Oct. 22, 1946. L. C. MILLER ET AL 2,409,782

CONSTRUCTING TUBULAR FUSELAGES

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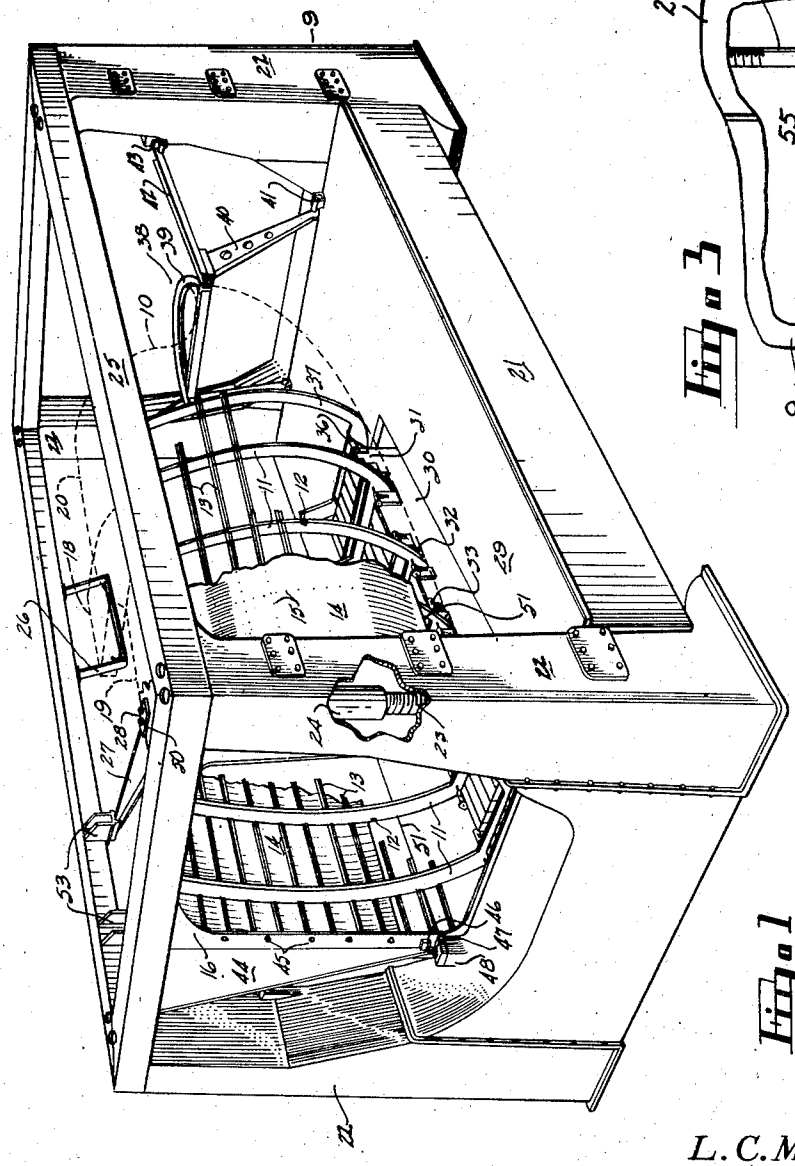


Fig. 1

Fig. 3

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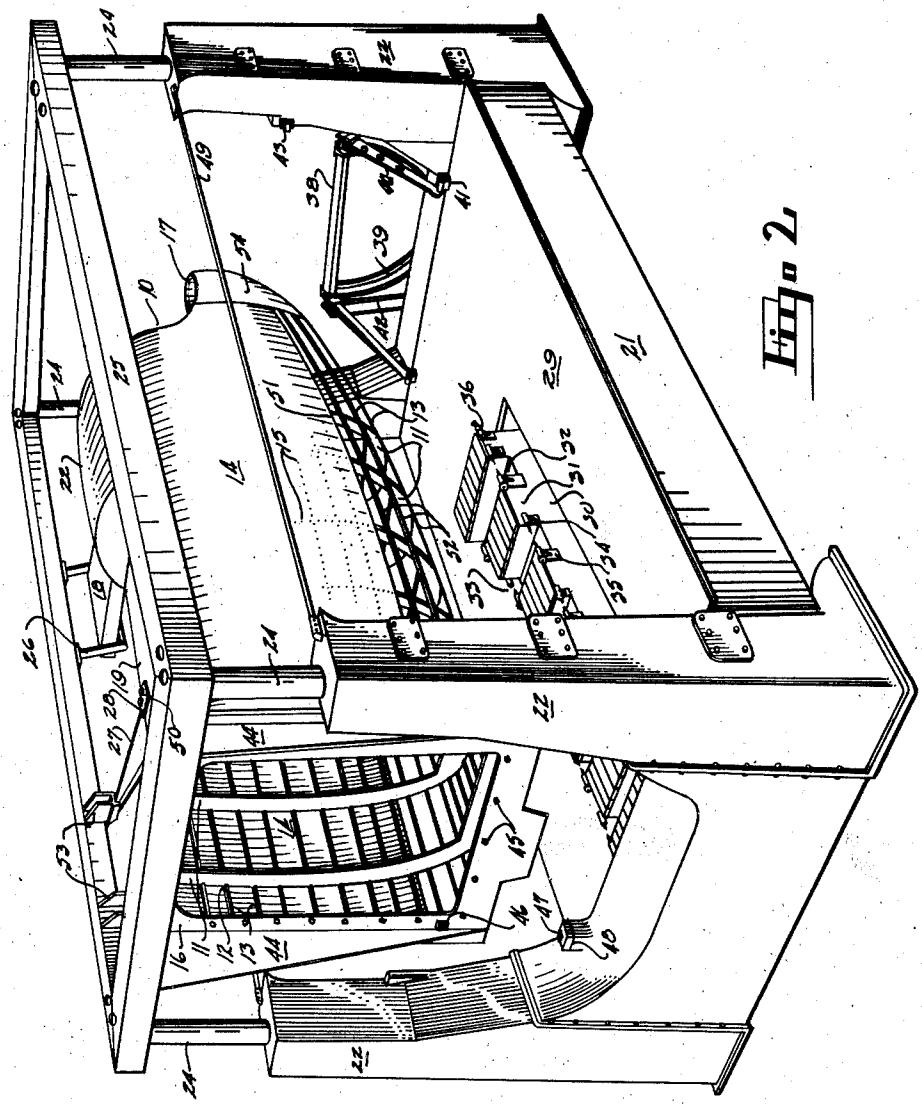


Fig. 2.

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CONSTRUCTING TUBULAR FUSELAGES

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10 Claims. (Cl. 29—286)

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This invention relates to the manufacture of airframes; and, more particularly, to a method and apparatus for use in the construction of substantially tubular fuselage components.

This invention finds particular application to the construction of those basically cylindrical airframe components best exemplified by complete fuselage sections. It is true that in the larger fuselage sections, considerable simplification of construction is possible when the fuselage is divided into a number of longitudinally extending panels which are separately constructed and thereafter joined together to form the completed component, as shown in copending application, Serial No. 487,278, filed May 17, 1943. This method of subdivision permits easy access for interior riveting and installation of wiring, accessories and fittings; and, of course, permits an increase in the number of persons who may work simultaneously on each section. This method, however, has certain limitations, particularly when applied to the smaller fuselages or the smaller sections of large fuselages, a notable example of the latter case being the extreme rear portion of the fuselage, usually referred to as a tail cone. Here, even in a large bomber, a much smaller section is involved than in the remaining portion of the fuselage and it is not practicable to build it by subdivision. When the components are characterized by the smaller diameters, it is advisable—if at all possible—to construct them as a unit with one-piece bulkheads rather than rely upon the subdivision of components. However, in these smaller sections, difficulties as to access to the work and the number of persons who may be employed simultaneously on the given component are emphasized and some steps must be taken to increase the accessibility and availability if these components are to be constructed readily as an integral unit.

Of course, from the earliest days of the art, it has been the custom to construct all these fuselage components as integral members; and the subdivision method referred to above represents a later advance. Thus, the method disclosed here—while a return to first principles in a way—represents a substantial advance in that it confers some of the advantages accruing from sectional construction to the purely integral method. Another advantage is that it permits an accuracy of construction which results in substantial duplication of successive components which was not inherent in the prior methods of integral construction and without which a

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mass production schedule is a practical impossibility. Still another advantage of the present method is that it greatly increases the availability of the structure—by which is meant that the number of persons who can work on it simultaneously is increased—thereby cutting down the time of construction and reducing the interval in which any particular fixture is occupied with the completion of one such structure. Not only is the availability increased, but the accessibility of the structure and the working conditions alike are improved.

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

Figure 1 is a perspective view of a fixture used in this invention shown in the primary assembly position.

Figure 2 is a similar view with the fixture shown in the secondary assembly position.

Figure 3 is an end elevation of the fixture, a portion of the wall being broken away to show the screw operating means.

Referring to Figure 1, 10 indicates generally a fuselage component which is substantially cylindrical in section and, in this instance, constitutes the tail cone of a heavy bomber. This, according to usual construction, comprises a number of bulkheads or ring-frame structures 11, notched at 12 adjacent their peripheries to receive the longerons 13 fastened by rivets thereto and the skin 14, in turn, is riveted to the longerons 13 and the bulkheads 11 at 15. In the present instance, the forward end of the fuselage section 10 has a mating bulkhead which cannot be seen, as it is disposed against and bolted at 45 to the end plate 16 of the fixture 9, but which is similar in form to the other bulkheads 11 and subsequently mates with a similar mating bulkhead in the main fuselage section disposed forwardly and is bolted to it to complete the airframe fuselage structure. The rear part of the tail cone 10, since this is a military plane, is shown as having a mounting for a rotatable gun turret including a circular track 17 (shown in Figure 2) and this is utilized in fixing the rear end of the fuselage component under consideration. It will be understood that in other types of planes, other structural features may be utilized such as a rudder post, stabilizer attaching means, or some similar major element

with inherent structural strength particularly suited for this purpose. In the present instance, the stub portions 18 of the elevator are a fixed part of the fuselage component and the empennage assembly proper rests on and is secured to the substantially flat top plate 19. Conditions may vary in other constructions, but again the method depends upon the use of a substantially continuous skin section along the top of the component to be built; and in the present case this is represented in its entirety in Figure 2 by the plate referred (which is quite flat forwardly of the elevator stubs but rounded at 20 to conform to the fuselage contour from there aft), extending from front to rear along the top of the component and initially secured in the position shown in the fixture 9.

The fixture 9 comprises a bed or base 21 having four side columns 22 which enclose a screw 23 and sleeve 24 jack arrangement, the sleeve 24 carrying the rectangular top frame 25. To this frame 25 are permanently attached the hangers 26 which are adapted to support the elevator stubs 18 in predetermined position and the brackets 27 removably secured in buttresses 53 and having angle plates 28, which are bolted to the top plate 19 through prepunched holes thereby establishing the position of the plate which comprises the upper portion of the fuselage component 10 with respect to the fixture 9. In Figure 1, this structure is largely broken away and shown in phantom to indicate details of the fixture construction.

The bed 21 of the fixture 9 has a working floor 29 and in the center of this are a number of bulkhead positioning steps 30 in the form of successively raised projections 31 having spaces 32 between them, these intervals corresponding to the bulkhead spacing and the general disposition of the steps following the contour of the lower surface of the fuselage section. The projections support clamps 33 each comprising a fixed bar 34 and a screw or spring plunger 35 arranged to secure a bulkhead inserted therebetween in predetermined elevation and alignment. The end projection has a hook clamp 36 holding the end bulkhead 37.

At the rear end of the fixture 9 is the turret track positioning means 38, which includes a sector 39 conforming to the shape of the turret track 17 (which is temporarily secured to it during the assembly step) and this is fixed on legs 40 pivoted at 41 to the bed 21. Straps 42, also fixed to the sector 39, are releasably secured to the rear columns 22 at 43. Thus, the turret positioning means may be fixed in the position shown in Figure 2 for assembly; and, when this is completed, detached from the component and swung rearwardly and down to the position shown in Figure 2.

The end plate 16 is rigidly attached to and depends from the forward end of the rectangular top frame 25 and is reinforced against longitudinal movement by the triangular shaped webs 44. The plate 16 conforms roughly to the outline of the fuselage section, although it is somewhat larger in plan and the initial bulkhead is bolted directly against the inner surface of said plate in predetermined position by the bolts 45. A hook-shaped projection 46 locks into a recess 47 on a boss 48 on the bed 21 when the frame 25 is in lowered position, securely restraining the end plate 16. The columns 22 at opposite ends are connected with a strut rod 49 to further increase their rigidity when the top frame 25 is raised.

In operation, the fixture is set in the position shown in Figure 1. The initial bulkhead is bolted to the end plate 16 and the top plate is placed with the stub elevators 18 in the hangers 26 and its forward edge against the end plate 16 to which it is bolted. It is then secured to the angle plates 28 on the brackets 27 by the bolts 50. Successive bulkheads 11 are angled under the top plate 19 into the spaces 32. They are then brought into vertical position at which their top portions are temporarily secured through prepunched rivet holes in the top plate and the bulkhead and their bottom portions are clamped by the clamps 33 or 36. They are now in predetermined alignment and spacing and the temporary securing means are replaced by rivets.

The topmost two-thirds of the longerons 13 are then laid in the notches 12, with their front ends butting against the inner surface of the end plate 16, and the rear ends of those in the lower part abutting against the turret track structure 54, which is built as a separate unit and carried by the positioning means 38, and are riveted to the bulkheads at each intersection starting adjacent the end plate 16. The skin panels 14 are then laid over this skeleton framework starting adjacent the end plate 16 and proceeding rearwardly and temporarily secured to the longerons, bulkheads and sides of plate 19. The horizontal extent of the skin panels placed is shown at 51 in Figure 1. The temporary securing means (such as "Cleco" fasteners) are then replaced by permanent rivets and the upper part of the fuselage section is complete. The turret track positioning means 38 and the clamps 33 and 36 may be released and withdrawn as the component is now substantially self-sustaining.

As shown in Figure 3, the screw 23 may now be operated through the worm wheel 57 and worm 56, the latter being mounted on a cross shaft 55 operated by the motor 58—care being taken that uniform motion is transmitted to each corner of the frame 23—and the frame 25 and the partially completed component raised. Since a large part of the skin and the greater number of longerons have been assembled and secured together, there is no chance for the lower parts of the bulkheads to be disarranged. The remaining longerons 52, comprising those in the bottom quarter or third of the structure, are attached by butting them against the end plate 16 and then securing them to the successive bulkheads 11 at their points of intersection. When this is completed, the remaining skin panels are affixed and riveted and the structure is finished. The end bulkhead is unbolted from the end plate 16 and the brackets 27 from the top plate 19 and the buttresses 53 and the completed component can be lifted out of the fixture by an overhead crane or other transport means for further processing.

By dividing the work longitudinally, albeit still using continuous ring bulkheads, the accessibility is greatly increased. The provision made for locking the individual bulkheads at points beneath the working floor level established by the steps 30, permits free movement inside the ship without the imposition of stresses on the skeleton structure. When the component is in the raised position, its construction is sufficiently advanced, so that the weight of the workmen in the interior will not seriously affect the alignment of

the structural elements. The entire structure is based substantially on the end plate 16 and each element (save the independently constructed and applied turret track structure 54) is started from it. The individual bulkheads are maintained in correct alignment, spacing and elevation by engagement with the top plate 19 and the clamps 33 and 36. The greater portion of the work on the exterior of the section can be done at a height best suited for maximum productive effort.

Some changes may be made in the arrangement, construction and combination of the various parts of the improved device 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 within the scope thereof.

The invention claimed is:

1. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to engage elements adjacent one surface of the component to be assembled therein, and readily releasable means on said base to secure other elements of said component adjacent the opposite surface of said component.

2. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to engage elements adjacent one surface of the component to be assembled therein, means on said base to receive and releasably secure successive bulkheads of said component.

3. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to engage elements adjacent one surface of the component to be assembled therein and secure the same in predetermined elevation, means on said base to releasably secure successive bulkheads of said component in predetermined spacing and alignment, and a vertically depending end panel secured to said frame and adapted to have an end bulkhead of said fuselage component releasably secured thereto.

4. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to engage elements adjacent one surface of the component to be assembled therein in predetermined alignment and elevation, means on said base to engage successive bulkheads of said components in predetermined spacing and alignment, an end panel depending vertically from said frame and adapted to have an end bulkhead of said component releasably secured thereto, and means effective between said end plate and said base to secure said plate to said base when said frame is in lowered position.

5. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base having a floor, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to be secured to elements adjacent one surface of the component to be assembled therein, a plurality of slots formed on said base, the spacing of such slots conforming to the spacing of the bulkheads in said components, clamping means adjacent said slots to secure bulkheads therein in predetermined alignment and spacing when said frame is in lowered position, a substantial portion of said bulkheads being disposed beneath the adjacent floor level of said base when secured in position by said clamps.

6. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a frame supported by said vertical columns, means to elevate said frame with respect to said columns and said base, means on said frame to secure elements adjacent one surface of the component to be assembled therein in predetermined elevation and alignment, a series of steps on said base arranged in increasing heights from one end of said base, spaces between said successive steps adapted to receive a portion of a bulkhead therein, clamping means on said steps adapted to engage said bulkhead received in said spaces, and an end plate vertically depending from said frame adjacent said end of said base and adapted to have an end bulkhead of said component secured thereto.

7. The structure in claim 6, which is further characterized in that a piloting means is pivotally supported at the opposite end of said base to engage an element of said component at the end opposite said bulkhead engaged by said end plate.

8. The structure of claim 6, which is further characterized in that further piloting means is pivotally supported at the opposite end of said base adapted to engage an element of said component at the end thereof opposite said end plate, and means effective between said base and said plate to lock said end plate with relation to said base when said frame is in lowered position.

9. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a horizontal frame supported by said vertical columns and having an opening adequate to permit the vertical withdrawal of said component therefrom, means to elevate said frame with respect to said columns and said base, means on said frame to engage elements adjacent one surface of said component in predetermined elevation and alignment, readily releasable means on said base to engage successive bulkheads of said component in predetermined spacing and alignment, at least a portion of the bulkheads being disposed beneath the floor level of said base when said frame is in lowered position.

10. In an apparatus for assembling substantially tubular airframe fuselage components from bulkheads and longerons and exterior skin panels, comprising, a base, vertical columns associated with said base, a horizontal frame supported

by said vertical columns, elevating means between said columns and said frame effective to elevate said frame a predetermined distance above said base, said frame having an opening sufficient to permit the vertical passage of said component therethrough, means on said frame to secure elements adjacent one surface of said component in predetermined alignment and elevation, a series of slots in the floor structure of said base, said slots adapted to receive successive bulkheads of said component in predetermined alignment and spacing and with at least a substantial portion

of said bulkhead being disposed beneath the adjacent floor level when said frame is in lowered position, an end plate vertically depending from said frame and adapted to have an end bulkhead of said fuselage section releasably secured directly thereto, the elevating means being effective on operation to lift said component with respect to said floor so that a considerable open working space is established therebetween.

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