Nov. 16, 1971 H. DISCHLER 3,619,885

VARIABLE-DIAMETER CRIMPING TOOL

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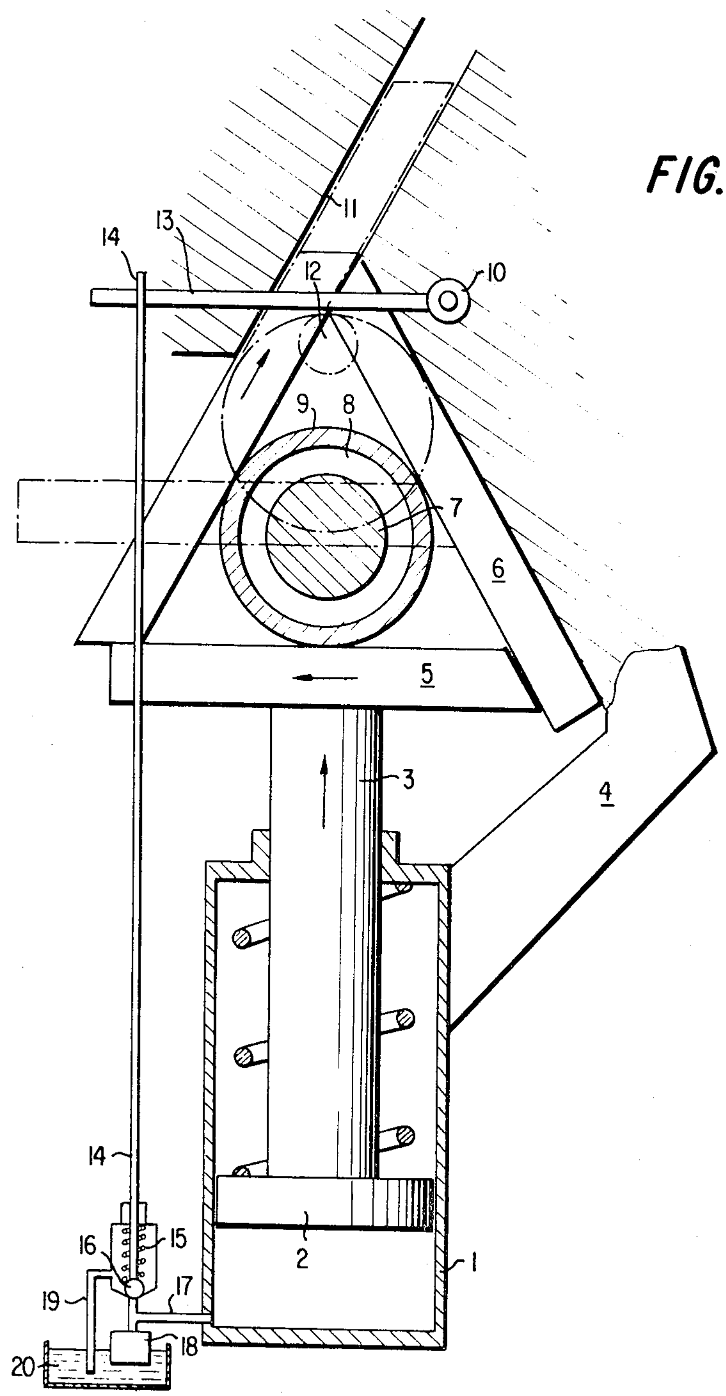
FIG. 1



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VARIABLE-DIAMETER CRIMPING TOOL

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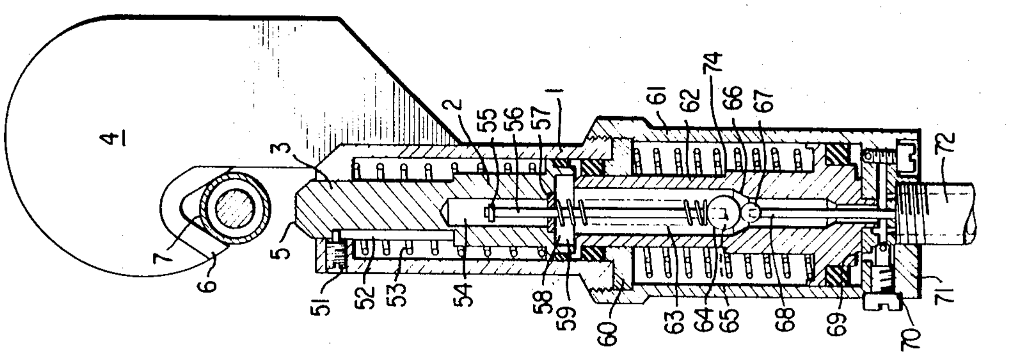

FIG. 4

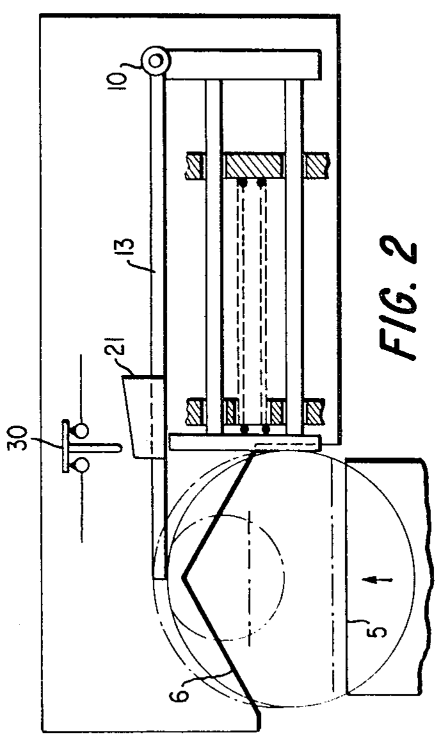

FIG. 2

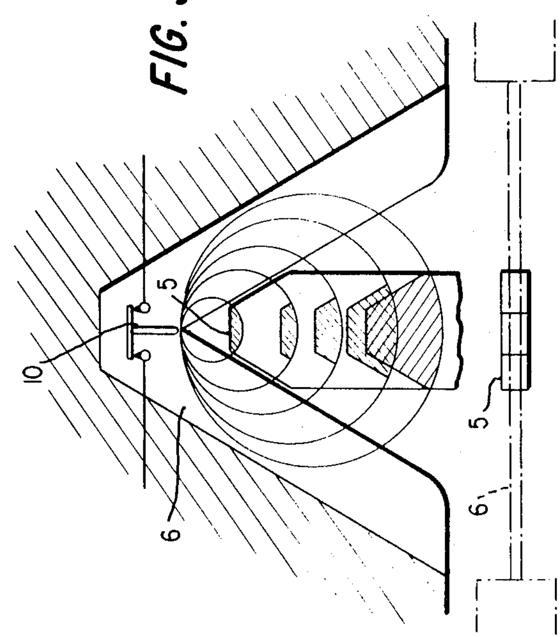

FIG. 3

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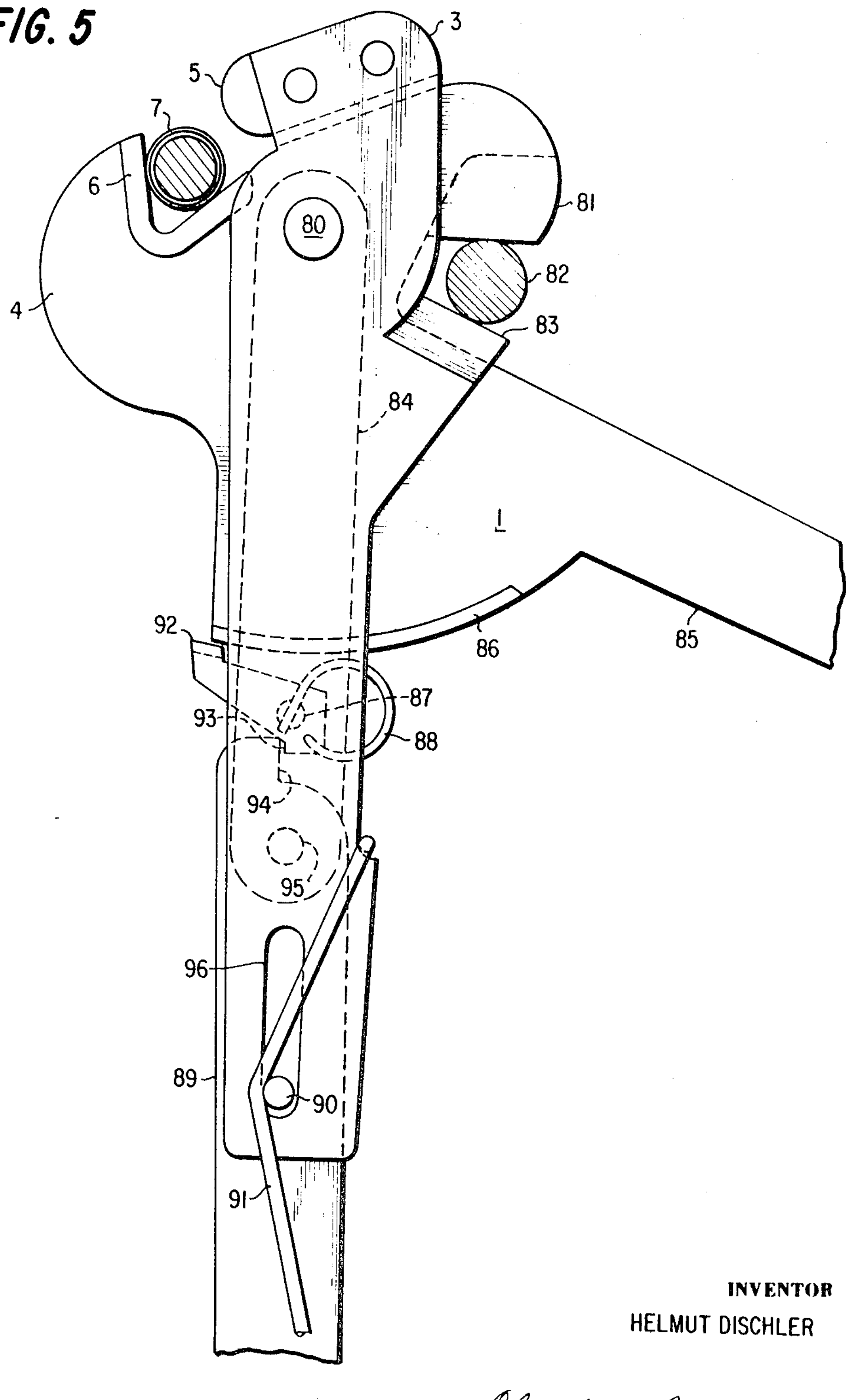
FIG. 5



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3,619,885
VARIABLE-DIAMETER CRIMPING TOOL

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Int. Cl. H01r *43/04*
U.S. Cl. 29—203 D 13 Claims

ABSTRACT OF THE DISCLOSURE

A device to assemble electrical connectors, cable shoes, fittings and sleeves onto electric conductors, cables, wire ropes, rods and ropes of different nominal sizes and diameters, by a crimping deformation operation where the correct depth of crimping and clamping deformation is automatically determined. The crimping jaw arrangement of said device is generally triangular in shape and is either power-hydraulically or manually plier-like actuated in a rapid approach and slow crimping and penetrating operating cycle.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates to a variable-diameter crimping tool and more particularly to a device for the crimping of cable shoes or sleeves and the like onto electric conductors, cables, or rods, whereby the materials to be crimped together are subjected to cold-flow deformation until they form a closed polygonal cold-weld connection.

DESCRIPTION OF THE PRIOR ART

Optimally, the cross-sections of material in a crimped connection are such that the stresses occurring in the crimped portion are the same as the stresses occurring in the adjacent portions of the conductor or of the sleeve. The transmission of tension and bending forces from a cable to a sleeve should create equal stresses in all parts, and the transmission of electric current from a conductor to a cable shoe should be without higher resistance or losses in any of the parts. For this purpose, it is necessary that the materials of both parts are caused to cold-flow and cold-weld at their interface; the cross-sectional area of the sleeve should be at least equal to the nominal cross-section of the conductor or cable. These nominal cross-sections may be composed of a multitude of different partial cross-sections and shapes, and it is therefore necessary that the sleeve has an inner diameter which is considerably greater than the outer diameter of the conductor or cable.

At the beginning of the crimping process, the crimping jaws must therefore deform the sleeve against a relatively small resistance until it touches the partial cross-sections of the cable which mutually support one another. Further closing of the crimping tool jaws causes the sleeve to be subjected to cold-flow deformation, against rapidly increasing resistance, thereby penetrating into the spaces between the partial cross-sections, and, if continued beyond the stage at which these spaces are filled, it will cause everything inside of it to flow, against a practically even resistance, as a homogenous mass, thereby being squeezed away in the longitudinal direction of the cable, until the latter is completely severed. For this reason, it is necessary to limit the closing movement of the crimping jaws to a position at which, while producing a good interface connection, the cross-sectional reduction of the sleeve and cable is of optimal size.

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This result can be obtained, for example, by using crimping dies whose movement is limited by abutment of the die parts against one another, thereby producing very favorable peripheral or polygonal crimped connections. However, such crimping dies have the disadvantage that they can only be used for a single nominal cross-section. A different set of crimping dies is therefore required for each separate nominal cable cross-section.

Crimping tools which are designed for the crimping of different nominal cross-sections must operate without a mechanical abutment. They require that the supporting jaws and the mobile crimping jaw itself are relatively movable past one another, either in mutually overlapping planes, or in parallel, but laterally offset planes.

The open, unilateral type of crimped connection, where a mandrel is advanced against a counter support, has additional shortcomings. Attempts have been made in this connection to limit the closing motion by applying only a predetermined amount of deformation energy, as is possible, theoretically at least, with the so-called ram devices which use explosive charges. But even here practical problems make it necessary to use abutting dies in conjunction with the ram devices and to absorb the excess of deformation energy in the die abutments and by wear. A limitation of the crimping motion as a function of the crimping pressure is only possible within the range of increasing resistance, which ends before complete homogenization of the material is achievable. It is therefore unsuitable for practical applications.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a crimping device which makes possible the use of a single crimping jaw size to operate over a considerable range of nominal cross-sections without the need of replacing the jaws, thus eliminating associated down time and tool costs.

This objective is attained by providing a crimping device whose jaws consist of several separate jaw sections moving relative to one another in a common plane, the closing movement of the sections being limited automatically by a motion control device which stops the jaw advance in response to the deformation of the outer surface of the sleeve or cable shoe which is being crimped onto a cable or an electric conductor, by sensing the sleeve diameter and/or its relative displacement.

The combination of a variety of different designs of the crimping jaws themselves, depending on whether an open or closed, or circumferential or polygonal connection is desired, together with different means for the automatic interruption of the jaw closing motion, or of the relative motion between the control member and the workpiece or the tool, by means of electronic or hydraulic stop switches, or in all-mechanical designs, by means of adjustable abutments makes for a multitude of possible embodiments of the invention, as they are adaptable advantageously to various work conditions.

Where the counter force is provided by a counter support without jaws, the sleeves are pressed against the latter and do not move during crimping; where the counter support is equipped with jaws, the sleeves move by about one-half of the crimping motion performed by the crimping jaw in the same direction. The quality of the crimped connection depends, on the one hand, on the shape of the crimped cross-section as laterally open or closed, and on the other hand, on the amount of cross-sectional reduction as compared to the outer diameter of the sleeve.

Devices designed for a radially open crimped cross-section allow the material displaced by the jaws to escape not only axially, but also radially and this feature requires the additional provision of means to compensate for the geometric deviations of the crimped cross-sections, especially when V-shaped jaws are used to produce the counter force. According to the invention, these deviations, resulting within the range of nominal cross-sections being crimped with the tool, are compensated for by a compensating mechanism cooperating with the control element that interrupts the closing motion.

A polygonal crimped cross-section, comparable to cross-sections obtained by dies, can be produced over a range of nominal diameters with a single tool having a closing stroke of variable length, by providing two angled crimping jaws on the counter support, at an angle between 60 and 90 degrees, and a closing member movable in the angle bisector having one transversal jaw or two similarly angled jaws, whereby one crimping jaw of each the counter support and the closing member is movable in its support at right angles to the direction of crimping penetration.

A nearly closed, triangular crimped cross-section of approximately the same quality as the above cross-section can be produced over a range of nominal cross-sections by providing similar V-shaped counter jaws with straight even jaw surfaces of identical width together with a closing member advancing in the angle bisector, the closing member having a jaw with an axially wider surface and whose radial length may have a convex curve or may be bevelled off on both sides. This embodiment of the invention avoids the earlier need for movable jaws.

In another preferred embodiment, the mobile closing jaw itself serves as the sensing element to determine the interruption of the closing motion. The drive motion for the closing jaw is subdividing into two modes of motion, a rapid-traverse approach motion, and a slower crimping or penetrating motion, executed under higher pressure in accordance with a pressure and speed ratio of between 1 to 1.6 and 1 to 2.5. The crimping motion is automatically interrupted by an abutment and the length of its stroke is automatically determined by the length of the stroke required to reach the sleeve. The shorter this approach stroke, the longer will be the crimping stroke in accordance with the speed ratio. The transition from the rapid approach motion to the power motion for crimping occurs when after approach and initial denting of the sleeve, the crimping resistance rises sharply, this rise in resistance being used to control the switchover.

This preferred embodiment has the advantage of a rapid approach and of a built-in pressure-boosting arrangement. For infrequent utilization one may also use an inexpensive pliers-type crimping tool with a leverage-increasing mechanism; for multi-purpose use, especially with additional tool inserts for cutting, hole-punching, tensioning and similar requirements one may also use a hydraulic cylinder with a pressure-boosting device. The latter offers an additional advantage in that the hydraulic pump used only be a medium-pressure pump delivering between 100 and 150 kg./cm.^{2} of pressure, instead of a high-pressure pump for more than 200 kg./cm.^{2}.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be described and explained in more detail by means of several embodiments illustrated schematically in the accompanying drawings where all the crimping jaws are operating in a common plane, and where the relative displacement of the sleeve is indicated.

FIG. 1 shows a device having a closed triangular crimping jaw arrangement and where the crimping motion is automatically stopped by a sensor-operated hydraulic valve;

FIG. 2 shows a device having an open triangular crimping jaw arrangement, the crimping motion being automatically stopped by an electronic end switch operated by a compensating mechanism;

FIG. 3 shows a device modified from the one shown in FIG. 2 for a nearly closed triangular shape, so that an automatic stop comparable to that of FIG. 1 can be used therewith;

FIG. 4 shows an embodiment having a crimping jaw arrangement similar to that of FIG. 3, where the hydraulic drive includes a two-mode advance mechanism for automatic sensing and penetration depth adjustment by the mobile crimping jaw itself;

FIG. 5 shows a pliers-type device with a leverage-increasing mechanism controlled by the plier motion.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 is shown schematically a crimping device consisting of a hydraulic cylinder **1** inside of which is movably arranged a piston **2** with a piston rod **3** which carries the closing tool. A support **4**, fixedly attached to the cylinder **1** carries two crimping jaws **6** and **11** arranged at an angle of 60 degrees, i.e. 30 degrees to either side of the piston rod axis. The support jaw **6** is fixedly mounted to the support **4**, while the support jaw **11** is longitudinally guided, so that it is movable in a direction perpendicular to the direction of crimping penetration. The driven jaw **5** mounted to the front end of the piston rod is likewise guided longitudinally, at right angles to the direction of advance. During the closing motion, the driven jaw **5** is thus caused to move sideways by contacting the inclined face of the fixed jaw **6**, and in turn, the driven jaw **5** displaces the mobile support jaw **11** by contacting its free end. With this mobility of the crimping jaws, it is possible to produce closed triangular crimped connections over a large range of nominal cross-sections.

In all cases where the support carries crimping jaws, the latter penetrate into the sleeve, and the sleeve **7** is therefore subjected to a relative motion toward the support jaws. In the special case where the angle between the support jaws is 60 degrees and the depth of penetration is one-quarter of the sleeve diameter, which corresponds to a total cross-sectional reduction in area from the full sleeve diameter of 0.5 to 1, the forward surface generatrix of all sleeve diameters reaches a common level when fully crimped, namely the level at which the surfaces of the support jaws intersect. On this level is therefore arranged a sensor **13** which is pivotably supported on one end by a pivot **10**, and which is moved out of position by the crimped sleeve contacting it. To the opposite end of the sensor **13** is connected a rod **14** which operates a hydraulic valve **16** which in turn interrupt the flow of oil to the pressure cylinder **1**. The pressure line **17** connecting the hydraulic pump **18** with the cylinder **1** is thereby opened into a return line **19** leading back to the reservoir **20**. Other parts of the hydraulic equipment are of the conventional kind and therefore not further described herein.

FIG. 2 shows the operation of a compensating mechanism in conjunction with an electric sensor switch to control a crimping device producing an open crimped connection. Such devices are more suitable for use in cramped areas, for example inside relay cabinets, because their support jaws can more easily be placed behind the conductors. The crimping support jaws **6** are arranged at an angle of 120 degrees, and therefore the resulting relative motions of different diameter sleeves will not be to a common point, as is indicated by the dotted lines. This makes it necessary to provide a compensating member **21** between the sensor **13** and the end switch **30**. This compensating member has a cam face which is being displaced transversely in response to the diameter of the sleeve. The sensor and compensating member can be modified to require less space.

In FIG. 3 is shown a set of crimping jaws producing an almost closed triangular crimped cross-section with a relative motion of the sleeve to a common point similar to the operation in FIG. 1. The support jaws **6**, arranged at an angle of 60 degrees, are both fixed, and the driven jaw **5** moving in the angle bisector has a jaw surface which is either provided with a convex curve or bevelled-off on both lateral ends. The cold-flow pressure produced by the advancing driven jaw is determined by its axial width and by that portion of the length of the jaw which penetrates into the sleeve diameter. Because of the V-shape of the crimping support jaws **6**, the axial width of the driven jaw must be larger than the width of the support jaws **6** by the ratio

$$\frac{\tan(\alpha+\vartheta)}{\tan\alpha}\times 2\sin\alpha$$

The depths of penetration thereby obtained with different nominal cross-sections is indicated in FIG. 3 by the cross-hatched areas. In view of the fact that the forward surface generatrix of all sleeves lies on a common level when fully crimped, the drive motion, if produced by an electric drive, can be controlled in a very simple manner by an electric sensor switch **10**.

In the FIGS. 4 and 5 are shown two preferred embodiments having crimping jaws of the kind shown in FIG. 3, but where the motion of the driven jaw **5** is limited by a positive abutment, the total motion being subdivided into two separate modes of motion: an approach motion, determined by the diameter of the sleeve, and a crimping motion following the approach motion, the crimping motion being reduced for smaller nominal cross-sections in response to the length of the approach motion, so that a correspondingly smaller penetration is produced for smaller diameters. This arrangement produces a rapid-traverse approach motion and a slow-motion high-power crimping stroke, the speed and force ratio, or leverage change between 1 to 1.6 and 1 to 2.5.

In FIG. 4 is shown a hydraulic version of the embodiment, consisting of a primary cylinder **1** with a primary piston **2** carrying the driven crimping jaw **5** on the forward end of its piston rod **3**. The piston rod is prevented from rotating by a guide channel **52** in the rod and a guide pin **51** in the cylinder. The piston is driven forward by hydraulic pressure acting against its pressure surface **58** and returned into rest position by the return spring **53**. To the primary cylinder **1** is connected a secondary cylinder **61** which houses a two-step booster piston **69** which has a through-bore **63** in its center. The booster piston **69** has a forward-oriented piston rod **62** reaching through an intermediate flange **60** into a cylindrical recess of the primary piston **1**; it also has an abutment shoulder **74** which, when contacting the intermediate flange **60** stops its forward motion. Inside the bore of the booster piston **69** is provided a valve seat **66** which can be closed by a valve ball **65** attached to the rear end of a control rod **56**. This control rod reaches into a center bore **54** inside the primary piston **2** and it is guided by an end plate **57** in the cylindrical recess of the piston. A spring **64** arranged between the end plate **57** and the ball **65** urges the latter against the valve seat **66**. When the device is in rest position, the valve ball **65** is lifted off its seat **66** by contacting an abutment ball **67** arranged in stationary position at the forward end of a rod **68** which is fastened to the end flange **71** of the secondary cylinder **61**.

When oil is pumped under pressure into the device through the oil supply pipe **72**, it is initially prevented from reaching the pressure surface **69** of the secondary piston by means of the primary pressure valve **70**. The oil thus enters through the center bore **63**, past the valve **65** and acts upon the surface **58** of the primary piston **2**. The latter is advanced toward the sleeve **7** while encountering little resistance. After contacting the sleeve, it begins to deform the latter against rapidly rising resistance, and the hydraulic pressure increases until the primary pressure valve opens, thus ending the approach motion and starting the crimping motion. The dimensions of the device are such that, when used with the largest nominal cross-section, the approach motion ends, when the collar **55** of the valve control rod **56** is near or just contacting the end plate **57**, so that it takes only a small forward motion of the booster piston to close the valve **65**. Further advance of the booster piston **69** causes the piston rod **62** to penetrate into the primary cylinder **1** thereby producing between the primary piston **2** and the closed valve **65** and increased pressure, the increase corresponding to the ratio of the pressure surfaces **69** and **59** of the booster piston. This higher pressure causes the primary piston **2** with the closing jaw **5** to continue its advance under an increased pressure, and at a correspondingly reduced speed, until the booster piston **69** is stopped by its abutment shoulder **74** contacting the intermediate flange **60**. As the valve **65** is kept closed by the higher pressure behind it, the motions of both pistons are blocked in this position until the oil is allowed to flow back through the supply line **72**. The springs **75** and **53** then return both pistons to their rest position.

When a smaller nominal cross-section is to be crimped, the primary piston must make a longer approach motion, so that the valve ball **65** is moved away from the abutment ball **67** by a distance corresponding approximately to the increase in the approach motion required. After the increase in crimping resistance has caused the approach motion to stop, the booster piston has to move by a correspondingly increased distance before it can close the valve **65**. As long as the valve is thus kept open, there is no forward motion on the primary piston **2**, while the secondary piston makes a no-load motion. This no-load motion corresponds to a reduction in the remaining crimping stroke which starts as soon as the valve **65** is closed, the reduction being proportional to the reduction in crimping penetration desired for the smaller nominal cross-section.

FIG. 5 shows an all-mechanical version of the preferred embodiment in the form of crimping pliers. The main body **1** takes the form of a first plier arm. This arm is provided on one end with a handle **85** and on the other end with a support **4** which carries crimping support jaws **6** of the kind described in connection with FIG. 3. The first arm is connected to a second arm over a pivot pin **80**. This second arm is provided with an automatically operating leverage multiplying mechanism. It consists of a pivoting arm **3** pivotable around the pin **80**. On one end this arm carries the driven crimping jaw **5**, and on its opposite end, it is provided with a radial slot **96**. To the pin **80** is also pivotably attached a link **84** extending in the same direction, but less far than the pivoting arm **3**. At its distant end, the link **84** carries another pin **95** which pivotably connects the second handle **89** to the link **84**. The handle **89** has at its near extremity a nose **94** and in the area of the distant end of the radial slot **96** a pin **90** engaging this slot. In the rest position, the pins **80**, **95** and **90** and consequently the arm **3**, the link **84**, and the handle **89**, are all in alignment. This alignment is maintained by a spring **91** under a given preload. At a point intermediate the pivots **80** and **95** is also pivotably attached to the link **84** a pawl **92** which is urged by a spring **88** to engage an arcuate tooth sector **86** which is part of the pliers main body **1**. However, the nose **94** on the handle **96** prevents the pawl **92** from engaging the tooth sector **86**, as long as the three members of the second arm are kept in alignment.

Thus, during the approach motion between the driven jaw **5** and the sleeve **7**, the second arm is kept in alignment. However, as soon as the jaw **5** encounters a given resistance, the preloaded spring **91** will yield, thereby allowing the advancing handle **89** to pivot around the pivot pin **95** instead of the main pivot pin **80**. This motion releases the pawl **92** to engage the tooth sector **86**. The pawl thus blocks any relative return motion of the link **84**, so that the pivot pin **91** can serve as a new fulcrum for the handle **89**. Further closing of the handle **89** causes the latter to rotate around this new fulcrum. Thus closing the arm **3** through the motion of the pin **90** inside the slot **96** under an increased leverage until the handles are closed. This second motion at increased leverage represents the crimping motion. The ratio of the lever arm represented by the distance between the pivot pins **80** and **95** on the one hand, and the pins **95** and **90** on the other hand must be chosen so as to correspond to the ratio of the sleeve diameter to the crimping penetration depth for the various nominal cross-sections. Like all the previously described embodiments, this device, too, may be equipped with additional tool inserts for other types of work, such as cutting, for example with the shear blades **81** and **83**.

I claim:

1. A device for the controlled crimping of sleeves, cable shoes and the like onto electric conductors, cables or rods, where the crimping operation is automatically ended in a different closing position for each different nominal cross-section within a given range of sizes, the device comprising in combination:

(a) a main body by which the device can be held and carried;

(b) a support fixedly attached to said main body and capable of reaching at least partially around the parts to be crimped together;

(c) supporting jaws means connected to said support, and supporting jaw means being designed to engage and hold the parts to be crimped on one side thereof;

(d) closing jaws means facing said supporting jaw means on the opposite side of the parts to be crimped, said closing jaw means being forcibly movable toward said supporting jaw means to effect a crimping operation therebetween;

(e) means to drive said closing jaw means through a closing and penetrating motion and through a no-load return motion, said driving means being arranged to allow the closing motion to be ended at different predetermined closing positions;

(f) means to automatically sense the distance of closing motion necessary for said closing jaw means in response to different sizes of the nominal cross-section, said sensing means being operatively connected with said driving means to end the closing motion.

2. The device as defined in claim **1**, wherein

said supporting jaw means include two straight supporting jaws arranged in a V-formation; and

said closing jaw means are movable, at least in a portion of their motion, in the angle bisector of said V-formation, so as to produce a substantially polygonal crimped cross-section.

3. The device as defined in claim **2** wherein said sensing means include means responsive to a predetermined depth of penetration of said V-shaped supporting jaws into the sleeve cross section by sensing the relative position of the sleeve surface generatrix closest to the intersection point of the faces of said jaws, so as to end the closing motion at this penetrated position.

4. The device as defined in claim **3**, wherein said V-shaped supporting jaws are arranged at such an angle to one another that the aforesaid sleeve surface generatrix of different sleeve sizes occupies a common penetrated position for all sizes, when said supporting jaws have reached the desired penetration depth.

5. The device as defined in claim **4**, wherein said angle between the supporting jaws is 60 degrees, and said common penetrated position of the surface generatrix of different sleeve sizes substantially coincides with said intersection point of the supporting jaw faces.

6. The device as defined in claim **3**, wherein said sensing means further include compensating means, responsive to different sleeve sizes, for variances occurring in said penetrated position of the sleeve generatrix of different sleeve sizes, so as to provide a common penetration sensing position for said sensing means.

7. The device as defined in claim **6**, wherein said compensating means include a wedge-shaped, transversely movable compensating cam interposed between said varying penetrated position of the sleeve generatrix and said sensing means, the transverse position of said compensating cam being automatically set in response to the sleeve size, so that said compensating cam presents a common

penetration sensing position, when it contacts, said sleeve generatrix in its penetrated position.

8. The device as defined in claim **1**, wherein

said supporting jaws means include a longitudinally movable supporting jaw and, arranged at an acute angle thereto, a stationary supporting jaw approaching said movable supporting jaw at the apex of said angle;

said closing jaw means include a longitudinally movable closing jaw arranged perpendicularly to the bisector of said acute angle, one extremity of said movable closing jaw contacting the face of said fixed supporting jaw, while one extremity of said movable supporting jaw contacts the face of said closing jaw so as to form a closed, variable triangle between the faces of said three jaws; and

said driving means comprise a hydraulic cylinder as part of said main body, and in said cylinder a piston and a piston rod extending in said angle bisector, so as to forcibly move said closing jaw against the sleeve to be crimped.

9. The device as defined in claim **8**, wherein

said closed triangle formed by said jaw faces is substantially equilateral, so that, when different sizes of sleeves are crimped within said triangle until the fully crimped cross-section forms a full triangle within the sleeve diameter, the apex corner of said triangle substantially coincides with a surface generatrix of each sleeve, thereby providing a sensing level for the penetrated position of each sleeve;

said driving means further comprise a bypass valve to end the closing motion of said piston and closing jaw upon actuation of the valve; and

said sensing means include a sensing member operatively connected with said bypass valve and positioned in said sensing level so as to respond when a fully crimped sleeve reaches said penetrated position, thereby causing said closing motion to end.

10. The device as defined in claim **2**, wherein

said driving means are capable of producing an approaching mode of moving said closing jaw means, the speed of advance being relatively rapid and the exertable force relatively low during this mode, and a penetrating and crimping mode of moving said closing jaw means during which the speed of advance is considerably slower and the exertable force proportionably higher, the two moving modes occurring consecutively and having a cumulative effect on the advance of said closing jaw means; and wherein

said sensing means include switchover means to switch said driving means from the approaching mode to the penetrating mode after said closing jaw means have contacted the sleeve to be crimped, said sensing means further including arresting means to end the penetrating mode of motion when the driving means have reached a predetermined end position, whereby the total advance distance travelled by said closing jaw means is greater when the switchover from the rapid advance mode to the slow penetration mode occurs later with respect to the distance travelled, the latter being the case with a smaller size sleeve.

11. The device as defined in claim **10**, wherein said switchover means respond to the rising resistance encountered by the advancing closing jaw means after contacting the sleeve.

12. The device as defined in claim **10**, wherein said driving means comprise

a primary hydraulic cylinder as part of said main body and, attached to the distant end thereof;

a secondary hydraulic cylinder of a larger effective diameter, with an intermediate flange therebetween, and an end flange with a centrally attached oil supply pipe at its distant end;

a primary piston and piston rod inside of said primary cylinder, said rod having a center bore open only to the piston side, said closing jaw means being attached to the forward end of said rod;

a hollow secondary two-step piston and piston rod inside of said secondary cylinder, said piston rod sealingly reaching through said intermediate flange and into said primary cylinder, thereby representing the second step, or pressure-booster step, of said piston, the larger piston representing the first step being so arranged that, when fully retracted, it sealingly contacts said end flange, thereby sealing off its effective area from the oil supply;

a spring-loaded center valve inside of said hollow piston rod, and a control rod attached to said valve, said control rod being operably connected with said primary piston, responding to the distance thereof from the secondary piston, said center valve including means to keep it open when said secondary piston is in retracted position; and wherein

said sensing means comprise as switchover means a pressure-responsive valve opening up an oil supply bypass around said sealing contact between said end flange and said first-step piston area, said pressure-responsive valve being actuated by the resistance encountered by said closing jaw means upon contacting the sleeve to be crimped; said sensing means comprising as arresting means an abutment shoulder on the secondary piston rod limiting its forward displacement against said intermediate flange;

said driving means and sensing means cooperating in such a way that, from the retracted position, only the primary piston advances in the rapid approaching mode until impact resistance from the sleeve causes said oil supply bypass to be opened up and said secondary piston to start moving, which motion does not affect the position of said primary piston until said center valve is closed by the advance of said secondary piston, the closing of said center valve indicating the beginning, and the abutment against said intermediate flange the end, of the slow penetrating mode of advance during which said primary piston is driven by said secondary piston at a stepped-down speed; the closing of said center valve occurring comparatively later, when a smaller sleeve is present, so that the advance in the penetrating mode is comparatively shortened.

13. The device as defined in claim **11**, wherein said driving means comprise

a first arm as part of said main body, and attached to it in a pliers-type arrangement,

a second arm assembly pivotable around a main pivot pin in said first arm; said second arm assembly comprising a link which is also pivotable around said main pivot, a handle extending from said link and pivotably connected thereto by a secondary pivot pin, a radial slot in said handle at a distance from said secondary pivot, a pivoting arm likewise pivotable around said main pivot and extending in the direction of said handle, with a pin in said pivoting arm engaging said handle slot so that rotation of said handle around said secondary pivot causes said pivoting arm to advance at reduced displacement and multiplied leverage; said pivoting arm carrying attached to it said closing jaw means; and wherein

said sensing means comprise

a preloaded spring maintaining said link and handle in radial alignment until a predetermined arm-closing moment is exceeded,

a spring-loaded pawl pivotably attached to said link, an arcuate tooth sector as part of said main body, and a nose as part of said handle to prevent said pawl from engaging said tooth sector as long as said link and handle are in alignment,

said driving means and sensing means cooperating in such a way that, from an open position, under a closing force applied to the first arm and to the handle, the second arm assembly pivots closed in a first mode of motion until the closing jaw means encounter rising resistance after contacting the sleeve and the bending moment thereby caused between said link and handle causes said spring to yield allowing said handle to rotate around said secondary pivot, whereby said pawl is released into said tooth sector so as to support said secondary pivot against motion; the second mode of motion thus initiated is limited by the space remaining between said first arm and said handle after the release of said pawl, said release occurring comparatively later, when a smaller sleeve is present so that the advance in the penetrating mode is comparatively shortened.

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