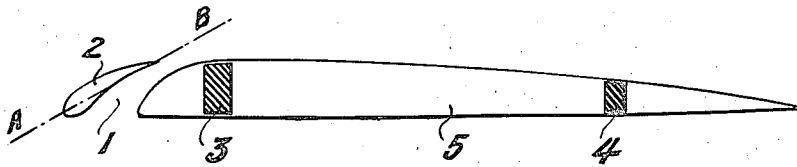


F. H. PAGE.
WING AND SIMILAR MEMBER OF AIRCRAFT.
APPLICATION FILED JULY 6, 1920.

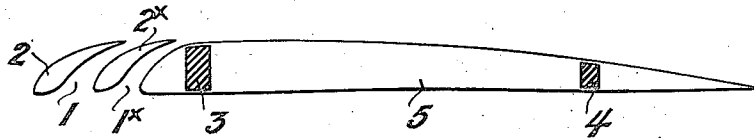
1,353,666.

Patented Sept. 21, 1920.
3 SHEETS—SHEET 1.

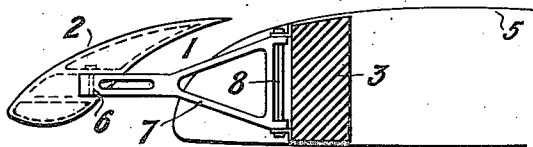
—FIG. 1.—



—FIG. 2.—



—FIG. 3.—



Frederick Handley Page
Inventor

By *Wm. E. Lamb*
Att'y.

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— Fig. 4. —

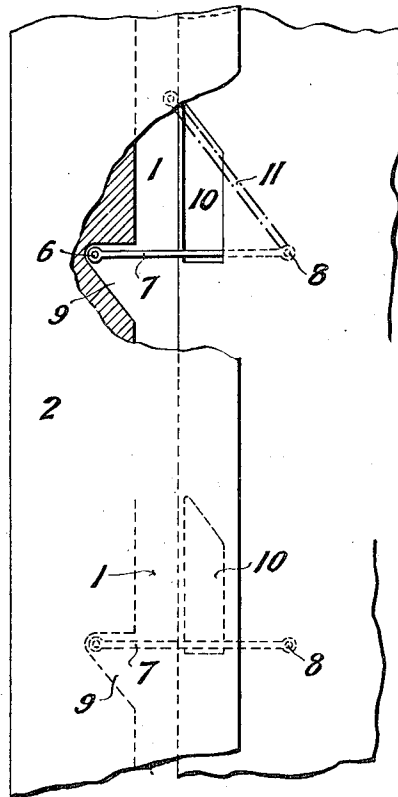
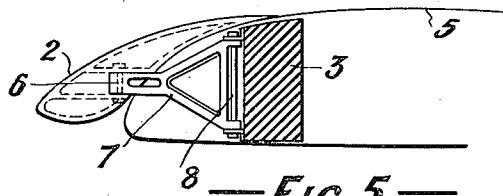
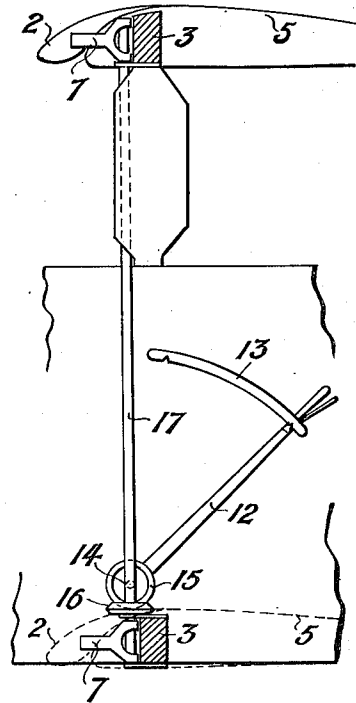


FIG. 7.



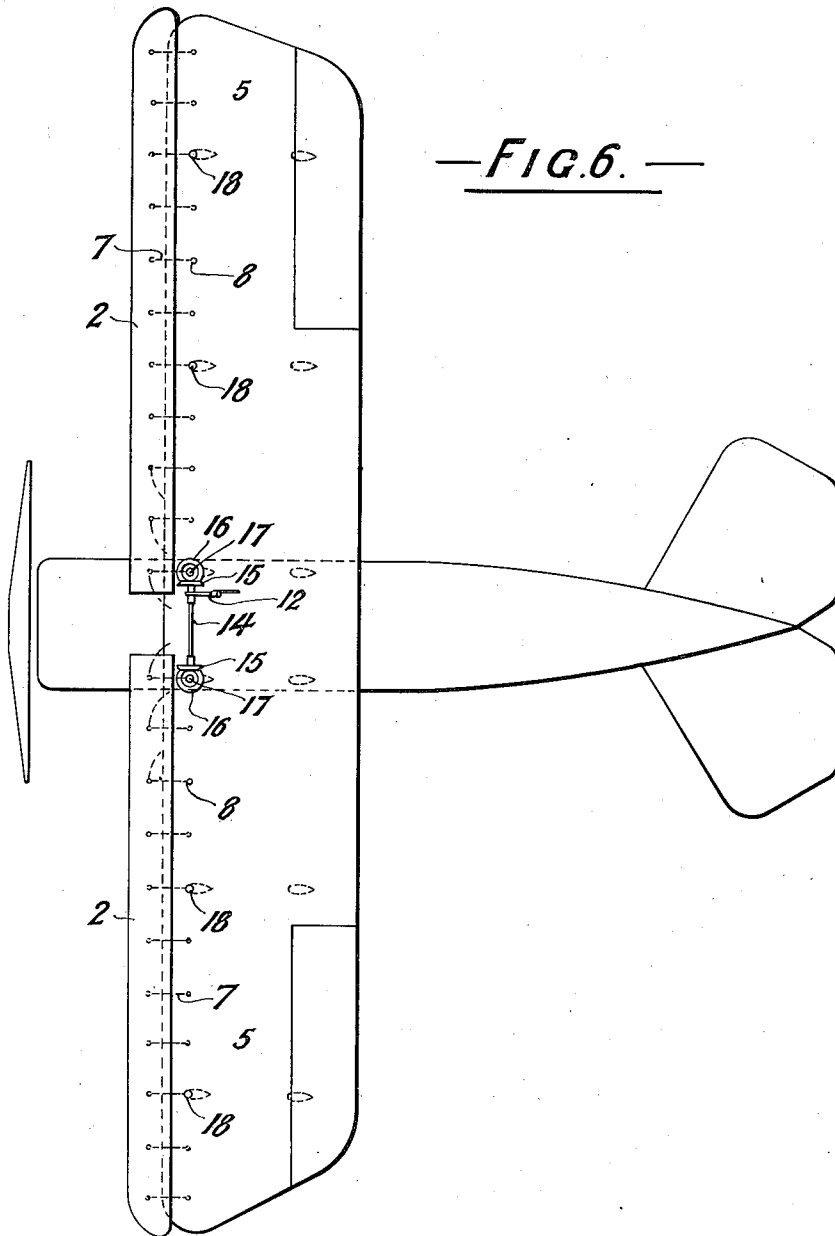
—*FIG. 5.*—

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Frederick Handley Page
By *[Signature]*
Att'y.

UNITED STATES PATENT OFFICE.

FREDERICK HANDLEY PAGE, OF LONDON, ENGLAND, ASSIGNOR TO HANDLEY PAGE LIMITED, OF LONDON, ENGLAND.

WING AND SIMILAR MEMBER OF AIRCRAFT.

1,353,666.

Specification of Letters Patent. Patented Sept. 21, 1920.

Application filed July 6, 1920. Serial No. 394,148.

To all whom it may concern:

Be it known that I, FREDERICK HANDLEY PAGE, a subject of the King of Great Britain, residing at London, England, have
5 invented certain new and useful Improvements in the Wings and Similar Members of Aircraft, of which the following is a specification.

In aeroplane flying machines, the object
10 of the wings and similar members is to deflect the air through an angle so as to obtain the lifting force due to the change of momentum in the air, and it has been found by experience that a thick or highly cambered wing has a larger lift per unit surface
15 than a less cambered or thinner wing, but the highly cambered wing has a disadvantage in that the resistance to passage through the air at small angles and at small values of the lift, is large.

Moreover it is already known that when a wing is inclined at an angle to the air through which it passes or which acts against it, that the lift coefficient of such a
25 wing increases with the increase of its angle up to a certain critical angle which varies between 12° and 25°. After this critical angle is passed the value of the lift coefficient of the wing decreases owing to an
30 effect called a "bubbling" taking place over the forward portion of the upper surface of the wing; and owing to such action the air flowing over the forward portion of the upper surface of the wing no longer exerts
35 its full suction effort, and this is due to a discontinuity of flow between the live air stream and the wing producing a region of eddying air, which above has been termed a "bubbling," and which makes it impossi-
40 ble for the full effect of the air suction to be obtained.

Now the primary object of the present invention is to provide means or a construction whereby this bubbling effect on the
45 back or upper surface of the forward portion of a wing can be overcome, so that the same lift can be obtained at slower speeds than is now possible even when the wing is inclined at a greater angle than
50 heretofore to the air through which it is driven.

For this purpose and according to this invention, the wings and similar members are constructed with a comparatively nar-

row through slot or, what is equivalent, a 55 series of slots in line, near the nose or front portion, said slot or series of slots extending substantially throughout the wing in a direction transverse to the direction of flight, in order that it or their influence 60 may be exerted at all points of the wing. When the wing has such a slot, or series of slots formed integral in its construction, a portion of the said wing obviously forms the front wall of the slot or series of slots, 65 or equivalently such front portion of the said wing may be constituted by a small auxiliary wing, either constructed integral with the structure of the remaining rearward main portion, which latter will be 70 termed the main wing, or constructed separately and connected thereto.

For the purposes of this specification it is therefore to be understood that the portion 75 of the main wing constituting the front wall of the slot or the small auxiliary wing above referred to, are alternative expressions, and such will be referred to hereafter as the auxiliary wing.

There have of course been numerous sug- 80 gestions for aeroplane construction comprising combinations of wings, arranged in some instances superposed and others in tandem, and in some cases the multiple wings have been of similar, and in others 85 of different, dimensions, but in no case have these wings been so designed as to bring about the objects of this invention, *i. e.*, that the forward auxiliary wing shall so influence the main after wing as to enable the 90 latter wing to be used at greater angles of incidence than it could otherwise have been, without bubbling ensuing.

In order to produce this result it is necessary that the auxiliary wing should be set 95 at an angle relatively to the main wing so as to mask its leading portion without being in contact with it, by having the nose of the auxiliary wing at the approximate level of the nose of the main wing, and having 100 its angle of incidence less than the angle of incidence of the main wing.

In explanation of said difference in angle of incidence, the chord of the auxiliary wing drawn from the tail to the nose (as indi- 105 cated by the line A—B in Fig. 1 of the drawings hereafter further referred to) must be at a less angle of incidence than the

chord of the main wing. Thus if, for example, there is a difference in angle of 30° between the chord of the main wing and the chord of the auxiliary wing, and the main wing happens to be at an angle of incidence of $+10^\circ$, then the angle of incidence of the auxiliary wing (or of the front face of the slot) would be -20° .

We wish it therefore to be understood that the aforesaid two features of arrangements, namely that the nose of the auxiliary wing shall be located at the approximate level of the nose of the main wing so as to mask the leading portion of the latter, and that such auxiliary wing shall be at a less angle of incidence than that of the main wing, are necessary characteristics of our invention, and when we speak herein of a slot we mean a slot or its equivalent possessing these features.

It is preferable to make the rear edge of the auxiliary wing (or the portion of the main wing forming the front wall of the slot) terminate at about the same height above the chord of the main wing as the highest point of the camber of such wing.

A wing may according to this invention be constructed or fitted with a plurality of such auxiliary wings forwardly located, one auxiliary wing rearward of the other, and in such case it is preferable that the slot formed between the most forward auxiliary wing and the next rearward auxiliary wing should be of greater dimension in the direction of motion of the wing through the air, than the next rearward slot, so that the most forward slot presents the largest openings on the top and bottom surfaces of the wing and the most rearward slot has the smallest openings.

In carrying out the invention, the opening of each slot formed between the auxiliary wing and the main wing has its opening on the upper surface of the wing at a short distance rearward of its opening on the under surface, and usually the dimension of the opening of a slot on the under surface of the wing in the direction of the line of flight is made greater than the opening on the upper surface.

The walls of the slot or slots, considering a wing section, are preferably curved rearwardly from the lower opening to the upper opening, it being a practical consideration in the construction that the air passing through the slot should be directed with a minimum possible change of direction from the under surface where there is pressure to the upper surface where there is suction.

We have found that by constructing the wing with one or a plurality of slots as above stated, a greatly increased lift coefficient can be obtained by such a wing when inclined at considerable angles to the air through which it is driven. By this con-

struction we are enabled to use a slightly cambered wing of the type possessing a high ratio of lift to drag and at the same time secure the advantages of a highly cambered wing, say on a machine carrying heavy weights, without the disadvantages of such a highly cambered wing which have been above stated.

The invention further provides means whereby the slot or slots formed between the auxiliary wing or wings and the main wing can be mechanically wholly, or partially, opened or closed preferably by the aviator while in flight, and this is particularly advantageous for application to a high performance machine, in which, owing to the normal high speed of landing, the great advantage is obtained of being able to reduce the landing speed by opening the slots, the latter at other times being closed.

It will be understood that when the slots are permanently open the resultant wing is suitable for use on a machine carrying heavy weights, whereas previously to this invention such a machine would have had a very highly cambered wing with its attendant disadvantages, the open slot or slots enabling the wing to be at considerable angles to the air through which it passes and to maintain the lift even when flying at slower speeds than has hitherto been possible.

Where it is desired to construct a wing so that the slot or slots formed between the auxiliary wing or wings and the main wing shall be capable of being closed at will, the auxiliary wing or wings can conveniently be made so as to be capable of being moved into contact with each other and with the rearward main wing, as by pivoting the auxiliary wing to the main wing, or equivalent means may be adopted for effecting closure of the slots when required, the invention not being limited to the mechanical details of the means by which such closure may be effected, but the means should be such that the slots on both sides of the longitudinal center line of the machine are actuated together.

The invention will be further described with reference to the examples of construction shown on the accompanying drawings.

Figure 1 shows by a diagram view, a wing section formed with a single through slot comprised between a front portion or auxiliary wing and a main rearward portion or main wing, said slot extending in length transversely of the direction of motion of the wing through the air, and Fig. 2 is a similar view showing a plurality of such slots according to this invention.

Figs. 3 to 7 show an example of construction of the invention in which the auxiliary wing is pivotally connected to the main wing so that the slot aforesaid can be opened or closed, and also illustrates an example of

the means by which such opening or closure of the slot can be effected by the aviator during flight.

Fig. 3 is a sectional elevation of a portion of the wing showing the pivotally connected auxiliary wing in the position taken when the through slot is open. Fig. 4 is a plan view of the same, and Fig. 5 is a sectional elevation showing the pivotally connected auxiliary wing in position when the through slot is closed. Fig. 6 is a plan view of an aeroplane flying machine constructed with the pivoted auxiliary wing as at Figs. 3 and 4, and Fig. 7 illustrates a means by which the auxiliary wing can be moved so that the through slot can be opened or closed at will by the aviator.

The diagram at Fig. 1 shows a wing section having a single through slot 1 formed between the auxiliary wing 2 and the main wing 5, in which latter, 3 and 4 represent the spars, or what has been explained as equivalent, the wing section has the slot 1 formed between a front portion 2 and a main rearward portion 5, and obviously the auxiliary wing 2 might be constructed integral with the main wing 5, or might be constructed separately and suitably connected to the main wing 5.

The slot 1 so formed, is located near the nose or front portion of the wing section and extends in length substantially throughout the wing in a direction transversely of the line of flight.

The nose of the auxiliary wing 2 is located at the approximate level of the nose of the main wing 5 and also the auxiliary wing 2 is set at an angle of incidence less than the angle of incidence of the main wing, so as to mask the leading portion of the latter. The slot 1 is formed so that the opening on the upper surface of the wing is at a short distance rearward of the opening of the slot on the under surface, and the slot 1 on the lower surface is greater in dimension in the direction of the line of flight than the same slot on the upper surface.

At Fig. 2 a wing section is shown having two auxiliary wings 2, 2^x forming between themselves and with the main wing 5, two through slots 1, 1^x, the slot 1^x extending parallel with the slot 1 and the slot 1 is of greater dimension in the direction of the line of flight than the slot 1^x.

In order to fully explain an example of a means by which the invention can be carried into effect so far as regards the operation of opening and closing the slot or slots during flight by the aviator, the construction will be now referred to as shown at Figs. 3 to 7.

Referring more particularly to Figs. 3, 4 and 5, the auxiliary wing 2 is carried by arms 7, the rearward ends of which may conveniently be pivoted upon substantially ver-

tical pivots 8, carried from the forward spar 3 of the main wing 5, while the forward ends of the arms 7 carry by approximately vertical pivots 6 the auxiliary wing 2, and by reference to Fig. 4 it will be observed that when the arms 7, of which there are a plurality parallel to each other, are in line with the line of flight, the auxiliary wing 2 is distanced from the main wing 5, and the nose of the auxiliary wing is approximately at the level of the main wing and set at a less angle of incidence than that of the main wing; it will also be observed that the slot 1 is produced which has its lower opening of a larger dimension in the direction of flight than its upper opening, and further that the lower opening is forward of the upper opening, and the walls of the slot are curved rearwardly. It may be mentioned that the auxiliary wing 2 is slotted at 9, Fig. 4, and the front part of the main wing 5 is slotted at 10, Fig. 4, to permit of the angular movement of the arms 7. It will be readily understood that by placing the arms 7 at an angle as indicated by dotted lines at 11, Fig. 4, the auxiliary wing 2 will be closed upon the leading part of the main wing 5 as shown at Fig. 5, while when in the position shown at Figs. 3 and 4 the slot 1 is open, the auxiliary wing 2 thus having adjustment relatively to the main wing after the manner of a parallel ruler.

Various constructions of means may be adopted whereby the aviator may effect the opening or closing of the slots, and in the example shown at Figs. 6 and 7 as applied to the construction described with reference to Figs. 3, 4 and 5, the machine is fitted with a hand lever 12 within reach of the aviator, the position of which can be governed by a sector 13 as is well known, and the hand lever 12 is fixed on a shaft 14, which in the instance illustrated at Fig. 6 has fixed on either end a bevel pinion 15.

In the construction shown at Fig. 6 the auxiliary wing 2 is divided centrally into two parts, which when moved to their closing position approach each other at the central division.

Each bevel pinion 15 gears with a bevel pinion 16 fixed on a shaft 17, the upper and lower ends of which are in rigid connection with the arms 7 of the auxiliary wing 2 adjacent to the longitudinal center line of the machine and form the vertical pivots of those particular arms 7.

By this arrangement, considering a biplane machine as at Fig. 7, the auxiliary wings 2 of both the upper main wing and the lower main wing will be simultaneously operated and adjusted in position by the aviator through the medium of the lever 12.

Obviously so as to assure uniformity of motion between the auxiliary wings 2 of the upper and lower main wings, the arms 7 of

the upper and lower main wings may be connected at other points by vertical shafts indicated at 18, Fig. 6.

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

1. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said auxiliary wing having its nose located at the approximate level of the nose of the main wing and said auxiliary wing having its angle of incidence less than the angle of incidence of the main wing so as to mask the leading portion of said main wing.

2. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said auxiliary wing having its angle of incidence less than the angle of incidence of said main wing, having its nose located at the approximate level of the nose of the main wing, and having its upper rearward edge at approximately the same distance above the chord of the main wing as the highest point of the camber of said main wing so as to mask the leading portion of said main wing.

3. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said slot formed between said auxiliary wing and said main wing having its opening on the upper surface of the wing at a short distance rearward of its opening on the under surface of the wing, said auxiliary wing having its angle of incidence less than the angle of incidence of said main wing, having its nose located at the approximate level of the nose of the main wing, and having its upper rearward edge at approximately the same distance above the chord of the main wing as the highest point of the camber of said main wing so as to mask the leading portion of said main wing.

4. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said slot formed between said auxiliary wing and said main wing having its open-

ing on the upper surface of said wing less in width in the direction of the line of flight than its opening on the under side of said wing, said auxiliary wing having its angle of incidence less than the angle of incidence of said main wing, having its nose located at the approximate level of the nose of the main wing, and having its upper rearward edge at approximately the same distance above the chord of the main wing as the highest point of the camber of said main wing so as to mask the leading portion of said main wing.

5. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, the walls of said slot being curved rearwardly from the lower opening to the upper opening to direct the air passing through said slot with a minimum possible change of direction from the lower surface of the wing where there is pressure to the upper surface where there is suction, said auxiliary wing having its nose located at the approximate level of the nose of the main wing, and said auxiliary wing having its angle of incidence less than the angle of incidence of the main wing so as to mask the leading portion of said main wing.

6. In aeroplane flying machines; wings and similar members each constructed with a plurality of small forwardly located auxiliary wings, located one behind the other and separated from each other and from the main wing to produce a plurality of narrow through slots lying one behind the other, each slot extending substantially throughout the wing in a direction transversely of the line of flight, each auxiliary wing being located with its nose at the approximate level of the nose of the main wing, and each auxiliary wing having its angle of incidence less than the angle of incidence of the main wing.

7. In aeroplane flying machines; wings and similar members each constructed with a plurality of small forwardly located auxiliary wings; located one behind the other and separated from each other and from the main wing to produce a plurality of narrow through slots situated one behind the other, the slot formed between the most forward auxiliary wing and the next rearward auxiliary wing being of greater dimension in the direction of motion of the wing through the air than the next rearward slot so that the most forward slot presents the largest openings on the top and bottom surfaces of the wing and the most rearward slot has the smallest openings, each slot extending substantially throughout the wing

in a direction transversely of the line of flight, each auxiliary wing being located with its nose at the approximate level of the nose of the main wing, and each auxiliary wing having its angle of incidence less than the angle of incidence of the main wing.

8. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said auxiliary wing having its nose located at the approximate level of the nose of the main wing, and said auxiliary wing having its angle of incidence less than the angle of incidence of the main wing so as to mask the leading portion of said main wing, and means to mechanically, wholly or partially open or close said slot so formed between said auxiliary wing and said main wing.

9. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said auxiliary wing having its nose located at the approximate level of the nose of the main wing, and said auxiliary wing having its angle of incidence less than the

angle of incidence of the main wing so as to mask the leading portion of said main wing, and means located adjacent to and operable by the aviator to wholly or partially open or close said slot so formed between the said auxiliary wing and said main wing.

10. In aeroplane flying machines; wings and similar members each constructed with a small forwardly located auxiliary wing, separated from the main wing to produce a comparatively narrow through slot extending substantially throughout the wing in a direction transversely of the line of flight, said auxiliary wing having its nose located at the approximate level of the nose of the main wing, and said auxiliary wing having its angle of incidence less than the angle of incidence of the main wing so as to mask the leading portion of said main wing, pivoted links to pivotally connect said auxiliary wing to said main wing so that said auxiliary wing can have parallel motion of adjustment to or away from said main wing to wholly or partially open or close said slot, and mechanism located adjacent to and operable by the aviator whereby said auxiliary wing can be adjusted relatively to said main wing to wholly or partially open or close said slot.

In witness whereof I have hereunto set my hand in the presence of two witnesses.

FREDERICK HANDLEY PAGE.

Witnesses:

JOHN WATT,

CYRIL GRIFFITH BREWER.