

Jan. 15, 1963

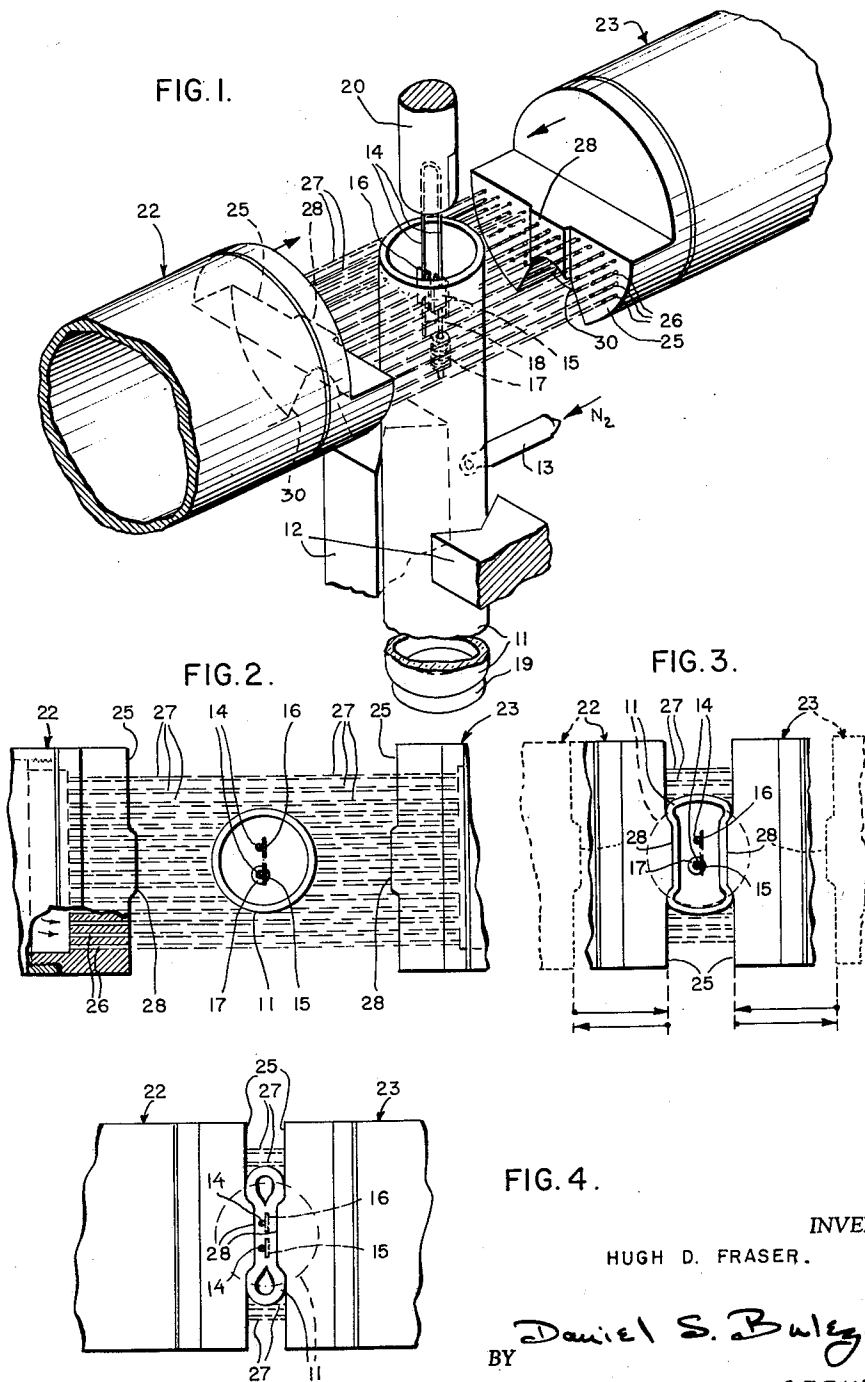
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PRESS SEALING PROCESS AND APPARATUS

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FIG. 5.

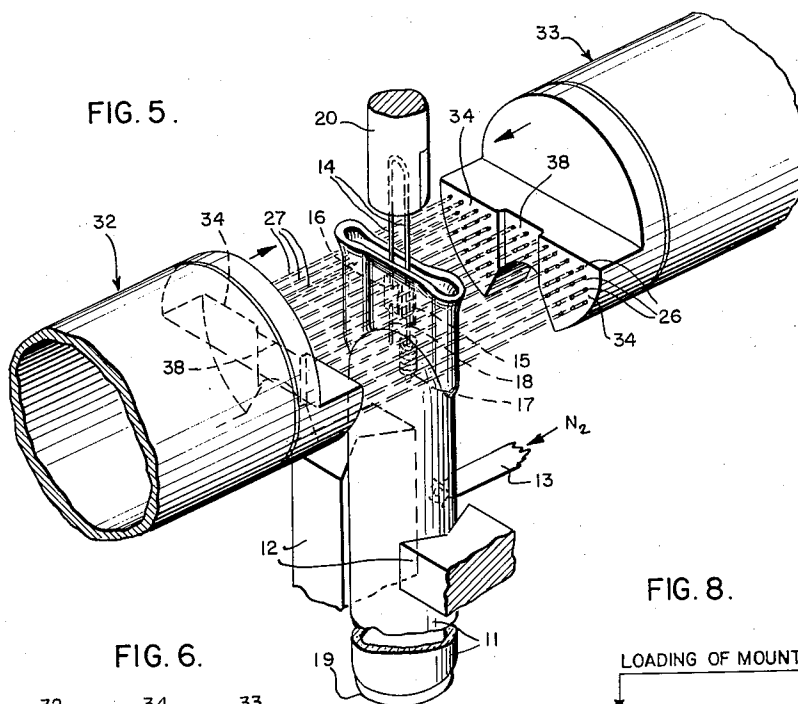


FIG. 6.

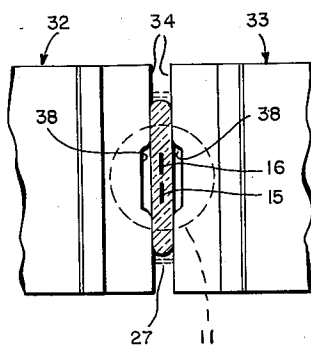


FIG. 8.

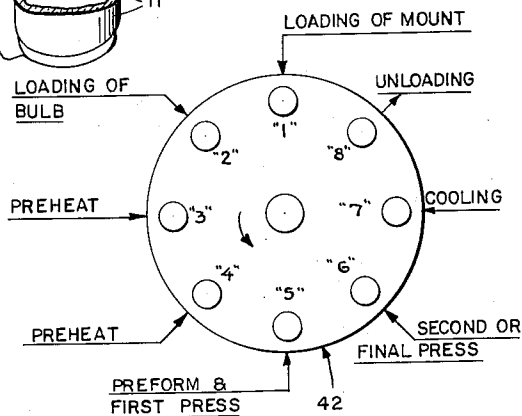
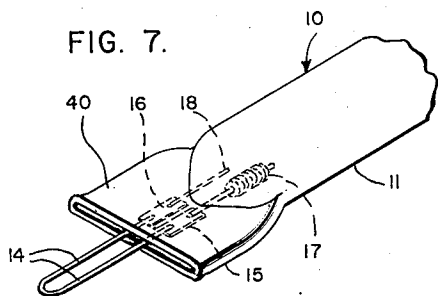


FIG. 7.



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PRESS SEALING PROCESS AND APPARATUS
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This invention relates to sealing and, more particularly, to an improved process and apparatus for forming a press seal on the end of a vitreous arc tube for a high pressure mercury vapor lamp and hermetically embedding a fragile lead-in conductor in said seal.

Heretofore it has been the practice in the manufacture of high intensity light sources, such as the inner arc tubes for high pressure mercury vapor (HPMV) lamps for example, to form a press seal around the fragile ribbon portion of the lead-in conductor conventionally employed in such lamps by providing constricted end sections on the arc tube and collapsing them by means of heat and pressure onto the lead-in conductors which were previously inserted therein. More recently the provision of end sections on the arc tube of smaller diameter and the cost connected therewith have been eliminated by collapsing the entire end segment of a quartz tube of uniform diameter onto the lead-in conductor and thus forming a so-called "full press" seal that extends across the full width of the tube. While the adoption of full press seals permitted the quartz tubing to be made directly into arc tubes without attaching constricted end sections thereto, the total amount of heat and pressure required to collapse the tube across its full width in a single pressing operation not only necessitated the precise adjustment and constant checking of the sealing fires and press jaws but frequently caused excessive heating of the extremely thin lead-in conductors and the resultant oxidation and embrittlement thereof. In addition, the lateral flow of plastic quartz over the fragile lead-in conductors produced when the arc tube was compressed over its full width and the tensioning of the conductors resulting from such flow frequently caused the conductors to tear thus ruining the seal and increasing the rate of shrinkage. Because of the volume of quartz that had to be heated and compressed a rather slow index speed was required for the automatic sealing machines normally employed to fabricate the arc tubes thereby limiting the productive capacity of these machines.

It is accordingly the general object of the present invention to overcome and avoid the foregoing and other problems associated with the manufacture of full press seals.

Another and more specific object is the provision of a process for forming a full press seal on a tubular vitreous article which process will not only materially reduce the amount of shrinkage but can be readily incorporated into automatic sealing machines and increase the speed thereof.

A further object of this invention is the provision of a specific apparatus for fabricating seals in accordance with the aforementioned method.

The aforesaid objects and others that will become apparent as the description proceeds are achieved by fabricating the press seal in two steps rather than by a single pressing operation as heretofore. That is, only a preselected portion of the tube end is collapsed and sealed off during the initial pressing operation thereby to complete the corresponding portion of the seal, whereupon the unsealed portion or portions of the tube are then compressed and sealed off in a subsequent and separate pressing operation without applying any further pressure

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to or otherwise working the first-finished portion of the seal. While it is preferred to seal-in the portion of the tube overlying the lead-in conductor first and thus avoid unnecessarily heating the conductor, the same advantageous results will be obtained if this portion of the seal is finished last. A preferred apparatus for pressing the end of the tube is also provided wherein the desired sequential compression of preselected portions of the tube and the continued application of heat thereto is accomplished by two pairs of pressing jaws the working surfaces whereof constitute the heads of oxyhydrogen gas burners and are especially contoured to exert the required differential pressure.

A better understanding of the invention will be obtained by referring to the accompanying drawings wherein:

FIG. 1 is a fragmentary perspective view of a seal assembly comprising an arc tube and a pair of electrode-conductor units held in sealing relationship between a pair of burner-press jaws preparatory to the first-pressing operation in accordance with this invention;

FIG. 2 is a plan view of the seal assembly and burner-press jaws shown in FIG. 1;

FIGS. 3 and 4 are views corresponding to FIG. 2 but illustrate the preforming and first-pressing steps, respectively, in the formation of the press seal in accordance with this invention;

FIG. 5 is a perspective view of the partially formed press seal assembly located between the second pair of burner-press jaws employed in accordance with this invention to complete the fabrication of the press seal;

FIG. 6 is a plan view of the seal assembly and jaws shown in FIG. 5 illustrating the final step in forming the seal;

FIG. 7 is a perspective view of the full press seal formed on the end of the arc tube in accordance with the invention; and

FIG. 8 is a diagrammatic plan view of an automatic sealing machine showing the location of the first and second-pressing stations in relation to the other stations and operations required to manufacture the seal.

While the present invention may be advantageously employed to hermetically seal any vitreous article having a relatively large opening, it is especially adapted for use in forming a full press seal on the end of a tubular arc tube for HPMV lamps and accordingly has been so illustrated and will be so described.

With specific reference to the form of the invention shown in the drawings, in FIG. 7 there is illustrated one end of the inner arc tube 10 for a HPMV lamp which tube comprises a light-transmitting envelope of highly refractory vitreous material such as a quartz tube 11 of relatively large and substantially uniform diameter the ends whereof are hermetically closed by a full press seal 40. Embedded in the seal 40 are a pair of thin and extremely fragile lead-in conductors 15 and 16 such as molybdenum ribbons or foil that connect with a main electrode 17 and an auxiliary starting electrode 18, respectively. Only one end of the arc tube 10 is provided with the two electrodes here illustrated, the opposite end having only a main electrode as is customary. The outwardly disposed ends of the ribbon conductors 15 and 16 are attached to the legs 14 of a U-shaped wire pin the looped end whereof extends outwardly from the seal and is left exposed. After the press seal 40 has been completed the looped end of the pin is cut off to provide the desired individual terminal leads for each of the electrodes.

In a preferred sequence of steps in accordance with the invention, the central portion of the end of the preheated quartz tube 11 is first collapsed onto and hermetically

united with the ribbon conductors 15 and 16 to complete the quartz-to-conductor portion of the seal, and then the marginal portions of the tube or the quartz-to-quartz area of the seal assembly is compressed and closed thereby extending the seal across the full width of the tube and completely closing the end thereof. While the aforesaid sequence of steps may be reversed if desired without affecting the quality of the finished seal or the speed with which it can be made, it is preferred since it immediately seals-in the fragile ribbon conductors 15 and 16 thereby reducing the heating thereof and the chances of excessive oxidizing them to a minimum.

The aforesaid two-step sealing sequence can be very conveniently incorporated into an automatic sealing machine 42 of the type diagrammatically shown in FIG. 8 wherein the various operations required to form the seal 40 are accomplished by periodically advancing or indexing the seal assembly through a series of eight work stations at which the indicated operations are performed. Automatic sealing machines of this type are well-known as are the operations performed at the various stations, with the exception of the preforming-and-first-pressing operation performed at station "5" and the second or final-pressing operation performed at station "6"—which operations constitute the two basic steps of this invention and will now be described.

As shown in FIG. 1, when in their loaded positions in the sealing machine 42 the quartz tube 11 and electrode-and-conductor elements are held in sealing relation by a bulb-holder 12 and a suitable jig 20, respectively, to form a seal assembly. Upon being indexed into station "5" of the machine the seal assembly is positioned between and centrally of the work surfaces 25 of a pair of movable and hollow burner-press jaws 22 and 23 provided and suitably located at the aforesaid station. When the seal assembly is thus positioned the central portion of the end of the tube 11 and ribbon conductors 15 and 16 located there-within are aligned with matching bosses 28 on each of the generally semi-circular work faces 25. The opposed surfaces of the bosses 28 are planar and generally rectangular and dimensioned to overlie the central portion of the tube end and the ribbon conductors 15 and 16, which conductors are oriented to lie in a common plane that is disposed at right angles to the line of movement of the bosses 28 and the press jaws 22 and 23 when the latter are advanced toward one another, as indicated by the arrows in FIG. 1. The work faces 25 of the jaws are provided with a plurality of fine holes 26 and said jaws are connected to a gas supply (not shown) such as a mixture of oxygen and hydrogen thereby permitting flame jets 27 to be concentrated onto the end of the quartz tube 11 when the jaws are not actually in contact therewith. The aforesaid jaws thus constitute the heads of gas burners and serve the additional purpose of heating and maintaining the quartz in its plastic condition. If desired, separate gas burners can be used to heat the quartz in which case the jaws could be of solid construction and the holes therein omitted. The press seal 40 is desirably made arcuate at its inward end by means of a concave groove 30 provided in each of the jaws 22 and 23 that extends radially toward and merges with the bosses 28.

During the preheating and pressing operations nitrogen or other suitable inert gas is passed through the tube 11 and over ribbon conductors 15 and 16 to prevent the oxidation of the latter, as is customary. The nitrogen may be fed into the tube 11 through a tubulation 13 thereon, the other end of the tube being closed off by a stopper 19 as shown.

When the seal assembly comprising the coaxially disposed tube 11 and ribbon conductors 15 and 16 is indexed from the preheating station "4" into the preforming-and-first-pressing station "5", the jaws 22 and 23 are immediately advanced toward one another a predetermined distance and then returned to their original open position, as indicated by the arrows in FIG. 3. The travel is such

that the bosses 28 and adjoining portions of the work faces 25 partially flatten and thus constrict the heated end of the tube 11 as shown. While this preforming operation may be omitted if desired, it is advantageous in that it facilitates the uniform heating of the central portion of the tube end prior to the first-pressing operation and also prevents the plastic quartz from sagging. Best results have been obtained by pre-flattening the tube end to approximately half its original diameter.

Immediately after the preforming operation is completed and the press jaws 22 and 23 have returned to their open position, the jaws are again actuated and advanced toward one another until the motion thereof is stopped by the pressed quartz thereby applying pressure to opposite sides of the central portion of the partially-flattened tube end and collapsing only this portion of the tube 11 onto and hermetically uniting it with the ribbon conductors 15 and 16 as shown in FIG. 4. As will be noted, the marginal portions of the tube 11, that is the quartz-to-quartz area of the seal assembly, remain open so that the end of the tube at this stage of the sealing operation is only partially closed off.

The partially fabricated seal assembly is then indexed into station "6" where, as shown in FIG. 5, the second or final pressing operation is accomplished in accordance with this invention by a second pair of movable press-burner jaws 32 and 33 which are identical in construction with the first pair of press jaws 22 and 23 referred-to-above except for the configuration of their work faces. As shown in the drawing, the work faces 34 of the jaws 32 and 33 are greater in area than the area of the flattened end of the tube 11, and thus the press seal 40 when finished, and are planar except for matching recesses or depressions 38 that correspond both in size and location with the bosses 28 provided on the first pair of jaws. Thus, when the second pair of jaws 32 and 33 are actuated and advanced toward each other (as indicated by the arrows in FIG. 5), only the quartz-to-quartz sealing area left unsealed by the first pair of jaws is compressed and sealed as shown in FIG. 6. This extends the region of compression across the full width of the tube 11 thereby completing the closure of the end thereof and the fabrication of the press seal 40.

It should be noted that since the quartz-to-conductor portion of the seal assembly previously sealed at station "5" is aligned with the matching depressions 38 and the latter provide a relief cavity, so to speak, for this section of the tube end when the second pair of jaws 32 and 33 at station "6" are closed, as shown in FIG. 6, only the unsealed area of the seal assembly is compressed during the second pressing operation. Thus, the fragile ribbon conductors 15 and 16 are not only protected from excessive heating by virtue of the fact that they are sealed into the tube first but the lateral flow of plastic quartz over and the resultant tensioning of these conductors during the formation of the seal is also minimized and kept within safe limits.

If desired, the aforesaid sequence of steps can be very conveniently reversed by placing the second pair of jaws 32 and 33 at station "5" and the first pair of jaws 22 and 23 at station "6". In this case the marginal portions of the seal assembly would be sealed first and the central quartz-to-conductor portion last.

Upon completion of the press seal 40 and the removal of the tube 11 from the sealing machine 42, the position of the tube is reversed and the tube reloaded and another conductor-electrode assembly inserted into the jig 20 to form a new seal assembly which is then indexed through the machine to form a similar seal on the opposite end of the tube in the manner described above.

Experience has shown that the reduction in the total amount of heat and pressure required per press achieved by converting an automatic sealing machine from one to two-step sealing in accordance with this invention is such that the index speed of the machine (that is, the length

of time spent at each station) is decreased from about 65 seconds to about 32 seconds thereby proportionately decreasing the total time for one complete revolution and approximately doubling the productive capacity of the machine. In addition, the percent shrinkage due to torn ribbons, leaky seals, etc., was reduced from a range of 35-40% to 15-20% resulting in an additional cost saving.

It will be apparent from the foregoing that the desired objectives have been attained by providing an improved process for fabricating full press seals which not only substantially eliminates the criticality heretofore connected therewith but enables them to be manufactured on a mass production basis with a minimum amount of shrinkage. Moreover, a preferred apparatus has been provided which applies both the heat and the controlled compressive sealing pressure to the seal assembly necessary to sequentially form the seal in accordance with the aforesaid process.

While a preferred sequence of process steps and apparatus have been described, it is to be understood that various modifications and refinements therein may be made without departing from the spirit and scope of this invention.

I claim:

1. The process of forming a press seal in a vitreous tube at a predetermined point thereon comprising, heating a segment of the tube at that point to render and keep it plastic during the sealing operation, applying pressure to opposite sides of only a preselected portion of said heated tube segment to collapse and seal off that portion, and then compressing only the unsealed portion of said tube segment to extend the seal across the full width thereof and thus complete the closure of said tube and the fabrication of said seal.

2. The process of forming a press seal on the end of a vitreous tube comprising, heating the end of said tube until it becomes plastic, applying pressure to opposite sides of the heated tube end to partially flatten and thus constrict said end, reheating the partially flattened end of said tube to maintain it in a plastic state, compressing only a preselected portion of said partially flattened tube end in the direction in which it was first pressed to collapse and seal off that portion, reheating the partially sealed end of said tube, and then compressing only the unsealed portion of said reheated tube end to extend the seal across the full width of the tube and thus complete the closure of said tube and the fabrication of said seal.

3. The process of forming a press seal on the end of a vitreous tube comprising, heating the end of said tube until it becomes plastic, applying pressure to opposite sides of only a preselected portion of said heated tube end while continuing the heating thereof to collapse and seal off that portion, and then simultaneously heating the partially sealed end of said tube and compressing only the unsealed portion thereof to extend the seal across the full width of said tube end and thus complete the closure thereof and the fabrication of said seal.

4. The process of forming a press seal on the end of a quartz tube of substantially uniform diameter and hermetically embedding a fragile lead-in conductor therein that is susceptible to damage when subjected to an excessive tensioning stress, which process comprises placing said lead-in conductor within the end of said tube to be sealed and thereby defining a quartz-to-conductor sealing area and a quartz-to-quartz sealing area, heating the end of said tube until it is plastic, compressing the part of said heated tube end corresponding to only one of the aforesaid sealing areas to collapse that part of the tube and complete the fabrication of the respective portion of the seal, applying additional heat to the partially sealed end of said tube to keep it plastic, and then compressing only the part of said tube end corresponding to the other of said sealing areas to complete the fabrication of said press seal and the closure of the end of said tube, whereby the lateral flow of plastic quartz over and the resultant tensioning of

said lead-in conductor during the formation of said seal is minimized and maintained within safe limits.

5. The process of forming a press seal on the end of a quartz tube of substantially uniform and relatively large diameter and simultaneously hermetically embedding a fragile lead-in conductor therein that is susceptible to damage when excessively heated or tensioned, which process comprises centrally locating the lead-in conductor within the end of the tube to be sealed, heating the end of the tube until it is plastic, compressing only the central portion of said heated tube end to collapse it onto and hermetically unite it with said lead-in conductor and thereby complete the fabrication of this section of the seal, applying additional heat to the partially sealed end of said tube, and then compressing only the unpressed marginal portions of said tube end to complete both the fabrication of said press seal and the closure of said tube, whereby the amount of heat imparted to and the lateral flow of plastic quartz over said lead-in conductor and the resultant tensioning thereof incident with such flow during the formation of the seal is reduced to a minimum.

6. In apparatus for forming a press seal across a preselected segment of a vitreous tube, a first and a second pair of movable press jaws having work faces and means for holding said tube and sequentially positioning the preselected segment thereof between and centrally of said first and second pairs of jaws, the work faces of said first pair of jaws having a pair of matching bosses therein the opposed surfaces whereof are planar and have a maximum transverse dimension smaller than the diameter of the preselected tube segment, and the work faces of said second pair of jaws being planar and having a pair of matching depressions therein that correspond both in size and location with the area of compression defined by the bosses in said first pair of jaws.

7. In apparatus for forming a press seal across a preselected segment of a vitreous tube, tube holding and positioning means and a first and second pair of movable press jaws as set forth in claim 6 wherein, each of said press jaws are hollow and constitute the head of a gas burner, and the work faces of each of said press jaws have a plurality of small openings therein.

8. In apparatus for forming a press seal across a preselected segment of a vitreous tube, tube holding and positioning means and a first and second pair of movable press jaws as set forth in claim 6 wherein, the work faces of said first pair of press jaws are of generally semi-circular configuration, and the matching bosses therein are of generally rectangular configuration and extend completely across and diametrically of said generally semi-circular work faces.

9. In apparatus for forming a press seal across a preselected segment of a vitreous tube, means for holding said tube and progressively indexing it through a plurality of work stations including a preheating station, a preforming-and-first-pressing station and a second-pressing station, in that order; a first pair of movable press jaws at said preforming-and-first-pressing station having planar work faces with matching depressions therein that define a relief cavity when said jaws are in closed position, and a second pair of movable press jaws at said second-pressing station having work faces with a pair of matching planar bosses therein that correspond both in size and location with the relief cavity defined by the depressions in said first pair of press jaws.

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