Nov. 25, 1958 W. A. BARNES 2,861,488

RATCHET POWERED TOOL

Filed Jan. 17, 1956 2 Sheets-Sheet 1

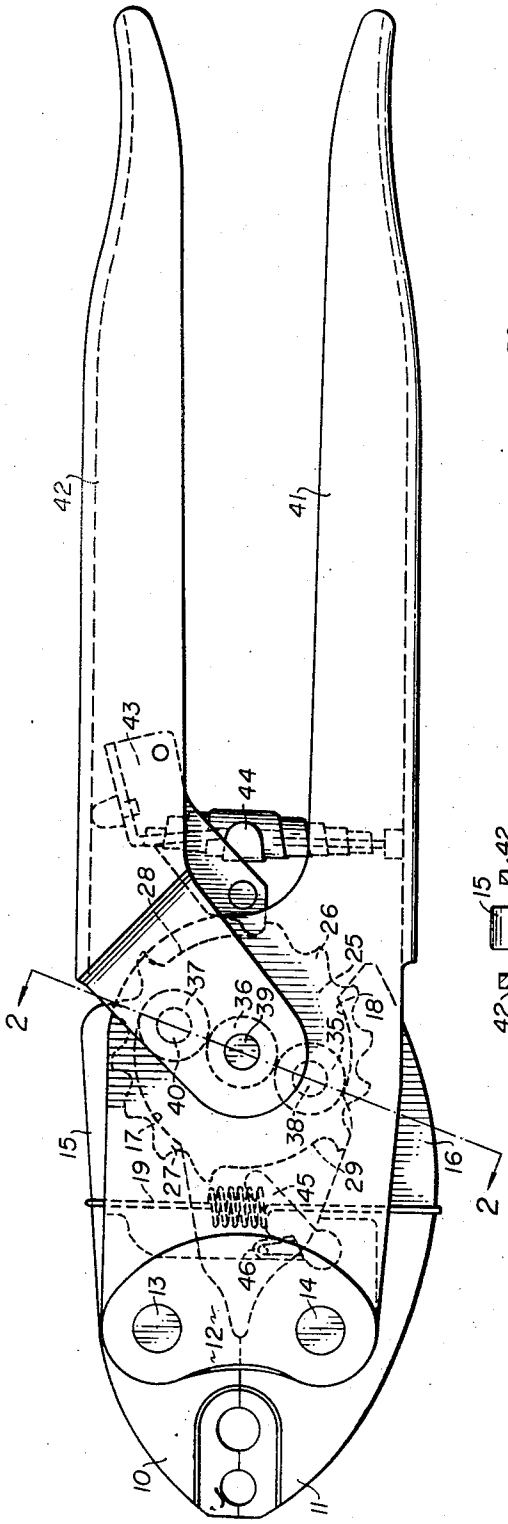


Fig. 1

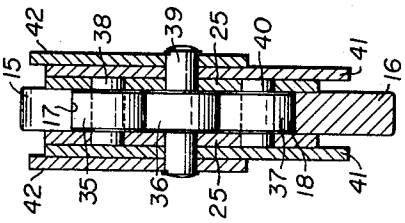


Fig. 2

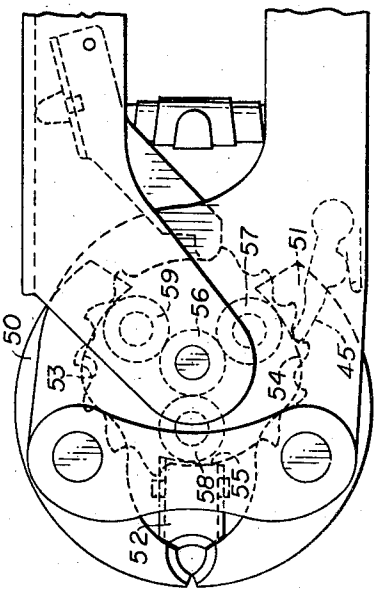


Fig. 3

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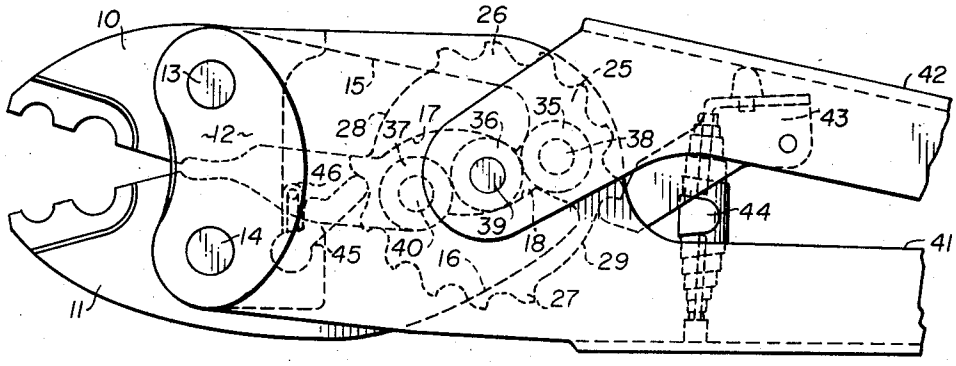


Fig. 4

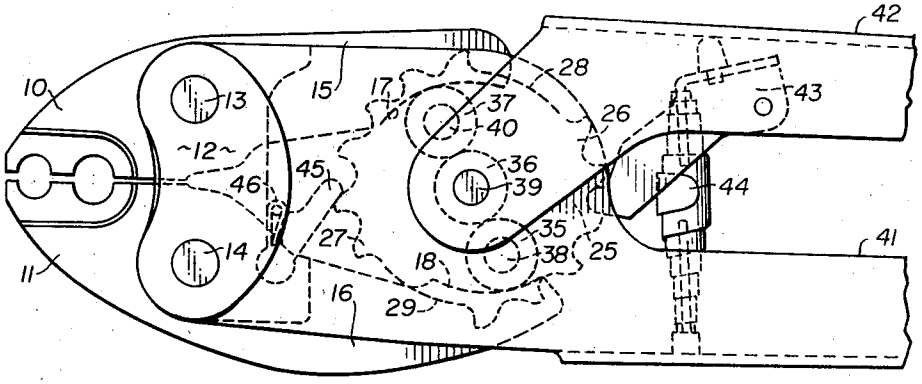


Fig. 5

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RATCHET POWERED TOOL

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Application January 17, 1956, Serial No. 559,605

7 Claims. (Cl. 81—15)

This invention relates to cam actuated tools, and particularly to a closable jaw hand tool of light weight and rigid construction for crimping or indenting workpieces such as electrical connectors.

The primary object of this invention is to provide a movable jaw tool having a wide jaw opening, fast closure to a work position, high mechanical advantage through the work closing cycle, and assurance of completing a full work cycle whereby the jaws are required to close to a specific relative position before opening.

Subgenerically, an object of this invention is to provide a ratchet device for cyclic drive actuation wherein a ratchet is employed to rotatably drive a revolvable wedge expanding device operating between separable cam driven surfaces, and the wedge device comprising a series of rollable members in active surface contact with one another to transmit the reaction forces through the series across the work field with little or no appreciable stress upon the mounting means carrying the rollable devices upon the ratchet wheel. This drive device may be employed for cam lever operation of any device operable by separable or shiftable cam driven surfaces.

A further object of this invention is to provide a ratchet device for such actuating mechanism, wherein the ratchet device is released over a portion of the work cycle thereof for rotation under forces acting upon the ratchet device at the end of the work cycle and thereby produce a quick movement response allowing fast reopening of the actuated tool at the end of the work cycle.

When using plier-type tools for crimping electrical connectors and severing heavy workpieces, or other similar high pressure jobs, it is customary to provide long handles to reduce operator fatigue, or to bring the mechanical advantage to such a degree that the desired operation is possible. Long handles or levers require less input force to do the required work and provide a high mechanical advantage. Lengthening the handles, however, introduces other undesirable factors. The longer the handle, the wider is the spread between the ends of the handles, and this makes the long levered pliers unlikely for use in confined quarters, more difficult to use, and induces early operator fatigue.

Another object of this invention, therefore, comprises the provision of pliers having a large mechanical advantage with a small span at the ends of the opened levers.

Further objects are to provide a short span lever actuated tool having a long lever characteristic, the jaws of which open wider than can be expected of ordinary pliers of similar size, and to provide such tool having the foregoing characteristics which are relatively light in weight and which do not require close tolerances in manufacture that are difficult to obtain in mass production.

Still a further object of this invention is to provide a a closable jaw hand tool with both the drive forces and the restraining reaction forces extending in short, transverse and substantially parallel paths across the tool.

And yet another object of this invention is to provide

a variable rate of closure speed and ratio of forces in a tool having the desired transverse forces.

Other objects and a fuller understanding of the invention may be had by referring to the following description and claims, taken in conjunction with the accompanying drawings, in which:

Figure 1 is a side elevational view of a pivoted jaw tool designed principally for crimping electrical connectors, and being actuated by the improved drive device of this invention;

Figure 2 is a sectional view taken along the line 2—2 of Figure 1;

Figure 3 is a side elevational view of a modification of such tool embodying three work producing jaws and driven by a planetary version of the drive device of this invention;

Figure 4 illustrates the tool of Figure 1 in its maximum open position assumed at the end of a work cycle and prior to the beginning of another work cycle; and,

Figure 5 is an operational illustration of the tool of Figure 1 intermediate the maximum open position of Figure 4 and the full closed position of Figure 1.

In the past, reliance has been principally upon fulcrum type of tools, employing single or multiple fulcrums. Sometimes these tools have been supplied with a link mechanism attached to the handles permitting a variable mechanical advantage. The well known bolt cutter is such a tool design. In this construction, handles are pivoted together and to the rearward extensions of the opposed pivoted jaws. The ratios are fixed. The jaws will not open wide to receive work. They have terrific power at completion of the closure but no variation from a uniform curve through various steps of closure and no guarantee that the operator will complete the closure. This type of tool has stresses perpendicular to the length of the tool but provides no variation at the jaw from a uniform curve of force. Such tools are heavy, rugged and the handles must be opened wide, making them one stroke, two handed tools.

Later developments brought about the use of tools having a fixed anvil and a movable anvil. The movable anvil being generally actuated by means of a pivoted cam surface or a jack step device. Such devices require rugged actuation structures because of the very large reaction stresses placed upon the pivotal mounting for any such actuation device. As a result, a large amount of the input power is consumed in overcoming frictional loads and the pivotal supporting surfaces are subject to rapid deterioration under high wear conditions, if not actually broken under the extreme loading conditions. Such tools require a stationary C type of frame with one actuating member pushing against the C member. The C frame has to be heavy, and has to be of heavy construction far back into the body structure and then the C frame springs under stress. This springing has to be calculated and allowed for. The longer and more involved the path of stress forces, the greater spring and greater variation of dimension at closure of the jaws with various sizes of work in the jaws. With simple, short path stresses across the tool, there will be much less spring, and hence variation in closure with varying loads in the jaws.

The present invention avoids the creation of any high reaction loads upon a driving pivot mount, and confines the reaction load within the reacting members themselves. Consequently, the actuation device of the present invention has very low mechanical losses and little deterioration due to frictional abrasion.

Two copending United States patent applications are of interest to furnish a general background of information with regard to the problems solved by the present invention. Those applications are; an application en-

titled "Ratchet and Cam Actuated Tool" bearing Serial No. 564,165, filed February 8, 1956, on an invention of Walter J. Rozmus, and an application entitled "Pivot Lever Retainer for Ratchet Powered Device" bearing Serial No. 562,253, and filed January 30, 1956, disclosing an invention of William A. Barnes.

For the purpose of illustrating the present invention in an operative and useful structure, an electrical terminal crimping device has been selected. As set forth in the drawings, the tool embodies a jaw **10** and a jaw **11** each having a conventional crimping forward end portion. Two matched sets of half round dies are illustrated, although any work performing construction may be substituted therefor.

The jaws **10** and **11** are pivotally mounted by means of an interconnecting link **12** having a pivot **13** mounting the jaw **10** and a pivot **14** mounting the jaw **11**. Extending from the pivot **13**, the jaw **10** has a drive receiving lever end **15**, and the jaw **11** is provided with a similar drive receiving lever end **16**. Therefore, by driving the lever ends **15** and **16** apart, a work closing force will be exerted upon the work ends of the jaws **10** and **11**. According to this invention, a cam actuating device of improved construction provides such drive opening force.

On the inner side of the drive lever **15** there is provided a cam surface **17**. On the inner side of the drive lever **16** there is provided a cam driven surface **18**. A spring **19**, which is set forth only in Figure 1 of the drawings in order to eliminate confusion from overlapping parts in the remainder of the views, is employed to pull the levers **15** and **16** together and urge the work portion of the jaws **10** and **11** to an open position. Spring **19** is only one such means of urging the jaws **10** and **11** to a given position. Therefore, the maximum closed position of the drive levers **15** and **16**, and the maximum open position will be considered to be a work field. The cam surfaces **17** and **18** are in opposed facing relationship defining an included drive field therebetween.

Figure 2 illustrates the actual construction of the illustrated embodiment, although this construction is not the only suitable construction. Figure 2 illustrates the fact that stampings are used largely as the structural parts. The ratchet and roller construction, to be more fully described hereinafter, may here be seen to consist of a double ratchet wheel with rollers therebetween.

In the two jaw version of the terminal crimping tool set forth in Figure 1 of the drawings, there are illustrated three roller members **35**, **36** and **37** positioned in surface contacting series with one another across the drive field between the opposed cam surfaces **17** and **18**. Although three such rollers have been illustrated, it will be appreciated that any plurality of odd numbered rollable members may be employed. Furthermore, the illustrated embodiment of the invention sets forth roller-bearing type of rollable members, although rollable members such as balls may be employed with suitable mounting and drive means. Nevertheless, the surface of the rollers each contact the surface of the neighboring roller in the series. Thus, when the series is wedging between the cam driven surfaces **17** and **18**, there will be no appreciable stress placed upon the mounting means for the rollable members, but rather the opposed reaction forces will be transmitted through the solid bodies of the rollable members. Thus, as set forth in the operative positions of the tool in Figures 1 and 5, the series of rollable members acts as a solid member. However, the full advantage of rollable members is achieved for reducing frictional drive losses and elimination of the wear that would normally take place between sliding surfaces under high contact pressures.

A rotary ratchet device has been provided to revolvably drive the three rollable members in a work cycle. To this end, a ratchet wheel **25** is rotatably mounted and serves as a carriage for the rollers **35**, **36** and **37**. Stud bearings **38**, **39** and **40** are employed to mount the three rollers on a side face of the ratchet wheel **25**. Therefore, as the ratchet wheel **25** is driven the series of rollers will be caused to revolve and wedge between the cam driving surfaces **17** and **18**. The shape of the surfaces **17** and **18** may be readily altered to produce any desired type of resultant movement of the jaws **10** and **11** for rapid initial closing followed by the desired slow movement under high pressure. Formation of the surfaces **17** and **18** is well within the scope and understanding of the qualified engineer. Note, however, as previously discussed, the position of the roller series in Figure 1 is transverse to the length of the tool, and generally parallel to a line through pivots **13** and **14**. This position is an important feature of this invention.

To facilitate the handling of the tool, and to provide a manual drive for the ratchet wheel **25**, there is provided a handle **41** which is fixed and serves substantially no other purpose than to support the tool. By contrast, handle **42** is pivotally mounted on the tool and serves principally as a drive lever. Preferably, as a feature of this invention, the handle is pivoted on the same center as ratchet wheel **25**. A pawl **43** is carried by the handle **42** and is positioned to act in the well known manner of such pawl devices upon the ratchet wheel **25**. This tool can be used with a slow, powerful, one hand progression by opening the handle enough to take one notch at a time. By using two hands and opening the handles wider to take two notches, the progression speed is doubled. A coiled spring **44** is employed to urge the handle lever **42** to an open position relationship with respect to handle **41**.

However, the ratchet wheel **25** is not conventional in all aspects. Ratchet wheel **25** is provided with two separate series of ratchet teeth indicated by the reference character **26** for one series, and the reference character **27** indicating the other series. Blank or toothless areas **28** and **29** separate the tooth series **26** from the tooth series **27**.

As may be readily understood by examining the Figures 1, 4 and 5 only a reversal of the position of the roller series through 180 degrees is required to produce a complete work cycle. Therefore, a complete 360 degree revolution of the ratchet wheel **25** will produce two complete work cycles.

Referring first to Figure 4 of the drawings, it may be observed that the levers **15** and **16** are in their maximum closed position under the drive of spring **19**. The series of rollers is positioned in an angular direction between the closed levers **15** and **16**. The form of the cam surface **18** is modified somewhat at the forward portion in order to permit maximum closing with respect to the roller **37**, whereas the length of the lever **15** is foreshortened in order to permit the lever to drop down between rollers **35** and **36**. Therefore, at the first revolving movement of the roller series, a fast opening action will result as the series of rollers begins to wedge between the surfaces **17** and **18**. This initial movement produces fast closing of the work ends of jaws **10** and **11**. After the roller series has been revolved sufficiently to position the end rollers **35** and **37** against the operative surfaces **17** and **18**, or substantially in the position as shown in Figure 5, then the closing movement is slowed considerably and is determined entirely by the provided form of the surfaces **17** and **18**. When the roller series is substantially vertical between the ends of the levers **15** and **16**, substantially as shown in Figure 1 of the drawings, the work ends of jaws **10** and **11** are closed to their maximum closed position and the maximum force is exerted by the roller series between the levers **15** and **16**. Nevertheless, very little if any stress is experienced by the bearing studs **38**, **39** and **40** carrying the roller series. The reaction forces are carried through the series between the two opposed levers **15** and **16**. This provides a very remarkable advantage

over previous actuation devices and results in very little frictional drive losses and surface disintegration. Further, the stresses are lateral and resisted by the link 12, and link 12 is stressed in tension.

When the roller series revolves slightly past the maximum opening position as set forth in Figure 1, the roller 37 will drop off of the end of lever 15, and the roller 35 will drop into the pocket on the forward end of the surface 18. The wedging action is lost instantaneously. At this point, and under these conditions, if the ratchet wheel 25 were fixed and restrained against free movement, there would be a very great force on the bearing studs carrying the roller series, and fast opening action of the jaws would be prevented. Therefore, the blank areas 28 and 29 have been provided on the surface of the ratchet wheel 25 to allow free movement without overriding the pawl 43. The extent of the blank areas 28 and 29 is sufficient to permit the roller series to resume the position shown in Figure 4 before the tooth series is again presented for contact by pawl 43. The roller series, now reversed 180 degrees, has completed one work cycle. It will be readily apparent that the work cycle may be repeated a second time before a full 360 degree revolution has been completed by the ratchet wheel 25.

In order to prevent reversed movement of the ratchet wheel 25 by reaction forces between power steps by the pawl 43, a detent 45 is positioned on the forward area of the ratchet wheel and is urged against the tooth series by means of a spring 46.

In Figure 3 of the drawings there is illustrated a three jaw modification of the tool. The construction and operation is quite similar. In this modification two pivoted jaws 50 and 51, and a single longitudinally reciprocable jaw 52 are provided. Cam driving surfaces 53, 54 and 55 on these jaws respectively are adapted and designed to receive the three rollable members to permit the described closing action upon revolution of the planetary series of rollable members to a given position, and to open through a work cycle upon further rotation of this planetary series. The rollable members are in a planetary arrangement wherein a center roller 56 is in surface contact with each of three planetary rollers 57, 58 and 59. A three way compression of a workpiece device may be achieved by this modification of the basic concept.

Although the invention has been described in its preferred form with a certain degree of particularity, it is understood that the present disclosure of the preferred form has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention as hereinafter claimed.

What is claimed is:

1. A ratchet device for cyclic drive actuation, comprising, a plurality of drive receiving members in spaced relationship, each drive receiving member having a driven cam surface, each drive receiving member having a work cycle path, the plurality of driven cam surfaces jointly defining a drive field area, a plurality of rollable members in a planetary system in said work field, said rollable members including planetary drive members to contact and actuate said driven cam surfaces and the remainder of said rollable members and in surface contact therewith being equidistant from the planetary members, said rollable members having surface contacting relationship across the planetary system to transmit reaction forces through the system for resistance externally of the system, and means to revolvably drive said planetary system in said drive field.

2. A ratchet device for cyclic drive actuation, comprising a plurality of drive receiving members in spaced relationship, each drive receiving member having a driven cam surface, each drive receiving member having a work cycle path, the plurality of driven cam surfaces jointly defining a drive field area, a plurality of rollable members in a planetary system in said work field, said rollable members including planetary drive members to revolve and describe a circular outer path, said work field area and said outer path related to cause revolving movement of the planetary drive members to drive said drive receiving members through their work cycle path, and the remainder of said rollable members being equidistant from the planetary members and in surface contact therewith, said rollable members having surface contacting relationship across the planetary system to transmit reaction forces through the system for resistance externally of the system, and rotary ratchet drive means to revolvably drive said planetary system in said drive field.

3. A power device for cyclic drive actuation, comprising, a first and second drive receiving member in spaced relationship, said first drive receiving member having a first driven cam surface, said second drive receiving member having a second driven cam surface, said first and second driven cam surfaces positioned in opposed relationship and defining a drive field, a rotatable carriage, a plurality of rollable members carried by said carriage, said plurality of rollable members being in surface contacting series position with one another across said drive field between said opposed first and second cam surfaces, whereby rotation of the carriage will revolve the roller series as a cam device and reaction forces will be transmitted from one driven cam surface to the other through the roller series with little stress upon the means mounting the roller series upon the carriage.

4. A ratchet driven plier type tool, comprising, a first and second jaw, said first and second jaws each having a work end and a drive receiving lever end, pivot means intermediate each said jaw for transposition of operating force on the drive receiving lever into work force on the work end, said first and second jaw lever ends having first and second driven cam sufaces respectively and in opposed facing relationship defining an included drive field, a rotatable ratchet wheel, a plurality of rollable members carried by said ratchet wheel, said rollable members being in mutual surface contacting series position with one another across said drive field between said opposed first and second cam surfaces, first and second handle members, pivot means mounting said first handle member for swingable movement thereof, and pawl means transmitting swinging movement of said first handle into drive force upon said ratchet wheel.

5. A closable jaw tool, comprising, first and second opposed pivoted jaw members, said first jaw member having a work end and a drive receiving lever end with a first pivot mounting point intermediate thereof, said second jaw member having a work end and a drive receiving lever end with a second pivot mounting point intermediate thereof, connecting means joining said first and second pivot mounting points and permitting partial rotation of the jaws about the pivots, said drive receiving lever ends of the first and second jaws having opposed first and second drive receiving surfaces respectively for expansion drive to operate said jaws, said drive receiving surfaces defining a drive field, rotatable cam wedge means between said first and second drive receiving surfaces, said first and second drive receiving levers and the rotatable cam wedge means formed to cooperate in producing a variable spreading rate of the first and second drive receiving surfaces and a variable power ratio with the maximum power ratio and minimum rate of movement occurring with the cam wedge producing resultant forces across said drive field in a direction generally perpendicular to the longitudinal center line of the tool, the maximum stresses of operation therefor being generally transverse to the longitudinal center line of the tool, said rotatable cam wedge means comprising a planetary system of rollable members in mutual surface contacting series and means to drivingly rotate said cam wedge means.

6. A power device for cyclic drive actuation, compris-

ing, first and second drive receiving members in spaced relationship, said first drive receiving member having a first driven cam surface, said second drive receiving memmer having a second driven cam surface, said first and second driven cam surfaces positioned in opposed relationship and defining an expandable drive field, a rotatable ratchet wheel, a plurality of rollable members carried by said ratchet wheel, said rollable members being in a surface contacting series position with one another across said drive field between said opposed first and second cam surfaces, and a pivoted lever with pawl means to actuate said ratchet wheel, said rollable member series having a first position between said first and second drive receiving members wherein the drive receiving members are in a maximum closed position thereagainst, said rollable member series having a second position wherein the drive receiving members are in a maximum open position, said second position being about 90 degrees of rotation advanced from said first position, said first and second cam surfaces formed to drop out of active force receiving relationship with said rollable member series upon an advance thereof of the rollable member series to a drive cessation position beyond said second position, said ratchet wheel having two separate tooth series separated by two blank spaces around the periphery thereof, said tooth areas spaced to cease active contact with said pawl upon driving said rollable series to said position of drive cessation, and spring means urging said first and second drive receiving members closed upon said rollable series, whereby said rollable series will rapidly rotate to the said first position thereof but in a 180 degree rotated condition with respect to the prior occupancy of said first position and the drive receiving members will collapse to their starting position.

7. A pivoted jaw compression tool, comprising, first and second jaws, a connecting link pivotally connecting the first and second jaws intermediate the ends thereof, the jaws therefore presenting first and second closable forward work ends and first and second rearwardly extending drive receiving levers, said first lever having a first driven cam surface, said second lever having a second driven cam surface, said first and second driven cam surfaces positioned in opposed relationship and defining an expandable drive field, a rotatable ratchet wheel, three

roller bearings carried by said ratchet wheel in a straight line series with the center wheel on the center of rotation of the ratchet wheel and the remaining two in surface contact with the center bearing, said two bearings describing a circular path upon rotation, said ratchet wheel having a diameter larger than said circle, said roller bearing series positioned in said drive field, a spring urging said first and second drive receiving levers closed upon said roller series, said roller series extending substantially longitudinally of the tool in the maximum open position of the jaws, said first and second driven cam surfaces formed to assume a maximum open position to fully close the jaw work ends when the roller series is rotated to a lateral position substantially parallel to a line extending between the pivotal connecting ends of said connecting link, said first lever having a length extending to about the position of the roller series in said lateral position whereby further rotation of the roller series will cause the series of rollers and the levers to drop free of one another and collapse to a starting position, said ratchet wheel having two sepaarte tooth series separated by two blank spaces around the periphery thereof, said ratchet wheel mounted upon a center for rotation, a first handle for manual support of the tool, a lever handle with pawl means to drive said ratchet wheel, said lever handle pivoted on the center of said ratchet wheel, said lever and pawl adapted to step as far as two ratchet teeth at the discretion of the operator for fast initial movement of the roller series, said tooth areas of the ratchet wheel spaced to end at the said pawl at the collapse position of the first and second levers and roller series, whereby a rapid return from the maximum closed jaw position to a starting position will take place free of the pawl drive, and whereby two complete work cycles will take place for each full revolution of the ratchet wheel.

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