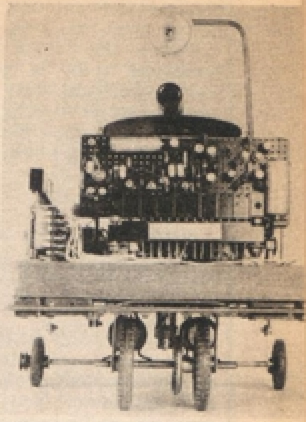
MODIFICATIONS TO CYCLOPS



Part 1
by L. C. Galitz

Cyclops, or Cybernetically Controlled Light Oriented and Powered System, was featured in our issues for July to December 1972. The present 2-part series describes modifications which may be carried out to enable him to exhibit further reactions to his environment.

REGULAR READERS WILL HAVE FOLLOWED THE SERIES on Cyclops which appeared in the last July to December issues inclusive. (These back-issues may be obtained by post from Data Publications, Ltd. at 20p plus 6p post each, or at £1.20 plus 21p post for the set of six.)

When we left Cyclops he was free to roam about his environment without offering anything in return for this privilege. Details will now be given of how to make him work for his living and, also, to see what happens when we try to make him work too hard.

CONDITIONED REFLEX

With the conditioned reflex unit on Board 2, we can present to the two inputs and the two outputs any combination of meaningful senses and responses, and the board, as a central core, will be ready to build up a conditioned reflex.

As the cost of building several conditioned reflex units is prohibitive, the next best solution is to have switching on the inputs and outputs of the conditioned reflex unit, and thus enable Cyclops to demonstrate several different versions of conditioned response, using only one conditioned reflex unit.

The first response that can be added is to attempt to make Cyclops work for a living. In the preceding series we saw that the basis of training animals in a circus is to reward it with food upon performing a trick successfully, and this can be extended to Cyclops.

Suppose we put a weight on Cyclops, back. Being a rather lazy animal, we might expect him to go into a tantrum and shake it off. However, we wish to train Cyclops to carry the weight, and so we must give him some sort of reward, and a good reward would be food. With Cyclops light is food, because it is assumed that light, by way of solar cells, can be converted to electricity, which is Cyclops' staple diet.

Thus if, every time we place a weight on his back, we shine light in his eye it would not seem unreasonable if Cyclops decided that it would be a good idea to put up with the weight.

It should now become obvious that if we present the output of some load sensing mechanism to the Sn input, and the output from RLC to the Ss input, and then if we connect the En output to the obstacle avoiding mechanism, we have satisfied the conditions outlined above. On receipt of Sn, a load, the conditioned reflex unit will evoke En, (in other words, the obstacle avoiding mechanism) and Cyclops will try to shake the load off his back. However, if Sn is coupled with Ss (in other words, light) after a while, instead of Sn evoking En, it will evoke Es. However, nothing is connected to Es and thus, after conditioning, the placing of a load on Cyclops' back will have no effect at all, and he will carry the load.

ANXIETY NEUROSIS

Cyclops is, after all, only a bundle of electronics, and if we try and ask too much of him, and tease him, it would not be surprising to find him behaving neurotically. Suppose that every time he tried to move off someone applied a magnet such that he had to stop for a while. Then, as he moved off after a short pause of 'playing dead' suppose he once more received a magnetic stimulus such that again he had to stop. After a while, the very act of moving off would mean the application of a magnet, and so Cyclops would stop in anticipation of this. However, when he tried to move off once more the very act of starting would trigger the conditioned reflex again, and he would have to stop. Thus Cyclops would move around in short jerks – a sad state indeed – until the conditioned reflex unit forget the association between starting to move and magnets. Naturally, if the conditioned response were continually reinforced,

Cyclops would continue nervously twitching and never recover from his attack of neurotic depression.

The way this state of affairs may be simulated is by connecting to the Sn input some device which senses when Cyclops just starts moving, and by connecting the magnetic sensor to th Ss input. One could then connect RLB to Es output, and the conditions just outlined would then evoke a fit of neurotic depression.

THE CIRCUIT

Before considering the conditioned reflex input switching, there are a number of modifications to be carried out first which do not alter the mode of operation at present, but are essential for correct operation later on.

Previously, only RLB was connected to En output, and it was convenient to connect the En output gate to the Sn monostable to provide the delay required for RLB operation. Now, however, other circuits are connected to En output which do not need the delay. Thus, the En output must be converted such that there is no delay and a delay circuit incorporated at the relay itself, seeing that other circuits, whose outputs are non-delayed, are also required to operate RLB.

In order to detect when the motors start operating, the voltages on both of the coils of RLB are monitored. Rather than use RLC contacts which, being connected directly to the motors, are rather noisy, a similar circuit monitors the voltage on RLC coil. These two circuits, plus the RLB delay circuit, are all mounted on a third piece of Veroboard, and the circuit of this third board is given in Fig. 1.

Dealing with the RLB delay circuit first, when D12 receives a negative pulse (from TR31 in Fig. 27 – Part 5 of the previous series) C14 charges by way of R53, and the voltage across it rises almost instantaneously to the full pulse potential. The voltage across C14 is monitored by TR34 whose output passes directly to a Schmitt trigger. If the voltage across C14 exceeds a certain amount the Schmitt trigger fires, and the voltage at TR36 collector rises to nearly the negative rail potential. This turns TR37 on, which operates RLB. As C14 discharges, eventually a point will be reached where the Schmitt trigger switches off, and RLB de-energises. There are, of course, simpler ways of arranging a delay circuit, but in order to simplify the circuit to be described in the next paragraph, the voltage across RLB coil must either be high or low, rather than a smoothly varying one as would be obtained if the Schmitt trigger were omitted. The delay circuit would still work, but the following circuit would not.

It would no doubt be simpler just to employ a relay across the drive motor to detect whether the motors were running, but a neater approach, which eliminates further moving parts, is to use solid-state electronics to detect whether RLB is energised or not.

To do this, R60 connects to one coil and R61 connects to the other of the coils of RLB. R62 causes a potential divider to be set up, and the junction of this potential divider is connected to the base of TR38, which is wired in the common emitter mode to give high voltage gain. TR39 inverts the output from TR38. When any of the coils are energised TR38 switches on, thus switching off TR39, whose collector consequently goes negative by virtue of the resistor going up to the negative rail in the input circuitry of the conditioned reflex unit (R37 in Fig. 27). When both of the coils are de-energised, and the motors start, the collector of TR39 goes positive, which is the effect desired, so that the monostable in the input circuitry of the conditioned reflex unit is triggered.

A similar circuit monitors the voltage on the basic reflex coil of RLC only, for reasons to be explained in a moment. This time, when the coil operates TR33 turns on causing the collector to go positive, which is the effect

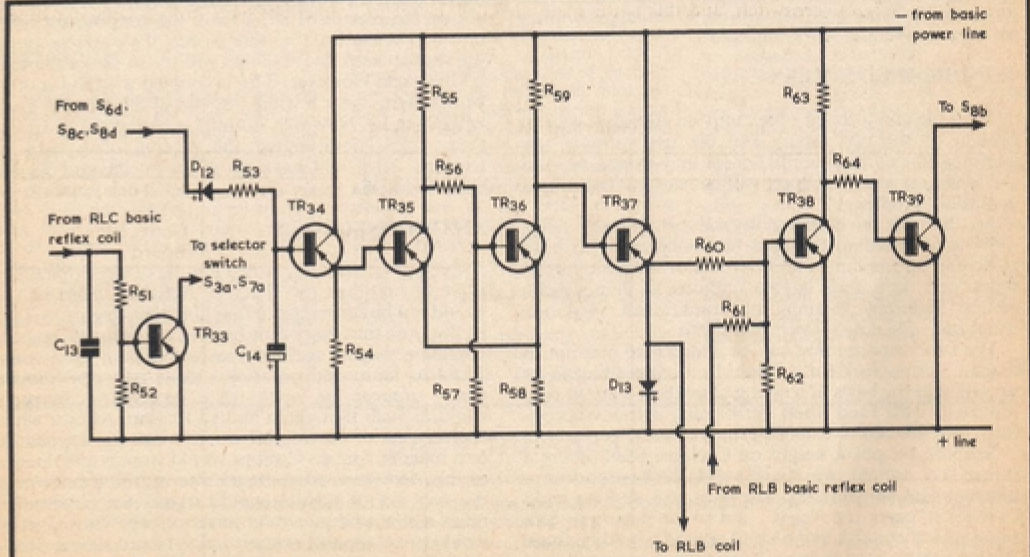


Fig. 1. The circuitry installed on the added component board

desired in this case. (TR33 couples via the switching circuits to pin 3 of Board 2.) C13 eliminates any noise on the input.

The inhibit Ss gate in the original design was included to prevent automatic reinforcement of conditioning when it was not required, because in certain cases, such as conditioning to light, the operation of Es automatically evoked Ss. The discerning reader will now notice that the circuit which detects the operation of RLC is connected to the coil operated by the basic reflex circuitry and, therefore, when the conditioned reflex circuitry operates RLC, no pulse is automatically fed back to Ss.

We similarly do not want automatic reinforcement of either of the two new conditioned reflexes, as neither are defensive, but seeing that there is nothing connected to Es in the weight training mode, and seeing that operation of RLB does not operate the reed switch in the anxiety neurosis mode, the inhibit Ss gate can now be totally dispensed with.

The Ss input circuitry is now changed to that shown in Fig. 2. Resistor R23 and capacitor C6 provide the circuitry required to trigger the monostable. The circuitry around TR15 and TR16 will be explained later.

Now that the delay for RLB has been dealt with by circuitry on the new board, the input of the En output gate that originally went to TR21 collector to provide the delay, now goes to Sn directly. However, in order for the gate to function correctly, the base of TR27 must be taken negative to cut TR27 off when Sn operates. When Sn operates it goes positive, and thus an inverter in the form of TR32, R49 and R50, is interposed between Sn input and the En output gate.

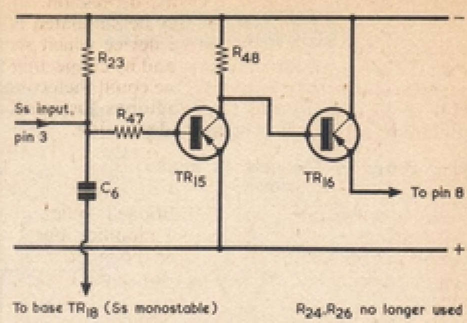


Fig. 2. The modified Ss input circuit

LOAD SENSING

There are several ways of arranging a mechanism such that, when a load is placed on Cyclops' back, the output goes positive. The easiest is to have a large hinged plate upon which loads can be carried, with the hinge operating a microswitch, and this is the method employed. One terminal of the microswitch is connected to the positive supply line, whilst the other terminal connects to the conditioned reflex input selector switch.

SELECTOR SWITCH

The conditioned reflex switching is carried out by an added 3-button interlocking push button unit, each switch having 4 changeover contacts. The inputs and outputs now provided are listed in Table I. The first button selects the old S3, so that the original two conditioned reflexes may be selected. The second button connects up the inputs and outputs in such a way that Cyclops is ready to learn how to carry loads. The third button connects the conditioned reflex unit so that Cyclops is susceptible to nervous breakdowns.

There are a number of extra components in the modifications whose functions have not yet been explained.

Table 1
Conditioned Reflex Connections

Reflex	*Ss*	*Sn*	*Es*	*En*
Touch	RLA2	Magnet Sensor, X2	RLA Delay Circuit. Pin 6, Board 1	RLB delay circuit. D12– Connection 1, Board 3
Light	RLC Sensor. TR33– Connection 5, Board 3	Magnet Sensor, X2	RLC Coil	RLB delay circuit. D12– Connection 1, Board 3
Weight	RLC Sensor. TR33– Connection 5, Board 3	Load Sensor, S9	—	RLA delay circuit. Pin 6, Board 1
Anxiety	Magnet Sensor, X2	RLB Sensor. TR39– Connection 7, Board 3	RLB delay circuit. D12– Connection 1, Board 3	—

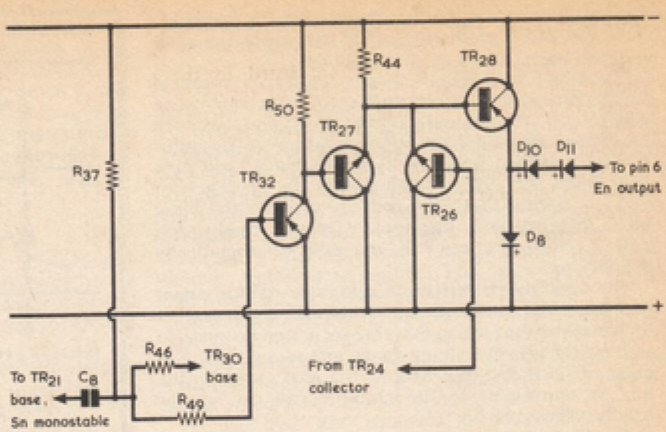


Fig. 3. The new En output circuit

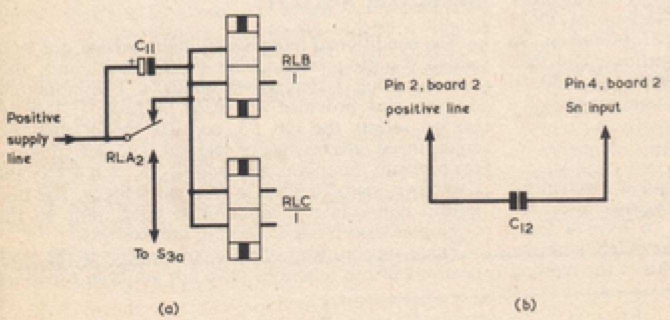


Fig. 4. (a). Suppression capacitor C11 is fitted as shown here
(b). Adding suppression capacitor C12

Two of these, C11 and C12, are shown in Fig. 4.

Even though the potential dividers eliminate spurious triggering of the monostables, pulses appear when RLA2 disconnects the common connection of all the coils from the positive line. The other ends of the coils tend to jump from 0.5 volt to 1.5 volt in nearly all cases. C11, connected across RLA2 contacts, eliminates the sharp pulse completely. C12 similarly reduces noise on the Sn input, being wired between pins 2 and 4 of the socket for Board 2.

When conditioning to touch or light is selected, the reed switch connects to Sn whilst D12 connects to En, so that detection of a magnetic field causes the robot to stop. However, when anxiety neurosis conditioning is selected, the reed switch is connected to Ss input and D12 is connected to Es. Unfortunately, no provision has been made to cause Es to be evoked by Ss and so, in this special case where existing circuitry does not do this, an extra circuit has to be brought in. Whenever Ss input goes positive, TR15 turns off allowing TR16 to switch on. When the selector switch is in the anxiety conditioning position, the emitter of TR16 connects to D12, and thus the reed switch which is connected to Ss input under these circumstances operates the RLB delay circuit.

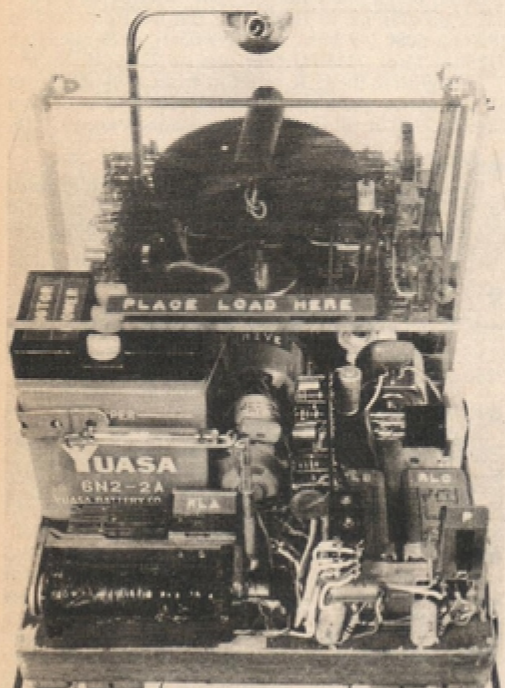
There are two extra diodes, D10 and D11, connected in series with the En output. It was found that the voltage on the En output was too high when Cyclops was in the unconditioned state, preventing release of RLA when En reverted to the off state. Similarly, the voltage was high enough when Cyclops was in the conditioned state to cause RLB to operate when Sn was given, even though the voltage on the output rose to only 1.5V instead of the usual 5V. Rather than include extra components in the gate to keep the voltage down, two silicon diodes were used to drop the output by about 1.35V. This was found to be sufficient to prevent an output appearing when it was not supposed to, whilst not being too high to prevent the gate operating when it was meant to.

COMPONENTS

The additional parts required are listed in the accompanying Components List. Some of the components, including in particular those under 'Miscellaneous', will be referred to in detail when the constructional information is given in next month's issue. The Veroboard and Perspex parts should not be obtained until further comments in the next article have been read.

The selector switch, S6-S8, is a miniature 3-button type, each button controlling a 4-pole changeover switch, and is such that depression of one button releases another that is already depressed. It was obtained from G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2.

S9 is the load microswitch and this has to be quite sensitive, so that the lightest of loads causes it to operate. The microswitch specified meets this requirement.



Cyclops, from behind, after the modifications. Board 3, with C11 below, is in the foreground with S5, in its new position, at the right. At the top is the Perspex load-carrying plate, with the Perspex brackets at left and right. The bracket on the right carries the microswitch, S9. The load-carrying plate tension spring is to the left of the microswitch actuating rod

COMPONENTS

Resistors

(All ¼ watt 10%)

R23	(new value) 2.2kΩ
R47	27kΩ
R48	5.6kΩ
R49	56kΩ
R50	2.2kΩ
R51	27kΩ
R52	2.2kΩ
R53	10kΩ (see text)
R54	12kΩ
R55	4.7kΩ
R56	22kΩ
R57	10kΩ
R58	470Ω
R59	4.7kΩ
R60	22kΩ
R61	22kΩ
R62	2.2kΩ
R63	6.8kΩ
R64	15kΩ

Capacitors

C11	125μF electrolytic, 10 V.Wkg.
C12	0.1μF
C13	0.05μF
C14	100μF electrolytic, 6 V.Wkg.

Semiconductors

TR32-TR39	Any p.n.p. transistors of medium gain, i.e. greater than 60
D10-D13	Any silicon diodes

Switches

S6-S8	Three push-button unit, each section with 4-pole changeover contacts (see text)
S9	Sensitive microswitch, e.g. Bulgin S530 (Home Radio Cat. No. WS104)

Miscellaneous

Veroboard, 0.15 in. matrix, 2¾ in. × 1 in. (6 strips × 18 holes – see text)
8-way plug and socket (optional – see text)
1-off piece ⅛ in. Perspex, 6⅝ in. × 6½ in.
2-off pieces ⅛ in. Perspex, 6½ in. × ⅝ in.
2-off Meccano angle brackets, part 12
1-off Meccano screwed rod, 2 in., part 81
1-off Meccano rod 8 in., part 13a
1-off Meccano rod 5 in., part 15
2-off Meccano rods 1½ in., part 18a
1-off Meccano tension spring 2 in., part 43
3-off Meccano bolts
6-off Meccano nuts

In the prototype, Board 3 was mounted on a miniature 8-way plug, with a corresponding socket on the chassis. However, the board is quite small and connections could be soldered direct to it if preferred.

All the diodes are silicon, and the transistors are as specified in the Components List.

(*To be continued*)