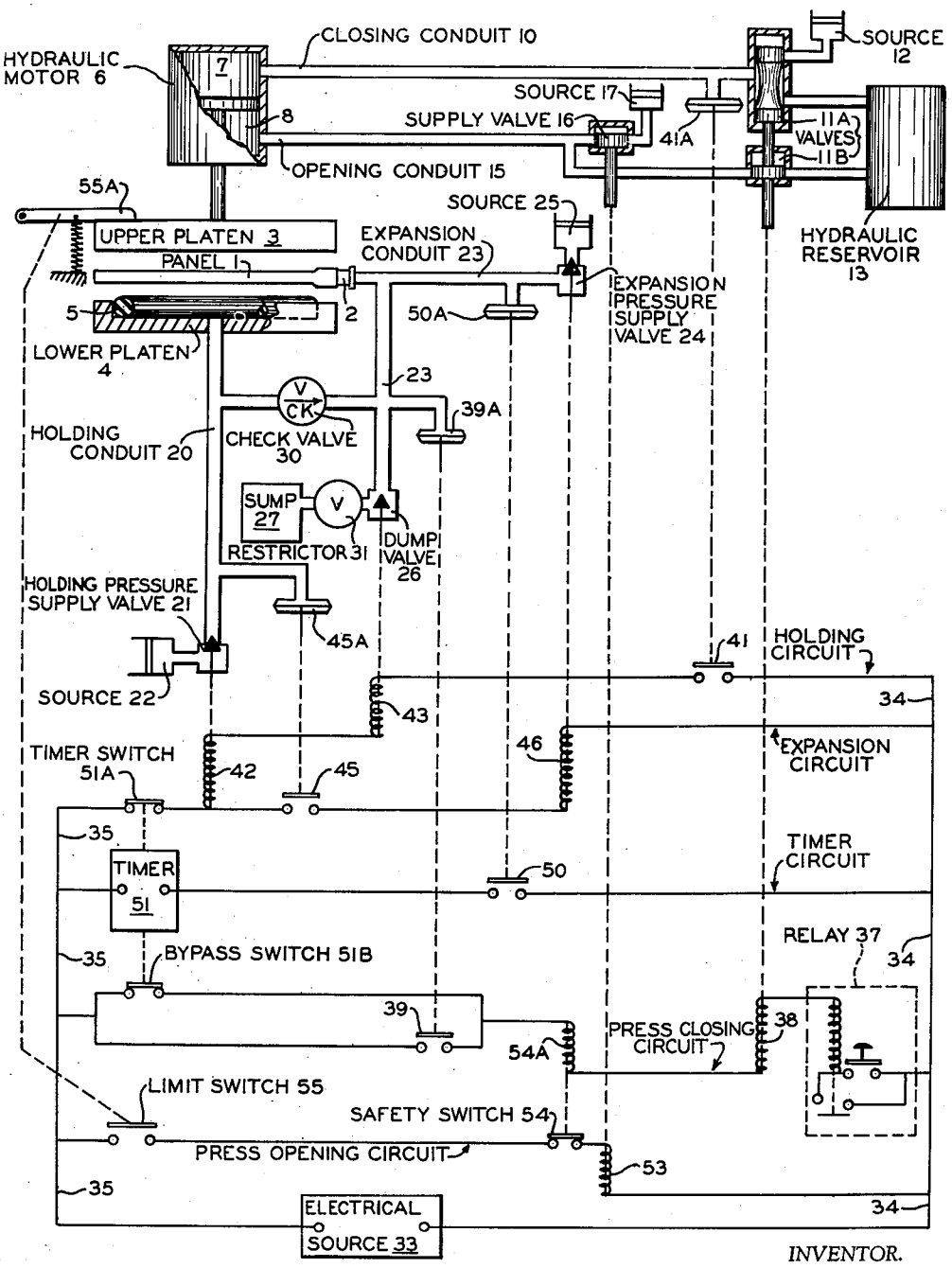
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METHOD OF AND APPARATUS FOR EXPANDING PASSAGEWAY PANELS ON ONE SIDE

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METHOD OF AND APPARATUS FOR EXPANDING PASSAGEWAY PANELS ON ONE SIDE

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This invention relates to an improved method of and apparatus for expanding pressure-welded passageway panels on one side only.

The conventional apparatus for expanding a passageway panel on one side only, comprises: an expansion press having an upper flat movable platen and a lower stationary platen having a pan-like holding pressure cavity into which one side of a panel is to be expanded; a sealing ring encircling the operative portion of the cavity into which the panel expands; and a hydraulic motor for moving the upper platen to open and close the press.

The conventional method of expanding a passageway panel on one side comprises: placing an unexpanded panel over the cavity in the lower platen of the press; closing the press to clamp the panel between the platens and thereby place the lower face of the panel in cavity-sealing engagement with the sealing ring and in position for expansion into the cavity; introducing a hydraulic holding liquid into the cavity under pressure, say 1,000 p.s.i., to force the panel upwardly and thereby hold its upper face in flush face-to-face engagement with the upper platen; introducing a hydraulic expansion liquid under pressure, say 3,000 p.s.i., into the unwelded passageway-forming system of said panel to expand the passageway walls of its lower face downwardly into the cavity; simultaneously releasing said hydraulic holding and expansion pressures; opening the press; and then removing the expanded panel.

The conventional method, as conventionally performed, produces an objectionably high percentage of rejects, one that is substantially higher than the acceptable percentage produced by present day commercially practiced methods of expanding passageway panels on both sides. I have found that the reject problem can be reduced to one of normal proportion simply by reducing the expansion pressure within the panel from its maximum expansion value to a holding-pressure neutralizing value approximating the holding pressure before releasing the latter; and thereafter simultaneously releasing both pressures. Such forms the principal object of the present invention.

Another important object is to provide a novel apparatus for automatically performing all steps of my improved method beginning with the press-closing step and ending with the press-opening step.

Another important object of the present invention is to provide means for applying the expansion pressure over a timed interval of sufficient duration to insure the performance of the expansion operation.

A further object is to prevent the opening of the press before the hydraulic holding and expansion pressures are substantially completely released.

The accomplishment of the objectives of the present invention involves the use of an apparatus comprising: (1) a motorized expansion press for receiving and holding a passageway panel; (2) a hydraulic system having a press motor operating section for opening and closing the press and, for expanding the panel, a processing section including (*a*) a holding segment for supplying holding

liquid under pressure and (*b*) an expansion segment for supplying expansion liquid under higher pressure; and (3) a control system having (*a*) a manually actuated closing circuit for closing the press, (*b*) a holding circuit operating, in response to the hydraulic pressure which holds the press closed, to cause the holding segment to supply holding liquid under pressure to the cavity, (*c*) an expansion circuit, responsive to a predetermined holding pressure, to cause the expansion segment to supply hydraulic liquid under pressure to the passageway system of the panel and (*d*) means for thereafter releasing the hydraulic pressures and opening the press.

All of the objects of the present invention can be achieved as follows: by releasing the hydraulic holding and expansion pressures through the expansion segment of the processing section and, for this purpose, arranging for the holding segment to discharge into the expansion segment through a check valve which prevents a reverse flow and preferably also arranging for the expansion segment to discharge through a restrictor which prevents the pressure therein from being released so fast as to prevent pressure equalization followed by simultaneous discharge; by providing a timer circuit which operates, in response to the achievement of maximum expansion pressure, to establish a predetermined time interval before the expansion and holding pressures can be released; by preventing the deenergization of the press-closing circuit before the expansion and holding pressures are completely released; and by interconnecting the press-closing and opening circuits to maintain the press-opening circuit in an open condition until the press-closing circuit is deenergized.

The single figure in the drawing schematically illustrates the expansion press, the hydraulic system and the control system as they appear after the end of the press-opening operation and before the beginning of the press-closing operation.

The equipment for expanding pressure-welded passageway panels 1 on one side only, as illustrated in the drawing, includes: an expansion press for receiving and holding a panel; a hydraulic system for opening and closing the press and expanding the panel; and a control system for controlling the operations of the hydraulic system.

EXPANSION PRESS

The expansion press comprises: an upper flat movable platen 3; a lower stationary platen 4 having a pan-like holding pressure cavity into which the passageway system walls on one side of a panel 1 is to be expanded; a sealing ring 5 encircling the operative portion of the cavity into which said panel expands; and a motor 6 for relatively moving said platens between an open position, in which they are openly spaced to permit an unexpanded panel to be interposed between them and located in a panel-receiving area corresponding to a predetermined expansion position, and a closed position, in which they are closed upon said interposed panel to clamp it in its said predetermined expansion position wherein the upper face of the panel is in flush face-to-face engagement with the corresponding face of the upper platen while the cavity-closing lower face of the panel has its passageway-system portion extending over the cavity and a system-encircling portion cooperating with the lower platen to clamp the sealing ring tightly therebetween and thereby effectively seal the holding cavity. While any suitable form of press operating motor may be used, the motor 6 shown is in the form of a hydraulic cylinder 6 having, on opposite sides of its piston, hydraulic pressure chambers 7 and 8 respectively for closing and opening the expansion press.

HYDRAULIC SYSTEM

The hydraulic system shown includes: a motor operat-

ing section for opening and closing the press; and a processing section for expanding the panel on one side.

Motor operating section

The motor operating section comprises: a hydraulic conduit 10 connecting the press-closing chamber 7 of the motor 6 through a two-position valve 11A either to a source of hydraulic pressure 12 in the press-closing position of the valve or a reservoir 13 in the press-opening position of the valve; and a hydraulic conduit 15 connecting the press-opening chamber 8 of the motor 6 either through a valve 16 to a source of hydraulic pressure 17 or through a valve 11B to reservoir 13. Valves 11A and 11B are connected to each other for simultaneous movement between a press-closing position, in which the press-closing chamber 7 is connected to hydraulic pressure and the press-opening chamber 8 to the reservoir 13, and a press-opening position, in which the connections are relatively reversed so that the press-closing chamber 8 is isolated from the reservoir 13 while the press-opening chamber 7 is connected to the reservoir.

Panel processing section

The panel processing section comprises: a holding segment including a hydraulic holding conduit 20 connecting the holding cavity of the lower press platen through a normally closed supply valve 21 to a source of hydraulic holding pressure 22; and an expansion segment including a hydraulic expansion conduit 23 connecting the passageway-system of a panel 1 either through a supply valve 24 to a source of hydraulic expansion pressure 25 or through a dump means, including valve 26, to a sump 27.

Operation of hydraulic system

In operating the hydraulic system, the motor operating section is initially operated to close the press upon an interposed panel and thereby close and seal the holding pressure cavity. Thereupon the panel processing section is operated as follows: first the holding segment is operated to fill the holding cavity with hydraulic liquid under a desired holding pressure, say 1,000 p.s.i.; and then the expansion segment is operated to introduce liquid into the passageway-system of the panel under an expansion pressure, ranging (for aluminum), from 2,000 to 2,500 p.s.i. higher than the holding pressure, sufficient to stretch-expand the passageway walls of its lower face downwardly into flattening engagement with the bottom of the cavity. At the completion of the expansion operation, the holding and expansion hydraulic pressures should be released and heretofore this has been done simultaneously.

Hydraulic system invention

In accordance with my invention, the expansion pressure is initially reduced to a holding pressure neutralizing value, approximating the operative holding pressure, whereupon both pressures are completely released. Accordingly, in carrying out my invention, I connect the holding conduit 20 to the expansion conduit 23 through a check valve 30 which permits a liquid flow from the holding conduit to the expansion conduit but prevents a reverse flow. With this arrangement, the release of both liquids is suitably effected by opening dump valve 26. The check valve 30 operates to prevent any release of the holding liquid until the expansion liquid pressure has dropped to a value approximating the operative holding pressure. When this value is reached, the check valve 30 connects both systems together causing them to lose pressure at the same time.

In further accordance with my invention, the dump mens includes a flow restrictor 31, which is connected in the hydraulic conduit 23 at a point located between the sump 27 and the effective juncture of the holding and expansion conduits 20, 23 and which is operative to slow down the rate at which these hydraulic pressures are released so as to prevent the expansion pressure from dropping below the holding pressure sufficiently to subject the panel 1 to damage before the check valve 30 has time to open the holding conduit into the expansion conduit. Preferably, the restrictor 31 is connected in expansion conduit 23 between the dump valve 26 and sump 27. It may, of course, be made a part of the dump valve 26.

Before passing, it may be noted that the check valve 30 may be spring biased in a direction causing it to open when the expansion pressure is above or equal to the holding pressure.

CONTROL SYSTEM

The control system includes the following elements: a press-closing circuit; a holding circuit; an expansion circuit; a timer circuit; means for deenergizing the press-closing circuit; and a press-opening circuit. These circuits are all normally open electrical circuits. They are operated from an electrical power source 33 having power lines 34 and 35.

Electrical press-closing circuit

The normally open press-closing circuit is energized when manually closed and operates, when energized, to cause the motor operating section of the hydraulic system to close the press and, more particularly, to accomplish this result simply by shifting hydraulic valves 11A and 11B of the motor operating system to the press-closing position.

The press-closing circuit extends from power line 34 serially through a normally open relay 37 and a solenoid coil 38 to the other power line 35. The relay 37 is manually closable to energize the press-closing circuit and automatically operative to remain closed as long as that circuit remains energized. The solenoid coil 38 is operative to shift valves 11A and 11B to their press-closing and opening positions respectively as the press-closing circuit is energized and deenergized. When this circuit is energized, the press is automatically moved to and held in its closed position. It is then ready for the application of hydraulic holding pressure.

Electrical holding circuit

The normally open holding circuit should not operate until the press is closed and a relatively elevated hydraulic pressure sufficient to hold it closed is built up. Accordingly, the holding circuit is arranged to be closed and energized, in response to the relatively elevated pressure which holds the press closed. It operates, when energized, to cause the holding segment, in the panel processing section of the hydraulic system, to supply hydraulic liquid under pressure to the holding cavity of the lower press platen. More particularly, it accomplishes this result simply by opening the normally closed supply valve 21 which controls the flow of liquid from the hydraulic holding pressure source 22.

The holding circuit extends from power line 34 serially through a normally open pressure-responsive switch 41 and solenoid coils 42 and 43 to the other power line 35. Since this holding circuit should not be energized until a predetermined press-closing pressure is built up, the closure of the normally open pressure-responsive switch 41 is made responsive to the hydraulic pressure in hydraulic conduit 10 by operating it through a diaphragm or other pressure-responsive device 41A in conduit 10. The pressure-responsive diaphragm 41A closes the holding circuit after the press has been closed long enough for the pressure in conduit 10 to rise to a value approximating its final holding pressure. The solenoid coil 42 is operative to shift supply valve 21 to its open and closed positions respectively as the holding circuit is energized and deenergized. The other solenoid coil 43 is operative to shift dump valve 26 in the reverse manner i.e., to its closed and open positions respectively as the holding circuit is energized and deenergized.

When the holding circuit is energized, supply and dump valves 21 and 26 are automatically moved to and held in their respective open and closed positions. This causes the holding cavity to be filled with hydraulic liquid under a desired holding pressure of, say, 1,000 p.s.i. although it may range from about 600 p.s.i. upwardly to several thousand p.s.i. depending on the expansion pressure and the metal being expanded. The system is now ready for the application of hydraulic expansion pressure.

Electrical expansion circuit

The normally open expansion circuit should not operate until the proper holding pressure is applied. Accordingly, it is arranged to be closed and energized, in response, to the panel holding pressure, and to operate, when energized, to cause the expansion segment, in the panel processing section of the hydraulic system, to supply hydraulic liquid under pressure to the passageway system of the passageway panel 1. More particularly, it accomplishes this result by opening the normally closed supply valve 24 which controls the flow of liquid from hydraulic expansion pressure source 25.

The expansion circuit extends from power line 34 serially through a normally open pressure-responsive switch 45 and solenoid coil 46 to the other power line 35. Since this expansion circuit should not be energized until a predetermined holding pressure is applied, the closure of the normally open pressure-responsive switch 45 is made responsive to the hydraulic holding pressure by operating it through a diaphragm or other pressure-responsive device 45A in the holding conduit 20. The pressure-responsive diaphragm 45A closes the expansion circuit to energize coil 46 after the holding pressure in conduit 20 rises to a value approximating the final holding pressure. The solenoid coil 46 is operative to shift expansion pressure supply valve 24 to its open and closed positions respectively as the expansion circuit is energized and deenergized.

When this expansion circuit is energized, the valve 24 is automatically moved to and held in its operative open position. This causes the passageway system of the panel to be filled with hydraulic liquid under a desired expansion pressure of, say 3,000 p.s.i. although it may also range upwardly to several thousand p.s.i. depending on the holding pressure and the metal being expanded.

While the system may now be ready for the release of the expansion and holding pressures, in further accordance with my invention, the final expansion pressure is maintain for a period of time amply sufficient to effect its completion. A timer circuit is employed for this purpose.

Electrical timer circuit

In accordance with my invention, a normally open timer circuit is arranged to be closed and energized in response to a predetermined expansion pressure, preferably of maximum value, and to operate, when energized, by ticking off a predetermined time interval, of say 2 to 3 seconds before terminating the expansion operation.

The timer circuit extends from power line 34 serially through pressure-responsive switch 50 and timer 51 to the other power line 35. The normally open pressure-responsive switch 50 is operated by a pressure-responsive device or diaphragm 50A in the expansion pressure conduit 23. Thus, when the predetermined expansion pressure is reached in conduit 23, diaphragm 50A closes the timer circuit rendering it operative to tick off the desired time interval at the end of which it becomes temporarily operative to open timer switch 51A which is serially contained in the common portion of the electrical holding and expansion circuits to deenergize these circuits. Thereafter, the timer automatically closes the switch 51A after a short time delay to allow the pressure to be released from the panel and the press to be moved to a completely open position.

As a result of the deenergization of the holding and expansion circuits at the conclusion of the time interval, several events occur, namely: (*a*) the holding circuit solenoid 42 is deenergized to cut off the holding pressure by closing supply valve 21; (*b*) the expansion circuit solenoid 46 is deenergized to cut off the expansion pressure by closing supply valve 24; and (*c*) the holding circuit solenoid 43 is deenergized to open dump valve 26 of expansion conduit 23. The expansion liquid in conduit 23 now flows to sump 27 at a restricted rate determined by restrictor 31. When the expansion pressure falls to a holding pressure neutralizing value, which approximates the pressure in holding conduit 20, the check valve 30 will either be opened by a spring or by the pressure of holding conduit 20. This equalizes the hydraulic pressure in both segments of the panel processing section and permits the equalized pressure of both segments to drop to zero at the same rate.

With the holding and expansion pressures thus completely released, it is desirable to deenergize the press-closing circuit and energize the press-opening circuit.

Means for deenergizing the press-closing circuit

In accordance with my invention, the press-closing circuit is opened and deenergized only when the expansion and holding pressures have been completely released. Accordingly, this circuit is provided with a pressure-responsive switch 39 and the operation of that switch is made responsive to the hydraulic pressure in expansion conduit 23 by operating it through a diaphragm or other pressure-responsive device 39A. Switch 39 opens when the pressure in expansion conduit 23 is completely released and closes when, and remains closed so long as, the liquid in the expansion conduit 23 is at an elevated pressure above a minimum pressure of say, 10 p.s.i. or more.

However, in order to make it possible to close the press-closing circuit when required for the next cycle of operation, this closing circuit is provided with a timer operated bypass switch 51B which is opened at the end of the time interval, the same as switch 51A, and remains open after that interval for another predetermined period long enough to permit the press to be moved to a completely open condition. The switch 51B is gang operated by the timer 51 with the switch 51A, hence both switches 51A and 51B are opened and closed together. Consequently, bypass switch 51B is opened at the start of and remains open for a short time after the pressure release period to permit the pressure closed switch 39 to delay the deenergization of the press-closing circuit up to the end of the hydraulic pressure release period. Bypass switch 51B is closed shortly thereafter, with switch 51A, to enable relay 37 to control the institution of the next press-closing operation.

Press-opening circuit

In further accordance with my invention, the normally open press-opening circuit is arranged to be closed and energized, in response to the deenergization of the press-closing circuit, and to operate when energized, to activate the hydraulic opening conduit 15 of the motor operating section of the hydraulic system by opening valve 16 to connect conduit 15 to hydraulic pressure source 17.

The press-opening circuit extends from power line 34 serially through solenoid 53, solenoid operated biased closed safety switch 54 and biased closed limit switch 55. The solenoid 53 operates, when energized and deenergized, to open and close hydraulic valve 16. Safety switch 54 is operated by solenoid 54A, in the press-closing circuit, to keep the press-opening circuit deenergized so long as the press-closing circuit is energized; hence, switch 54 energizes the press-opening circuit when the press-closing circuit is deenergized and remains closed as long as the press-closing circuit is idle. Limit switch 55 serves to open or deenergize the press-opening circuit when the upper platen 3 reaches a predetermined elevation corresponding to the maximum opening or spacing desired. The operation of limit switch 55 is effected by

connecting it to a movement measuring element 55A positioned to be engaged and operated as the upper platen 3 approaches and moves into its extreme upper position.

Having described my invention, I claim:

1. A method of expanding one side of an unexpanded pressure welded passageway panel, composed of at least two superposed metal sheets which are capable of being drawn and the adjacent faces of which are partially welded together, the unwelded area thereof providing said panel internally with a potential passageway system, comprising: applying a holding liquid against one outer face of said unexpanded panel under a sufficiently elevated pressure to press its other outer face tightly against a surface and to hold it there during the subsequent expansion of said potential passageway system; introducing an expansion liquid into said potential passageway system under an elevated pressure, which is sufficiently higher than the holding liquid pressure, to expand the unwelded areas, of the sheet having said one outer face, outwardly into said holding liquid; thereafter reducing the expansion liquid pressure until it reaches a holding liquid pressure neutralizing value approximating the holding liquid pressure; and then simultaneously releasing both liquid pressures.

2. The method of claim 1 wherein: the step of releasing the pressures simultaneously is performed in a manner maintaining them substantially equalized as they decrease in value.

3. In a method of expanding one side of a pressure welded passageway panel, composed of at least two superposed metal sheets which are capable of being drawn and the adjacent faces of which are partially welded together, the unwelded areas thereof providing said panel internally with a potential passageway system, wherein a holding fluid is applied to one outer face of the panel at an elevated pressure sufficient to press the other outer face of the panel tightly against a surface and hold it there during subsequent expansion and, wherein subsequently, an expansion fluid is introduced into the potential passageway system at a sufficiently higher elevated pressure to expand the unwelded panel areas, of the sheet having said one face, outwardly into said holding fluid, a method of releasing the holding and expansion fluid pressures to avoid distorting the panel comprising: reducing the differential between the two pressures until one pressure reaches a neutralizing value approximating the other pressure; and then simultaneously releasing both pressures and maintaining them substantially equalized as they decrease in value.

4. The release method of claim 3 wherein: the differential reducing step is performed by reducing the expansion fluid pressure until it reaches a holding-pressure neutralizing value approximating the holding fluid pressure.

References Cited in the file of this patent

UNITED STATES PATENTS

1,561,312	Ruther et al.	Nov. 10, 1925
2,522,915	Woods	Sept. 19, 1950
2,662,273	Long	Dec. 15, 1953
2,690,002	Grenell	Sept. 28, 1954
2,728,317	Clevenger et al.	Dec. 27, 1955
2,866,429	Staples	Dec. 30, 1958