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# FOREIGN TECHNOLOGY DIVISION

A DEVICE FOR REMOTE MEASUREMENTS OF WIND PARAMETERS

by

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12

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ABSTRACT

(U) An Author Certificate has been issued for a device to be used in remote measuring of wind parameters. This device contains a set of wind receivers with a wind vane rigidly connected to the casing of the unit, a screw with a mobile part of contactless resistance pulsed velocity gauge attached to its axis, and a measuring unit with pulse counters. To increase the accuracy and reliability of this device by contactless conversion of the wind direction change into a phase shift between a series of pulses, the device is provided with two additional contactless pulse gauges. The movable part of these gauges is fixed to a horizontal gear of a pair of conical gears connecting the guages to the screw. To determine the mean direction of wind, the set of wind receivers is supplied with an indicator showing the position of the wind vane. This indicator has the form of a magnetic half-ring fixed on the casing and an immovable contacting couple, while the measuring unit contains a logic circuit with a distributor electrically connected to the pulse gauge and to the contacting couple. This arrangement automatically selects the datum for measuring the angles, interrelated to the state of the contacting couple. To correlate automtically the direction of wind with its velocity, the measuring unit contains a pulse generator connected to the resistance velocity gauge. The output part of this generator is connected to the pulse counter. Orig. art. has: 1 figure.

# A DEVICE FOR REMOTE MEASUREMENTS OF WIND PARAMETERS

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Devices for measuring wind parameters, containing a wind receiver unit with a vane and propeller, pulse converters, and a measuring unit, are known.

The proposed device is distinguished from the known ones, in that it has two supplementary contactless pulse pickups, the moving part of which is fastened to the horizontally-positioned gear of the helical pinion pair that connects the pickups with the propeller shaft. The wind receiver unit is equipped with a vane position indicator in the form of a magnetic half-ring, connected to the frame of the unit, and a fixed pair of contacts. The measuring unit has a logic circuit with a distributor, electrically connected to the pulse sensors and the contact pair, for automatic selection of the start of the angle readings, depending on the position of the contact pair. Besides this, the unit is equipped with a pulse generator connected to a reference velocity sensor; the output of the generator is switched into the pulse counter. All this enables us to increase the measurement accuracy of the device, increase its reliability, and also to determine average wind direction and automatically represent the wind direction in connection with its speed.

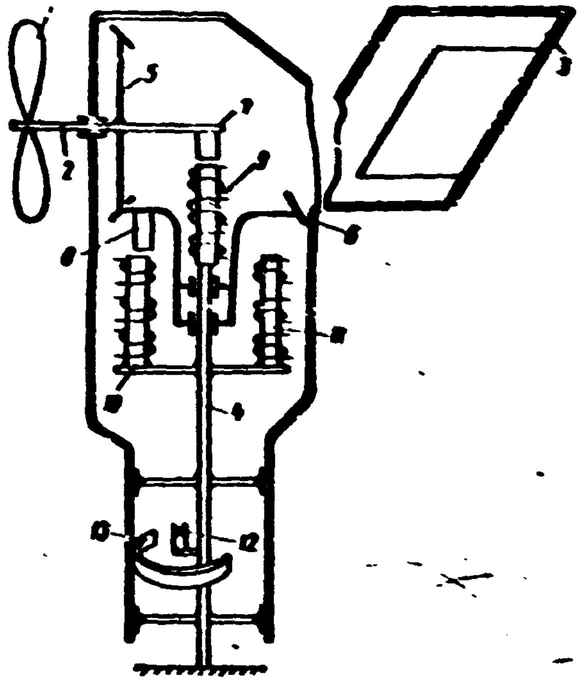

Fig. 1

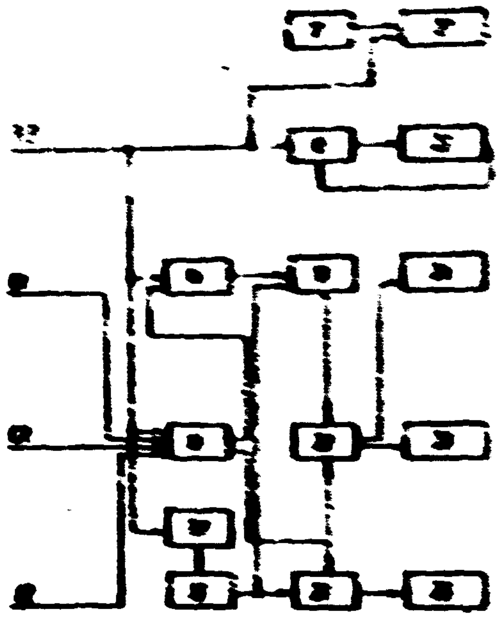

Fig. 2

Figure 1 shows the structural diagram of the wind detector unit; Fig. 2 shows the diagram of the measuring unit device.

Propeller 1 of the wind receiver unit, rotating around horizontal shaft 2, together with vane 3, may also rotate around stationary vertical support 4. Mounted on shaft 2 and support 4 is a pair of helical pinions 5 and 6, with a gear ratio; pinion 6 can rotate as the propeller turns, and turn with vane 3. Three contactless pulse counters, consisting of movable parts 7 and 8 and fixed parts 9-11, are mounted on shaft 2 and support 4. Movable part 7 and fixed part 9 make up the windspeed reference sensor which generates reference pulses (RP). Movable part 8, together with fixed parts 10 and 11, in the same plane 180° apart, make up the first and second auxiliary sensors which generate pulses C1 and C2, respectively.

The vane position indicator, consisting of hermetically sealed contact pair 12 and half-ring permanent magnet 13, is mounted on the wind detector unit frame in a precisely determined position (with regard to the auxiliary gauges).

The measuring unit of the device (see Fig. 2) contains shaper 14, which transforms the phase shift between pulses RP, C1, C2 to voltage differentials, the duration of which is equal to the indicated shift; distributor 15, which switches pulses C1 or C2 to the input of shaper 14, depending on the position of the contacts of contact pair 12 of the vane position indicator; modulating-pulse generator 16; time marker 17; adjustable frequency divider 18; modulator 19 of the measurement differentials shaped by unit 14; commutator 20 which controls distributor 15; rectifier 21 which controls distributor 15; circuit 22 that counts the number of RP pulses for the time interval periodically generated by time marker 17, and stores the largest of the counted numbers; reference pulse counter 23; and pulse counters 24-26.

Switch 20 switches the input of modulator 19 to the input of counters 24 or 25, depending on the position of distributor 15.

Rectifier 21 passes the pulses of generator 16 to the input of pulse counter 26 in one of the positions of distributor 15.

The device works as follows.

Reacting to the oncoming air flow, the propeller starts shaft 2 rotating. Helical pinion 5, which is rigidly fastened to the shaft, and movable part 7 of the direction reference sensor rotate together with shaft 2. Pinion 5 causes helical pinion 6 to rotate, together with movable part 8 of the auxiliary counters which is fixed to pinion 6. Pinion 6 and movable part 8 of these sensors may also turn as vane 3 turns. Thus, pinion 6 may rotate as a result of two independent integrating actions. When movable parts 7 and 8 pass over fixed parts 9 of the sensors, voltage pulses are generated. Thus, when pinions 5 and 6 rotate, three pulse trains – RP, C1, and C2 – are generated. The pulse repetition frequency of each train is the same, and is proportional to the instantaneous windspeed. By means of adjustment, it is possible to have pulses RP and C1 in phase when vane 3 is at the reference position. When the vane turns by angle $\phi$ in relation to the reference position, pinion 6 with movable part 8 continuing to rotate with the propeller, additionally turns by the same angle $\phi$ (because the gear ratio is 1:1). Owing to this, pulse train C1 is phase shifted by $\phi$ in relation to pulse train RP. This shift is equal to the angle that vane 3 turns in relation to the fixed part of the instrument, i.e., to the change in wind direction.

The mutual position of contact pair 12 and half-ring permanent magnet 13 of the vane position indicator assures that the contacts of pair 12 are closed when the vane is in the 270°-0°-90° sector and open in sector 270°-180°-90°. Any other mutual position of the indicator may be selected.

Reference pulses RP generated by the reference sensor, pulses C1 and C2, and also the position of contacts 12 of the indicator are transmitted to the measuring unit of the device (see Fig. 2).

The system for measuring average direction is set up with consideration of the fact that finding the direction as the mean arithmetical series of measurements is possible only for instantaneous values which differ from one another by no more than 180° (during rotation in the given direction). In particular, in the process of averaging, passage of the current direction values through the origin of the angle readings cannot be permitted. We use the following method to exclude the influence of this latter fact on the authenticity of the result during automatic averaging of the wind direction: in those cases when the probability that the current direction will pass beyond the averaging interval is comparatively large, we automatically shift the beginning of the reading by 180°. In other words, when the direction lies in the 270°-180°-90° sector, the measurement is made with the aid of the C1 pulses, i.e., the angles are read from 0°. If the current direction is located in the 270°-0°-90° sector, the angle measurements are made with the aid of the C2 pulses (shifted, as indicated, relative to pulses C1, by 180°), which is equivalent to transferring the beginning of the reading by 180°.

At the beginning of each propeller revolution, i.e., when the next RP appears, distributor 15 selects the coordinate origin in accordance with the stated principle, namely: if contacts 12 are open, the next

C1 pulse passes through to the input of shaper 14 from the pulse output of distributor 15, i.e., 0° is assumed as the origin. In the opposite case, pulse C2 is passed through to the shaper input, i.e., 180° will be assumed as the origin.

The voltage differentials developed in shaper 14, the duration of which is equal to the time shift between pulses RP and C1 or C2, are modulated in measuring differential modulator 19 by pulse voltage from generator 16. At the output of the differential modulator we get pulses, the number of which is proportional to the overall (for the time of measurement) duration of the input voltage differentials, i.e., to the desired value.

If 0° is assumed as the beginning of the reading, then switch 20 is set by a control signal from the potential output of distributor 15 to a position where the output of modulator 19 is coupled to pulse counter 24. This signal prohibits passage of pulses from generator 16 through rectifier 21. Upon transfer of the beginning of the reading, the indicated signal switches the output of measurement differential modulator 19 to the input of pulse counter 24. Simultaneously, the signal permits passage of the modulating pulses through rectifier 21 to the input of counter 26. These pulses are, in this case, time marks, since the number of these pulses counted in counter 26 determines the lifetime of the shift in reading origins.

If in the given averaging interval T the reading is made with the aid of pulses C1 during time $T^{1}$ and with the aid of pulses C2 during time $T^{11}$, then the numbers accumulated in pulse counters 24-26 will uniquely determine (on a certain scale) the corresponding values from which can be found the desired magnitude of the average direction.

The information accumulated in counters 24-26 is encoded into a form convenient for transmission along communications channels for input to a digital computer, and also for visual output of the readings.

The system for measuring average wind direction has the following characteristics.

If averaging interval T is selected such that in time t the current wind values cannot differ from one another by more than 180°, then there is no longer any need for switch 20, rectifier 21, system 22, and pulse counter 26 in subsequent calculations.

In this case the coordinate origin is automatically established by distributor 15 at the beginning of the averaging interval and remains unchanged through the whole averaging cycle T. The result is received directly in pulse counter 24.

To get the value of the average wind direction, the voltage differentials in shaper 14 are modulated by a beat frequency which is proportional to the current windspeed.

It is possible to derive this beat frequency, for example, by converting the reference pulses RP to voltage (current), and by secondary conversion of this voltage to a frequency proportional to the current windspeed.

The conversion of reference pulses to a proportional voltage (current) is accomplished by converter 27, which may be designed, for example, as a frequency-capacitance converter.

The secondary voltage conversion t⁻ frequency is accomplished by modulating signal generator 16, which may be designed, for example, as a capacitance converter system with periodic integration.

The expression for the average direction $\phi_{av}$ is:

$$\phi_{av} = \frac{\Sigma \phi_i t_i V_i}{T V_{av}},$$

where $t_i$ and $V_i$ are the values of time and speed for direction $\phi_i$.

$V_{av}$ is the average windspeed for interval T and is a parameter included in the wind measurements.

Such a representation of wind direction in connection with windspeed reflects considerably more fully the physics of air mass transfer than do analogous type instruments.

If there is need for an output to the indicating (or recording) instrument, to the output of shaper 14 across a low-frequency filter there is connected an instrument that measures (registers) the current force, and the required degree of averaging is determined by the value of the filter time-constant.

The average windspeed for interval $T_{av}$ is determined (to a certain scale) from the result of calculating the number of RP or C1, C2 pulses that arrive in time $t_{av}$. Such a calculation is made by counter 27 which is preceded by variable frequency divider 18. Its division factor is varied by one of the familiar methods. Varying the division factor takes into consideration the scatter of the aerodynamic characteristics of the wind receiver propellers. The result of the measurements is stored in the counter in a code that is suitable both for introduction into a communications channel and for a visual indication system. If it is necessary to obtain the output on the indicating instrument, an appropriate electromechanical counter is coupled to the output of variable frequency divider 18.

The "current" windspeed is determined from the result of averaging its instantaneous value over a sufficiently small time period (2-5 seconds).

The maximum speed is determined from the greatest value of the current speeds in the observation interval.

The "current" speed may be determined by one of the known methods of analog-digital conversion and, in particular, by a method analogous to that described above for determining the average windspeed. Determination of the maximum windspeed, which reduces in the given example to the comparison of two numbers (the previous and the present values of the "current" speed) and to the storage of the larger of them, may also be realized by any of the numerous methods of digital engineering in a form suitable for transmission over communications channels and for visual reading.

When there is need for output to the indicating (recording) instrument, a "frequency-current" converter (for example, a capacitor-type frequency meter) is coupled to the RP or C1, C2 pulse input, the load of which is the indicating or recording instrument. The averaging level in this case is established by proper selection of the filter time-constant, while for storage of the maximum current value (maximum speed) there can be used the so-called fixed pointer or other device that performs analogous functions.

## Object of the Invention

1. A device for remote measurements of wind parameters, containing a wind-receiver unit with a vane rigidly fastened to the housing, and a propeller to whose shaft is attached the moving part of a reference, contactless, velocity pulse sensor, and also a measuring unit with pulse counters, is distinguished in that, with the goal of increasing the accuracy and reliability of the device by means of the contactless conversion of wind direction values to a phase shift between series of pulses, it is equipped with two auxiliary contactless pulse sensors whose moving part is fastened to the horizontally-positioned gear of a helical rack and pinion connecting these sensors with the propeller shaft.

2. The device described in paragraph 1 is distinguished in that, with the goal of measuring the average wind direction, the wind receiver units are equipped with a vane position indicator in the form of a magnetic half-circle fastened to the frame of the unit and a fixed contact pair, while the measuring unit has a logic system with a distributor electrically coupled to the pulse sensors and the contact pair for automatic selection of the beginning of the angle readings, depending on the position of the contact pair.

3. The device described in paragraphs 1 and 2 is distinguished in that, with the goal of automatically obtaining the connection

between wind direction and speed, the measuring unit is equipped with a pulse generator which is coupled to a reference speed sensor. The generator output is coupled to the pulse counter.