June 12, 1956 E. D. PALMER ET AL 2,750,132

AIRPLANE AILERON AND SPOILER COMBINATION

Filed Jan. 7, 1953

2 Sheets-Sheet 1

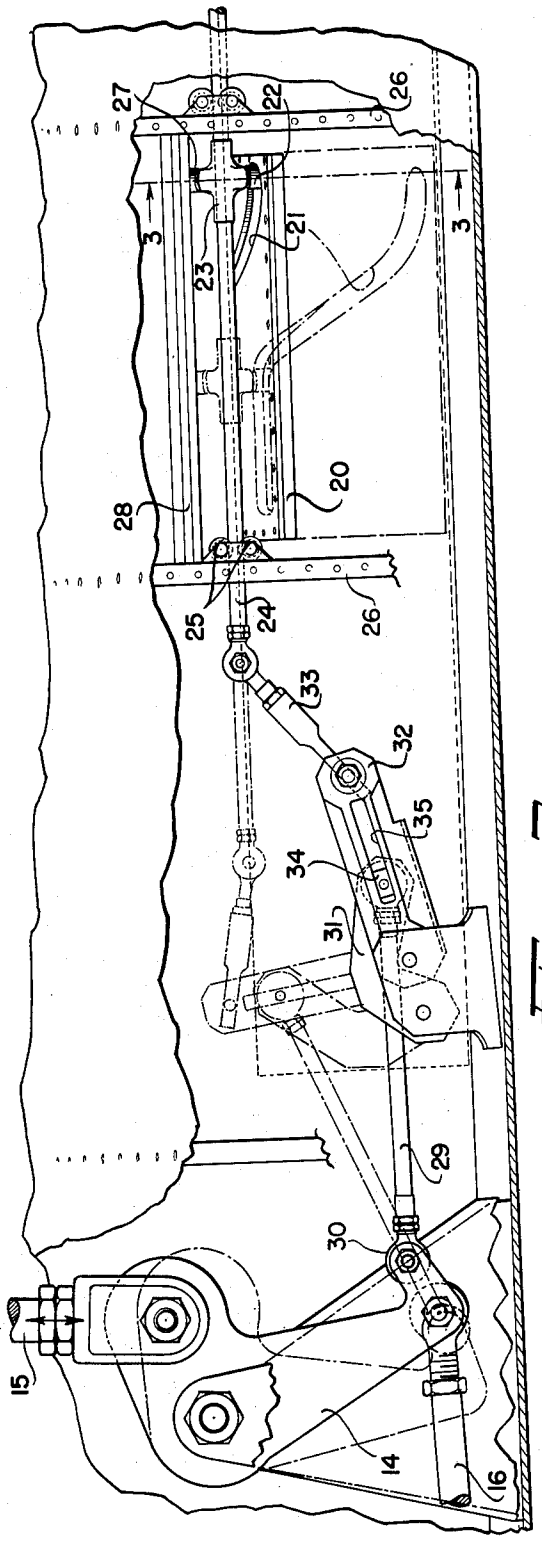


FIG. 2

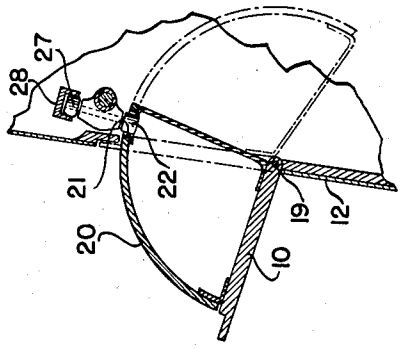


FIG. 5

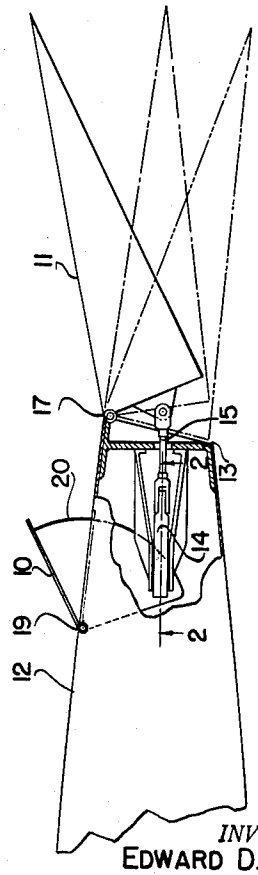


FIG. 7

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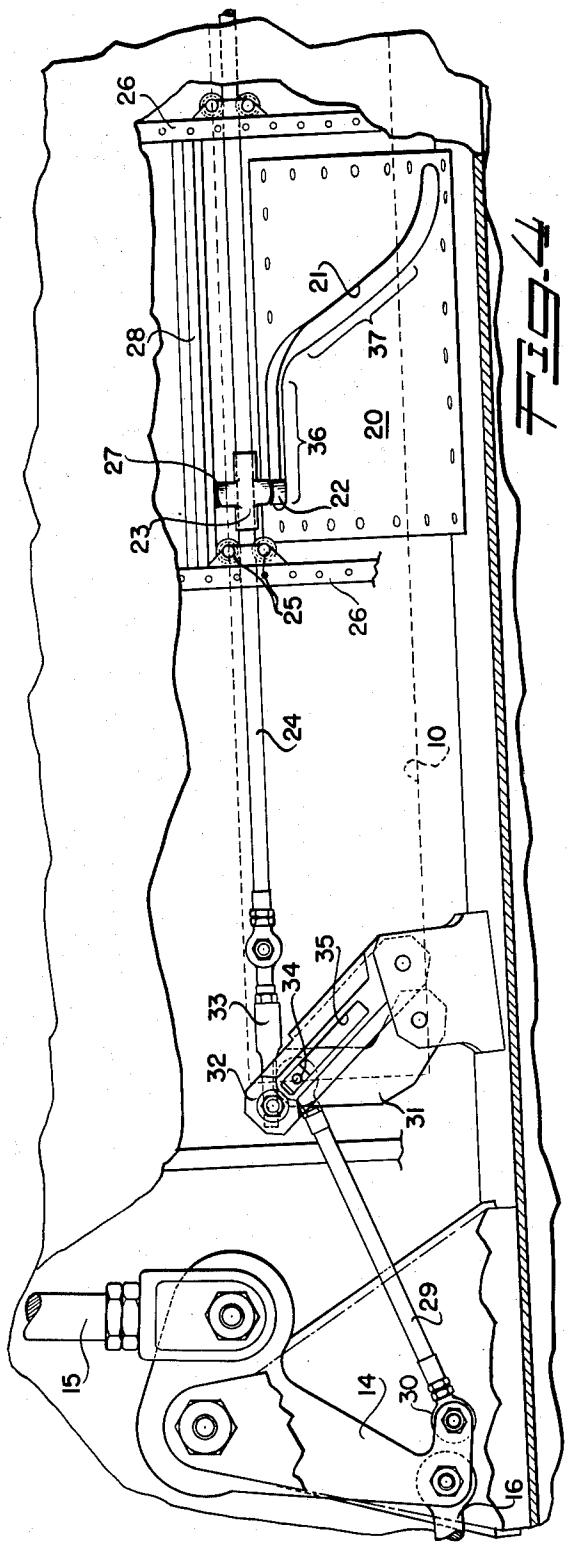


FIG. 4

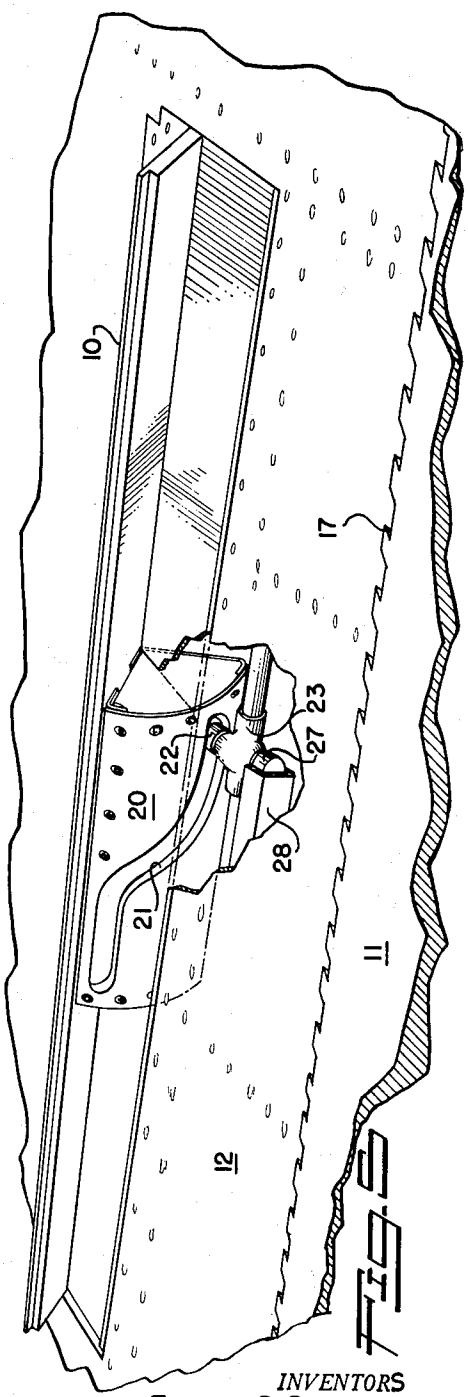


FIG. 5

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AIRPLANE AILERON AND SPOILER COMBINATION

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4 Claims. (Cl. 244—90)

This invention relates to coupling a spoiler to a conventional aileron control system to improve the lateral control and rate of roll of high speed aircraft, which may encounter control reversal at transonic speeds.

The airflow over the wing of an airplane is not completely laminar in character and the separation point moves forward as air speeds approach the transonic range. Thus conventional trailing edge ailerons operate in turbulent air during their upward movements. It has heretofore been proposed to use boost operated or oversize ailerons to maintain adequate lateral control and rate of roll of the airplane. The present invention relates to the use of a spoiler to decrease the wing lift in connection with the use of an up aileron to force the wing down and thus supplements aileron action under conditions where maximum rate of roll is desired, without requiring extensive additional aileron booster forces.

It is accordingly an important object of this invention to supplement conventional ailerons with spoilers to improve the performance of ailerons at speeds approaching the transonic range, under which conditions ailerons alone lose effectiveness.

It is a further object of this invention to provide an improved operating linkage from the pilots control to the spoiler when a downward movement of the wing is desired.

It is also an object of this invention to provide a simple and reliable operating connection from the aileron to the spoiler that will hold the spoiler down flush with the wing surface during aileron down movements, and lift and retract the spoiler during the range of aileron up movements.

Other objects and features of the invention will be readily understood from the following detailed description of a typical preferred form of the invention wherein reference will be made to the accompanying drawings in which:

Figure 1 is a wing section to show the relationship of the wing spoiler to the aileron;

Figure 2 is an enlarged section taken on the line 2—2 of Figure 1 showing the aileron and spoiler linkage in full lines for the neutral aileron or retracted spoiler position;

Figure 3 is a section on the line 3—3 of Figure 2 showing the drum cam and follower operating the spoiler;

Figure 4 is a section similar to Figure 2 showing the aileron and spoiler linkage in the aileron down position wherein the spoiler is held down against aerodynamic suction acting thereon; and

Figure 5 is a partly broken away view showing the spoiler operating drum cam and follower.

As shown on the drawings:

This invention relates to the use of a spoiler in connection with the up movement of a conventional aileron to improve the lateral trim of high speed aircraft. A spoiler operates to disturb the flow of air over an airfoil surface, thus decreasing the aerodynamic lift of said surface.

Figure 1 shows the positions of the spoiler 10 and aileron 11 relative to the top surface 12 and aileron hinge line support beam 13 of a wing 12. The aileron 11 is shown as operated through a bell crank 14 and push rod 15, a push-pull rod 16 extending from the pilot's control stick to the bell crank. It will be understood that the aileron is moved both up and down about its hinge 17 by a conventional pilot operated control to depress or lift the wing to which it is attached, and that the aileron on the opposite wing is simultaneously operated in the opposite direction.

The spoiler 10 is a substantially flat flap which lies flush with the upper wing skin 12 when retracted and has a hinge 19 at its leading edge. A drum like cam 20 is attached to the under side of the spoiler, this cam being a partially cylindrical surface with its axis at the hinge 19. A groove 21 in the surface of the cam is engaged by an operator roller 22 carried by a collar 23 on a push-pull rod 24 which reciprocates in roller guides 25 mounted on wing ribs 26. The collar 23 carries a second roller 27 on the side opposite the roller 22, the roller 27 operating in a straight track 28 which takes the torsion load on the collar 23 due to the spoiler load on the roller 22. Thus the push-pull rod 24 is relieved of the torsion load due to the air forces acting on the spoiler.

The push-pull rod 24 is operated by a link 29 pivotally connected to the aileron bell crank at 30 and operating compound levers 31 and 32, the latter connected to the rod 24 by a link 33. The compound levers 31 and 32 are utilized to increase the stroke of the rod 24, to reduce the steepness of the angle of the cam groove 21, and the lever 31 operates the lever 32 by a shoe 34 sliding in a slot 35 in the lever 32 to increase the throw of the latter.

The linkage and compound levers are shown in the aileron neutral position in dotted lines in Figure 2, which also shows the aileron up position in solid lines. Figure 4 shows the aileron down position of the linkage. Since it is desired to operate the spoiler only during upward movements of the aileron, the cam groove is used to lock the spoiler down against the suction forces acting thereon with down aileron, the cam groove 21 for the corresponding movements of the rod 24 and roller 22 is cut straight or parallel to the rod 24 for this range of aileron movements, as indicated at 36 in Figure 4. The groove 21 is cut spirally of the drum, as indicated at 37 to produce a non-linear opening movement of the spoiler with upward movements of the aileron, the spiral being curved at its juncture with the straight part 36 of the groove to give a smooth transition. The compound levers 31 and 32 amplify the movement of the rod 24 to provide for an 83 degree angular movement of the spoiler during 17 degrees of aileron up travel.

It is believed that the operation of the ailerons for lateral control is so conventional as not to require description. As the aileron bell crank 14 is moved clockwise (corresponding to down ailerons) from the dotted line position of Figure 2, it pulls the compound levers 31 and 32 and rod 24 into the position of Figure 4, where the roller 22 enters the straight portion 36 of the cam groove to hold the spoiler in its retracted position. Counter-clockwise movement of the aileron bell crank 14 for up aileron movements, pushes the compound levers 31 and 32 and roller 22 from the dotted to the full line positions of Figure 2 causing the roller 22 to ride the spiral part 37 of the cam groove 21 to lift the spoiler into operating position. Variations in the slope of the cam groove 21 can be tailored to match the spoiler effect on the wing lift and airflow thereover to the aileron position.

The addition of the spoiler operating mechanism has little effect on the pilot's conventional control of the

ailerons, which are operated in the normal manner. The spoiler effect is additive to the up aileron forces developed to push the wing down, and thus aids in lateral control or rate of roll of a high speed airplane.

It is to be noted that the spoilers can be used to replace normal ailerons and the mechanism therefor operated direct from the pilot's control.

Having described only typical forms of the invention we do not wish to be limited to the specific details herein set forth, but wish to reserve to ourselves any variations or modifications that may appear to those skilled in the art and fall within the scope of the following claims.

We claim as our invention:

1. In combination with an airplane wing, an aileron and aileron control mechanism, a spoiler hinged to the upper surface of the wing in advance of the aileron thereon, said spoiler lying flush with the wing surface in its retracted position, and operating means for pivoting said spoiler upwards as the aileron is moved upwardly, comprising a drum cam on the under side of the spoiler cylindrically curved about the hinge axis of the spoiler and having a spiral groove therein, a push-pull rod having a roller engaging in said cam groove, and movement multiplying means linking said push-pull rod to the aileron control mechanism for operation thereby.

2. An arrangement as defined in claim 1 wherein the push-pull rod extends parallel with said hinge axis and the means linking the push-pull rod to the aileron control mechanism includes compound levers for multiplying the movement of the push-pull rod relative to the aileron control movement.

3. In an airplane with an aileron and an aileron control mechanism having an operating push-pull member the combination of; a spoiler hinged to the airplane ahead of the aileron to be movable between a down position and a raised active position, a cam on the under side of the spoiler having a spiral cam slot, a push-pull rod movable parallel with the hinge axis of the spoiler, a motion multiplying lever means connecting the rod with the member to be operated thereby, a roller mounted on one side of the rod and engaging in the cam slot to move the spoiler upon movement of the rod, a relatively stationary track paralleling the rod, and a second roller mounted on a side of the rod and engaging in the track to support the rod against torsion loads imposed by the spoiler.

4. In an airplane with an aileron and an aileron control mechanism having an operating push-pull member the combination of; a spoiler hinged to the airplane ahead of the aileron to be movable between a down position and a raised active position, a drum cam secured on the under side of the spoiler cylindrically curved about the hinge axis of the spoiler and having a spiral slot terminating in a straight extension extending parallel with said axis, a push-pull rod movable parallel with said axis, means operatively connecting the rod with said push-pull member to be operated thereby including motion multiplying compound levers, a part on the rod cooperating with the slot to move the spoiler during movement of the aileron when in its raised condition and cooperating with said slot extension to hold the spoiler in the down position during movement of the aileron in its lowered condition, a stationary guide track parallel with the rod, and a second part on the rod cooperating with the track to relieve the rod of torsion loads imposed by the spoiler.

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