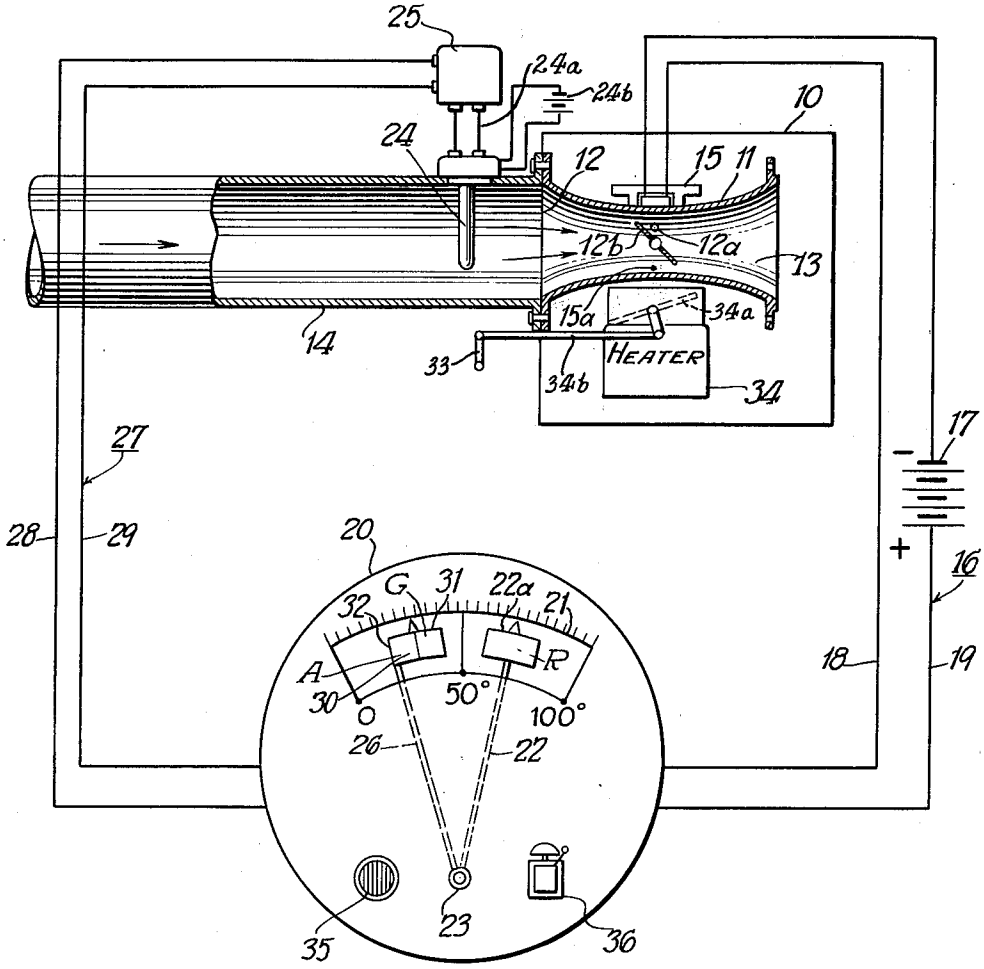
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CARBURETOR DEICING DEVICE

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CARBURETOR DEICING DEVICE

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5 Claims. (Cl. 261—128)

This application is a continuation-in-part of my copending application Serial No. 58,751 filed September 27, 1960 and now abandoned.

This invention relates to methods and apparatus for preventing condensation and/or icing, and more particularly to methods and apparatus for controlling and preventing condensation and icing upon surfaces such as those in the interior of carburetors and other compartments.

One of the objects of the present invention is to warn a pilot of an aircraft of the trend toward imminent icing conditions in a carburetor, particularly in the venturi of the carburetor of an internal combustion engine of such craft.

In the throat of the venturi of such a carburetor there exists a reduced pressure due to the passage of air therethrough and this can have a substantial cooling effect, for example, 25° to 40° F., drop. Also, suction due to vacuum produced by pistons can reduce pressure as much as 28 in. Hg. Further downstream from such throat of the carburetor further cooling can occur due to evaporation of the fuel during carburetion, and this cooling or temperature drop chills the metal or material of the venturi and throttle valve mechanism and in some circumstances can so chill such metal below the ambient air temperature, that is, below the mean temperature of the air which enters the venturi. If the Dewpoint temperature of the air entering the venturi is high enough so that its subsequent Dewpoint at its reduced pressure (which occurs at or beyond or in the vicinity of the throat) is higher than the temperature of the surface of the annular venturi throat itself or of the throttling valve therein, moisture condenses on this surface, and often frost and eventually a ring of ice is formed in or around such throat or valve which restricts the effective cross-sectional area of the throat. This throttles the flow of air and reduces materially the power of the internal combustion engine. This choking can stop the engine, particularly if the engine is idling or at reduced power, as when in a descent, or when climbing at full power and entering strata of wetter air of high Dewpoint.

No satisfactory apparatus of the prior art exists for comparing these two essential conditions and for warning the pilot well in advance of this condition and at present the pilot of the aircraft is warned merely by noting a power loss as by a reduction in engine r.p.m. which means that icing has already occurred and is presently taking place. The pilot then can actuate suitable means for directing heat upon the carburetor, for example, by manually operating a damper device which directs hot air by suitable channel means from engine exhaust to the carburetor manifold or by electric heating thereby raising the temperature of the carburetor throat above the Dewpoint temperature of the air mixture passing through it.

Such prior warning and remedial action by the pilot has not proven entirely satisfactory in that the warning by reduction in r.p.m. and/or power output may come too late, cause the engine to stop, and result in disaster. The time heretofore to take remedial action may be as little as 30 seconds.

Apparatus embodying the present invention is designed to overcome the above difficulties, and to foretell safely and well in advance such approaching icing conditions and thereby to warn the pilot by visual and/or audible means when action should be taken. Also, one form of

apparatus embodying the present invention automatically can take the necessary action to direct heat to the carburetor. In lieu of the employment of the means for directing heat to the carburetor or in lieu of the step in applying heat thereto there can be substituted any suitable means for controlling condensation and/or icing conditions in an enclosure not necessarily limited to the tubular enclosure comprising the aforementioned venturi such as a storage compartment. For example, any suitable means can be actuated for reducing the Dewpoint temperature of the air which enters such enclosure and which otherwise may produce such condensation and/or icing.

The invention in one aspect thereof is constituted by apparatus for sensing Dry-Bulb temperature of a selected part of an enclosure, such as the surface of the throat of a venturi of a carburetor, and controlling a visual indicator therefor comprising, for example, a pointer which is angularly shiftable over a scale which is calibrated suitably for representation of any desired set of values, preferably a linear representation comprising a scale calibrated by equal subdivisions. In or upstream from the venturi but not necessarily in or near the carburetor there is employed a Dewpoint temperature sensing device which may be of the "Dewcell" type as set forth in FIG. 3 of U.S. Patent 2,359,278 which produces electrical signals which are employed for controlling a second pointer which is angularly shiftable over the same calibrated scale as aforementioned. A suitable operative interconnection exists between such Dewpoint sensing device and the last-mentioned pointer controlled thereby, there being interposed in such operative interconnection means for converting the signals representing Dewpoint temperature to the same set of values of the scale aforementioned on which the Dry-Bulb temperature indicator moves. Such output of the Dewpoint sensing means, for example the "Dewcell," in the absence of such converting means produces an exponential output and it is necessary to convert this exponential type of output to a linear type by converting the values thereof by suitable electrical or mechanical means whereby a valid and meaningful comparison between Dewpoint temperature and Dry-Bulb temperature can be made. The two pointers aforementioned, in one form of the invention, are capable of angular movement about a common axis and also of movement relative to one another. When these two pointers move to within a selected angular distance of one another, for example, 10°, it indicates that serious condensation and/or icing conditions are approaching in the carburetor and a suitable alarm device, such as a visual light or an audible buzzer, is operatively connected to the pointers thereby to be actuated when they come within the aforementioned angular distance of one another. Also, suitable means for directing heat to the carburetor are employed and such means can be actuated manually by the pilot after being warned that the relative positions of the aforementioned pointers are within such critical range, or in lieu thereof suitable means are employed for automatically actuating such heating means as by the same circuit which actuates the alarm first mentioned.

The above and further objects and novel features will more fully appear when the description set forth below is read in connection with the accompanying drawing, the latter being for purposes of illustration only and does not define the limits of the invention, reference for this latter purpose being had to the appended claims:

The drawing comprises a schematic representation of one form of the invention.

Referring to the drawing in greater detail, a carburetor of an internal combustion engine is schematically indicated at **10**, such carburetor having therein a venturi **11** which in turn has an air inlet **12**, a fuel inlet **12***a* at the

venturi throat, and an outlet 13 for the mixture of air and fuel, the air being directed to the carburetor via a conduit 14. Also, a butterfly throttle valve 12*b* is provided in the venturi throat.

For purposes of sensing the temperature of the throat or throat region of the venturi 11 there is provided a suitable temperature sensing device 15 which may comprise a thermocouple or any other suitable means, such as a thermistor or temperature probe 15*a* in the airstream within the venturi. Preferably the temperature sensing means is of the type which produces an electrical signal responsive to temperature thereby facilitating the representation of such temperature at some remote location via electrical wiring. In the form shown, the temperature sensing device 15 is connected in an electric circuit 16 having a suitable source of electrical energy such as a battery 17, such circuit 16 including leads 18 and 19 connected as shown schematically.

The expression "throat region" as employed herein means at or in the vicinity of the throat or of the throttle valve.

For purposes of indicating Venturi Dry-Bulb temperature to the pilot of the aircraft there is provided an indicating instrument 20 such as a voltmeter or ammeter and having a calibrated scale 21 for movement over which there is provided an angularly shiftable Dry-Bulb temperature pointer 22 which is pivotally mounted for angular movement about an axis 23. The leads 18 and 19 are connected to the indicating instrument 20 in the usual manner so as to produce movement of the Dry-Bulb temperature pointer 22 in accordance with the electrical signal produced on these leads by the output of the temperature sensing means 15. Examples of electrical indicating instruments which indicate physical quantities as represented by electrical voltages, currents or other electrical signals are well known in the instrumentation art. Examples of such instruments are described and explained in the Mechanical Engineers Handbook, McGraw Hill Book Company Inc., New York, 1958, on pages 16–23 to 15–26; and also in the Standard Handbook for Electrical Engineers, McGraw Hill Book Company Inc., 1949, on pages 113 et seq.

The Dry-Bulb temperature pointer 22 responds in well known manner to the electrical signals produced by the temperature sensing device 15. The pointer has a flat flag portion 22*a* secured to it near its extremity. The flag portion 22*a* may be colored, for example, red.

The scale 21 is calibrated, for example, to represent Dry-Bulb temperature although the invention is not limited to a scale so calibrated, it being possible to employ any suitable scale having any desired system of values or increments.

The Dry-Bulb temperature of the throat of the venturi 11 or throttle 15*a* is compared with the Dewpoint temperature of the entering air, that is, the Dewpoint of the air entering the venturi via the conduit 14 by the following means:

A Dewpoint sensing means 24, which may be of the aforementioned type known as a "Dewcell," in the form shown is positioned upstream to venturi 11 in the conduit 14 and is constructed and arranged as taught in the aforementioned "Dewcell" patent to produce electrical signals representative of Dewpoint temperature. The invention is not limited to sensing Dewpoint temperature of the air in the conduit 14 or venturi 11, but embraces the sensing of Dewpoint of the air anywhere in the vicinity of the carburetor. This particular Dewpoint temperature sensing device produces electrical signals which are related exponentially to the Dewpoint temperature being sensed and it is therefore necessary to convert this exponential relationship to a linear function for purposes of comparison with the Dry-Bulb temperature. More specifically, it is necessary to convert the electrical signals produced by the measurement of Dewpoint temperature to the same system of values as the electrical signals produced by the measurement of Dry-Bulb temperature. This is accomplished by an element 25 which in effect is a function generator whose transfer function or output to input relationship is precisely the inverse of the exponential Dewpoint temperature to electrical signal relationship of the Dewpoint sensing means 24. Such function generators are well known to those skilled in the art of the electronic instrumentation and the particular device used may take any of a variety of well known forms. Examples of such devices are given on page 284 of the text entitled "The Electronic Analog Computers," 2d edition by Korn and Korn, published by the McGraw Hill Book Company, New York, N.Y., 1956. These include non-linear circuit elements such as tubes, rectifiers and thyrite resistors. The Dewpoint sensing means 24 is connected via a circuit 24*a* to the function generator 25. This circuit 24*a*, as shown, may include a battery 24*b* for supplying power thereto and to the function generator for actuating the indicating instrument 20.

Broadly, there are thus required suitable means for converting the values of the Dewpoint temperature to the same set of values as are employed for representing the Dry-Bulb temperature. Alternatively, the situation can be reversed, that is, the values of the Dry-Bulb temperature can be acted upon by suitable means for converting them to the same system of values as that of the Dewpoint temperature.

The Dewpoint temperature sensing means 24, is connected in conventional manner via the linearizing element 25 and electrical leads 28 and 29 to a second voltmeter, ammeter, or other electrical signal detector in the indicating instrument 20. This second signal detector is arranged to move a second pointer 26 about the axis 23 in accordance with the electrical signals produced by the Dewpoint sensing means 24 as modified by the element 25. Those skilled in the art will readily perceive how the indicating instrument 20 may be arranged to accommodate the two signal detectors. The use of a common electrical indicating instrument for the simultaneous presentation of two types of detected physical data is illustrated in U.S. Patent No. 2,613,350, issued October 7, 1962.

Thus the two pointers 22 and 26 are angularly shiftable about a common axis 23 and thus movable relative to one another to represent their respective temperature difference.

There is employed on one of the pointers, preferably pointer 26, a flag portion 30 which is angularly shiftable therewith and which provides a means for indicating when the two pointers are in a critical angular relation to one another, that is, for indicating when the pointers 22 and 26 have moved relatively within the critical angular limit of proximity. Thus the flag 30 may be subdivided into a portion 31 which may bear one color, such as geen, and a portion 32 which may bear another color, such as amber, these portions being on one side of the pointer 26, that side toward the higher temperature readings.

In operation, when the pointer 22 with its red flag 22*a* moves to a position over the green portion of flag 31 it is indicative of the imminence of moisture condensation or of icing conditions. The width of such green portion of the flat determines the warning range by which the pilot is forewarned in ample and safe time to direct heat, for example, hot engine exhaust gases upon the carburetor or carburetor manifold thereby to prevent the throttling of the fuel mixture by icing.

Thus a manual control, as a handle 33, can be provided for governing suitable heating means 34. The latter may comprise a damper means 34*a*, which may be actuated from the handle 33 by means of a mechanical linkage 34*b*, or any other suitable device for channeling hot exhaust gases (or heat from any other source) over the carburetor.

If desired, a suitable alarm system may be employed utilizing for example a flashing red light 35 and/or an audible buzzer 36. These alarms may be connected in

any of several well known arrangements so that they become actuated when the pointer **22** moves close enough to the pointer **26** so that the red flag **22***a* on the pointer **22** covers the green flag **31** on the pointer **26**. If the red flag **22***a* covers the amber flag **32**, it indicates that condensation is taking place and if the pointer **22** shows a Dry-Bulb freezing temperature as at 32° F. for water or below while covering the amber flag **32** icing is revealed.

The alarm system by any conventional operative interconnection can be made to actuate a heating means to raise the Dry-Bulb temperature above the Dewpoint temperature; or on the other hand to actuate a Dewpoint temperature reducing means for reducing the Dewpoint of the air entry in the selected location, such as for example, the venturi **11**.

The heating means can be constructed and arranged to direct heat upon or develop temperature in the material of the venturi **11** as shown in the drawings and also upon the conduit **14** or the throttle valve **15***a* or by any other suitable surfaces.

What is claimed is:

1. The method for indicating approaching icing conditions in a venturi which consists in, sensing the Dry-Bulb temperatures at the throat region of such venturi, sensing the Dewpoint temperature of air in the vicinity of such venturi, converting the values of such sensed Dewpoint temperature to the same system of values as such sensed Dry-Bulb temperature, and indicating such values upon a common scale of such values.

2. The method in accordance with claim **1** including applying heat to such venturi in response to such indicated values of Dry-Bulb and Dewpoint temperatures achieving a degree of proximity commensurate with the onset of condensation in said venturi.

3. The method in accordance with claim **2** and including reducing the Dewpoint of air entering said venturi in response to such indicated values of Dry-Bulb and Dewpoint temperatures moving to within said degree of proximity to one another.

4. In apparatus of the class described, a venturi element, Dry-Bulb temperature sensing means for sensing the Dry-Bulb temperatures at the throat of said venturi element, means for sensing the Dewpoint temperature of air entering such element, a Dry-Bulb temperature indicator, means for moving such Dry-Bulb temperature indicator in response to signals from such Dry-Bulb temperature sensing means and including an operative interconnection therewith, a Dewpoint temperature indicator, means for moving said Dewpoint temperature indicator in response to signals from said Dewpoint temperature sensing means and including an operative interconnection therewith and means interposed in such last operative interconnection for converting the values of Dewpoint temperature to the same system of values as the Dry-Bulb temperature.

5. Apparatus for indicating approaching or existing condensation or icing conditions in a selected location and comprising in combination means for sensing the Dry-Bulb temperature in the vicinity of such location, means for sensing the Dewpoint temperature of the atmosphere in such location, a Dry-Bulb temperature indicator, means for moving such Dry-Bulb temperature indicator in response to signals from such Dry-Bulb temperature sensing means and including an operative interconnection between such moving means and sensing means, a Dewpoint temperature indicator, means for moving said Dewpoint temperature indicator in response to signals from said Dewpoint temperature sensing means and including an operative interconnection between such indicator and sensing means, means interposed in one of such operative interconnections for converting the values of the signals passing therethrough to the same system of values as those of the other temperature, a common graduated scale, means mounting said indicators for temperature response movements over said common scale, and proximity indicating means mounted on said indicators and operative to indicate the position of said indicators at a mutual proximity commensurate with the onset of condensation conditions in said selected location.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,210,058 October 5, 1965

Oliver D. Colvin

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 4, line 53, for "geen" read -- green --; column 6, lines 28 and 29, for "response" read -- responsive --.

Signed and sealed this 17th day of May 1966.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWARD J. BRENNER
Commissioner of Patents