May 3, 1932. J. BLONDIN 1,856,532

OUTRIGGER FRAME, FORE AND AFT CONTROL TYPE AIRPLANE

Filed July 22, 1929 3 Sheets-Sheet 1

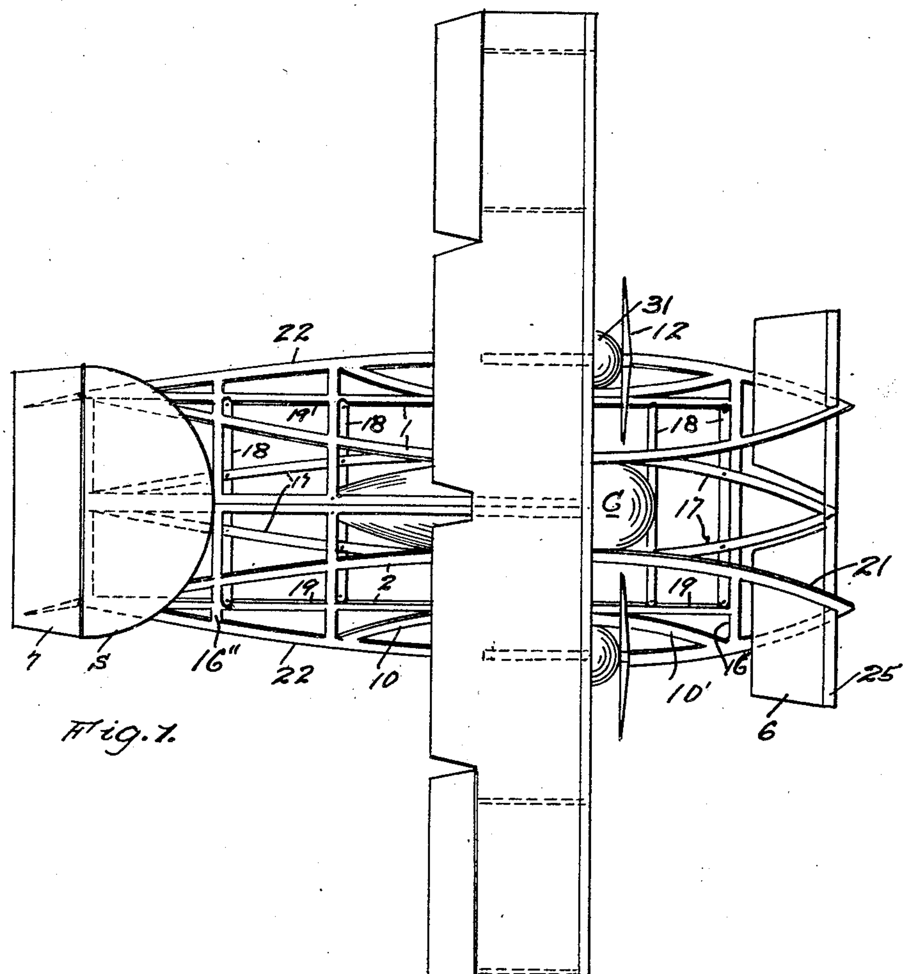

Fig. 1.

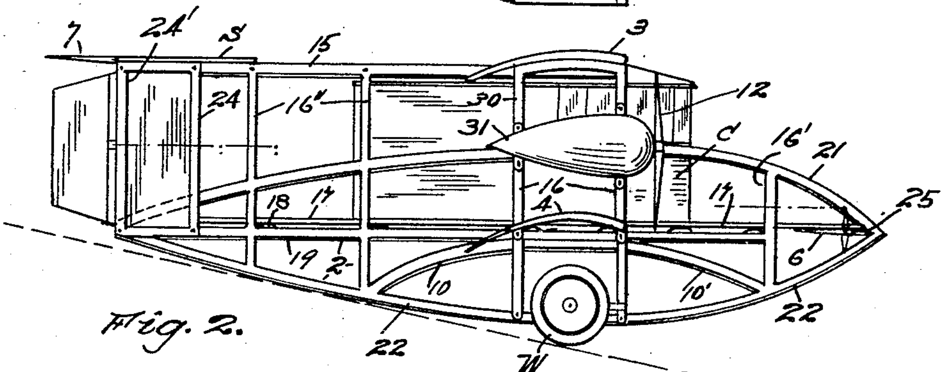

Fig. 2.

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OUTRIGGER FRAME, FORE AND AFT CONTROL TYPE AIRPLANE

Filed July 22, 1929 3 Sheets-Sheet 2

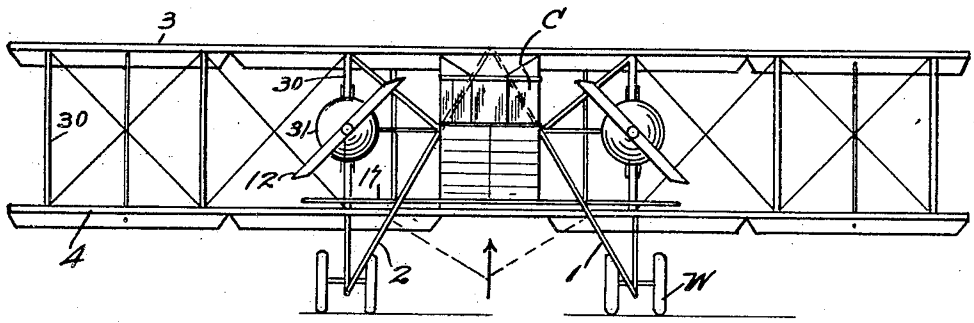

Fig. 3.

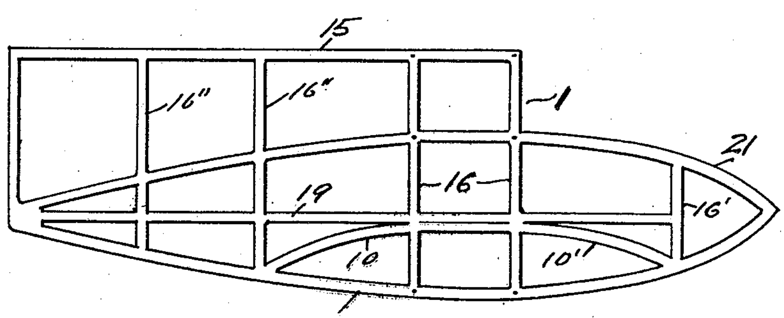

Fig. 4.

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OUTRIGGER FRAME, FORE AND AFT CONTROL TYPE AIRPLANE

Filed July 22, 1929 3 Sheets-Sheet 3

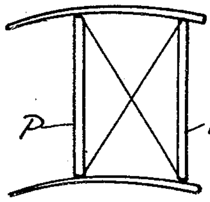

Fig. 5.

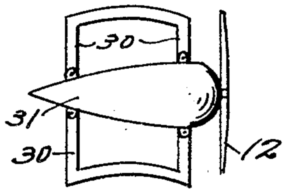

Fig. 6.

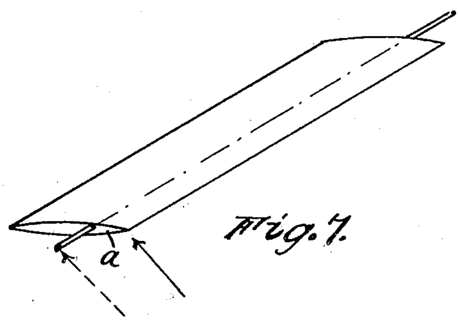

Fig. 7.

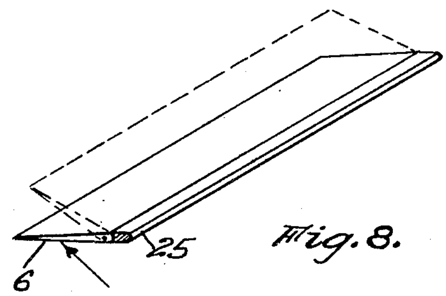

Fig. 8.

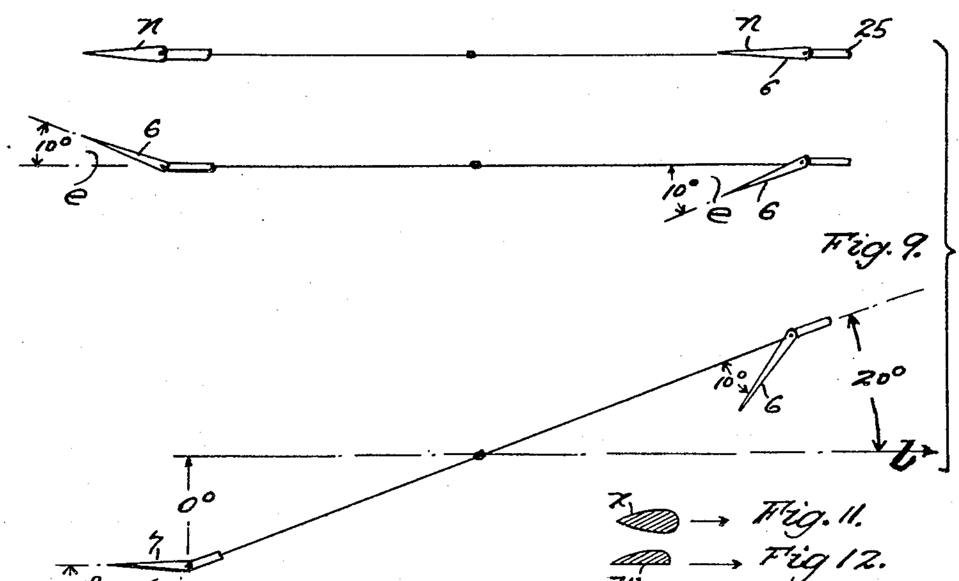

Fig. 9.

Fig. 11.

Fig 12.

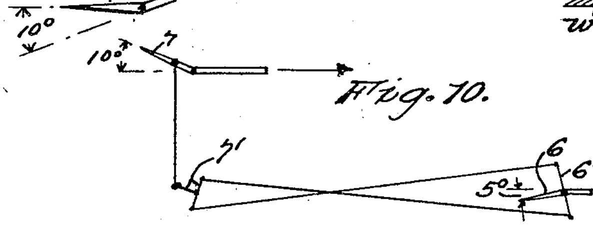

Fig. 10.

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Patented May 3, 1932

1,856,532

UNITED STATES PATENT OFFICE

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OUTRIGGER FRAME, FORE AND AFT CONTROL TYPE AIRPLANE

Application filed July 22, 1929. Serial No. 380,126.

This invention relates to airplanes and particularly to the "outrigger", fore-and-aft control type, and has reference to important improvements relating to the construction, lift-efficiency and manual control of the type of airplane shown in Blondin Patent No. 1,240,-812, of September 25, 1917.

Such patent discloses the principle of unit frame construction embodied in its side-frame elements and its interplane struts.

The present invention has numerous objects among which are: to provide a design of unit side-frame which reinforces and strengthens in important aspects; to provide a novel combination of the side-frames in their relation to accomplish a particular function by a novel shaping of the elements of the side-frames: to introduce a new and stiffening structural feature; to provide an arrangement of control means whereby to materially reduce the manual effort of their operation and to increase the efficiency of the fore-and-aft control of the machine as a whole. Also, to provide a new principle of coupling and operation of the fore-and-aft control surfaces whereby these are moved through paths of predetermined unequal extent, or differentially, and whereby the aerodynamic efficiency of the controls is materially improved. The general purpose of these improvements is to contribute to the production of airplanes of increased strength and rigidity, of increased lift capacity and of control and more safety in flight, applying more particularly to large transport airplanes of the multi-motor type.

Additional objects, advantages and features and principles of construction and mode of operation will be made manifest in the ensuing description of the herewith illustrated embodiment; it being understood that modifications, variations and adaptation may be resorted to within the spirit, scope and principle of the invention as it is more directly hereinafter claimed.

Figure 1 is a top plan of the airplane.

Figure 2 is a side elevation thereof.

Figure 3 is a front elevation thereof.

Figure 4 is a side elevation of one of the unit side-frames.

Figure 5 illustrates an end-bolted, two pole strut construction of conventional form.

Figure 6 is a side elevation of a unit-frame strut and motor combination.

Figure 7 illustrates a conventional control mount.

Figure 8 is a perspective of my improved control mount.

Figure 9 is a diagrammatic illustration of positions of the control surfaces.

Figure 10 is a diagram showing the system of connected elevator controls.

Figures 11 and 12 are detail views.

The main frame of the airplane consists of a pair of rigid-structure, skeleton, side-frames 1 and 2 each of which comprises a main longitudinal component 19 which extends forward and rearward of uprights 16 which extend upward and carry a ridge element 15 that extends well to the rear and as shown in Figures 1 and 3 constitutes a double ridge when the side-frames are secured in downward and outward angular relation, or A-form. Along the lower ends of the uprights 16 of each side frame is joined an inverted arcuate skid strip 22 and this is provided with arch braces 10—10′ reaching up to the element 19 and disposed fore-and-aft of ground-wheels W.

The skids 22 extend forward of the main elements 19 and curve upward to form a fore-rig which includes arch strips 21 intersecting the main uprights 16 and running rearward and downward to form a rear outrigger structure including rudder posts 24′. These posts here consist of vertical parts of unit-strut frames 24 stepped on the rear ends of the elements, 19, Figure 2 and which, with the rear end of the united ridge beams 15, support the fixed stabilizer S to the rear of which is hinged the rear elevator 7.

The uprights 16 are supplemented by a forward brace 16′ reaching from skid 22 to arch 21 and abutted by the main element 19, and other uprights 16″ tie all longitudinal elements of each unit side-frame.

The arch member 10—10′ has the important function of reinforcing and strengthening the strut and skid frame adjacent to the front elevator and underlies and reinforces that portion of the side frame which supports the lower wing 4, and at its rear end reinforces and stiffens the skid frame at its normal point of land contact when at rest and when landing.

An important improvement in this frame structure resides in a "bowsprit" frame 17 of narrow, elliptical outline laid longitudinally and horizontally between the spread side-frames 1 and 2, and securely fastened to a number of transverse beams 18 which are attached at their ends to the spaced main limbs 19 and form cross-braces for the whole. This bowsprit frame forms a base for the nacelle or car C and forms, with the forward nose angles of the side-frames 1 and 2, a straight-line, three-point support for a transverse, elevator beam 25 which is secured in the angle of the frame limbs 21—22 and to the fore, axial end of the bowsprit frame.

The rear-end stabilizer S also has a three-point support on the axial, apex junction of the ridge elements 15 and the vertical fin-frames 24.

But a principal function of the novel bowsprit frame is to brace and stiffen the chassis as a whole against lateral displacement and mis-alignment. This single, arcuate-element frame displaces and takes the place of many cables, turnbuckles and other inefficient fittings used on outrigger frames; particularly on airplanes of commercially practicable size.

Pioneer airplanes of this general type carried their front elevator between outrigger frames on a shaft or axis situated about ⅓ chord-length back of the elevator's leading edge as shown in Fig. 7 at *a*, the theory being that all air pressure and reactions would center upon and along the line of the shaft as indicated by dotted arrow, thus relieving the pilot of undue muscular effort in operating said control-surface. As a matter of fact, however, reactions quite as frequently took effect on the area in front of the shaft as shown by full-line arrow, the result being that an uprising current of air would turn upward or increase the elevator's lifting angle and force the airplane as a whole into a "stall".

Conversely a downward gust of air would be just as likely to reverse the elevator angle and force the machine into a "nose-dive."

A feature of my present invention is in improving the elevator 6 by hinging its fore-edge to the leading cross-beam 25, whereby, it is seen, any upward gust of air can have no other effect than to raise the elevator surface rearward of the beam thus automatically forcing the elevator into an attitude that steers the airplane down or in opposition to the air gust. Conversely, any air gust from above automatically increases the elevator's angle and steers the airplane upward or in opposition to the gust.

Further, early fore-and-aft elevator airplanes employed conjunctively operated elevators but they were so connected as to be operated through equal arcs or angles above and below the horizontal. This conjunctive action of elevators in aircraft results in a very detrimental effect as is indicated in Fig. 9 wherein it is seen that from a neutral attitude *n* the action of the elevators moved through equal angles (oppositely) as 10° at *e* by inclining the angle of the machine proper thus reduces the rear elevator to zero angle while augmenting the angularity of the front elevator past its effective range or into a position where its drag preponderates over its lift. The inertia of the machine as a whole, opposing immediate obedience to—and deviation under the action of—the elevators, introduces an appreciable time-lag during which the machine continues to follow its immediately preceding line of flight and it is during this period that the rear elevator produces a minimum effect while the front elevator introduces more drag than lift, both control-surfaces thus combining to minimize the desired quick response to elevator control.

My remedy for this detrimental action of fore-and-aft controls is to couple said controls differentially; reducing the angularity of travel of the front elevator with relation to the rear elevator to such an extent that when the rear elevator reaches its attitude of zero-angle with relation to the line of flight *l*, Fig. 9, the front elevator shall not have reached its "burble-point" or angle where its "effective lift" becomes subordinate to its detrimental drag, whereby the front elevator shall continue to be a "continually effective" control element.

This improvement effects this differential operation by means of dissimilar lengths of elevator horns or levers as shown in Fig. 10 in which the levers 6′ of front elevator 6 are longer than the levers 7′ of rear elevator 7, whereby by suitable connection the front elevator will move through say but one-half of the angular travel of the rear elevator.

Early fore-and-aft control types also use their conjunctively operative elevators merely as directive or horizontal control surfaces; a dynamic function only. My present invention involves this function but also endows the surfaces with an entirely new function constituting a very material factor by making the front and rear elevator devices of equal weight—however much they may differ in area and in shape, whereby a condition of static balance is secured thereby minimizing muscular effort on the part of the aviator and materially increasing this efficiency of control of the elevator mechanism in flight.

Early design of fore-and-aft elevator airplanes were composed of outrigger frames all attached individually to the machine's wing structure which constituted the foundation of the entire assembly. Furthermore, these outrigger frames consisting of "longérons" and "struts" were placed perpendicularly to the horizon, serving the obvious purpose of "beams" and "spacers" alone and introducing direct parasitic resistance to propulsion. The present disclosure embodies the "unit-frame" system of frame or skeleton in such combination as to constitute the chassis or foundation of the whole design, entirely independent of the wing structure, and which is shown in the above mentioned patent, and includes a new and important improvement wherein the "side-frame" units 1 and 2 are inclined inward and upward from the skid line and have their ridge components lapped longitudinally into a rigid ridge beam 15. The spaced main longitudinals 19 of the side frames are rigidly secured by the horizontal cross beams 18 disposed well toward the skid plane and thus forming a triangularly trussed chassis, as shown in Fig. 3.

All of the component limbs of this A-frame chassis, instead of being stream-lined in section x, Fig. 11, are now cambered or given a "wing" cross section w, Fig. 12. This is for the purpose of giving a material lift resultant to the machine as well as the primary frame-forming function. In the larger types of machines the limbs may be so proportioned as to lift their own weight or even contribute to the surplus or pay-load lift of the machine.

It will be seen that as this type of machine is driven through the air every cambered strut limb of the frame and to a lesser degree, every arcuate longéron element of the chassis, will derive from the air a lift-reaction whose direction, normal to the plane of said elements, is shown by the dotted lines of Fig. 3, and the resultant of these lift reactions will be directly upward as shown by full-line arrow. Thus this triangular-truss chassis of cambered limbs may be carried to dimensions exceeding any other outrigger type whose framework does not contribute to the lift of the machine.

For comparison, Fig. 5 shows how a conventional interplane post strut P whose incidence wires are depended upon to maintain the proper flying-angle of the wings relative to the machine as a whole, is poorly adapted for such a purpose, particularly when any other than flying stresses are imposed on the post struts, under the best of normal flying conditions these incidence wires, however well they may be "tuned" and aligned at the beginning of a flight, will, and inevitably do—"give" under the influences of torsional stresses in the wings and the effect of heat, cold, vibrations, etc. These are just the normal defects of the wired interplane strut system on all airplanes today. Any attempt to further load such struts with a power plant and propeller would obviously greatly increase their inherent defects.

In contrast with the wire post strut of Fig. 5, I provide a window-frame strut 30 of the type shown in said patent, with which is combined a stream-lined shell 31 supporting the power plant and the driven propeller all set outboard from the car body as designed for multimotor, transport planes. The rigidity of the shell and unit frame strut structure constitutes a high factor of strength and safety in connecting the upper wing 3 to the lower wing 4.

Therefore, it will be seen, that I accomplish, generally, the improvement of aircraft and particularly all "outrigger" type airplanes whereby the framework of the machine is so fashioned as to constitute a "unit chassis" to unite, strengthen, and support all other elements and whereby the several frame limbs are given a lifting effect profile; and, further, improve the stability and control of balance in flight, and provide a plane which is superior in points of simplicity, strength, design and organization, positiveness of action, safety and general efficiency.

What is claimed is:

1. In an airplane, upwardly converged and ridge joined plural outrigger-frame of unit construction forming a chassis and designed to support on its fore end a front elevator surface, at its median portion carrying the main lifting wings and a car between the wings, and at its rear end having a stabilizer surface, a rear elevator surface and fin and rudder surfaces for directional control.

2. In an airplane, outrigger frames including two converged and ridge joined integral, side structures all limbs of which are permanently connected and whose longitudinal elements consist of arcuate parts forming triangular trusses within said frame and whose lowermost members form skids.

3. In an airplane, outrigger structure comprising right and left side, integral skeleton frames which incline inwardly and upwardly and join to form a ridge beam and whose lower spread sides are rigidly joined by transverse horizontal beams; thereby forming a triangular, trussed unit chassis whose lowermost, lateral longitudinals form land skids.

4. In an airplane, outrigger framework unit-chassis consisting of a system of flat skeleton frames set in A-form relation and whose limbs are of wing or lift camber-section.

5. In an airplane, outrigger framework forming an upright triangular truss which supports and interconnects all other elements of the airplane as a whole, and provides an A-form unitary chassis for ready attachment and detachment of its wings to and from the apex of the truss to facilitate storage in restricted space.

6. In an airplane, a unit-chassis having A-

shape cross-section and including horizontal, transverse tie-beams, and bowsprit frame laid on said beams and forming a transverse and longitudinal reinforcement for the chassis.

7. In an airplane, means for supporting front and rear control surfaces and including an elongated bowsprit frame in combination with widely spaced side-frame units which, at each end of the airplane, provide a three-point support for the respective surfaces.

8. In an airplane, an interplane frame-strut including upright and top and bottom members of rigid, permanent structure for determining fixed wing-incidence, and a power plant shell mounted for rigid support on the uprights of the frame-strut the uprights being relatively immovable.

9. In an airplane, a power plant including a streamline shell which is mounted in, and in the plane of and forms a rigid part of an interplane strut of rigid window frame structure free of incidence wires.

10. Upper and lower main wings, in an airplane, a streamline shell disposed therebetween and constituting a bearing for an enclosed power plant, and a wing-spacing strut along the vertical plane of the shell axis comprising a rigid frame carrying the shell; whereby the plant is supported without body stress.

11. In an airplane, rigid-body, skeleton side frames each including a ridge part and a curved part forming a skid, and a longitudinal base-beam, said side frames having their ridge parts fixed side by side and their skids widely spread, and cross-beams fixed to the said base-beams to form a bed for an interposed car.

12. In an airplane, rigid-body, skeleton side frames each including a ridge part and a curved skid part and a main longitudinal base-beam, said side frames having their ridge parts fixed side by side and their skids widely spread, and cross-beams fixed to the said base-beams to form a bed for an interposed car, and said frames having forearches connected at their tips by an elevator supporting beam.

13. In an airplane, rigid-body, skeleton side frames each including a ridge part and a curved skid part and a main longitudinal base-beam, said side frames having their ridge parts fixed side by side and their skids widely spread, and cross-beams fixed to the said base-beams to form a bed for an interposed car, and said frames having forearches connected at their tips by an elevator supporting beam, and a bowsprit frame laid on the cross-beams and fixed to said supporting beam.

14. In an airplane, divergent unit-structure side frames which are joined at their ridge beams and have each forwardly convergent forerig limbs, and an elevator beam fixed in the angle of the forerigs.

15. In an airplane, divergent unit-structure side frames which are joined at their ridge beams and have each forwardly convergent forerig limbs, and an elevator beam fixed in the angle of the forerigs, and an elevator hinged at its leading edge to the rear edge of said beam.

16. An airplane having downward divergent, unit-skeleton, side frames presenting elongated curved skids which form isolated supports for respective landing wheels and having top longitudinals which are lapped and joined.

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