PATENT SPECIFICATION

Application Date: Aug. 31, 1936. No. 23758/36. **472,567**

Complete Specification Left: Jan. 23, 1937.

Complete Specification Accepted: Sept. 27, 1937.

PROVISIONAL SPECIFICATION

Improvements in Aerofoils with Variable Camber

I, HORACE CHARLES LUTTMAN, 1, Hooley Range, Heaton Moor, Stockport, Cheshire, British, do hereby declare the nature of this invention to be as follows:—

The mechanism consists of two main parts (a) the rib (b) the skin.

(a) The rib (see figures 1, 2 and 3 in the accompanying drawings).

The unit consists of two links AB and CD, pin-jointed at A, B, C and D to the spar AC and to the rigid rib BD (fig. 1). The movement is indicated by the dotted lines.

This unit may be considered as a hinge. AC represents the rear spar of the wing or tail plane, or the fin post; BD being a rib of the moving component. The control may be incorporated in the hinge fairings 1 and 2, themselves hinged at or near D and B and sliding over the spar and under the surfaces of the main or fixed component. By pulling, or pushing, through 1 or 2 the flap BD may be raised, or lowered.

If now two or more of these units are superimposed a link mechanism is formed which can be regarded as the basis of the variable camber rib (fig. 2). To insure a uniform and unique movement throughout the mechanism it is necessary to add links alternately connecting the units, e.g., AH or CE and DG or BF. Taking units ABCD and BDEH, if BD is connected only AH or CE can be connected, that is AB and DH, CD and BE may be connected by only two links, say AH and DB. If now symmetry of movement is required D and B may be imagined to move down DC and BE respectively, to give a link CE.

(Hence for a rudder where symmetrical movement is required DB and EH would be omitted and the links arranged as in fig. 3: whereas for an aileron, where greater travel upwards than downwards may be desired, an arrangement similar to fig. 2 can be adopted.)

By studying the diagrams 2 and 3 it will be realised that the mechanism is composed of two separate series of units; (a) the primary series, composed of links such as AB, CD, DH and so on; (b) the secondary series, composed of links such as AH, CE, DG and so on, with links DB, EH as alternatives as explained.

(b) The skin (see figures 4 and 5 in the accompanying drawings).

Several such ribs as described above may be fitted, pin-jointed at such points as A and C to the rear spar of the fixed component. Parallel to this spar and along the length of the moving component run hinges w; x, y and z. These are attached to the rib mechanism by links Bx, Ez, Dw and Hy (see figs. 4 and 5).

These hinges connect, along the chord, light rigid panels 1, 2, 3, 4, 5 and 6; 5 and 6 being hinged at their rear edges at or near F and G to the rigid triangular section trailing edge 1 and 2 consisting of part rigid panel and part slightly flexible fairing, the division being at f whose position is determined by the travel of the component.

The control is transmitted through the skin, which may be stiffened in the neighbourhood of the ribs for this purpose. The directions of the control forces are indicated by arrows on fig. 4.

In the diagrams shown three primary and two secondary units are used but any number may be employed if desired, giving of course greater approximation to a smooth surface in all positions though increasing the weight and complications. By a suitable choice of link lengths and arrangement of units almost any type of variable camber movement can be obtained. As an example of this it may be noted that if the links DG and EG do not cross BF and HF, i.e., if the positions of G and F are interchanged, then the trailing portion will move in an opposite direction to the remainder of the component giving a servo device to the control.

The mechanism may be applied to ailerons, rudder and elevator surfaces and on large aircraft to trimmers, bias or servo flaps.

Dated the 27th day of August, 1936.

HORACE C. LUTTMAN.

[Price 1/-]

COMPLETE SPECIFICATION

Improvements in Aerofoils with Variable Camber

I, HORACE CHARLES LUTTMAN, 1, Hooley Range, Heaton Moor, Stockport, Cheshire, British, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

GENERAL.

This invention relates to a means of effecting variation in the camber of an aerofoil by a structure having a hinged or flexible skin supported on ribs of link mechanism capable of deflection to any desired angle by forces transmitted through the skin. It is possible by this means to obtain a comparatively smooth surface for the aerofoil in any position of the control surface, without the break in contour which is unavoidable with the orthodox hinged components.

According to the present invention the main component, wing, fin or tail plane, is of normal construction. The control component, aileron, flap, rudder or elevator, consists of two principal parts, ribs of link mechanism and a skin which may be flexible or made up of panels hinged to one another along their span—or vertically in the rudder case. The skin is so arranged that it may slide under a fairing or extension of the skin of the main component and is hinged at its rear end to the rigid triangular trailing portion of the control component. It is attached to the mechanism of the rib by links at each hinge between the panels.

The link mechanism of the rib is composed of two series of units. In one series each unit consists of two crossed links pin-jointed to the links of the next unit along the chord. In the other series the units consist of two crossed links, the units over-lapping one another by the length of one unit of the first series and picking up the pin-joints between alternate units of the first series. At one end both series are pin-jointed to the spar or subsidiary member of the main component and at the other end to the rigid triangular trailing portion of the control component.

Movement of the control surface is effected by forces transmitted from within the aerofoil through the skin to the rigid triangular trailing portion.

The mechanism may also be applied to trimmers, bias or servo flaps on control components of orthodox construction on large airtraft.

The drawings accompanying this specification are as follows:—

Figs. 1, 2 and 3 indicate diagrammatically the general arrangement of the linkage, showing the development of the principle from the single unit to the full rib.

Fig. 4 gives details of the assembly of a typical rib.

Fig. 5 indicates in the same manner as Figs. 1, 2 and 3 the further development of the principle to the method of attaching the skin.

Figs. 6 and 7 are perspective views showing a suitable arrangement of the skin and a general lay-out of a control component.

Fig. 8 indicates, in the deflected position, the modified arrangement of the rib linkage so that the trailing portion moves in the opposite direction to the rest of the component, giving a servo device.

THE UNIT:

Considered as a means of providing a faired flexible hinge joint between a rigid main component and a rigid but movable control surface, the unit consists of two links AB and CD, pin-jointed at A, B, C and D to the spar AC and to the rigid rib BD (shown cross-hatched in fig. 1 of the accompanying drawings). The movement is indicated by the dotted lines.

AC represents the rear spar or a subsidiary spar of the main component; BD being a rib of the control component. The control may be incorporated in the hinge fairings 1 and 2, themselves hinged at or near D and B and sliding over the spar and under the surfaces of the main component. By pulling, or pushing, through 1 or 2 the member BD may be raised, or lowered.

THE RIB:

(a) Principle of operation.

If now two or more of these units are added a link mechanism is formed which can be regarded as the basis of the variable camber rib. (See fig. 2). To ensure a uniform and unique movement throughout the mechanism it is necessary to add links alternately connecting the units, e.g. AH or CE and DG or BF. Taking units ABCD and BDEH, if BD is connected only AH or CE can be connected, that is AB and DH, CD and BE may be connected by only two links, say AH and DB. If now symmetry of movement is required D and B may be imagined to move along DC and BE respectively, to give a link CE.

(Hence for a rudder where symmetrical movement is required DB and EH would

be omitted and the links arranged as in fig. 3: whereas for an aileron, where greater travel upwards than downwards may be desired, an arrangement similar to fig. 2 can be adopted.)

By studying the diagrams 2 and 3 it will be realised that the mechanism is composed of two separate series of units; (a) the primary series, composed of links such as AB, CD, DH and so on; (b) the secondary series, composed of links such as AH, CE, DG and so on, with links DB, EH as alternatives, as explained.

(b) Construction.

Eye-bolts at A and C through the top and bottom booms of the spar of the main component provide the necessary attachment for the rib links of the control component.

All the rib links are made of strip material with a bushed hole at either end. They are assembled as indicated in fig. 4 with a standard headed pin at each joint. (Fig. 4:—The "clocks" show the order of assembly at each joint; e.g. at joint H the link H*y* is on top 1, HA is second, HF third, a washer fourth and HD fifth at the bottom.) The rigid triangular trailing edge portion is a flanged pressing, with suitable lightening holes and bushed holes for the pin-joints at F and G.

THE SKIN:

The skin is composed of light panels 1, 2, 3, 4, 5 and 6 (see figs. 5 and 6, the latter showing 1, 3 and 5 only, for clearness) and a V-section panel 7 is fitted round the triangular trailing edge and riveted to the flanges of the ribs (fig. 7). These panels are rigid and may be attached to one another along the span by piano hinges *w*, *x*, *y* and *z*: 5 and 6 being hinged to panel 7 by hinges situated as near as possible to F and G.

The hinges occur opposite the pin-joints of the rib and are attached to the mechanism by links D*w*, B*x*, H*y* and E*z* (figs. 5, 6 and 7). These links pick up with the normal pin-joints at D, B, H and E and with the hinge pins at *w*, *x*, *y* and *z*, protruding as little as possible through the surface at these points.

The panels may be stiffened, if necessary, by light angle section N riveted to the inner surface diagonally between each rib, as shown in fig. 7. A light channel M is also riveted to the panels chordwise in the neighbourhood of the ribs.

Panels 1 and 2 are partly so stiffened and partly slightly flexible, the division being at *f* (fig. 5), with the flexible portions sliding under the upper and lower surfaces of the main component. The position of *f* is determined by the travel of the component.

Small holes may be provided near each rib and at each hinge to facilitate lubrication of the pin-joints of the mechanism.

All riveting is countersunk on the outer surface and the hinges are flush externally.

CONTROL:

The final points of application of the control forces are F and G. The control is transmitted via the skin, reinforced by the channel M, from *w* and *x* to G and F respectively.

Push and pull rods P, passing through the spar to a suitable differential, apply the control forces to *w* and *x* (see fig. 4).

NOTE:

In the component described above three primary and two secondary units are used but any number may be employed if desired, giving of course greater approximation to a smooth surface in all positions though increasing the weight and complications. By suitable choice of link lengths and arrangement of units many types of variable camber movement can be obtained. As an example of this it may be noted that if the links DG and EG do not cross BF and HF, i.e. if the positions of G and F are interchanged, then the trailing portion will move in an opposite direction to the remainder of the component giving a servo device to the control. (See fig. 8).

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. A hinge unit between the rear spar or subsidiary member of a fixed aircraft component and the spar of a control component constituted by links pin-jointed at their ends, diagonally connecting the upper and lower booms of the two spars.

2. A rib comprising a linkage comprising two series of hinge units as claimed in Claim 1, in one series each unit consisting of two cross links pin-jointed at their ends to the links of the next unit and in the other of two crossed links picking up alternate pin-joints between the units of the former series, the bays of the latter series overlapping one another by one bays length of the former series, both series terminating on the fixed spar of the main component at one end and on the rigid trailing portion of the rib at the other.

3. A movable portion of an aerofoil structure consisting of ribs as claimed in Claim 2 covered by a skin, which may be flexible or composed of hinged panels, attached to the rib mechanism by links between the pin-joints of the latter and the hinges of the skin, each hinge being

thus connected to one pin-joint, the skin sliding at one end under the outer surface of the fixed portion to compensate for the varying length thereof due to variations in camber of the aerofoil, and hinged to the skin of the rigid trailing portion of the aerofoil structure at the other.

4. A movable portion of an aerofoil structure as in Claim 3 actuated by forces transmitted chordwise, through the skin or otherwise, to the rear pin-joints of the rib linkage on the rigid trailing portion.

5. A linkage as claimed in Claim 1 or 2, in conjunction with a skin attached as claimed in Claim 3, employed to provide a faired hinge between a fixed and a movable component of otherwise orthodox design or between any two parts of an aerofoil as a means of effecting variations in camber.

Dated the 20th day of January, 1937.

HORACE C. LUTTMAN.

Leamington Spa: Printed for His Majesty's Stationery Office, by the Courier Press.—1937.

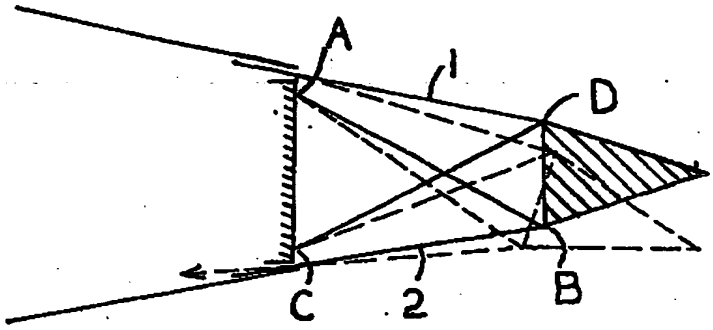

FIG. 1.

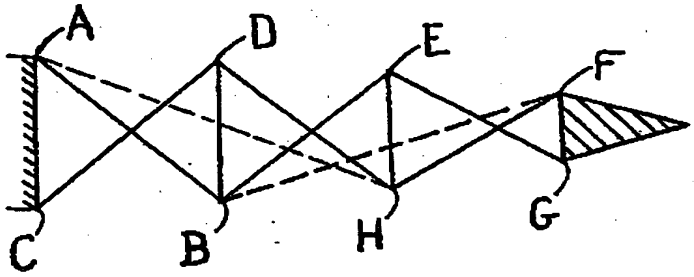

FIG. 2.

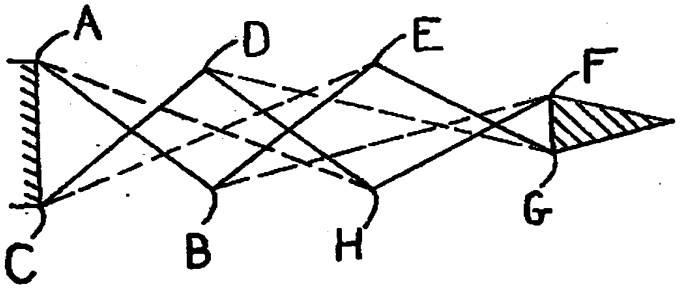

FIG. 3.

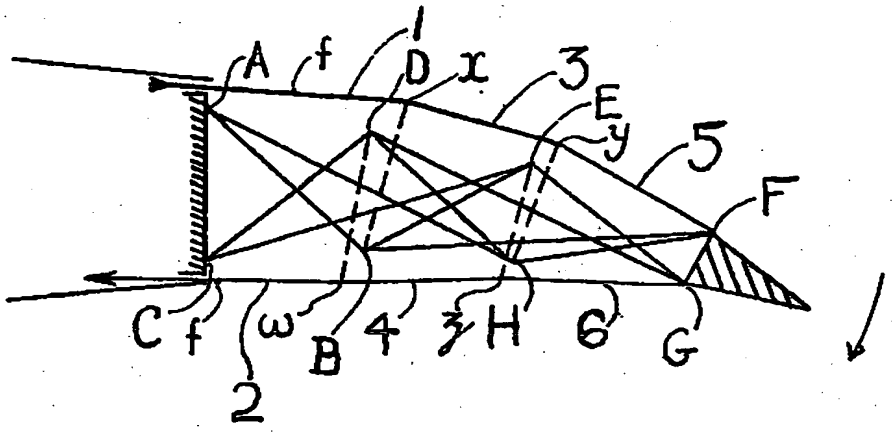

FIG. 4.

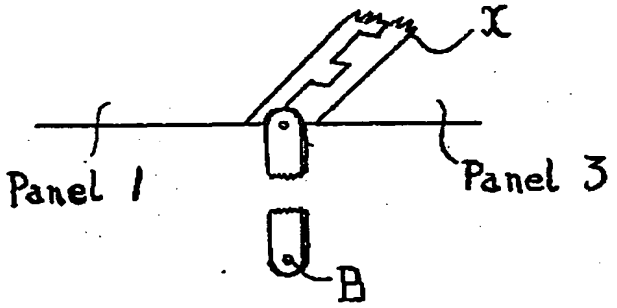

FIG. 5.

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SHEET 1

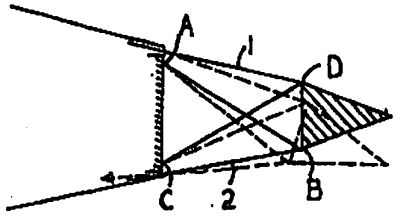

FIG. 1.

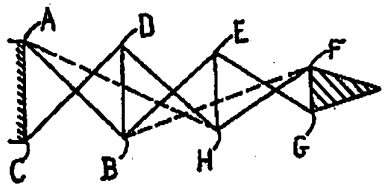

FIG. 2.

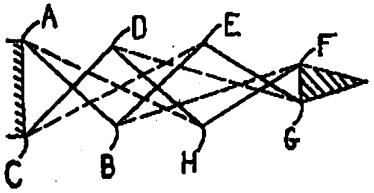

FIG. 3.

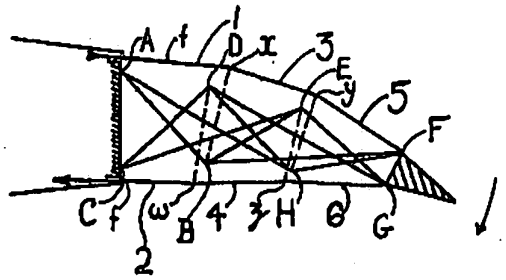

FIG. 4.

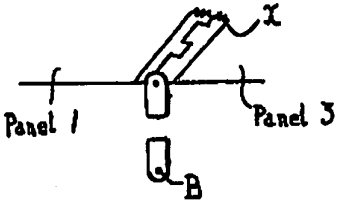

FIG. 5.

[This Drawing is a reproduction of the Original on a reduced scale.]

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FIG. 1.

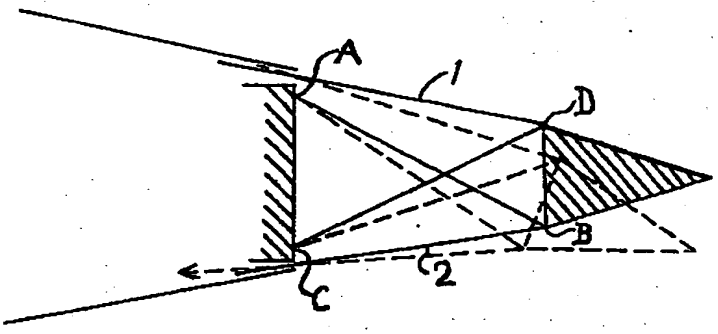


FIG. 2.

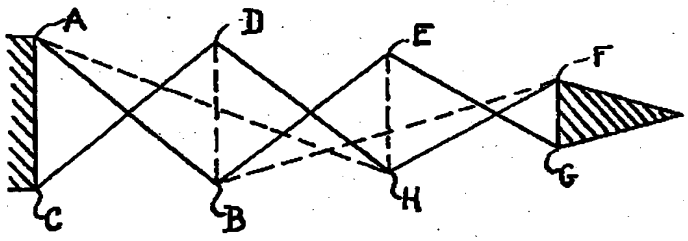


FIG. 3.

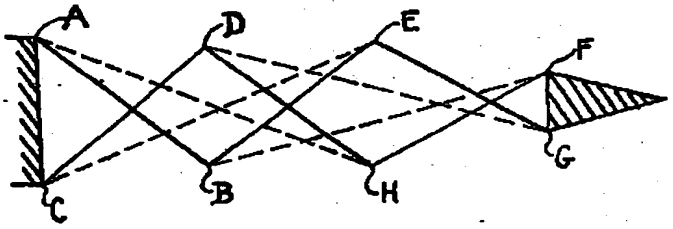
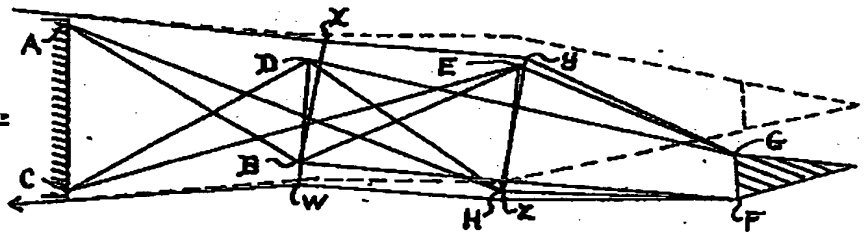
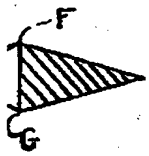
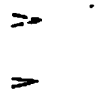
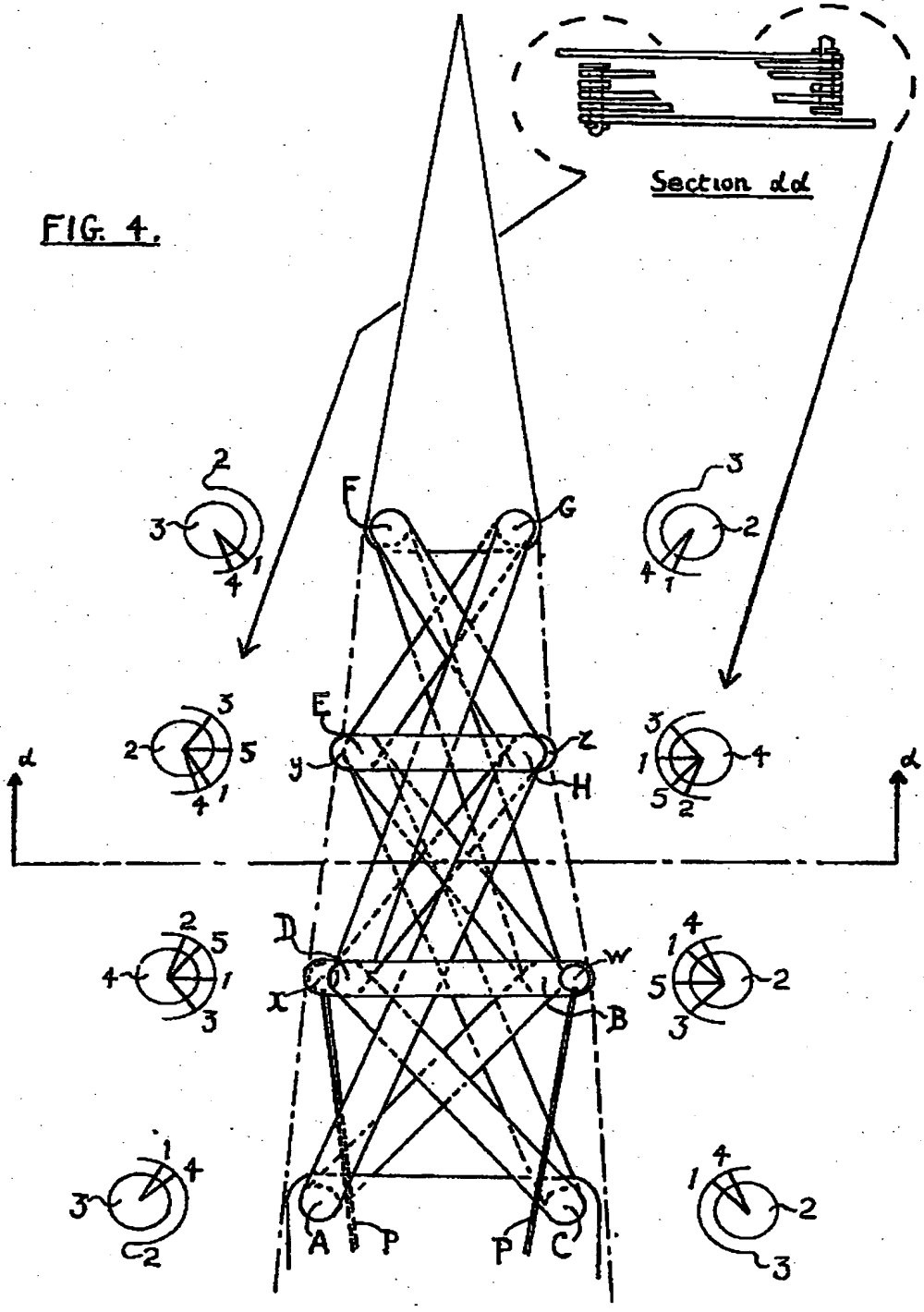


FIG. 8.









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472,867 COMPLETE SPECIFICATION

SHEET 1

[This Drawing is a reproduction of the Original on a reduced scale.]

FIG. 1.

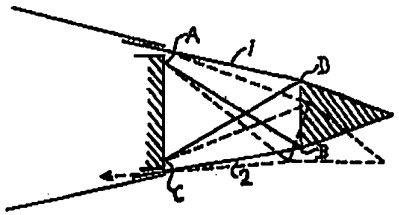


FIG. 2.

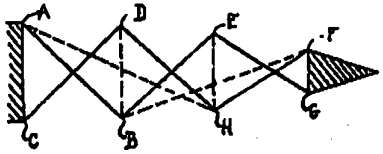


FIG. 3.

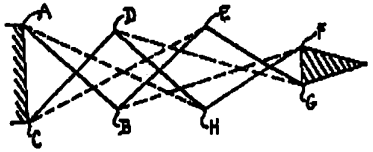


FIG. 8.

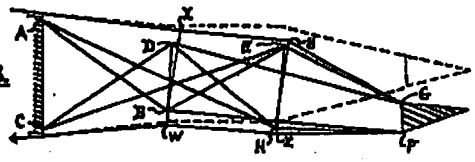
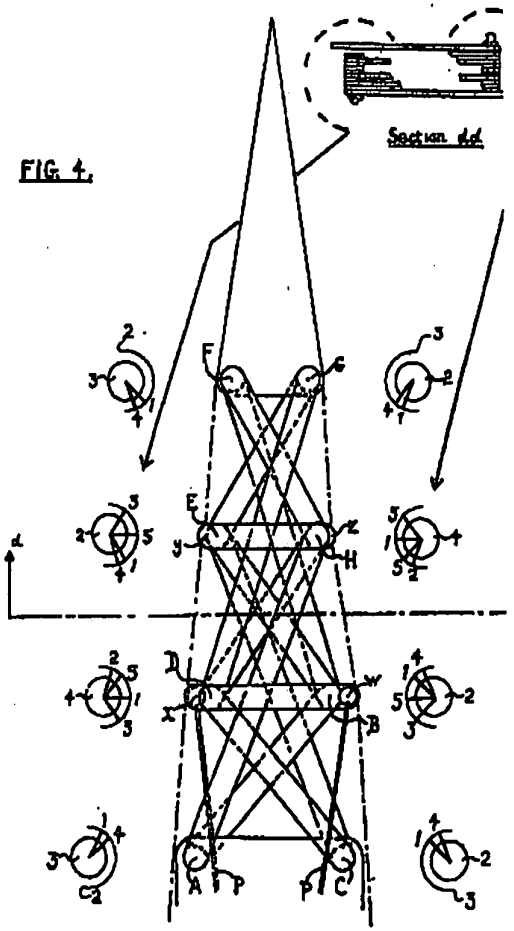


FIG. 4.



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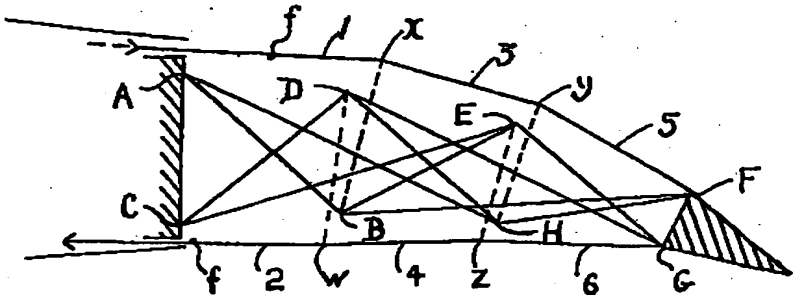
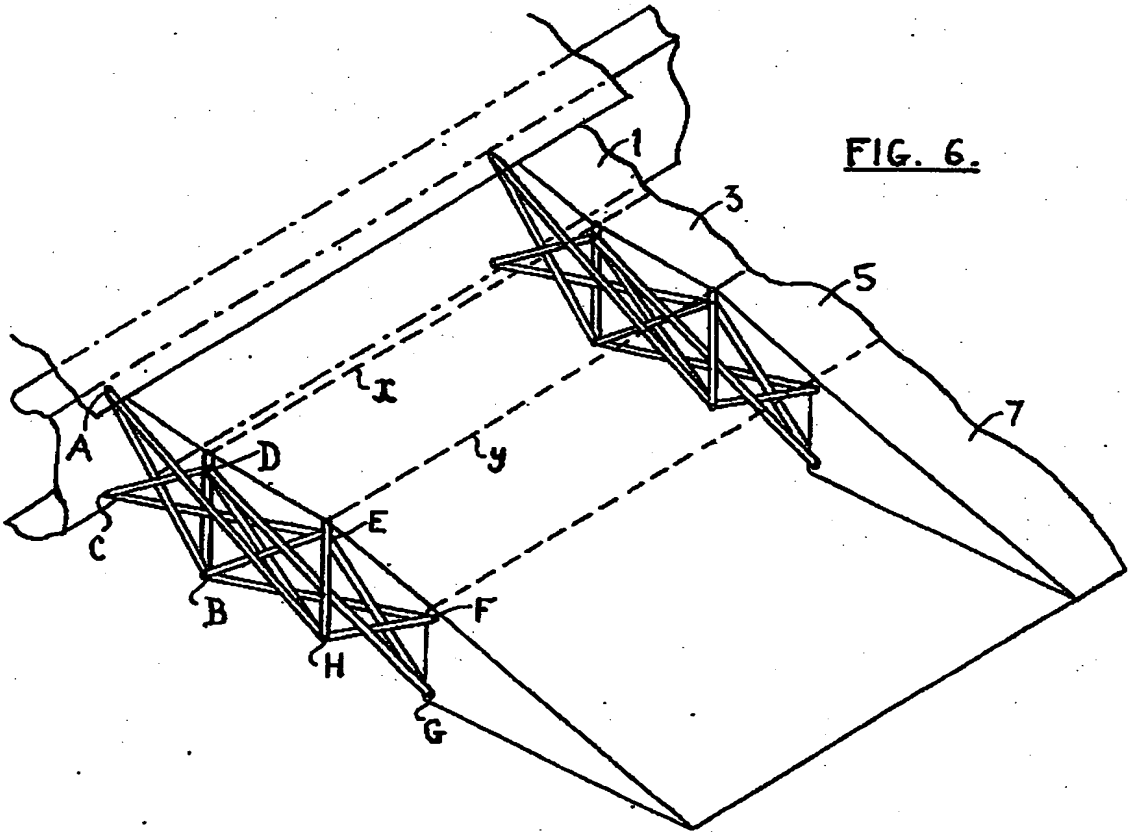


FIG. 5.



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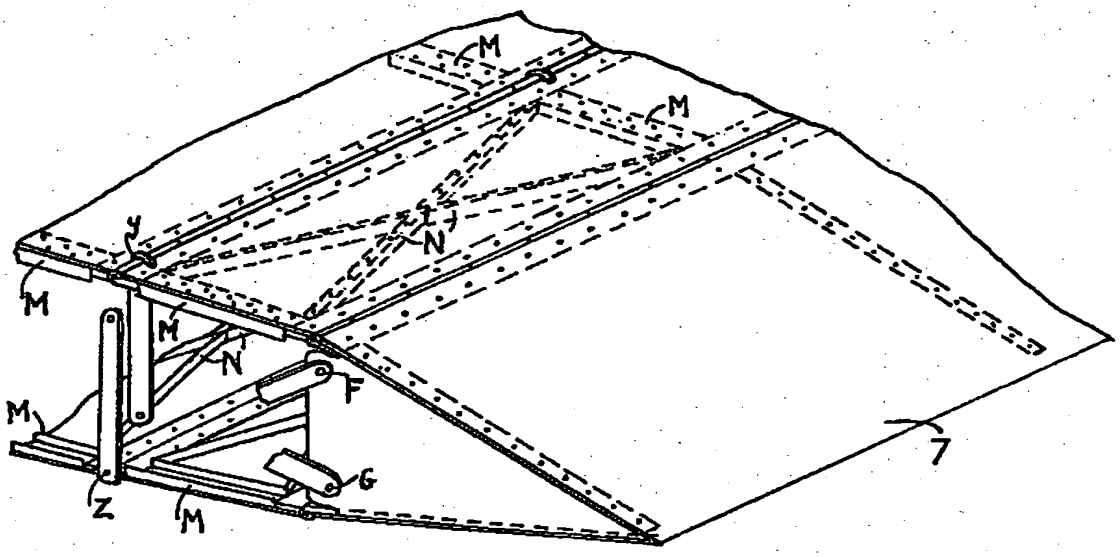

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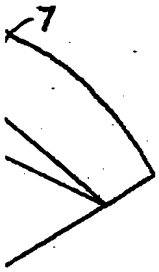

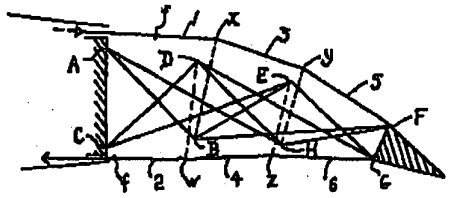

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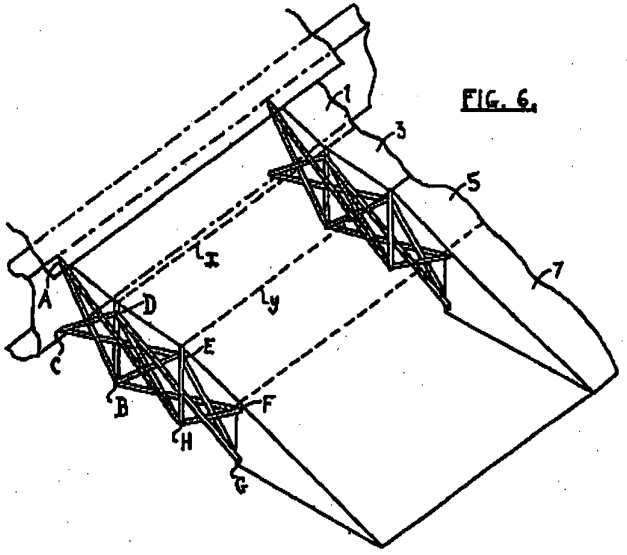

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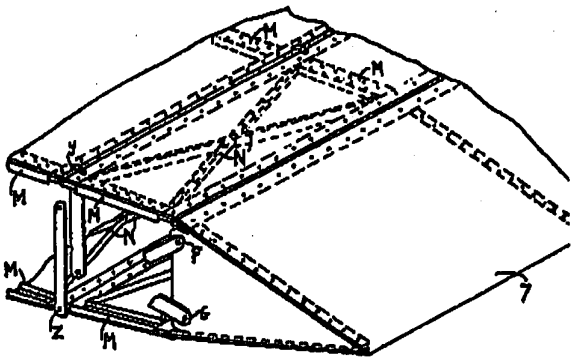

FIG. 7.

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