March 26, 1968 J. W. BALDYGA 3,374,657

METHOD AND APPARATUS FOR CRIMPING ELECTRICAL CONNECTORS

Filed May 24, 1965 3 Sheets-Sheet 1

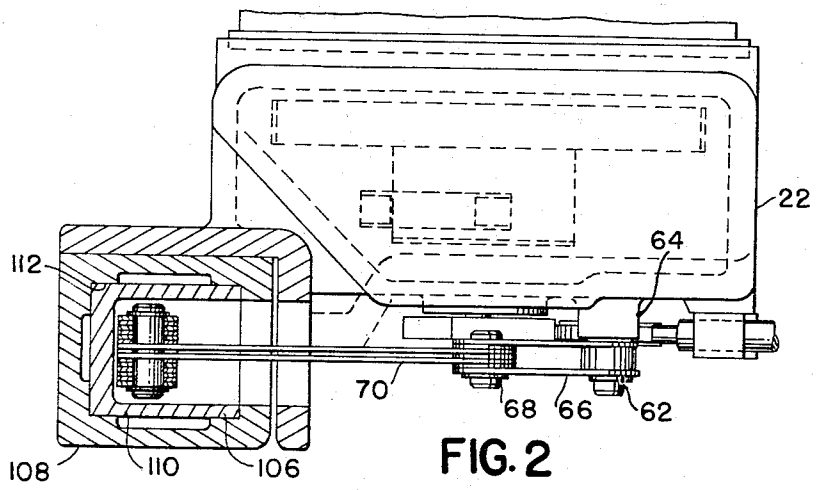


FIG. 2

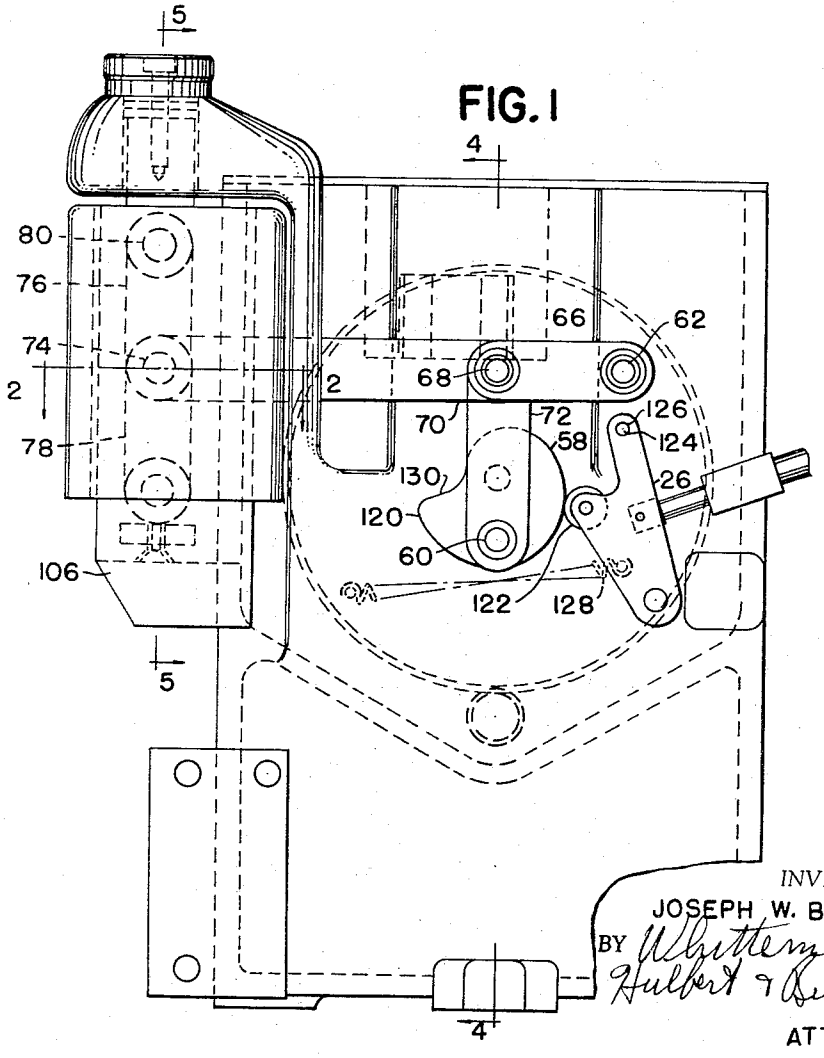


FIG. 1

INVENTOR.
JOSEPH W. BALDYGA
BY Whittemore Hulbert & Belknap
ATTORNEYS

March 26, 1968 J. W. BALDYGA 3,374,657

METHOD AND APPARATUS FOR CRIMPING ELECTRICAL CONNECTORS

Filed May 24, 1965 3 Sheets-Sheet 2

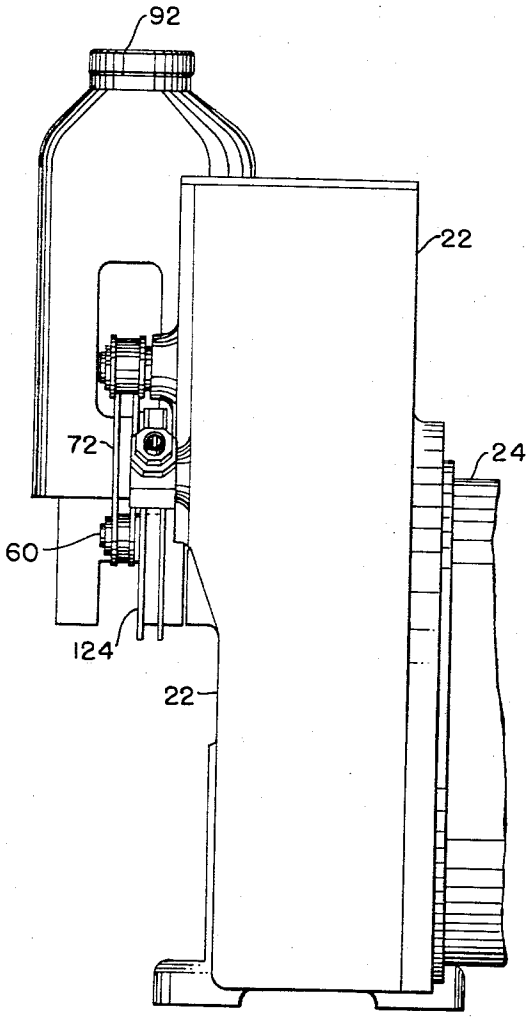


FIG.3

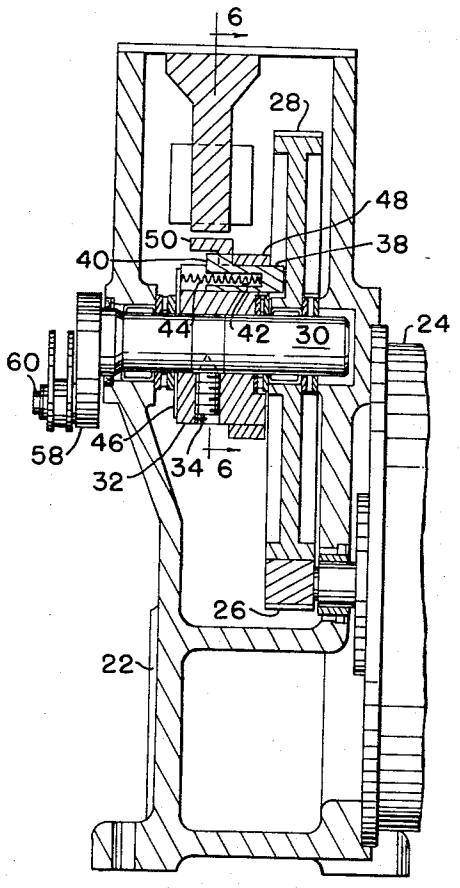


FIG.4

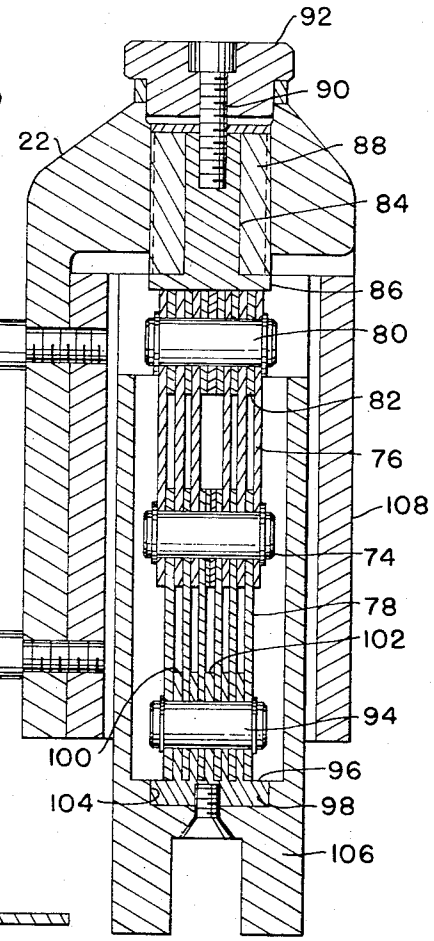
INVENTOR.
JOSEPH W. BALDYGA
BY Whittemore Hulbert & Belknap
ATTORNEYS

March 26, 1968 J. W. BALDYGA 3,374,657

METHOD AND APPARATUS FOR CRIMPING ELECTRICAL CONNECTORS

Filed May 24, 1965 3 Sheets-Sheet 3

FIG. 5



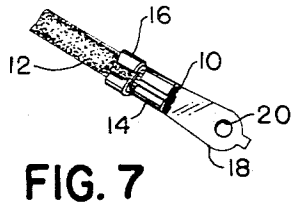


FIG. 7

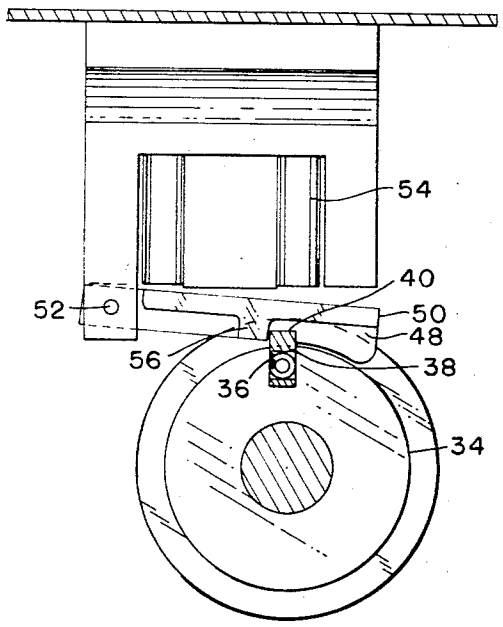


FIG. 6

INVENTOR.
JOSEPH W. BALDYGA
BY Whittemore, Hulbert & Belknap
ATTORNEYS

United States Patent Office 3,374,657
Patented Mar. 26, 1968

3,374,657

METHOD AND APPARATUS FOR CRIMPING ELECTRICAL CONNECTORS

Joseph W. Baldyga, Utica, Mich., assignor to Diamond Die & Mold Co., Mount Clemens, Mich., a corporation of Michigan

Filed May 24, 1965, Ser. No. 458,141
7 Claims. (Cl. 72—413)

ABSTRACT OF THE DISCLOSURE

Crimping apparatus and its method of operation comprising a movable ram, a pair of toggle devices connected in series, crank mechanism connected to one of said toggle devices, said crank mechanism including a connecting rod, and drive means for effecting substantially 360° rotation of the crank from a starting position in which the connecting rod is in substantial alignment with a line joining the axis of the crank and the pivot connection between the links of the toggle to which the crank is connected.

At the present time electrical connectors are crimped to the end of insulated wire by an operation in which one or more pairs of tabs formed on the electrical connector are crimped over into engagement with the electrical conductor or the insulation surrounding the electrical conductor, or preferably both. The electrical connectors are ordinarily formed of brass and it has been found that best results are obtained when the crimping force is applied in such a way that substantially the maximum crimping force is maintained for a sensible time interval. In other words, crimping by impact is not satisfactory.

It is an object of the present invention to provide a method and apparatus for crimping electrical connectors to insulated conductors characterized in the provision of maintaining crimping pressure for a sensible interval as for example about one-tenth of a second.

More specifically, it is an object of the present invention to provide a method and apparatus for crimping electrical connectors to conductors employing double toggle mechanism with the result that movement of the crimping ram or press into final position is relatively slow and results in maintaining substantially maximum crimping pressure for a sensible interval.

It is a further object of the present invention to provide crimping mechanism of the character described comprising a rotatable driver, toggle actuating mechanism, selectively operable means for connecting the toggle actuating mechanism to the driver, and means for automatically disengaging the toggle actuating mechanism from the rotating driver after one actuation of the toggle mechanism.

It is a further object of the present invention to provide apparatus of the character described comprising a crimping ram, a toggle connected to said crimping ram, a second toggle connected to the first mentioned toggle, and means for actuating the second toggle to produce movement of the crimping ram characterized in extremely slow movement of the final crimping position, and extremely slow movement out of crimping position so that in effect, substantially maximum crimping pressure is maintained for a sensible interval.

It is a further object of the present invention to provide crimping mechanism comprising a rotary member adapted to move through approximately 360 degrees to effect a single crimping operation, a crimping ram, toggle mechanism connected between said ram and said rotary member, a cam connected to said rotary member, and work feed mechanism actuated by said cam.

It is a further object of the present invention to provide apparatus as described in the preceding paragraph in which

the cam for actuating the work feed mechanism is provided with an abrupt fall-off positioned to register with a cam follower when the toggle mechanism is in substantially collapsed position.

Other objects and features of the invention will become apparent as the description proceeds, especially when taken in conjunction with the accompanying drawings, illustrating a preferred embodiment of the invention, wherein:

FIGURE 1 is an elevational view of the crimping apparatus.

FIGURE 2 is a plan view of the apparatus shown in FIGURE 1, partly sectioned on line **2—2**, FIGURE 1.

FIGURE 3 is an elevational view of the apparatus shown in FIGURE 1, viewed from the right.

FIGURE 4 is a sectional view on the line **4—4**, FIGURE 1.

FIGURE 5 is a sectional view on the line **5—5**, FIGURE 1.

FIGURE 6 is a fragmentary sectional view on the line **6—6**, FIGURE 4.

FIGURE 7 is a fragmentary perspective view showing an electrical connector crimped to an insulated electrical conductor.

Referring first to FIGURE 7 there is illustrated a typical application of the crimping operation to connect an electrical connector to an insulated electrical conductor. As seen in this figure, the insulated electrical conductor comprises an elongated electrical conducting element such for example as a copper wire or assembly of copper filaments indicated at **10**. Insulation **12** surrounds the electrical conductor. The electrical connector, which may be of brass or the like, may be in the form of a plate **14** having a pair of ears or tabs **16** adapted to be bent around and crimped into clinched engagement with the insulated conductor, and more specifically, with the insulating cover **12** thereof. At the same time, a pair of smaller ears or tabs **18** are provided which are crimped around and firmly clinched to the bared end of the electrical conductor. The plate **14** may be provided with suitable formations for cooperation with elements of an electrical circuit and in the present instance this is illustrated simply as comprising a circular opening **20** formed in the end portion of the connector.

Since the electrical connector has two pairs of tabs which are respectively firmly clinched to the insulating cover of the electrical conductor and to the conducting core or element thereof, the connector is firmly and permanently attached to the conductor.

It has been found that the clinching of the tabs to the conductor as above described is best accomplished when crimping pressure is applied in such a way that substantially maximum pressure is maintained for a sensible interval. This is to be contrasted with a clinching operation in which tabs are clinched by extremely brief application of pressure such for example as by impact.

The method suggested in the foregoing is adapted to be carried out by the apparatus illustrated herein.

Referring now to FIGURES 1–6, the apparatus comprises a frame **22** to which a motor **24** is connected, the motor driving a pinion **26** which is in mesh with a gear **28** mounted for free rotation on a shaft **30**. Securely fixed to the shaft **30** is a collar **32** the connection to the shaft being illustrated in FIGURE 4 as including a pointed set screw **34**, the pointed end of which is received in a recess in the shaft **30**. Slidably carried by the collar **32** in a channel **36** is a pin **38** having a radially projecting dog **40**. The pin **38** is provided with an elongated recess **42** in which is received a compression spring **44** the outer end of which seats against a disc **46**. With this arrangement the spring **44** biases the pin **38** to the right as seen in FIGURE 4. Movement of the pin **38** to the right is

normally prevented by engagement between the dog **40** on the pin **38** with a depending flange **48** formed on a lever **50** which is pivoted as indicated at **52** and is adapted to be moved upwardly by momentary energization of the windings of a solenoid **54**. The gear **28** is provided with a plurality, as for example six, openings in circumferential alignment with the pin **38** and when the pin is freed for movement under the action of the spring **44** the pin moves into the next opening in the gear, and thus, directly mechanically couples the gear **28** to the collar **32**. As a single rotation of the collar **32** nears completion, the dog **40** on the pin **38** engages a camming surface on the flange **48** so that the pin is retracted from the opening in the gear **28**. The lever **50** carries a dog **56** which is engaged by the dog **40** on the pin, thus arresting rotation of the collar **32** after 360 degrees's rotation.

The collar **32** of course, during its rotation imparts rotation to the shaft **30** and this shaft in turn rotates a combined cam and crank arm **58** having a crank pin **60** thereon.

Mounted on the exterior of the frame **22** is a pivot mounting pin **62**, the pin being rigidly mounted in a boss **64** as best seen in FIGURE 2. Connected to the pin **62** are a pair of links **66** which are connected by a pivot pin **68** to a pair of links **70** and a second pair of links **72**. The links **72** have the opposite end connected to crank pin **60**. Links **70** are connected to a pin **74** and to this pin are also connected the links **76** and **78**. The opposite end of the links **76** are connected to a pin **80** which in turn is supported in openings in a plurality of leaves **82** formed on a support member **84** having the circular flange **86** engaged against a threaded abutment member **88**. Support **84** is retained in assembled relation against the adjustable abutment member **88** by a screw **90** carried by a cap **92**.

The other ends of the links **78** are connected to a pin **94**, the pin being carried by a driver **96**, the driver having a circular base portion **98** and vertically extending leaves **100**, and a central relatively thick leaf **102**. The circular base of the driver **98** is received in a similarly shaped recess **104** in the ram **106** which is vertically slidable in a guide housing **108**, as best seen in FIGURE 2. In this figure it will be observed that the ram **106** has four corner portions **110** each of which is guidingly received in a correspondingly shaped corner **112** of the guide and housing member **108**. Thus, the ram **106** is firmly supported for rectilinear movement upon actuation of the toggle mechanism. It will be further be apparent that the downward limiting position of the ram **106** may be accurately predetermined by adjustment of the adjustable abutment member **88**.

Referring now to FIGURE 1 it will be observed that the links **66** and **70** form a first toggle in which the toggle elements are moved into substantial alignment when the actuating links **72** are in the position shown in this figure. The first toggle mechanism comprising the links **66** and **70** is connected to the second toggle mechanism comprising the links **76** and **78** and the relationship is such that when the links of the first toggle mechanism approach substantial alignment the links **76** and **78** of the second toggle mechanism also approach alignment. Thus, it is apparent that as the ram **106** approaches its lowermost position, it is moving extremely slowly and also it is capable of applying forces of relatively great magnitude with only moderate power being supplied to the drive pinion **26**.

More important than the relatively great magnitude of the pressure capable of being applied by the ram is the fact that the described arrangement in effect operates to maintain the pressure applied to a work piece such as an electrical connector, at approximately the same peak value for a sensible interval. In practice, the apparatus is semi-automatic in that the uncrimped connectors are automatically fed to crimping position while the ram is at the top of its stroke and the operator inserts the prepared conductor end so that the bared conductor is positioned between one pair of tabs, and the insulating cover adjacent the bared ends is positioned between the other pair of tabs on the connector. At this time the operator energizes the solenoid **54** momentarily. In practice, the solenoid may be energized by discharge from a condenser. Energization of the solenoid raises the lever **50** and releases the pin **38** for movement into coupling engagement with the gear **28**. The collar **32** is given 360 degrees' rotation and as it completes such rotation the pin is retracted so as to disconnect the collar from the gear and rotation of the collar and associated mechanism is terminated in precise position by engagement between dogs **40** and **56**.

Referring to FIGURE 1, there is illustrated a cam surface **120** engageable by a roller **122** on a lever **124** pivoted to the frame **22** as indicated at **126**. The lever **124** is biased to the left as seen in this figure by a tension spring **128** and is adapted to connect with mechanism (not shown) for effecting feed of an uncrimped connector into position beneath the ram **106**. Details of the crimping head and the base which receives the uncrimped connector are omitted since these elements are of course designed in accordance with each particular crimping operation to be performed. It will be observed however, that the cam surface **120** includes the abrupt fall-off portion **130** which is adapted to move into position adjacent the roller **122** when the two toggles are substantially completely collapsed. Thus, feed of the connector is accomplished very quickly when the ram is in its uppermost position, thus affording maximum clearance and at the same time, the arrangement provides for a minimum of delay in conditioning the apparatus for the succeeding crimping operation.

While the force supplied in the crimping operation is of course variable in accordance with the particular connector, it has been observed that a pressure of 23,400 pounds has been developed when the press is .001" displaced from its maximum downward movement, using a ½ horsepower motor operating at 1750 r.p.m. The gear ratio between the pinion **26** and the gear **28** is such that shaft rotation is at the rate of 180 r.p.m. This of course means that only .333 second are required for complete rotation of the shaft or for a complete downward and upward reciprocation of the ram. However, with the arrangement of the crank and double toggle, about half of this time or approximately one-sixth of a second, is taken up by the last .015" of movement of the ram. Thus, the cycle involves a crimping operation in which the pressure is increased at a controlled but increasing rate and is maintained at relatively high values for a sensible interval. While variations are possible and are in accordance with the material and shape of the connectors, it may be stated that the application of pressure adequate to crimp the connector tabs into required position should be maintained for an interval of at least .100 second.

The drawings and the foregoing specification constitute a description of the improved method and apparatus for crimping electrical connectors in such full, clear, concise and exact terms as to enable any person skilled in the art to practice the invention, the scope of which is indicated by the appended claims.

What I claim as my invention is:

1. A crimping press comprising a base, a ram slidable on said base, a first toggle connected between said base and ram and having a first movable pivot and links connected thereto and movable into substantial alignment to exert maximum crimping force, a second toggle connected between said base and the movable pivot of said first toggle, said second toggle comprising a first link pivoted to said base, a second link pivoted to the movable pivot of said first toggle, and a second movable interconnecting the links of said second toggle, and actuating means comprising a crank carried by said base, a connecting rod connecting said crank to said second pivot, and means for driving said crank through substantially 360° from a starting position in which said connecting rod

extends in substantial alignment with a line joining the axis of said crank and said second pivot.

2. In a press of the character described a base, a vertical column on said base, a hollow ram slidable longitudinally in said column, a first toggle seat mounted in said column for adjustment longitudinally thereof, a second toggle seat in said ram, a first toggle connected between said first and second toggle seats, said column having a lateral opening, a second toggle extending through said opening having one end connected to said first toggle and the other end connected to said base, a crank on said base, and a connecting rod connecting said crank to said second toggle, said column being of generally rectangular internal cross-section providing four guide corners, said ram being elongated and of corresponding rectangular cross-section and having four corners slidably received in the guide corners of said column, said ram having openings at its top and at one side, said first toggle being received in said ram and extending through the top opening thereof, said second toggle extending through the side opening thereof.

3. Apparatus as defined in claim 2 in which said toggle seats comprise members having a plurality of flat apertured parallel leaves, said toggle comprising a plurality of flat parallel links pivotally connected at one end to said leaves and at the other end to each other.

4. In a press of the character described, a base, a vertical column on said base, a hollow ram slidable longitudinally in said column, a first toggle connected between said column and said ram, a second toggle connected between said first toggle and said base, both of said toggles comprising a pair of links each of which is made up of a plurality of flat parallel elements, the elements of each link being interleaved between the elements of another link pivotally connected thereto.

5. In a press of the character described, a base, a vertical column on said base, a hollow ram slidable longitudinally in said column, a first toggle connected between said column and said ram, a second toggle connected between said first toggle and said base, a crank on said base, a link connecting said crank to said second toggle, a crank shaft to which said crank is secured, a collar fixed to said shaft, a gear rotatable on said shaft, a pin slidable on said collar parallel to said shaft and in position to engage a side of said gear, a pin receiving opening in the side of said gear, a spring urging said pin toward said gear, a lever, a dog on said pin engaging said lever and retained thereby against movement into an opening in said gear, means for swinging said lever

to release said dog, camming means on said lever engageable by said dog to cam said pin out of the opening in said gear as said collar completes one revolution, and a dog on said lever engageable by the dog on said pin to arrest rotation of said collar and shaft after 360 degrees' rotation.

6. In a press of the character described, a base, a vertical column on said base, a hollow ram slidable longitudinally in said column, a first toggle connected between said column and said ram, a second toggle connected between said first toggle and said base, a crank on said base, a link connecting said crank to said second toggle, a crank shaft to which said crank is secured, means for driving said shaft through one rotation, stop means for limiting rotation thereof, a cam on said crank, feed actuating means comprising a cam follower, said cam having an abrupt fall-off cam surface in position to be engaged by said follower when said toggles are collapsed, and resilient means connected to said follower to provide for abrupt actuation of feed means when said ram is fully retracted.

7. In a press of the character described, a base, a vertical column on said base, a hollow ram slidable longitudinally in said column, a first toggle seat mounted in said column for adjustment longitudinally thereof, a second toggle seat in said ram, a first toggle connected between said first and second toggle seats comprising links interconnected by a first pivot, said column having a lateral opening, a second toggle extending through said opening comprising a first link having one end connected to the pivot of said first toggle and a second link having one end connected to said base, a second pivot connecting the links of said second toggle, a crank on said base, and a connecting rod connecting said crank to said second pivot, and drive means for said crank including means to limit rotation thereof upon initiation of a cycle to substantially 360° from a starting position in which said connecting rod extends in substantial alignment with a line joining the axis of said crank and sad second pivot.

References Cited

UNITED STATES PATENTS

10,410	1/1854	Lester	72—451
1,806,217	5/1931	Rees	72—451

HARLES W. LANHAM, *Primary Examiner.*

RONALD D. GREFE, *Examiner.*