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C. F. KRAMER ET AL

2,391,426

GLUING FIXTURE

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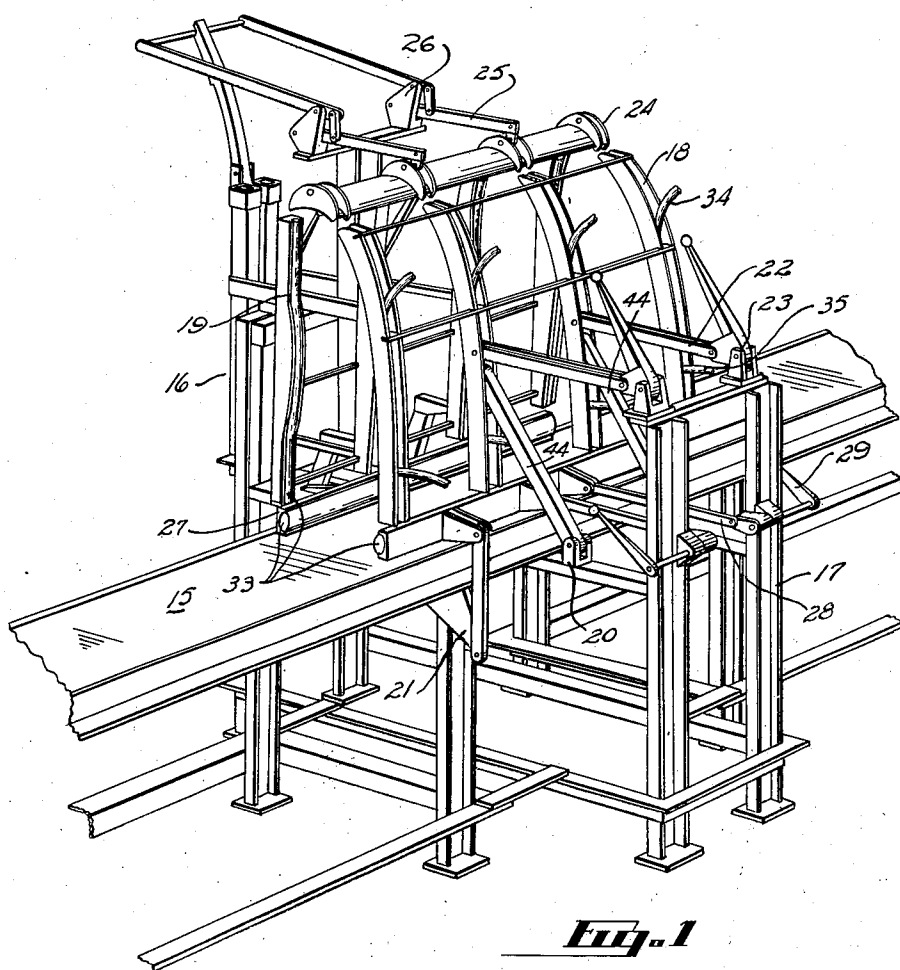


Fig. 1

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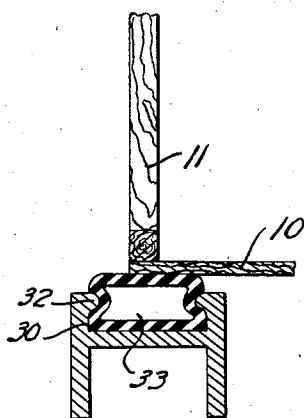
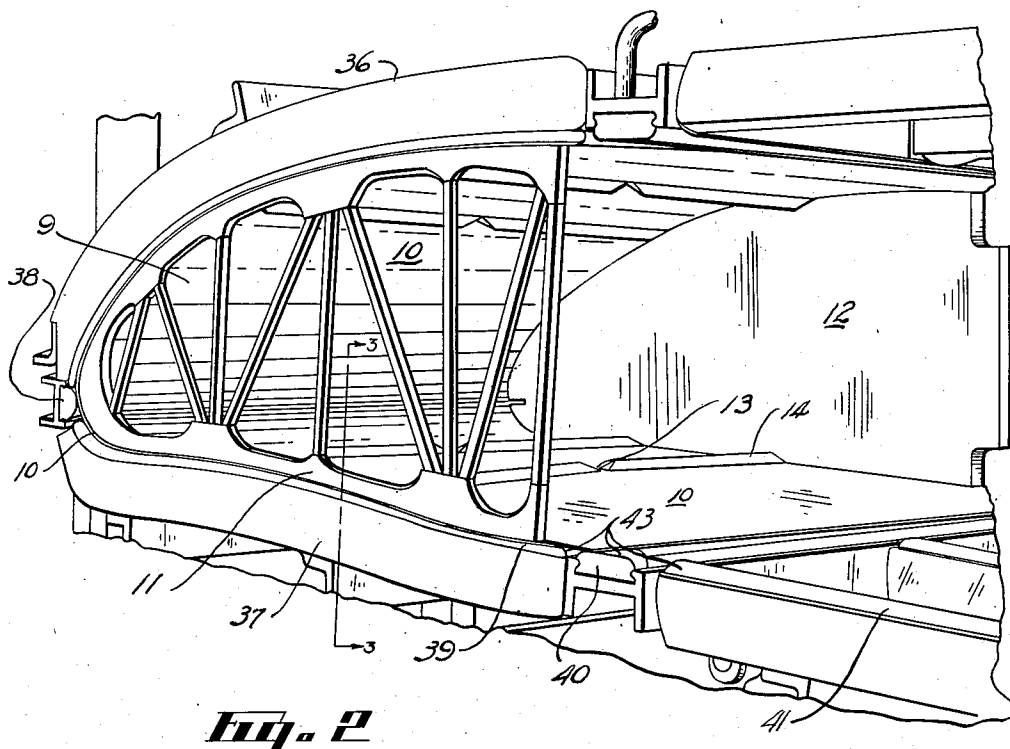
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3 Sheets-Sheet 2



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3 Sheets-Sheet 3

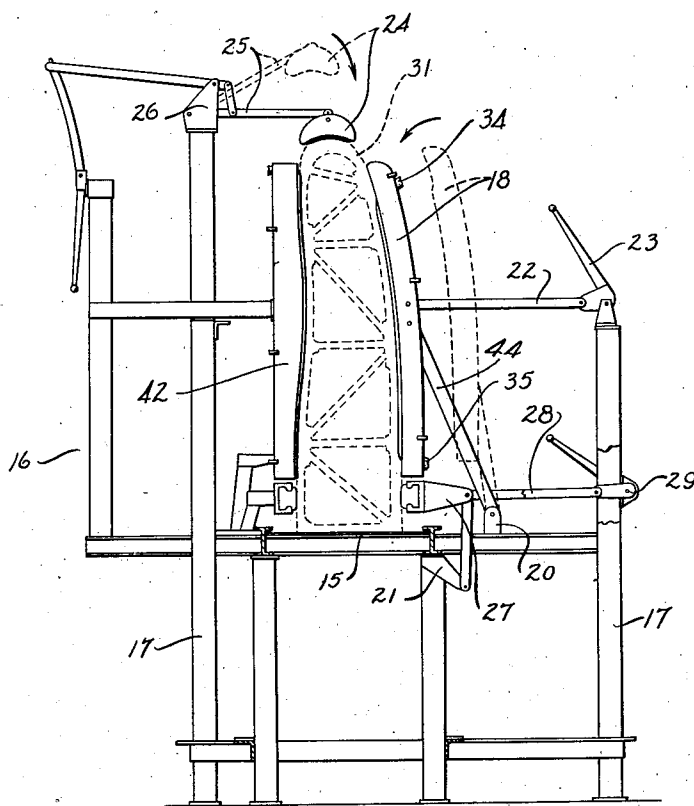


Fig. 4

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UNITED STATES PATENT OFFICE

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GLUING FIXTURE

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Application January 8, 1943, Serial No. 471,715

5 Claims. (Cl. 144—281)

This invention is concerned with the assembly of structures with adhesive materials; and, more particularly, with an apparatus and method of operation thereof for the construction of aircraft components using various adhesive features.

Adhesives in various forms have long been used in the construction of aircraft, and particularly so when such construction comprised wood and fabric components. In larger structures this has been generally superseded by all-metal construction and the use of rivets or welding; but in smaller craft and in those in which it is possible to use wood and fabric construction and thus avoid the use of critical metals, the earlier method is still followed. Indeed, an extension of the method may be expected to cover structures employing metal components, as advances in research develop adhesives which are efficient in obtaining metal-to-metal joints. It will thus be seen that the adhesive process offers considerable promise as a means of avoiding the repetitive work now required in riveting and welding, with the consequent increase in speed of construction and saving of materials and time.

The adhesive method has always required the use of pressure and sometimes of heat (depending upon the type of adhesive used) to perfect the bond between the components being joined; and many methods have been worked out to obtain these necessary conditions in connection with the various types of work to be performed. It is at this particular phase of the problem that the present invention is directed and the apparatus and method shown attack the problem in a novel way, resulting in joints of uniformly higher strength obtainable with a minimum of time and labor.

An advantage of the method of apparatus shown is that a precise control of temperature and pressure is possible and this control is such that it may be varied for specific parts of the structure which, by the nature of their construction, require special treatment. Another advantage is that the apparatus insures proper alignment and forming of the structure so that the successive structures made in the device are interchangeable and uniform throughout. Yet another advantage of the invention is that a minimum of heat is required and still the adhesive operation is concluded in a very short time. Other advantages number the saving in setup time of the various components, maintenance of these components in rigidly preselected positions, provision made for ready removal of the completed structures, as well as other considera-

tions which will appear more fully from the drawings and the specification.

With these and other objects in view, the invention consists in the arrangement, construction and combination of the various parts of the improved device described in the specification, claimed in the claims, and illustrated in the accompanying drawings in which:

Figure 1 is a perspective view of a portion of one form of a gluing fixture.

Figure 2 is a perspective view of a second form of the apparatus on a somewhat larger scale.

Figure 3 is a section taken on the line 3—3 of Figure 2.

Figure 4 is an elevation of the device shown in Figure 1.

Figures 1 and 4 show a portion of the fixture used for securing plywood skin to ribs and formers to construct the leading edge component of an airframe wing. Figure 2 shows another fixture for the simultaneous construction of the leading edge and wing section which may be used where circumstances do not require the separable construction shown in Figure 1. The operation of each fixture is, however, similar, and in the interest of clarity, the work is shown in detail only in Figure 2. Referring to the latter, the work in position is a portion of the leading edge structure 9 including the skin 10 which is preformed to substantially the shape shown, a rib 11, which is prefabricated of a number of individual parts, and a bulkhead 12. Omitted from the view are the usual formers which normally are positioned in the notches 13 in the longitudinal stiffening members 14 attached to the inner surface of the preformed skin 10. It will be understood that the complete edge component comprises a number of additional units similar to those shown continuously arranged, but the view chosen is representative of the whole. The distinction between Figures 1 and 2 is that in the former, the edge component alone is constructed, while in the latter, the assembly of both edge and wing is contemplated.

The assembly of the edge component, as shown in Figures 1 and 4, takes place on an extended worktable 15 which corresponds to one of the spars of the completed wing structure. Associated with this intermediate length is the press 16 which includes a supporting frame 17 to which are hinged a number of movable skin pressure strips 18 and fixed strips 42 arranged in spacing to conform to the rib, former and bulkhead spacing of the structure desired and having inner faces 19 conforming to the exterior curvature of

the structure which is shown in dotted line at 31. Strips 18 are hinged on the link 44 to frame 17 at bracket 20 so they may be withdrawn laterally and upwardly as indicated by the dotted line position to clear the work table to permit ready assembly of the structural component and its removal after the adhesive operation has been completed, as well, to insure that it will occupy precisely the same position during each successive operation. The position of the strips is further controlled by the links 22 and toggle means 23 permitting accurate placement and controlled application of initial pressures. The arrangement of the links 44 and 22, together with the toggle means 23 being such that the side pressure member comprising the pressure strips 18 initially urges the skin into engagement with the ribs adjacent the upper portion of said member and thereafter extends this engagement to areas positioned downwardly therefrom until the entire side of the work is engaged.

Similarly, a nose pressure strip 24 is pivotally mounted on the frame 17 by links 25 and toggle 26 and adapted to move upwardly and rearwardly (or towards the side having the fixed strips 42 as shown in dotted line) to clear the work area and to facilitate the assembly and removal of the structural component. The effect of successive operation of the nose and movable skin strips is to urge the skin as indicated by the arrows in Figure 4 and to draw it tight upon the ribs rather than merely clamping it in place. Finally, the base pressure strips 27 corresponding to spar location are hinged to bracket 21 and their lateral position is controlled by links 28 and toggles 29. These move laterally to clear the table area.

Each of the pressure strips is preferably of H section, as shown in Figure 3, and included in the inner face channel 30, are detent means 32 adapted to secure a rubber expansion tube 33 which extends along each of the pressure strips 18, 24 and 27. Intake connections 34 are associated with the several expansion tubes 33, through which steam may be admitted under the desired pressure to obtain the necessary heat and pressure for the setting of the adhesive in the adjacent joints and exhaust connections 35 to remove steam and condensate from the tubes 33. In some instances, these tubes may be continuously connected to form a skeleton-like structure in which all of the tubes are at the same temperature and pressure. However, one of the principal advantages of the apparatus shown here is that the various runs of tubes may be kept separate and maintained under different conditions of temperature and pressure by suitable variation of the steam supplied to obtain the particular conditions which are found best for each portion of the structure. This is important when differing adhesives are to be used between different types of materials.

Still referring to Figure 1, the apparatus shown is particularly valuable in the formation of any structure having a closed edge, such as the leading edge of a wing. This results in the fact that the nose press is operated separately from the side presses. It is possible to apply force progressively to the skin commencing at the closed edge, continuing over the wing section and concluding at the base or spar making it conform closely to the underlying rib structure to obtain the precise curvature desired and yet to graduate this force so as to avoid any danger of distortion or cracking. In effect, a sort of graduated squeezing action is obtained. At the same time, a complete bond is

obtained throughout the structure, and there is no tendency for failure of adhesion encountered when conventional upper and lower presses alone are used.

In operation, successive sections of the nose component are operated on by the press 16 as the component slides intermittently along the table 15. The control of heat and pressure makes the gluing operation a matter of minutes rather than hours so that practically continuous fabrication of uniform sections is possible although the fixture itself is but a fraction of the size of the component worked on. In Figure 2, on the other hand, the structure is not uniform in section but variable so that an over-all fixture must be used. In this way alone is it possible to compensate for the necessary variation of the wing section. Thus, the wing fixture includes the upper and lower surface wing presses generally referred to as 36 and 37 and the nose press 38. The surface presses comprise a number of individual pressure strips (as in Figure 1) such as for nose ribs or formers 39, spars 40, wing ribs 41, etc. These, as before, are preferably of H section and include the tubes 43. The presses 36 and 37 are movably secured to a support which is not shown but which corresponds in structure and purpose to 17 of Figure 1. The movable connection likewise includes toggle or like means by which the press positions can be changed to admit preassembly of the work, imposition of initial pressure, curing of adhesive under heat and pressure, and clearing of the presses for work removal. However, the presses 36 and 37 are preferably arranged vertically with the nose press 38 downwardly and in this position, press 38 may be fixed and proper pressure sequence applied to the work by engaging the components of 36 and 37 successively from the bottom upwardly, that is, the portion of press 36 and 37 immediately adjacent the nose press 38 is brought into contact first and then the remainder of the press is swung into engagement. In this instance, the various pressure tubes are shown somewhat more clearly and it is apparent how the pressure may be varied—for instance, between those defining the wing rib 41 and that in conjunction with the spar 40 to fit precisely the work which must be done and the type of adhesive used.

It is believed that the operation of the apparatus is clear, and its advantage is that it confines pressure and heat necessary to effect an adhesive bond only to those portions of the structure where they are required and where the structure itself is adapted to resist such forces without distortion or failure. It is also believed apparent how the gluing operation may be facilitated and strictly controlled by proper control of individual temperatures in individual portions as may be required by the conditions pertaining. As an example, in some of the joints there may be several thicknesses of material to be adhesively joined, in which case a greater amount of heat and pressure may be required. Again, the materials to be joined may differ, requiring cements of different curing properties. In others, there may be generally similar joint conditions, yet the heat and pressure necessarily required in one might cause failure or destruction at the second because of difference in underlying structure. This is completely avoided in the present device in which due allowance is made for all of these various factors. The press itself serves as an assembly fixture for the various components, as is particularly shown in Figure 1, and the build-up and preliminary work may be done in the fixture, which in turn

secures these components without additional effort before the final assembly and curing step. This is a clear distinction to other methods in which it is necessary to secure the components, as by nails or other means prior to the gluing step, and later remove or cover the fastening means so employed. It is equally applicable to step-by-step gluing of long components having an unvarying cross-section or over-all gluing of nonsymmetrical components. In the present instance, it is only necessary to assemble the various components with the adhesive therebetween, clamp the device and apply the requisite steam pressure which, in turn, effects an even pressure throughout and supplies the heat necessary for the completion of the adhesive bond. It permits the graduated application of pressure which is most useful in fabricating closed structures or those having substantial surface curvature. Its application to the newer cements which require curing temperatures in excess of 200° F. and pressures on the order of 250 to 350 pounds to square inch will be readily appreciated.

Some changes may be made in the steps of the method disclosed or the structure described without departing from the spirit of the invention, and it is the intention to cover by the claims such changes as may be reasonably included in the scope thereof.

The invention claimed is:

1. In a gluing fixture for structural components of rib and skin construction, a longitudinally extending support, press means located intermediate of said support, said press means including side pressure members movable laterally of said support and a hinged vertical press member disposed above said support, a toggle device associated with said vertical pressure member and selectively operable to move said member substantially vertically with respect to said support, operating means to move said side pressure members laterally of said support, said pressure members comprising a plurality of tubular pressure strips formed of resilient material, said pressure strips being disposed in predetermined relationship with ribs on said component to be assembled therein, and means to admit steam under pressure selectively to said pressure strips.

2. The structure of claim 1, which is further characterized in that each of the said pressure members comprise a channel having opposed flanges and inwardly extending projections at the ends of said flanges, said tubular pressure strip being disposed between said flanges and retained

by said projections, a portion of said tubular pressure strips extending outwardly of said flanges, and a steam connection through the web of said channel to said tubular member to admit steam under pressure thereto.

3. In a gluing fixture for an aircraft wing component including the leading edge portion thereof and having as structural elements spaced ribs and a continuous skin conforming to said ribs, comprising, a longitudinally extending support, press means located above said support including a vertical pressure member and side pressure members intermediate said vertical pressure member and said support, said members adapted to operate upon the leading edge portion and the opposite skin surfaces of said component respectively, said vertical pressure member being hingedly mounted, one said side pressure member being fixed, the other side pressure member being hingedly mounted, said mounting of said last-named side pressure member comprising a link pivotally connected at one end to said member intermediate its ends and extending downwardly and outwardly therefrom and having its other end pivotally engaging said support, a second link pivotally connected at one end to said member above the point of connection of said first link thereto, and reciprocable operating means engaging the other end of said second link, the operation of said hinged side pressure member by said links initially urging said skin into engagement with said ribs adjacent said vertical pressure member and thereafter occasioning such engagement at points successively more remote from said pressure member.

4. The structure of claim 3 which is further characterized in that vertical pressure member is pivotally supported at one end of a link member, the other member of said link being pivotally mounted on means fixed with respect to said support located adjacent to said fixed side pressure member, and means associated with last-named link to operate said vertical pressure member.

5. The structure of claim 1 which is further characterized in that there are lower pressure members beneath said side pressure members each having a pressure strip extending along said supporting means on opposite sides thereof, at least one of said lower pressure members being movable independently of said side pressure members laterally of said supporting means.

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