gravity and are in turn aligned with said slot near the lower end of said track;

a crimping tool juxtaposed with said track and including radially movable jaws having a centerline coaxial with the longitudinal centerline of said slot;

a plunger movable in said slot for moving, in turn, each of said contacts to a position where it may be contacted by the jaws of said crimping tool;

an electrical motor and a source of electrical energy coupled thereto;

a cylindrical cam member mechanically coupled to said motor for rotation thereby and having a first cam surface formed in one end and second cam surface formed in a portion of the periphery of said member near the other end thereof;

a plurality of electrical switches positioned adjacent to said cam member with the contact elements thereof engaging said second cam surface, said switches being electrically coupled between said motor and source of electrical energy to control as a function of the shape of said second cam surface the activation of said motor and correspondingly the rotation of said cam member;

a mechanical linkage coupled to said motor for rotation thereby and to said crimping tool for radially moving the jaws thereof;

a contacting rod having one end coupled to said plunger and the other end engaging said cam member so that said plunger moves in a reciprocating fashion as a function of the shape of the first cam surface;

whereby said first cam surface is of a shape permitting said switches to activate said motor sufficiently to produce one revolution of said motor and said second cam surface is of a shape permitting said plunger to move through one cycle of reciprocating movement during each revolution of said motor.

2. The apparatus of claim **1** wherein the hopper is coupled to a source of electrical energy and is adapted to vibrate at a predetermined frequency.

3. The apparatus of claim **1** wherein the hopper is coupled to a source of electrical energy and is adapted to vibrate at a predetermined frequency, said apparatus also including

a pair of light actuated switches positioned adjacent to said track and electrically coupled between said hopper and said source of electrical energy therefor, each of said switches being near a different end of said track and each including a light source on one side of said track and light sensitive element on the other side of said track and a chamber connecting each light source with the corresponding light sensi-

tive element so that when an electrical contact is located in said track and aligned with said chamber insufficient light falls on said light sensitive cell to activate said light switch; wherein

one of said switches disconnects the electrical energy from said hopper when said track contains a predetermined maximum number of contacts and said other switch connects said electrical energy to said hopper when said track contains a predetermined minimum number of contacts.

4. The apparatus of claim 1 wherein the track assembly inclined with its higher end nearest said hopper, opposite the slot in the lower end further comprises a solenoid plunger mechanism to separate the contacts, to make sure that only one contact moves into the slot at a time, and to assist the alignment of the contact in the slot so

that said contacts move along said track under the force of gravity and are in turn aligned with said slot.

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