Jan. 25, 1966 W. R. McDURMONT 3,230,713

CONTROL SYSTEM

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FIG. 1.

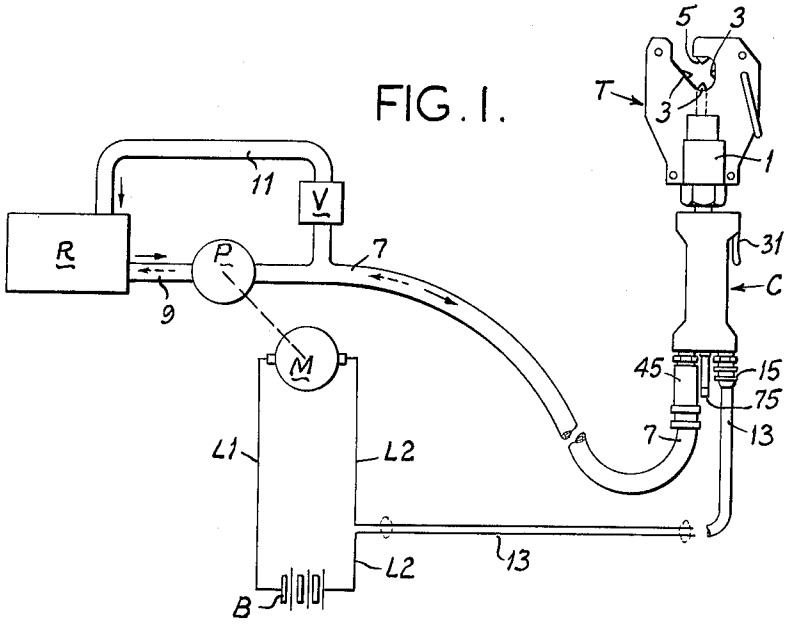

FIG. 3.

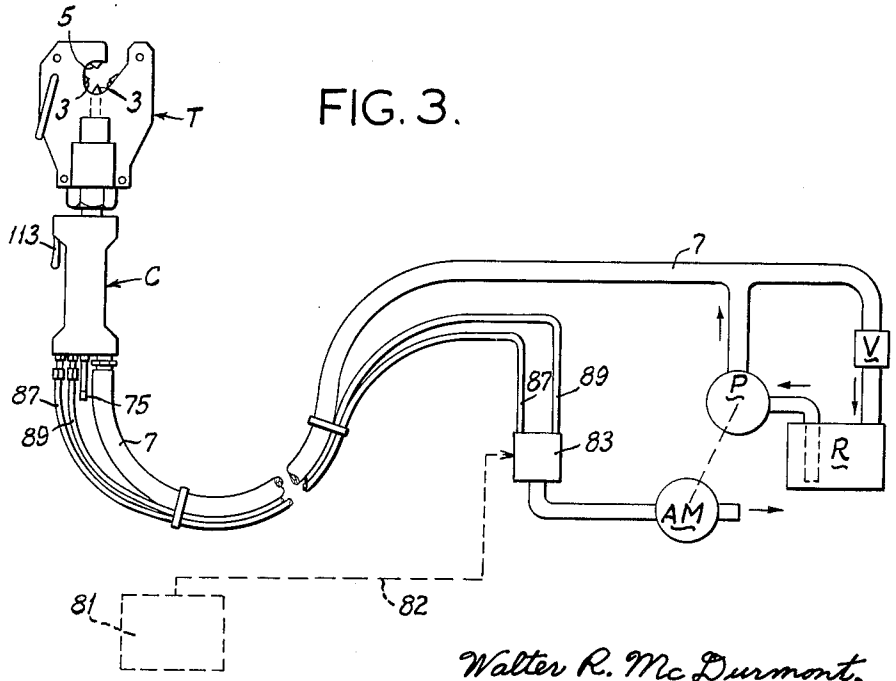

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FIG. 2.

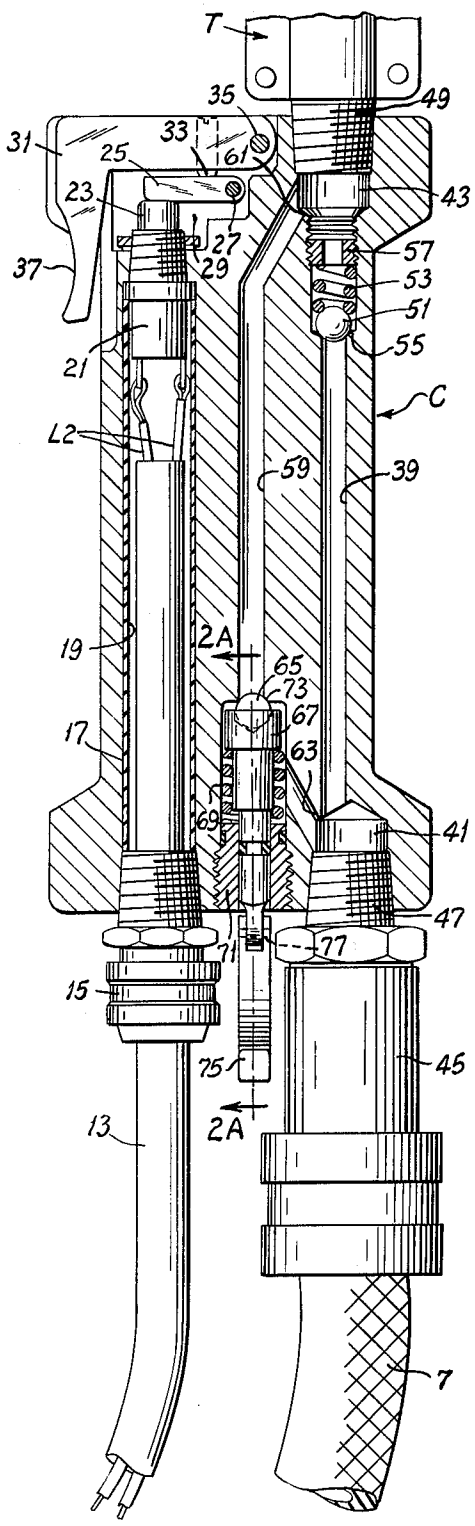

FIG. 2A.

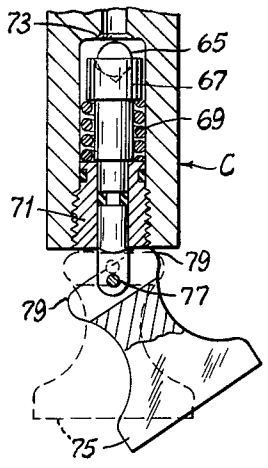

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FIG. 4.

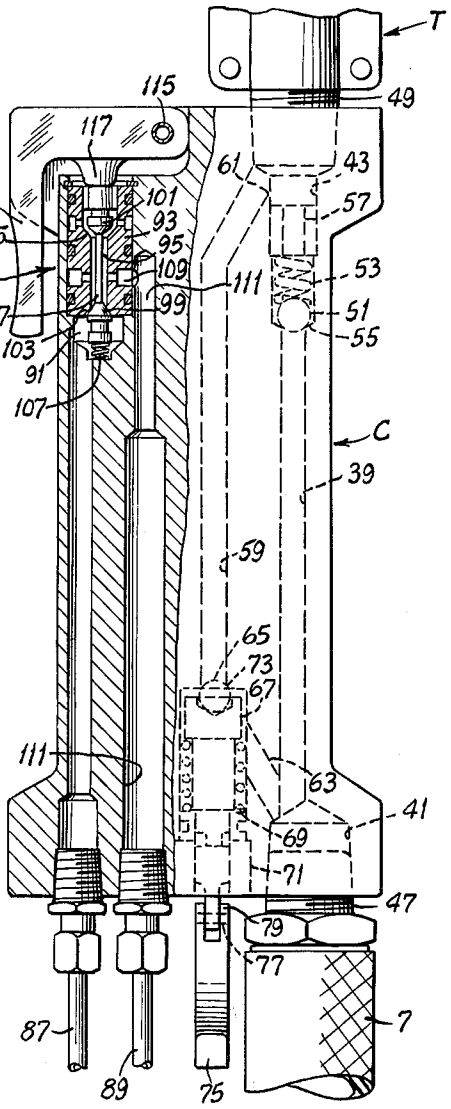
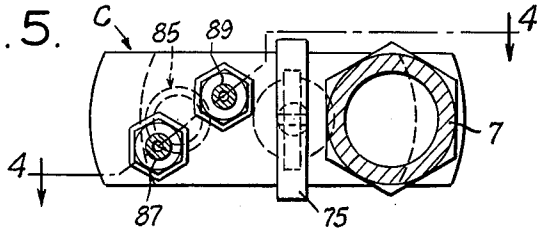


FIG. 5.



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3,230,713

CONTROL SYSTEM

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9 Claims. (Cl. 60—52)

This invention relates to a control system for compression crimping tools and more particularly to a control system for fluid-pressure-operated crimping tools adapted to crimp connectors onto cables, electrical conductors, and the like.

Among the several objects of this invention may be noted the provision of a control for compression crimping tools which permits the connector or workpiece, prior to being crimped, to be held by the tool with a minimum gripping pressure; the provision of a crimping apparatus including a fluid-pressure-operated crimping tool in which the crimping dies may be inched or moved together until a predetermined minimum gripping or holding pressure is exerted on a connector, the minimum gripping pressure once reached thereafter being maintained after the supply of pressurized fluid to the tool is discontinued; the provision of such crimping apparatus in which the crimping dies, subsequent to the crimping of the connector, are maintained in firm contact with the crimped connector with a minimum gripping pressure until the operator desires to remove the tool therefrom; the provision of a control for crimping tools which is useful to control the operation of the tool when located in a position remote from a source of pressurized fluid supply; the provision of a control of the class described which can be conveniently operated by one hand and which permits the crimping tool to be hot-stick mounted; the provision of a control for compression crimping tools which enables the operator to stop the movement of the crimping dies at any desired opening or position; the provision of such controls which permit the operator to position the tool initially to grip the connector or workpiece to be crimped so that the tool may be used as a holding device for the connector, thereby reducing the time required for installation of crimped connectors and to overcome job awkwardness in forming crimped connections on overhead conductors; the provision of crimping apparatus including such controls which may be conveniently used in the field and which is compact, self-contained, easily isolated from ground, and in which the crimping tool may be operated from a position remote from air or electrically driven hydraulic pumps; and the provision of crimping apparatus which is reliable in operation, light in weight, and simple and economical in construction. Other objects and features will be in part obvious and in part pointed out hereinafter.

Briefly, my invention comprises a control for a fluid-pressure-operated crimping tool which may be actuated by fluid under pressure from a supply source. The control is interconnected by a fluid line between the supply source and the tool and has a fluid passage with a normally closed check valve positioned therein. This valve opens to supply fluid to the tool when fluid under pressure is supplied from the source. The control also includes an auxiliary or second check valve which will open when the pressure in the tool and downstream from the first check valve exceeds a predetermined value, which effects the bleed off of pressure from the tool and then automatically recloses and maintains substantially the predetermined value of pressure in said tool. Preferably the control also includes means, such as an electric switch or a pneumatic valve, which functions selectively to actuate and deactuate a hydraulic pump or other convenient supply source for pressurized fluid, and another means (preferably manually operable) for selectively opening the auxiliary valve to vent or release the fluid pressure at the tool and to permit its return to the supply source.

The invention accordingly comprises the constructions hereinafter described, the scope of the invention being indicated in the following claims.

In the accompanying drawings, in which several of various possible embodiments of the invention are illustrated,

FIG. 1 is a schematic of an embodiment of crimping apparatus of the present invention, an electrical power source being provided;

FIG. 2 is a section of the control of the crimping apparatus shown in FIG. 1;

FIG. 2A is a section taken on line 2A—2A of FIG. 2 and showing a certain check valve in an open position;

FIG. 3 is a schematic of another embodiment of crimping apparatus of the present invention in which compressed air is utilized as the power source;

FIG. 4 is a partial section taken on line 4—4 of FIG. 5; and

FIG. 5 is a bottom plan of the control of the crimping apparatus of FIG. 3.

Corresponding reference characters indicate corresponding parts throughout the several views of the drawings.

Referring to FIGS. 1 and 2 of the drawings, a fluid-pressure-operated crimping tool of crimping apparatus of one embodiment of this invention is generally indicated at reference character T. Tool T may, for example, be of the type shown and described in my coassigned copending U.S. patent application Serial No. 115,625, filed June 8, 1961, now Patent No. 3,154,981 granted November 3, 1964 which includes, a hydraulic ram type fluid motor 1 operatively connected to movable dies 3. Upon actuation of motor 1, dies 3 converge uopn a workpiece such as an electrical connector (not shown) positioned between movable dies 3 and a fixed die 5. A control C of the present invention is interconnected by a hydraulic fluid line 7 between a hydraulic pump P and tool T. Pump P, interconnected by a hydraulic fluid line 9 to a reservoir R, serves as a supply source for pressurized fluid. Preferably this supply source includes a pressure relief valve V which is automatically actuated when a preselected high (e.g., 10,000 p.s.i.) pressure in line 7 is exceeded to thereby return fluid via a return line 11 to reservoir R. This pressurized fluid supply source also includes an electric motor M driving pump P and a suitable unloading valve (not shown) for the system which, upon deactuation of the pump, automatically opens, permitting hydraulic fluid to return to reservoir R from line 7 thereby reducing the pressure in line 7 to atmospheric. Such pressurized hydraulic fluid sources are available commercially, one such type being a light-wenght, compact portable unit obtainable under the trade designation #1729 from Greenlee Tool Co. of Rockford, Illinois. This crimping apparatus may be conveniently carried by the lineman with the pump motor M being powered by a self-contained chargeable battery B. If desired, the apparatus may be electrically powered from the battery of a utility service vehicle or any other convenient source of A.C. or D.C. power.

The electrical power source B is electrically interconnected to motor M by means of electrical lines L1 and L2, the latter including a cable 13 connected to control C. Cable 13 is strain-secured to the control body C by means of a compression bushing 15 threaded into the end of a bore 17 having an insulated internal sleeve 19. A conventional spring-biased open single-pole single-throw switch 21 is mounted at the other end of bore 17 having its contacts serially connected in line L2. Switch 21 has a plunger type actuator 23 positioned for opera-

tion by actuating cam 25 pivoted on the control body tion by an actuating cam 25 within a slot 29 thereof. An L-shaped trigger 31, having a projection 33 riding on cam 25, is mounted for pivotal movement about a pin 35 and within slot 29. The outer leg of trigger 31 is concavely recessed at 37 to accommodate the finger of a lineman.

Extending through control body C is a main fluid passage 39 having an inlet 41 and an outlet 43. A coupling 45 on fluid line 7 terminates in a nipple 47 threaded within inlet 41. Crimping tool T is interconnected to outlet 43 by a threaded nipple 49. Mounted in fluid passage 39 is a check valve including a ball 51, a spring 53 biasing ball 51 to a closed position against a seat 55, and a retainer 57 which holds spring 53 in position. This normally closed check valve prevents the return of fluid from tool T through fluid passage 39 and opens at a relatively low pressure (e.g., about 100 p.s.i.) to supply pressurized hydraulic fluid to tool T.

A bypass passage 59, constituting a bleed for tool T, communicates at 61 with outlet 43 and at 63 with inlet 41. An auxiliary valve constituting a second check valve is provided in this bypass 59. This valve includes a check ball 65 carried in a concave end portion of a valve stem 67 which has a reduced shank portion, and a spring 69 positioned around the midportion of the shank portion and having one end bearing against the inner surface of a bushing 71, thereby biasing the valve stem 67 so that valve check ball 65 is biased against a valve seat 73. This normally closed check valve prevents the release of hydraulic fluid from tool T as long as fluid pressure in bypass 59 does not exceed the predetermined but relatively low pressure (e.g., 100–200 p.s.i.) as determined by the biasing force of spring 69.

The outer end of the valve stem shank is slidable within the bore of bushing 71 and may be retracted to open this auxiliary valve by manual movement of a toggle trip 75 pin-connected at 77 to the shank end protruding from the control body C. As corners 79 of the portion of toggle trip 75 which engage the surface of the body of control C are arcuate and spring 69 biases valve stem 67 inwardly, trip 75 will automatically return to its dashed-line position (FIG. 2A) when manual pressure is discontinued.

Operation is as follows:

A workpiece, such as a connector to be crimp-connected to a cable or the like, is positioned within the jaws of crimping tool T and between the crimping dies 3 and 5. Trigger 31 is initially momentarily depressed one or more times, thereby forcing fluid under pressure by normally closed check valve ball 51 and causing initial converging movement of dies 3 against the surfaces of the workpiece to be crimped. Upon each release of trigger 31 the fluid pressure in line 7 (i.e., upstream from this check valve) is released or vented by the unloading valve (not shown) which returns the fluid in line 7 to the reservoir each time pump motor M stops. The fluid pressure in tool T (i.e., downstream from valve ball 51), however, can only be released by opening of the auxiliary or second check valve. When the fluid pressure downstream from check valve ball 51 exceeds a predetermined value, i.e., the fluid pressure at tool T is more than 100 p.s.i. (assuming this is the biasing force of spring 69 against ball 65), ball 65 will move away from its seat and bleed pressurized fluid from tool T until the tool pressure drops to this predetermined value. Thus, the pressure in tool T is maintained at this reduced pressure, thereby causing the dies 3 and 5 to effect a light but firm gripping pressure on said connector. The lineman operating this crimping apparatus may then move the connector to the desired position engaging a cable or electrical conductor.

Trigger 31 is then again depressed and held depressed, causing pressurized fluid to be supplied through line 7 and passage 39 past the first check valve ball 51 to tool T to effect crimping of the connector. During this operation, and during any period when trigger 31 is held depressed, the pressure upstream and downstream of the check valve ball 51 is equalized and auxiliary check valve 65 will be held open by the hydraulic pressure overcoming the biasing action of spring 69. If, at any time prior to completion of the crimping operation, trigger 31 is released, the fluid pressure in line 7 will drop due to operation of the unloading valve (not shown) associated with pump P, and the pressure in tool T will also drop, but not below the 100 p.s.i. predetermined value since the check valve 65 closes at this pressure by biasing action of spring 69 thereby causing the tool dies to continue to grip the connector. When the fluid pressure at tool T reaches the preselected high (assumed, for example, to be 10,000 p.s.i.) value, valve V will open. If trigger 31 is thereafter held in the depressed position, hydraulic fluid will simply be returned to reservoir R via line 11 and tool T will not exert any increased pressure on the already fully crimped connection. This operation of valve V will indicate the completion of the crimping operation to the lineman, not only by the audible sound of its operation, but by the sudden relaxation of the fluid pressure in line 7.

Trigger 31 is then released by the lineman and this action causes deenergization of pump P and venting of the line 7 to atmospheric pressure. Auxiliary valve ball 65 will remain open against the relatively light biasing action of spring 69, thereby bleeding the highly pressurized fluid from tool T via passage 59 to line 7 and thence to reservoir R. The pressure in tool T will rapidly drop until it reaches the 100 p.s.i. predetermined value, whereupon this auxiliary valve closes, maintaining this reduced pressure and a continued light but firm gripping action of the tool dies on the crimped connection. To remove the tool from the crimped connection, the lineman simply moves toggle trip 75 from its dashed to its solid-line position (FIG. 2A) which overcomes the bias of spring 69 moving ball 65 away from its seat 73, thereby bleeding the tool T. As the dies 3 are lightly biased to an open position, the tool can then be conveniently disengaged from the crimped connection for a subsequent operation. As the crimping tool cannot be removed from the connector unless toggle trip 75 is manually actuated, inadvertent partial crimping is avoided.

It is to be noted that control C is easily gripped by only one hand, with toggle trip 75 and trigger 31 both being easily accessible to the lineman. This allows the lineman to perform gripping and crimping operations sequentially and repetitively while having one hand free to position connectors in the jaws of the tool, or for support.

Crimping tool T is easily removed from control C by unthreading nipple 49. A hot-stick extension (not shown) may be easily inserted between control C and tool T in a minimum time. Such an extension is particularly useful for overhead work such as making a tap connection to a primary circuit or conductor.

Referring to FIGS. 3, 4 and 5, an alternate embodiment is shown in which pump P in the fluid system is driven by an air motor AM instead of by the electric motor M employed in the first embodiment described above. This second embodiment is also particularly adapted for use with utility service vehicles which are normally equipped with air compressors, constituting an air source for the operation of the motor AM. The fluid system in the FIGS. 3–5 embodiment is identical to that of FIGS. 1 and 2, and like references are employed for the fluid system.

An air compressor, illustrated diagrammatically at 81, delivers air via an air line 82 to a control valve 83 which controls the flow of air to air motor AM. A pilot air control valve, generally designated 85, positioned in control C, controls the opening and closing of valve 83. Small-diameter, flexible, pilot control lines 87 and 89 interconnect pilot control valve 85 and control valve 83.

Pilot line **87** communicates with air line **82** and leads to an inlet chamber **91** in control C.

Pilot control valve **85** includes a valve body **93** having a central bore **95** in which a valve stem **97** is slidable. Heads **99** and **101** are provided on valve stem **97** and are adapted to seat against respective seats **103** and **105**. A spring **107** biases valve head **99** into seating engagement with seat **103**. An outlet port **109** communicates with bore **95** and an outlet passage **111**. A trigger **113** is pivoted at **115** on the body of control C. Mounted on trigger **113** is a downward projection **117** contacting valve head **101**. Manual depression of trigger **113** moves valve head **99** against the bias of spring **107**, thereby seating valve head **101** and unseating valve head **99**. Air will then flow from control line **87**, through inlet chamber **91**, bore **95**, outlet port **109**, air passage **111**, and pilot control line **89** to control valve **83**, thereby opening it to supply compressed air to motor AM for driving pump P. Release of trigger **113** effects reseating of valve head **99** under bias of spring **107** to stop the flow of air through pilot valve **85** to valve **83** which then closes to stop air motor AM. The operation of the embodiment of FIGS. 3–5 in effecting the crimping operation is identical to the operation of the embodiment of FIGS. 1 and 2, the pump P being operated by a pneumatic motor and a pneumatic valve, rather than by an electric motor and switch.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A control for a fluid-pressure-operated crimping tool adapted to be actuated by fluid under pressure from a supply source including a reservoir and a pump, a fluid line interconnecting said control and said supply source, said control comprising a first fluid passage and a normally closed check valve in said passage adapted to open and supply fluid to said tool when fluid under pressure is supplied from said source, said control further including a second fluid passage bypassing the check valve, an auxiliary valve in the bypass passage, means biasing the auxiliary valve closed against a predetermined fluid pressure downstream from the check valve, the auxiliary valve being adapted to open when the pressure in the tool and downstream from the check valve exceeds the predetermined pressure, the means biasing the auxiliary valve closed automatically reclosing the auxiliary valve when the fluid pressure in the tool and downstream from the check valve falls below the predetermined pressure whereby the tool remains under substantially said predetermined fluid pressure after the pressure in the fluid line falls below the predetermined value, and means for selectively relieving the fluid pressure in the bypass passage between the auxiliary valve and the check valve to bleed back fluid from said tool to said reservoir whereby fluid pressure is removed from the tool.

2. A control as set forth in claim **1** which further includes means for selectively energizing and deenergizing said pump.

3. In fluid-pressure-operated crimping apparatus including a fluid-actuating crimping tool, a fluid reservoir, and means to supply fluid under pressure from the reservoir through a fluid line to the crimping tool for effecting a crimping action; a control having a first fluid passage interconnected to said fluid line, said control including a normally closed check valve in the passage adapted to open and supply fluid to the tool when fluid under pressure is supplied from said supply means and to prevent return of fluid from the crimping tool through said valve, a second fluid passage communicating with the first passage

downstream from the check valve between the check valve and the tool and communicating with the first passage upstream from the check valve between the check valve and the means to supply fluid under pressure thereby bypassing the check valve, means actuated when the fluid pressure in the first fluid passage reaches a preselected maximum pressure to prevent an increase in the fluid pressure in the tool above the preselected maximum pressure, an auxiliary valve in the bypass passage, means biasing the auxiliary valve closed against a predetermined fluid pressure downstream from the check valve, the auxiliary valve being responsive to pressure downstream from the check valve to open when the downstream pressure exceeds the predetermined pressure, the means biasing the auxilary valve closed automatically reclosing the auxiliary valve when the fluid pressure in the tool and downstream from the check valve falls below the predetermined pressure whereby the tool remains under substantially said predetermined fluid pressure after the pressure in the fluid line falls below the predetermined value, and means for selectively relieving the fluid pressure in the bypass passage between the auxiliary valve and the check valve to bleed back fluid from said tool to said reservoir whereby fluid pressure is removed from the tool.

4. A control for a fluid-pressure-operated crimping tool adapted to be actuated by fluid under pressure from a supply source, a fluid line interconnecting said control and said supply source, said control comprising a body having a passage therethrough for flow of pressurized fluid from the source to the tool, a first normally closed valve in the passage in said body adapted to open for flow of fluid to the tool in response to the supplying of pressurized fluid to said passage, said body having a bleed communicating with the passage downstream from the valve between the valve and the tool and communicating with the passage upstream from the valve between the valve and the source of fluid pressure for bleeding off pressurized fluid from said passage downstream from said first valve, and a second valve in the bleed for controlling said bleed, means biasing the second valve closed against a predetermined value of fluid pressure downstream from the first valve, said second valve being opened when pressure downstream from said first valve exceeds the predetermined value, the biasing means automatically reclosing said second valve and said bleed when the fluid pressure in the tool and downstream from the check valve falls below said predetermined value whereby said second valve holds pressure at substantially said predetermined value in said tool upon cessation of supply of fluid under pressure to said passage and upon venting of pressure from said passage upstream from said first valve, said control further including manually operable means for selectively opening said second valve thereby permitting fluid in said tool and said bleed to return through said fluid line whereby fluid pressure is removed from said tool.

5. A control as set forth in claim **4** in which said supply source includes a reservoir and a pump, and said control further includes means for selectively energizing said pump.

6. Crimping apparatus comprising a fluid-pressure-operated crimping tool including dies adapted when actuated to close upon and thereafter crimp a workpiece, a fluid reservoir, a fluid line, a pump for delivering pressurized fluid from said reservoir to said line, and a control interconnected to said pump by said line and having a fluid passage for supplying pressurized fluid to said tool and a check valve in said passage adapted to open for flow of pressurized fluid to said tool and to close upon cessation of delivery of pressurized fluid to said passage, said control further including a bleed communicating with the passage downstream from the check valve between the check valve and the tool and communicating with the passage upstream from the check valve between the check valve and the line for bleeding pressure from the tool downstream from the check valve, said bleed including a

second valve, means biasing the second valve closed against a predetermined value of pressure downstream from said check valve, the second valve being opened when said pressure downstream from said check valve exceeds said predetermined value, the biasing means automatically reclosing said second valve and said bleed when the fluid pressure in the tool and downstream from the check valve falls below said predetermined value whereby said second valve maintains the fluid pressure at said tool at substantially the predetermined value upon cessation of supply of pressurized fluid from said supply source and upon venting of pressure from said passage upstream from the first valve, said control having means for selectively actuating said pump whereby upon initial momentary actuation of the pump said predetermined fluid pressure will be applied to said tool to close said dies upon said workpiece and lightly grip it and upon subsequent pump actuation increased fluid pressure will be applied to the tool to cause the dies to crimp said workpiece, and means for selectively opening said second valve to bleed back fluid from said tool to said reservoir whereby the dies will reopen and release the workpiece.

7. Crimping apparatus as set forth in claim 6 which further includes means actuated when the pressure in said line exceeds a preselected maximum value to permit fluid

to return to the reservoir whereby when the crimping of the workpiece is completed the supply of pressurized fluid to said tool will be discontinued and upon operation of said selective actuation means to deactuate the pump the fluid pressure at said tool is reduced to said predetermined value and the dies will continue to grip said crimped workpiece.

8. Crimping apparatus as set forth in claim 7 wherein said pump is an electrically actuated pump and said means for selectively actuating said pump is an electric switch.

9. Crimping apparatus as set forth in claim 7 wherein said pump is a pneumatically driven pump and said means for selectively actuating said pump includes a pneumatic valve.

References Cited by the Examiner

UNITED STATES PATENTS

1,706,309	3/1929	Miller	60—52
2,467,509	4/1949	Trautman	60—52
2,573,993	11/1951	Sedgwick	60—52
2,921,438	1/1960	Klingler	60—52

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