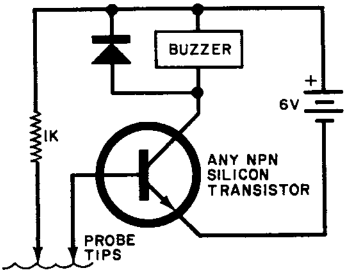
How to Detect Water in the Basement

Q. *With all of the rain we've had this spring, I keep getting flooding in the basement. Could I rig up some sort of simple system that would let me know when to go down and turn on the sump pump? I'm not really very experienced electronically.*

A. The circuit here is about the simplest you could build to do the job. You can use some

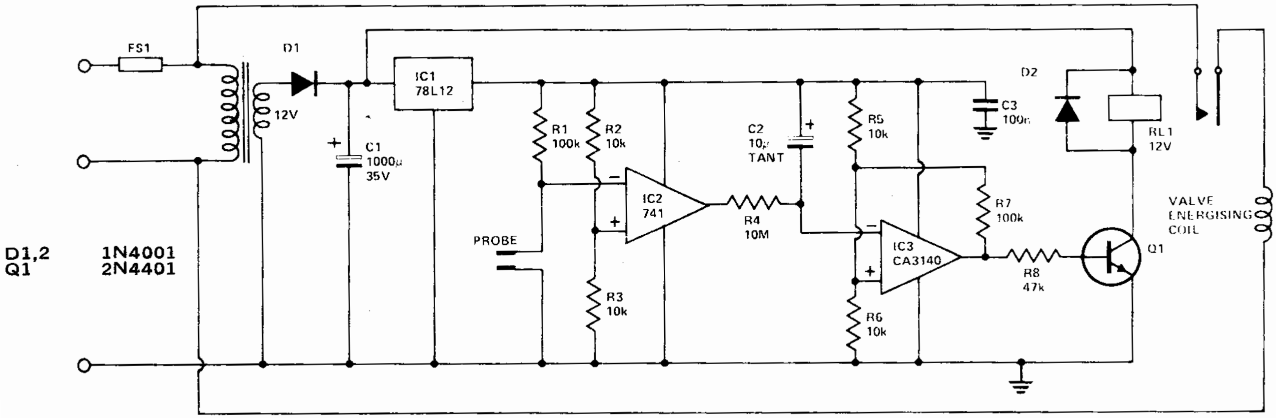


ordinary D cells for the power and any type of warning device that will operate on 6 volts. The circuit draws very little current on standby, but when water touches the probe tips, the alarm will sound off.

Getting Semiconductor Information

We get a lot of mail asking where certain semiconductors and other special parts can be obtained. Most of the parts used in construction projects can be found in the catalogs of our advertisers. Of course, they can't show everything in their ads, so please write to them for their catalogs. You will find a goldmine of useful information in them.

Have a problem or question on circuitry, components, parts availability, etc.? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, NY 10016. Though all letters can't be answered individually, those with wide interest will be published.



Electronic Ballcock

Cliff Heath

This circuit detects low water level in a swimming pool and switches the water supply on for about 20 seconds when it occurs.

The inverting input of IC2 is held low by a short across the probe (which can simply be a couple of bolts through the side of a fibreglass pool). When the water level is low the probe will go open circuit and the output of IC2 will go low. C2 will begin to charge and after about 2 minutes, the output of IC3 will change state. This 2 minute delay is to prevent waves from setting the device off prematurely.

Once triggered, IC3 (which is connected as a Schmidt trigger) will give a high output voltage for at least 20 seconds — this is the length of time needed for IC2 to change the inverting input voltage of IC3 past its hysteresis point.

While the output of IC3 is high, Q1 will turn on and energise the water supply valve coil. Care should be taken with the valve line supply — it's a good idea to put the end of the water supply hose into the pool. This will remove the possibility of line voltage water falling into the pool due to a short inside the valve.

Tech-Tips is an ideas forum and is not aimed at the beginner; we regret that we cannot answer queries on these items. We do not build up these circuits prior to publication.

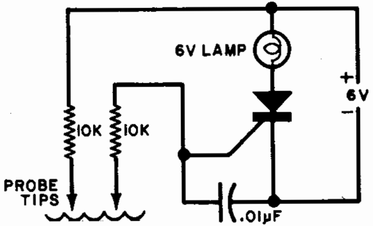
ETI is happy to consider circuits or ideas submitted by readers; all items used will be paid for. Drawings should be as clear as possible and the text should be preferrably typed. Anything submitted should not be subject to copyright. Items for consideration should be sent to the Editor.

Hobby Scene

BASEMENT WATER WARNING

Q. ***For my country home, I need some sort of simple warning system to provide an alert when the water in the basement backs up.***

A. This circuit is just about as simple as you can get—and quite sensitive. The lamp can easily be replaced with a Sonalert, or other low-voltage sound generator, to provide an audible warning. Use the resistor tips as the probe. The circuit draws no power when not working so a set of batteries should last all summer.



Multiplexed detectors isolate water leaks

by F.E. Hinkle
Applied Research Laboratories, University of Texas, Austin

The need to detect water leaks at any number of sites is common to public utilities, communications links, warehouses, chemical plants, and many other industries. Warning systems are required to indicate not only the existence of the leaks, but also their location, and the warning arrangement should be as simple as possible for reliability, efficiency, and economy.

This warning arrangement is built of several water-detectors and one master indicator that monitors all of the detectors simultaneously. Each detector indicates the presence of water by sounding a unique tone signal on a loudspeaker at the master-indicator location. The system uses only two wires for supplying power to all of the detectors and carrying signals from all of the detectors to the monitor.

Each detector is composed of one complementary-MOS quad NOR-gate integrated circuit and a few components. One of the NOR gates is used as the water sensor, the second as an inverter, and the other two as an astable multivibrator. If the input terminals of the sensing gate are dry, the resistance between them is greater than 500 kilohms, and the output logic level is low. Therefore the output from the inverter is high, and the multivibrator is disabled. But if water connects the input terminals of the sensor, the resistance between them is below 100 kilohms, the input to the inverter is high, and the multivibrator oscillates at a frequency determined by its RC time constant. Each detector has its own characteristic frequency, given by

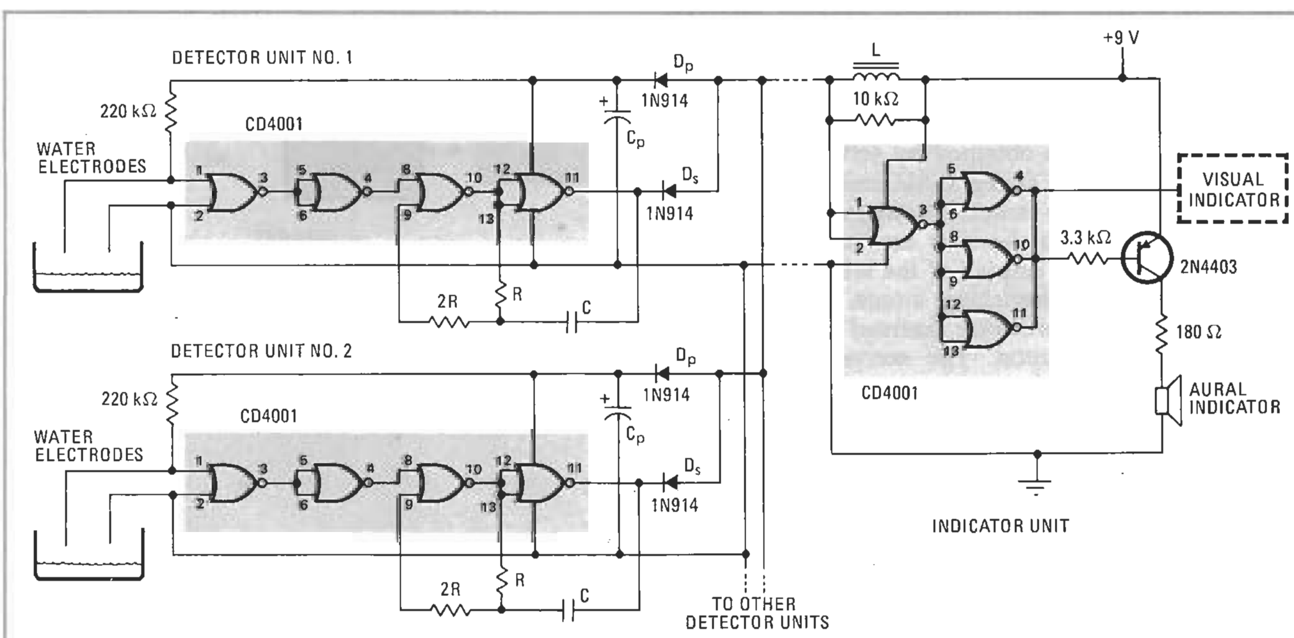
$$f_n = 1/1.4\,R_nC_n$$

where the resistance R_n is in ohms and the capacitance C_n is in farads.

The oscillator signal is carried back to the indicator unit over the two wires that supply dc power to the detector. Since the signal oscillates between 0 and +9 volts with a 50% duty cycle, the average value of the supply voltage is reduced considerably. Therefore, diode D_P and capacitor C_P are used to detect the peak supply voltage and store it. The value of C_P in farads is chosen to be $1/1000f_L$, where f_L is the lowest frequency (in hertz) used by any of the detectors. This amount of capacitance allows less than 0.5-volt ripple on the C-MOS chips.

To isolate all of the detector oscillators from one another, a diode, D_S, is used at the output of each multivibrator. Collectively, these diodes in the detectors form a multi-input OR gate.

The indicator unit contains a C-MOS gate that detects voltage fluctuations on the two-wire interconnect line and feeds a transistor amplifier to drive the loudspeaker. Inductor L isolates the detector signals from the dc-power source. The inductance value is deter-



Handles water music. A variety of tones from a loudspeaker signals water leaks and their locations. Visual display can also be provided, if necessary or desirable. Each one of a large number of detectors is identified by its unique frequency. Only two wires are needed to connect all detectors to the monitoring location; the wires supply power to the detectors, and carry the warning signals back to the indicator.

mined by the lowest signal frequency and the maximum current permitted during the oscillations. If this current is taken to be 1 milliampere for C-MOS devices used, the value of L in henries is about $1600/f_L$. This value of inductance seems large if f_L is a few hundred hertz, but the low currents permit use of miniature types of coils. A resistor shunts the coil so that no signal will see an impedance greater than 10 kilohms.

In operation, the detectors normally are quiescent. If a leak is detected, the frequency corresponding to the particular location is generated and transmitted via the two-wire interconnect cable to the indicator unit. The indicator emits the tone that identifies the location of the leak.

In a large system with many detectors, the oscillating frequencies may be too close together to distinguish between them, but a visual display, such as an oscilloscope or frequency counter, can be used to measure the precise frequency of oscillation.

Because C-MOS integrated circuits are used, the standby power demand is extremely low. A 9-V battery can power the complete system.

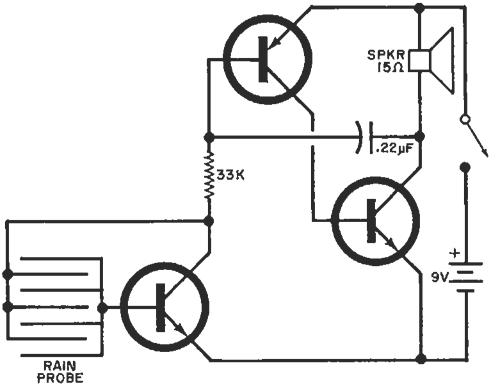
This system can be adapted to many other applications besides water-leak detection. Various types of sensors can be connected to produce logic-level changes at the input gate of the detector; only two interconnect wires would still be required to tie all the detectors to the indicator unit. □

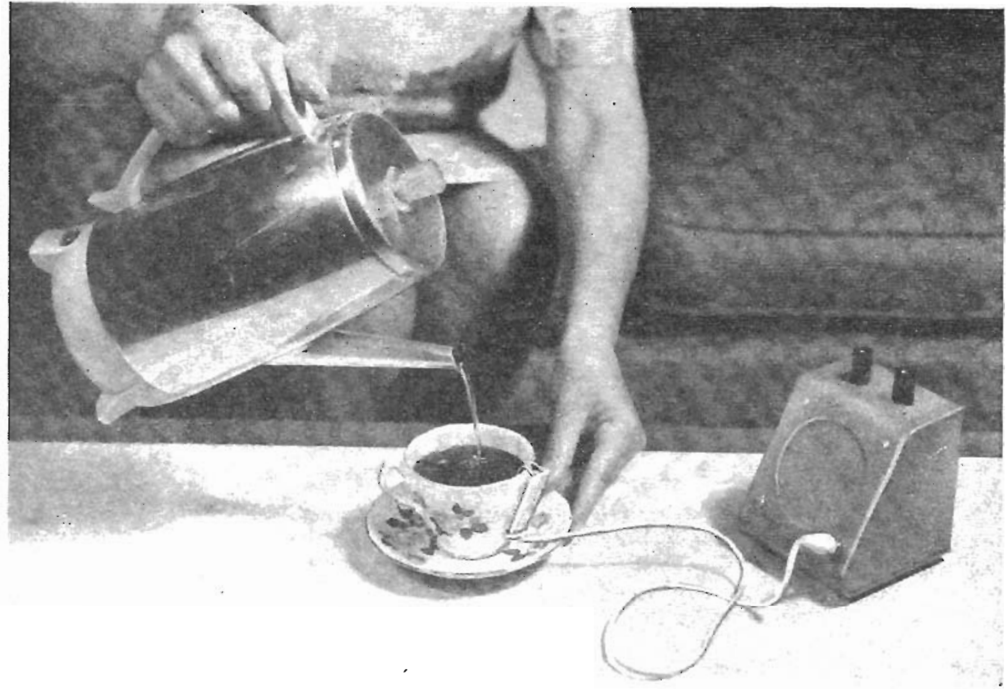
When Is It Raining?

Q. *Is there any way (electronically) that I can tell when it starts to rain? Seriously, if my mother is doing the laundry and can't see outside, how could I warn her about the rain?*

A. Build your mother a device using the circuit shown below. With silicon transistors, the standby power drain is negligible. The switch is used to stop the alarm. The

rain probe is made of several lengths of bare wire (or a printed circuit board) placed next to each other as shown, with just enough spacing to provide contact when a raindrop strikes them. Readily available transistors can be used.





LIQUID LEVEL INDICATOR FOR THE BLIND

ELECTRONIC DEVICE LETS BLIND PEOPLE POUR COFFEE, SOUPS, AND OTHER HOT OR COLD LIQUIDS—WITH CONFIDENCE

WHEN YOU POUR steaming liquids into a cup or bowl, you know when to stop—unless you happen to live in the perpetual darkness of the blind. A continuity checker, rigged up with a suitable liquid-sensing probe which gives an audible signal when the cup is full enough, solves the problem admirably.

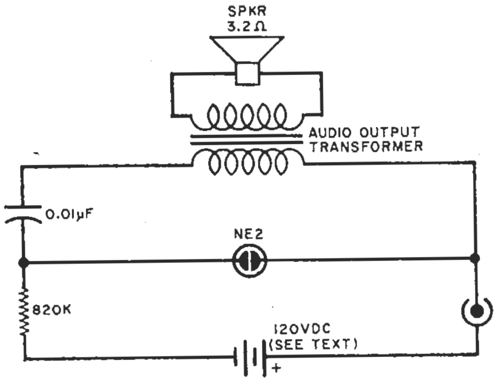
The simple neon lamp relaxation oscillator circuit presented here was devised by the author and has been used with much success by blind clients of the Bureau of Rehabilitation Services in Kentucky.* This level indicator is not only suitable for use with hot liquids, but with cold liquids such as milk or carbonated drinks—and even with spirits.

The author serves as Director, Division of Services for the Blind, Bureau of Rehabilitation Services, Department of Education, Frankfort, Kentucky.

By T. V. CRANMER, K4MMB

The first circuit tested for this application was suggested by L. W. Butler of Milwaukee, Wisconsin. Mr. Butler used a single transistor in a conventional Hartley oscillator circuit with the sensing probe connected in the battery lead. This circuit worked well, but the audio level of the output was insufficient to permit its use in noisy surroundings.

Mr. Butler has since made a clever modification of a conventional pocket-size radio which gives a much better output. To make this modification, you need only feed the output from one side of the speaker transformer through a 100-pF capacitor through the probe to the center connection or wiper of the



The value of the resistor can be either increased or decreased to respectively raise or lower the pitch or frequency of the tone heard at the speaker.

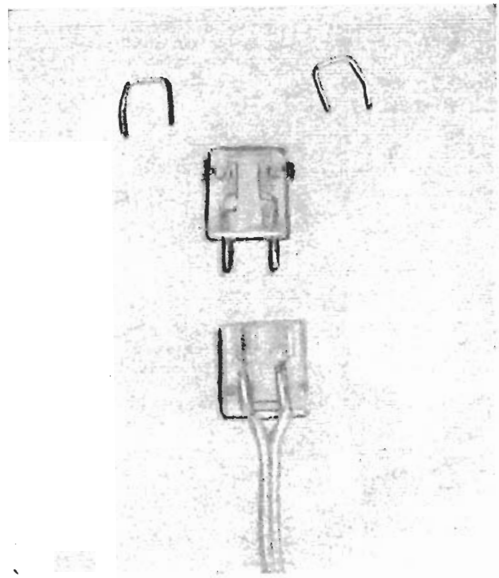
volume control. When the probe is in contact with a liquid, the feedback circuit is completed and the transistor radio goes into strong oscillation.

The neon oscillator circuit shown in the drawing has the advantages of low cost, high reliability, excellent output signal and negligible battery drain. Value of the resistor can be changed to vary the pitch of the sound output. Four small 30-volt batteries (Burgess U-240, or similar) can be used in series to power the circuit. The unit is housed in a 4" x 4" x 5" sloping panel meter case.

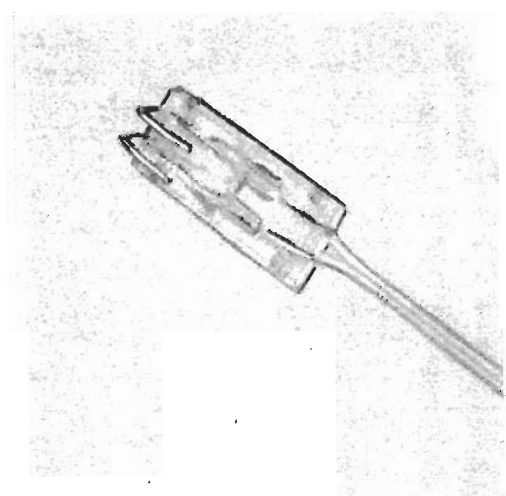
The probe can be made with a twin-lead Mosley 301 and 311 connector. One-half of the connector is attached to a flexible cord. A phono plug on the other end of the cord fits into a jack on the oscillator's case. The other half of the connector holds two horseshoe-shaped pieces of stainless steel rods having a diameter of about 0.050".

Suitable stainless steel wire for the probe can be obtained from dental supply stores. Two 2¼"-long pieces of this wire are needed. When each one is bent into the correct shape, the dimensions are: long leg, about ⅞"; short leg, about ¾"; crown (or width), about ½". You insert the short legs into the connector, and tighten the connector's setscrews. Then complete the assembly by plugging the two halves of the connector together.

This arrangement allows removal of the "business" end of the probe for occasional washing. In use, the probe is hung over the side of the cup or bowl.



Two lengths of non-corrosive stainless steel wire make up the probe. These wires should be fitted into a suitable connector as shown and the whole assembly connected to two-conductor flexible wire.



Some of the blind hams in Kentucky have built this equipment for themselves. There are many blind people, however, who have no technical background and would need help in building a liquid level indicator. If you have a blind friend, why not offer your assistance? Besides the satisfaction you would derive from such a gesture, you would help instill in your friend the one thing most needed by the handicapped—confidence. -30-

Diode sensor and Norton amp control liquid-nitrogen level

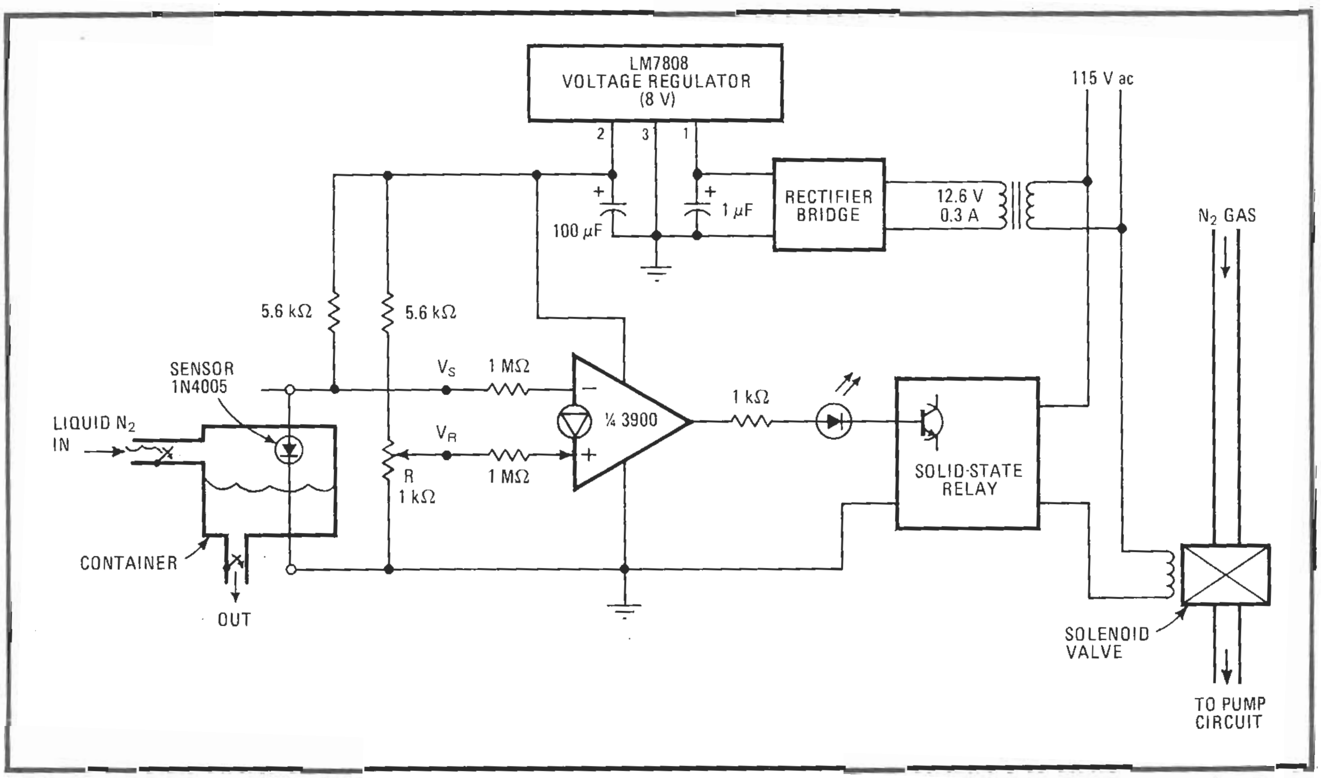
by V. J. H. Chiu
National Research Council, Ottawa, Canada

In parametric amplifier and other cryogenic applications, it would be handy to have an inexpensive sensor and controller of the level of liquid nitrogen. One can be built around a standard silicon diode and a Norton (current) amplifier.

The circuit's operation is based on the principle that the diode's junction voltage increases from 0.7 volt at room temperature to 1.05 v in liquid nitrogen (liquefaction temperature: −196°C). This voltage change is used to activate the amplifier, which controls a solenoid valve. The valve regulates a nitrogen-gas supply, which pumps liquid nitrogen from a reservoir to the desired container that houses the sensor.

The controller is shown in the figure. The sensor is placed in the container at any desired level. When liquid nitrogen rises to this level, voltage V_S reaches the preset voltage V_R almost instantly, and the output of the 3900 Norton amp becomes zero, closing the valve. When the liquid nitrogen falls below the desired level, V_S drops below V_R, and the valve opens.

Circuit sensitivity is adjusted by R. The diode need not be completely immersed in the liquid nitrogen, for its range is such that liquid as much as 2 inches below it will start the refilling of the container. Frequent cycling is thus avoided. The state of the solenoid valve may be determined by observing the light-emitting diode. □



Fixing the nitrogen level. When liquid-nitrogen level in container is below the diode position, solenoid is turned on and pumps in more N_2. When level reaches that of diode, its junction voltage jumps from 0.7 to 1.05 V, turning off solenoid and stopping N_2 inflow.

DEW LINE

**The washing machine starts to leak while you're watching TV . . . .
Or the freezer fails and you don't notice it for a day or two . . . .
Or the children turn on the taps in the bath and leave them running . . . .
In all these cases, and many more, some form of Domestic Early Warning System (DEW line) can prevent more or less serious consequences. What is required is a system that will monitor various vital points throughout the house and give timely warning if anything goes wrong.
A very simple alarm line is described here.**

In spite of its extreme simplicity, this alarm system will prove quite adequate in many cases.
The alarm line proper consists of a sufficient length of three-core cable. Either three-core mains cable or two-core screened cable can be used. The alarm sensors and the receiving station (or stations) can be connected to this cable at any point along its length.
The electronics required are very simple, because the system works on the principle of audible recognition. In other words, the sophisticated sound recognition system which is part of human hearing is used as part of the alarm system.
To be more specific, the alarm sensors each produce a different warning tone if something goes wrong. They are all connected to the three-core cable. The receiving station is nothing more than a two-transistor audio amplifier. As soon as one of the alarm sensors registers the fact that something is wrong (the bath is running over, the deep-freeze is becoming too warm, etc.) it puts its own unique alarm tone on the line. This tone is reproduced by all the receiving stations. It is up to the listener to decide from the frequency and repetition rate which alarm sensor it is.
In this article, alarm sensors for water leaks and for deep-freezers will be described. The refrigerator alarm described elsewhere in this issue can also be connected into the DEW line. In the 'Summer Circuits' issue (Elektor 15/16) a 'Bell extender' was described, including a telephone bell pick-up. This, too, can be connected into the alarm system.
Alternatively, any or all of these sensors can be connected into the original 'Wireless bell extender' circuit (Elektor 15/16, circuit 52), if one is not inclined to run three-core cable all over the house.

Deep-Freeze alarm

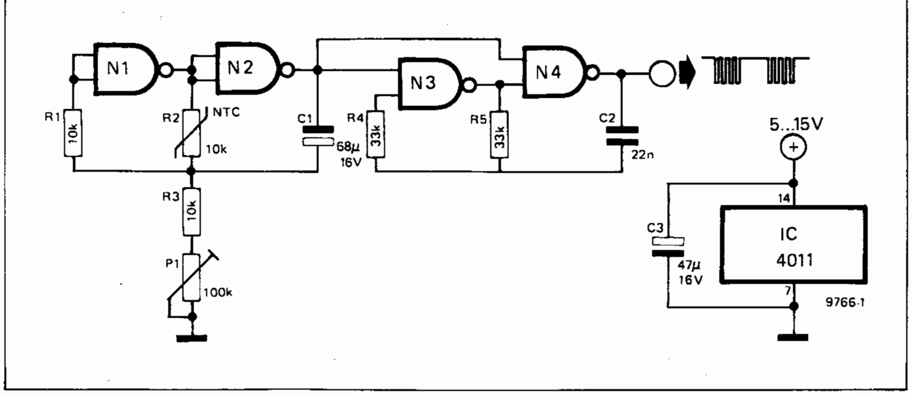
The first 'domestic calamity sensor' to be described is a unit that produces an intermittent warning 'bleep' if the temperature inside the deep-freeze becomes so high that the food is in danger of thawing out.
The circuit is shown in figure 1. Only a single COSMOS integrated circuit and a good half-a-dozen other components are required. The four NAND gates in the IC are used in two multivibrators: N3/N4 produce an audible tone, and N1/N2 produce a very low frequency square wave. This low frequency oscillation is used to turn the audible tone oscillator (N3/N4) on and off, producing an intermittent 'bleeping'.
As long as the temperature of the NTC is sufficiently low, the first oscillator is blocked and the output of N2 is 'low'. This blocks the second oscillator, so that no tone is produced. If, however, the temperature rises above a certain point, the resistance of the NTC drops sufficiently far to enable the first multivibrator, sounding the alarm. The temperature at which this happens can be set with P1.
The repetition frequency of the alarm depends on the resistance of the NTC. As the temperature rises further, the repetition frequency increases. The more urgent the alarm sounds, the higher the temperature!
Needless to say, the NTC must be mounted inside the freezer. It can be connected to the rest of the circuit via thin, insulated wires.

Flood warning

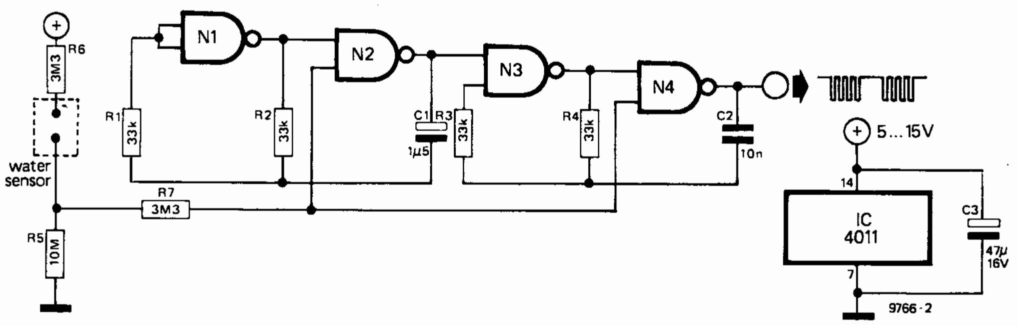
The circuit for the flood warner (figure 2) is very similar to the previous one. As before, gates N1 and N2 produce a low frequency square wave which switches

Figure 1. The deep-freeze alarm. The temperature sensor is an NTC, which must be mounted inside the deep-freeze.

1



2

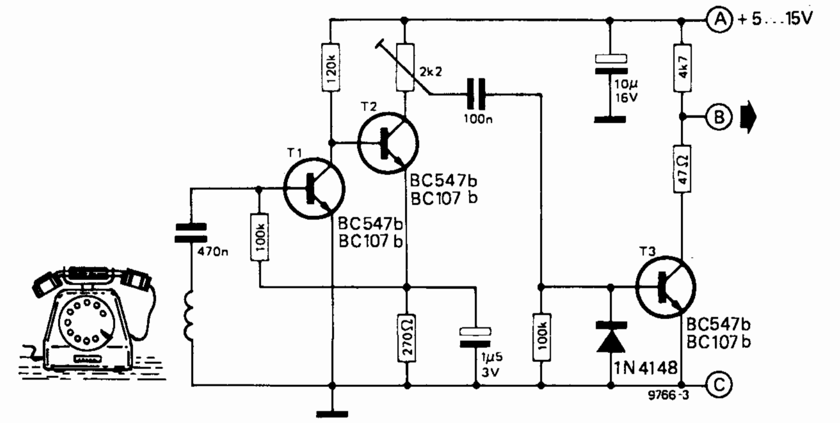


the audio oscillator (N3/N4) on and off to produce the bleeping alarm signal.
In this case, however, the oscillators are switched on by a 'flood sensor'. This is just a nice-sounding name for two nails in a piece of wood. As soon as this becomes sufficiently wet there will be a conducting path between the nails. This turns on the two oscillators, sounding the 'wet alert'.
The frequency of the alarm tone itself and the repetition rate are both somewhat higher than those in the previous circuit. It should not be at all difficult to distinguish the two different alarm sounds.
If more than one flood sensor is required (for instance, one in the bathroom and one on the floor near the washing machine), they can be 'tuned' to give different alarm signals. C1 sets the repetition rate and C2 sets the frequency.
If the wood used for the sensor is too green, it may be sufficiently moist to trigger the alarm unnecessarily. There are two solutions to this problem. One is to try a different piece of wood, or use bolts in a piece of plastic instead. The other is to reduce the value of R5 until the alarm signal stops.

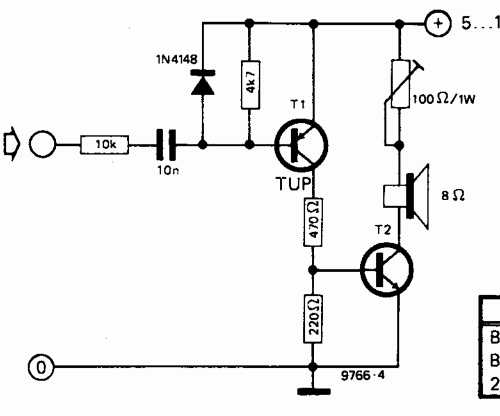
Telephone bell extender

This circuit has already been described in a previous article ('Wireless bell extender', Elektor 15/16). However, since it can also be incorporated in the DEW line, the circuit is repeated here (figure 3).
The sensor proper is an inductive pick-up, which can be attached to the telephone by means of a suction cup. These units are available for use in 'loud-speaking' telephones and the like. A three-stage amplifier boosts the signal

3



4



T2	Vb max
BD135	12V
BC140	8V
2N2219	6V

to a sufficient level (adjustable with the 2k2 preset potentiometer). The output (point B) can be connected into the DEW line.

The receiver

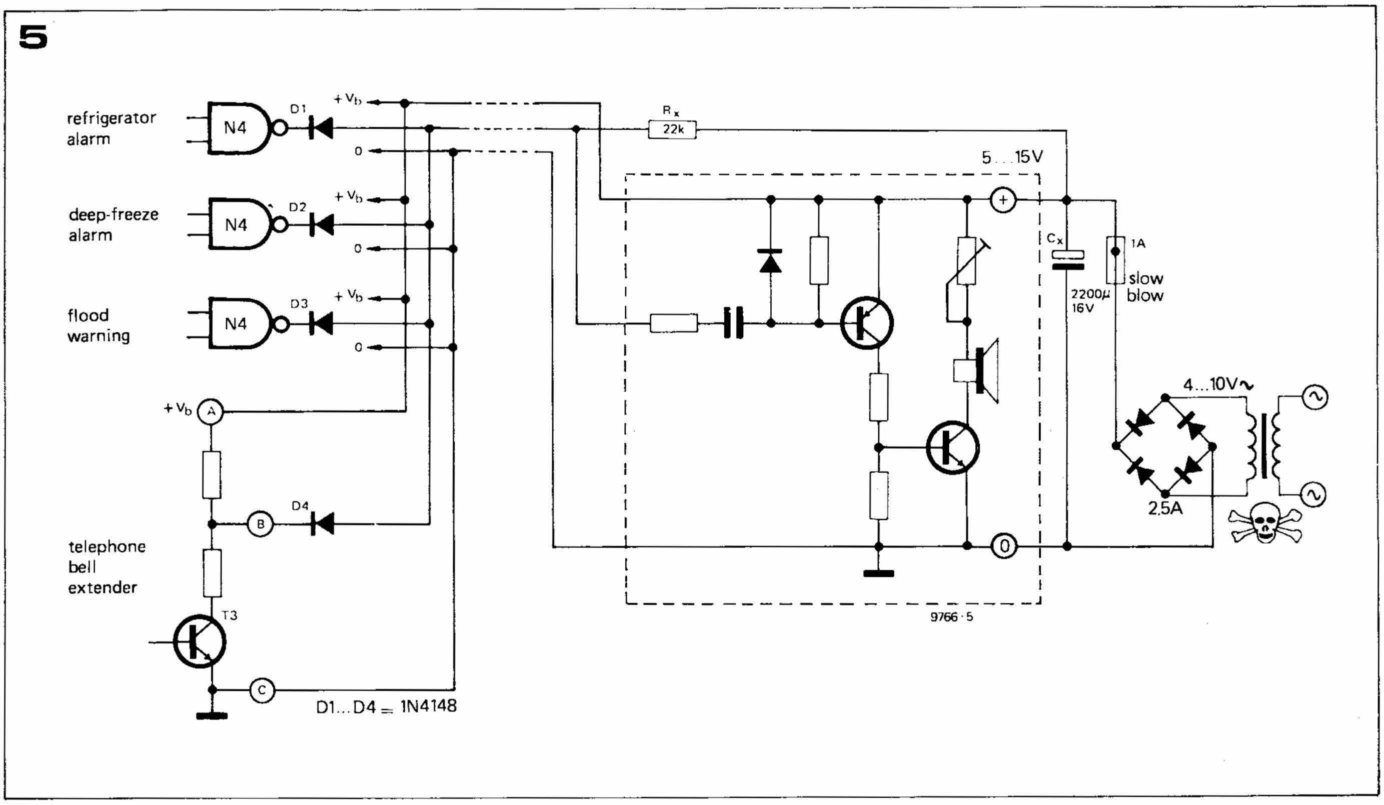
The receiver is nothing more than a two-stage amplifier and a loudspeaker (figure 4). No attempt has been made to achieve 'Hi-Fi' sound quality.
The power dissipation in the output stage is fairly low, since the input signal is a square-wave. Even so, some form of cooling fin on T2 can't do any harm . . .
The type of transistor to use depends on the supply voltage. As shown in the table, the 2N2219 can only be used for supply voltages of 6 V or less; the BC140 can be used up to slightly higher voltages and the BD135 is all right up to 12 V. Note that the 5 . . . 15 V specified for the supply is valid for T1 and for all the sensor circuits, but not necessarily for T2!

If it is the intention to use only one of the alarm sensors with one (or more) receivers, the output of the sensor can be connected direct to the input of the amplifier(s). However, if more than one sensor is to be used, they must be interconnected as shown in figure 5. This is the alarm line proper.

Figure 2. The flood warning circuit. This is very similar to the deep-freeze alarm, but the sensor consists of two nails in a block of wood.

Figure 3. The telephone bell extender.

Figure 4. The receiver is a very simple power amplifier circuit.



The DEW line

The interconnection of all alarm sensors described and the receiver is shown in figure 5. To avoid cluttering this diagram, only the last gate (N4) is shown of the refrigerator alarm, deep-freeze alarm and flood warning and only the last transistor (T3) of the telephone bell extender.

As can be seen in this diagram, one core of the (three-core) alarm cable is used for the positive supply connection and one for supply common. The third core is the signal line.

All the sensors have been designed to give a high-level output signal under normal conditions. This means that they can all be connected to the alarm line through diodes, as shown — the 'quiescent' sensors will not prevent an active alarm from sounding.

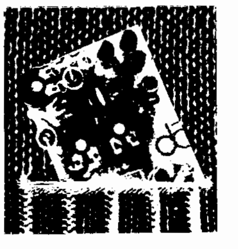
The receiver is connected directly to the line, as shown. As stated earlier, more than one receiver can be used; each receiver is connected to the line at the point required. There is one point to watch, however. If the 'volume' control in the receiver (the 100 Ω preset) is turned up to maximum, the peak current consumption can be more than 1 Amp. For this reason, it is advisable to give each receiver its own power supply. R_X should only be incorporated in one of the receivers.

While on the subject of the power supply, it is important to note that electrical safety is even more important than usual in this case. The alarm line will be running all over the house, and some of the sensors will be in a moist environment (the bathroom, for instance). For this reason, the transformer must be absolutely reliable, and the wiring inside the supply must also be such that there is absolutely no chance of a short or even leakage between the mains and the rest of the circuit.

Figure 5. The DEW line. Utmost care must be taken when constructing the power supply, so that there is absolutely no possibility of mains voltage appearing on the alarm cable.

If the sensors described here are to be connected into the 'Wireless bell extender' circuit, they are interconnected with diodes as shown in figure 5. Instead of being connected into the receiver circuit, however, they are connected to point 'B' in the transmitter. ◀

pocketronics



Anybody who regularly looks inside modern factory-produced equipment, and particularly radio and TV front-ends, will often be astounded by the number of components per square inch of printed circuit board.

On Elektor p.c. boards, we do try to keep the component layout fairly compact — but some fairly large components are used in most circuits. Furthermore, resistors and capacitors are all mounted flat on the board, since mounting them 'on end' requires rather more skill and care.

However, we felt that many of our readers might like to try their hand at mounting interesting little circuits in the smallest possible space.

The first idea was to start a series 'electronics in a nutshell', but this was soon dropped as definitely too ambitious.

The next suggestion was 'matchbox circuits'. Several circuits have indeed been developed that can be squeezed into a large-sized matchbox. Examples are the egg-timer and cricket elsewhere in this issue.

Even this title was found to hamper our stride, however: some interesting projects had to be housed in a cigarette carton. Finally, we settled for the all-embracing title 'pocketronics'.

To be able to fit the units into such a cramped space, the boards have all been designed for truly miniature components. This may have the disadvantage that some of them are not so readily available:

- Resistors should be 1/8 watt types.
- Depending on the value, capacitors are usually miniature ceramic, Siemens MKM, tantalum electrolytic or miniature electrolytic.
- Transistors and ICs are usually standard types, but extensive use is made of the Darlington transistors BC516 and BC517 (Texas Instruments).
- Batteries are usually 1.2 V miniature mercury types, as used in hearing aids, photographic equipment and the like.
- The 'loudspeaker', if required, is actually a dynamic microphone capsule (Sennheiser type HM35). Other types may also be suitable; the requirements are: very small dimensions, relatively high impedance (more than 500 Ω), and, preferably, relatively high efficiency.
- Standard potentiometers are not used. Where these would normally be needed, presets are mounted on the board. Some mechanical ingenuity, of the bent-wire type, may be required to replace the 'control knob'.

◀