

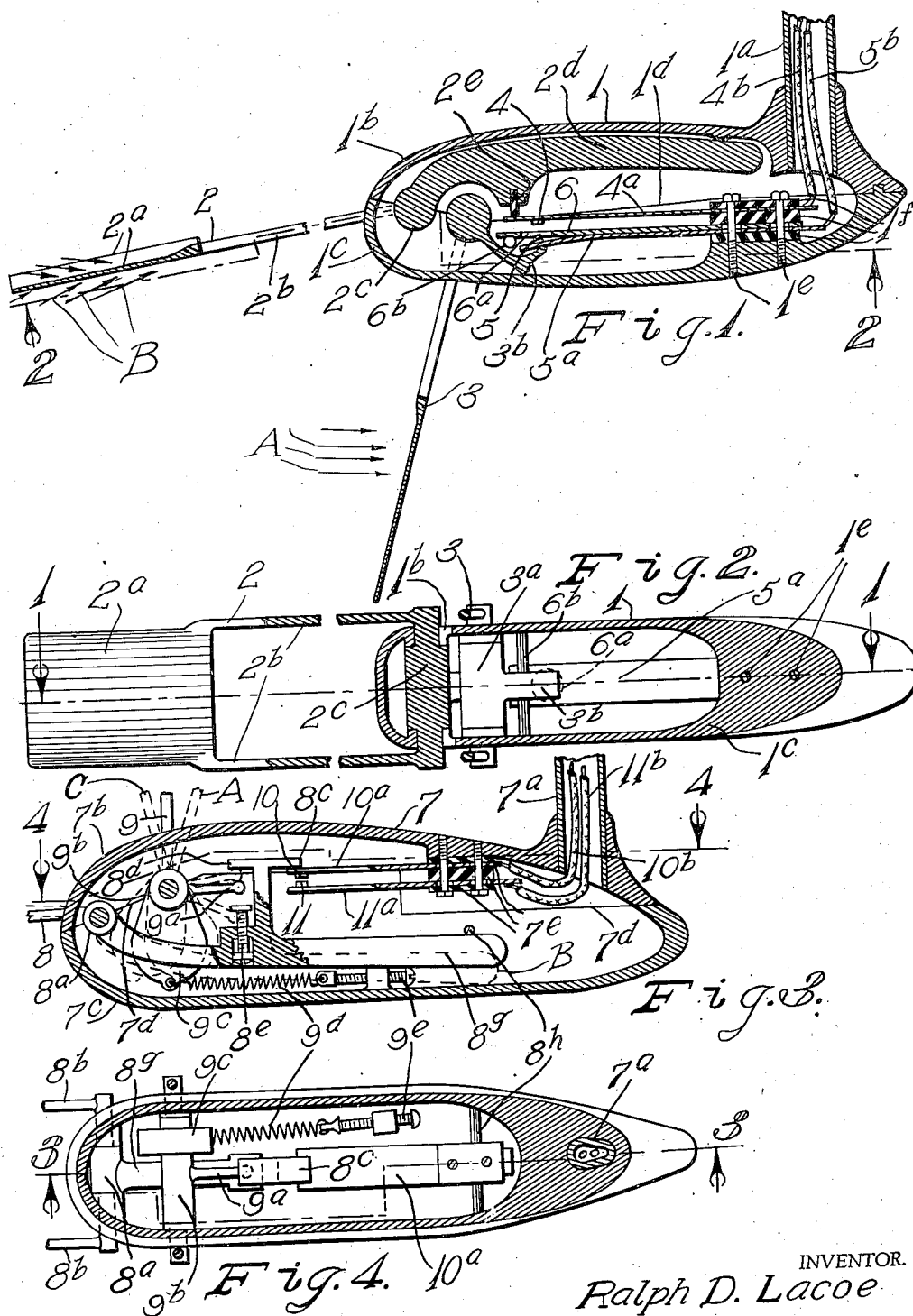
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AIRPLANE STALL AND HIGH SPEED INDICATING APPARATUS

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AIRPLANE STALL AND HIGH-SPEED
INDICATING APPARATUS

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4 Claims. (Cl. 177-311)

My invention relates to a device for indicating a dangerous flying condition of an airplane, and can be used to deliver an appropriate warning should flight become dangerous due to the approach or presence of a stalling condition, or due to a condition of excessive speed. In the preferred embodiment of my invention, indications of the presence of both of these dangerous flying conditions are given.

It is desirable to indicate the approach or presence of a maximum allowable speed for the airplane to avoid danger of such excessive speed as might cause structural failure through fluttering or other causes. It is an object of my invention to provide a device which can be used to indicate to the pilot the approach or presence of the maximum allowable speed.

It is known that if the angle of attack of the airplane is increased to a predetermined point, a stalling condition ensues which destroys the lifting power of the wings. An increase in the angle of attack to 15° may often result in the production of such a dangerous stalling condition, and it is an object of the present invention to provide a simple device which can warn the pilot of the approach or presence of such a dangerous stalling condition.

In accomplishing this result, I provide an air vane disposed in the air stream and which is asymmetrically pivoted about a generally horizontal axis so as to move up and down in response to changes in direction of the air stream. It is an object of the present invention to provide a novel mounting for such an air vane and a novel arrangement of electrical contacts which can be used to give the desired warning.

It is another object of the invention to dispose such an air vane at such position with respect to the airplane as to be substantially out of the influence of the slip stream of the propeller, and sufficiently removed from the air guiding surface of the airplane (for example, the fuselage and wings) so as not to be substantially influenced by the air streams adjacent to and affected by such surfaces during normal flight or under extreme variations in flight conditions, such as side slips and skids. On the other hand, some of the features of the invention are novel irrespective of such mounting position of the device.

While in certain embodiments of the invention such an air vane may be positioned aft of the pivotal axis, I have found that extreme sensitivity and a toggle-like action with a more positive closing of the electrical contact can be obtained by arranging the device so that the center

of pressure of the air stream on the air vane is forward of the pivotal axis. While with such a system the vane can be made to assume a position generally parallel with the air stream, I prefer to dispose the air vane in a slightly downwardly inclined position so that the air stream normally exerts a downward pressure thereon, and to provide a suitable stop means for limiting the motion of the air vane under these downward pressures. If, then, the direction of the air stream changes (or what is in effect the same, the angle of attack of the airplane increases), the air stream may exert an upward pressure on the air vane to cause lifting thereof. It is an object of the present invention to provide such a system and to arrange the vane in such position that a shift in pressure from the upper to the lower surfaces thereof will give an indication of a dangerous flying condition. It is another object of the invention to restrict the angular movement of the air vane about the pivotal axis so that a correction of the dangerous flying condition will move the vane member to its normal position and discontinue the warning signal.

Another object of the invention is to provide a stall-responsive device in which the air vane is appropriately counter-balanced in such manner that the force of gravity exerts substantially no net moment tending to turn the air vane and its associated mechanism about the pivotal axis, and in such manner that jarring or vibration of the device will not cause oscillation of the air vane.

Another object of the invention is to provide a device providing an air vane responsive to the approach or presence of a stalling condition, in conjunction with an auxiliary means controlling the warning signal. For example, the auxiliary means may comprise a device rendering the warning or indicating means inoperative while the airplane is on the ground or before it has obtained a predetermined speed.

Another object of the invention is to provide a device including a stall-responsive air vane and an auxiliary air vane responsive to the velocity of the air stream, and to provide a novel operative connection between these air vanes, whereby, if desired, a single indicating means can give a warning of the approach or presence of either a stall condition or a condition of maximum allowable speed.

Another object of the invention is to provide an apparatus of this general class in which opposed spaced contacts are each arranged in operative shiftable relationship with an air vane.

Another object of the invention is to provide

a novel operative connection between a casing and one or more air vanes external thereof to provide a substantially dustproof and waterproof construction within which some of the operating mechanism is positioned.

Still another object of the invention is to provide a pair of contacts which can be moved into signalling position in response to the approach or presence of a stalling condition and which can be moved into a signalling position in response to other conditions, such as the approach or presence of maximum allowable speed of the airplane. A further object of the invention is to provide means for retaining such contacts in non-signalling position under certain conditions, for example, when the forward speed of the airplane is less than a predetermined amount, by which term I have reference not only to conditions during flight, but also to conditions when the airplane is at rest on the ground or moving along the ground preparatory to take-off.

Further objects and advantages of the invention will be made evident to those skilled in the art from the following description of the preferred embodiments of the invention.

Referring to the drawing:

Figure 1 is a fragmentary longitudinal sectional view of my airplane stall and high speed indicating apparatus taken from the line 1—1 of Fig. 2 showing parts and portions in elevation to facilitate the illustration; Fig. 2 is a fragmentary sectional view taken from the line 2—2 of Fig. 1; Fig. 3 is a fragmentary longitudinal sectional view showing a modification of my airplane stall and high speed indicating apparatus taken from the lines 3—3 of Fig. 4 showing portions broken away to facilitate the illustration; and Fig. 4 is a sectional view taken from the line 4—4 of Fig. 3.

Similar characters of reference refer to similar parts and portions throughout the related views of the drawing:

The casing 1, air vane member 2, secondary air vane 3, electrical contacts 4 and 5 and the contact retaining member 6 constitute the principal parts and portions of my airplane stall and high speed indicating apparatus in one form.

The casing 1 is a hollow substantially streamlined casing, as shown in Fig. 1 of the drawing. Rigidly secured to this casing 1 is a tubular member 1a, which tubular member 1a is arranged for use in connecting my airplane stall and high speed indicating apparatus to a portion of an airplane. For example, the tubular member 1a may extend downward from a wing of the airplane to position the device out of the slip stream of the propeller so as to be under the influence of the air stream moving relative to the plane and which, in effect, is established by the forward motion of the airplane. This tubular member 1a is arranged to serve as a conduit for the electrical conductors 4b and 5b, which are electrically connected with the electrical contacts 4 and 5, shown best in Fig. 1 of the drawing. This casing 1 preferably consists of two casing portions 1b and 1c, which casing portions 1b and 1c are separable along the line 1d. It will be observed by reference to Fig. 1 of the drawing, that these casing portions 1b and 1c separate at the axes of the air vane member 2 and the secondary air vane member 3 which are journaled in opposite sides of said casing member 1, as shown best in Fig. 2 of the drawing.

The air vane member 2 is provided with a transversely curved plate-like air vane portion

2a at its extended end with which are rigidly connected at opposite sides thereof bifurcated portions 2b, which bifurcated portions 2b are rigidly secured at opposite ends of the journaled shaft portion 2c of said air vane member 2, as shown best in Fig. 2 of the drawing. Integral with this shaft portion 2c is a counterweight portion 2d, which extends backwardly from the shaft portion 2c near the upper inner side of the casing member 1, as shown best in Fig. 1 of the drawing.

The counterweight portion 2d is illustrative of one form of counterbalance means serving substantially to counterbalance the gravitationally-induced moments about the shaft portion 2c under static conditions, and to prevent vibration or oscillation of the air vane member 2 due to shocks or jars transmitted to the casing 1, for example, when the airplane is moving on the ground. Rigidly connected with this counterweight portion 2d is an insulation contact engaging member 2e, which is arranged to engage the shiftable end of the spring support 4a of the electrical contact 4, as shown best in Fig. 1 of the drawing. This spring support 4a is rigidly secured to the casing portion 1c by means of the bolts 1e and this spring support 4a is insulated from the bolts 1e and the casing member 1 by the insulation members 1f. Secured to the casing portion 1c in a similar manner by means of the bolts 1e in spaced relation with the contact supporting spring support 4a are the electrical contact supporting spring 5a and the resilient contact retaining member 6, as shown best in Fig. 1 of the drawing.

Referring particularly to Fig. 1 of the drawing, it will be observed that the electrical contacts 4 and 5 are mounted in opposed spaced relation from each other on their respective spring supports 4a and 5a and these contacts 4 and 5 are arranged to engage each other through the opening 6a in the resilient contact retaining member 6.

It will be noted that the resilient character of this contact retaining member 6 tends to force it toward the contact 5 and the extending end of this contact retaining member 6 is limited in its downward movement by engagement with the stop member 6b mounted in rigid connected relation with the casing member 1, as shown best in Figs. 1 and 2 of the drawing. The contact-supporting spring 5a is also of resilient character but is formed of lighter material than the contact-retaining member 6 so that an upward force applied to the forward end of the former will first move the contact 5 into the opening 6a, whereupon further upward movement will cause the forward ends of both members to move upward together.

The secondary air vane member 3 is constructed in substantially the same form as the air vane member 2 providing a bifurcated portion retaining a secondary air vane. However, in this instance, the secondary air vane is disposed to face the air stream to be responsive to the velocity of the air stream, or to the related forward motion of the airplane through the air. The secondary air vane member 3 is journaled in opposite sides of the casing 1, as shown best in Fig. 2 of the drawing and is provided with a shaft portion 3a similar to the shaft portion 2c of the air vane member 2. Integral with this shaft portion 3a is an extending arm portion 3b which is arranged to engage the lower side of the contact supporting spring 5a to which

the contact 5 is electrically connected, as shown best in Fig. 1 of the drawing.

When the airplane is not in flight, the contact supporting spring 5a forces the arm portion 3b downwardly into engagement with the casing portion 1c which serves as a stop. The arm portion acts to counterbalance the external portions of the air vane member 3 and, together with the contact supporting spring 5a, prevents oscillation or vibration of the secondary air vane when the airplane is moving along the ground or is subjected to jarring conditions.

The electrical contacts 4 and 5 are connected in a circuit (including the conductors 4b and 5b with a suitable indicating means which is usually positioned within the airplane and which indicates to the pilot the approach or presence of a dangerous flying condition. This indicating means may deliver a warning signal at this time; for example, an audible visible, or otherwise sensible signal, such indicating means being known in the art, the details thereof being per se no part of the present invention. As will be hereinafter explained, the same indicating means can be used to give an indication of the approach or presence of a stalling condition or of a high-speed condition, the pilot knowing which of these dangerous conditions exists due to his knowledge of the general conditions under which the airplane is flying. In general, the contact 4 is moved in response to conditions affecting the air vane 2a, while the contact 5 is moved in response to conditions affecting the secondary air vane 3. This secondary air vane 3 serves to maintain the contact 5 out of the locus of motion of the contact 4 when the airplane is on the ground and when the forward motion of the airplane is small. In this connection, it will be apparent that the locus of motion of the contact 4, as well as of the counterweight portion 2d, is quite limited. The total angular motion of the air vane member 2 about the axis provided by the shaft portion 2c is usually not more than 8 or 10 degrees and, preferably, less than about 6 degrees in the embodiment shown. As viewed in Figure 1, the maximum counterclockwise motion of the air vane member 2 is determined by engagement between the counterweight portion 2d and the upper, inner surface of the casing portion 1b. This is the normal position of the air vane member 2 during safe flying conditions. Clockwise rotation of the air vane member 2 is limited by engagement with one of the bolts 1e. During this clockwise rotation, the contact 4 will be lowered. This will result in engagement with the contact 5 in the event that this contact has been lifted into the opening 6a by the action of the secondary air vane. On the other hand, if the airplane is on the ground and the contact 5 has not been lifted, it will remain out of the locus of motion of the contact 4 so that no indication will be given.

Considering the operation of the device during and following take-off of the airplane, it will be apparent that, as the airplane moves forward, the secondary air vane 3 encounters an air stream, indicated generally by arrows A of Figure 1. This moves the air vane 3 rearward and causes the arm portion 3b to lift the contact supporting spring 5a, and thus move the contact 5 into the opening 6a and thus into the locus of motion of contact 4. Assuming that the contact 4 is in its uppermost position, the contact 5 will never be lifted into electrical contact therewith so long as the flying speed is in a safe

range. In fact, flight in the lower portion of this range will not cause sufficient rearward pressure on the secondary air vane 3 to lift the contact retaining member 6 from stop 6b. However, upon the approach of a dangerous flying speed, the secondary air vane 3 will move rearward, due to increased pressure of the air stream, until the contact retaining member 6 is raised from the stop 6b a sufficient distance to permit engagement between the contact 5 and the contact 4, thus closing the indicated circuit and giving a warning of the approach or presence of a dangerous over speed condition. As soon as the pilot corrects this condition, the contact 5 will move downwardly from its engagement with the contact 4, thus interrupting the alarm. It is desirable that the secondary air vane 3 should move the contact 5 into the locus of motion of the contact 4 when the forward speed of the airplane is just below the stalling speed thereof.

During normal flight, the air vane member 2 holds the air vane 2a in a position extending forwardly in the air stream, but slightly depressed with respect thereto at such angle that the upper surface thereof is exposed to the air stream. A small downward force component is thus applied to the air vane 2a, downward motion of this air vane being prevented by the stop means comprising the upper surface of the counterweight portion 2d and the lower surface of the casing portion 1b. Thus during normal flight, the contact 4 remains in its upper position, shown in Fig. 1. If the angle of attack of the airplane is increased to such a point that a stalling condition is imminent or present, the relative position of the air vane 2a and the air stream changes to such an extent that the lower portion of this air vane is exposed to the air stream resulting in an upward pressure on the air vane portion 2a. As soon as this condition exists, the air vane portion 2a moves quickly upward until the counterweight portion 2d engages the bolt 1e. This action is very rapid and is in the nature of a "toggle" action, moving the contact 4 downwardly and positively into electrical connection with the contact 5 and thus completing the indicating circuit, this circuit remaining closed until the stalling condition is corrected and until the air stream again strikes the upper surface of the air vane 2a, at which time this air vane moves quickly downwardly to separate the contacts 4 and 5. The permissible angle of movement of the air vane member 2 is desirably made small so that a large over correction of the stalling condition need not be made before the air vane 2a is again moved downwardly.

It is a feature of my invention that it can be designed to eliminate the giving of any warning of a stall condition until such a condition actually exists in flight. When the airplane first starts moving on the ground preparatory to take-off and with the tail structure in a low position, the angle of attack is such that the air stream presses upwardly on the air vane 2a, thus lowering the contact 4. However, a warning will not be given at this time because the contact 5 remains out of the locus of motion of the contact 4 due to the fact that sufficient forward velocity has not been attained to move the air vane member 3 rearwardly. As soon as the tail is lifted, the angle of attack changes to permit the air stream to press downwardly on the air vane 2a, thus retaining the contact 4 in its uppermost position. Subsequent slight lowering of the tail structure to permit take-off is not sufficient to

cause the air stream to exert an upward force on the air vane so that the contact 4 remains in this upper position. At a speed somewhat below stalling speed, the secondary air vane 3 is moved rearwardly to raise the contact 5 into the locus of motion of the contact 4 so that a subsequent stalling condition in flight will lift the air vane 2a and give the desired warning.

In the modification, as shown in Figs. 3 and 4 of the drawing, the casing 7 is similar to the casing 1, as hereinbefore described. The casing 7 is supported in connection with an airplane in substantially the same relation as the structure hereinbefore described by means of the tubular member 1a. This casing 7 consists of separable casing portions 7b and 7c which are to separate at the axis of the air vane member 8 and the secondary air vane member 9, as indicated by the line 7d in Fig. 3 of the drawing. Secured on the upper inner side of the casing portion 7b in spaced relation to each other are the electrical contacts 10 and 11, as shown best in Fig. 3 of the drawing. These electrical contacts 10 and 11 are insulated from each other and the casing 7 by means of insulation members 7e, as shown best in Fig. 3 of the drawing.

It will be here noted that the air vane member 8 is similar in construction and function to the air vane 2a of the structure hereinbefore described and the secondary air vane member 9 is similar to the secondary air vane 3 in structural arrangement and function, as shown best in Figs. 3 and 4 of the drawing. The air vane member 8 is provided with a shaft portion 8a and bifurcated arms secured on the opposite ends thereof designated 8b, as shown best in Fig. 4 of the drawing, these bifurcated arms carrying an air vane similar to that indicated by the numeral 2a. Secured on the shaft portion 8a is a counterweight member 8g. The lower inner side of the casing portion 7c is arranged to be engaged by the counterweight 8g forming a stop for its downward movement and a stop member 8h is provided to limit the upward movement of said counterweight 8g. Said stop member 8h extends across the casing 7, as shown best in Figs. 3 and 4. Integral with this counterweight 8g is an extending contact engaging portion 8c which is arranged to engage the upper side of the electrical contact spring portion 10a, as shown best in Fig. 3 of the drawing. In opposed relation to the contact engaging portion 8c is an arm portion 8d. This arm portion 8d is arranged in opposed relation to an adjusting screw 8e which is screw threaded in the lower side of the counterweight portion 8g and is arranged to be engaged by the extending arm portion 9a of the secondary air vane 9, as shown best in Fig. 3 of the drawing. This arm portion 9a is arranged in integral relation with the shaft 9b of the secondary air vane 9 and secured on this shaft 9b is a counterweight 9c, all as shown best in Fig. 4 of the drawing. This counterweight 9c is positioned in the casing 7 at one side of the counterweight 8g of the air vane 8, as shown best in Fig. 4 of the drawing. Secured to the lower end of this counterweight 9c is a tension spring 9d, the opposite end of this tension spring 9d is secured to an adjusting screw 9e, all as shown best in Figs. 3 and 4 of the drawing. It will be noted that the electrical contacts 10 and 11 are supported on plate springs 10a and 11a, as shown best in Figs. 3 and 4 of the drawing. The electrical conductor wires 11b and 10b are electrically connected with the electrical contacts 11 and

10 respectively, as shown best in Fig. 3 of the drawing and these electrical conductor wires 10b and 11b extend upwardly through the tubular member 1a, as shown best in Fig. 3 of the drawing.

The operation of the modified structure, as shown in Figs. 3 and 4 of the drawing is substantially as follows: When this modified structure, as shown in Figs. 3 and 4 of the drawing is secured on an airplane in flight, the secondary air vane 9 normally assumes the solid line position, as shown in Fig. 3 of the drawing. When the airplane approaches the maximum allowable speed, the secondary air vane member 9 is forced into dash line position A forcing the arm portion 9a into engagement with the upper end of the screw 8e shifting the counterweight member 8g into substantially the dash line position B carrying the contact engaging portion 8c downwardly into engagement with the contact 10 forcing the same into engagement with the contact 11 closing an electrical circuit and operating a signalling device in the pilot's compartment of the airplane to which this modified structure is connected. It will be noted that the secondary air vane member 9 shifts from the dash line position C to the solid line position, as shown in Fig. 3 of the drawing, at a speed just below the stalling speed of the airplane. Therefore, when the airplane approaches the stall condition, the secondary air vane 9 is in the solid line position, as shown in Fig. 3 of the drawing. When the air vane 8 shifts to the dash line position B, the extended contact engaging portion 8c thereof forces the contacts 10 and 11 into engagement with each other indicating to the pilot of the airplane the stall condition of the airplane. It will be here noted that the tension spring 9d in connection with the counterweight 9c of the secondary air vane 9 is arranged in adjustable relation with the casing 7 by means of the adjusting screw 9e providing an arrangement whereby the secondary air vane 9 may be adjusted and arranged to operate at different speeds. The adjusting screw 8e, which is screw-threaded in the counterweight 8g is arranged to be adjusted in relation with the arm portion 8a of the air vane 8, as shown best in Fig. 3 of the drawing. When the secondary air vane 9 is in the dash line position C, as shown in Fig. 3 of the drawing, the arm portion 9a thereof engages the arm portion 8d of the counterweight 8g preventing the extending contact engaging portion 8c from forcing the contacts 10 and 11 into engagement with each other. This arrangement provides means whereby no signal may be given by the apparatus until the airplane has reached the approximate stalling speed. Therefore, when the airplane is on the ground and being maneuvered about, the signalling means in connection with the electrical wire conductor members 10b and 11b is inoperative.

It will be apparent that, in both embodiments of the invention herein described in detail, I provide a pair of contacts movable from a non-signalling position to a signalling position upon the approach of a stall condition.

I believe it to be new to mount an air vane asymmetrically with respect to an axis so that the center of pressure is forward of the axis and to use this in indicating a dangerous flying condition, and it should be understood that, in certain embodiments of my invention, this feature can be used irrespective of its combination with auxiliary means responsive to the forward speed of the airplane. Likewise, I believe it to be new to

use an air vane positioned in the air stream and movable about an axis, together with counterbalancing means serving substantially to counterbalance the gravitational moments about such axis, this being true irrespective of whether the center of pressure of the air vane is for or aft of this axis. Various other features of this invention may also be used individually as well as in the combination shown.

Though I have shown and described a particular construction, combination and arrangement of parts and portions and a certain modification, I do not wish to be limited to this particular construction, combination and arrangement, nor to the modification, but desire to include in the scope of my invention the construction, combination and arrangement and the modification 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 a combination airplane stall and high speed indicating apparatus of the class described, the combination of an enclosure casing, a stall indicating air vane member outwardly of said casing on a substantially horizontal plane with its pivotal axis in said casing and provided with a counterbalance portion positioned in said casing, a high speed indicating air vane outwardly of said casing on a substantially vertical plane with its pivotal axis in said casing and having an extended arm portion in said casing, a resiliently supported first contact member in said casing in operative relation with said counterbalance portion arranged in a predetermined normal position when the airplane is in a safe flying condition and is moved to a second position when the airplane is in a stall condition, a resiliently supported second contact in said casing in operative relation with said extended arm portion arranged in normally spaced relation from said first contact a distance greater than the range of movement of said first contact, said second resilient contact being movable by said extended arm portion to engage the first resilient contact in said second position and in said normal position dependent upon the speed of the plane.

2. In a combination airplane stall and high speed indicating apparatus of the class described, the combination of an enclosure casing, a stall indicating air vane member outwardly of said casing on a substantially horizontal plane with its pivotal axis in said casing and provided with a counterbalance portion positioned in said casing, a high speed indicating air vane outwardly of said casing on a substantially vertical plane with its pivotal axis in said casing and having an extended arm portion in said casing, a resiliently supported first contact member in said casing in operative relation with said counterbalance portion arranged in a predetermined normal position when the airplane is in a safe flying condition and is moved to a second position when the airplane is in a stall condition, a resiliently supported second contact in said casing in operative relation with said extended arm portion arranged in normally spaced relation from said first contact a distance greater than the range of movement of said first contact, said second resilient contact being movable by said extended arm portion to engage the first resilient contact in said second position and in said normal position dependent upon the speed of the plane, and stop means in

cooperative relation with each of said vanes and the interior of said enclosure casing for limiting their shiftable movements.

3. In a combination airplane stall and high speed indicating apparatus of the class described, the combination of an enclosure casing, a stall indicating air vane member outwardly of said casing on a substantially horizontal plane with its pivotal axis in said casing and provided with a counterbalance portion positioned in said casing, a high speed indicating air vane outwardly of said casing on a substantially vertical plane with its pivotal axis in said casing and having an extended arm portion in said casing, a resiliently supported first contact member in said casing in operative relation with said counterbalance portion arranged in a predetermined normal position when the airplane is in a safe flying condition and is moved to a second position when the airplane is in a stall condition, a resiliently supported second contact in said casing in operative relation with said extended arm portion arranged in normally spaced relation from said first contact a distance greater than the range of movement of said first contact, said second resilient contact being movable by said extended arm portion to engage the first resilient contact in said second position and in said normal position dependent upon the speed of the plane and a third resilient member interposed between the resilient contact members provided with an opening therein arranged to permit either of said contact members to pass through said intermediate resilient member, said third resilient member being movable with said second contact toward said first contact member by said extended arm portion.

4. In a combination airplane stall and high speed indicating apparatus of the class described, the combination of an enclosure casing, a stall indicating air vane member outwardly of said casing on a substantially horizontal plane with its pivotal axis in said casing and provided with a counterbalance portion positioned in said casing, a high speed indicating air vane outwardly of said casing on a substantially vertical plane with its pivotal axis in said casing and having an extended arm portion in said casing, a resiliently supported first contact member in said casing in operative relation with said counterbalance portion arranged in a predetermined normal position when the airplane is in a safe flying condition and is moved to a second position when the airplane is in a stall condition, a resiliently supported second contact in said casing in operative relation with said extended arm portion arranged in normally spaced relation from said first contact a distance greater than the range of movement of said first contact, said second resilient contact being movable by said extended arm portion to engage the first resilient contact in said second position and in said normal position dependent upon the speed of the plane, a third resilient member interposed between the resilient contact members provided with an opening therein arranged to permit either of said contact members to pass through said intermediate resilient member, said third resilient member being movable with said second contact toward said first contact member by said extended arm portion, and stop means in said casing on one side of said third resilient member arranged to limit its movement in one direction.

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