United States Patent [19]

Hallworth

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[54] **ACTUATING MEANS FOR A VANE**

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[73] Assignee: **Lockheed Aircraft Corporation,** Burbank, Calif.

[22] Filed: **Apr. 5, 1973**

[21] Appl. No.: **348,269**

[52] **U.S. Cl.** ..... **244/42 DB,** 74/471 R

[51] **Int. Cl.** **B64d 9/10,** B64d 9/20

[58] **Field of Search** ..... 244/42 D, 42 DA, 42 DB, 244/42 DC, 82, 75 R; 74/471 R

[56] **References Cited**

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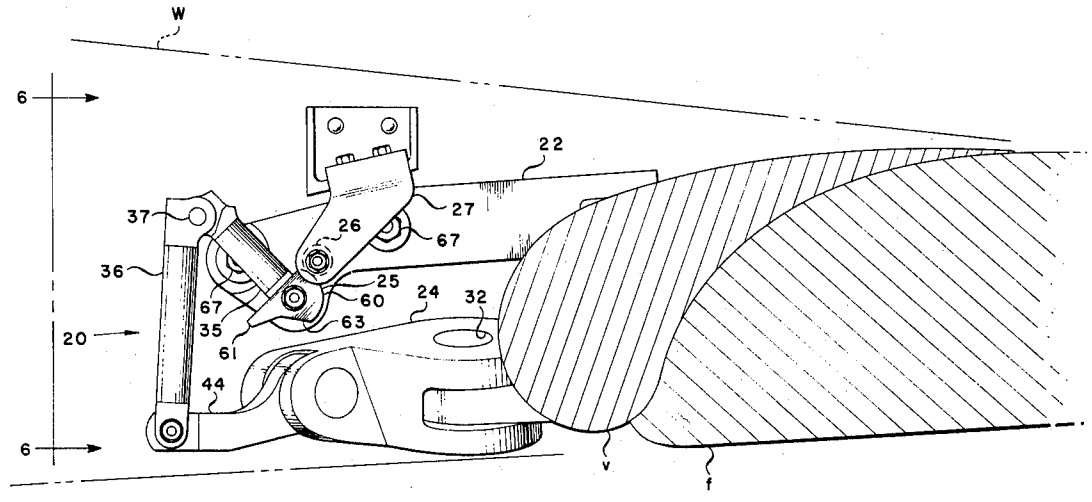
Assistant Examiner—Barry L. Kelmachter
Attorney, Agent, or Firm—Billy G. Corber; Frank L. Zugelter

[57] **ABSTRACT**

A mechanism, two of which position a vane in proper working and aerodynamic relationship with a flap throughout the latter's travel in a Fowler flap assembly for an aircraft. The forward end of a folding linkage is operatively connected, via a vane support fitting, to a vane, and is operatively connected at its rear end to a flap. Each vane support fitting is secured to one or more carriages having banks of rollers mounted on tracks fixed to wing structure. A cam is mounted on the forward end of the linkage to co-act with a follower stationarily disposed upon wing structure. In flap extension, the latching of cam upon follower prevents the folded linkage, its vane support fitting and vane from further opening and extending. Continued rotation of the unfolding linkage and cam provides disengagement from the follower. The linkage unfolds to a biased stiff or unyielding position as the flap pulls the linkage. In flap retraction, engagement of cam with follower breaks the biased unyielding position of the linkage. The linkage folds as the flap retracts. The vane does not further retract until the linkage is folded to a degree where the cam can pass by its follower. The folding linkage includes a spring-piston-cable arrangement which assures biasing thereof in its unyielding and extended position, until the cam engages the follower in the retracting mode for the flap.

1 Claim, 11 Drawing Figures



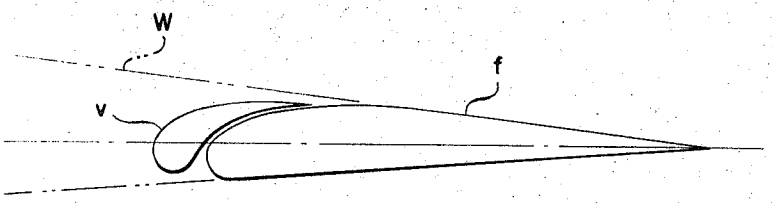


FIG. 1

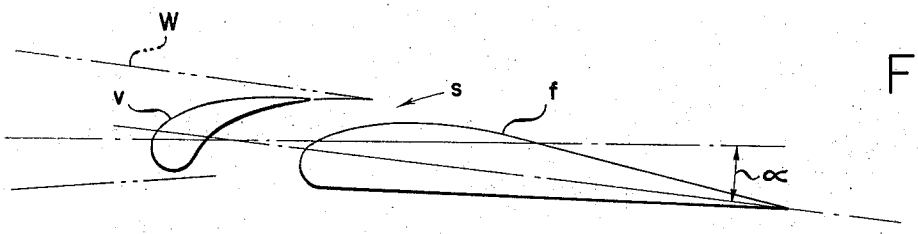


FIG. 2

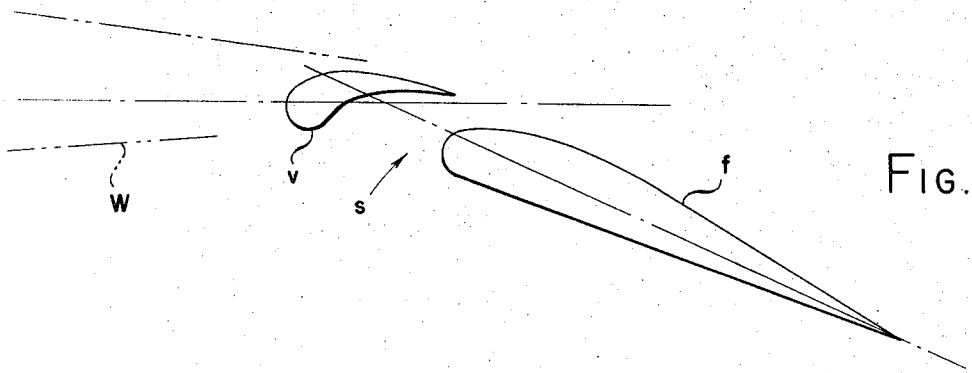


FIG. 3

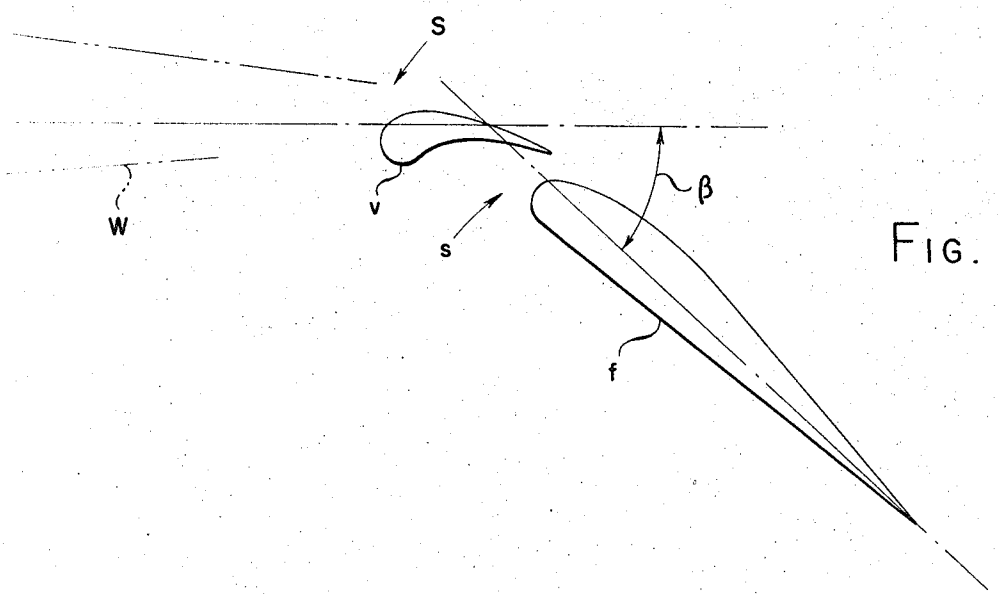
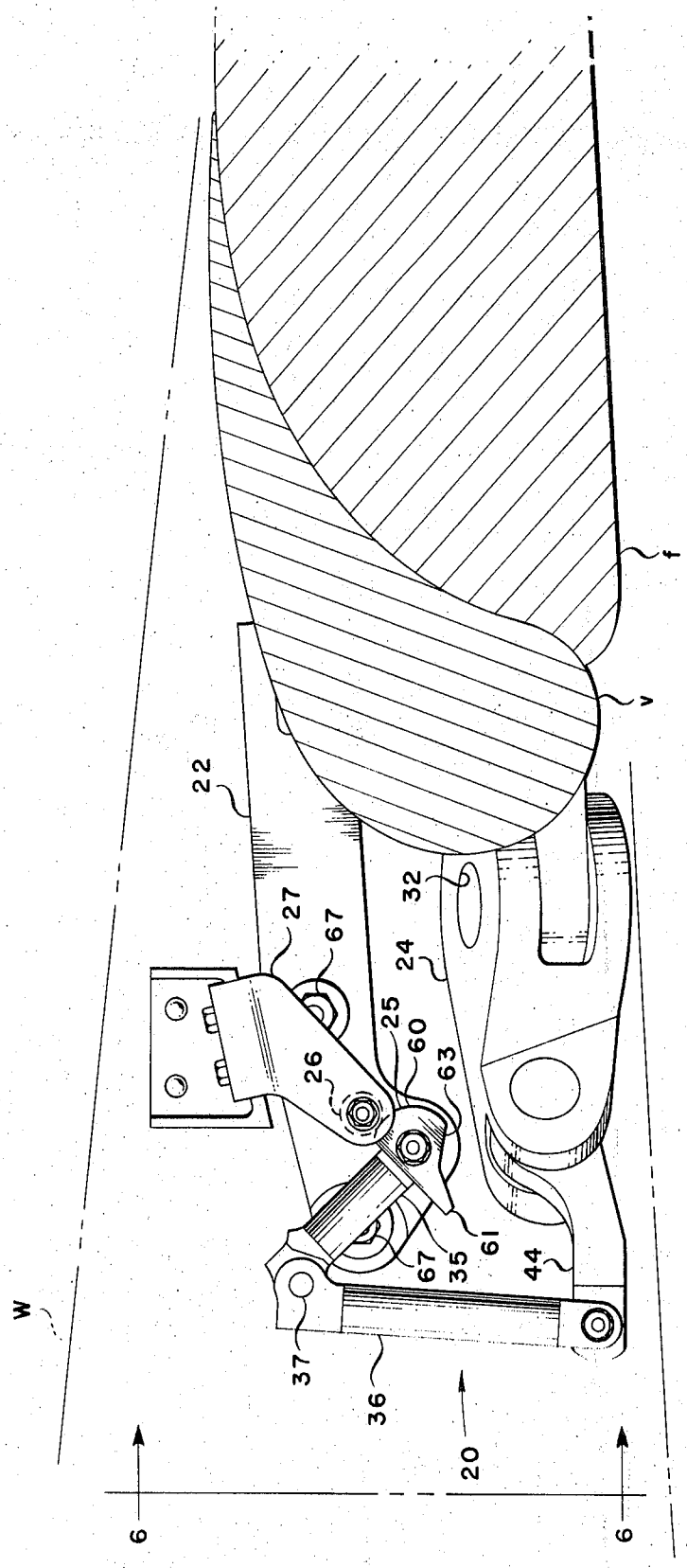


FIG. 4

FIG. 5



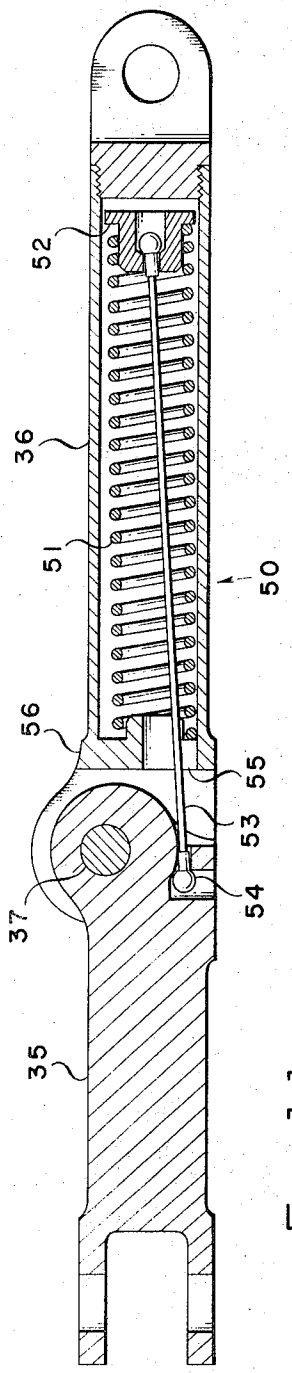


FIG. 11

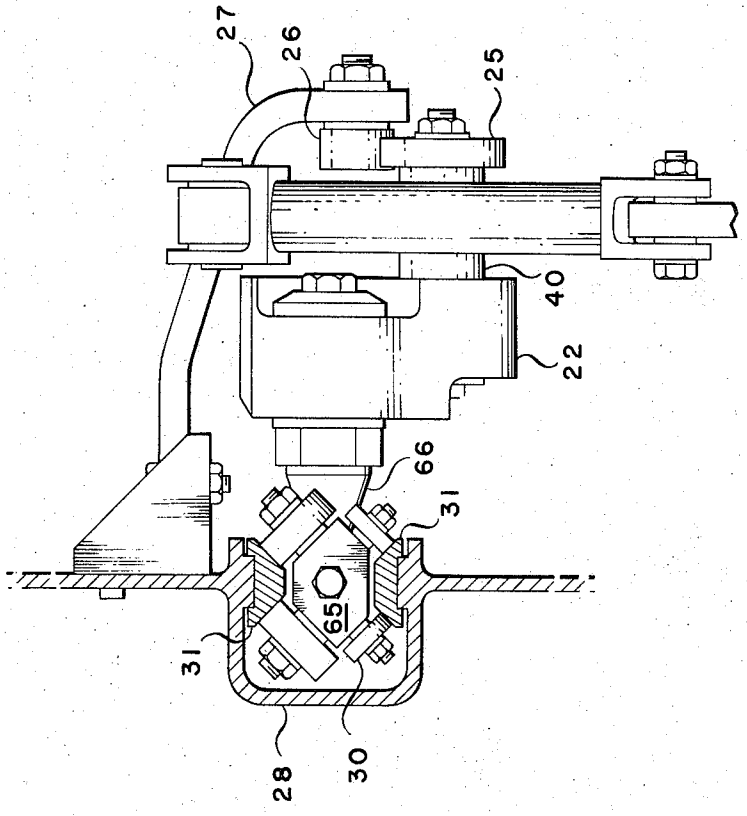


FIG. 6

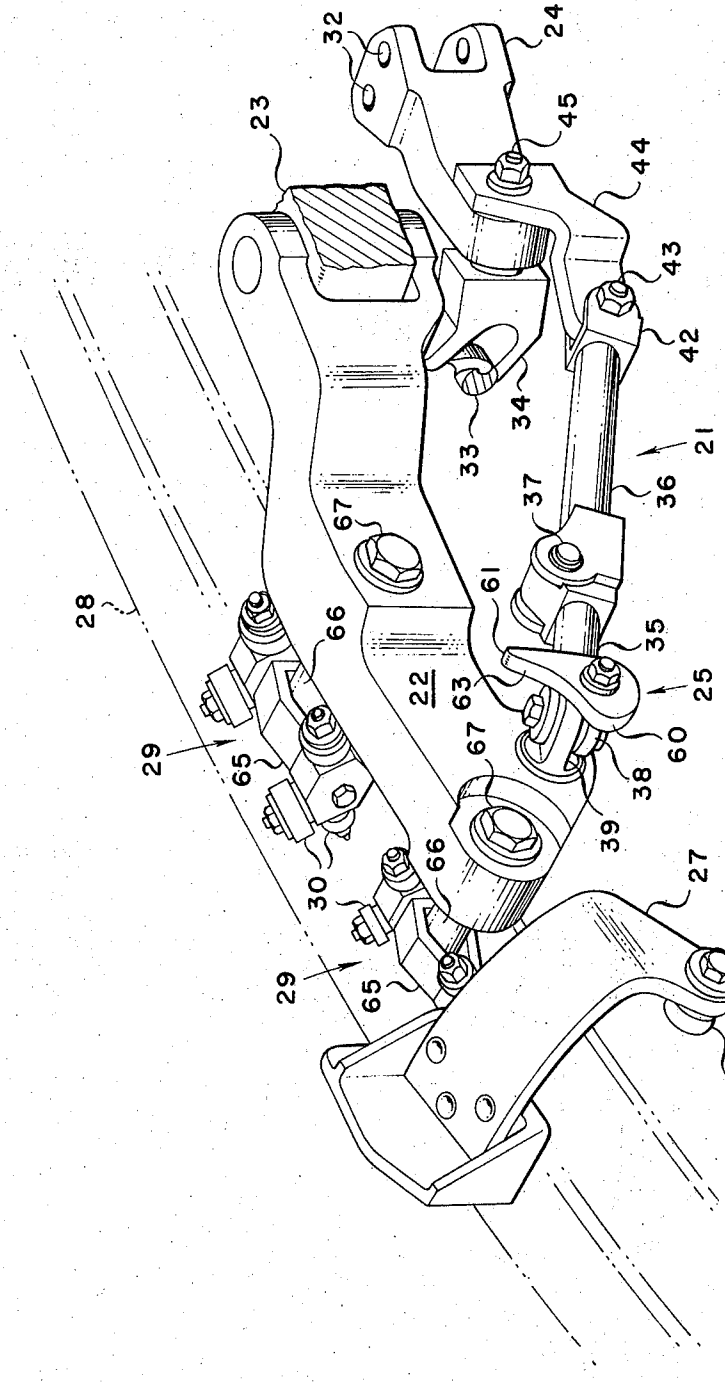

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FIG. 7

FIG. 8

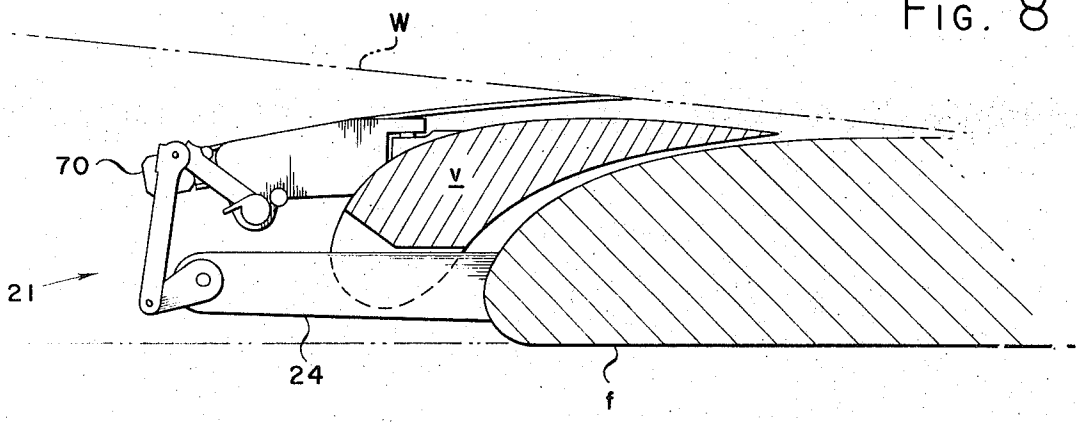
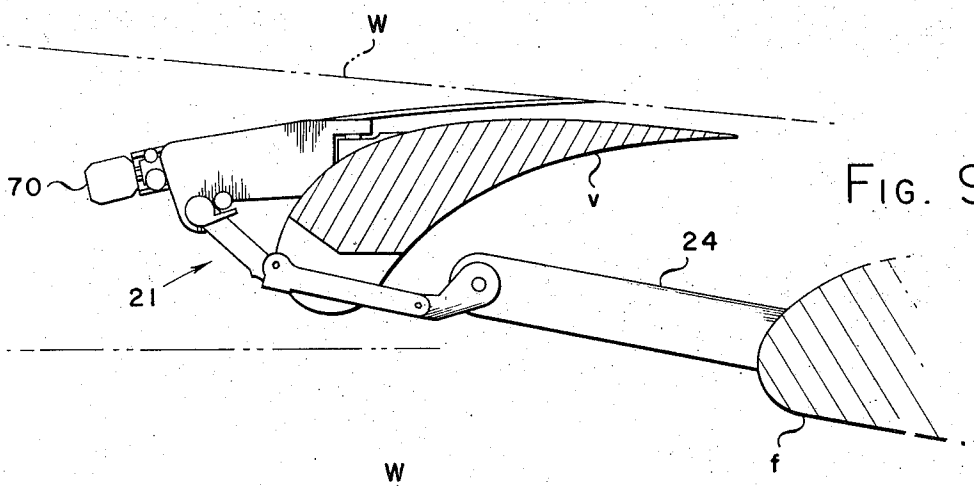


FIG. 9



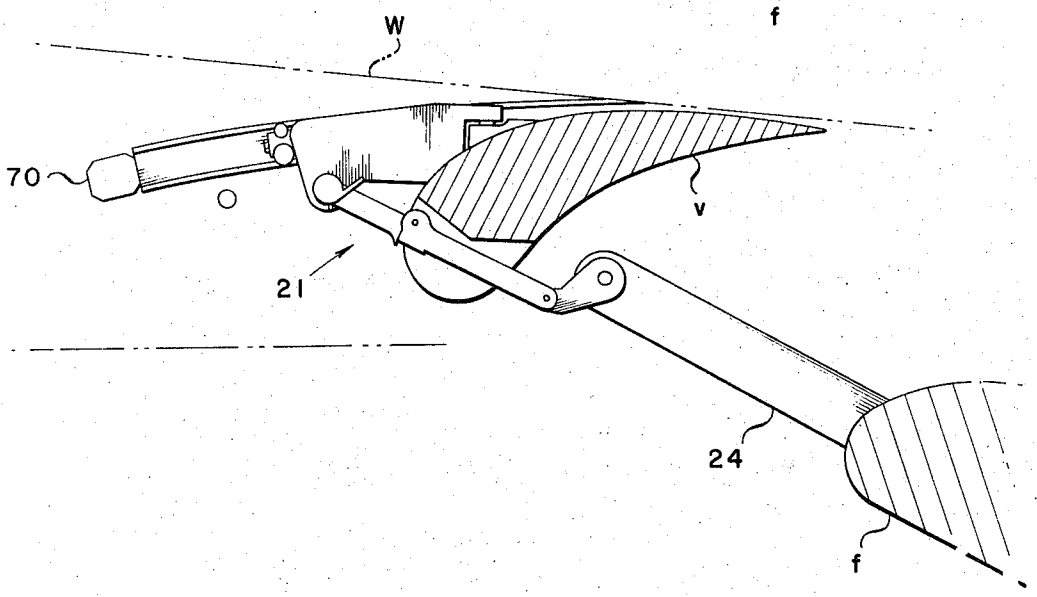


FIG. 10

ACTUATING MEANS FOR A VANE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The field of art to which the invention is most likely to pertain is located in a class of devices generally relating to lift increasing devices for airplane wings.

2. The Prior Art

Examples of prior art devices in the arts to which this invention most likely pertains are U.S. Letters Pat. Nos. 2,169,416; 2,404,956; 2,624,532; 3,528,632; and German Pat. No. 1,296,527 (May 29, 1969).

3. Problems in the Prior Art

It is believed that this invention is a completely novel one, as I am not aware of any major problems existing with similar mechanisms that have been utilized in aircraft in the past. Long sliding mechanisms are known to be commonly used for extending and retracting flaps and vanes; however, a need for this invention has developed in view of the heavier wide-bodied and jumbo jet aircraft of today. This need demands a simple, lightweight and nevertheless efficient mechanism for extending and retracting flaps and vanes of such aircraft. This invention solves such need.

SUMMARY OF THE INVENTION

This invention relates to lift increasing devices mounted on aircraft wings, and in which a trailing portion is separated from the wing's main portion, and is particularly related to a mechanism which actuates such a trailing portion.

Briefly summarized, the present invention is utilized in connection with a Fowler flap action desired to be taken for extending and retracting a vane and flap of a wing of an aircraft. A pair of vane actuator mechanisms are employed in an expanding double-slotted flap configuration for the wing. Each vane actuator mechanism includes a folding linkage at each (rib) side of the vane. The forward end of the linkage connects to a vane support fitting and its rear end connects to a flap actuating yoke or fitting, however, being driven by a flap actuating trunnion. Each linkage is held in an unyielding, unfolded position when the vane is fully separated from the flap, by means of a biasing means coupled with an over-center pivotal hinge connecting the members of the linkage. As the flap retracts, a cam at the forward end of each linkage engages and is held by or latches upon a roller mounted on relatively fixed structure thereby exerting a force on the linkage to cause it to break from its biased unyielding position. As the flap continues to retract to its nested position, the linkage continues to fold to its closed position. Continued folding of the linkage frees the cam from its follower and the vane approaches its nested position with the flap. Upon extending the flap, the cam engages its follower, such contact serving as a forward latch preventing the vane from further extending until the folded linkage is unfolded to a degree at which the cam passes by the follower. The extending flap in its movement can then continue to draw the linkage and the vane until the flap is in its fully extended position. Means are provided the linkage to bias it in its unyielding position.

An object of this invention, therefor, is to extend and retract such trailing portion by novel means.

Another object of this invention is to properly separate and space a wing, vane and flap relative to each other during such extension and retraction, for realization of advantages gained by the aerodynamic slotting achieved.

A further object of this invention is to maintain such proper separation and spacing of the wing, vane and flap during the retracting and extending modes of operation for the flap system.

A further object of this invention is to provide an actuator mechanism which is unaffected by any wing deflection or flexing.

A still further object of this invention is to provide an aerodynamically clean, lightweight, simple and efficient apparatus.

These and other objects of the invention will become more fully apparent upon a complete reading of the following description, appended claims thereto, and the drawing comprising five sheets.

BRIEF DESCRIPTION OF THE DRAWING

FIGS. **1–4** schematically represent in four views various positions of an airfoil on which the Fowler flap principle is employed and in which such airfoil this invention is employed.

FIG. **5** is an elevational view of a mechanism, in a closed or folded position, embodying the invention.

FIG. **6** is a view taken on line **6—6** of FIG. **5.**

FIG. **7** is a perspective view of the mechanism in a fully extended position.

FIGS. **8, 9** and **10** schematically represent the vane actuating mechanism in fully closed, partially open, and fully open or unfolded positions, respectively.

FIG. **11** is a view partly in section and partly in full, of a biasing device employed in the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Background. The schematic views of FIGS. **1-4** represent the desired positions for a flap *f* and a vane *v* employed in an aircraft wing W utilizing the well-known Fowler flap principle. In a retracted position shown in the first view, the flap and vane are nested together in the trailing edge or portion of the wing, and thereby occupy minimum space. In FIG. **2,** the Fowler principle becomes apparent, as the flap is extended for take-off of the aircraft. The flap panel has been extended for a maximum increase in wing area of a given aircraft, and is deflected to a desired angle α. In this position, the vane remains nested and is separated from the flap, exposing a single slot *s*.

FIG. **3** represents further deployment of the flap towards its fully extended position (for landing) which is shown in FIG. **4.** The third view shows that the vane plugs the cavity formed in the trailing edge as the flap further extends, and also serves as an air control panel for a smooth flow of air through the original slot *s*. As the flap is continued to be fully deployed, or extended for landing, the vane extends from its position near the trailing edge. A second slot S is established and is shown in FIG. **4.** The angle of the flap in the meantime is further increased to another desired angle β.

This invention is directed to achieving the maintenance of an efficient aerodynamic relationship for the vane with the flap throughout the latter's travel in the retracting and extending modes of their operation.

Description. Referring now to the drawing in which reference characters correspond to like numerals hereinafter, reference character **20** (FIG. **7**) refers to and

identifies a preferred embodiment of the invention. It should be understood that a pair of mechanisms **20** is used at each side or rib end of each flap and its associated vane on an aircraft; however, for clarity of description of the invention, the following description and the accompanying drawings are directed to just one mechanism **20.** A like mechanism **20** complements same in actual outboard or inboard installation and operation of a flap and vane mounted in a wing of the aircraft, and its elements are merely situated in a reverse position to their corresponding elements shown in the accompanying drawing.

The actuator **20** comprises a linkage **21** having its forward end connected to a support member or fitting **22** on the rear end of which a vane lug **23** is adapted for pivotal connection thereto. The rearward end of the linkage **21** is operatively connected to an actuating yoke or flap hinge fitting **24** to which a flap (not shown) is secured. At the forward end of the linkage **21,** a cam member **25** is mounted for cooperative action with a follower **26** mounted upon a bracket or extension member **27** secured to wing structure, or in this instance to a torque box **28.** The vane support fitting or member **22** is connected to one or more carriage assemblies **29** having banks of rollers **30** which cooperate with fixed opposing tracks **31** (FIG. **6**) included in the torque-box **28** fixed to wing structure. The actuating yoke or flap hinge fitting **24** for the mechanism **20** is adapted to be secured to the flap by suitable means such as bolts or the like extending through apertures **32** provided in the yoke **24** and as shown in FIG. **7.** Although not illustrated, each flap is operatively mounted upon carriages or the like also having banks of rollers which ride in corresponding tracks in the same manner as the carriage assemblies **29** and rollers **30** which provide the guiding movement for the vane fitting or support member **22.** The actuation of the flap itself may be accomplished by operation of a conventional ball-screw mechanism **33** to which a flap actuator fitting or trunnion **34** is operatively mounted. The actuating yoke or flap hinge fitting **24** is rotatably mounted about the trunnion **34.** It is sufficient to note that actuation of the flap ball-screw mechanism **33** causes the trunnion **34** to extend or retract and thereby extend or retract the flap and operate the mechanism **20.**

The linkage **21** includes a pair of rigid members or casings **35, 36** (FIGS. **7, 11**) having their complementary ends pivotally connected together as at **37.** A bifurcated element **38** is included in the forward end of the rigid member **35** for securing it to a lug **39** projecting from a rotatable spindle **40** (FIG. **6**) laterally supported by and mounted in the vane support fitting **22.** A bifurcated element **42** is mounted at the rear end of the rigid member **36,** to be pivotally attached, such as by a bolt **43** to an arm **44.** The arm **44** is spline bolted by a bolt **45** to the flap actuator trunnion **34.** It should be understood that the arm **44** is required in the operation of the linkage as illustrated in this embodiment. However, it is not a necessary limitation on the spirit or to the merits of the invention.

As shown in FIGS. **7** and **11,** the pivotal connection **37** for the rigid members **35, 36** is offset from their longitudinal axes. This offset coupled with a biasing arrangement **50** of elements (FIG. **11**) for the casings forming the rigid members **35, 36** biases the linkage **21** in a direction tending to maintain it in an open or unfolded, and unyielding position.

Such arrangement **50** comprises an elongated coil spring **51** mounted in the length of a hollow casing for the rigid member **36,** a piston **52** seated on one end of the spring **51,** and a cable **53** one end of which being attached to the piston **52** and its other end to a point **54** on the rigid member **35.** An opening **55** is provided in the casing base **56** in order that the cable **53** extends for attachment to the rigid member **35.** The compressive force of the spring **51** tends to maintain the piston **52** at the top or right end (FIG. **11**) of the rigid member **36,** thereby exerting a force through the cable **53** to maintain the rigid member **35** in a hard position relative to the base **56** of the other member **36.**

As shown in FIGS. **5** and **7,** the cam **25** is mounted at the one end of the rigid member **35,** and by virtue of its securement to the lug **39** to which the bifurcation **38** is fixed, it rotates or turns in unison with such rigid member **35** in the folding and unfolding of the linkage **21.** The cam **25** comprises a circular riding face **60** and a tang **61** formed thereto. The tang **61** includes a cut-away face **63** contiguous to the circular face **60.** In the folded position for the linkage means **21,** it will be observed (FIG. **5**) that as the circular face **60** cooperates with the stationarily disposed follower **26,** by direct contact, the cam **25** is prevented from further moving to its right. However, as the linkage unfolds, the cam rotates with the rotation of the rigid member **35.** The follower **26** continues to latch upon the face **60** until the rigid member **35** has rotated through an arc at the end of which the face **60** no longer contacts the follower. The cam's cut-away face **63** in turn does not fall along a path through the follower **26** and is in a position to pass by the follower **26,** thereby freeing the unfolding linkage **21** to translate rearwardly.

Each vane support fitting or support member **22** is connected to one or more carriages **29.** Preferably, a carriage assembly **29** includes a mounting element **65** (FIG. **7**) mounted to a universal ball joint (not shown) situated on an extension shaft **66** integrally projecting from a bolt **67** which is secured to and through the lateral thickness of the vane support fitting **22.** In the preferred embodiment, the carriage assembly **29** for each vane support fitting **22** comprises two in number and are spacedly mounted along an exterior side of and along the forward half of each support fitting. It will thus be seen from FIGS. **6** and **7** that each vane support fitting **22** is guided in its movement by the translation of its associated carriage assembly **29** within the torque box **28** and upon the vertically oriented tracks **31** by means of rollers **30.**

A stop block **70** (FIGS. **8, 9, 10**) is securely provided in the forward extremity of each torque box **28** to prevent the banks of rollers **30** on the carriage assemblies **29** from running off their tracks while also maintaining each actuator mechanism **20** in operable relationship relative to its associated vane and flap.

OPERATION

Extension. Referring now to FIGS. **8, 9, 10** and FIGS. **1–4,** the extension of each flap *f* and vane *v* from their nested position (FIG. **1**) is initiated by the flap's own ball-screw mechanism **33** in a manner well known in the art. Each actuating yoke **24** thus pulls a folded linkage **21** along with the extending flap. As the flap continues to extend, the circular face **60** of each cam **25** continues to engage or latch upon its stationarily disposed follower **26** to prevent translation of its asso-

ciated vane support fitting **22,** etc., and the vane *v*. Each linkage **21** continues to unfold with the extending flap, as shown in FIG. **9** and FIG. **2.** Each cam **25** is continuing to rotate until the cut-away face **63** on its tang **61** is able to pass by or unlatch from its follower **26.** The flap assumes the position shown in FIG. **3** and FIG. **10** wherein the members **35, 36** of each linkage are hard against each other. As the flap *f* continues to be extended, each vane support fitting **22,** etc., translates rearwardly, by the pulling of the flap. Both the flap *f* and the vane *v* now assume a fully extended position shown in FIG. **4.**

Retraction. The retraction of the flap f is initiated by its ball-screw mechanism. Both the flap and the vane translate forwardly, as each biased linkage **21** continues to remain in its unfolded or unyielding position. As soon as each cam's tang **61** engages its follower **26,** a force is exerted upon its corresponding linkage **21** to break it about its over-centered pivotal hinge **37.** Each linkage **21** pivots about the pin **37,** thus initiating its folding. The vane *v* no longer continues to retract with the flap; however, the flap *f* continues to retract while further folding each linkage **21.** Each cam **25** continues to rotate around its follower **26** and as soon as each cam in its rotation is free of its follower **26,** the carriage assemblies **29,** each vane support fitting **22,** etc., and thus the corresponding vane *v*, again translates further inwardly until each fitting **22** engages its stop block **70** provided at the front end of its torque box **28.** The flap *f* continues to retract, and each linkage further folds until it reaches its fully closed position. Both the flap and vane return to their nested position as shown in FIG. **1.**

It should be understood that various changes and modifications in design and position of essential elements from the illustrated embodiment may be made, without departing from the spirit and scope of the invention. For example, in regard to an inboard flap-and-vane embodiment, the cam may be mounted on the center line of the rotatable spindle but between the vane fitting and the torque box. In such instance then, the roller is mounted on a flat bracket secured to and spaced from the side of the torque box.

In summary, the invention relates to a foldable linkage mechanism for delaying the action of a flap actuator to provide a desired movement of a vane segment of a Fowler flap assembly. The actuator comprises an elbowed linkage having two arms which constantly tend to assume an unbent configuration against a spring-piston-cable arrangement but which, upon application of a force to the forward end of one of the arms, may assume a folded position at its intermediate pivot point. Thus, the cable element of the arrangement bends around the pivot joint and stresses the spring element within the actuator. The actuator is utilized in combination with a cam and follower arrangement, the cam being mounted at such forward end of the linkage and the follower being attached to fixed wing structure. Upon extension of the flap system, the vane is initially restrained against motion, or at least against an undesired motion, by the engagement of the cam with its follower, until the principal flap segment is extended to a desired point. The cam element is then at a location with respect to its follower such that the linkage is enabled to unfold or function to position the vane in predetermined location with respect to the wing and its flap. Upon retraction of the flap assembly, the cam engages the follower to cause retraction of the vane actuator mechanism to its folded condition during the final retraction phase.

Pursuant to the requirements of the patent statutes, the principle of this invention has been explained and exemplified in a manner so that it can be readily practiced by those skilled in the art to which it pertains, or with which it is most nearly connected, such exemplification including what is presently considered to represent the best embodiment of the invention. However, it should be clearly understood that the above description and illustrations are not intended to unduly limit the scope of the appended claims, but that therefrom the invention may be practiced otherwise than as specifically described and exemplified herein, by those skilled in the art, and having the benefit of this disclosure.

Therefore, what I claim as patentably novel is:

1. In an aircraft wing lift increasing device including a vane and flap positioned and functioning in accordance with a Fowler flap action or principle and which includes means for mounting the vane and flap independently of each other but in sliding relation to their wing structure for the purposes of extending and retracting them in an efficient aerodynamic relationship,

an improvement for actuating the vane in proper and efficient relationship to the flap in such extension and retraction modes, and comprising in combination,

foldable linkage means comprising a pair of rigid members hingedly attached together at their adjacent ends, the respective free ends of said members constituting a forward end and a rear end for said linkage means, respectively,

means for biasing said members towards an unyielding, unfolded position for said linkage means,

a cam member in fixed and non-rotatable relation to and mounted on said forward end for rotation with its rigid member as said members unfold and fold, said forward end and cam member being adapted for rotation about the mounting means for the vane, and

means mounted on the wing structure and upon which said cam member engages as said linkage means movingly folds and unfolds during the extending and retracting modes for the vane and flap,

said cam member being disposed forwardly of said mounted means and with folded position for its linkage means, said cam member engaging said mounted means to prevent extension of the vane as the flap extends until the flap extends to a point at which said linkage means becomes unfolded to cause said cam member to become disengaged from said mounted means to provide for extension of the vane as the flap continues to extend,

said cam member with its unyielding, unfolded linkage means being disposed rearwardly of said mounted means, the vane remaining extended until said cam member engages said mounted means as the flap is retracting, such engagement overcoming said biasing means to break the unfolded linkage means, said linkage means continuing to fold to a point where said cam member disengages from said mounted means to thereby provide for retraction of the vane as the flap continues to retract.

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