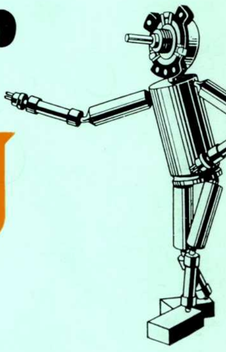
PHILIPS electronics for YOU



ELECTRONIC COMPONENTS AND MATERIALS DIVISION

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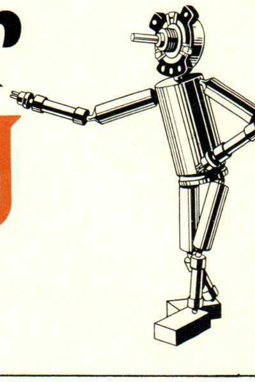


Dear Experimenter,

There is no doubt about it: the good old thermometer is an extremely useful instrument! To give it full credit: it is an indispensable aid in industry and science, in the hospital and in our home. It has, however, one serious drawback: it is so silent! It has no means of calling or warning us and in many instances that is just what we should like it to do.

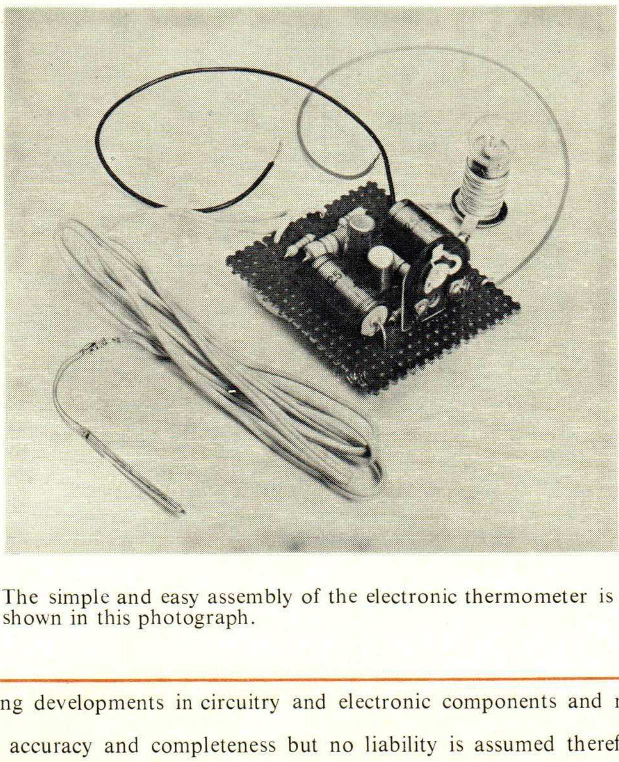
An electronic thermometer does not show this disadvantage. Connected to a signal lamp it can give you a warning that it is becoming too hot in the room, the water in your bath is warm enough, the temperature outside has dropped below zero, spring has set in, your newly hatched birdies are in danger because it is too warm or too cold for them, your hothouse is too hot. Conversely, the very simple electronic circuit in combination with a relay can be used to keep the temperature constant, whether in the dishes and basins you are using in your dark room, or in the tank which is the home of your tropical fish.

You need only a few components to build the electronic warning system and when you have finished it you will be surprised at the large number of additional uses. Mind you, it is not even necessary to go to another room or out of the house to have a look at the thermometer when you install the signal lamp close to your armchair.

Your attention, please, for the basic principle: a negative temperature coefficient resistor has been employed. Some of our future experimenter's circuits will be based on the same principle.

We wish you much pleasure in experimenting and, don't forget:

OPTIMAL RESULTS WITH PHILIPS COMPONENTS ONLY



The simple and easy assembly of the electronic thermometer is shown in this photograph.

ELECTRONIC THERMOMETER

Possible uses

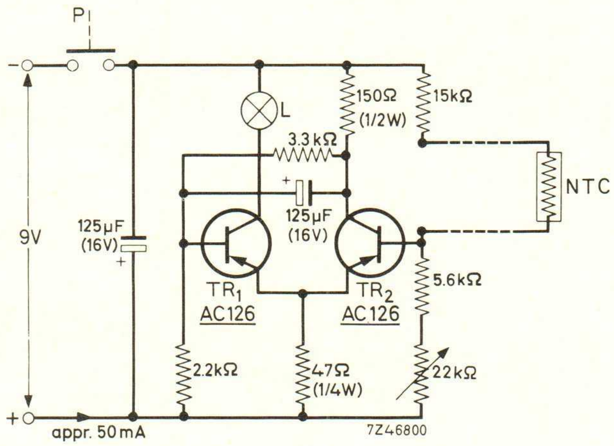
Signalling unit at preset temperatures between −10 and +75 °C

In this case a signal lamp or buzzer is connected to the device to give a warning when the preset "critical" temperature is approached (intermittent signal), or has been exceeded (continuous signal). The "critical" temperature is either a maximum or a minimum.

Typical examples
– *maximum temperature not to be surpassed:*
of the air in cold stores, cooling rooms, glasshouses, etc.
of water in bath-tub;
– *minimum temperature not to be underpassed:*
of the air in cellars, garages and glasshouses;
of photographic baths (which also must be made sure to have the *same* temperature, especially for colour photographs).

Thermostat

A relay is connected instead of the signal lamp or buzzer; its function is to switch a heating or cooling system on or off. This electronic thermostat may be used for any of the applications mentioned above, either as a new control device, or to replace an existing thermostat when this is out of order, for instance, in a refrigerator or a central heating system.



Circuit diagram of the electronic thermometer equipped with an NTC thermistor.

Parts list

		Catalogue number
NTC thermistor	: 4.7 kΩ	2322 627 11472
Potentiometer	: 22 kΩ	2322 411 02208
Capacitors	: 125 µF/16 V electrolytic (2×)	2222 001 15131
Transistors	: AC 126 (2 ×)	
Signal lamp	: 6 V/50 mA, Philips type 7121 D	One of these two
Relay	: 200 Ω, operating current abt. 40 mA	One of these two
Resistors	: 1/8 W unless indicated otherwise in the diagram. Use Philips vaporized carbon resistors.	

Note:

When the relay is connected into the circuit the electrolytic capacitor of 125 µF (shunted across the resistor of 3.3 kΩ) must be removed because otherwise the relay will operate intermittently when the "critical" temperature is approached. Shunted across the relay, connect a Philips type OA202 diode with the cathode (indicated by the white band) linked to the transistor.

Principle of operation

See the circuit diagram.
A Philips NTC thermistor, catalogue number 2322 627 11472 is the sensor. It is part of a voltage-divider circuit that determines the voltage for the base of TR2. The 22 kΩ potentiometer can be so adjusted that variations in the resistance of the NTC thermistor have the desired effect on the rest of the circuit. If, for instance, the device is to operate as a frost indicator the setting of this potentiometer must be such that resistance variations of the NTC thermistor, caused by the temperature decreasing from room temperature down to the freezing point, make the circuit behave as a flip-flop (TR1 and TR2 alternatively driven into the conductive state). Signal lamp L will then flash intermittently. With the temperature continuing to decrease to zero the resistance of the NTC element will increase from 4.7 kΩ to 15 kΩ. TR2 can then no longer become conductive since the base has attained too high a positive voltage with respect to the emitter. The circuit has been so dimensioned that TR1 receives sufficient negative voltage on its base to be driven into the conductive state. As a result the signal lamp will burn continuously. Any further decrease in temperature, although causing the resistance of the NTC element to rise accordingly, will have no important effects on the current flowing through signal lamp L.

Adjusting the circuit

The moment at which the circuit starts to give the intermittent signal as a warning that the "critical" temperature has been reached must be preset. This is done as follows *for a frost indicator:*

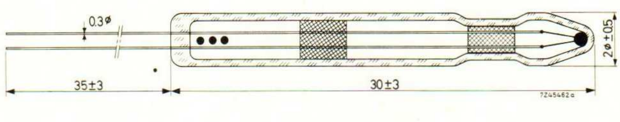
1. Place the NTC element in a container with melting ice and check with a thermometer whether the temperature is actually zero degrees centigrade.
2. Leave the NTC element in the container for some time to allow it to assume the temperature of the melting ice.
3. Depress button P and adjust the 22 kΩ potentiometer in such a way that signal lamp L is about to start flashing but just keeps burning continuously.

To adjust the device for any other temperature-indication purpose, place the NTC element in water which has been brought to the "critical" temperature.

It is obvious that the circuit can also be used the other way round. For instance, in the case described above lamp L will burn continuously when the temperature is below the freezing point, then start flashing when the temperature reaches the freezing point, and go out when it rises above freezing point.

Summarizing, the device can be used to give a warning when a minimum temperature is underpassed:
- Signal lamp off = no change in condition;
- Signal lamp flashes = approaching "critical" temperature – find out why;
- Signal lamp on = "critical" temperature underpassed – take measures.

Or, it can be used to signal when a maximum temperature is surpassed:
- Signal lamp on = no change in condition;
- Signal lamp flashes = approaching "critical" temperature – find out why;
- Signal lamp off = "critical" temperature surpassed – take measures.

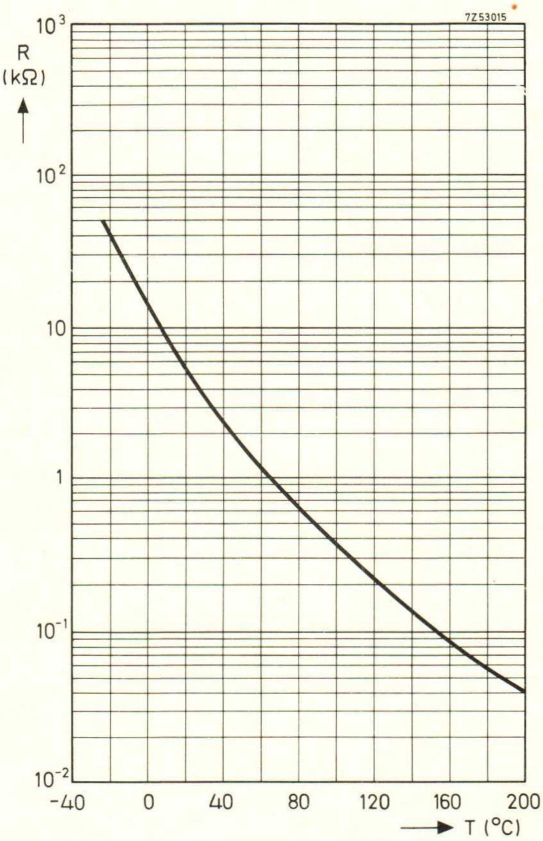


Dimensions in mm of Philips NTC thermistor 2322 627 11472.

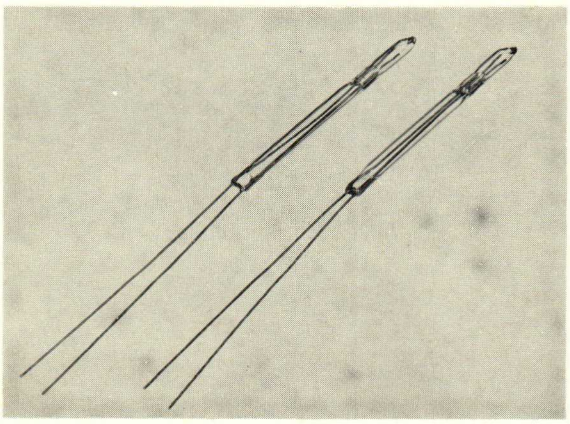
Some particulars of NTC thermistors

N(egative) T(emperature) C(oefficient) thermistors are resistors with a large negative temperature coefficient of resistivity, and made from semiconducting oxides. The resistance of these oxides decreases rapidly when the temperaure rises (around 25 °C this decrease is between 3 and 5% for a rise in temperature of 1 °C). Miniature NTC thermistors are made by applying a drop of oxide paste between two parallel platinum alloy wires, followed by drying and sintering. For most applications the miniature NTC elements are mounted in glass for protection against agressive gases and fluids. Others are mounted insulated in a metal housing to ensure good thermal contact with the chassis.

The relation between resistance and temperature is illustrated by the adjoining graph. As "nominal" resistance is taken the value at 25 °C, with a spread of ± 20%. The curve shows that the resistance of the 4.7 kΩ NTC thermistor, varies between 50 000 Ω at −25 °C and 40 Ω at 200 °C (with 4700 Ω at 25 °C).



Resistance variation as a function of the temperature of Philips NTC thermistor 2322 627 11472.



Philips NTC thermistor 2322 627 11472.

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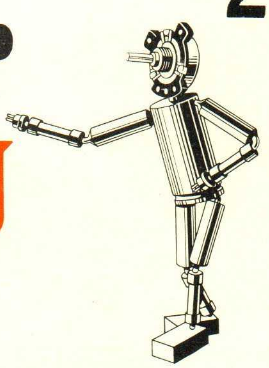


2

Dear Experimenter,

This issue of "Electronics for You" aims at helping you to build an intercommunication system. The system is a special one in that the units – master unit and remote unit – are extremely mobile and not, as is normal, tied to a certain place because of the fixed cable connecting them.

As most "intercoms" are mains-operated it is natural that people have been looking for a possibility of using the mains also for transporting the signals. It would then become feasible to plug the units into any wall socket connected to the signal-carrying phases.* In the system to be described here a 80 kHz modulated carrier is injected into and taken from the mains leads by means of small separating capacitors. The method does not allow long distances to be covered because of the low resistance and high capacitance of the mains: the carrier is strongly attenuated. In practice, however, one will find that inside the house the signal strength is sufficient; also, that almost no signal gets past the electricity meter.

What about interference? Naturally the electric appliances you have in the house will cause some "background" noise or hum but this will generally not become strong enough to be a nuisance. However, we cannot advise you to use the intercom in offices or factories since there the level of the interfering noise will be too high.

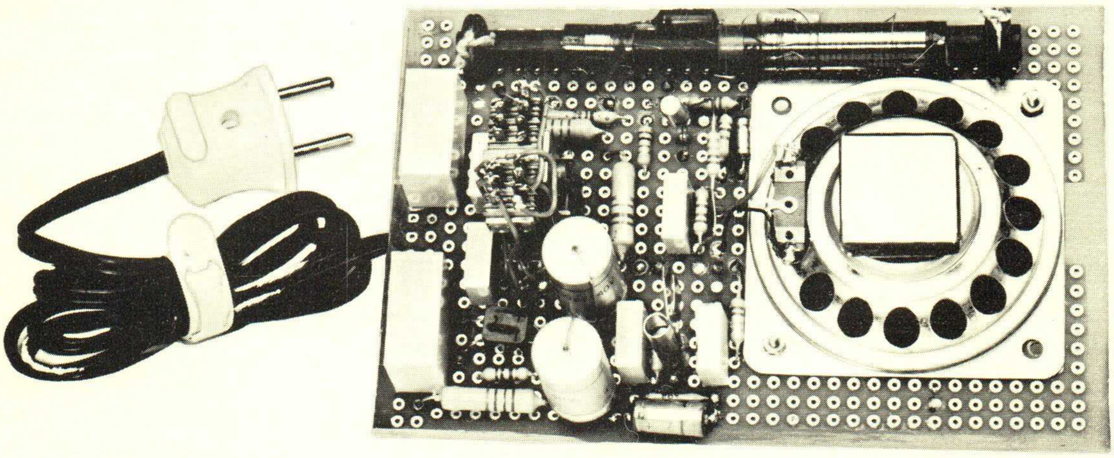
What about safety?

The circuit being connected direct to the mains it is necessary to insulate it properly to avoid electric shocks. Therefore a wooden or plastic housing should be used, lined with a sound-absorbing material because otherwise acoustic resonance may occur.

We wish you much pleasure in experimenting and, don't forget:

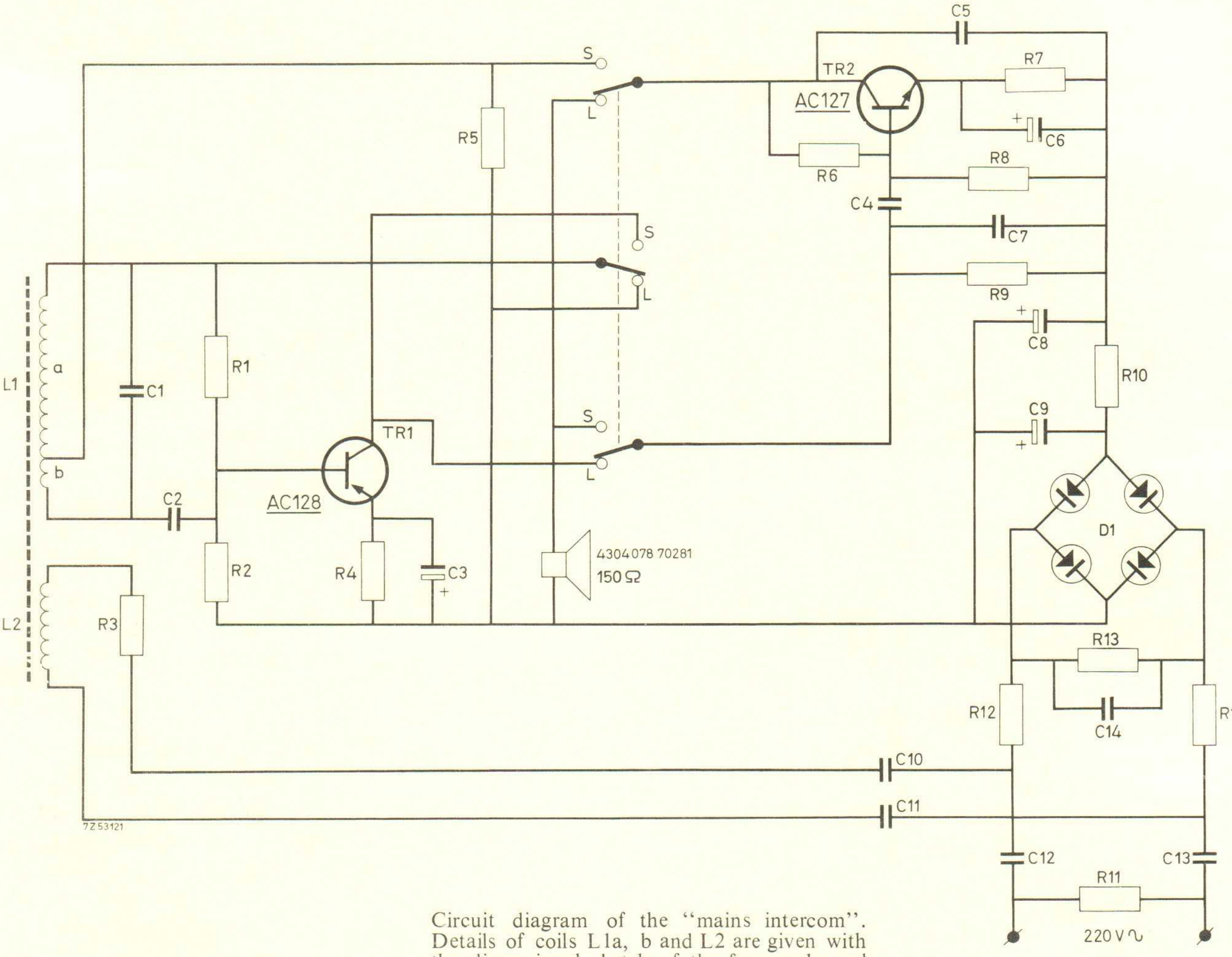
* Make sure that the wall sockets are connected to the proper phase. If two or three phases are used in the mains circuit of the house some of the wall sockets will not be interconnected.

OPTIMUM RESULTS WITH PHILIPS COMPONENTS ONLY



The simple and easy assembly of the "mains intercom" is shown in this photograph.

INTERCOMMUNICATION VIA THE ELECTRIC MAINS



Circuit diagram of the "mains intercom". Details of coils L1a, b and L2 are given with the dimensional sketch of the ferroxcube rod on page 3.

Parts list

				Catalogue number
C1	15	kpF	(ceramic capacitor)	2222 552 03153
C2	3.9	kpF	(ceramic capacitor)	2222 563 02392
C3	10	μF/16V	(electrolytic capacitor)	2222 001 15109
C4	0.47	μF/100V	(polyester capacitor)	2222 344 21474
C5	0.1	μF/100V	(polyester capacitor)	2222 344 21104
C6	10	μF/16 V	(electrolytic capacitor)	2222 001 15109
C7	0.1	μF/100 V	(polyester capacitor)	2222 344 21104
C8	250	μF/40 V	(electrolytic capacitor)	2222 023 17251
C9	250	μF/40 V	(electrolytic capacitor)	2222 023 17251
C10	0.1	μF/400 V	(polyester capacitor)	2222 344 51104
C11	0.1	μF/400 V	(polyester capacitor)	2222 344 51104
C12	1	μF/400 V	(polyester capacitor)	2222 344 51103
C13	1	μF/400 V	(polyester capacitor)	2222 344 51103
C14	0.1	μF/100 V	(polyester capacitor)	2222 344 21104
R1	47	kΩ		2322 101 33473
R2	10	kΩ		2322 101 33103
R3	10	Ω		2322 101 33109
R4	470	Ω		2322 101 33471
R5	1	kΩ		2322 101 33102
R6	33	kΩ		2322 101 33333
R7	39	Ω		2322 101 33399
R8	4.7	kΩ		2322 101 33472
R9	2.2	kΩ		2322 101 33222
R10	100	Ω		2322 101 33101

(R1 up to R10 are carbon resistors of the 1/8 W type)

			Catalogue number
R11	0.1	MΩ	2322 101 63104
R12	220	Ω	2322 101 63221
R13	1	kΩ	2322 101 63102
R14	220	Ω	2322 101 63221

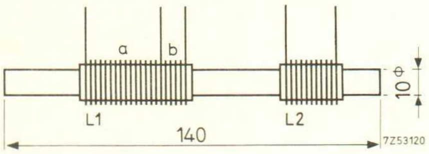
(R11 up to R14 are carbon resistors of the 1 W type)

TR1	AC128	(p-n-p transistor)	
TR2	AC127	(n-p-n transistor; this should be used here with a cooling fin type 56200)	
D1	BY122	(full-wave bridge rectifier assembly)	
Ferroxcube aerial rod	(diameter	10 mm; length 140 mm)	3122 104 91242
Loudspeaker		Impedance at 1000 Hz: 150 Ω	4304 078 70281
S/L		three-pole, two-position switch; push-button type (any switch which meets requirements can be used for this purpose)	

Principle of operation

See the circuit diagram.

Either unit is equipped with a three-pole two-position switch, one position being used for talking, the other for listening. When not manipulated this switch always retruns to the "listen" position under spring pressure. The first transistor, a type AC128 p-n-p element, is then connected as a detector, the second one, a type AC127 n-p-n transistor, serves as a power amplifier. The former is non-conductive as its base is connected via resistor R2 to the positive terminal of the bridge rectifier in the supply circuit. Except for a single very strong pulse no interfering signals can then reach the loudspeaker. An incoming modulated carrier is, on the other hand, detected by the base-emitter diode of TR1; the resulting base current makes TR1 conductive so that it can pass on the speech signal to TR2. With the switch in the "listen" position the total current drawn by the circuit is 10 mA at a supply voltage of 12 V. The input circuit for the modulate carrier comprises capacitors C10 and C11, resistor R3 and coupling coil L2, and circuit L1-C1 which is tuned to 80 kHz. Coils L1 and L2 can be shifted along the ferroxcube rod to give maximum sensitivity.



Dimensional sketch of ferroxcube rod (catalogue mumber 3122 104 91242).

Coils L1 and L2 can easily be wound by the experimenter himself. The coil formers may be of cardboard or any other suitable material; the minimum lengths should be 25 mm for L1 and 15 mm for L2. The inside diameter should be slightly over 10 mm, so that they fit nicely on the ferroxcube rod; the thickness of the former material is not critical. The wire is enamelled 0.4 mm copper wire. Numbers of turns are as follows:

L1 - 49 turns (a = 40 turns, b = 9 turns); L2 - 22 turns.

With the switch in the "speak" position the first transistor is connected as an oscillator and the second as a microphone amplifier (the loudspeaker is now used as a microphone). The two transistors are arranged in series so that any variation in the current through TR2 causes a corresponding variation in the amplitude of the carrier. This provides for modulation of the carrier by the microphone signal. The modulated carrier is then coupled into L2 and, through R3, C10-C11 and C12-C13, it is injected into the mains. Resistors R12 and R14 block the path for the carrier wave to the bridge rectifier. The total current with the switch in the "speak" position is about 8 mA at a voltage of 15 V.

The supply circuit, which is fully mains-powered, comprises:

- a voltage divider consisting of C12 - C13 - R12 - R13 - R14 and reducing the mains voltage to 15 V a.c. (under load conditions); capacitors C12 and C13 bring the voltage down without heat being evolved, that is, without losses;
- the type BY122 full-wave bridge rectifier and smoothing capacitors C8 and C9 which provide the necessary direct voltage.

Remarks on some components

The following remarks may be made about some of the components.

Aerial rod. The various units that are part of the system — there may be two or more — should all be equipped with the same aerial rod; preferably rods made of the material grade 4B1 should be taken.

Loudspeaker 4304 078 70281. Impedance 150 Ω, so a loudspeaker transformer is not needed. Coupling to microphone amplifier is effected through a relatively small capacitor (0.47 μF) which attenuates low frequencies thus improving clarity of speech signals; for same reason decoupling capacitor is also relatively small (10 μF).

C5 and C7. Prevent any 80 kHz signal from reaching the a.f. circuit.

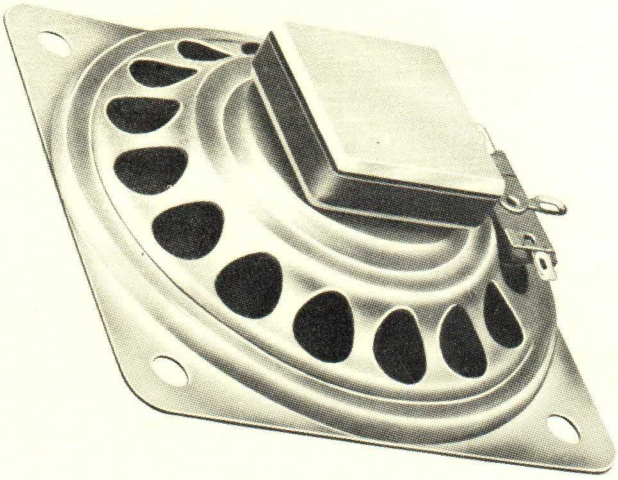
C14. Serves to suppress modulation hum.

R3. Damps the resonant circuit with L2 and the associated capacitances and thus prevents the oscillator from generating other frequencies.

R4 and R7. Provide required temperature stabilization.

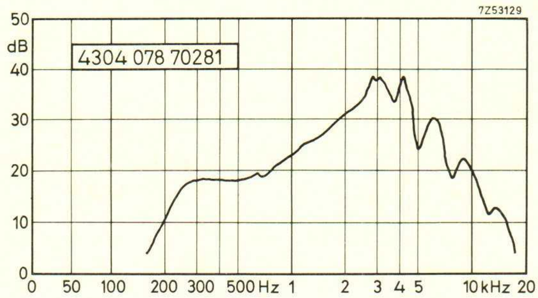
R11. Provides a path for the residual charge of capacitors C12 and C13 to leak away after the mains voltage has been removed.

MIDGET LOUDSPEAKER



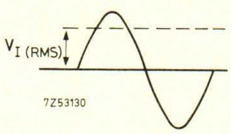
The 3″/1 W loudspeaker, catalogue number 4304 078 70281, used in the intercom system, has a cone diameter of about 3 inch (75 mm).

Both as loudspeaker and as microphone its performance at speech frequencies is very good, thanks to the special construction of the coil and the very small air gap. See the peak at 3000 Hz in the diagram below. Because of its high-ohmic coil (150 Ω) it can be connected direct (without loudspeaker transformer) into the collector lead of the base circuit of a transistor.

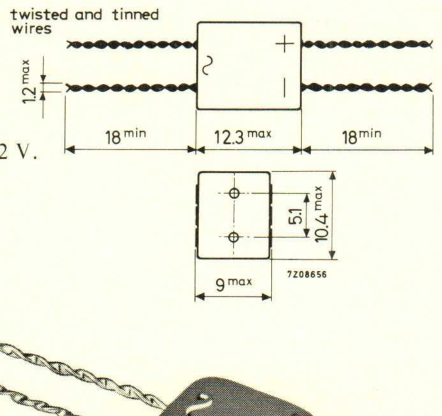


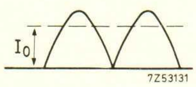
BRIDGE RECTIFIER ASSEMBLY BY122

The BY122 is a bridge rectifier assembly in a plastic encapsulation equipped with four silicon diodes. It is used for transistorized equipment drawing its power from the mains. The maximum a.c. input voltage is 42 V r.m.s. The maximum direct output current is 0.8 A, average value.

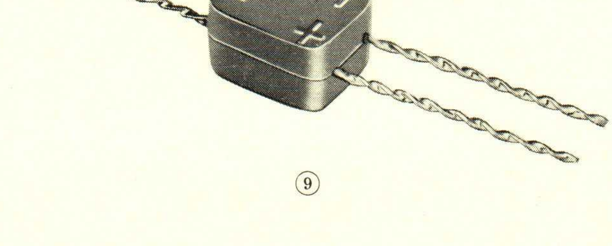


$V_{I\,(RMS)}$ (r.m.s. input voltage) max. 42 V.





I_0 (average output current) max. 0.8 A.



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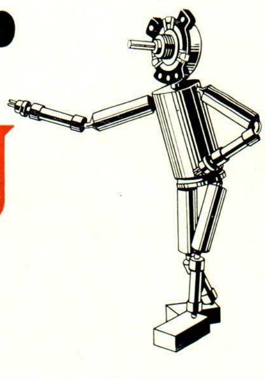


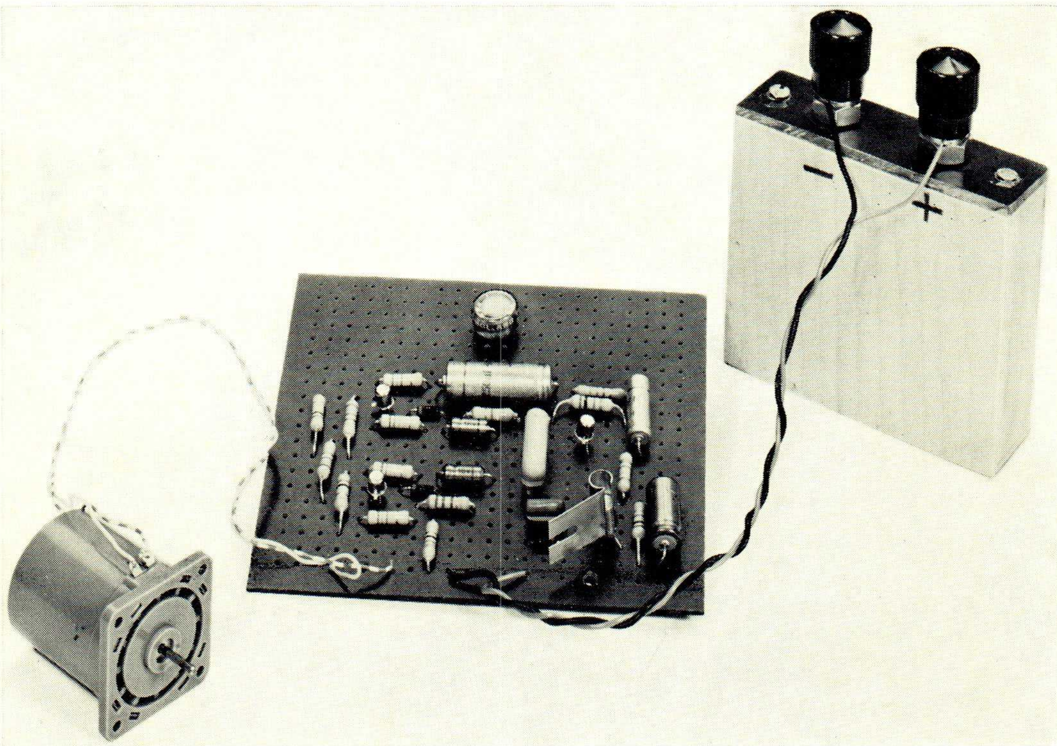
Dear Experimenter,
Have you ever tried using a beam of light as a means for starting a toy train or racing car, for switching on a lamp in a room, or the illumination of your shop windows? It's quite fun to show a customer who is *outside* your shop how he can "manipulate" the shop-window lights, or a scale model which you have *inside*. On the same lines you can also make a "light gun" for your son, or a device which ensures that a number of photographic flashlights ignite at the same moment.

The component which forms the heart of the control system in all these cases is the Philips L(ight) D(ependent) R(esistor). The accompanying universal circuit diagram will enable you to try out the interesting possibilities of the LDR. In some instances you will need one of our miniature electric motors, viz. the 9904 120 07401 (manufactured by Polymotor S.A.). We are convinced that you will be surprised to find so many applications for the LDR (and/or the motor). The method is simple and . . . you do not need licences or permits of any kind!

Now you may have noticed for yourself that despite the good points mentioned above the method of remote control by means of light flashes is not being used on a large scale. To explain this we must draw your attention to a few disadvantages. First, the object to be controlled must be "visible" by the source of the light pulses, in most cases a sharp, thin beam of light must be employed which makes it even more difficult to meet this requirement. Second, the intensity of the light sent out by our light source must be above that of the environment.

We wish you much pleasure in experimenting and, don't forget:

OPTIMUM RESULTS WITH PHILIPS COMPONENTS ONLY



REMOTE CONTROL BY LIGHT

Two circuits will be dealt with below:

a) a basic circuit; a light flash is used to make a small lamp come on;

b) a more complicated circuit which, when actuated by a light flash, operates a lamp, a motor or a relay.

Possible uses

The main applications of the remote control systems are found in the world of toys; to give some examples:

— in a mock rifle range, the rifle being a "light gun" producing a pencil beam of light concentrated by means of a lens; the beam can be very accurately directed at the "target" which carries an LDR;

— for starting and stopping an electric motor built into a toy train or car; the light produced by any electric torch is suitable for this purpose since pencil-beaming is not necessary; on the other hand, only the circuit mentioned under b) is applicable.

Some applications in the adult's world are:

— opening a garage door which involves including an additional relay in circuit b); the relay should be capable of switching on an electric motor big enough to operate the door mechanism, and the LDR should be positioned in such a way that only the light from the car's headlamps can reach it;

— igniting a battery of photographic flashlights at the same moment; one flashlight is ignited in the usual way by the camera contact and when its light falls on the LDR the remaining flashlights are all ignited via a separate circuit; this method does away with the necessity to connect each separate flashlight to the camera contact, and prevents the camera contact from being damaged by the heavier current.

We hope that you will be able to think of other useful applications. Please, do not hesitate to write us if you should like to consult — or tell — us about your ideas.

Parts list

				Catalogue number
(Fig. 1)	LDR	Light Dependent Resistor		2322 600 95001
	R1	Linear potentiometer (470 Ω)		2322 411 02203
	TR1	Transistor		AC126
	L	Lamp (6 V/50 mA)		7121D
(Fig. 2)	LDR	Light Dependent Resistor		2322 600 95001
	R1	Carbon resistor (¼ W)	82 Ω	2322 101 33829
	R2	Carbon resistor (¼ W)	2.2 kΩ	2322 101 33222
	R3	Carbon resistor (¼ W)	39 kΩ	2322 101 33393
	R4	Carbon resistor (¼ W)	10 kΩ	2322 101 33103
	R5	Carbon resistor (¼ W)	3.9 kΩ	2322 101 33392
	R6	Carbon resistor (¼ W)	1 kΩ	2322 101 33102
	R7	Carbon resistor (¼ W)	12 kΩ	2322 101 33123
	R8	Carbon resistor (¼ W)	680 kΩ	2322 101 33681
	R9	Carbon resistor (¼ W)	6.8 kΩ	2322 101 33682
	R10	Carbon resistor (¼ W)	10 kΩ	2322 101 33103
	R11	Carbon resistor (¼ W)	10 kΩ	2322 101 33103
	R12	Carbon resistor (¼ W)	150 Ω	2322 101 33151
	R13	Carbon resistor (¼ W)	12 kΩ	2322 101 33123
	R14	Carbon resistor (¼ W)	6.8 kΩ	2322 101 33682
	R15	Carbon resistor (¼ W)	680 Ω	2322 101 33681
	C1	Electrolytic capacitor	200 μF/10 V	2222 001 14201
	C2	Electrolytic capacitor	64 μF/10 V	2222 001 14649
	C3	Electrolytic capacitor	10 μF/10 V	2222 001 14169
	C4	Electrolytic capacitor	10 μF/10 V	2222 001 14169
	C5	Polyester capacitor	470 nF	2222 344 21474
	C6	Electrolytic capacitor	200 μF/6.4 V	2222 001 13201
	C7	Polyester capacitor	100 nF	2222 344 21104
	D1, D2, D3	Diodes		OA202
	TR1, TR2, TR3	Silicon p-n-p transistors		BC178
	TR4	Germanium p-n-p transistor		AC128
	M	D.C. motor (4.5 V/0.1 to 0.3 A)		Polymotor S.A.
(Fig. 3)	R1	Carbon resistor (¼ W, 10 Ω)		2322 101 33109
	C1	Electrolytic capacitor (2 mF/10 V)		2222 060 14202
	L	Lamp (2.7 V/0.15 A)		PR9 (Philips)

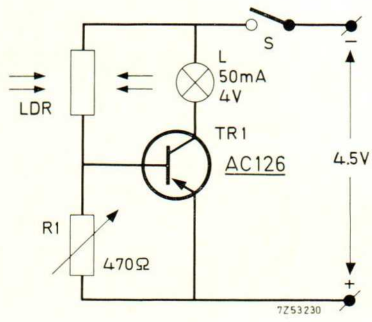
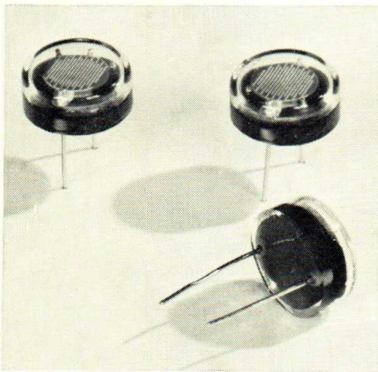


Fig. 1.


Philips LDRs (2322 600 95001).