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EXTENDIBLE SLOTTED DEFLECTOR FLAP

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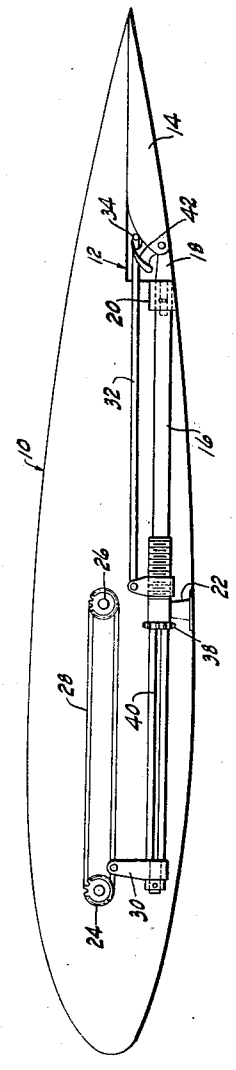


Fig. 1

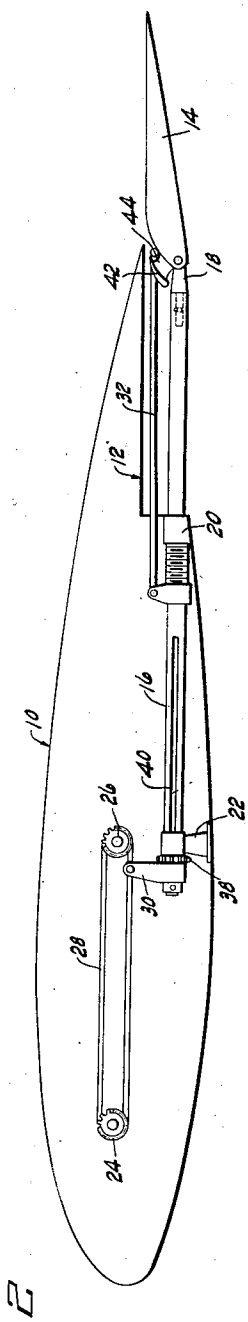


Fig. 2

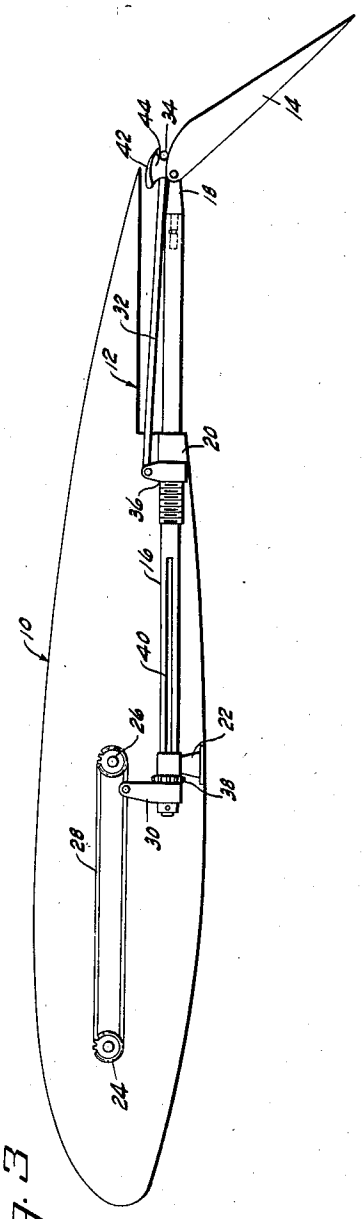


Fig. 3

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EXTENDIBLE SLOTTED DEFLECTOR FLAP

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9 Claims. (Cl. 244—42)

This invention relates to improvements in lift increasing devices for airplane wings and has particular reference to an improved arrangement of a lift increasing flap.

An object of the invention resides in the provision of an improved lift increasing device.

A further object resides in the provision of a lift increasing flap provided with means for causing an air stream to follow the upper surface of said flap.

Other objects and advantages will be more particularly pointed out hereinafter or will become apparent as the description proceeds.

In the accompanying drawing in which like reference numerals are used to designate similar parts throughout, there is illustrated, somewhat schematically, a suitable exemplification of what is now considered to be the preferred form of the idea of the invention. The drawing, however, is for the purpose of illustration only and is not to be taken as limiting the invention, the scope of which is to be measured entirely by the scope of the appended claims.

In the drawing:

Fig. 1 is a schematic sectional view of an airplane wing provided with a lift increasing device, showing the lift increasing device in a position in which it is retracted within the airfoil contour of the wing.

Fig. 2 is a view similar to Fig. 1 showing the lift increasing device in a projected position.

Fig. 3 is a view similar to Fig. 1, showing the flap in its extended and tilted position.

Referring to the drawing in detail, the numeral 10 generally indicates an airplane wing constructed according to some design well-known to the art. The wing may have a suitable reinforcing and supporting frame work which may include longitudinal spar members, transverse rib members secured to the spar members and other conventional or necessary elements, and a cover secured to the rib members.

A suitable recess, generally indicated at 12, is provided in the rearward portion of the under-surface of the wing to receive a lift increasing flap 14. The flap 14 may extend for any desired portion of the wing span length, but preferably extends for a major portion thereof, in order that the maximum lift increasing effect may be obtained.

From an inspection of the drawing, it will be observed that the flap 14 is movable from a retracted position in which it is received in the recess 12 to an extended position in which it is disposed rearwardly of the wing, and that, when in its extended position, it is tiltable downwardly.

The flap 14 may be moved from one to the other of its two limiting positions, as illustrated in Figs. 1 and 2, by any suitable mechanism, several forms of which are well-known. One form of such operating mechanism has been illustrated by way of example in the accompanying drawing.

In the flap operating mechanism illustrated, a plurality of rodlike flap supporting members, as indicated at 16 are pivotally connected at their rearward ends to the forward portion of the flap by suitable load transmitting connections, as indicated at 18, arranged to permit rotation of the rod-like members 16 with respect to the flap. The rods 16 extend into the interior of the wing 10 and are supported within the wing by suitable means, such as the bearings 20 and 22 mounted upon fixed portions of the wing frame structure. The rods 16 may be disposed at any suitable or desired angle with respect to the wing but are preferably disposed substantially parallel to the longitudinal axis of the wing in order that the flap 14 may be brought to its rearwardly extended position by a straight axial movement of the rods.

The rod members 16 are moved by any suitable form of mechanism, this mechanism, in the example illustrated, taking the form of a pair of sprocket members 24 and 26 carrying an endless chain 28, a chain and a pair of chain carrying sprockets being preferably provided for each of the rod-like members 16. Suitable means are provided for rotating one of the shafts upon which the sprockets are mounted in order to impart movement to the chain 28. The inner end of each rod member 16 is connected to the respective chain 28 by a suitable pivotal connection as indicated at 30.

From this description, it will be observed that when one of the sprocket carrying shafts is rotated, the chain 28 will be moved and will in turn impart axial movement to the respective rod member 16. Axial movement of the rods 16 from front to rear of the supporting wing will move the lift increasing flap 14 rearwardly to its lift increasing position while movement of the rods 16 in a direction from the rear towards the front of the supporting wing will move the flap 14 from its lift increasing position to its retracted position within the recess 12.

The flap 14 may be tilted by some suitable mechanism, such as the link members, one of which is indicated at 32. Each of the link members 32 is connected at its rearward end to the

forward portion of the flap 14 by a connection 34 spaced from the connection 18. The forward portion of each link 32 passes into the interior of the wing and is pivotally connected at its forward end to a movable abutment 36 screw threaded onto the intermediate portion of the respective rod member 16 in such a manner that rotation of the rod-like members will cause movement of the respective abutments 36 relative to the rod members in an axial direction to impart flap tilting movements to the links 32. The rod members 16 may be rotated by any suitable mechanism, such as the sprockets 38 slidably but non-rotatably connected with the rods by suitable means such as the splines 40. While, in the schematic illustration of the device shown, the sprockets 38 are independent of the chain 28 and sprockets 24 and 26 so that tilting of the flap is brought about independently of the extending and retracting movements of the flap, it is obvious that, if desired, the drives for the flap extending and retracting elements and for the flap tilting elements could, if desired, be combined so that the flap would be automatically tilted as it is moved to its extended position, and also, that suitable means could be provided for selectively combining or separating the flap extending and flap tilting drives so that the flap could be tilted either coincidentally with or independently of the extending movements of the flap at the will of the operator of the airplane. It is also apparent that, by rotating the members 16, the flap may be tilted to any desired angle of inclination with respect to the wing, regardless of the position of the flap with respect to the length of the recess 12.

While a suitable flap operating mechanism has been illustrated by way of example, it is to be understood that the invention is not limited to the particular mechanism so illustrated and described but that various other mechanisms may be utilized for moving the flap between its extended and retracted positions.

A deflector plate 42 is mounted upon the upper forward portion of the flap 14 in such a position as to provide an airflow slot 44 between the inner surface of the plate and the forward upper portion of the flap. This airflow slot is preferably tapered from front to rear, that is, the rearward portion of the deflector plate is disposed closer to the adjacent surface of the flap than is the forward portion to provide a slot having a desirable confinement ratio from front to rear. The movement of the flap 14 is so determined that the deflector plate 42 divides the space between the forward portion or leading edge of the flap and the adjacent portion or trailing edge of the wing when the flap is in its extended lift increasing position, illustrated in Fig. 2.

One purpose of the deflector plate 42 is to improve the airflow about the rearward portion of the wing and about the flap when the flap is in its extended position. When the wing 10 is set at an angle of attack with respect to the direction of the airflow, there is some tendency for the air to break away from the rearward portion of the upper surface of the wing and when the flap is positioned behind and below the trailing edge of the wing and inclined at an angle of incidence with respect to the wing, there is a strong tendency for the air to break entirely away from the upper surface of the flap and thereby cause the flap to lose its lift. The opening of an airflow space between the leading edge of the flap and the trailing edge of the wing, when the flap is in its extended position, has some corrective effect on the tendency of the airflow to break away from the upper surface of the flap, particularly at relatively small flap angles with respect to the wing. The deflector plate 42 collects a considerable portion of the air which flows at high velocity through the space between the leading edge of the flap and the trailing edge of the wing from the lower to the upper surface of the wing and constrains such air to flow substantially tangential to the upper surface of the flap.

A portion of the air flowing through the space between the leading edge of the flap and the trailing edge of the wing flows at high velocity between the deflector plate and the wing into the region of increasing pressure at the rear of the wing. This jet of air is so directed and has such a velocity that it tends to decrease the pressure gradient in the rear of the wing and delay or prevent the breaking away of airflow from the rearward portion of the upper surface of the wing, thereby maintaining an improved condition of main wing lift in addition to the high lift effect added by the flap 14 and deflector plate 42.

The air flowing through space between the flap and the wing from the high air pressure region below the wing to the region of relatively low air pressure above the wing, which does not flow between the deflector plate and the wing enters the nozzle like slot between the deflector plate 42 and the adjacent surface of the forward portion of the flap. The flap is so positioned when in its extended position that the deflector plate is always within the chordwise extent of the recess 12 and all the air flowing through the space between the wing and the flap is constrained to flow through the slot between the deflector plate and the flap or the secondary slot between the deflector plate and the adjacent rearward portion of the main wing. Both of these slots have favorable aerodynamic characteristics and normally rearwardly directed outlets and none of the air flowing through the slot is permitted to escape except through the exit gaps provided for that purpose.

For a somewhat more detailed description of the action of the deflector plate 42, reference may be had to application Ser. No. 94,189 of Roger W. Griswold II, filed August 4, 1936, for Slotted deflector flap.

Although there has been illustrated and described in a somewhat schematic manner a suitable mechanical embodiment of what is now considered to be the preferred form of the idea of the invention, it is to be understood that the invention is not limited to the construction so illustrated and described, but that such changes in the size, shape and arrangement of parts may be resorted to as come within the scope of the subjoined claims.

Having described the invention so that others skilled in the art may clearly understand the same, what it is desired to secure by Letters Patent is as follows:

What is claimed is:

1. In combination with an airplane wing, a lift increasing device comprising a flap of airfoil section normally received within a recess in the lower rear portion of said wing, a plurality of rodlike members slidably supported within said wing for supporting said flap and moving the same into and out of said recess, a plurality of

links associated respectively with said rodlike members for tilting said flap, a plurality of movable abutments screw-threaded one on each of said rodlike members and pivotally connected with the forward ends of the respective links, means for rotating said rodlike members to impart flap tilting movement to said movable abutments and connecting means between said rodlike members and said flap constructed and arranged to permit rotation of said rodlike members relative to said flap and tilting of said flap relative to said rodlike members.

2. In combination with an airplane wing having in the lower rearward portion thereof a recess provided with a flat upper surface substantially parallel to the main chordwise axis of said wing, a lift coefficient increasing device comprising a spanwise flap movable in said recess and spaced at its leading edge from said surface to provide an airflow gap between the flap and said surface when said flap is tilted, means for imparting to said flap a movement substantially parallel to said surface and a tilting movement without materially changing said airflow gap after said gap has been opened by an initial tilting movement of said flap, and a deflector plate on said flap spaced therefrom and arranged to receive the air flowing through said gap and deflect said air over the upper surface of said flap in all positions of the flap.

3. In combination with an airplane wing having in the lower rearward portion thereof a spanwise recess the upper boundary of which is constituted by the undersurface of the overhanging upper rearward portion of the wing, a spanwise flap of a size to substantially fill said recess, means for pivotally supporting said flap and moving said flap pivot in a direction generally chordwise of said wing and substantially parallel to said surface, means combined with said supporting means but independently operable for tilting said flap about said pivot at any chordwise position, said pivot being so positioned as to maintain the forward portion of said flap spaced a predetermined distance from said surface at each flap position, and a deflector plate on said forward portion of said flap and spaced therefrom to receive air flowing through the space between said flap and said surface and direct said air over the upper surface of said flap.

4. In combination with an airplane wing having a recess in the lower rearward portion thereof, a lift increasing device comprising a flap received in said recess, means supported by said wing for imparting to said flap a bodily movement into and out of said recess in a generally chordwise direction without tilting said flap relative to said wing, and means associated with said first mentioned means but independently operable for tilting said flap about a substantially spanwise extending axis any desired amount at any chordwise position of said flap.

5. In combination with an airplane wing having a recess in the lower rearward portion thereof, a lift increasing device comprising a flap normally received in said recess, a plurality of rod like members supported by said wing for supporting said flap and guiding its movement into and out of said recess, means for moving said flap into and out of said recess, means associated with said rod like members for tilting said flap and means independent of the means for moving said flap for rotating said rod like members for actuating said tilting means and tilting said flap relative to said recess.

6. In combination with an airplane wing having a recess in the under rearward portion thereof, a lift increasing device comprising a flap of airfoil section normally received within said recess, means for supporting said flap operative to move said flap between said normal position in which said flap is received within said recess and a position in which at least the major portion of said flap projects beyond said recess to the rear of said wing, and means associated with said supporting means for tilting said flap in any position to which the flap may be brought by said supporting means, said supporting means being so arranged that the space between adjacent surfaces of said flap and said wing does not change upon movements of said flap by said supporting means if the angle of inclination of said flap remains substantially constant.

7. In combination with an airplane wing having in the lower rearward portion thereof a recess the upper boundary of which is constituted by the undersurface of the overhanging upper rearward portion of the wing, a spanwise flap movable into and out of said recess, a pivotal support for said flap, means for moving said flap pivot substantially parallel to said surface, means for tilting said flap to open an airflow gap between the upper forward portion of said flap and said surface, the width of said gap being independent of the location of said pivot along the width of said recess, and a deflector plate on said flap curved to receive air flowing through said airflow gap and direct said air along the upper surface of said flap.

8. In combination with an airplane wing having in the lower rearward portion thereof a spanwise recess the upper boundary of which is constituted by the undersurface of the overhanging upper rearward portion of the wing, a lift coefficient increasing device comprising, a tiltable spanwise flap of airfoil section movable in said recess between a position in which it is wholly within said recess and a position in which the major portion thereof projects beyond the trailing edge of said wing, the leading edge of said flap being spaced from said surface to provide a substantially constant airflow gap between the flap and said surface when said flap is tilted sufficiently to open said gap, means for imparting to said flap a movement substantially parallel to said surface, means for tilting said flap in any position to which it is brought by said first mentioned means, and a deflector plate on said flap spaced therefrom and arranged to receive the air flowing through said gap and deflect said air over the upper surface of said flap in all positions of the flap.

9. In combination with an airplane wing, a lift increasing flap below the rearward portion of said wing, flap supporting means, a pivotal connection between said flap and said supporting means, means for moving said pivotal connection in a chordwise direction substantially parallel to the undersurface of said wing, and means for tilting said flap about said pivotal connection at any operative position of said connection relative to said wing.

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