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A DIGITAL INDICATOR FOR MAXIMUM WINDSPEEDS

by

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ABSTRACT

A simple device for indicating maximum windspeed during a time interval is described. Use of a unijunction transistor, for voltage sensing, results in a stable comparison circuit and also reduces overall component requirements. Measurement is presented digitally in 1-mile-per-hour increments over the range of 0-51 m.p.h.

Voltage output from a generator-type anemometer can be displayed in a variety of ways. A display suitable for photorecording was required during a recent study. Digital presentation in the camera field (using simple decimal code) was selected for maximum legibility and accuracy over the more obvious analog format. Maximum windspeed during the time interval between film exposures was chosen as the more significant wind parameter to be recorded, although instantaneous windspeed could have been similarly measured.

The system for measuring peak windspeed requires the following:

(1) Reference voltage generation,
(2) Voltage comparison,
(3) One-way rebalancing, and
(4) Readout and reset.

Reference voltages are produced with a 52-resistor series divider operating at a low current level from a stable mercury battery. The

series divider was chosen to utilize a number of precision resistors and an available 52-position stepper switch. The 51 fixed resistors in the chain were 0.1-percent tolerance. A wire-wound variable resistor completes the chain and allows for proper calibration of all steps in the chain. More inexpensive 5- or 10-percent tolerance components can be used if selected and positioned properly in the chain.[1/]

The reference source voltage is 6.75 v., which is adequate for a peak windspeed in excess of 51 m.p.h. The final wire-wound resistor in the chain creates the necessary voltage drop from the reference battery to establish the proper voltage steps of about 100 mv. per m.p.h. The drop across the variable resistor is then about equivalent to an 18-m.p.h. step.

Other voltage dividers[2/] could have been used here with equal success. An example of a parallel divider would be the Kelvin-Varley or one of its variants. These parallel dividers require several stepping switches but reduce the number of rebalancing steps. A parallel divider also offers the possibility of increase in full-scale measurements.

Voltage comparison is performed in a simple circuit incorporating a unijunction transistor (fig. 1).[3/] [4/] Out-of-balance conditions requiring higher reference voltages fire the unijunction and the silicon-controlled rectifier (SCR) providing stepped voltage increments until balance is obtained. If input voltage from the anemometer equals or is less than the reference voltage, the system is stable. Thus only the maximum voltage is registered. Sensitivity of this voltage comparison circuit is adequate to isolate the approximately 100-mv. steps equaling the 1-m.p.h. increments. A long-term stability of 10 mv. or better is claimed for the comparison circuit which insures a stable calibration. To minimize power supply variation and its effects on circuit operation, the comparison circuit also operates on mercury cells.

1/ Owen, R. P. Forming accurate dividers with nonprecise resistors. Electronics 38(20): 100-101, illus. 1965.

2/ Non-Linear Systems, Inc. Digital voltmeters. 208 pp., illus. Del Mar, California. 1962.

3/ Sylvan, T. P. The unijunction transistor characteristics and applications. Application Note 90.10, 95 pp., illus. Syracuse: G.E. Semiconductor Products. 1965.

4/ General Electric Co. Transistor Manual, Sixth Edition. 456 pp., illus. Syracuse: G. E. Semiconductor Products. 1962.

Two steps are required to establish the proper threshold for the unijunction transistor comparison circuit. With the input shorted and the reference battery removed, R_o is adjusted to a point where the circuit is about to fire. Next, R_o is adjusted such that an input voltage equal to 1 m.p.h. will cause the unijunction to fire and the stepper to advance continuously. Resistor R_t is adjusted for maximum temperature stability. It may be necessary to readjust R_o after R_t has been adjusted.

Calibration consists of setting the voltage steps along the divider chain equal to the 1-m.p.h. voltage increments produced by the anemometer. This may be done in a wind tunnel where windspeed can be accurately determined. By adjustment of the single series resistor, all steps are established in the proper sequence. At a constant windspeed, the stepper is reset, then allowed to step to the stable position. Adjustment of the divider chain series resistor is continued until readout indicates proper windspeed.

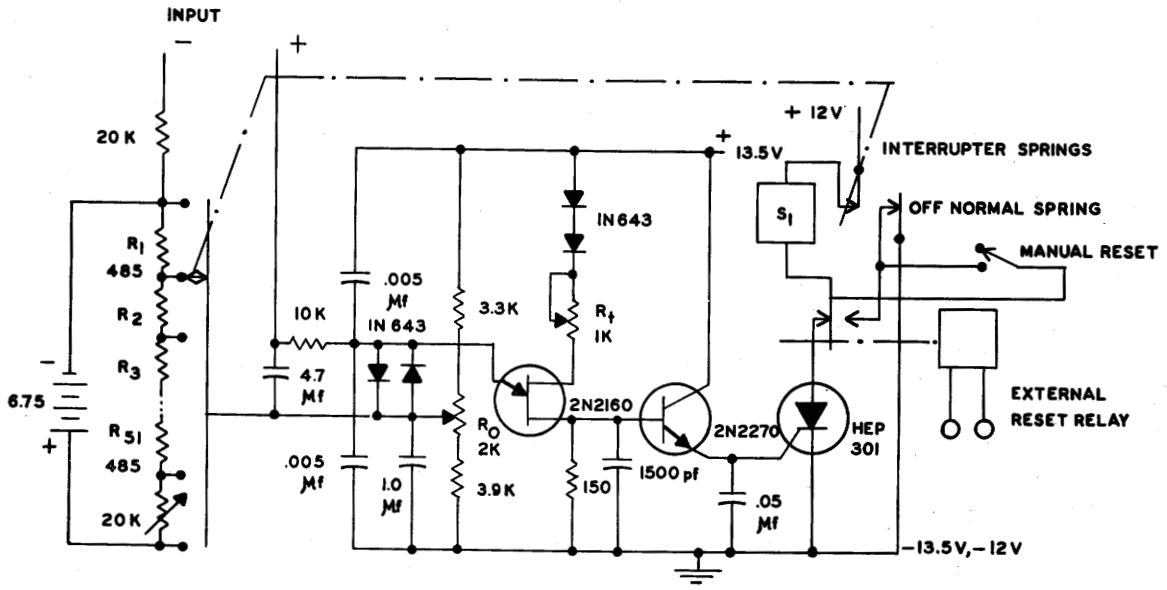
Reset is accomplished at the end of each sample period by actuating the stepper to the home or zero position. At the end of this reset cycle, if the anemometer is producing a voltage, the voltage comparison circuit senses an unbalance and causes the stepper to cycle to the appropriate balancing voltage along the divider chain.

Readout of the peak windspeed is by coded lights. Simple decimal coding on the stepper provides the contact closures for the light bank presentation. The light bank is illuminated slightly prior to the camera pulse and the stepper is reset at the termination of the camera sequence.

The system is battery operated, a requirement for this type of unattended service. Current drain is low; regulation of supplies is not critical with the exception of the reference supply.

Manual test and reset functions can be added for determination of satisfactory operating conditions. Manual reset is accomplished as shown on the schematic diagrams (fig. 1). A test function for simulation of a peak windspeed consisted of a single-pole, double-throw, pushbutton switch to disconnect the anemometer and connect a reference battery to the input terminals.

Parts layout is not critical; the arrangement used (fig. 2) was adequate. An edgewise voltmeter used to monitor input voltage on an instantaneous basis has been removed for clarity. It is not required for normal operation.



Note: S_1 is Type 45, 50 position stepper; 3 nonbridging circuits

Figure 1.--*Schematic drawing of anemometer circuit.*

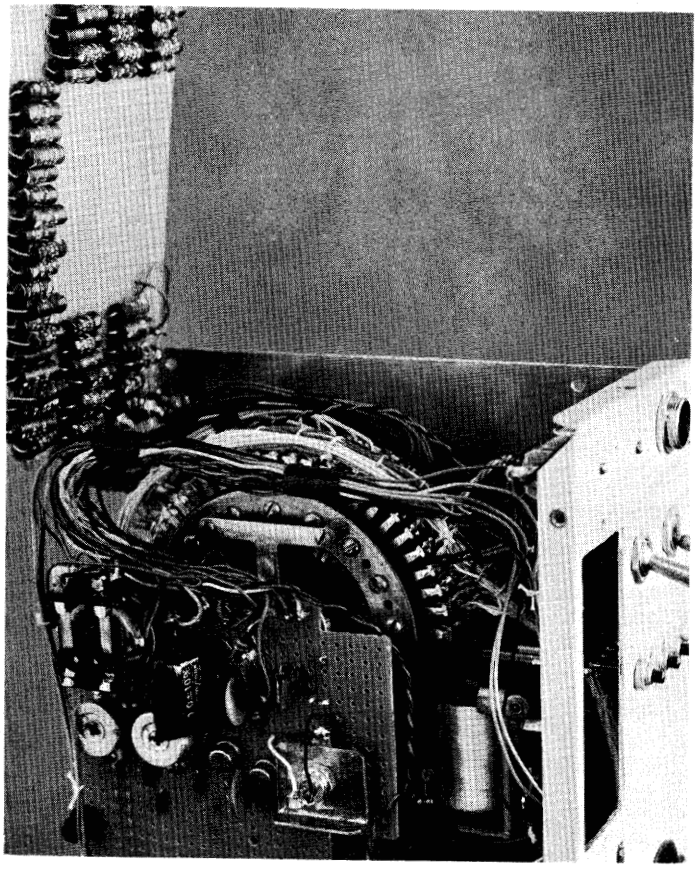


Figure 2.--*Completed circuit with reference divider wiring swung away and panel meter removed for clarity.*