

1 604 744

PATENT SPECIFICATION

(11) 1 604 744

- (21) Application No. 21651/78 (22) Filed 23 May 1978
(31) Convention Application No. 7 717 173
(32) Filed 31 May 1977 in
(33) France (FR)
(44) Complete Specification published 16 Dec. 1981
(51) INT CL³ G01N 21/59
(52) Index at acceptance
G1A A10 C13 C1 C8 D10 DJ FH G11 G13 G16 G17 G7 G8
P10 P17 P9 R7 S12 S3 S4 T15 T1 T20



(54) APPARATUS FOR MEASURING THE OPTICAL TRANSMISSIVE POWER OF THE ATMOSPHERE

(71) We, SOCIETE NATIONALE D'ETUDE ET DE CONSTRUCTION DE MOTEURS D'AVIATION, a French Corporate Body, of 2 Boulevard Victor, 75015 Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for measuring the optical transmissive power of the atmosphere, and has particular but not exclusive application to providing an indication of visibility at airports.

For some years, investigations have been into measuring the visibility on or near runways of an airport. The visibility depends on the transparency or transmissive power of the atmosphere hereinafter referred to, for greater convenience, as TPA.

The subject of the present invention is an apparatus enabling TPA to be measured in a very precise and very simple manner.

Numerous devices are known which are based on the response of a photosensitive cell receiving, through a certain path within the atmospheric medium to be studied, the light beam emitted by a source situated at the other end of the path, the response varying as a function of the transmissive power of the medium. The major difficulty in operating these devices, arises from the fact neither the intensity of luminance of the luminous source nor the sensitivity of the photosensitive cell are constant with time. Various automatic compensating arrangements have already been proposed for overcoming correlative errors. In particular, in French Patent Application No. 71.09954 of 22nd March 1971, the applicants proposed a system using a main and an auxiliary light source irradiating the same photosensitive cell, light from the auxiliary source passing along a path in which the absorption is independent of that of the medium to be studied by means of the light from the main source. The luminosities of the main and auxiliary sources are controlled

in such a manner that the fluxes received by the cell from the two sources, are in a constant ratio. For correcting for variations in the sensitivity of the cell, the prior system also includes a control arrangement connected to the said cell and the auxiliary source so as to maintain the light emission from the auxiliary source in inverse proportion to the sensitivity of the cell.

Whilst this system operates satisfactorily, it requires the presence of a qualified maintenance staff. The frequent absence at small airports of specialised staff for maintaining such equipment necessarily means that the maintenance operations must be less frequent and as simple as possible at site level.

With a view to overcoming this difficulty the present invention provides an apparatus for measuring the optical transmissive-power of the atmosphere comprising: a single, electrically driven source for producing luminous flux; a current supply device arranged to supply an electric current to drive said source; first and second detectors for producing electrical signals indicative of luminous flux incident thereon from said source, said first detector being spaced from said source and arranged to receive luminous flux from said source through the atmosphere, said detectors having substantially the same operating characteristics; a fibre optic light guide arranged to supply from said source to said second detector luminous flux which has not passed substantially through said atmosphere; means for establishing an essentially constant reference signal; and a comparator adapted to compare said reference signal and a signal from said second detector, said comparator being arranged to control operation of said current supply device in accordance with the comparison; and means responsive solely to the output of the first detector to produce signals indicative of the optical transmissive power of the atmosphere.

Losses of the flux incurred in the fibre optic light guide, being a function of the spectrum of the emitted light, preferably are

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predetermined distance corresponds to an exact TPA well determined. For example, for a measuring base of 30 metres and for a contrast threshold of 0.05, it is noted that for a visibility of 5 kilometers the TPA is 98.21%, for a visibility of 10 kilometres the TPA is 99.10% and for a visibility of 20 kilometres the TPA is 99.55%. It will also be noted that it is simple for an operator situated in an airport control tower to have a number of reference locations situated at known distances within the landscape such as those which have just been referred to of 5, 10 and 20 kilometres. Thus, it can be admitted that there will be many days in the month during which it will be possible for the operator to determine the threshold of visibility by enumerating the visible reference points and those which are not visible. Thus, at this instant, the operator will know the TPA which should be displayed by the measuring apparatus, a readjustment of the latter then being possible to the extent where the indication would not be satisfactory.

The device which will be described hereafter with regard to Figure 2 enables the calibration method to be conveniently carried out. Figure 3 concerns an embodiment of the invention identical to that of Figure 1.

In Figure 2 there are simply represented the elements which comprise the receiving portion of the assembly in Figure 1. These elements have the same references as in Figure 1.

The measuring information delivered by the measuring amplifier 11 is transmitted through a line 16 to a display apparatus 17 located near the operator. Similarly, a line 18 supplies an alarm device 19 constituted for example by a signalling lamp which is extinguished in the case of failure of the apparatus. The lines 16 and 18 are two wires, but for the sake of convenience they have been shown as single wires.

A switch 20 enabling the circuit of the line 16 to be interrupted is disposed in the circuit of the line 16 near to the operator.

At the level of the receiver, a circuit 21 ensures detection of a break in the line 16 and then starts a clock 22. This clock 22 delivers pulses to a selector 23 which selects a standard information, from among many standards, for example three, and transmits it to a comparator 24 which provides a comparison between it and the measuring information.

The difference signal delivered by the comparator 24 controls the gain G_1 of the measuring amplifier 11 so as to cause the measuring information to vary in such a sense that the said difference is cancelled.

Moreover, at each progression consequent upon a pulse from the clock 22, the selector 23 delivers into the line 18 a signal which

controls the alarm 19 thus permitting the operator to know the position of the selector and, consequently, the standard information effectively taken into account by the apparatus. In the case of an alarm 19 constituted by a signalling lamp, the latter is extinguished at the moment when the line 16 is broken and is illustrated for an instant at each progression of the selector 23.

The different forms of standard information which can be selected for comparison in the comparator 24 with the measuring information, each have a value such that the comparison with the measuring information provides a zero difference signal when the said measuring information is exactly that of the TPA corresponding to a visibility at a predetermined distance. For example, the standard information values may have values such that the comparator 22 delivers a zero difference signal when the measuring information corresponds to a TPA of 98.21%, 99.10% or 99.55% on the assumption that the chosen reference marks correspond to visibilities of 5 kilometres, of 10 kilometres, or of 20 kilometres.

Thus, it will be understood that when the operator is in a position to determine the threshold of visibility with accuracy, he can reset the apparatus so that it provides the PTA information corresponding to the said visibility. To this end, the operator interrupts the line 16 by means of the switch 20 and selects the standard information corresponding to the visibility at the time based on the number of times the signal lamp 19 is re-illuminated.

The different values of standard information which are capable of being compared to the measuring information within the comparator 24, and under the command of the operator, are obtained in known manner in the form of standard calibrated voltages for example by means of zener dioxides.

After such a calibration operation, the gain G_1 of the measuring amplifier 11 is such that the measuring information will have the desired accuracy for at least 15 days.

For spacing the cleaning operations of the windows sufficiently, a range of adjustment of the order of 5% of the TPA is provided. With respect to the original adjustment, this range of adjustment is advantageously arranged from at least 1% to 4% at the most. In fact, the dirt has a tendency to reduce the luminous flux received by the measuring cell 8 and consequently it is generally necessary to correct in a sense of increasing the value indicated for the TPA.

The calibration system which has just been described not only corrects measuring errors due to dirty windows but also all long term variations of various origins.

In addition to the circuits represented in

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Figure 2, conventional memory circuits are used to maintain the value of the gain of the measuring amplifier 11. The latter is especially useful when the operation of cleaning the windows takes place on a day when the visibility does not permit the carrying out of a calibration operation. In that case it is advisable to provide the measuring amplifier 11 once again with a gain identical to the initial gain. Moreover, it is of importance that after an interruption, for example a break in the supply current to the apparatus, the measuring amplifier 11 automatically resumes the value of the gain corresponding to the last effected calibration.

Thus, the apparatus for measuring the TPA in accordance with the invention and which has just been described has been designed so as to simplify maintenance operations and to enable them to be performed by non-specialised staff. Its remote control calibration system, permitting a simple interaction with the operator, enables a certain and accurate compensation for the dirt on the windows and for the long term variations in the apparatus to be carried out on the site.

The various qualities of the described apparatus for measuring the TPA, that is to say, its accuracy, its simplicity of operation and maintenance, and its low cost, makes it useful for airports of all kinds.

WHAT WE CLAIM IS:—

1. An apparatus for measuring the optical transmissive power of the atmosphere comprising:

- (a) a single, electrically driven source for producing luminous flux;
- (b) a current supply device arranged to supply an electric current to drive said source;
- (c) first and second detectors for producing electrical signals indicative of luminous flux incident thereon from said source, said first detector being spaced from said source and arranged to receive luminous flux from said source through the atmosphere, said detectors having substantially the same operating characteristics;
- (d) a fibre optic light guide arranged to supply from said source to said second detector luminous flux which has not passed substantially through said atmosphere;
- (e) means for establishing an essentially constant reference signal;
- (f) a comparator adapted to compare said reference signal and a signal from said second detector, said comparator being arranged to control operation of said

current supply device in accordance with the comparison; and

- (g) means responsive solely to the output of the first detector to produce signals indicative of the optical transmissive power of the atmosphere.

2. Apparatus as claimed in claim 1 wherein the current supply device includes modulating means for modulating the current selectively whereby to modulate the luminous flux produced by the source, and including means for demodulating the electrical signal produced by the first detector, the comparator being arranged to compare the reference signal with the demodulated signal produced by the demodulating means and to vary the modulation effected by the modulating means as a function of the comparison.

3. Apparatus as claimed in claim 1 or 2 wherein said detectors both are mounted in a receiving station disposed remotely of said source.

4. Apparatus as claimed in any preceding claim including a filter having a spectral response of the light guide, the filter being situated in the path of luminous flux from said source which impinges on said first detector.

5. Apparatus as claimed in any preceding claim including a filter arranged in the path of light travelling in said fibre optic guide from said source to said second detector, said filter having a spectral response so arranged to render the spectral bandwidth of the flux transmitted to the second detector independent of the spectral bandwidth of the luminous flux produced by said source.

6. Apparatus as claimed in any preceding claim including variable gain amplifier means arranged to amplify the signal produced by said first detector, and means for selectively varying the gain of the amplifier means in dependence upon operating conditions of the apparatus.

7. Apparatus as claimed in claim 6 including a store adapted to store predetermined gains for said amplifier, and operator controlled means for selecting a particular one of the stored gains from the store.

8. Apparatus as claimed in claim 7 including means for automatically selecting a predetermined one of said gains in response to a cessation of operation of the apparatus.

9. Apparatus as claimed in claim 7 including a control lamp for controlling the gain of the amplifier in accordance with the selected stored value.

10. Apparatus for measuring the optical transmissive power of the atmosphere, substantially as herein described with reference to the accompanying drawings.



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Thus, the apparatus for measuring the TPA in accordance with the invention and which has just been described has been designed so as to simplify maintenance operations and to enable them to be performed by non-specialised staff. Its remote control calibration system, permitting a simple interaction with the operator, enables a certain and accurate compensation for the dirt on the windows and for the long term variations in the apparatus to be carried out on the site.

The various qualities of the described apparatus for measuring the TPA, that is to say, its accuracy, its simplicity of operation and maintenance, and its low cost, makes it useful for airports of all kinds.

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- (d) a fibre optic light guide arranged to supply from said source to said second detector luminous flux which has not passed substantially through said atmosphere;
- (e) means for establishing an essentially constant reference signal;
- (f) a comparator adapted to compare said reference signal and a signal from said second detector, said comparator being arranged to control operation of said

current supply device in accordance with the comparison; and

- (g) means responsive solely to the output of the first detector to produce signals indicative of the optical transmissive power of the atmosphere.

2. Apparatus as claimed in claim 1 wherein the current supply device includes modulating means for modulating the current selectively whereby to modulate the luminous flux produced by the source, and including means for demodulating the electrical signal produced by the first detector, the comparator being arranged to compare the reference signal with the demodulated signal produced by the demodulating means and to vary the modulation effected by the modulating means as a function of the comparison.

3. Apparatus as claimed in claim 1 or 2 wherein said detectors both are mounted in a receiving station disposed remotely of said source.

4. Apparatus as claimed in any preceding claim including a filter having a spectral response of the light guide, the filter being situated in the path of luminous flux from said source which impinges on said first detector.

5. Apparatus as claimed in any preceding claim including a filter arranged in the path of light travelling in said fibre optic guide from said source to said second detector, said filter having a spectral response so arranged to render the spectral bandwidth of the flux transmitted to the second detector independent of the spectral bandwidth of the luminous flux produced by said source.

6. Apparatus as claimed in any preceding claim including variable gain amplifier means arranged to amplify the signal produced by said first detector, and means for selectively varying the gain of the amplifier means in dependence upon operating conditions of the apparatus.

7. Apparatus as claimed in claim 6 including a store adapted to store predetermined gains for said amplifier, and operator controlled means for selecting a particular one of the stored gains from the store.

8. Apparatus as claimed in claim 7 including means for automatically selecting a predetermined one of said gains in response to a cessation of operation of the apparatus.

9. Apparatus as claimed in claim 7 including a control lamp for controlling the gain of the amplifier in accordance with the selected stored value.

10. Apparatus for measuring the optical transmissive power of the atmosphere, substantially as herein described with reference to the accompanying drawings.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1981.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from
which copies may be obtained.