July 15, 1952 P. H. SATRE 2,603,437

HIGHLY SWEPTBACK WING FOR FLYING MACHINES

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Fig. 1.

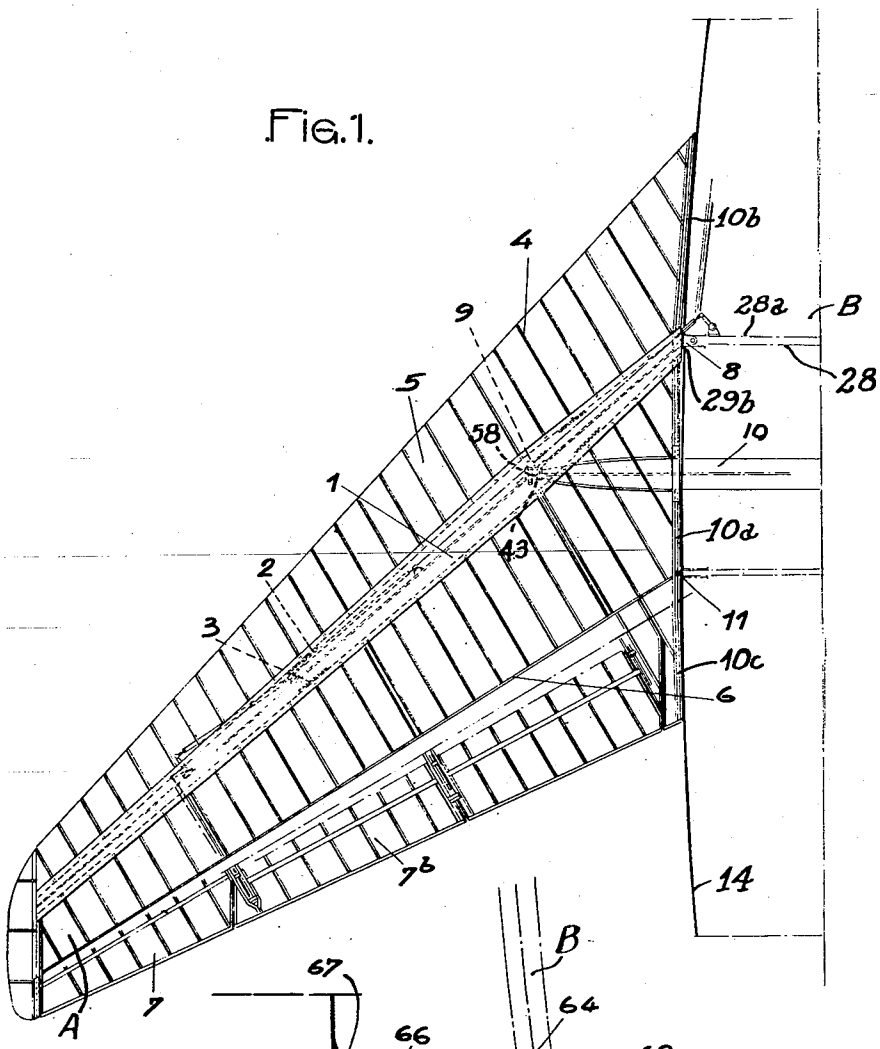
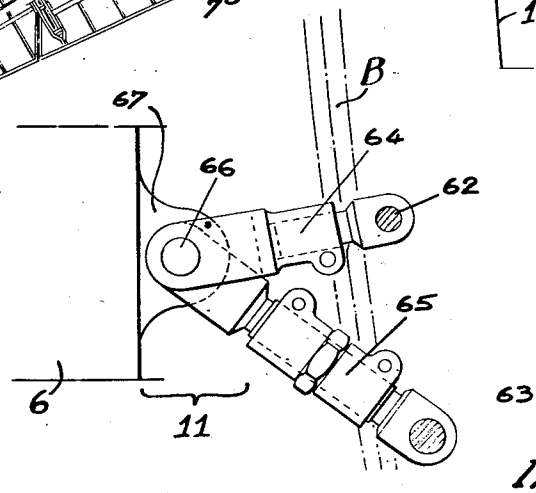


Fig. 4.



Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

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Fig. 2a.

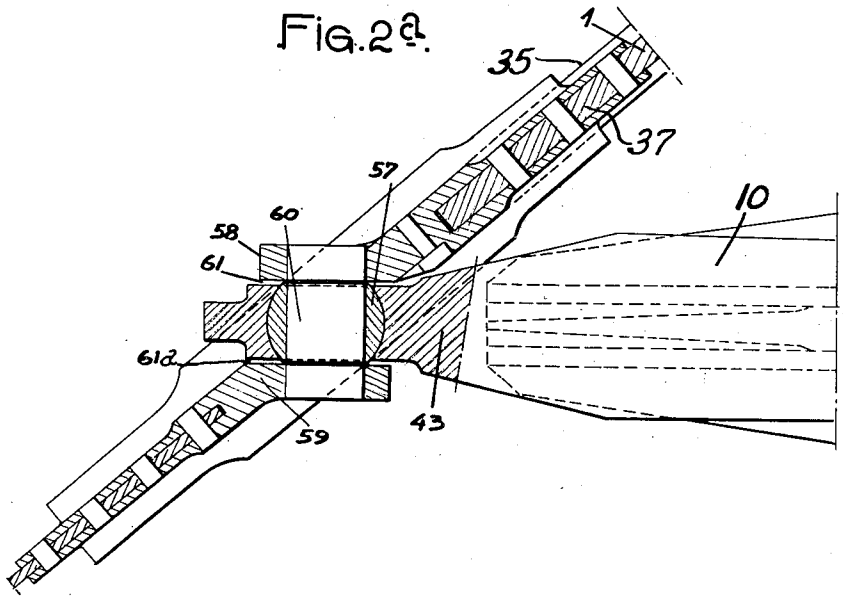
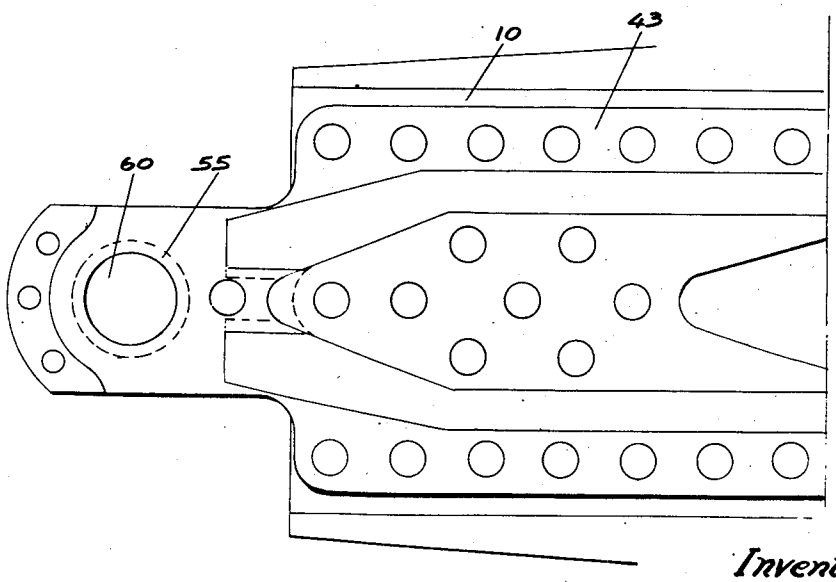


Fig. 2b.



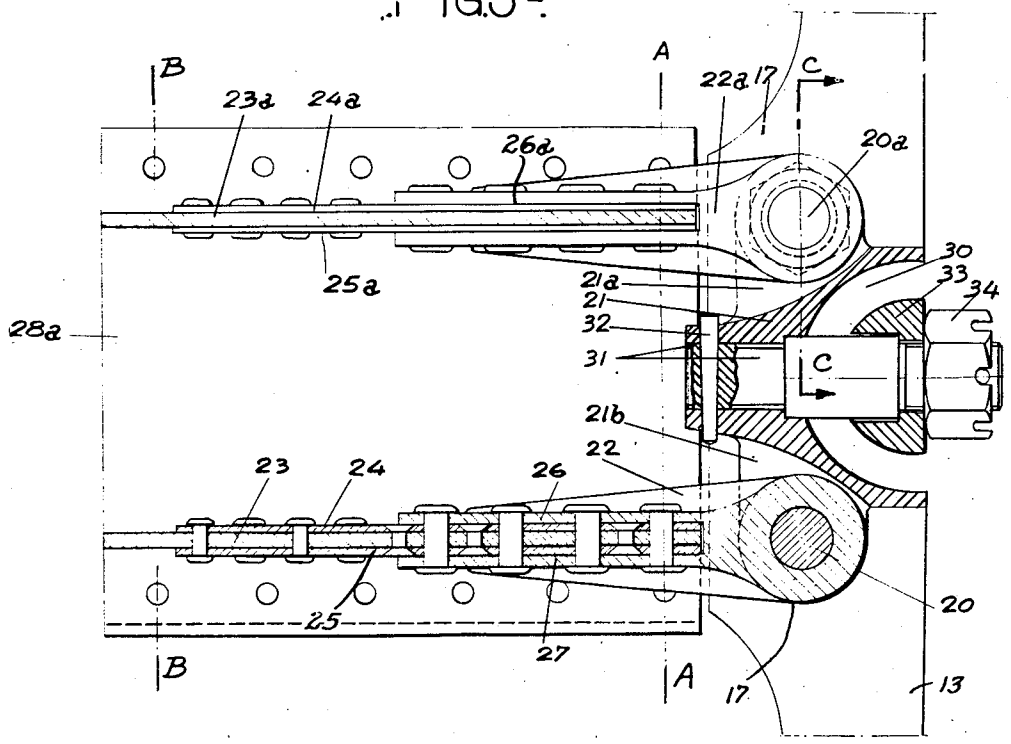
Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

July 15, 1952 P. H. SATRE 2,603,437

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Fig. 3a.



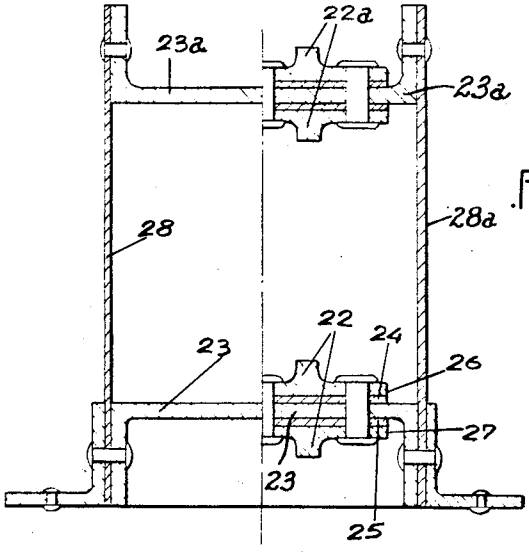


Fig. 3b.

Inventor
PIERRE HENRI SATRE
By Hasseltine, Lake & Co.
Agents

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Fig. 3c.

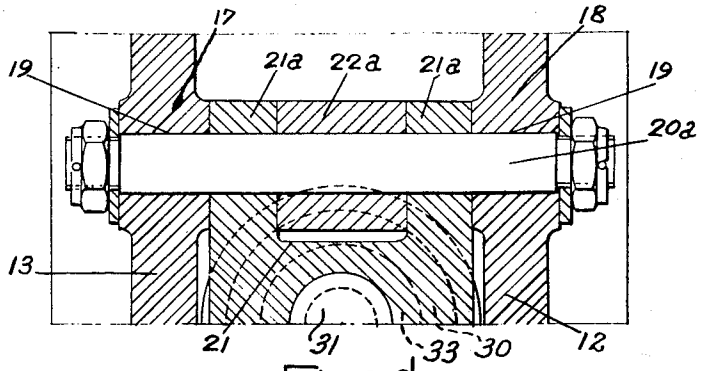


Fig. 3d.

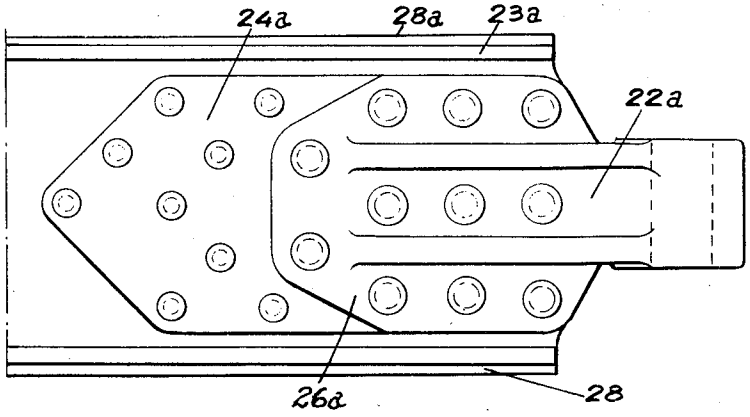
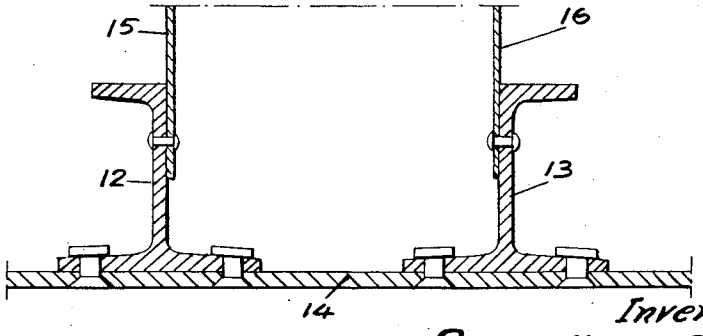


Fig. 3e.

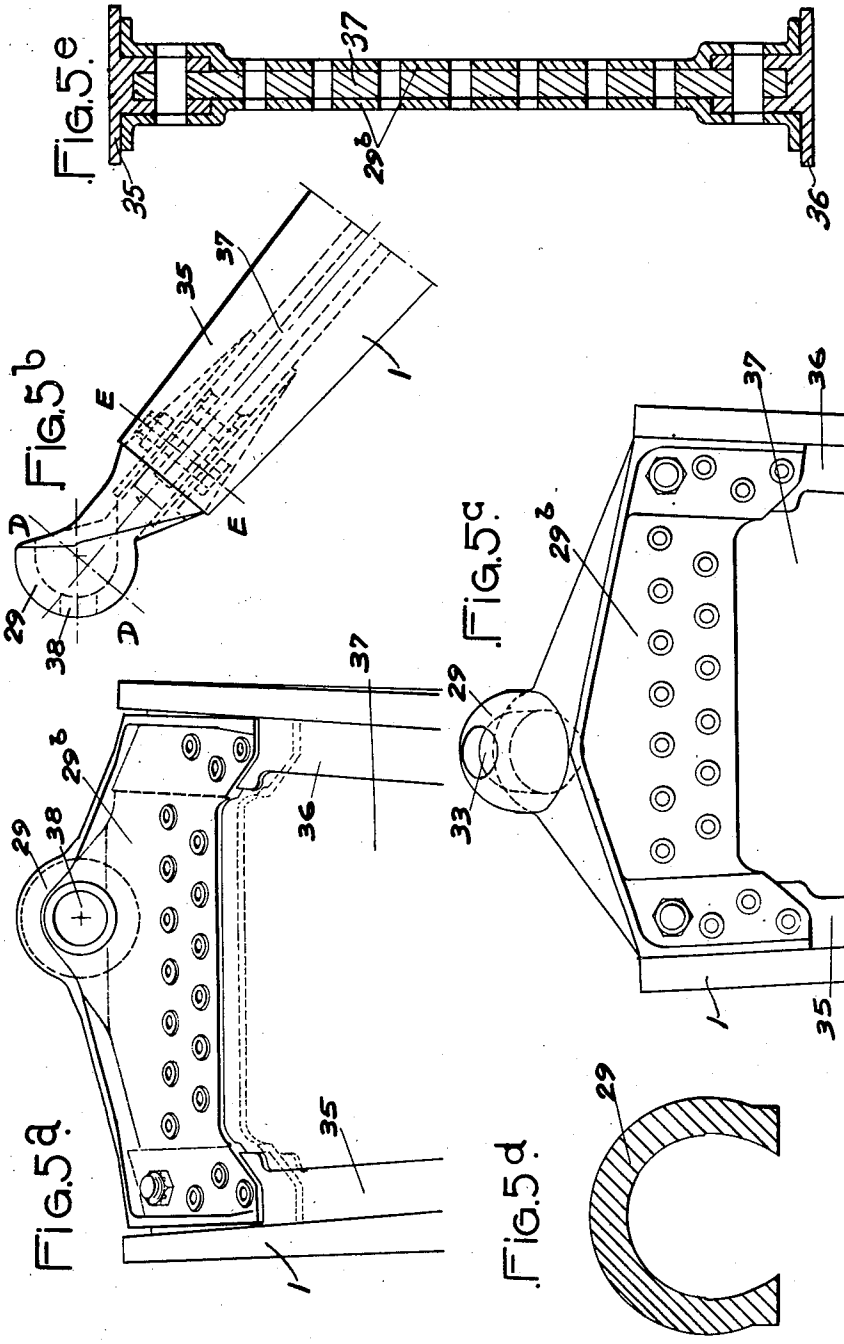


Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

July 15, 1952 P. H. SATRE 2,603,437

HIGHLY SWEPTBACK WING FOR FLYING MACHINES

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Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

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HIGHLY SWEPTBACK WING FOR FLYING MACHINES

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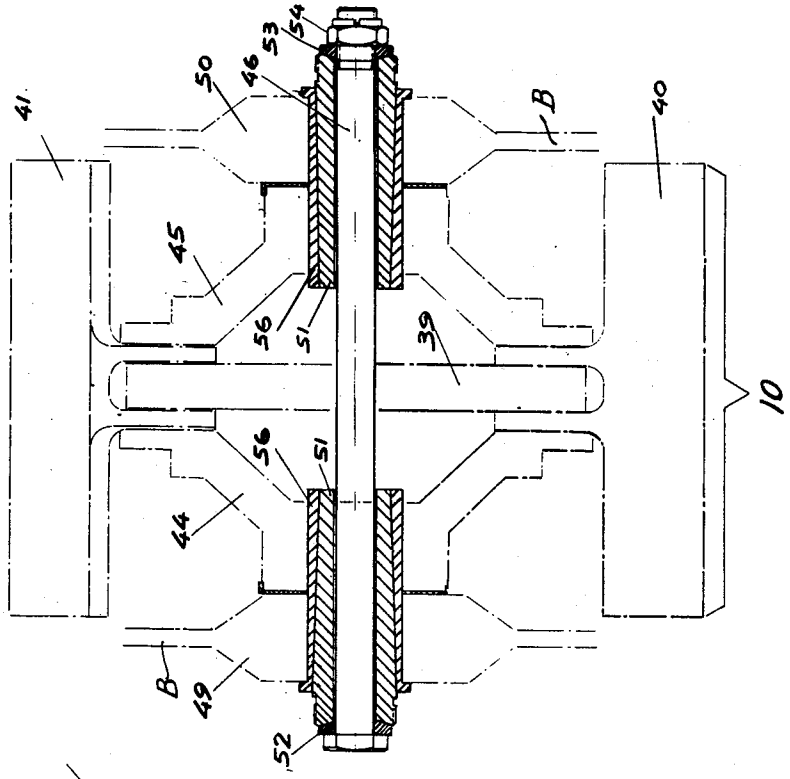


Fig. 7.

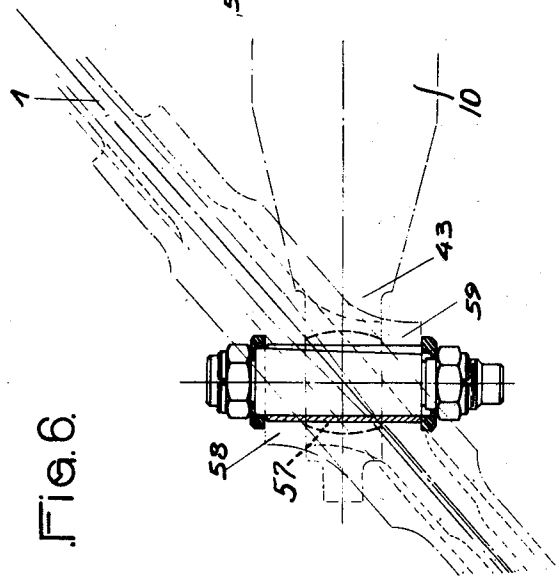


Fig. 6.

Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

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HIGHLY SWEPTBACK WING FOR FLYING MACHINES

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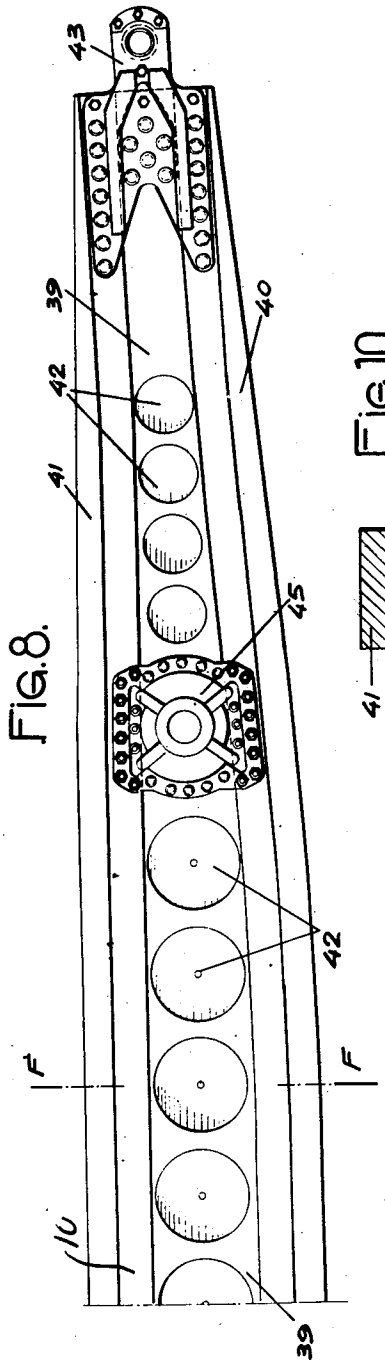


Fig.8.

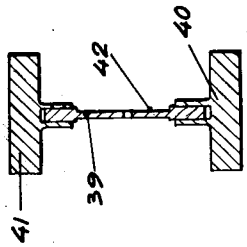


Fig.10.

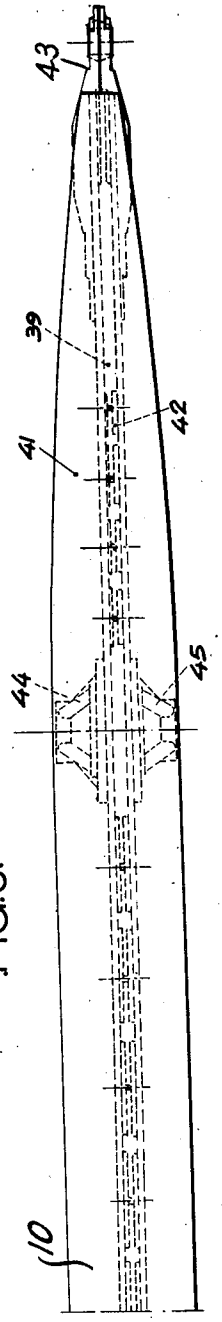


Fig.9.

Inventor
PIERRE HENRI SATRE
By Haseltine, Lake & Co.
Agents

Patented July 15, 1952 2,603,437

UNITED STATES PATENT OFFICE

2,603,437

HIGHLY SWEPTBACK WING FOR FLYING MACHINES

Pierre Henri Satre, Toulouse, France, assignor to Societe Anonyme called: Societe Nationale de Constructions Aeronautiques du Sud-Est

Application December 2, 1947, Serial No. 789,151
In France April 23, 1947

8 Claims. (Cl. 244—117)

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The present invention relates to back swept wings, i. e. wings which have a very pronounced V shape as seen in plan. Such wings are used to particular advantage in fast aircraft, in particular aircraft the speed of which approaches or exceeds that of sound. Such wings are very heavily loaded, so they have to withstand very considerable forces and their construction sets problems the difficulty of which is well known. The present invention provides a particularly advantageous solution of those problems inasmuch as it provides a simple and lightweight construction of such wings. It is moreover applicable to any sweptback surface having a shape similar to wings such as the fins, empennages or like members.

It is well known that a cantilever wing can be constructed either by forming the entire wing assembly as an integral whole which is subsequently assembled with the fuselage, or alternatively forming the wing in two overhanging parts, each of which is then secured to the fuselage. In the case of a backswept wing structure, it is somewhat difficult to obtain a simple and lightweight construction through the use of the first one of the above mentioned methods because of the crooked line formed by resisting elements of the wing comprising box-spars or spars.

The method involving two half wings is consequently advantageously applied to backswept wing forming the subject matter of the present invention.

In such conditions, the wing forming the subject matter of the present invention is comprised of a pair of half wings each of which essentially includes a main spar obliquely directed with respect to the axis of the fuselage and secured to the fuselage through a deformable connection, said half wings being furthermore deformably connected with a strong transverse beam rigidly secured to the fuselage and attached at its ends to the main spar of each of said half wings at a point intermediate of its length.

Further advantageous features of the sweptback wing forming the subject matter of this invention will appear from the ensuing disclosure made in reference with the accompanying drawings given by way of example and not of limitation and showing one embodiment of said wing.

Figure 1 is a plan view of one of the half wings.

Figure 2*a* is a horizontal cross-section through the attachment of the main wing spar with the transverse beam.

Figure 2*b* is an elevational view, to a larger scale, of the fittings for assembling the transverse beam with the main wing spar.

Figure 3*a* shows, partly in section, in a plane perpendicular to the longitudinal axis of the

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fuselage, the various parts of the attachment of the main spar with the fuselage which are secured to said fuselage.

Figure 3*b* is a cross-section, on line A—A on the right hand side and on line B—B' on the left hand side of the drawing of Fig. 3*a*.

Figure 3*c* is a cross-section on line C—C of Fig. 3*a*.

Figure 3*d* is a plan view corresponding to Fig. 3*a*.

Figure 3*e* is a cross-section at any intermediate point of the fuselage ring-frame supporting the attachment of the main spar with the fuselage.

Figure 4 shows the attachment of the false spar with the fuselage.

Figure 5*a* is a view of the fitting for assembling the main wing-spar with the fuselage.

Figure 5*b* is a side view of said fitting.

Figure 5*c* is a plan view of said fitting.

Figure 5*d* is a section through the ball-socket for said fitting on line D—D of Fig. 5*b*.

Figure 5*e* is a section, on line E—E of Fig. 5*b*, of said fitting.

Figure 6 shows the pin for assembling the transverse beam with the oblique or main wing spar.

Figure 7 shows the assembly of the transverse beam with the fuselage.

Figure 8 is half an elevational view of the transverse beam.

Figure 9 is a plan view corresponding to Fig. 8.

Figure 10 is a transverse cross-section of the transverse beam at any intermediate point of its length, except at the points of attachment of said beam with other elements of the aircraft, and for example at F—F' of Fig. 8.

The sweptback wing A forming the object of this invention comprises two overhanging elements symmetrically secured on each side of the fuselage B. Said wing is one of the so-called single-spar type, including a main spar 1 extending in the area of maximum thickness of the wing contour and forming owing to the general sweepback of the wing, a suitable angle with the normal to the axis of the aircraft. Shear stresses are transmitted to said spar through the foremost and rearmost parts of the wing which are connected in a known manner with the spar 1 through two banks of hinges 2 and 3 connected to the lower and upper wing surfaces. The foremost and rearmost parts of the wing are formed in a well known manner by box elements comprising a skin 5 supported by ribs 4. They form box elements adapted to be stressed torsionally. The rearmost part may comprise rearwardly a false spar 6, and carries ailerons 7 and hypersustentation devices 7*b*. The transverse beam 10 receiving a shearing stress from the main spar at 9 makes it possible to attach the latter by a pair of supports only.

The combination including the assembly of said main spar and said transverse beam offers the following advantages:

(*a*) It reduces the maximum bending moment for which the main spar is to be designed and consequently reduces the section of the section material forming the booms;

(*b*) It avoids the necessity of providing intricate connection devices for connecting together the booms of a spar and a beam when said spar must transmit big bending moments, since according to the invention the stresses applied to the connection are shearing stresses only.

(*c*) It enables the provision of straight spars and beams.

The torsional stresses are transmitted to the fuselage through a marginal rib **10***a* comprising a front part **10***b* and a rear part **10***c* respectively lining the foremost and rearmost box elements of the wing while respectively secured to the front and rear faces of the main spar **1**. A transverse beam **10**, the function of which will be disclosed hereafter, passes through said marginal rib **10***a* which is secured to the fuselage at the passage of said transverse beam and by means of the fittings of said main spar at **8** and of said false spar at **11** for securing the same on the fuselage.

The manner in which the wing may be built which has up to this point been described in a general manner is now about to be described in its details.

The fitting **8** serving as an attachment of the main oblique spar **1** of the wing in overhanging condition is secured to a particularly strong ring-frame of the fuselage. Said ring-frame (see in particular Fig. 3*e*) is formed by two thick sections **12** and **13** riveted to the skin sheathing **14** and on which are riveted two flat sheets **15** and **16** forming the core of the ring frame and completing the box structure formed by the ring-frame. The webs of the sections **12** and **13** carry two reinforced portions **17** and **18** each formed with two holes **19**. Two pins **20** and **20***a* mounted in said holes are adapted to rigidly assemble the part **21** the purpose of which will be described hereinafter, and both fittings **22** and **22***a*, with the ring-frame.

The fitting **22** illustrated in plan in Fig. 3*b*, and which is identical with the fitting **22***a* is essentially an attachment fitting riveted about the web of the spacer **23** illustrated in cross-section in Fig. 3*b*. In Fig. 3*a* there is shown at the bottom of said figure a longitudinal cross-section of the fitting **22** and its mode of attachment to the part **23**. The part **23** is reinforced by two plates **24** and **25** riveted thereto. It is to the assembly formed by the part **23** and both plates **24** and **25** that the flanges **26** and **27** of the fitting **22** are secured. The spacers **23** and **23***a* which are U-shaped co-operate with two flat plates **28** and **28***a* to form a box structure extruding transversely of the fuselage providing for the rigidity of said fuselage in a transverse direction.

The part **21** secured by means of four lugs **21***a* and **21***b* to the pins **20** and **20***a* acts to transmit thereto the stresses it receives from the main spar through the ball and socket joint shown in Figs. **5***a* to **5***d*. To that end it comprises a hemispherical socket recess **30** formed in its center. A threaded pin **31** is engaged centrally of said hemispherical recess and is locked through a tapered cotter pin **32**. It carries a half ball-element **33** concentric with the hemispherical socket and adapted to be locked through a lockable nut **34**.

The portion of the attachment structure **8** which is rigid with the oblique spar is shown in detail in Figs. **5***a* to **5***e*. It comprises a single fitting **29***b* terminated by a socket **29** and secured on the other hand to the ribs **35** and **36** of the main spar **1** and the web **37** thereof (Figs. 1 and **5***a*–**5***d*). The sections shown in Figs. **5***d* and **5***e* show the contour of the fitting **29***b* firstly through the socket **29** and secondly in the portion of said fitting which is secured to the web **37** and the ribs **35** and **36** of the oblique main spar **1**. Between both those sections, the cross-section of the fitting is varied gradually.

The ball element **29** contains an hemispherical recess designed to receive the half ball element **33**. It is also formed with a bore **38** through which the pin **31** is adapted to extend. Between the bore **38** and the pin **31**, there is provided a clearance to enable the part **29***b* to pivot slightly with respect to the part **21**. Fixation of the fitting **29***b* to the main spar **1** is secured through rivets and bolts provided with lock nuts.

The transverse beam **10** includes a web **39** (see Figs. 7 to 10) and two booms **40** and **41**. The web is lightened by circular recesses **42**. The beam **10** carries at its ends two fittings **43** adapted to insure its connection with the main spar **1**. At the points where it extends through the fuselage, said beam is connected with the latter by an assembly including two connecting fittings **44** and **45**.

The junction of the transverse beam **10** with the fuselage is shown in Fig. 7. Both fittings **44** and **45** secured on either side of the web **39**, are rigidly connected through expansible pins **51** with press-formed parts **49** and **50** secured to the fuselage B. Said parts are adapted to bridge two longerons of the fuselage and make it possible to restrict to a certain extent the resistance with which it is necessary to provide the ring-frame at that point. They serve as a reinforcement for said ring-frame between said two longerons and at the same time as working points for the stresses transmitted from the wing. The two expansible pins **51** are each surrounded with a slotted sleeve **56**, the inner surface of which is formed with a taper complementary to that of the parts **51**. A bolt **46** provides for clamping the assembly through the medium of dome-shaped washers **52** and **53**. The diameter of the bolt **46** is smaller than the inner diameter of the pins **51**, so as to maintain a certain amount of clearance. Clamping of the bolt is provided for by the lock nut **54**. The whole assembly is designed to provide for easy mounting or removal of the pins even if there is misalignment in the axes of the bores.

The fitting **43** terminating the transverse beam **10** at each end thereof is made of steel. It is shown in detail in Figs. **2***a* and **2***b*. Said fitting, which is adapted to concentrate the stresses in a single point, is secured through bolts and rivets to the web and to both booms of the beam **10** and terminates in a ball-socket **55**. The ball **57** adapted to engage the socket **55** is formed with a bore **60** adapted to serve as a housing for an expansible pin shown in detail in Fig. 6. Said pin may be of any known type, its purpose being to facilitate mounting and dismantling of the assembly. It provides for assembly of the fitting **43** with both fittings **58** and **59** carried by the main oblique spar **1** and secured on either side of its web to the web and to the booms thereof, as shown more particularly in Fig. **2***a*.

It will be seen in Fig. **2***a*, at **61** and **61***a* that lateral clearance is provided between the fitting

43 and both fittings 58 and 59. Such clearance makes it possible, in co-operation with the ball 57, to compensate, on the one hand, for any errors effected in positioning the device and, on the other hand, any slight errors in angular direction which may result during construction, and thereby to ensure that the members of the aircraft are interchangeable. Another function of said clearance is to avoid the transverse beam being submitted to lateral bending stresses under the action of drag.

Also for the purpose of ensuring interchangeability of the elements of the aircraft, there is provided for attachment with the fuselage of the false spar, when such is provided, a fitting adapted to compensate the quite large errors or differences in position and direction of the elements of the aircraft.

Indeed, the fixed point of assembly of the wing with the fuselage including the ball members of the connection 8, the larger errors involve the position which the parts assume at the point 11. Such an arrangement is desirable because such an assembly should be provided at a point where there are not great stresses to be transmitted since otherwise the fitting required at that point would have to be unduly heavy. Such is precisely the case of the false spar which transmits at 11 stresses considerably lower than those transmitted at 8 by the main spar. The fitting formed at 11 is an adjustable fitting. It bears on two pins 62 and 63 rigid with the fuselage B. Two connecting links adjustable in length 64 and 65 are pivoted with respect to each other on a single pin 66 and are pivoted by means of a ball-and-socket joint not shown, with respect to the fitting 67 terminating the false spar 6. Adjustment in length of the links 64 and 65 is provided for by means of a system including oppositely threaded sleeves. Adjustment thereof is adapted to modify the positions of the pin 66 in the plane containing said links. To avoid misadjustment of the links in service, means may be provided for locking said sleeves. The links 64 and 65 are moreover articulated with the pins 62 and 63 by means of yokes including ball and socket joints whereby said links may execute movements outside of their theoretical plane of mounting. Those arrangements make it possible to meet errors in longitudinal alignment, and correspond with the clearance 61 provided in the fitting of the main spar with the transverse beam to ensure in all cases that the wings and fuselages are interchangeable.

It will of course be understood that the construction described above in detail may, without exceeding the scope of the present invention, be subjected to modifications of detail in accordance with the particular structures to be built. Thus, for supersonic aircraft having a very high angle of sweepback the transverse beam will be located more rearwardly than in the embodiment described above, and said transverse beam may be made to bear upon the oblique main spar at a point correspondingly more remote from its connection with the fuselage.

The described construction is capable of perfectly general application which in particular may be extended to all backswept wing structures, including empennages and fins of flying machines of any type, such as aeroplanes, rockets, guided projectiles, regardless of the method of propulsion or launching used.

What I claim as my invention and desire to secure by Letters Patent is:

1. In a sweptback wing construction for an aerodyne having a fuselage, a transverse beam rigidly secured on the fuselage and equally projecting from each side thereof, and two single spar sweptback wings, each of said wings comprising a main spar rearwardly inclined from its inboard to its outboard ends with respect to said fuselage, said main spar being articulated at its inner end on a point of said fuselage located in the front of said transverse beam and articulated on the corresponding end of said transverse beam, said main spar being located in the area of maximum thickness of the wing contour, front and rear box elements comprising ribs secured on said main spar and a skin supported by said ribs, and a marginal rib flanging the ends of said box elements which are adjacent to the fuselage, said marginal rib being secured on said fuselage at a plurality of points.

2. A sweptback wing construction, according to claim 1, further comprising, for each wing, a false spar substantially parallel to the main spar, said false spar being disposed at the rear of the transverse beam and articulated on the fuselage at its inner end, rear box elements comprising ribs pivotally mounted at the rear of said false spar and a skin supported by said ribs.

3. A sweptback wing construction, according to claim 1, further comprising, for each wing, a false spar substantially parallel to the main spar and disposed at the rear of the transverse beam, an adjustable fitting connecting the fuselage at the rear of said transverse beam and the inner end of said false spar, means for adjusting said fitting for correcting errors in alignment of said false spar, and rear box elements comprising ribs pivotally mounted at the rear of said false spar and a skin supported by said ribs, the adjustable fittings respectively corresponding to both false spars of the aerodyne being symmetrically mounted on the fuselage with respect to the longitudinal axis thereof.

4. A sweptback wing construction, according to claim 3, wherein each adjustable fitting and the corresponding adjusting means comprise a pin, a ball and socket joint articulating said pin at the inner end of the corresponding false spar, two links adjustable in length, one end of each of said links being articulated on said pin, two pins secured on the fuselage, two yokes respectively mounted at the other ends of said links and articulated respectively on said pins through ball and socket joints, means for adjusting the lengths of said links, and means for locking said length adjusting means.

5. In a sweptback wing construction for an aerodyne having a fuselage, a transverse beam rigidly secured on the fuselage and equally projecting from each side thereof, and two single spar sweptback wings, each of said wings comprising a main spar rearwardly inclined from its inboard to its outboard ends with respect to said fuselage, said main spar being located in the area of maximum thickness of the wing contour, front and rear box elements comprising ribs secured on said main spar and a skin supported by said ribs, and a marginal rib flanging the ends of said box elements which are adjacent to the fuselage, said marginal rib being secured on said fuselage at a plurality of points, a first pair of mountings each of which comprises a ball and socket joint, the ball elements of said two joints being respectively connected with said fuselage at locations in front of said transverse beam symmetrically with respect to the longitudinal axis of the aerodyne while the socket elements

thereof are respectively connected with the inner ends of the main spars, whereby said main spars may pivot respectively around the centers of said ball elements, and a second pair of mountings each of which comprises a ball and socket joint, the socket elements of said second pair of mountings being respectively carried by the ends of said transverse beam, while the ball elements thereof are respectively connected with intermediary points of the main spars for allowing small relative movements of said main spars with respect to said beam.

6. A sweptback wing construction, according to claim 5, wherein the supports for the ball elements of the first pair of mountings comprise a common reinforced box spar forming a ring-frame for the fuselage and comprising on each side of said fuselage an inner yoke having two flanges which are formed with two pairs of holes longitudinally aligned two by two, a second common reinforced box spar located between said yokes to stiffen said fuselage in the transverse direction, said second reinforced box spar having on each of its ends facing said yokes two superposed fittings located between the flanges of the corresponding yoke, each of said fittings being formed with a hole registering with a pair of longitudinally aligned holes of said corresponding yoke, and, for each of said first pair of mountings, a part formed with a central hemispherical recess and having a tapped bore centrally opening in said recess and four lugs forming two forks respectively located between the flanges of the corresponding yoke and respectively straddling the two superposed fittings located on the corresponding end of said second box spar, said lugs being formed with holes longitudinally aligned two by two with the pairs of longitudinally aligned holes of the corresponding yoke, two pivots each extending through the holes of the corresponding fittings and the pairs of longitudinally aligned holes of said lugs and of the corresponding yoke for securing together said yoke, fittings and part on the corresponding side of the fuselage; and wherein each socket element fixed to the inner end of the corresponding main spar is formed with a bore and a spherical recess, a pin traversing with a small clearance the bore of said socket element and formed with a thread end for engaging in the tapped bore of said part, a hemispherical ring mounted on said pin in the spherical recess of said socket element, and means for securing said hemispherical ring on said pin.

7. A sweptback wing construction, according to claim 5, wherein each socket of the second pair of mountings is longitudinally limited by two transverse plane surfaces and is formed with a spherical recess opening at said surfaces, two bent fittings mounted on the corresponding main spar in order to present two transverse faces parallel to said transverse plane surfaces, each one of said bent fittings being formed with a hole normal to the related face thereof, a ball element mounted in this spherical recess and formed with a bore of the same diameter as said holes, and an expansible pin passing through said bore and said holes for securing together said fittings and said ball element, the longitudinal distances existing between said two transverse parallel faces being greater than the longitudinal thickness of said socket, whereby any error resulting from the construction of the main spar or the transverse beam as well as from their relative positioning when mounting may be corrected, and wherein the means for securing the transverse beam on the fuselage comprises four fittings fixed by pairs on either side of the transverse beam, said paired fittings being located adjacent the sides of the fuselage, two parts respectively fixed on said fuselage adjacent the sides of the latter and respectively bearing against said paired fittings on said transverse beam, said parts and fittings being all formed with aligned holes of the same diameter, two internally conical slotted sleeves formed with heads and adapted to be respectively arranged in the aligned holes of the adjacent parts and fittings, said heads respectively abutting against the outer surface of said parts, two hollow expansible pins respectively arranged in said rings, said expansible pins having outer surfaces formed with tapers complementary to those of said sleeves, a connecting pin the diameter of which is less than those of the bores of said hollow expansible pins for securing the latter opposite to each other, and means for securing said pin by pressing on said hollow expansible pins.

8. In a sweptback wing construction for an aerodyne having a fuselage, a transverse beam rigidly secured on said fuselage and equally projecting from each side thereof, a box element comprising a pair of pieces laterally secured on said fuselage in front of said transverse beam and a transverse spacer connecting said two pieces for withstanding the drag strains, two single spar sweptback wings, each of said wings comprising a main spar inclined with respect to said fuselage, said main spar being located in the area of maximum thickness of the wing contour, front and rear box elements comprising ribs secured to said main spar and a skin supported by said ribs, and a marginal rib flanging the ends of said box elements which are adjacent to the fuselage, said marginal rib being secured to said fuselage at a plurality of points, a first pair of mountings each of which comprises a ball and socket joint, the ball elements of said first pair of mountings being respectively connected with said pieces while the socket elements thereof are respectively connected with the inner ends of the main spar, whereby said main spars may respectively pivot around the centers of said ball elements, and a second pair of mountings each of which comprises a ball and socket joint, the socket elements of said second pair of mountings being respectively carried by the ends of said transverse beam while the ball elements thereof are respectively connected with intermediary points of the main spars for allowing small relative movements of said main spars with respect to said beam.

PIERRE HENRI SATRE.

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