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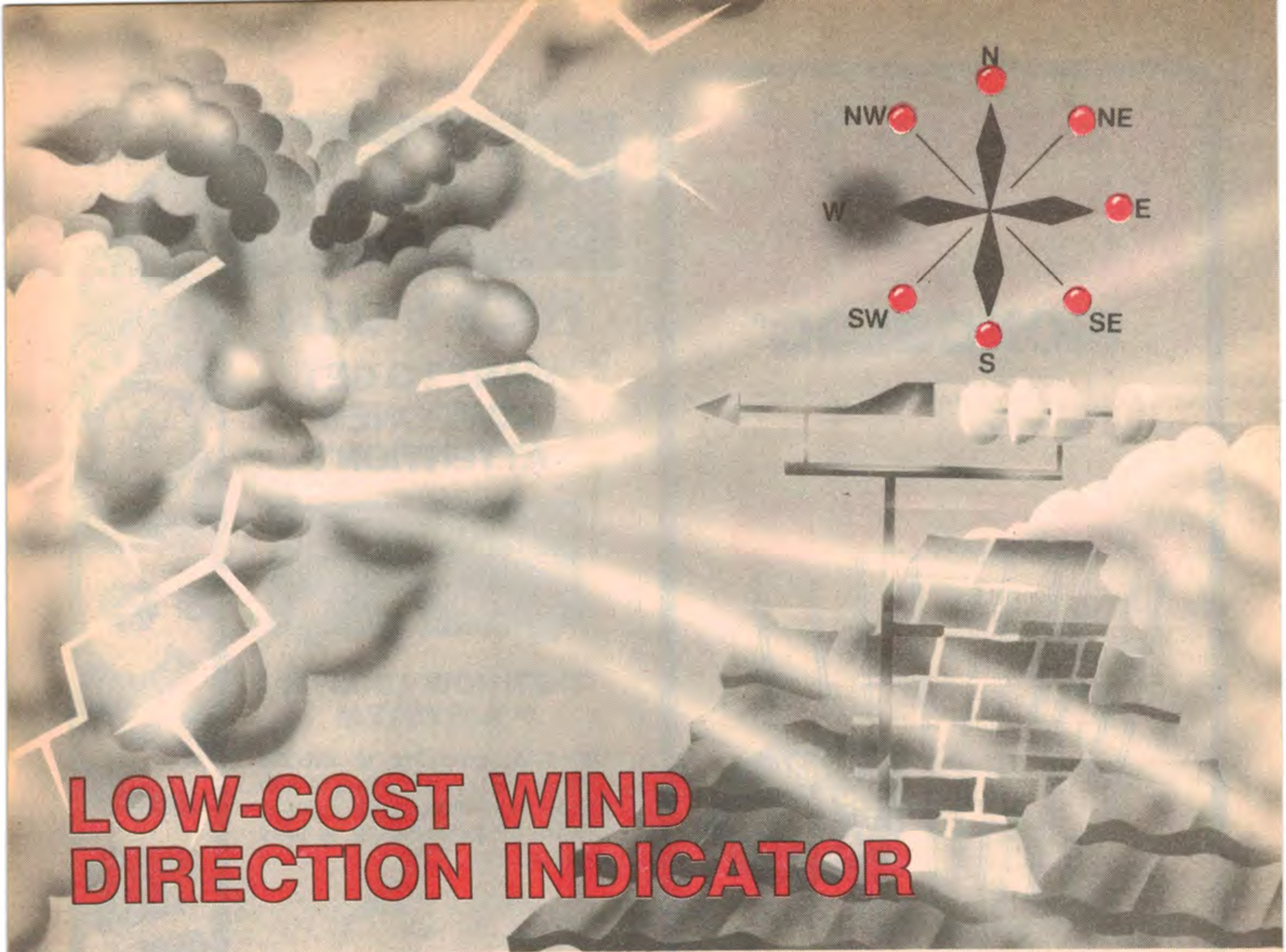
JANUARY, 1982 AUST $1.90* NZ $2.10

Simple low-cost WIND INDICATOR



LOW-COST WIND DIRECTION INDICATOR

Add this simple wind direction indicator to the anemometer published in our August 1981 issue to obtain a complete wind speed and direction indicator. The circuit gives wind indication at eight points of the compass with only two wires between the remote sender and the electronic indicator.

By JOHN CLARKE

Knowing wind speed is only half the story. In most instances, it is just as important to know wind direction (or apparent wind direction) as well, particularly if you are involved in flying or boating activities. Wind direction is vitally important to parachutists, hang glider pilots and model enthusiasts, while no weather forecaster would dare give a forecast without this vital piece of information.

In fact, knowing wind direction can be more important than the actual wind speed. Consider for example, the case of stalking a rhinoceros with your camera. It is vitally important to be down wind, lest the rhino picks up your scent and charges you. (This guy shows imagination – Ed.)

But enough flippancy. Our new "Wind Indicator" is a practical device likely to interest a diverse range of people. It can be built for a fraction of the cost of current commercial units and could even form the basis of your own home weather station.

HOW IT WORKS

There are many traditional methods of measuring wind direction, including the old wet-finger-in-the-air trick, balloons, wind socks and mechanical wind vanes. The version described here is essentially a mechanical wind vane, to which we have added electronic position sensing linked to an electronic readout. This enables you to measure both the speed and direction of the wind without ever venturing outdoors.

We opted for a wind vane to detect the wind direction since it is relatively easy to incorporate sensors to detect the position of the vane. As can be seen from the photographs, the vane is similar to the tail of an aircraft and is supported on a bearing that rotates in the horizontal plane. When the wind changes direction, the vane rotates until equal wind pressure is applied to both sides of the tail – ie when the counterweight is pointing into the wind.

The electronic position sensors consist of reed switches arranged radially around the vane spindle to represent the points on a compass. A magnet attached to the spindle activates the nearest reed to give the appropriate front panel display. If the magnet subsequently changes position due to a wind change, the reed switch is released and a new reed activated.

With this arrangement, it is quite easy to use the reeds to independently activate LEDs arranged in a corresponding pattern. All we would have to do is connect a LED in series between each reed switch and ground, and run the other ends of the reeds to a common power supply rail. The drawback with this system, however, is that nine separate leads must be connected between the vane and the display unit, one for each reed plus a common.

For the average constructor, running a nine-lead cable between the vane and an indoors display unit is a rather messy prospect. The cable tends to be bulky and can become quite expensive, particularly where long runs are used.

A far better method is to use the reeds to switch resistors in a voltage divider string. Extra circuitry is then used in the display unit to decode the voltage levels from the divider and to light the appropriate LED. This allows us to use only two wires between the vane and the display unit and, as a bonus, we can eliminate one of the reeds. More about this later.

CIRCUIT DESCRIPTION

The circuit can be divided into two distinct sections: a UAA170 dot display driver IC and a voltage divider circuit connected to pin 11. Seven resistors are used in the lower arm of the voltage divider, and each resistor can be shunted to ground by one or more of the reed switches. The UAA170 decodes the voltage set by the divider on its pin 11 input and drives the appropriate LED.

Let's take a closer look at the UAA170. Although the IC is rather complex internally, it is easy to use in practice.

First, pins 15 and 16 control the LED drive current. In this circuit, a 10kΩ resistor between pins 16 and 14 and a 1kΩ resistor from pin 15 to ground set the LED current to 20mA to ensure sufficient LED brightness.

Pin 14 provides a stabilised voltage (Vstab) of 5V, and this is used as a reference level to program the IC. Two other pins (pins 12 and 13) are directly connected to 0V and Vstab respectively to set the minimum and maximum reference voltages (Vref min and Vref max). These minimum and maximum reference voltages determine the range over which Vcont (pin 11) must vary in order to light all the LEDs.

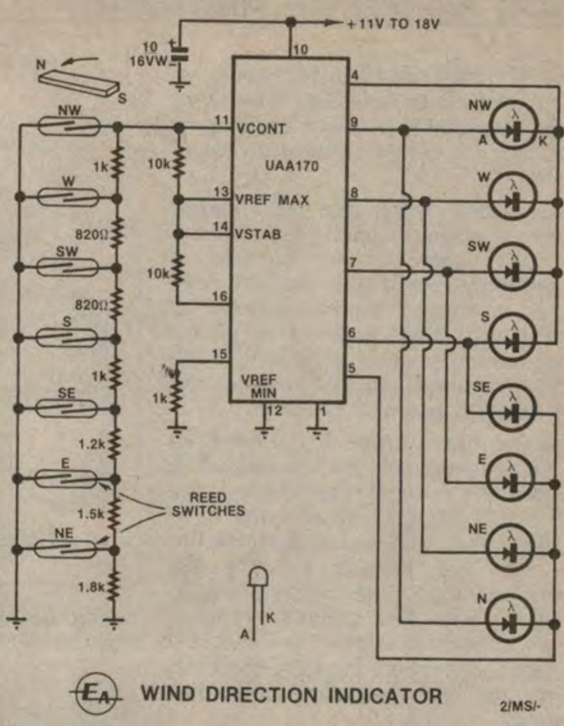
Cunning internal design ensures that there is always one LED lit for any voltage from Vstab to 0V and, in this circuit, that no two LEDs can be on at the same time. In practice, this means that there is a small voltage range over which Vcont can be varied while still keeping the same LED lit. When this range is exceeded, the next LED lights.

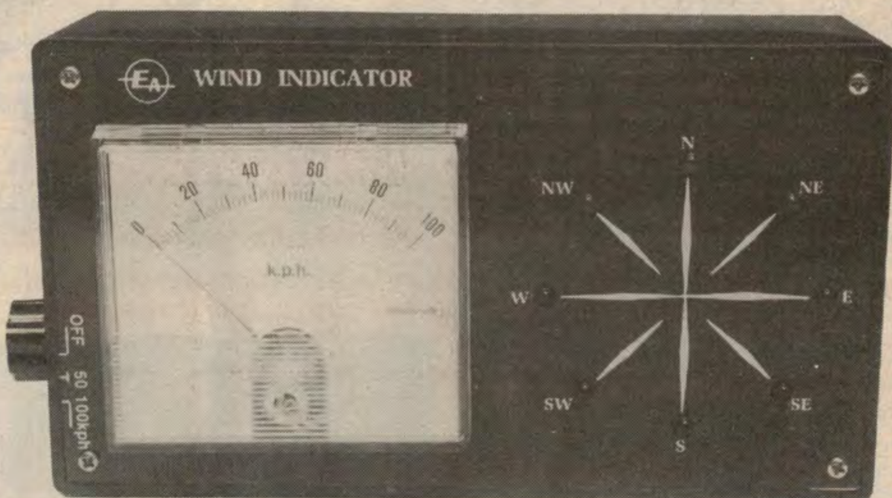
The voltage range over which each LED is lit is shown in Fig. 1, and is approximately 0.3V (5V divided by 16). Because the IC is designed to control 16 LEDs, the eighth LED (the N LED) will be lit when Vcont is at ½Vstab; or, more accurately, when Vcont is between ½Vstab and ½Vstab − 0.3V (see Fig. 1). So, in this circuit, Vcont has been set to a maximum value of slightly less than ½Vstab by the voltage divider network connected to pin 11.

The voltage divider consists of the 10kΩ resistor connected from Vstab to Vcont and the resistive divider string from Vcont to 0V. As we've just seen, the N LED is lit when all the reeds are open and Vcont is at maximum voltage. Result: no reed switch is required for the N position.

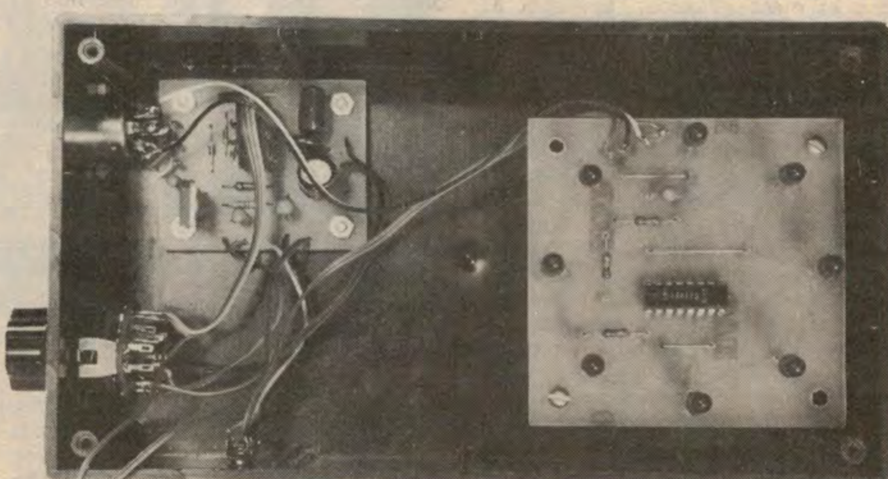
Thus only seven reed switches are required, one each for the remaining

The circuit consists of seven reed switches in a voltage divider circuit, and a UAA170 dot display driver IC driving eight LEDs.





The completed unit can measure both wind speed and wind direction.



View inside the completed display unit. External connections to the direction and speed sensing units are made via a five-pin DIN socket (top, left).

points on the compass. Depending on the position of the magnet, they shunt various resistors in the divider string to 0V to vary the control voltage on pin 11 (Vcont).

For example, when the NW reed is closed, Vcont is pulled to 0V and the NW LED lights. If the W reed is subsequently closed and the NW reed opened, a voltage divider is formed by the 1kΩ and 10kΩ resistors to give a voltage which is within range to light the W LED. The remaining reed switches and LEDs function in similar fashion.

However, there is one final subtlety to the circuit that should be appreciated. It is important to note that closing any reed below another closed reed does not affect the voltage divider, since the top reed has already brought the relevant section of the divider string to 0V. This ensures that, when the magnet is moving down the circuit, the next LED will light only when the next reed has closed and the preceding reed has released.

Conversely, if the magnet is moving up the circuit, the next LED will light as soon as the next reed is closed, regardless of whether or not the preceding reed has released. In other words, whenever two reeds are closed, the top reed always dominates and only one LED can light.

What this means in practice is that we can physically arrange the magnet and reed assembly so that slight overlapping occurs at the transition point – ie the next reed is activated just before the preceding reed is released. If this were not done, all the reeds would be momentarily open at the transition point and the N LED would flash on to give a false reading.

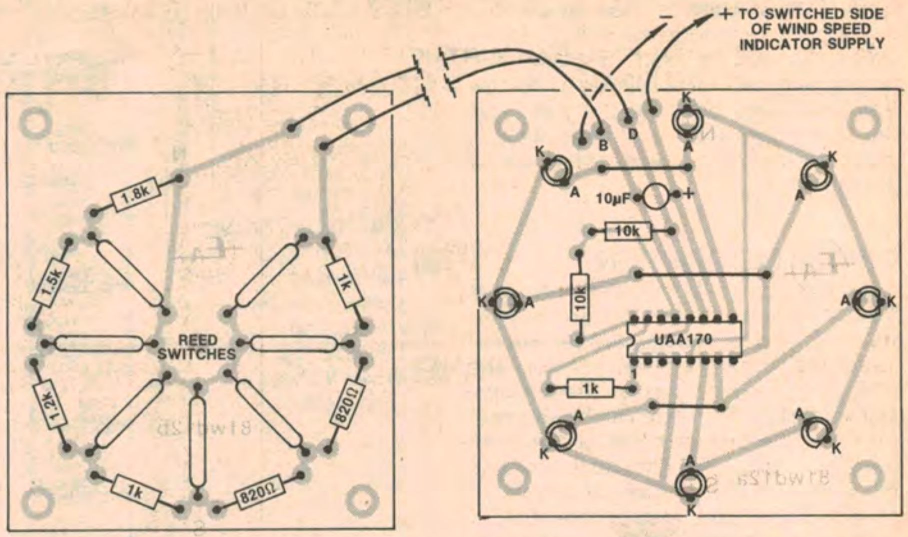
Power for the circuit can be derived from any 11-18V DC supply capable of supplying around 25mA. The unit will also operate quite happily from a 9V DC plugpack, which will have an output of about 12V at this low current. A 10μF capacitor across the supply provides decoupling.

CONSTRUCTION

We constructed the circuit on two separate printed circuit boards (PCBs) coded 81wd12a and 81wd12b and measuring 77 × 77mm and 64 × 80mm respectively. The 81wd12a board is housed in the original Wind Speed Indicator case and supports the IC and LED display. The other board, 81wd12b, supports the resistor string and reed switches and is mounted in a plastic utility case (150 x 90 x50mm), along with the vane and magnet assembly

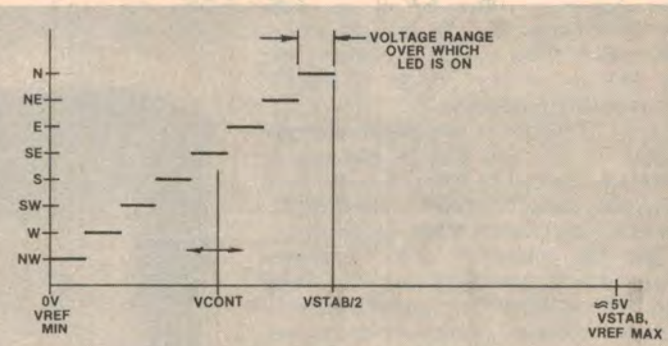
The first step is to construct the PCBs according to the wiring overlay diagrams. Be careful when bending the leads for the reed switches since the glass envelope is easily broken and make sure that all polarised components (LEDs, IC and tantalum capacitor) are connected the right way round. Note that the LEDs are soldered so that the top of each LED is 20mm above the PCB.

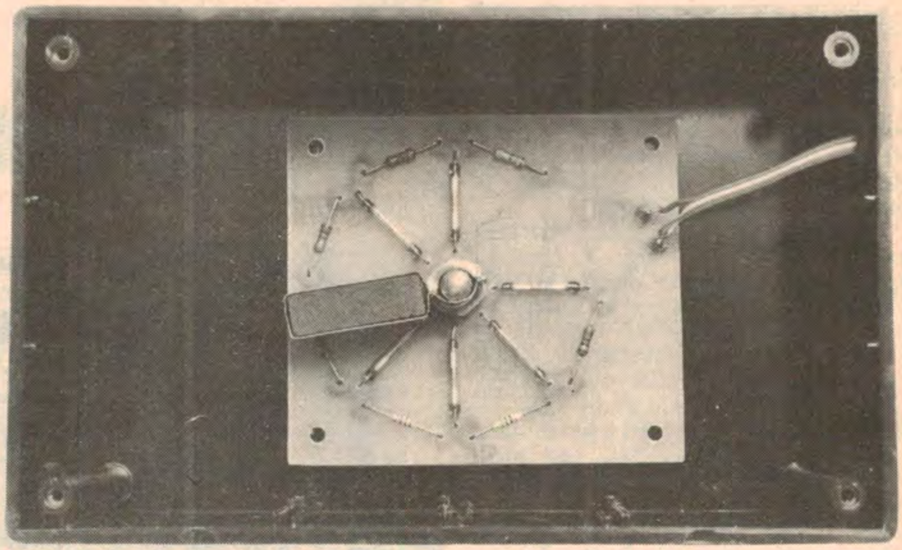
Once the PCBs are complete, they can be mounted on their respective cases. First, remove the old Scotchcal label from the Wind Speed Indicator case and fit the new label. Drill the holes for the meter and LEDs and mount the 81wd12a PCB on 38mm (2 × 19mm) standoffs so



Wiring diagram for the direction sensing and display circuits. Note that the circuit must be run from the unregulated side of the power supply (see p51, Oct, 1981).

Fig. 1: This diagram shows how each LED is lit in turn as Vcont varies between 0V and ½Vstab.



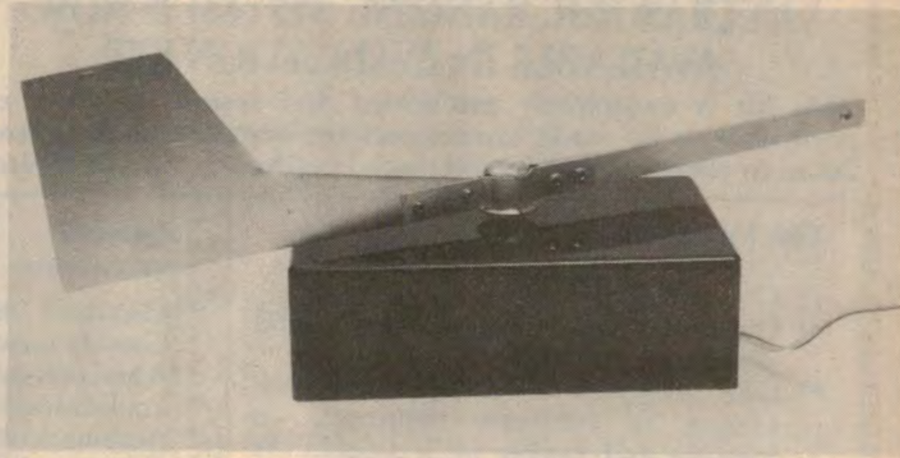


View inside the direction sensing unit showing the magnet and reed assembly.

that the LEDs protrude through the lid of the case.

As shown in the photographs, the power/range switch must be relocated from its original front panel position to the side of the case. Mount it carefully so that the marking on the knob will coincide with the positions marked on the Scotchcal label.

The wiring for the display unit can now be completed. The positive supply rail for the new PCB is taken from pin 7 of switch S1 (see October issue), while the 0V rail can be obtained from the negative side of the meter or from the negative side of the power input socket. The other two leads, labelled B and D on the overlay diagram, are connected to spare terminals on the DIN socket.



Close-up of the completed vane assembly mounted atop the direction sensing unit. The view at the bottom of the page shows how the direction and speed sensors were mounted on a mast.

VANE ASSEMBLY

Fig. 2 shows the basic scheme for the vane and reed switch assembly. As can be seen, the tail is made from 0.5mm sheet aluminium while the counterweight and brackets are made from 3mm aluminium. Cut out the tail piece first, then fashion the brackets by bending them around the knob and by using pliers to straighten the ends. Secure the tail piece to the brackets using rivets or machine screws and nuts.

Note that an access hole should be drilled in one of the clamps opposite the knob grub screw. This will enable you to tighten the screw when the knob is subsequently placed on the spindle.

The counterweight can now be made and should be cut to length to balance the tail. Cut it longer than necessary at first and attach it to the rest of the assembly. The counterweight can then be trimmed until the setup balances on a pivot placed in the hole of the knob.

A dial-drive spindle is used as the bearing for the vane and is attached to the 81wd12b PCB by screwing it into a nut soldered to the component side of the board (see Fig. 2). The spindle thread protrudes through a central hole in the base of the case (the case is used upside down) and the whole assembly secured by a second nut on the outside. Note that the component side of the PCB faces into the case.

The magnet holder is made of solderable sheet metal (eg, tin plate). Bend the metal tightly around the magnet and solder the two ends together as shown in Fig. 2. The two free ends are then bent around the spindle and soldered together for a tight fit. Finally, the magnet can be glued in the holder using epoxy resin and the completed magnet assembly glued (or soldered) to the spindle.

Alternative methods of holding the

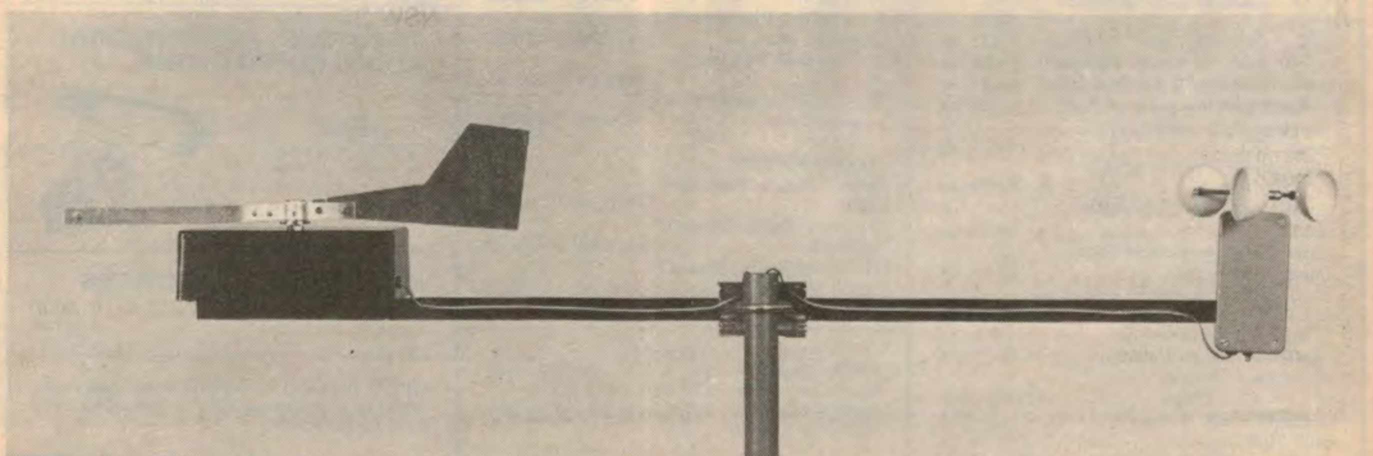
PARTS LIST

- *1 knob*
- *1 sheet of aluminium, 0.5mm × 153 × 75mm*
- *1 160mm length of 12 × 3mm aluminium bar*
- *1 magnet, 8 × 27 × 8.5mm*
- *1 brass dial drive spindle and two nuts*
- *4 19mm standoffs*
- *6 PC stakes*
- *1 printed circuit board, code 81wd12a, 77 × 77mm*
- *1 printed circuit board, code 81wd12b, 64 × 80mm*
- *1 Scotchcal front panel, 107 × 192mm*
- *1 plastic utility case, 150 × 90× 50mm*

COMPONENTS
- *1 UAA170 LED dot display IC*
- *8 5mm red LEDs*
- *7 reed switches, 15mm long*
- *1 10μF/16VW electrolytic capacitor*

RESISTORS (¼W, 5%)
2 × 10kΩ, 1 × 1.8kΩ, 1 × 1.5kΩ, 1 × 1.2kΩ, 3 × 1kΩ, 2 × 820Ω

MISCELLANEOUS
Cable, screws, solder, hook-up wire etc.



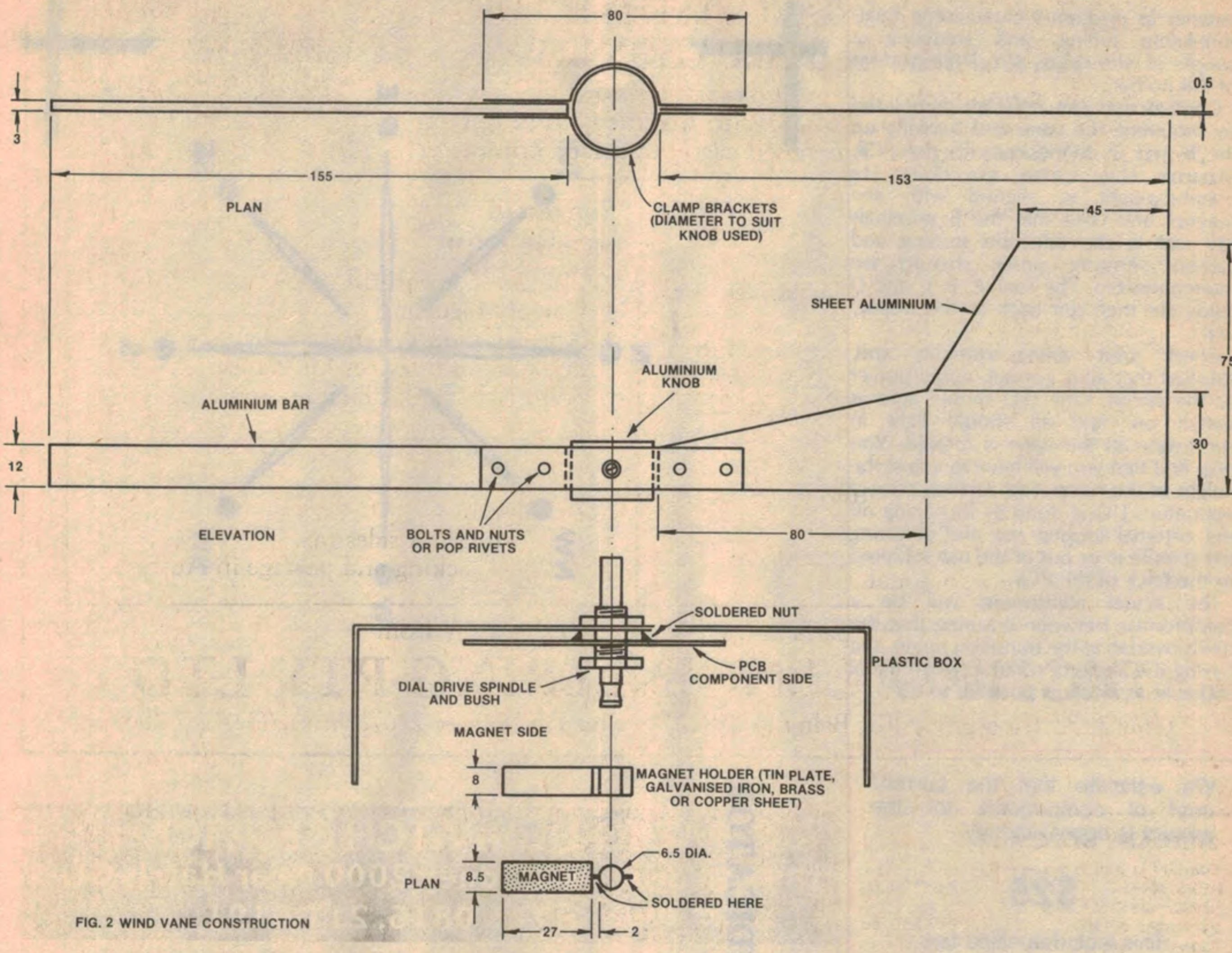
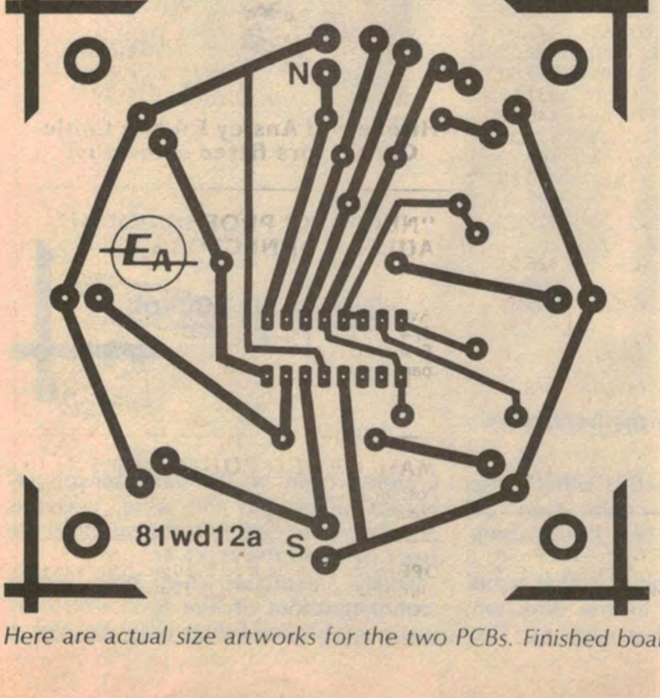
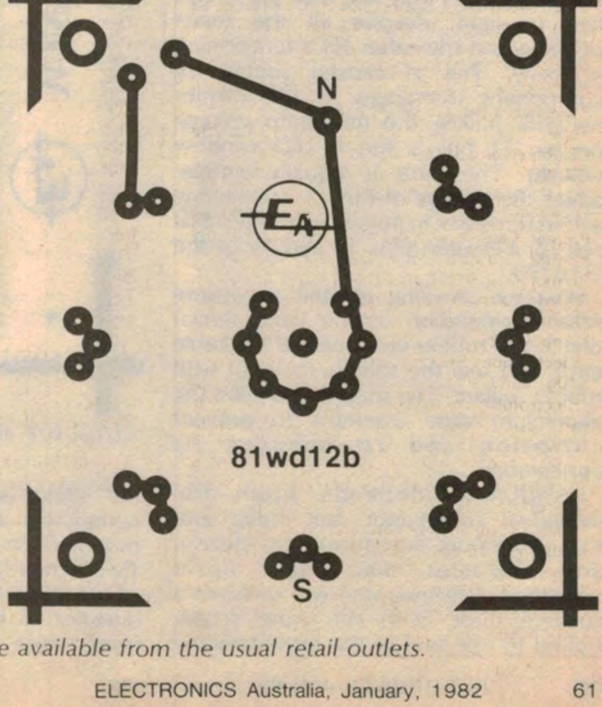


FIG. 2 WIND VANE CONSTRUCTION

This metalwork diagram shows the construction details for the aluminium vane.





Here are actual size artworks for the two PCBs. Finished boards will be available from the usual retail outlets.

magnet in position include using heat-shrinkable tubing, and soldering a couple of wire straps across the bottom of the holder.

Construction can now be completed by mounting the vane and hooking up the B and D connections to the PCB. Mount the vane so that its counterweight is aligned with the magnet and note that the B terminals (0V rail) in the direction sensing and speed sensing units should be interconnected. The four A, B, C and D leads are then run back to the display unit.

Check your wiring carefully and, satisfied that all is correct, apply power to the circuit. One LED should light at switch on, and all should light in succession as the vane is rotated. You may find that you will have to adjust the height of the magnet to achieve correct operation. This is done by loosening off the external locking nut and screwing the spindle in or out of the nut soldered to the back of the PCB.

The actual adjustment will be a compromise between ensuring that the reeds overlap at the transition points and having the angle of rotation while the N LED is lit as close as possible to 45°.

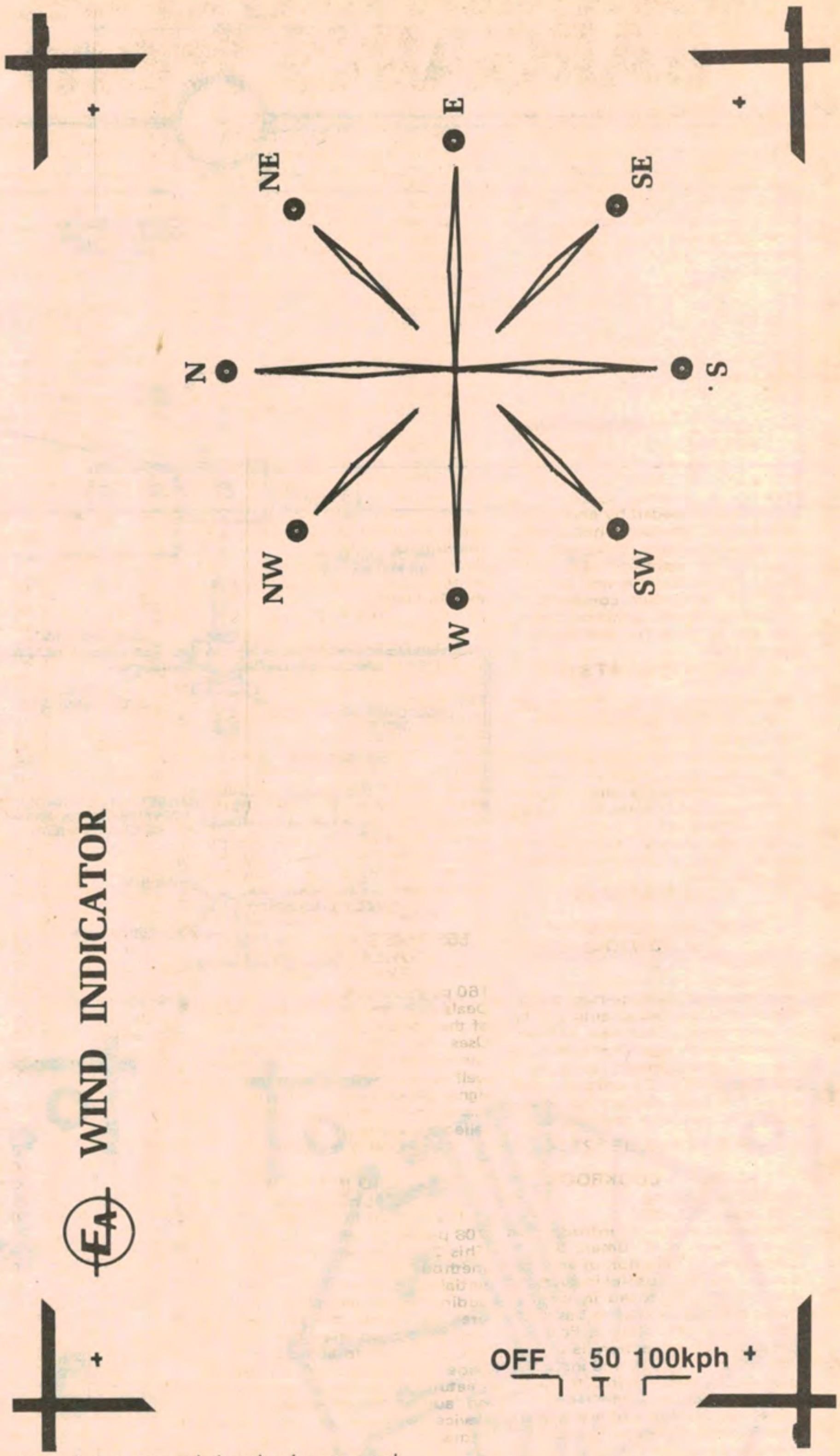
We estimate that the current cost of components for the project is approximately

$25

This includes sales tax.

Some readers may find that the N LED fails to light, despite all the reeds opening and the other LEDs functioning normally. This is caused simply by component tolerances in the divider network pulling the maximum voltage on pin 11 below the N LED window voltage. The cure is equally simple: adjust the voltage divider by connecting a 150kΩ resistor in parallel with the 10kΩ resistor between pins 11 and 14 of the UAA170.

Weather proofing is vital to ensure reliable operation of the vane sensor unit. Use a rubber grommet for the cable entry and seal the spindle lock nut with rubber sealant. You should also paint the aluminium vane assembly to prevent corrosion and to enhance its appearance.



Actual size artwork for the front panel.

Installation depends upon the individual constructor, but make sure that you mount the sensor units clear of any obstacles that might upset operation. We mounted our units on a suitable mast, with the vane sensor bolted to one end of the cross-arm and the speed sensor to the other. The completed assembly could then be mounted on the roof of a house using TV-antenna hardware.

One thing to remember is that wind direction is measured as the direction from which the wind is coming. The counterweight on the vane sensor will always point into the wind, and this should be the direction indicated on the front panel of the receiver.

Finally, exercise due care when stomping about on the roof. We don't want any broken bones now, do we?