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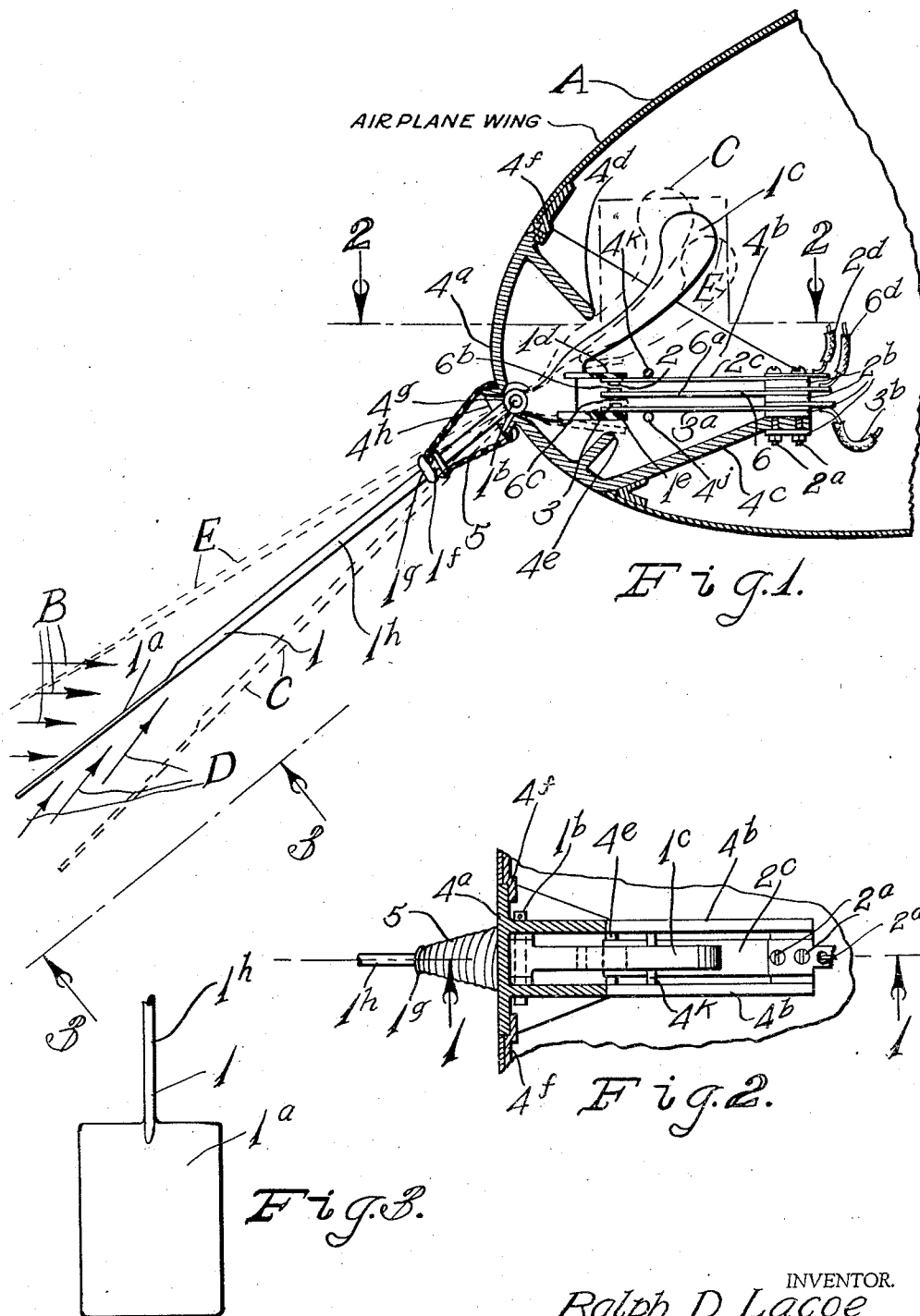
R. D. LACOE

2,328,384

AIRPLANE STALL AND HIGH SPEED INDICATING APPARATUS

Filed March 3, 1941

2 Sheets-Sheet 1



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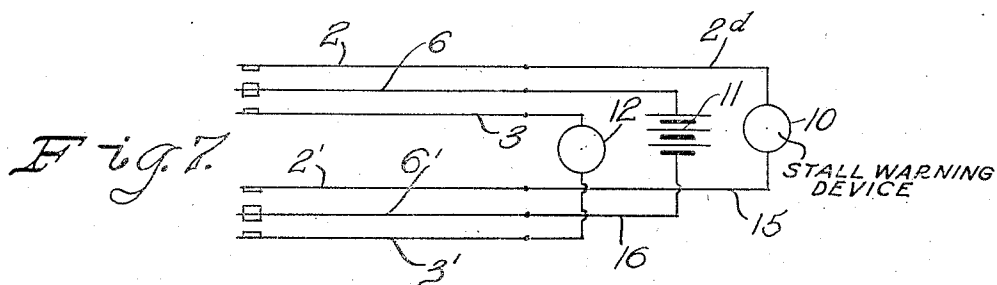
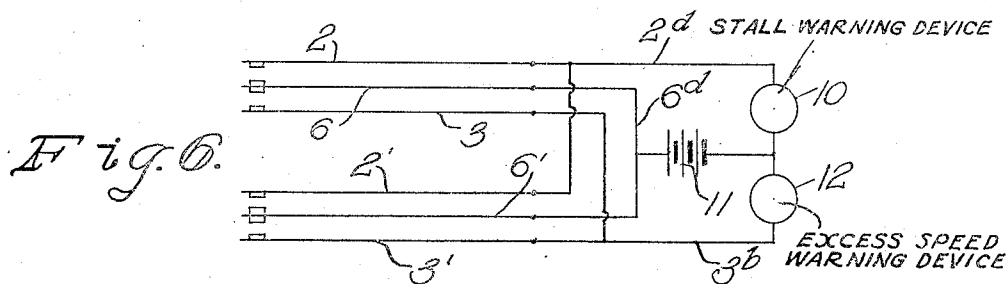
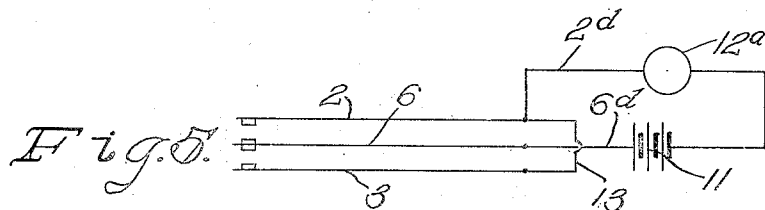
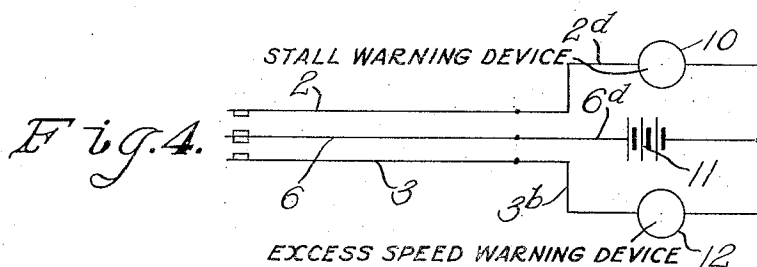
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2 Sheets-Sheet 2



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AIRPLANE STALL AND HIGH-SPEED
INDICATING APPARATUS

Ralph D. Lacoe, San Diego, Calif.

Application March 3, 1941, Serial No. 381,454

5 Claims. (Cl. 177—311)

My invention relates to a device usable on an airplane to determine the approach or presence of a dangerous flying condition. More particularly, the preferred embodiment relates to a device capable of giving an indication to the pilot upon the approach or presence of either a stalling condition or a high speed condition.

In my co-pending application, Serial No. 380,280, I have disclosed an air vane extending generally forward in the air stream produced by the forward movement of an airplane through the air. This air vane is inclined slightly downward so that, during normal flight, the air stream strikes the upper surface thereof to exert a downward pressure which is resisted by suitable stop means. However, upon the approach of stalling conditions, the position of the vane is such that air will strike the under portion thereof and lift it to give an indication of the dangerous condition. In my application supra, a secondary air vane is shown, cooperatively associated with the main air vane in such manner as to give an indication of the approach or presence of a maximum allowable speed condition, thus permitting the pilot to correct this condition before structural failure occurs.

It is an object of the present invention to use a single air vane to give an indication of the approach or presence of a stalling condition and of a high-speed condition, such indications being given on the same or different indicating means which may warn the pilot through visual, audible, or otherwise sensitive means.

Another object of the invention is to movably mount an air vane in the air stream in such position that the air will strike the upper surface thereof during normal flight but will strike the lower surface thereof upon the approach or presence of a stalling condition, in combination with a means resiliently restraining the downward force on the air vane in normal flight. When the forward speed of the airplane becomes such as to move the vane against the action of this resilient means to a predetermined position, a high-speed indication will be given. It is another object of the invention to apply such a restraining force to the air vane throughout only a portion of its locus of motion.

As discussed in my application supra, the air vane may be positioned sufficiently far removed from the fuselage and wings of an airplane so as not to be substantially influenced by deflected portions of the air stream moving thereadjacent. The present invention can be used in such an environment and can produce both a high speed and stall indication without the use of a secondary air vane. In this and other respects, the present invention is an improvement on that shown in my application supra.

On the other hand, the present invention is

concerned, in one of its aspects, with the novel positioning of an air vane to be influenced by air currents adjacent an airfoil, for example, an airplane wing, and this embodiment of the invention will be particularly described by way of example.

It is an object of the present invention to provide a device for indicating a flight condition of an airplane and which is responsive to the conditions of air flow in the vicinity of an airfoil. In this manner, the device can be sensitive to the very conditions which establish a condition of dangerous flight.

While the invention can be used to be responsive to air currents other than those affected by and flowing in the vicinity of an airfoil, it is particularly applicable to use in conjunction with the wing of an airplane, and this embodiment will be described in detail, without intention of limiting the invention thereto.

During normal flight, the air stream is divided in its approach to the leading edge of the wing to produce air currents flowing smoothly along the upper and lower surfaces of the wing. As a stalling condition is approached, turbulence is produced in the upper air stream, starting usually near the trailing edge and moving forwardly. I have found that the air currents adjacent the leading edge of a wing are less turbulent and can be more satisfactorily used to give an accurate indication of the approach or presence of a stalling condition, and it is an object of the present invention to provide a novel means responsive to conditions in air flow adjacent the leading edge.

My tests indicate that as the wing approaches a stalling condition, there are greater changes in the direction of air flow adjacent the leading edge. Under actual stalling conditions, there is an almost vertical flow of air in front of the leading edge. If an air vane is extended generally forward in this zone, it will be influenced by these greater changes in the air currents in such manner as to give a very accurate and positive indication of the approach or presence of a stalling condition. Preferably, the air vane is so positioned that the air currents during normal flight will exert a pressure on one side thereof and, during stalling conditions, will exert a pressure on the opposite side thereof, and it is an object of the present invention to provide a device operating on this principle.

It is another object of the present invention to provide such an air vane in combination with means responsive to an increase in downward and backward air pressure on the upper surface of the air vane for indicating the condition of maximum allowable speed.

Still another object of the invention is to provide a suitably counterbalanced air vane mem-

ber carrying an air vane extending generally forward of the leading edge of an airplane wing.

Another object of the present invention is to provide an air vane member extending generally forward from an airfoil and operatively connected to mechanism within the air foil, and to provide a novel sealing device for sealing the junction of the airfoil and the external mechanism.

Still another object of the invention is to provide a novel contact system (preferably positioned within the airfoil) in operative relationship with an air vane positioned outside this airfoil.

Another object of the invention is to provide a device which can be made to give separate warning signals upon the approach of a stall or a dangerous high speed condition.

If the device of the invention is installed on both right and left wings of an airplane, for example adjacent the leading edges of the wings on both sides of a fuselage in a monoplane, these devices can be connected in such way as to give a warning when one or both wings approach a stalling condition or when the wings are subjected to a dangerous high speed condition, and it is an object of the present invention to dispose a suitable responsive device on each wing and to connect these devices electrically in a novel manner.

Further objects and advantages of the invention will be made evident to those skilled in the art from the following description of one embodiment of the invention, this showing being exemplary and being made without intent of limiting the invention thereto, it being apparent that various changes can be made without departing from the spirit of the invention.

Figure 1 is a sectional view of my airplane stall and high speed indicating apparatus taken from the line 1—1 of Fig. 2 shown in conforming connected relation with a fragmentary portion of the leading edge of an airplane wing, said fragmentary portion of said airplane wing being shown in cross section; Fig. 2 is a fragmentary sectional view taken from the line 2—2 of Fig. 1; Fig. 3 is a fragmentary elevational view taken from the line 3—3 of Fig. 1; and Figs. 4, 5, 6 and 7 are wiring diagrams indicating different ways of connecting the invention to one or more indicating means.

Similar characters of reference refer to similar parts and portions throughout the several views of the drawings:

The air vane member 1, electrical contact members 2 and 3, casing member 4, sealing member 5 and the dual contact member 6 constitutes the principal parts and portions of the illustrated embodiment of my airplane stall and high speed indicating apparatus.

The air vane member 1 is provided with an air vane 1a at its forward end, this air vane being shown as a plate-like portion. The air vane member 1 is pivotally mounted on a pin 1b which is rigidly secured to the casing member 4, as shown best in Figs. 1 and 2 of the drawings.

This air vane member 1 is provided with an integral counterweight portion 1c and opposed contact engaging arm portions 1d and 1e which are preferably made of electrical insulated material, all as shown best in Fig. 1 of the drawings.

The casing member 4 is provided with a curved side wall portion 4a which conforms with the curvature of the leading edge of the airplane wing A, as shown best in Fig. 1 of the drawings,

and which is suitably secured to a frame member 4f attached to the inner side of the airplane wing, as shown in Figs. 1 and 2. This casing member 4 is also provided with integral side portions 4b extending in spaced parallel relation backwardly from the curved side wall portions 4a, as shown best in Fig. 2 of the drawings. This casing member 4 is also provided with a backwardly extending bottom portion 4c on which the electrical contact members 2 and 3 and the dual contact member 6 are rigidly secured by means of bolts 2a. These electrical contact members 2 and 3 and the dual contact member 6 are suitably insulated by insulation plates 2b from each other and from the casing 4, as shown best in Fig. 1 of the drawings.

Referring particularly to Fig. 1 of the drawings, it will be observed that the electrical contact members 2 and 3 respectively comprise resilient plate spring portions 2c and 3a, each carrying a contact, these contacts being spaced from each other. The electrical contact member 6 likewise provides a resilient plate spring portion 6a on which are mounted contacts 6b and 6c respectively arranged in spaced opposed relation with the contacts of the contact members 2 and 3. The plate spring portion 3a of the electrical contact member 3 is relatively heavy as compared with the other plate springs and acts to assert a restraining force on the air vane member 1, for a purpose to be hereinafter mentioned, so long as this plate spring portion 3a is lifted from engagement with a stop 4j, shown in Fig. 1 as a pin extending between the side portions 4b.

Positioned in spaced relation to the upper side of the counterweight portion 1c of the air vane 1 is a stop member 4d, which is integral with the casing 4. Positioned beneath the arm portion 1e of the air vane member 1 is a stop member 4e which is integral with the casing 4, as shown best in Fig. 1 of the drawings. These stop members 4d and 4e are arranged to limit the pivotal movement of the air vane members 1 preventing the plate spring portions 2c and 3a of the electrical contacts 2 and 3 respectively and the plate spring portion 6a of the dual contact member 6 from being bent out of operative position. It will be noted that the casing member 4 at its connection with the leading edge of the airplane, is positioned in a frame member 4f which is rigidly secured to the inner side of the airplane wing near its leading edge, as shown best in Figs. 1 and 2 of the drawings. Electrically connected with the electrical contacts 2 and 3 and the dual contact member 6 are electrical conductor wires 2d, 3b and 6d respectively, which are arranged to extend to the pilot's compartment of the airplane and connect with signalling devices, not shown in the drawings, and no part of my present invention.

It will be noted that the casing member 4 is provided with an opening 4g therein through which the air vane member 1 extends and in which said air vane member 1 is pivotally mounted. This casing member 4 is provided with a funnel-shaped flange portion 4h around the opening 4g therein on the outer side of which is positioned one end of the sealing member 5. This sealing member 5 is preferably made of pliable material, such as rubber or the like and the opposite end of this sealing member 5 from the end positioned around the flange portion 4h is positioned in an annular groove portion 1f of the sealing connection member 1g on the shank

portion 1h of the air vane member 1, all as shown best in Fig. 1 of the drawings. Opposite ends of this sealing member 5 are resilient and tend to contract and tightly engage the flange portion 4h and the sealing connection member 1f, all as shown best in Fig. 1 of the drawings. This sealing member 5 prevents dust, water, or other elements from entering the opening 4g in the casing member 4 and causing damage to the electrical contacts 2 and 3 and other mechanism within the airplane wing.

Figure 4 shows one way of connecting the invention to produce separate warnings upon the presence or approach of a stalling or high speed condition of an airplane. Referring thereto, the contact member 2 is connected by conductor 2d with a stall-warning device 10 connected in series with a source of potential 11 which, in turn, is connected by conductor 6d to the contact member 6. When the contacts of the contact members 2 and 6 are in closed position, current will flow therethrough and through the stall-warning device 10 to give an indication of the presence or approach of a stalling condition. A separate speed-warning device 12 is connected in series with the potential source 11 and is connected to the contact member 3 by conductor 3b. Correspondingly, the warning of a high speed condition will be obtained when the contacts of the contact members 3 and 6 are brought into engagement.

The operation of the invention during conditions of flight is substantially as follows: When the airplane is travelling in normal flight, the air vane 1a is in such position that the air current strikes the upper surface thereof to create a downward pressure thereon. These air currents are indicated generally by the arrows B, and the downward force exerted thereby is opposed by the restraining action of the plate spring portion 3a which must be lifted from its stop 4j by the contact engaging arm 1e if the air vane member 1 is to move from its full-line position shown in Fig. 1 toward its dotted line position, indicated by the dotted lines C. When the airplane reaches a dangerous high speed condition, the air vane member 1 overcomes the restraining action of the plate spring portion 3a and moves into its dotted line position C and these contacts come into engagement to complete the circuit to the speed warning device 12. As soon as the condition of excessive speed is corrected, the air vane member 1 again moves forward and interrupts the circuit.

The air vane 1a is disposed in such position that, upon the approach or presence of a stalling condition, the air currents will strike the lower surface thereof, as indicated diagrammatically by the arrows D. At this time, the air vane member 1 will overcome the light restraining force of the spring 2c resting against the stop member 4k and will move upwardly into its dotted line position indicated by the letter E, thus bringing the contact of the contact member 2 into engagement with the contact 6b and closing the circuit through the stall warning device 10. As soon as the stalling condition is corrected (as by decreasing the angle of attack of the airplane), the air currents will again strike the upper surface of the air vane 1a, thus moving the air vane member 1 into its full-line position shown in Fig. 1. The angle of movement of this air vane member 1 between its full-line position and the dotted line position E is preferably small. Also, the rate of movement between these positions is very

rapid, as is also the return movement to the full-line position, so that the circuit is completed or interrupted quickly and positively.

It will be apparent that movement of the air vane member 1 from its full-line position to its dotted line position E takes place after the restraining force of the plate spring portion 3a has been removed by engagement thereof with the stop 4j.

By such a construction, a single air vane can be used to give a warning of the presence or approach of a stalling condition or a high speed condition. Separate warning devices 10 and 12 can be used, though, if desired, the invention can be connected as shown in Fig. 5 to use a single warning device 12a which gives a warning of the presence or approach of either adverse condition. The circuit shown in Fig. 5 is generally similar to that shown in Fig. 4 except that the contact members 2 and 3 are electrically connected by a conductor 13, whereby the warning circuit will be completed upon either upward or downward movement of the air vane sufficient to complete the circuit through the contact members 2 and 3 respectively in which case the middle contact 6 may be eliminated by connecting member 3 to 6d instead of connecting to member 2 by conductor 13.

In many instances, it will be satisfactory to dispose the device shown in Fig. 1 on only one wing of the airplane. However, a more satisfactory system is to install one of the devices on both right and left wings to indicate separately the conditions affecting each wing. In this event, the circuit shown in Fig. 4 can be duplicated to provide four warning devices grouped in pairs to indicate stalling or high speed conditions affecting the wings. Alternatively, as shown in Fig. 6, the two sets of contact members (respectively responsive to conditions affecting the wings) may be wired in parallel to permit the use of a single stall-warning device 10 and a single speed warning device 12. In Fig. 6, the contact members on the other wing are indicated by primed numerals, otherwise corresponding to the numerals applied to the contact members in Fig. 1. From Fig. 6 it will be apparent that the stall warning device 10 will be energized upon the presence or approach of a stalling condition affecting either the right or left wing, while the speed warning device 12 will be energized in response to the presence or approach of a dangerous speed condition affecting either wing.

In some instances, it may be desirable to give a warning only when both wings are subject to the presence or approach of a stalling condition. In this instance, the circuit shown in Fig. 7 may be used, this circuit including means for connecting in series relationship the stall responsive contacts and for connecting in series relationship the speed responsive contacts. In this embodiment, electrical connection of the contact members 2 and 6 will cause current to flow from one terminal of the source 11 through the closed switch contacts and through the conductor 2d to the stall warning device 10. A conductor 15 connects this device with the contact member 2' and if this member is in electrical contact with the contact member 6' (as it would be if the associated wing were subjected to a stalling condition), the circuit to the source 11 will be completed through conductor 16. If, however, both wings are not in a stalling condition, the warning will not be given. If both wings are subjected to a high speed condition, current will flow from

the source 11 through contact members 6 and 3 to the speed warning device 12 and thence through contact members 3' and 6' to the source, thus giving a warning of excessive speed. It will be noted that it is considered impractical to indicate any difference in maximum speed of the two wings.

While the invention has been particularly described in a placement adjacent the leading edge of the wing, it will be apparent that it may be used in other positions to be influenced by the air stream adjacent the wing or other airfoil. Likewise, the device can be used at positions far remote from an airfoil, for example, at a position in the main air stream and substantially out of the influence of the air current flowing in the vicinity of the wing or fuselage. In this instance, the vane 1a will still extend forward and downward, though the angle of inclination will not usually be as large as shown in Fig. 1. The air vane will be so positioned that the air currents will reach the upper surface and exert a downward pressure thereon during the existence of non-stalling conditions, but will shift to press upward on the lower surface of the air vane when the angle of attack becomes such as to establish a dangerous stalling condition.

Though I have shown and described a particular construction, combination and arrangement of parts and portions, I do not wish to be limited to this particular construction, combination and arrangement, but desire to include in the scope of my invention the construction, combination and arrangement substantially as set forth in the appended claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In an airplane combination stall and high speed indicating apparatus of the class described, the combination with the leading edge of an airplane wing, of a pivotally mounted combined stall and high speed indicating air vane member extending forwardly and downwardly from near the middle portion of said leading edge and provided with a vane portion on its forward end and spaced arm portions near its other end shiftable spaced electrical contacts intermediate said spaced arm portions of said air vane member positioned within the leading edge of said airplane wing and indicating means in electrical connection with said electrical contacts and arranged to be responsive to a downward motion of said air vane from normal position to a predetermined lower position for indicating a high speed condition and responsive to an upward movement of said air vane from normal position for indicating a danger stalling condition.

2. In an airplane combination stall and high speed indicating apparatus of the class described, the combination with the leading edge of an airplane wing, of a pivotally mounted combined stall and high speed indicating air vane member extending forwardly and downwardly from near the middle portion of said leading edge and provided with a vane portion on its forward end and spaced arm portions near its other end shiftable spaced electrical contacts intermediate said spaced arm portions of said air vane member positioned within the leading edge of said airplane wing and indicating means in electrical connection with said

electrical contacts and arranged to be responsive to a downward motion of said air vane from normal position to a predetermined lower position for indicating a high speed condition and responsive to an upward movement of said air vane from normal position for indicating a danger stalling condition, said electrical contacts independently supported on resilient members.

3. In an airplane combination stall and high speed indicating apparatus of the class described, the combination with the leading edge of an airplane wing, of a pivotally mounted combined stall and high speed indicating air vane member extending forwardly and downwardly from near the middle portion of said leading edge and provided with a vane portion on its forward end and spaced arm portions near its other end shiftable spaced electrical contacts intermediate said spaced arm portions of said air vane member positioned within the leading edge of said airplane wing and indicating means in electrical connection with said electrical contacts and arranged to be responsive to a downward motion of said air vane from normal position to a predetermined lower position for indicating a high speed condition and responsive to an upward movement of said air vane from normal position for indicating a danger stalling condition, said electrical contacts independently supported on resilient members, one of said resilient members relatively heavy in relation with the other resilient member.

4. In a device responsive to a flight condition of an airplane; an air vane disposed in the air stream created by forward motion of the airplane through the air; means for mounting said air vane to swing about an axis generally transverse to the direction of flight and disposed to the rear of the center of pressure of the air vane, said air vane being disposed in a normal position inclined forward and downward with respect to the air stream such that the air stream strikes the upper surface of said air vane in normal flight; electric contact and circuit means responsive to a downward motion of said air vane from said normal position to a predetermined lower position for indicating a high speed condition; and similar means responsive to an upward motion of said air vane from said normal position for indicating a dangerous stalling condition.

5. In an airplane combination stall and high speed indicating apparatus of the class described, the combination with the leading edge of an airplane wing, of an air vane member pivotally mounted slightly below the middle of the leading edge of said airplane wing, an air vane member on the extended end of said air vane member, spaced electrical contact members positioned within the leading edge of said wing, a portion of said air vane member at its opposite end from said air vane portion arranged to shift said electrical contact members into engagement with each other and indicating means in electrical connection with said electrical contacts and arranged to be responsive to a downward motion of said air vane from the normal position to a predetermined lower position for indicating a high speed condition and responsive to an upward motion of said air vane from the normal position for indicating a danger stalling condition.

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