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SEMI-AUTOMATIC APPARATUS FOR EXPANDING A PRESSURE WELDED PASSAGEWAY PANEL

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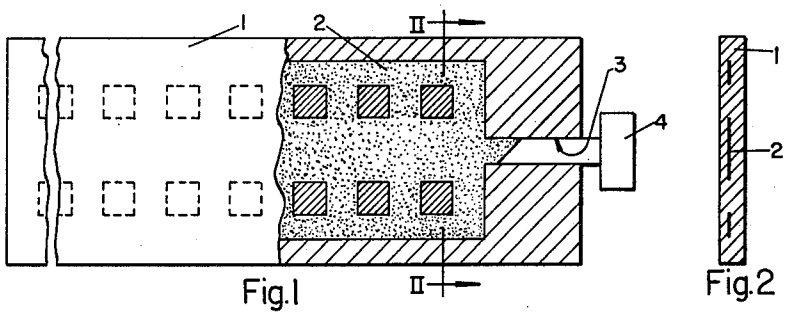

Fig.1

Fig.2

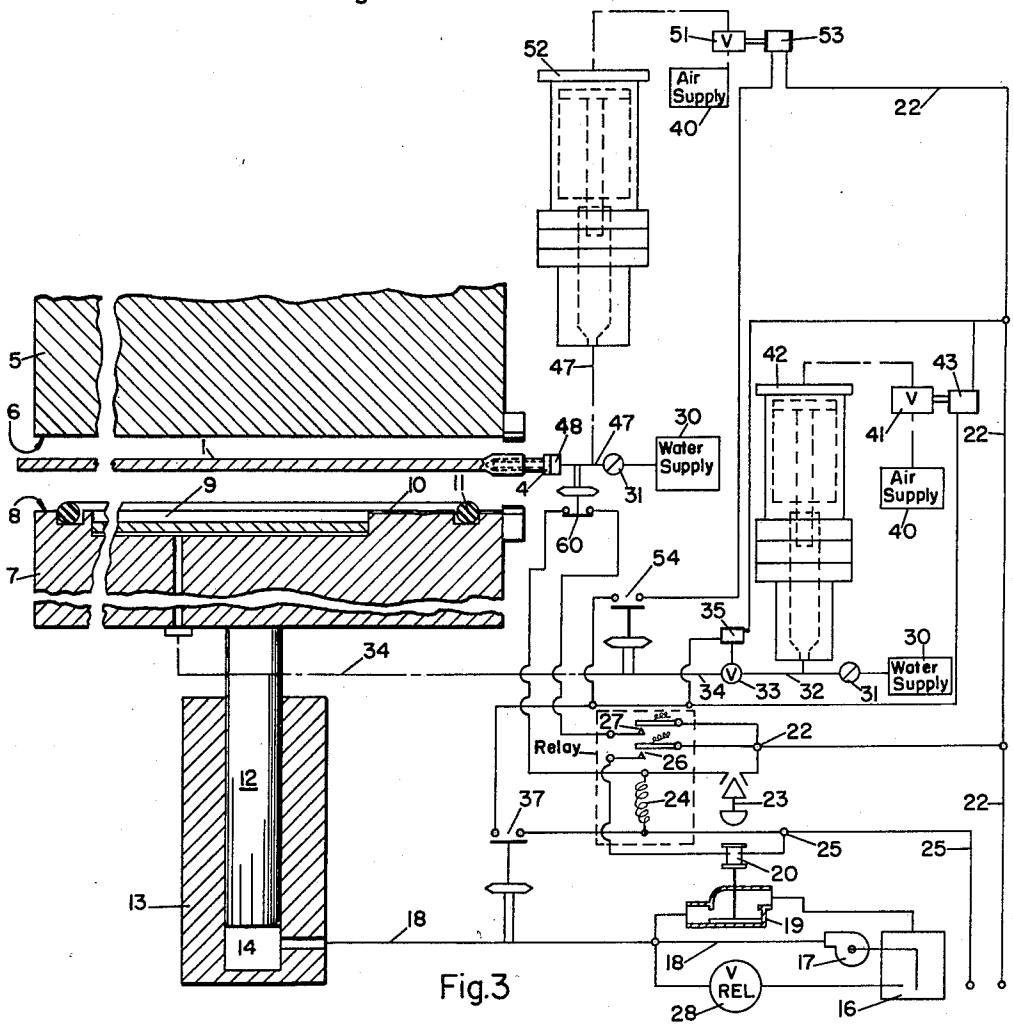

Fig.3

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SEMI-AUTOMATIC APPARATUS FOR EXPANDING A PRESSURE WELDED PASSAGEWAY PANEL

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1 Claim. (Cl. 113—44)

This invention relates to a semi-automatic apparatus for expanding the unbonded portions of a pressure welded passageway panel.

It has been proposed to expand a pressure welded or roll bonded passageway panel on one outer face only by applying a holding liquid under pressure to that one outer face so to hold its other outer face in flat face-to-face contact with the die and then introducing an expansion liquid under relatively higher pressure into the panel. The holding pressure on the one outer face of the panel holds the other outer face in relatively unyielding engagement with the die and thus tends to prevent the said other face from expanding while permitting the said one face to expand into the holding liquid.

Variations occur in the expanding operation when it is controlled manually. Such variations result in expanded passageways of varying volumetric capacity. This is objectionable particularly when the expanded panel is to be used as an evaporator in a refrigerator of the type wherein a capillary tube is employed to provide a pressure differential. Here the relationship, between the volume of the refrigerant charge and that of the system, is somewhat critical.

It is an object of the present invention to provide a control apparatus for developing and applying pressures of the desired magnitude and in the desired sequence for producing one side expansion of the unbonded passageway forming portions of the panel and for automatically releasing the pressures at the desired rates and times.

Another object is the provision of an apparatus for producing a uniform degree of expansion throughout the panel so as to minimize volumetric variations in the expanded passageways due to variations in the overall thickness of the panel.

A conventional apparatus, for expanding the unbonded portions of a pressure welded passageway panel on one side of the panel, comprises: a pair of dies relatively movable between open and closed positions, said dies being adapted to receive a panel in the die open position and to limit the outward expansion thereof in the die closed position, one of the dies having a holding chamber over which said one side of the panel is placed; a hydraulic jack for moving one of said dies; and three conduits including a die conduit connected to the jack for transmitting die closing liquid thereto, a holding conduit connecting to the holding chamber for transmitting panel holding liquid thereto and a panel expansion conduit adapted for connection to a panel for transmitting panel expanding liquid to its unbonded portions; and manually operable means for supplying liquid under pressure to each of these conduits. In the closed position of the dies, the holding chamber is covered by the one adjacent face of a panel interposed between dies. This holding chamber is large enough lengthwise and widthwise to embrace said one face over the expansion area containing the unbonded portions of the panel which are subsequently to be expanded into the holding chamber. That chamber is also dimensioned depthwise to limit subsequent expansion to

a predetermined extent whereby variations in expansion between the unbonded portions of the panels may be accommodated. The other die has flush face-to-face engagement with the other face of said panel over an area corresponding to said expansion area.

In accordance with the present invention, a control apparatus takes the place of the manually operated liquid supply means. This control apparatus successively uses the pressures of the die closing liquid to institute the supply of holding liquid under pressure, of the holding liquid to institute the supply of expansion liquid under pressure and of the expansion liquid to release all pressures. In the preferred embodiment, the control apparatus comprises: means operating, when manually actuated, to supply die closing liquid under pressure to the die conduit; means operating, when automatically actuated in response to a predetermined pressure in a die conduit, to supply panel holding liquid under pressure to said holding conduit; means operating, when automatically actuated in response to a predetermined pressure in the holding conduit, to supply panel expanding liquid under pressure to said expansion conduit; and means operating, when automatically actuated in response to a predetermined pressure in the expansion conduit, to release the pressure in all conduits.

An embodiment of the invention is illustrated in the drawings, wherein:

Figure 1 is a partly broken plan view of an unexpanded roll bonded passageway panel;

Figure 2 is a section taken along line II—II of Figure 1; and

Figure 3 is a more or less schematic or diagrammatic view of the die and control apparatuses for practicing the present invention.

The present invention can be readily explained in connection with the drawing which illustrates: a panel; a die apparatus; and a control apparatus.

PANEL

The panel 1 is a conventional pressure welded panel containing a system of unbonded portions 2 which are to be expanded on one side, to form a corresponding system of passageways, by applying a holding pressure to that side and, while maintaining that holding pressure, introducing an expansion fluid, preferably a liquid, through the inlet 3 of the panel 1. To facilitate the introduction of the expansion fluid, the panel is provided with a fluid connector 4, the stem of which is forced into and held frictionally within inlet 3.

DIE APPARATUS

The die apparatus comprises: an upper stationary die member 5 having a rigid flat die face 6; a lower movable die member 7 having a die face 8 which is recessed at 9 to provide a holding chamber 9 and recessed at 10 to provide an entrance to that holding chamber; an O sealing ring 11 encircling chamber 9; and a conventional hydraulic jack 12 composed of a piston, also designated 12, and a cylinder 13 having a liquid pressure or jack chamber 14.

It will be understood that panel 1 is placed between the upper and lower die members 5 and 7 with its bottom face resting on the O sealing ring 11. The dies are closed to effect a very tight seal, between the panel 1 and the sealing ring 11, which completes the enclosure of the holding chamber 9. Now a holding pressure may be introduced into the recess or chamber 9 while an expansion pressure is introduced into the panel 1. The control apparatus operates to effect the closing of the dies, the application of the holding and expansion pressures and the final release of all such pressures.

CONTROL APPARATUS

The control apparatus comprises: die closing means; panel holding pressure applying means; panel expansion pressure applying means; and pressure releasing means.

Die closing means

The die closing means includes a reservoir **16**, from which a continuously operating pump **17** draws liquid and pumps it into conduit **18** which is not only connected to the hydraulic jack chamber **14** but also connected back to reservoir **16** through a normally open solenoid valve **19**. So long as this valve **19** remains open, it prevents the pump **17** from building up a die operating pressure in the jack chamber **14**.

The normally open valve **19** is controlled by a normally de-energized solenoid coil **20**. The energization of solenoid coil **20** is controlled by a normally open manually closable starting circuit which extends from one side **22** of the supply line through a push button **23**, relay coil **24** to the other side **25** of the power supply line. The energization of relay coil **24** closes both of its normally open switches **26** and **27**, switch **26** operating to close the solenoid coil **20** circuit extending from line **22** through switch **26**, coil **20** to line **25** and switch **27** operating to establish a shunt circuit around push button **23** so as to maintain coil **24** energized when push button **23** is released.

With the energization of solenoid coil **20**, valve **19** closes the hydraulic return circuit from conduit **18** back to the reservoir **16** and thus enables pump **17** to build up a pressure in the hydraulic jack chamber **14** sufficient to move the dies to the closed position. When the dies reach the closed position, the pump **17** will increase the hydraulic pressure on the dies to a predetermined value, which is determined by the setting of a normally closed relief valve **28** connecting the conduit **18** back to the reservoir **16**. The die holding pressure, at which the dies are held closed, or the strength of other means by which they may be held closed, is large enough to overcome the combined effects of the panel holding pressure, which is to be introduced into the holding chamber **9** of the lower die, and expansion pressure, which is to be introduced into the pressure welded panel **1** itself.

The closure of the dies is used to initiate the operation of the means for applying the holding pressure.

Panel holding pressure applying means

Liquid, for panel holding pressure purposes, is supplied through water supply **30**, check valve **31**, conduit **32**, normally closed solenoid valve **33** and conduit **34** to the holding chamber **9**. To open the normally closed panel holding pressure line **34**, the coil for solenoid valve **33** must be energized. The means to energize it is made responsive to the closure of the dies by connecting solenoid coil **35** to the power supply line through a normally open switch **37** which is responsive to the die holding pressure in the jack chamber **14** and the conduit **18** and which is designed to close when the pressure, developed in circuit **18**, rises to a value sufficient to prevent the dies from being forced apart during the expansion operation by the maximum counteracting load imposed on the piston as a result of the expansion operation.

To provide a panel holding fluid, under the requisite value of holding pressure, a compressed air supply **40** is connected, through solenoid valve **41**, to the low pressure side of a booster accumulator **42**, the high pressure side of which is connected to the holding liquid conduit **32**. The booster accumulator **42** is of conventional structure utilizing a low air pressure acting on the large area of a differential piston to apply, to the liquid in the hydraulic conduit **32**, a large total pressure through the smaller differential area of that same piston. The booster accumulator **42** is made to operate, in response to the closure of the dies, by connecting its solenoid coil **43** and the solenoid coil **35** for the valve **33**, in parallel between line **22** on the one side and switch **37** on the other.

Now it will be understood that, when the die holding pressure in conduit **18** reaches its predetermined die holding value, it becomes effective to close pressure switch **37**, which is in series with each of the parallel solenoid coils **35** and **43**. As a result, the panel holding pressure line **34**, leading to the holding chamber **9**, is opened and the booster accumulator **42** operated to place the liquid in line **34** and chamber **9** under a panel holding pressure of a predetermined order.

The rise of the panel holding pressure, toward or to a predetermined value, is used to initate the operation of the means for applying the expansion pressure.

Panel expansion pressure applying means

The panel expansion pressure liquid system includes water supply **30** leading through check valve **31** and conduit **47** to a quickly detachable coupling **48** for the fluid pressure connector **4**. The coupling **48**, for connector **4**, is of the conventional quick-operating type having a valve, which, when the coupling is connected, provides an open passageway between expansion liquid conduit **47** and the interior of the fluid connector **4**, and, when the coupling is disconnected, closes the end of the conduit **47** and thus prevents the leakage of water.

The panel expansion system is made responsive, to a predetermined value of panel holding pressure in the conduit **34** and holding chamber **9**, by connecting the compressed air supply **40** through solenoid valve **51** to a booster accumulator **52** and by connecting the coil **53** of the solenoid valve **51** to power through a normally open pressure switch **54** which is responsive to the panel holding pressure in conduit **34**. The circuit for solenoid coil **53** extends from one side **22** of the line through solenoid coil **53**, pressure switch **54** and pressure switch **37** to the other side of the line **25**. As a consequence, as soon as coil **53** is energized, the booster accumulator **52** operates to impose an expansion pressure in the hydraulic expansion circuit containing conduit **47** causing the panel **1** to be expanded as the expansion pressure in its passageway system rises to a predetermined value.

The top value of expansion pressure, which is predetermined, is used to initiate the operation of the means for releasing all pressures.

Pressure release means

When the expansion pressure reaches a predetermined value, it is desirable to release the pressure and shut down the entire apparatus. Accordingly, a normally closed pressure switch **60**, which is responsive to the expansion pressure, is arranged to open at the predetermined top expansion pressure. This switch **60** is serially connected with relay switch **27** to form the shunt circuit, which extends around push button switch **23** and which maintains the relay-energizing circuit of relay coil **24** closed when switch **23** opens. Consequently, when switch **60** is opened, it de-energizes relay coil **24** causing relay switches **26** and **27** to open.

The opening of relay switch **26** de-energizes the solenoid coil **20** to open valve **19**. This releases the pressure in the hydraulic die-holding circuit, allowing the dies **5** and **7** to open. The release of the die-holding pressure, opens pressure switch **37**, which, in turn, opens two electric circuits, namely: the electric circuit of solenoid coils **35** and **43** respectively, controlling the flow of panel holding fluid in the hydraulic holding circuit through valve **33** and the application of pressure thereto through valve **41**; and the electric circuit of solenoid coil **53**, controlling the application of pressure to the panel expanding fluid in the hydraulic expansion circuit through valve **51**. As a result, the panel holding and expanding pressures are immediately released.

The opening of relay switch **27** creates a second opening in the shunt circuit around push button **23**, and thus prevents relay coil **24** from immediately becoming re-energized by the re-closure of pressure switch **60**, which re-closure occurs with the release of expansion pressure in line **47**.

The de-energization of the relay coil **24** and the opening of its switches **26** and **27** thus conditions the apparatus for the next series of operations involving the removal of the expanded panel, its replacement by the next unexpanded panel and the institution of the automatic operations which follow the closure of the manually operated push button **23**.

Operating conditions and variations

The fluid pressure valves used will, of course, vary depending on the composition of the panel. With a conventional aluminum panel, a differential between the holding and expansion pressures of about 2,000 to 3,000 p. s. i. is recommended. With a differential of 2,400 p. s. i., a holding pressure of 600 p. s. i. and an expansion pressure of 3,000 p. s. i. may give good result but progressively higher holding pressures, within operating limits, should give progressively better results. Necessarily, whatever the holding and expansion pressures are, the pressure which holds the dies closed must be sufficient to resist the die separating forces created by the holding and expansion pressures.

The present invention may be applied to a die apparatus for expanding both sides by eliminating the holding chamber, holding conduit and the holding liquid pressure supply means and by making the expansion liquid pressure supply means automatically responsive to the die closing pressure. The latter can be accomplished swiftly by eliminating pressure switch **54** and permanently closing the contacts of switch **54**.

I claim as my invention:

An apparatus for expanding certain unbonded portions of a pressure welded passageway panel on one side or face of the panel comprising: a pair of dies relatively movable between open and closed positions, said dies being adapted to receive a panel in the open position and to limit the outward expansion thereof in the closed position, one of said dies having a holding chamber which, in the closed position of the dies, is covered by the one adjacent face of an interposed panel, said holding chamber being large enough lengthwise and widthwise to embrace said one face over the expansion area containing said unbonded portions which are subsequently to

be expanded into the holding chamber and being dimensioned depthwise to limit the expansion to a predetermined extent whereby variations between the unbonded portions of the panel faces may be accommodated, the other die having flush face-to-face engagement with the other face of said panel over an area corresponding to said expansion area; a hydraulic jack for moving one of said dies; a die conduit connected to the jack for transmitting die closing liqud thereto; a holding conduit connected to the holding chamber for transmitting panel holding liquid thereto; an expansion conduit adapted for connection to a panel for transmitting panel expanding liquid to its unbonded portions; means operating, when manually actuated, to supply die closing liquid under pressure to the die conduit; means operating, when automatically actuated in response to a predetermined die-closing liquid pressure, to supply panel holding liquid to said holding chamber through said holding conduit under a predetermined holding pressure exerted against said one face for the purpose of maintaining said corresponding area of said other face in flush face-to-face engagement with said other die during subsequent expansion; means operating, when automatically actuated in response to a predetermined panel-holding liquid pressure, to supply panel expanding liquid to the interior of said panel through said expansion conduit under a predetermined panel-expanding liquid pressure sufficient to expand said unbonded portions on said one face into said holding chamber against said holding pressure therein but insufficient to expand the corresponding unbonded portions on said other panel face while such portions are held in said flush engagement with said other die by said holding pressure; and means operating, when automatically actuated in response to a predetermined panel-expanding liquid pressure, to release said die-closing, panel-holding and panel-expanding pressures.

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