Radio Control Models & ELECTRONICS

JANUARY - - - - 1961

FREE INSIDE

Pull-Out Battery Performance Data Chart

★ ★ ★

CASCADE ACTUATOR

★ ★ ★

"POTTING PROCEDURE"

★ ★ ★

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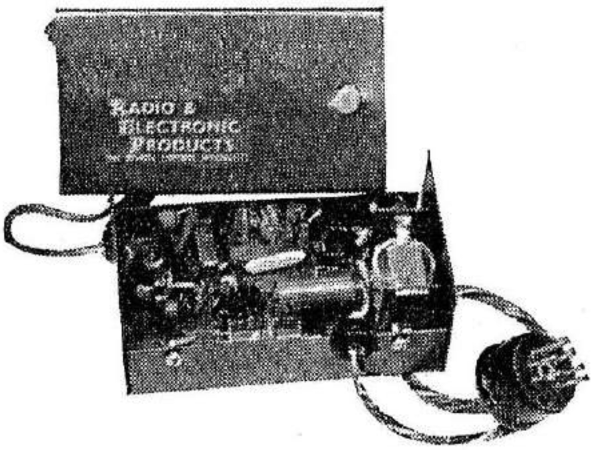

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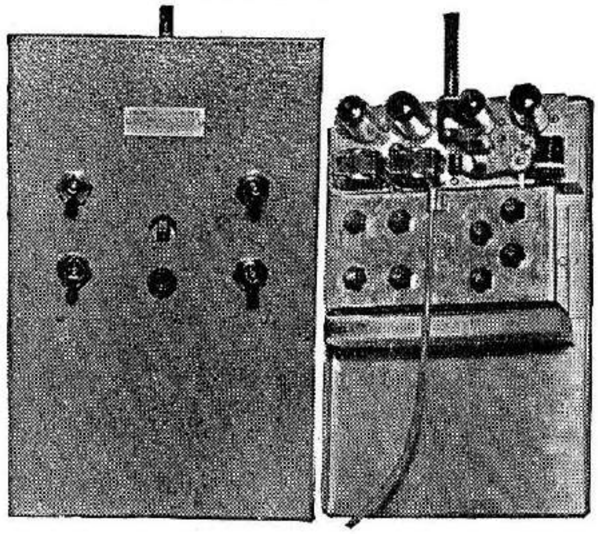
Single Channel Tone, Exceptional Range.

OCTONE



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NOTE.—Unitone and Tritone Transmitters are available crystal controlled at extra cost of £2/7/0 & £2/14/0.

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3-Reed unit ...	...	**35/-**
6 Reed unit ...	...	**50/-**
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Radio Control Models & ELECTRONICS

VOLUME 2 NUMBER 1 JANUARY 1961

Editorial Director: D. J. Laidlaw - Dickson.
CONSULTING EDITOR: T. H. IVES.
Advertisement Director: C. S. Rushbrooke.
Editorial and Advertisement Offices:
38 CLARENDON ROAD : WATFORD : HERTS
Telephone: WATFORD 32351/2 (Monday to Friday).

Here, There & Everywhere

New Year Prospects

How nice to be starting another clean new diary full of determination that every important date will be religiously marked on the appropriate page, and the innumerable "things to do" noted down in good time for them to be finished when required. But alas after only a very few weeks we tend to revert to scraps of paper for notes which get buried in the pile on the editorial desk, and memory as ever proves a poor substitute for writing it down. So that if correspondents do sometimes have to wait longer than they feel their due, please accept this as our humble apology. Others who sometimes get impatient as those casual contributors who do not know the ropes regarding payment for their contributions. Contributions are normally paid approximately the middle of the month following publication of their offerings, that is to say, articles in this January issue, appearing on the 10th December will be rewarded about the 14th January. So please don't worry until that date is well past. In the case of overseas contributors we usually ask them if they want the money sent, or would prefer it to be credited to some British firm whose goods may be more precious in their part of the world than our cheque.

May we take this opportunity of wishing our readers and contributors everywhere the best of everything for 1961, and give our assurances that we shall be doing our utmost to provide a regular and varied selection of material to this end.

Volume 1 Indices

In order that volumes may run with the year, we are concluding Volume I of *Radio Control Models & Electronics* with the December, 1960, issue. This means that the volume will be somewhat slimmer than in future years, but enables us to start Volume II with this January number. Subscribers should be receiving a copy of the index for binding in with their copies with this issue. Other readers who would like a copy can obtain one by sending a stamped addressed envelope and a postal order for 6d. to our editorial offices. Envelopes should be large enough to take it without folding, otherwise, if required for binding rather than reference, it must necessarily arrive creased.

No Litter! Is this a Record?

One rally at least seems to have solved the great litter problem which makes more bad friends amongst those

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able to provide flying field facilities than any other single cause. Ed. Johnson writes as follows: "While flying at Wallop on Saturday, the C.O. came to watch and asked that we thank everyone who attended the Southern Counties Radio Rally for their co-operation. Not one item of litter was left at the end of the day and he was very pleased. If you can find room to express our thanks we would all be grateful". This is almost front page news, Ed., and a fine example which shows it can be done !

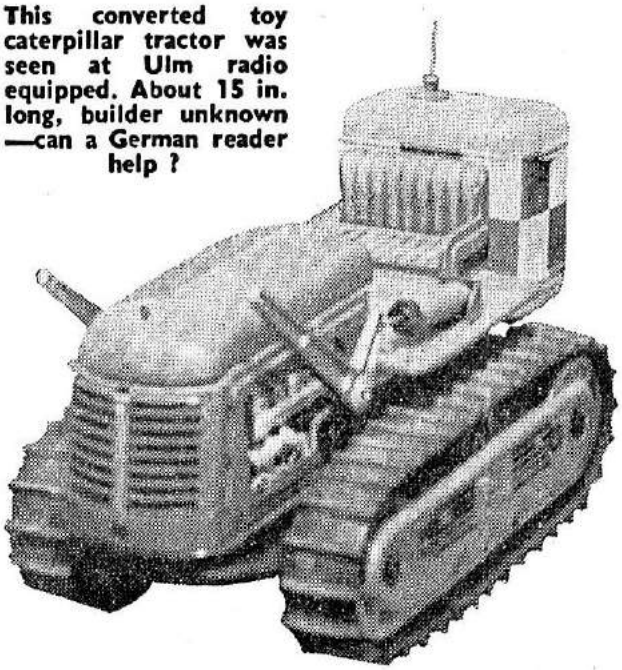
R.E.P. in Damascus

Cover picture this month shows a Fordson tractor outside the British Pavilion at the Damascus International Trade Fair. To the left will be seen John Dumble of R.E.P. wielding a chest-slung Tx. which is operating this hefty agricultural monster. John tells us that temperature was about 110° F. in the shade when pictures were taken; exposed metal became too hot to touch; but the radio functioned perfectly. As a footnote, similar sets, he adds, have been operated in Fordson Major and Dexter tractors from Australia to the Arctic Circle. Technical details of equipment are: Tx. is an industrial version of the Octone, powered by a 6v. accumulator; Rx. is a valve superhet, with a standard 8-reed unit operating primary relays, which in turn operate 12v. slave relays necessary to switch the high actuator currents (by model standards); a ninth channel is obtained by cutting the constant "background" note on the Tx. (lower than the lowest reed), allowing the "fail-safe" relay to drop out and release a solenoid, which cuts the fuel supply (the Dexter has a three-cylinder diesel engine). Four reeds operate the clutch and steering by solenoid-operated hydraulic valves; two reeds operate an electro-mechanical jack to raise and lower an implement (a harrow was used in the demonstration compound at the Fair) and the other two control the "D.A.R. valve", which operates the power-take-off pulley.

International Boat Show

Once again the Boat Show now "International" in title is upon us. It will be running at Earls Court from January 4th to 14th. Organisers as usual are the *Daily Express* and we are again invited to join with them in a

This converted toy caterpillar tractor was seen at Ulm radio equipped. About 15 in. long, builder unknown —can a German reader help ?



model boat display, which our big sister magazine *Model Maker* is arranging. R/C boats will be on display, and demonstration exhibits are under review. We hope that *H.M.S. Wolvertown* and her builder, Mr. P. Drake (see last month's issue) will be in attendance for part of the time, and we are arranging a simple demonstration unit with an E.D. Black Prince and Arrow 4-channel set-up to show the beginner where things go and how they work (we shall not aspire to why on this occasion!).

"Sandy Dean's Schooldays"

We have been enjoying "Lion" one of Fleetway's boys' comics, particularly for their model strip "Sandy Dean's Schooldays" which features the usual skullduggery of such strips interwoven with radio controlled model aircraft. Endeavouring to identify components used in the story provides quite an amusing hour. "The diesel twin crackled into life steered by the amazing control box held by Skimpole" . . . Is it a Taplin Twin . . . has Skimpole improved on the McQue box . . . then when the model is making loops round its rival . . . is Skimpole actually Charles Riall in disguise ? We can hardly wait for next week's denouement!

Cheap at the Price

Strangely enough very few readers have drawn attention to the "bargain price" quoted for Transmites in our last issue. We must have been wishfully thinking of the dollar devaluation to translate nearly $30 into £5/5/0. So please don't bludgeon your supplier and quote us on price!

Pity the Poor Contributor

Like Barnum we cannot hope to do more than please some of the people all the time and all the people some of the time. Comments (adverse) range from criticism of the extreme simplicity of some articles to grumbles about the size 7 heads required to understand others. Again, we publish an oscilloscope article, and some readers say it is out of our orbit (what about the *Electronics* part of our title kind sir?); others write in to say how much they are enjoying making it thank you. Now, we have an indignant member of the trade, who shall be nameless, who considers our Modulation Technique series "unkind to the trade" since so large a proportion of them follow the author's "common but incorrect methods of modulation". He gives an analogy from the motor trade that the ideal gearbox should be infinitely variable, but is not adopted commercially. The new Dutch DAF, incidentally, *has* got such a gearbox! We are unabashed, and maintain that theoretically perfect standards should always be considered — whether thy can be adopted practically or commercially cannot alter their perfection!

Queer Queries

Some of the questions we are asked to solve in McQuery Column ramble on for several pages, with everything bar the enquirers' birthday mentioned, to end with an extremely simple problem. A lot of time has to be spent sorting out the meat from such letters. Even more questions are so brief as to be curt, which makes their solution virtually impossible without a vast amount of practical work. Could we ask readers, therefore, to set out their questions clearly, stating what steps if any they have already taken or what tests they have applied before deciding the job was beyond them. If they wish to write on other matters at the same time, would they kindly do so on a separate sheet. In this way, general correspondence can be handled as such, and queries passed to those experts most competent to deal with them.

Aircraft Radio Control Club

November 6th proved to be a very successful day for the A.R.C.C. meeting at Odiham. The weather couldn't have been better and as a result the standard of flying was high.

Pylon racing seemed to trouble some of the competitors and the results indicated that a good deal of practice is necessary if the quality of flying is to equal that of "multi". Frank van den Bergh came a cropper after the turn and managed to write off his model completely.

In the multi class Chris Olsen lost elevator control on landing and cracked up his fuselage, etc. He hastened to say that it was due to the fact that he was using the "Nike" super-het converter and not his usual Rx.

Paul Rogers of High Wycombe put up an impeccable performance helped by "Dad" and was far ahead on points. Charles Riall performed well as usual.

Results were:—Multi: 1st, P. Rogers (H.W.; 2nd, C. Riall; 3rd, Brooks. Single: 1st, G. White; 2nd, J. Dumble; 3rd, — Yates. Pylon: 1st, Chas. Riall at 41.5 m.p.h.

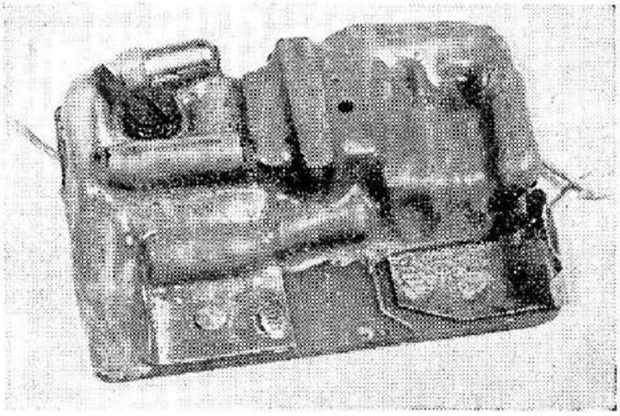
"Films Will Be Shown!"

What to do when a hall has been booked, refreshments laid on, guests and their ladies invited for a film show and social and then NO FILMS ARRIVE was the dilemma facing Sutton Coldfield R.C.M.A.C. chairman Bert Marsh recently! Frantic scurrying round to borrow films for a makeshift substitute programme enabled a belated start to be made with an audience 60-strong and then, the *Projector broke down* irreparably!

With unabated aplomb, a tea break was suggested, and the interval utilised for yet another mad chase for another projector and the club's own amateur 8mm. films. So at length a good time was had by all—or should we say, nearly all . . . for Bert Marsh will soon have lovely grey hair to match his lovely grey Phoenix if this sort of thing goes on!

R/C at Photokina Fair

We see from reports of the German Photokina Fair that at least one Japanese firm is now selling cameras complete with R/C triggering equipment for remote control, either for naturalists—an obvious must—or for use where a live operator could not get in, or subsequently not get out (some public meetings, perhaps?). Vic Rigby of E.D.s tells us that his firm have made a number of one-off sets for Press Agency work on the same lines, mainly to set off remote placed flash where extending leads would be impossible.



"Potting Procedure"

By Sqn. Ldr. STAN SARLL,
R.A.F., A.M.(Brit.), I.R.E.

A simple method of encapsulating receivers and other small items of equipment within the scope of the do-it-yourself fan with none of usual disadvantages of the system, described by a practical expert.

Introduction

GREATER use and much more enjoyment can be obtained from a well-made radio controlled model if the radio installation continues to function without breakdown or failure. This freedom from defect is a state of reliability we are all seeking. Models are lost or damaged, competitions lost and pleasure trips spoilt because something unexpected 'let us down'. Much of this trouble can now be avoided with good design and installation, but the inevitable environment that models suffer will often nullify the best efforts.

These environment hazards fall under the broad headings of—vibration, shock, damp or moisture, dirt, foreign matter such as fuel, mishandling and sometimes extremes of temperature. Any of these conditions can cause a failure somwhere, particularly in unprotected connections and where parts are close together.

Encapsulating the whole equipment in a sealing or potting compound can reduce these hazards down to an acceptable level, where reliability is such that a radio could be kicked around, plunged into water or left in the sun and still work properly. Model radio control equipment often suffers treatment as severe as this and yet we still expect it to continue working even without potting.

One manufacturer is offering radio control equipment potted into solid blocks. Doubtless an extremely reliable result is obtained, but if a defect *should* occur, repair within the block is virtually impossible with present day techniques.

The technique described in this article produces an encapsulated unit with a high resistance to most adverse conditions, but is still capable of component repair by peeling off the potting compound (see figure 1). It will keep out moisture, fuel and dirt, partially insulate external temperature changes, and probably most important, give a mechanical strength to soldered connections and flimsy components out of all proportion to the added weight. It can be used for receivers, transmitters, all

Above : The author's Monitor (December R.C.M. & E.) duly encapsulated. Fig. 1 (larger picture) shows preparation of the mixture in a tin lid, preparatory to spreading it over the equipment.

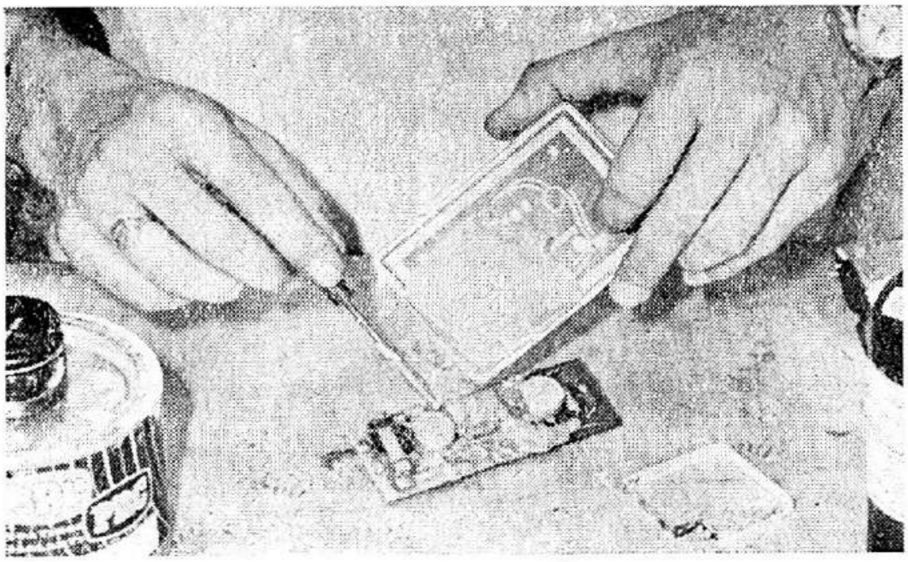


FIG. 2. The mixture being spread over a receiver with the aid of an old screw-driver.

soldered or screwed electrical joints, over battery terminals in fact anywhere requiring sealing or protection. Model boat enthusiasts will find it an invaluable protection against the effect of water.

The Potting Process
Type of Compound Used

The particular potting compound used is made by British Paints Ltd. (Northumberland House, 303 High Holborn, London, W.C.1) and is called Electrical Potting and Sealing Compound, reference PR 1201Q. It is supplied in kits comprising the base synthetic rubber compound in one tin with the accelerator in a separate container attached. Supplies are available from Burleighs of 303 Edgware Road, London, W.2, the smallest quantity being ¼ pint kits or from the makers.

Handling Precautions

The Room. Choose a cool dry room and work quickly. The compound is in no way dangerous, but soon solidifies and becomes unworkable. If you have to store the mixed compound for an hour or two, the ice box in a 'fridge' is useful as low temperatures delay setting.

Tools and Equipment. A shallow flat square tin lid, such as a mustard or 25 cigarette tin lid is suitable as a mixing container. Have two available if an undercoat is to be applied. Use the same container for both measuring proportions and for mixing to avoid the necessity of transferring the materials. If you intend to mix by volume proportions, cut a ¼ in. strip of thin tin and bend into a shape such that when placed in the mixing container it forms two compartments, one of $\frac{15}{16}$ in. and the other of $\frac{1}{16}$th of the total area. (It can be seen on the table in the illustrations, Figures 2 and 3.) If you intend mixing by weight proportions, a sensitive balance scale and weights will be required. The proportions will be 10 units to one unit and since the material is fairly light each unit may be only 1/10 oz. The only other equipment required is a small stirring stick and a piece of clean rag.

Cleanliness. The content of the larger tin is extremely tacky, like treacle, and when handled it somehow manages to contaminate tools, clothing, table and anything lying around. Although it can be cleaned off with Toluene solvent (obtained from larger branches of Boots Chemists) it is better to work methodically and avoid the mess. When the tin is opened, place the sticky lid away from other objects. Pour the 'goo' over the same part of the rim each time, and pour slowly using the stirring stick to stop the flow. Wipe off any unwanted spots before proceeding further.

Preparing the Radio

First ensure that the electronic equipment to be potted is PERFECTLY SERVICEABLE. See that there are no loose joints, pieces of solder, dirt or other imperfections and that the equipment is really clean and dry. Remember that what is inside at this stage will be trapped in by the potting so check first. Make up a celluloid masking around any reed or relay armature and contacts; frames and coils can be potted in to improve rigidity. Fit the masking so that it can be lifted out when the compound has set. Arrange a support for the equipment to hold it firm and level while pouring. Each side can be potted separately if required.

Preparing the Main Mixture

In the larger container is a white

liquid of treacly substance and to this is added the accelerator in the small container. This is a red-brown coloured paste and when mixed with the main compound in correct proportions produces a resultant light milk chocolate coloured 'goo'.

Ideally the whole of the accelerator should be added to the base compound to obtain the exact proportions of 10 parts of base to one part of accelerator by weight (or 15 parts base to one part accelerator by volume). If this quantity is more than required for the job on hand, smaller quantities may be measured out using the scales, or the 'proportion measure' fitted into the mixing container.

Preparation by Weight. Place the mixing container on the balance scales, and weights equal to 10 units plus the container weight on the other side. Pour the base compound into the container until balance is achieved. Add a further one unit weight to the others, and drop a small quantity of the accelerator into the base compound until balance is again achieved.

Proportion by Volume. Place the 'proportion measure' in the mixing container and pour sufficient base compound into the larger (15 parts) compartment for immediate use. Smooth it out level, then fill the smaller (1 part) compartment to the same level with the accelerator paste. Carefully withdraw the proportion measure, wiping off compound and paste which has adhered to it using the stirring stick and adding that to the mixing container.

Mixing. Thoroughly stir the accelerator into the white base with the stirring stick until an even consistency and colour is obtained (see figure 2). Try not to create or trap air bubbles in the mixture as they cannot easily escape and will later form air pockets in the potting.

Mixing of Undercoat

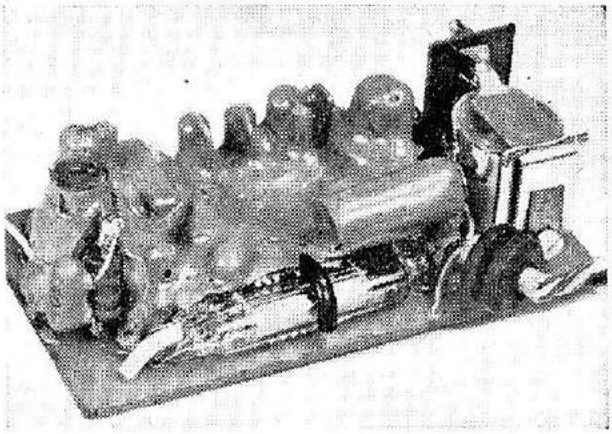
If the components on the radio to be potted are fitted close together or in layers, the main mixture may not flow under them all. It is necessary in this event to use a thin undercoat. Transfer a small proportion of the main mixture (the rest can be stored in the fridge until wanted) to another mixing container and thin with Toluene solvent. Stir until an even mixture of the consistency of cellulose dope is obtained.

Applying the Undercoat

Pour the undercoat all over the equipment to form an even thin skin. Keep moving the equipment to let the liquid run into all spaces but not over the edge onto the table. Sealing the spaces underneath components is more important than the top surfaces. At this stage have confidence for the equipment now looks a ruined mess but all will be well when the mixture is 'cured' or set!

Applying the Main Mixture

Within a few minutes of apply-



Above: A R.E.P. receiver which had been encapsulated was deliberately cut away to change components as shown —a change which was completely satisfactory.

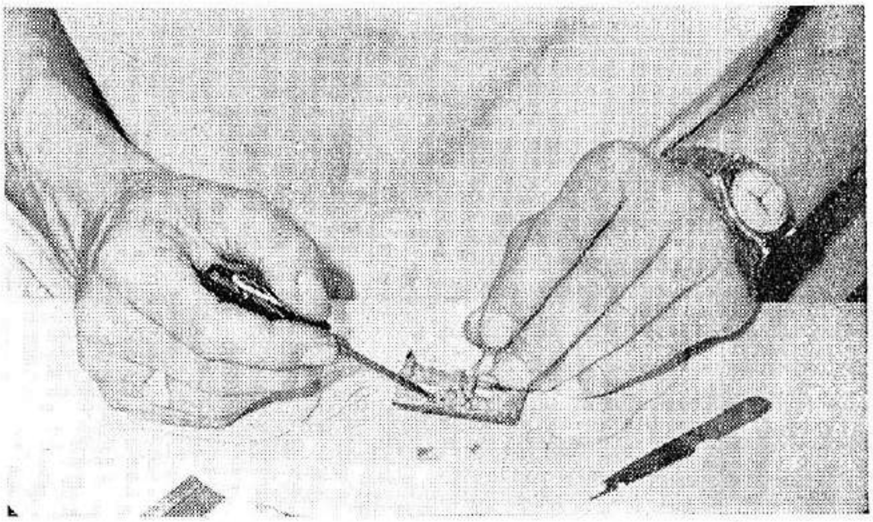


FIG. 3. Breaking away the mixture after it had set to enable a part to be replaced. This method is particularly suitable for such repair work.

ing the thin undercoat, or even without an undercoat if the components are well spaced out, the main mixture can be applied. It will not run unless encouraged by the stirring stick or a small screwdriver, poke the mixture under and around the components avoiding any mechanically moving parts (see figure 2). Work quickly for the mixture will soon 'cure' to a firm solid rubber at normal room temperature. This process can be improved and hastened by heating in the oven at a temperature not greater than 130° F. (On the lower shelf of a domestic gas oven set at 0 with the door not fully closed.) In this way it should be cured for 20 minutes.

Both sides of the baseboard can be potted, as much or as little being applied as you wish. If weight (and cost) is unimportant, a complete mould can be made with the work inside and a cubic block of potting produced. Cover well any leads where they leave the equipment to reduce the risk of fracture.

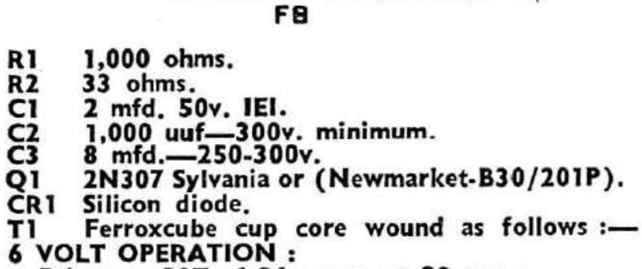
Repairing a Potted Circuit

Should the equipment develop a fault the whole, or any part of the potting compound can be peeled off leaving the components unmarked (see figure 3). A razor blade—carefully applied—will start the removal, then small screw driver, tweezers or pointed pliers can be used to poke or peel off the rubbery compound. Don't apply excess force and don't 'poke' more than you would into an unpotted circuit, but carefully 'dig out' the components.

When the fault has been rectified, the uncovered area can be resealed as described above.

A Power Converter

Once more we are indebted to GRID LEAKS for advance news of an interesting and easily made power converter, which can well save its cost in batteries over a year's running.



R1 1,000 ohms.
R2 33 ohms.
C1 2 mfd. 50v. IEI.
C2 1,000 uuf—300v. minimum.
C3 8 mfd.—250-300v.
Q1 2N307 Sylvania or (Newmarket-B30/201P).
CR1 Silicon diode.
T1 Ferroxcube cup core wound as follows :—
6 VOLT OPERATION :
Primary—38T of 26 s.w.g. or 28 s.w.g.
Feedback—25T of 28 s.w.g.
Secondary—1100T of 38 s.w.g.
5 VOLT OPERATION :
Primary—Same as 6 volt.
Feedback—Same as 6 volt.
Secondary—1300T of 38 s.w.g.

In the construction of the transformer, the secondary is wound on the inside first, then the primary followed by the feedback winding. This is important for correct operation.

An aluminium plate may be necessary under Q1 as a heat conductor.

THERE is a trend showing up in the contest field, it seems, toward the use of smaller hand-held transmitters, particularly among the multi boys.

This trend is being pushed by the appearance of some very excellent transistorized power converters which operate from the now very readily available nickel cadmium type of batteries and make for simple, self-contained hand-held units at far less eventual expense than would be the case if the usual dry batteries were used.

At the outset, of course, the cost is rather high because it will require a minimum of five nickel cadmium cells of either two, four or five ampere-hour types whichever is available and whichever will readily fit into your cabinet plus the power converter itself.

Among the power converters coming on to the American market, there is one being manufactured by M.C. Manufacturing & Sales. It is the M.C.135-15. This model is primarily intended for small C.W. and audio transmitters of the single channel type, and was designed by Bill Webb, an ardent R/C flyer.

The M.C.135-15 is just what the title implies. It has 135 volts output at a 15 mil. full capacity load. There is very little noticeable ripple, very little sag on the voltage at full output, and it will do an extremely good job very efficiently from a battery input.

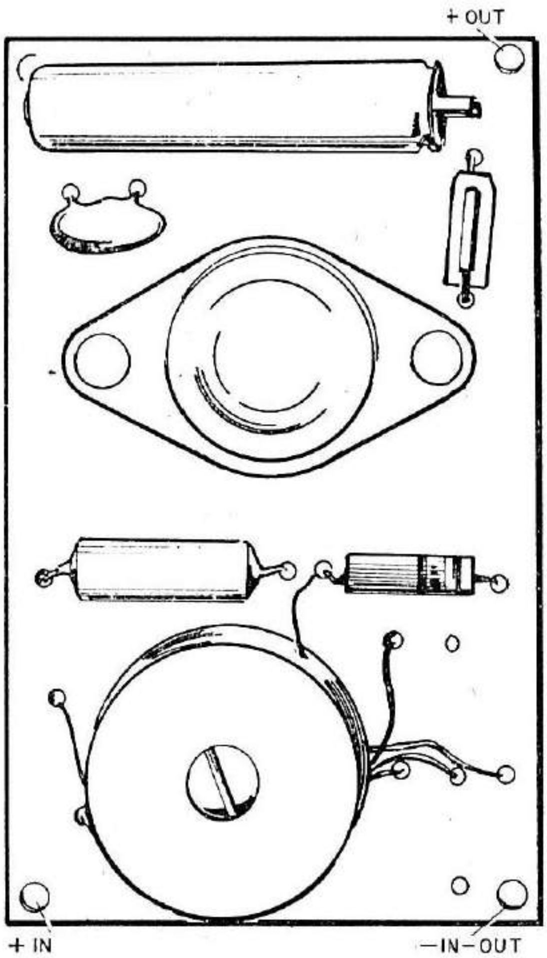
Another feature which makes it very feasible for hand-held transmitters is the fact that it may be operated either with 4.8 volts input or 5.8 volts input so that it may be used with four nickel cadmium cells for 4.8 volts or one lantern type battery of the dry cell variety for far greater economy than use of two 67½ volt of the dry battery type.

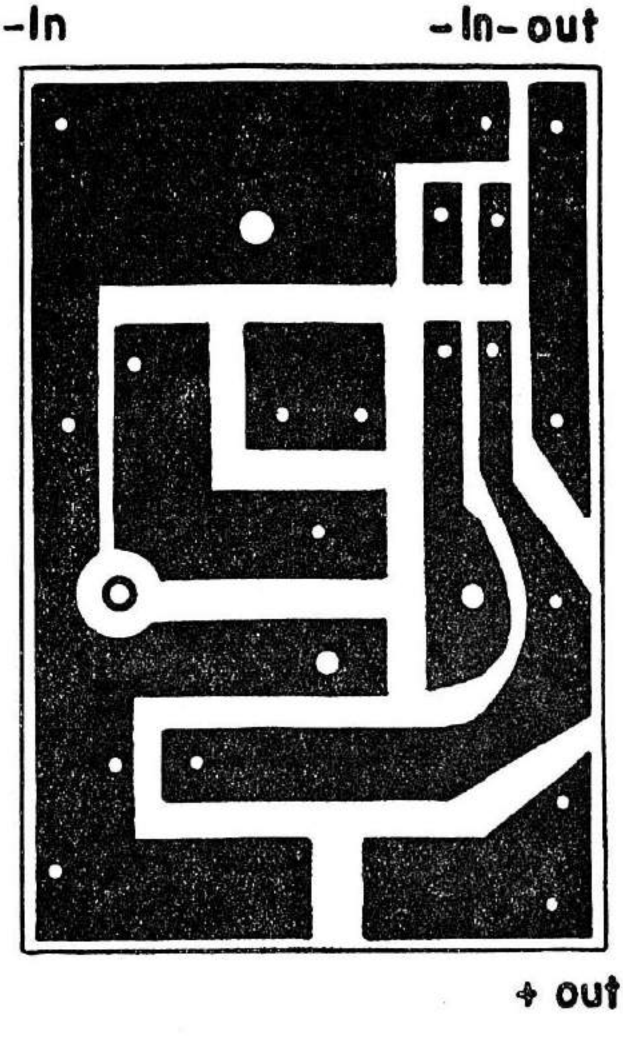
Very small in size, this unit is of the printed circuit board type, full size pattern for which is shown, as well as a top view, the components in position. Input power on the original was provided by four two ampere-hour A.B.C. nickel cadmium batteries, while the fifth battery is used as a filament supply. Each of the nickel cadmium cells, of course, has a 1.2 volt output even under load and this means that you have a potential input of 1.2 volts to the filament and 4.8 volts to the power converter.

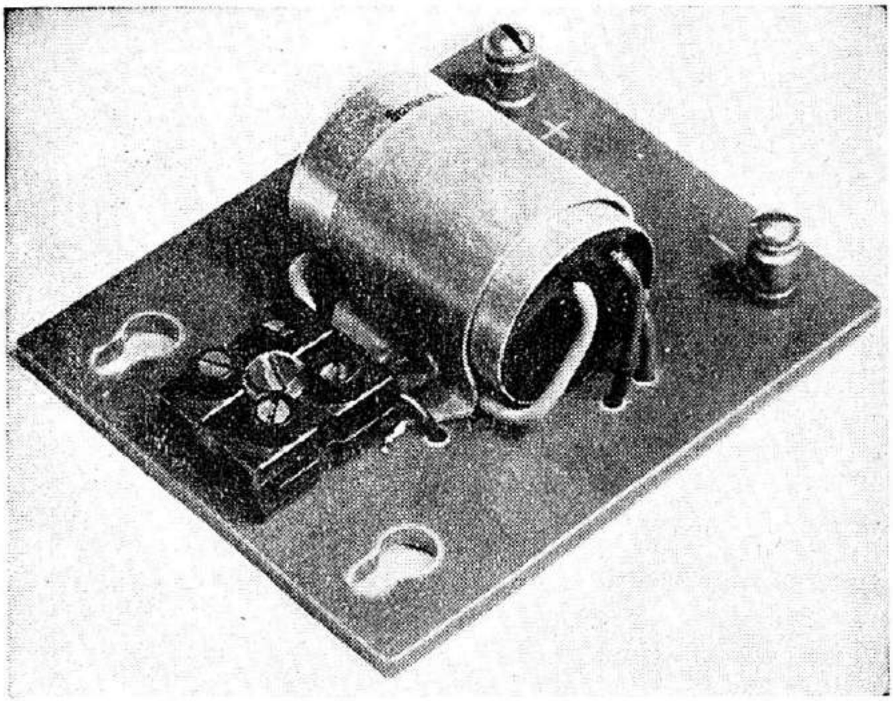
Having a drain of about 500 mils., depending upon the type of transmitter with which it is used, the power converter is extremely easy on batteries of any type. With the two ampere-hours almost four hours of continuous operation can be had, which is a lot of flying or boating in anyone's language.

Another strong point to recommend the M.C.136-15 is that it can be used with a 6 volt type of lantern battery. In this event, of course, the 5.8 volt tap must be used. (This is not shown on the schematic). If the transmitter is of the type requiring a 1.5 volt filament, a separate 1½ volt battery must, of course, be used for this supply. Should it be intended for use with a 6 volt type transmitter such as the M.C.25-T tone transmitter, only one battery is required of the 6 volt type since 6 volts may be used for both the power converter and for the filament. However, in the interest of ultimate economy and transmitter case balance, two of the 6 volt type lantern batteries may be used—one for the filament and one for the power converter—with exceptionally long life. It has been found by members of the R/C club that one lantern battery will last in excess of two 67½ volt transmitter H.T., supply batteries which cost considerably more.

While the M.C.135-15 power converter is intended primarily for single channel C.W. and audio equipment, M.C. is busy working on a more powerful unit

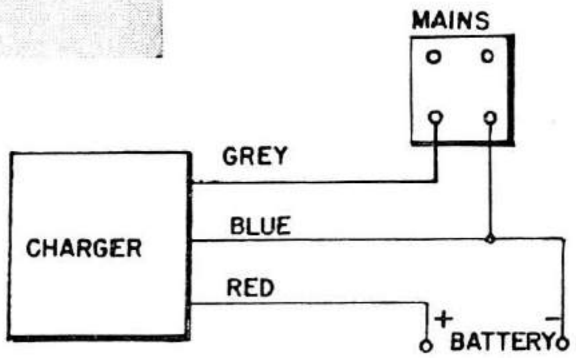






DEAC Charger

Tommy Ives makes up a mounting for this new unit



WE have been trying a neat little charger for DEAC cells which is now available at £1. As it comes it is plain encapsulated cell with (in our case) three leads. It requires to be mounted and connected in accordance with instructions supplied, which should be carefully followed since errors may lead to destruction of the unit.

The unit is live to the mains and great care must be exercised by the user in order to avoid shock. Our panel is designed to hang up adjoining the power source and reduces these risks to no more than those of, say, inserting a three-pin power plug.

The sample we have is marked LG 225 and 220v. so presumably is only suitable for use with DEAC 225 on 220v. mains.

Warning is given in the manufacturer's instructions as follows:

(1) The battery must be connected *before* switching on. If not the charger will be irreparably damaged and no responsibility whatsoever can be accepted by us unless this simple but extremely important rule is strictly observed.

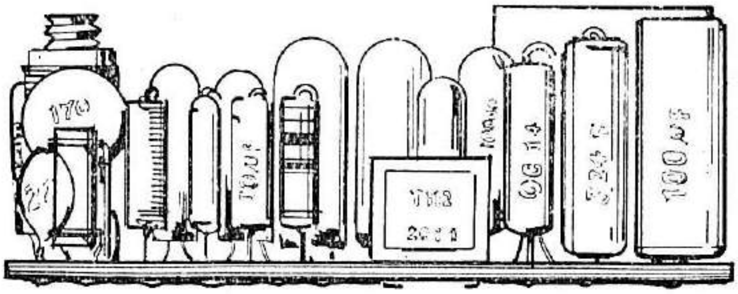
(2) The charge is 14 hours from full discharge to full charge. If the cell is left on after this presumably the charge continues and the battery may swell. It is not therefore a constant voltage charger.

POWER CONVERTER

(Continued from page 15)

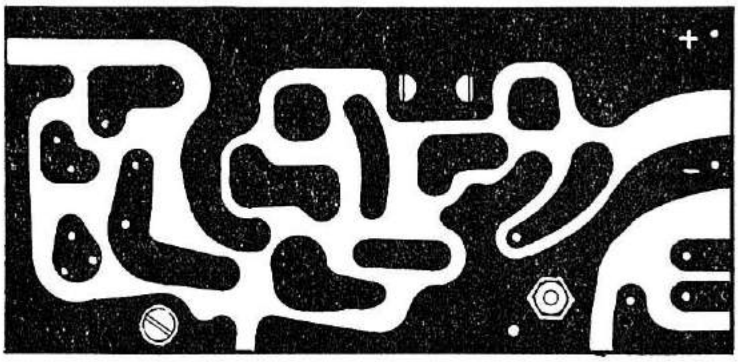
which has been extensively used by the multi channel boys in their Orbit and similar 8 and 10 channel equipment and which will perform a beautiful job with the Kraft 8 and 10 channel dual and triple simultaneous units when they become available. This unit will be known as the M.C.135-30 power converter and, while not yet obtainable, will appear on the American market soon. It will command a somewhat higher price but will give excellent regulation and very little ripple and, since it has been so successfully tested with existing multi-channel equipment, will find a ready market among the multi boys. With simpler single channel and C.W. equipment, where this drain is not required, the M.C.135-15 would appear adequate.

So by the courtesy of Grid Leaks we present this circuit, printed circuit board outline, and wiring data for those do-it-yourself builders who wish to build this unit without waiting for the commercial supply to become available.



Windy Kreulen's All-Transistor Receiver

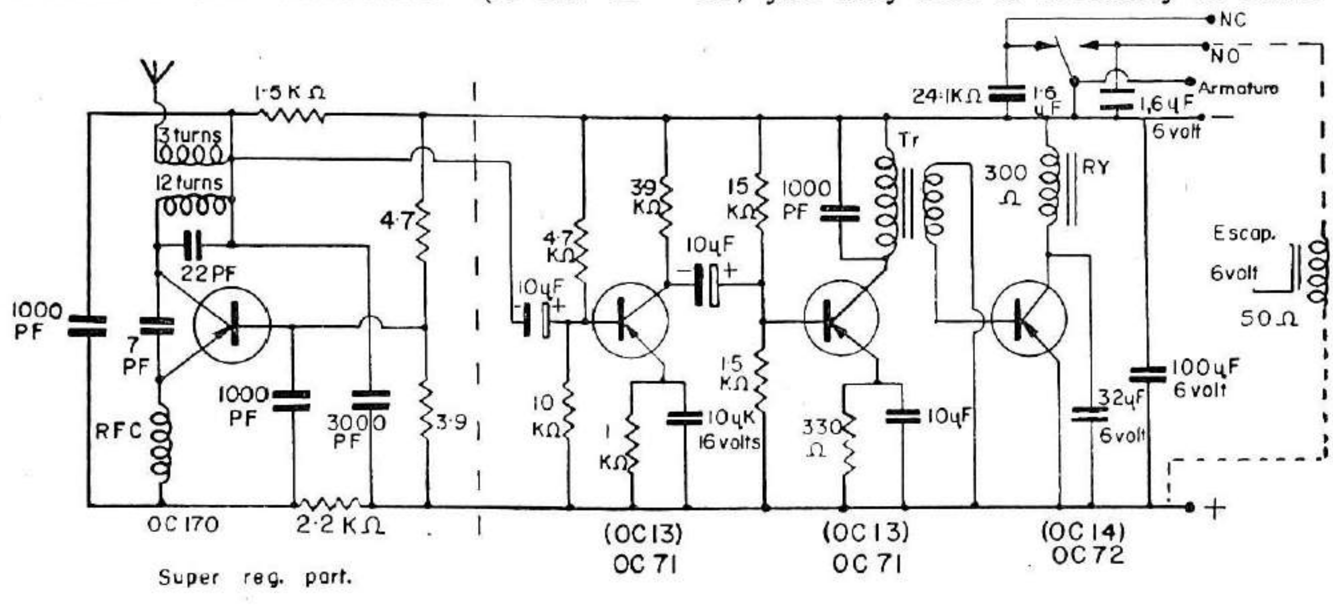
Our Dutch Correspondent also has some typical comments on the use of transistors and other parts seen from his essentially practical viewpoint.



WHILST waiting for plans of my new model I have been making up all-transistor receivers—you see my hobby for the past four years is to build any circuit I can obtain. I approached the subject of RF transistor stages in five different ways to see which circuit offered the best results. My opinion: The RF stage with a transistor gives much less power and is less selective than a valve stage. To get the maximum out of it rather critical adjustment and selection of components is necessary. This calls for good test equipment and some knowledge. The lack of power can be overcome by using one more AF amplifier stage and for this reason I use a total of four transistors. (It *can* be done with three if good quality transformers are used. But transformers take room and weight and are more expensive.)

You may like my set up. It is nothing special, in fact the Schoorel Rx. (itself a simplified T.R. 4.5) again amplified! But WITHOUT transformer coupling. The single transformer used is not important—I mean it has no important job to do, so any make will serve! The results I obtained are excellent, and I have been able to build the set on a PC panel 26 x 65 mm. inclusive of relay.

Here are some random comments on construction, components used and so on; you may find it necessary to make



some changes if available bits and pieces differ. All resistors are ¼ watt or smaller if obtainable. All condensers are of ceramic type except 10,000 pf. across transformer. This can be any type. I have used 10 uf. 16v. electrolytic condensers as these were the smallest I could obtain. R.F.C. not too critical for normal operation, but for best results some different types should be tried (I use the type G. H. Redlich puts in his Unitone, etc.). The R.F.C. has to some extent influence on the sensitivity.

We use 6 volt because one pencell does not add much weight to the battery pack and due to less m.A. through a 300 Ω relay we do not need an OC 76 as switching transistor but use the less expensive OC 14. This is a transistor that equals the OC 72 but is not exact to its specification and is sold as an experimental transistor at one-third off the OC 72 price. On the same battery pack we run the escapement that should have a D.C. resistance of about 50 Ω and not the normal 8 Ω type. One must rewind one's own, or buy the Graupner relay servo.

The receiver "likes" a long aerial ± 1 metre long and an audio tone from the Tx. of about 900 c.p.s. (depends on the transformer and C). Only one transformer is used as these things are: (*a*) expensive; (*b*) take too much room; (*c*) good ones are hard to obtain—in Holland and Belgium anyway. The only one has not much to do and the smallest (and less efficient) is good enough. The very small ones are not so good for coupling RF stages to AF stages. That is why we prefer RC coupling.

There are some advantages in using transistors only in a receiver for model control—but there are disadvantages.

Advantages :

1. Less vulnerable in the event of a crash;
2. Smaller Rx. can be built;
3. Only one battery need be used —4.5 or 6 v. and the result is fewer wires and single pole switch;
4. Unlimited life if care is taken not to ruin the transistors;
5. Needs no carrier if quench noise and hiss of super-regen stage is filtered out, thus saving Tx. H.T. battery;
6. Good positive action of low resistance relay.

Disadvantages :

1. H.F. Transistors rather expensive (four times price of a valve in Holland);
2. H.F. stage must be constructed very carefully and power from this stage is very little;
3. Quite broad in tuning (picks up stray signals from other sources easily;
4. Battery pack weighs more than for a valve-transistor Rx. (4 × 1.5 v. D14 is heavier than 1 × 22½ v. B122 for plate and transistor supply);
5. One more A.F. stage a must, otherwise a more powerful Tx. required. (See commercial equipment all Tx. / Rx. combinations use powerful Tx. if Rx. has only three stages or are run on 3 volts);
6. Some all-transistor Rx. are easily swamped close to the Tx.

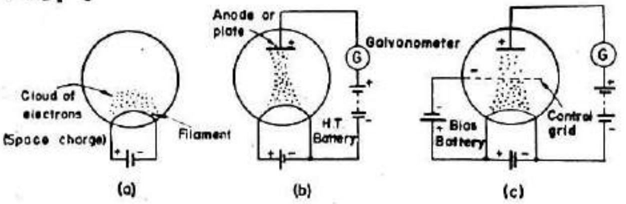
To make an all-transistor really advantageous it must be small otherwise it is useless (point 1). It must not consume a lot otherwise the battery must be a big one (point 3). Other advantages and disadvantages may occur to the reader.

To make the Rx. small, PC board and upright mounting of the parts is a must. The use of the smallest resistors and capacitors is recommended. For this reason transformers are avoided, but with RC coupling it is a little more difficult to obtain maximum results and the use of good measuring equipment —preferably an oscilloscope is a great help.

For stable operation adjusting the H.F. transistor to full power is not recommended. It is better to have working nicely and quite stable and use *one* more amplifier stage. The use of low resistors in the divider over the H.F. transistor bases gives more stable operation, but more battery consumption. One must compromise. We use 47 — 3.9 Ω.

The values in the amplifier stages are optimum, and only good if the same type transistors are used. Otherwise 15/50 K Ω potentiometers should be placed temporarily in place of the base and emitter resistances to positive (+) and carefully adjusted. Since it has only one transformer the best procedure is to tune the audio at the Tx. and use tone that suits transformer the best.

FIG. 1



Basic Radio

PART 3: VALVES

By G. E. DIXEY

The Diode

It was found in the early days of radio that if a piece of tungsten wire was heated in a glass bulb, from which the air had been removed, electrons which were present in the tungsten actually left it and formed a cloud or 'space-charge' adjacent to the wire. Some of the electrons fell back to the wire and were absorbed, but others were being given off, or 'emitted', all the time so that there was a space-charge around the wire continuously. This state of affairs is illustrated in Fig. 1(a).

Now we know that electrons are negative particles of electricity and there is a law that unlike signs attract each other, and like signs repel. Therefore, if we place a positive body in the vicinity of this negative space-charge the electrons will feel a force of attraction towards this body (Fig. 1(b)). Electrons flow from the tungsten wire (known as the filament) towards the positive material (known as the anode or plate) and enter this anode. They now flow through the wire in the usual manner, through the galvanometer (G) and battery and eventually find themselves back where they started at the filament. So, we have a continuous flow of current through the valve and round the circuit known as the 'anode current'. The presence of this current is shown by the galvanometer, which is a sensitive milliampmeter. This is the simplest type of valve having only two electrodes and is known as the 'diode'. Because electrons are emitted by one electrode and collected by the other current can only flow in one direction, and this is from negative to positive. Convention has it that electricity flows from positive to negative, because in the unenlightened past this was the way that it was thought to flow. However, conventions die hard and today we have two ideas on the direction of current flow—conventional flow and electron flow. When dealing with valves we usually use the electron flow theory.

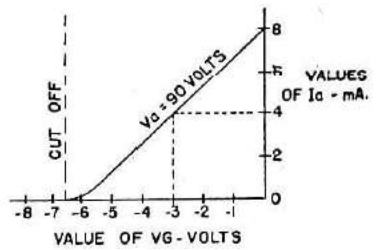
The Triode

When the diode was first invented it proved to have many applications, but it also offered a good basis for experiment.

The first derivation was the triode or three electrode valve (Fig. 1(c)). In the triode a mesh of fine wire known as the control grid is interposed between the filament and the anode and connected to the *negative* side of a 'bias' battery. Thus the control grid exerts a repelling force on the electrons leaving the filament. This repelling force depends on the voltage of the bias battery, and if made large enough will prevent any electrons from reaching the anode at all. The fact that some electrons do get past is due to the fact that they leave the filament with a high velocity which may be sufficient to enable them to get clear of the influence of the grid. When that state has been reached where no electrons get through the grid to the anode the valve is said to be 'cut off'.

If we make the value of the bias voltage variable we also make the controlling force of the grid variable, and this in turn varies the number of electrons that can flow between filament and anode. Thus we can vary the size of the anode current by varying the voltage applied to the grid.

FIG. 2

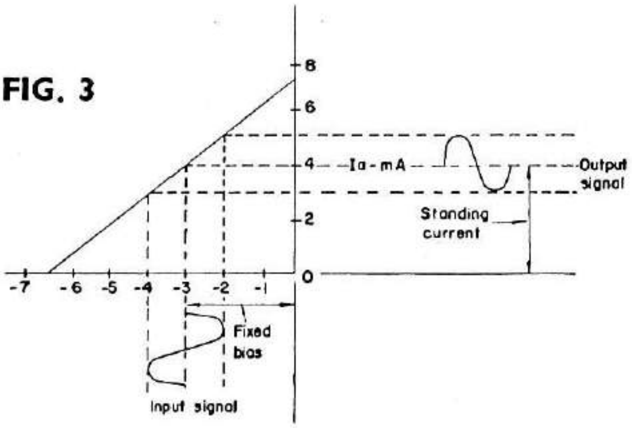


The Ia/Vg Characteristic

An important graph is the one showing the relationship between anode current (Ia) and grid voltage (Vg).

On the vertical axis are shown the values of Ia for certain values of Vg. When Vg = O the anode current Ia is high (8 m.A.), and when Vg = 8 volts, Ia = O, because the valve is now cut off. As an example of intermediate values when Vg = —3 volts, Ia equals 4 m.A. Because the voltage applied to the anode by the H.T. battery also governs, to some extent, the value of the anode current the value of H.T. is quoted against the curve. In this case, the anode voltage, Va, = 90 volts. In practice a number of curves, known as a family of curves, is shown for different values of anode voltage Va. The values of Va, Vg and Ia shown in our example are purely arbitrary and do not apply to any particular valve. The valve manufacturers issue sets of valve curves for each of their valves.

FIG. 3



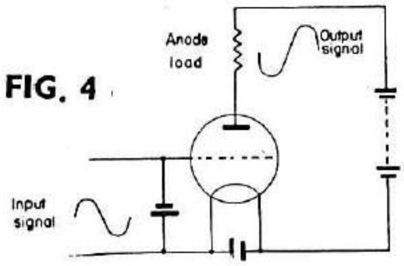
The Triode Valve as an Amplifier

If we adjust our bias voltage to, say, —3 volts, we cause an anode current of 4 m.A. to flow. We say that we have a fixed bias of —3 volts and a standing current through the valve of 4 m.A.

If we now apply an alternating voltage to the grid, whose peak amplitude is 1 volt, the voltage of the grid will vary between —2 and —4 volts (Fig. 3). If we draw verticals through —2 and —4 volts and then horizontals where they cut the curve we find the limits of the anode current variation which, in this case, is between 3 and 5 milliamps. So an alternating grid voltage produces an alternating anode current and all we need to do now is to insert some means of converting this current into a voltage, and we shall have an amplifier. The easiest way of achieving this is to pass the current through a resistance and we then have a volt drop across the resistance proportional to the size of the current flowing through it.

Fig. 4 shows our triode with a resistance in the anode circuit. This resistance is known as the anode load. The alternating anode current developes an alternating voltage across it, and, because we make the value of the resistance large, the voltage developed across it is much larger than the alternating voltage applied to the grid. Thus we have amplified our input signal.

FIG. 4



Hard Valves, Soft Valves and the Thyratron

We mentioned earlier that all the air is pumped out of the glass envelope of the valve. Such valves are known as 'hard valves'. In certain valves a trace of an inert gas such as argon is put into the valve after evacuation of the air content. A three electrode valve of this type is known as a thyratron. When the electrons flowing from filament to anode strike the molecules of the gas the force of the collision knocks electrons out of the molecules. These liberated electrons contribute to the electron stream, and we get a rise in anode current. This process of liberating electrons from the molecules of gas is termed 'ionisation', and is accompanied by a characteristic bluish glow. Apart from this effect and the structure of the control grid the thyratron is basically similar to the hard valve triode. Any valves into which gas has been introduced in the process of manufacture are termed 'soft valves'. It sometimes happens that the vacuum of a hard valve becomes contaminated by the presence of gas due to air leaks, or to the valve's having been abused. The presence of gas in a hard valve may be detected in operation by a bluish glow within the glass envelope.

Next month's article deals with multi-electrode valves.

Previous parts of this series appeared in November : Fundamentals.

December : Alternating Current.

Back numbers are at present still available from these offices.

Rubber Power Escapements

By R. H. WARRING

THE rubber motor offers a simple, cheap and reliable source of power, hence its popular application for actuator power via simple escapements. Probably because it *is* so simple, little or nothing has been written on the subject of the rubber motor itself, yet there are several important points which should be considered. There are distinct limitations with the rubber motor, and with the rubber drive escapement combination.

Almost invariably a two strand (complete loop) motor is specified for escapements. There are several sizes of strip—$\frac{1}{16}$ in square, $\frac{1}{8}$ in. × 1/30 in., $\frac{1}{8}$ in. × 1/24 in., $\frac{3}{16}$ in. × 1/30 in., $\frac{3}{16}$ in. × 1/24 in., $\frac{1}{4}$ in. × 1/30 in. and $\frac{1}{4}$ in. × 1/24 in. In this country today only three sizes are readily available, all 1/24th in. thick—$\frac{1}{8}$ in. × 24, $\frac{3}{16}$ in. × 24 and $\frac{1}{4}$ in. × 24. (Note: This is the correct designation, the figure '24' only being used to designate 1/24th in.)

Escapement manufacturers normally specify a certain size of strip—usually $\frac{3}{16}$ in. × 24 as a maximum—which is fixed not so much by power requirements as by the maximum torque the escapement can accommodate without danger of skipping or sticking. This, in fact, is the main limitation of the rubber motor - escapement actuator. Maximum torque which can be accommodated by the escapement itself is strictly limited, so that the output force is limited.

This condition is rather arbitrary. The escapement mechanism may well take more torque (i.e. more powerful rubber motor) without 'skipping', but under this higher torque would require more power for the armature to unstick. This may or may not be achieved by increasing the power developed in the coil, i.e. by increasing the applied voltage. Apart from inherent limitations of the electro-magnetic circuit the answer here depends both on design and manufacture of the escapement components. The more 'agricultural' they are, in general, the more prone to sticking they are likely to be—often aggrevated by the rather coarse contacting setting necessary to prevent skipping.

A measure of the overall electro-mechanical efficiency of the design, in fact, is the size of rubber motor which can be accommodated with a given supply voltage. Similarly, the higher the voltage required to work consistently with a certain size of rubber motor the less efficient the design. The excess of electrical power required will also be aggrevated by poor mechanical design and bad initial setting up. The latter feature can often be improved by careful adjustment and smoothing and polishing the contacting faces, but there may be other limitations in the design itself which cannot be overcome.

It is a common feature of poor engineering design that many lightweight escapements have a large and thick rubber hook—often big enough to accommodate a 16 strand motor of $\frac{1}{4}$ in. strip when the largest motor they will be called upon to accommodate is two strands of $\frac{1}{4}$ in. strip, and usually only $\frac{3}{16}$ in. strip. The extra rigidity given is not a good reason for such a design, and in fact may be a cause of trouble. On many lightweight escapements tested the whole escapement is distorted slightly if the rubber motor is out of alignment with the main spindle, causing skipping and sticking (mainly the former) and erratic operation. This is also poor design from the weight point of view, steel wire being a heavy material which should be kept down to minimum volume on any lightweight unit. When Wakefield modellers built return-gear units for rubber motors, in fact, the major weight-contributing factor was the steel shafts required (rubber hooks and gear spindles). To get the lightest possible gear unit, the amount of steel wire used had to be kept to an absolute minimum. The same applies equally to rubber driven escapements. It is far more convenient to mount these in the rear end of the fuselage to simplify linkage to the rudder and run the rubber motor through the fuselage to a forward anchorage. Unless they are really lightweight units, however, this may introduce balance problems.

Because of the limited rubber power which can be used with escapements, this type of actuator is generally limited to operating rudder controls only on aircraft. This can offer a distinct advantage over servo-motor power for single-channel, rudder-only by virtue of the faster response achieved. Many motor servos are too slow to provide effective rudder-only control as with this type of flying response to control action is critical, calling for minimum delay between 'signal on' and full response by the model.

A slow response leads to over-controlling and, almost inevitably, a loss of co-ordination. The *degree* of control response required is excessive and thus the greater the delay between 'control on' and response the more likely the operator is to run into trouble. The same thing does not arise on multi-control systems because the rudder is no longer used as a primary control—and in many cases seldom used at all. Thus neither the same *degree* of control nor *minimum delay* are required. Rubber-driven escapements are virtually ruled out in any case because of the low mechanical force available — certainly not enough to operate elevators and ailerons. At first sight a rubber-driven escapement for rudder operation along with motor-servos for the other controls might appear an attractive solution, but it can be ruled out on several counts—

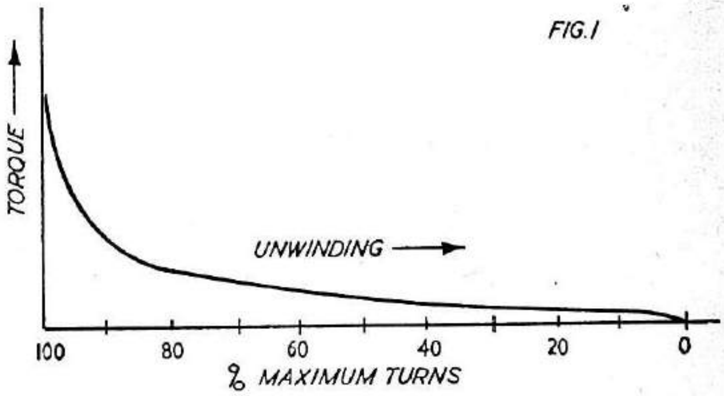
(i) The fact that the rudder is no longer a primary control on a typical 'multi' installation, as explained.

(ii) The higher flight speeds may increase the control surface displacement forces beyond the limit which can be handled by a rubber motor.

(iii) The complication of having one rubber motor to wind when all the other servo power is electric is hardly worth while—nor are 'mixed' controls good engineering design.

(iv) The fact that the rudder control would have to be sequence operated further detracts from the value of an escapement-type actuator, although it could free one channel for an additional sequence control.

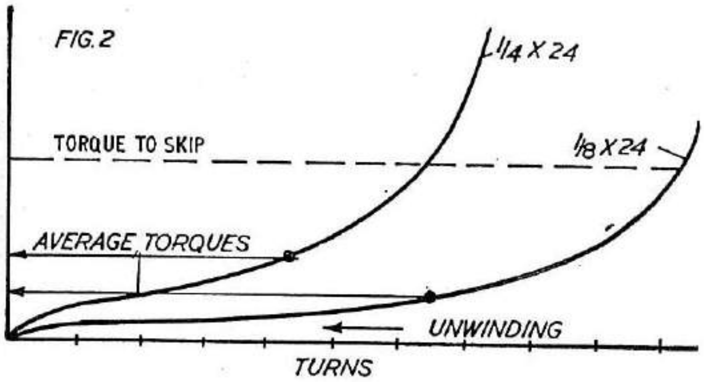
Point (iv) could be an attraction in an 'economy' installation—enabling elevator, ailerons, rudder and motor control to be operated on a six-channel system, for example, the latter two as sequence controls each taking one channel.



Returning to the rubber motor itself, the size—and thus the power available—is definitely limited by the design and operating characteristics of the escapement, as we have seen. The torque output of a rubber strip motor, however, is not constant. Wound to capacity, initial torque is high, rapidly falling off into a more or less linear curve where torque decreases slowly as further turns are run off. With a two-strand motor the linear range of torque output is substantially constant (see Fig. 1).

Since there is a considerable difference between initial torque and 'linear' torque, escapement motors are never wound to anything like capacity turns. A $\frac{1}{8}$ in. strip motor wound to, say, 90% maximum turns, could initially develop far more torque than a $\frac{1}{4}$ in. strip motor working over the 'linear' range. Thus it could develop more torque than the escapement could take without skipping or sticking, but after a few turns had been run off the torque then available would be appreciably lower than could be made available, using a more powerful motor wound to a lower limit initially (see Fig. 2).

Broadly speaking, therefore, it is an advantage to use the larger sections of strip and limit the number of turns applied, so that maximum 'linear torque' is available over the usable range. The fact that this reduced the number of turns available is not important. This can be compensated merely by increasing the motor length. Torque, as a matter of scientific fact, increases as (cross section) 3/2 and thus *doubling* the section produces, roughly, nearly *three times* the torque. A slight increase in cross section, therefore, may make all the difference between 'marginal' mechanical power output and one which is satisfactory and still within the limits of the escapement to handle.



Because, inherently, we are restricted to low mechanical power outputs, design and assembly of the linkage is equally important. Friction must be reduced to the minimum possible for consistent performance. The actual mechanical linkage merely represents another 'sticking' load on the escapement and the best of escapements cannot be expected to work properly through poor linkage.

Using a maximum rubber size limiting turns is indicated by the point at which the escapement starts to skip, as checked by operating the escapement. This is too high a point for normal operation, which should limit turns to some 10% less, at least, at which skipping is known to start. It is preferably to work to a check figure like this rather than on the basic of a 'double row' or 'treble row' of knots, but not so easy to *establish* the final winding point. Escapement motors are invariable rewound whilst they still have turns on them, the number of turns remaining being an unknown figure. One has, therefore, almost entirely to judge the 'maximum safe' turns almost entirely on the appearance of the wound motor.

Using a motor which will definitely produce skipping if wound past a certain point, this can be dangerous. Probably the best that can be done is to *check* that skipping is not likely to take place by at least a dozen control operations with the engine running. The use of a weaker motor is *safer* because it allows for considerably more margin of error in winding and, usually, a clear visual indication by appearance as to maximum safe turns.

How long the rubber motor will continue to deliver usable torque depends on the escapement and the linkage. Some well designed systems will operate down almost to the last turn, others start sticking as soon as the motor runs down to a single row of knots. On a bench test, any good system should run off almost all the turns on the motor —which is a good check on the mechanical efficiency of the system. If the motor is never let run down past the single row of knots it should then provide consistent power operation.

Finally, rubber motors should be lightly lubricated (with castor oil or rubber lubricant), and replaced from time to time. They are unlikely to fatigue through repeated windings but may get 'cooked' in a hot fuselage and tend to deteriorate. The cost of a motor is negligible and it is false economy not to replace it at regular intervals—say every two or three months.

COMPARATIVE DATA

Strip Size	1/8 x 30	1/8 x 24	3/16 x 30	3/16 x 24	1/4 x 30	1/4 x 24
Cross Section	.67	.83	1.0	1.25	1.33	1.67
Torque	.55	.75	1.0	1.4	1.5	2.2

These data related to the performance of 3/16 x 30 Strip as a Datum.

APPROX. MAXIMUM TURNS PER IN. TWO-STRAND MOTORS

Strip Size	1/8 x 30	1/8 x 24	3/16 x 30	3/16 x 24	1/4 x 30	1/4 x 24
Max. Turns	90	86	82	66	63	60

Oil Your Contacts!

We have been playing for several months now with a fascinating little pen-type oil dispenser which goes under the name of Electrolube. It is oil with a difference, however since it is good for electrical contacts. Recently, in the north, we received a quite unsolicited testimonial for it from a disinterested friend who swore by his. He told us that its use by a local TV servicing firm had reduced one arduous morning's dismantling work to get at dirty contacts and clean them to a dainty ten minutes job of just call at house, jab with Electrolube, raise hat and depart—and produced a far more satisfactory result at that. Complete with the magic oil Electrolube costs 12/-.

Yugoslav reader Nikola Nikolic offers this interesting

Modification of the A.M. Transistor Rx.

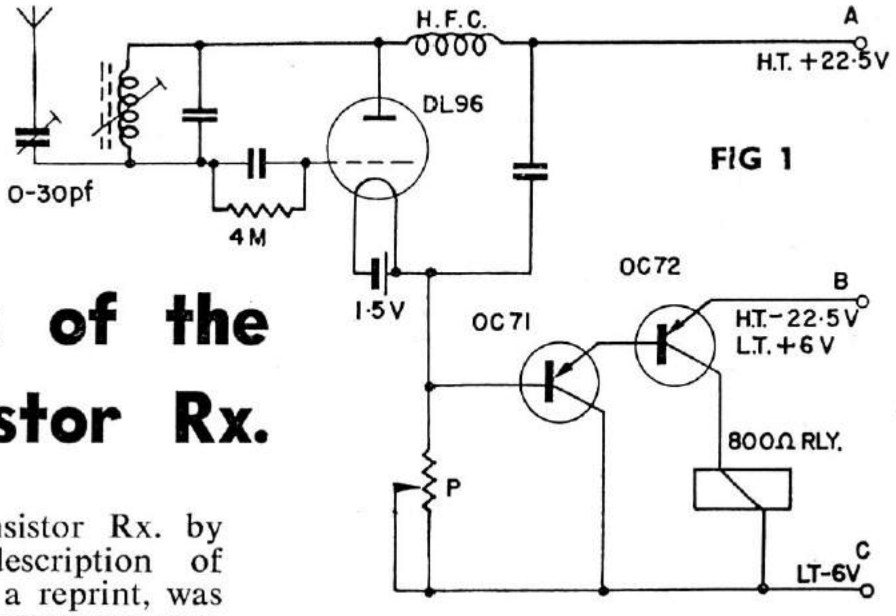


FIG 1

THE *Aeromodeller* Transistor Rx. by Tommy Ives, a description of which is still available as a reprint, was widely considered as an important contribution to the art, and still retains a large deal of its original importance.

Considerable difficulties in adjusting the D.C. transister amplifier were, however, encountered by R/C amateurs in Yugoslavia, due to our being unable to obtain the original parts. We succeeded at last in redesigning the electrical circuit so as to obtain much easier adjustment and better impedance matching, achieving at the same time a considerable saving of parts. The modified circuit is given below (Fig. 1).

The front end of the Rx. is almost identical as in (Fig. 3) with the original article, so there is no need for a description. We found the value of the plate current 0.2 m.A. typical, dropping to 0.18 m.A. on signal. If differing, the plate current may be adjusted by suitably altering the grid-leak resistor between 0.5 and 5 M-Ohm, although this is not absolutely necessary.

The D.C. transistor amplifier of the simplest possible type is included in the cathode lead of the valve. The transistors used are OC 71 and OC 72, but many others of the PNP type are equally suitable. The potentiometer P has a value of 50 k-Ohm max., or a resistor of 30 or 20 k-Ohm and a potentiometer of 10 k-Ohm may be used in series.

With a plate current of 0.2 m.A. (or whatever may be the actual case) the p.d. of the actuator battery (6v.) and the voltage drop on the pot. P should cancel each other, leaving zero signal at the entrance of the transistor D.C. amplifier. To achieve this, a point should be found on the pot. P, at which the current through the relay is zero or very small, but is just starting to rise.

On signal, there will be a drop of plate current to, say, 0.18 m.A. The diminished current will produce a smaller voltage drop on the pot. P, which is no longer sufficient to counteract the p.d. of the actuator battery (6v.), and an ample negative signal will appear at the entrance of the D.C. transistor amplifier. With an 800 ohm relay coil a current rise from zero to 5 m.A. was obtained, which was enough for our purposes. In some experiments an actuator battery of only 4.5v. or even 3v. has been used quite successfully.

The H.T. plate battery of 22.5v. can be of the smallest type obtainable, as the current drain is only 0.2 m.A. In order to avoid the use of the H.T. battery, we developed a suitable transistor converter around an OC 72 transistor, of which the electrical circuit only is given in Fig. 2, as I am unable at the moment to recall the details of the parts.

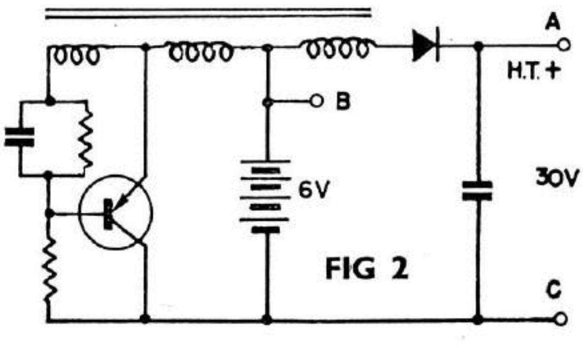
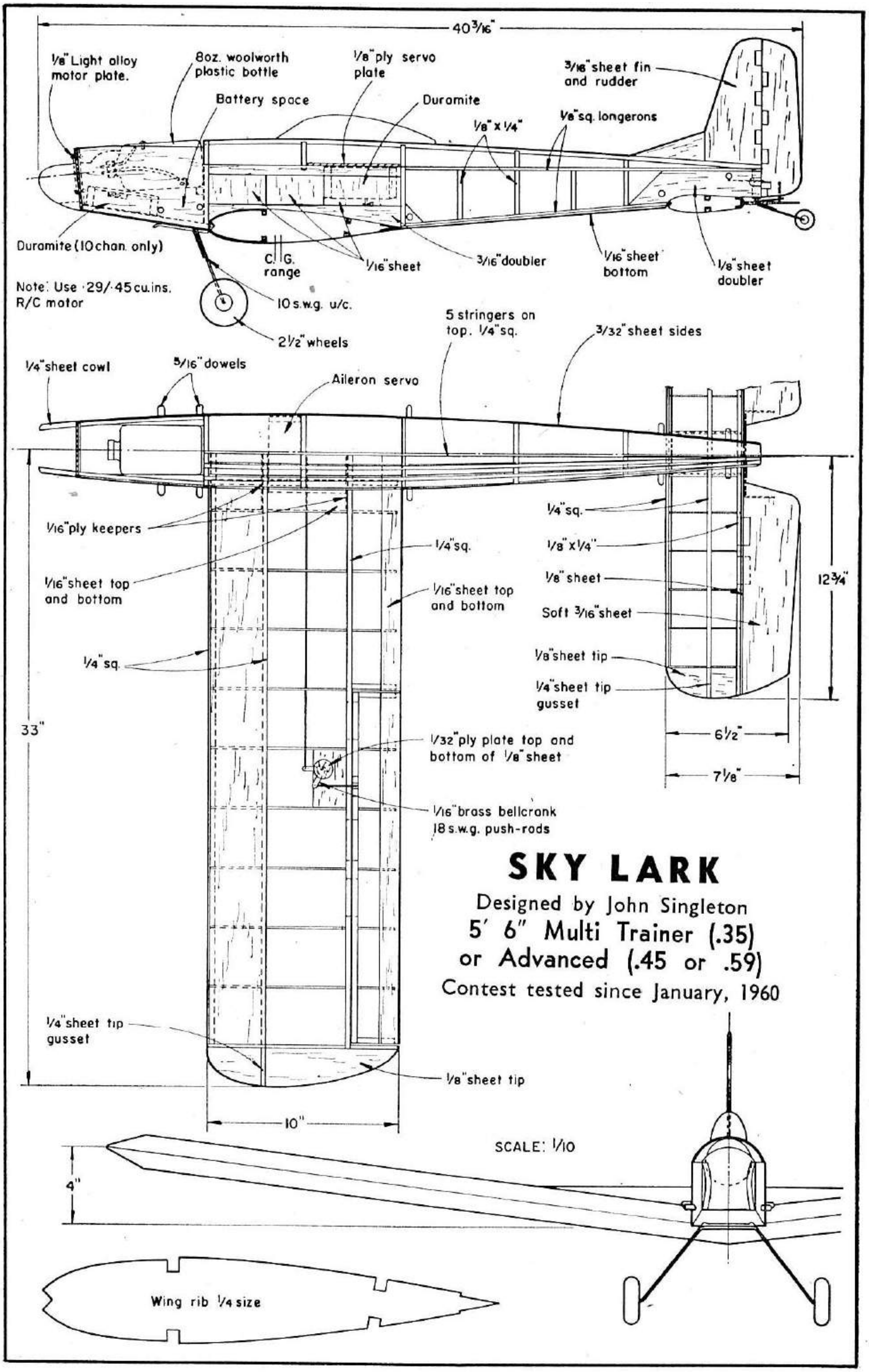


FIG 2

Skylark's contest record includes 3 1sts, 4 2nds, 2 3rds, and 1 4th in hands of Ed. Johnson, John Singleton 'et alia'. Early models were equipped with 8-channel vacuum gear, later replaced with 8 and 10 channel electrical. Drawings, full-size, on two sheets from Ed. Johnson at 12/6d.

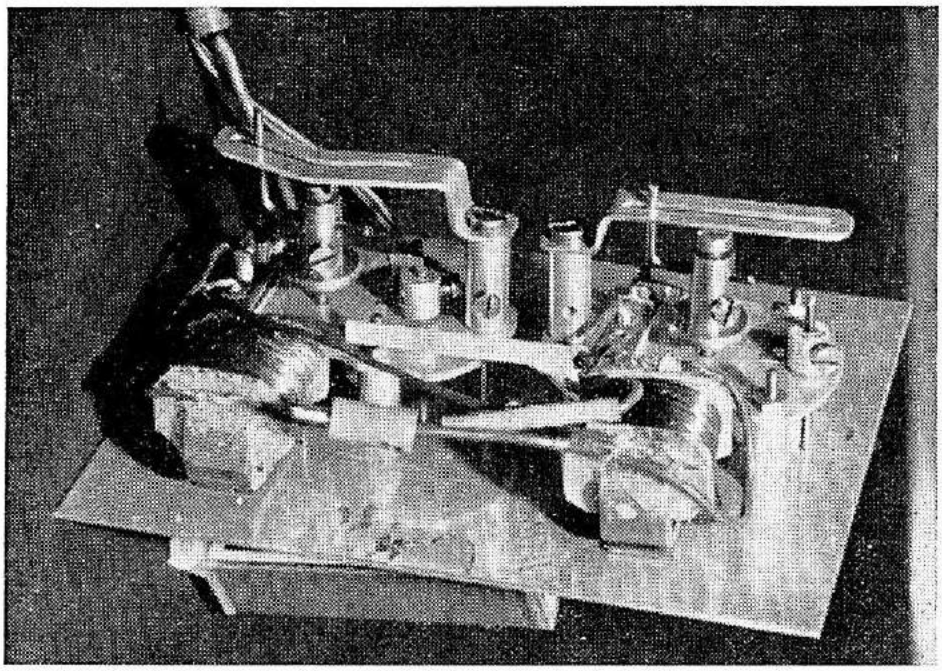


SKY LARK

Designed by John Singleton

5′ 6″ Multi Trainer (.35) or Advanced (.45 or .59)

Contest tested since January, 1960



Six-Fu

By Harold Kurth

Illustrations show the author's prototype actuator, which in the drawings and description has been slightly modified in the interests of simplicity and availability of parts.

THE relay described can be used to actuate six controls; right and left rudder, up and down elevator and via a simple auxiliary escapement, engine control (throttled or full power). On gliders landing flaps or a landing parachute can be controlled. The escapement for rudder and elevator is self-neutralizing.

Functioning of the Relay

The top mechanism controls the rudder, the lower one the elevator. The contacts behind the rudder relay control the auxiliary escapement.

The Rudder Relay

A rubber motor wound approximately 150 turns is fixed to the main spindle. The claw can be turned by the rubber motor, but is prevented from doing so by the spring tensioned armature. On closing the 6 volt circuit (2-3 volt batteries), the claw is freed and turns through 90° until it is stopped again by the armature. The claw will remain in this position for as long as the coil stays energised. When the circuit is broken, the spring returns the armature to its original position. The claw then turns through 270° until it is again stopped. When signalling, key, release, hold, allows the claw to turn through 270°. Upon release the claw will turn through 90° and return to its neutral setting.

Elevator Relay

The elevator escapement is actuated when the contacts of the rudder escapement are closed momentarily. This only occurs when the side arm of the claw is held by the armature. This can be obtained by keying twice, release, pause, key and hold. Hence the sequence is key (right rudder), release, key (left rudder) release, key and hold (close contacts). The circuit in the elevator escapement is now made (down elevator) and at the same time the contact arm on the elevator escapement moves to the left. This breaks the rudder escapement circuit and returns the rudder to neutral. On release, key and hold (breaking and making the elevator relay circuit once more) the pawl wheel will turn through 180° and up elevator will result. On finally releasing the elevator will return to neutral. Actuating the elevator can only be done via the rudder and the sequence is as follows:—Right rudder; left rudder; short break—key, down elevator, rudder returns to neutral, release, key, up elevator, release, neutral.

Contacts for Actuating on Auxiliary Escapement

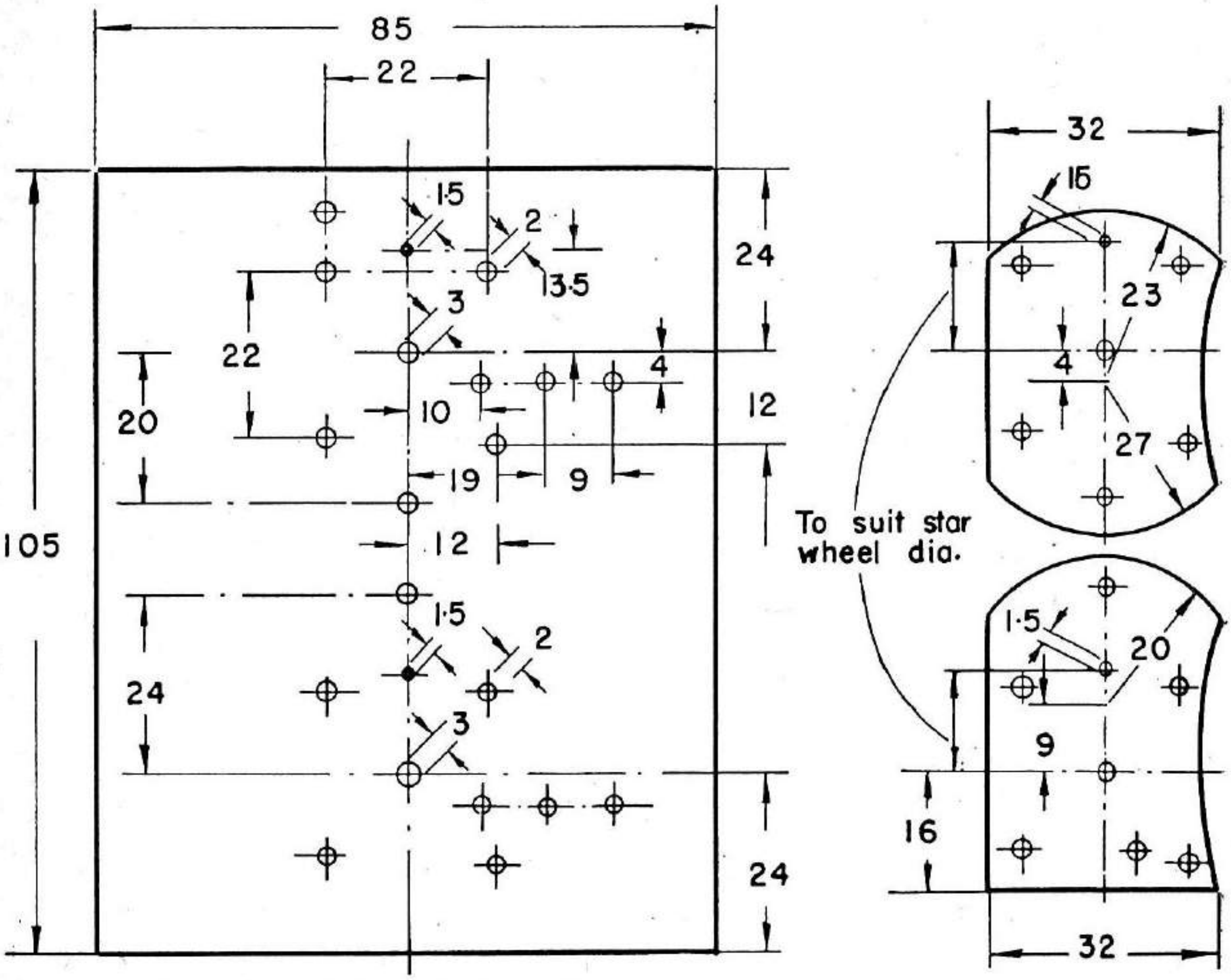
(Standard 2 pos. self-centring.)

It is necessary to use a SP/DT Rx. relay; the coil of the auxiliary escapement will only be energised when a circuit is completed via the normally closed contacts of the Rx. relay and the contacts behind the rudder relay. This is done by a blip signal causing the rudder escapement armature to bounce, freeing the claw and allowing the rear cam to close the contacts whilst the Rx. relay "lock" contact is closed.

Construction

Obtain starwheels first. The distance

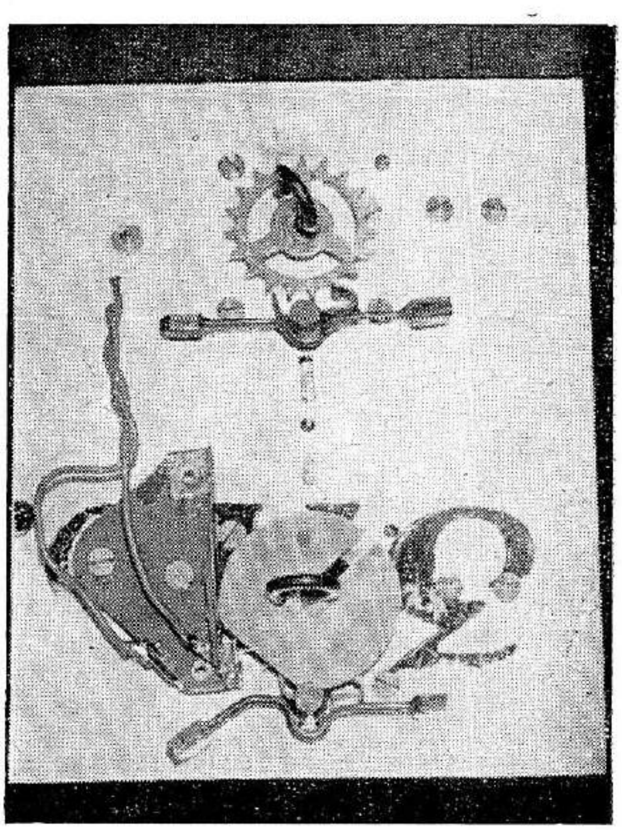
ction Cascade Actuator



between the main spindle and the pallet spindle will have to be adjusted to suit the starwheels available. The escapement should be installed in the fuselage centre, preferably in the last one-third wing chord position.

The baseplate is sawn from paxolin sheet and filed to shape. Next mark off and drill the holes. The paxolin bearing plates are also sawn out and the holes drilled simultaneously with the baseplate. The distance tubes must be all the same length and square.

The spindles are formed from piano wire. The claws are made from ½ mm. sheet. It is very important to have the claws of correct length as otherwise operation will be unreliable. It is best to drill (2 mm.) first and then to file the arms to length. Crank carriers are made from 14 s.w.g. bushes as sold for model aircraft. Drill laterally for the crank wire. With the aid of a 1.5 mm. wire placed in the hole cam flats can now be filed on the shoulders. The shaft should be a tight fit in the bush and should be soldered in. Watch that



on the armature the lip on the coil side is only half as wide, and file it to this size. Great care must be taken when making the magnet core that both ends are dead square. To avoid sticking of the armature, both ends must be coated with a thin (approx. 0.2 mm.) layer of solder. The coil bobbin which is cemented together in three parts, is wound with copper wire of 0.2 mm. dia. or even less. The ends are soldered to thin contact strips and then cemented to the coil body with an all purpose cement.

A hand drill can be used to facilitate winding the coil. Cement a plywood strip of 28 × 8 × 1.5 mm. to a slotted dowel of 6 mm. and fit this to the drill chuck. The coil bobbin can now be slipped over the plywood strip for winding. When making the 18 s.w.g. piano wire yokes, it is important to ensure that the slot (1.5 mm.) is exactly parallel and of equal width. The slot in the elevator yoke is slightly angled to ensure that the deflection is smaller for down than for up. When making the contacts the greatest care and accuracy must be exercised using silver contacts when available riveted to the arms and supports. Alternatively contacts from a discarded relay may be soldered on. The starwheels and pallets are obtained from an old alarm clock. Remove the spindle from the starwheels and drill. Remove the pallet spindle and replace with 16 s.w.g. piano wire. Add solder blob weights on the pallets. Alternatively new pallets may be formed from scrap tinplate strip with solder blob weights.

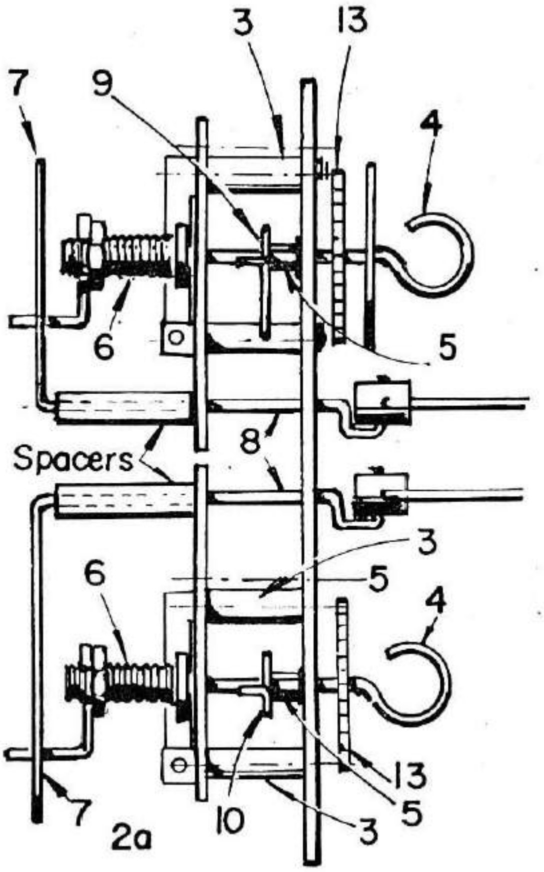
Assembly

Commence with the rudder relay.

Solder the cam close to the hook on the spindle. Solder the starwheel approximately 6 mm. behind it. The spindles are now placed in the appropriate holes in the baseplate and a washer (2 mm. hole) fitted. Next solder the claws (part 6).

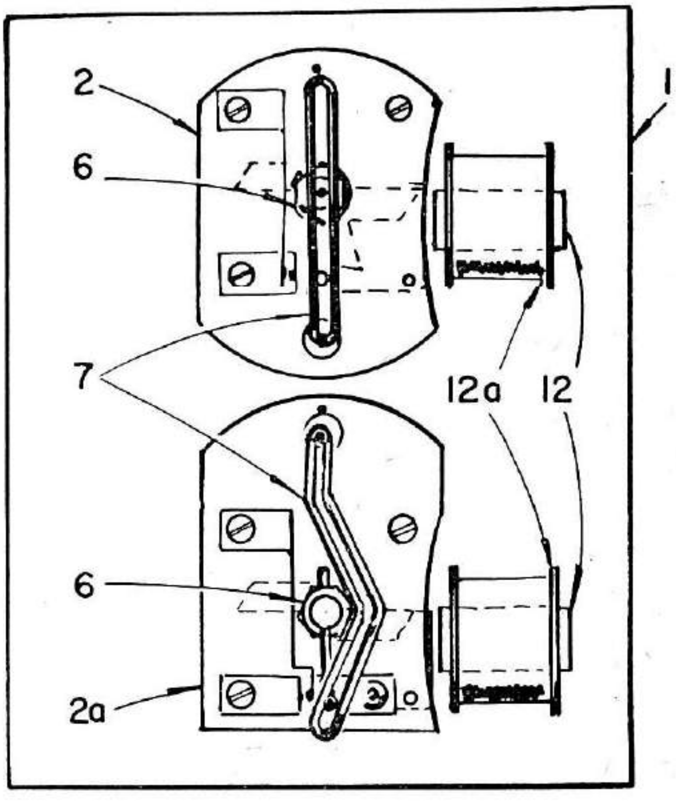
Cam and claws are positioned according to the drawing. Next rivet the contact assembly to the bearing plate with hollow rivets.

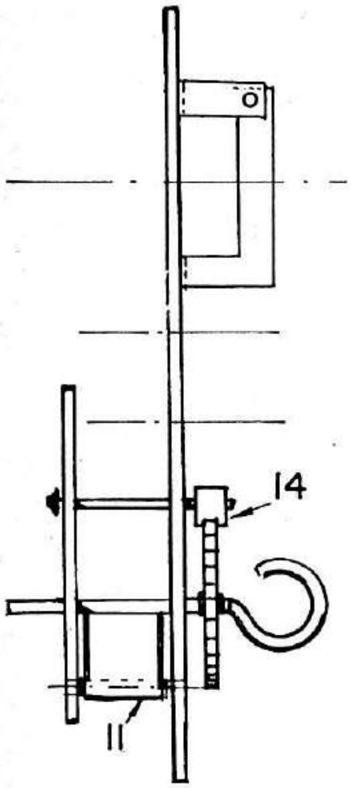
After assembling the rudder relay it should be tested for satisfactory working. When energised the armature should contact both sides of the magnet core without any air space in between. This can be achieved by adjusting the armature. The spring must return the

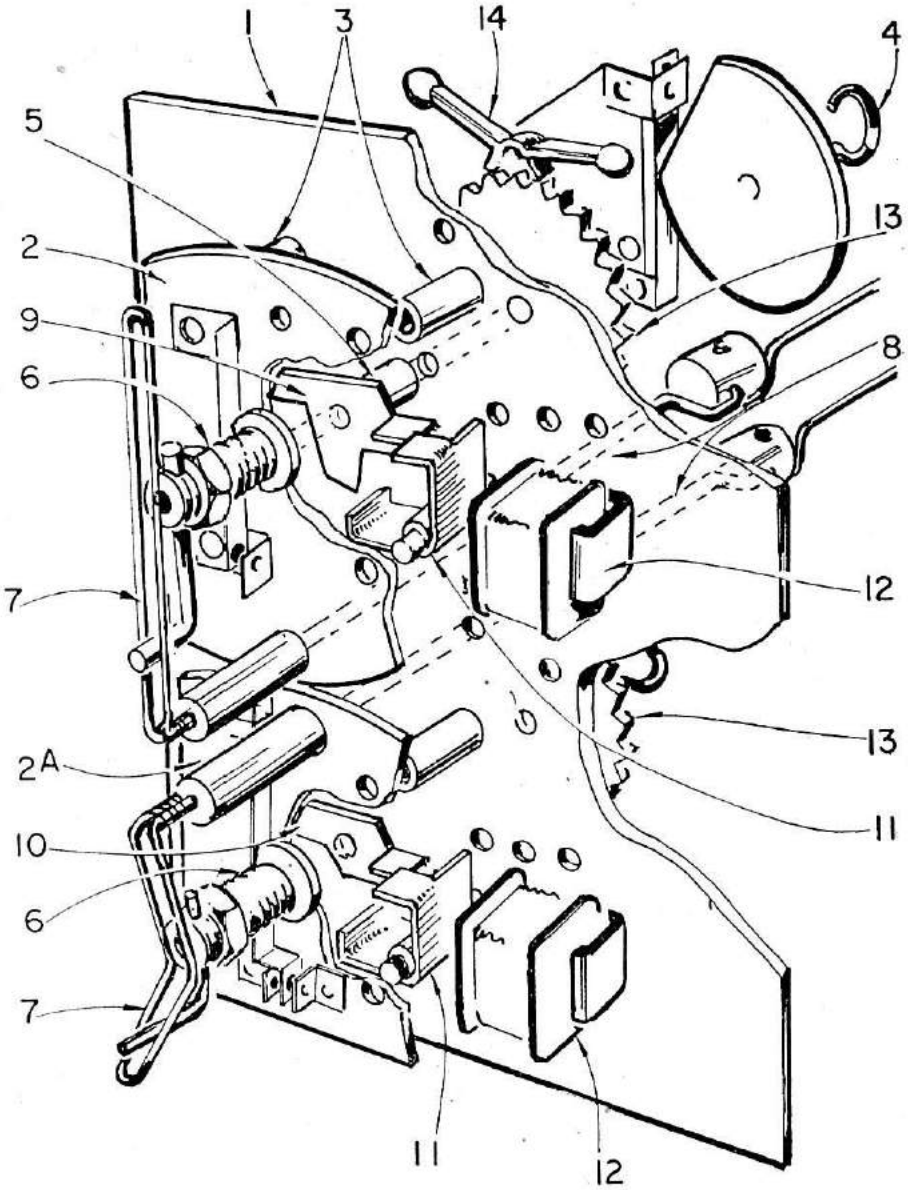


KEY TO PARTS

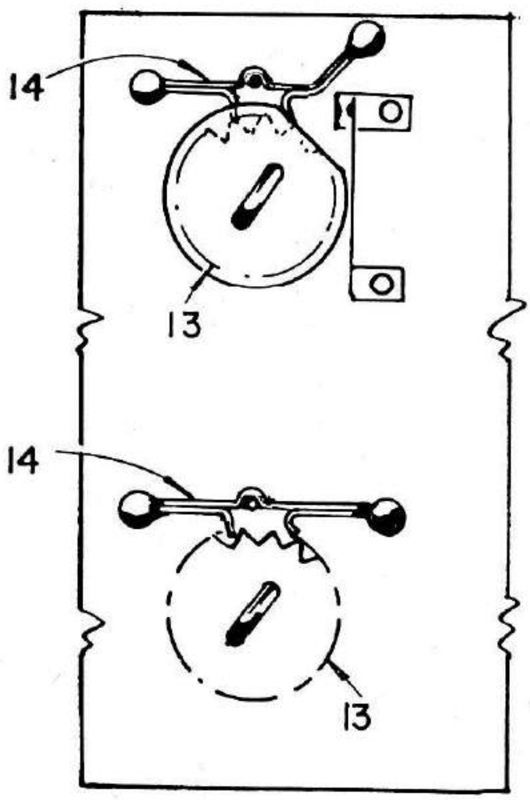
1. Baseplate 1/16 in. paxolin.
2. & 2a. Front bearing plates 1/16 in. paxolin.
3. Spacers ⅛ in. I.D. brass tube, 6 off.
4. Crankshafts 16 s.w.g. piano wire, 2 off.
5. Spacer 16 s.w.g. brass tube, 2 off.
6. Crank carriers (ex 16 s.w.g. brass bush), 2 off.
7. Yoke 18 s.w.g. piano wire.
8. Torque shaft 16 s.w.g. piano wire.
9. Rudder claw 18 s.w.g. brass.
10. Elevator claw 18 s.w.g. brass.







11. Armature 18 s.w.g. soft iron, 2 off.
12. Magnet core 14 s.w.g. soft iron, 2 off.
12a Bobbin, ply or paxolin.
12b. Spacer 18 s.w.g. alum.
13. Star wheel (ex-alarm clock).
14. Pallet (ex-alarm clock) or tinplate.



armature about 1 mm. from the magnet core. Adjust this by bending the spring and stop. Both ends of the armature may have to be bent or filed so that the claw arms will either just pass by or be arrested.

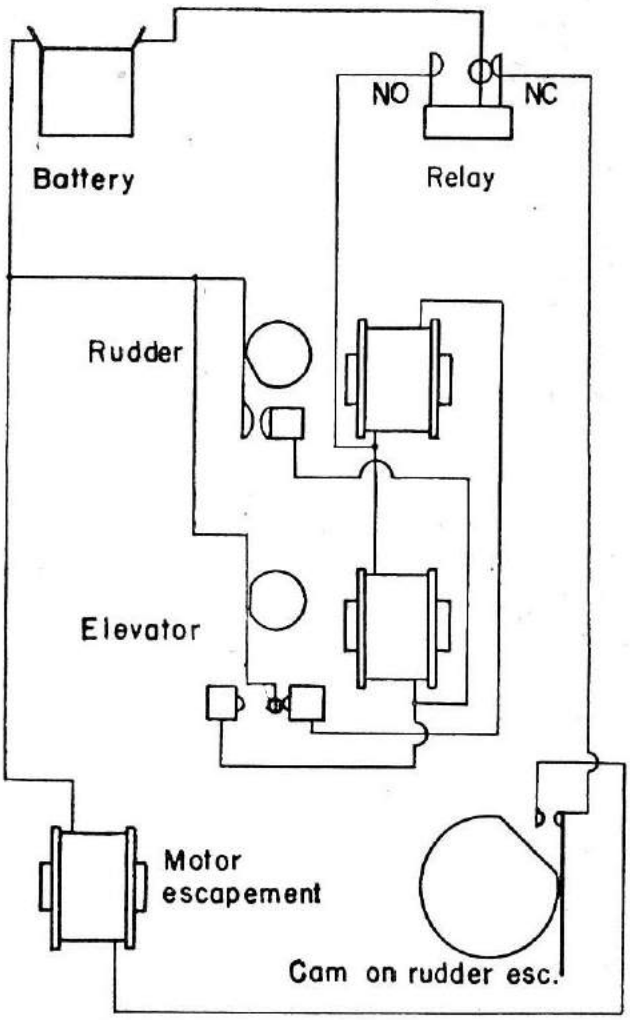
Satisfactory working of the relay depends entirely on this, so the utmost care must be taken in adjusting. Part 6 must be fitted so that it closes its contacts at the end of part 10. This can be achieved by bending the contact arm. Fit the contact assembly behind the rudder escapement making certain that the rear cam makes no contact with the top part of the contact arm.

Next assemble the elevator escapement. The starwheel is soldered to the bearing spindle and the remainder the same as the rudder escapement. Next rivet the contact assembly to the bearing plate with hollow rivets. Repeat for the elevator relay, fit crank carrier so that it is close with the crank wire in the neutral position, and the claw vertical. Solder the various connections according to the wiring diagrams.

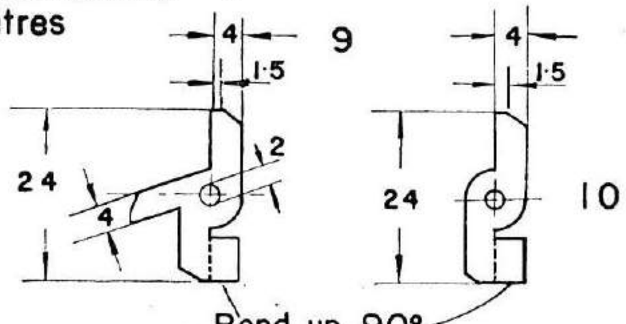
Test the escapements with the appropriate rubber motor (for each escapement use two strands of 1/24 in. × $\frac{1}{4}$ in. or six strands of $\frac{1}{16}$ in. × $\frac{1}{16}$ in.) loose between hooks.

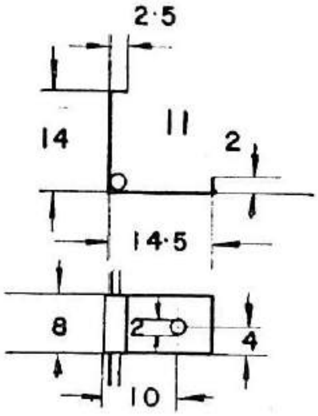
When, on giving the appropriate signal, the rudder escapement is found to work satisfactorily, the delay unit (starwheel and pallet) can be adjusted. If the pallet does not move correctly, its claws may be filed carefully. Check for consistency and smoothness.

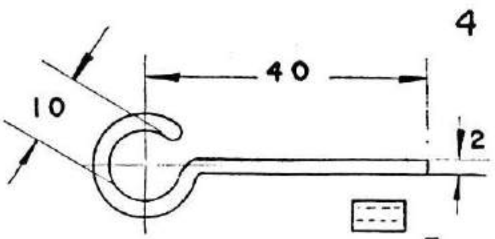
After obtaining satisfactory results with the rudder proceed to check the elevator escapement. Here again test it first without the delay unit and then with. As the elevator escapement is actuated via the rudder escapement care must be taken to see that the contacts are made in the appropriate positions.

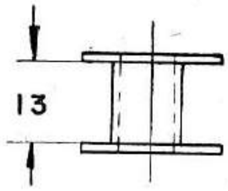


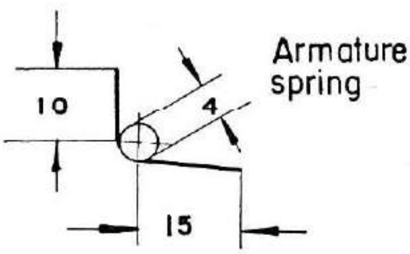
All dimensions in millimetres

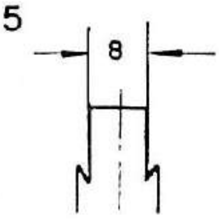


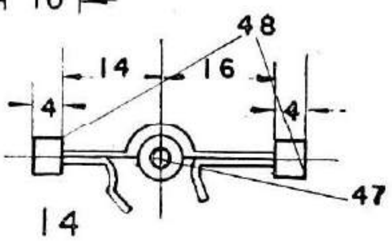


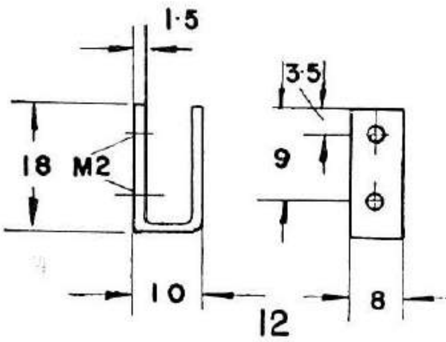


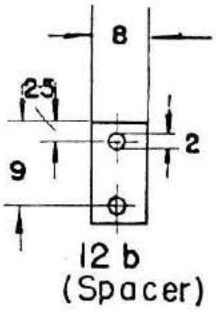


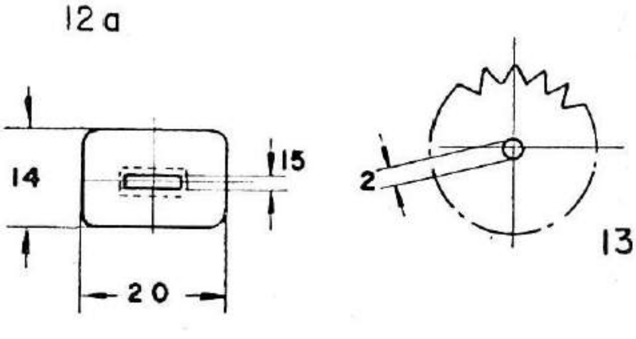












Modulation Technique . . .

FOR SIMULTANEOUS MULTI-CHANNEL CONTROL

By

H. CUCKSON, A.M.Brit., I.R.E.

In Part 3 the author gives further practical circuits and notes on commercial applications

IT is now considered that the blocking oscillator tone generator, popular a decade ago, is unsuitable. Although its output waveform can approximate a sine wave under certain conditions (6), it is unstable and its frequency varies with H.T. voltage.

The most suitable sine wave generator for those unable or reluctant to wind inductances is the C.R. phase shift oscillator. This has been described recently by Sills (7), but a point not mentioned is that in its common configuration using low gain battery valves it is not always successful. The attenuation of a three-stage network is such that a stage gain of 29 is required to produce a loop gain of unity when oscillation will be just maintained. When it is considered that a typical valve (1S5, 1L5, etc.) has an audio gain of 35—40 under optimum conditions, clearly there cannot be much gain in hand. This situation can be improved by using a "tapered" or "graded" network where the impedance of each C.R. cell is progressively increased towards the grid of the valve (Fig. 1).

FIG. 1

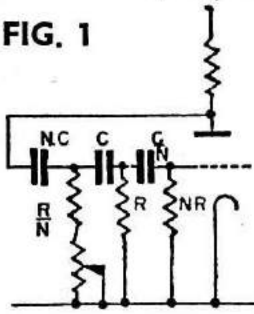
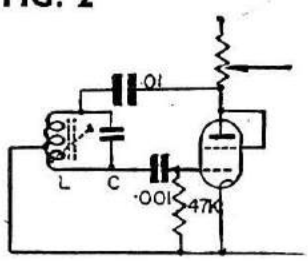


FIG. 2



With a ratio of 17 ÷ 2, a gain of only 12 is necessary and this is well within the capabilities of the valves mentioned above. The stability of this type of oscillator still leaves a little to be desired, especially for reed work, but it can be improved by stabilizing the screen potential with a small neon.

A method which has found favour with at least two manufacturers uses a transformer as the anode load. If the secondary is unloaded it will behave as an inductance so that ideally the anode voltage will lead the anode current by 90°. The remaining phase shift of 90° can be achieved with two sections and correspondingly less attenuation.

Until comparatively recently, low frequency oscillators using tuned circuits were unpopular because of the bulk of the inductance and the uncertainty of achieving the designed inductance value. However, due to the introduction of ferrox cores, inductances can be easily wound, with values of several henries, small physical dimensions, calculated tolerances, and, a high Q factor, the latter quality being essential for good stability. Such a circuit used in conjunction with a valve operating under conditions of negative resistance has produced a tone generator of high stability for use with a reed set and is used in a popular commercial equipment which is enjoying a lot of success. The circuit was published recently in the pages of the *Aeromodeller*.

The somewhat newer adjustable ferrox cores, "Vinkers" are ideal for the higher audio ranges, i.e. > 5 Kcs. and these can be used successfully with well-known oscillator circuits, i.e. Hartley, etc. (Fig. 2).

Mixing the Tones

The simplest method in use is to common the outputs through isolating resistors. The objection to this system is that complete isolation of each oscillator is not possible and inter-modulation can occur.

A better method is to use the summing amplifier which employs negative feedback to produce a virtual earth at the input terminals (Fig. 3).

The summing amplifier output is the negative sum of the input voltages, it

FIG. 3

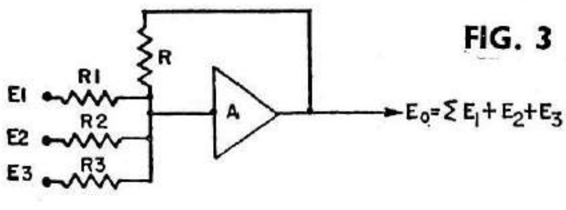
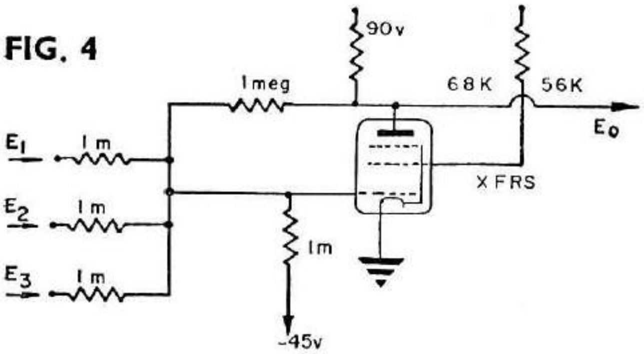


FIG. 4



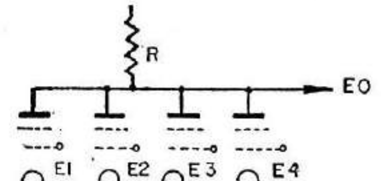
should also be mentioned that it is possible to multiply any of the input voltages by varying its input resistance with respect to the feedback resistor.

N.B.—There is no coupling between the tone generators.

A practical circuit is given in Fig. 4.

An expensive method uses one valve or transistor per channel but with the anodes or collectors commoned into the load (Fig. 5).

FIG. 5



There is no coupling between the tone generators, but triodes must not be used because inter-modulation will occur. Pentodes or transistors being constant current devices are ideal.

Some Practical Circuits

A circuit similar to Fig. 6 was described by the writer in the *Aeromodeller* six years ago. It was subsequently modified to the form shown and was used for several years by two of our leading exponents.

It will be seen that it consists of a self-excited Colpitts oscillator 958A anode modulated by a 3A4, transformer coupled. Other points of note are the phase shift oscillators of the "graded" type and the stabilization of the screens of the IT4S. Mixing is achieved by two isolating resistors and the combined signals are applied to the modulation via a potentiometer which is adjusted to give the correct modulation depth.

Fig. 7 shows another circuit intended for reed operation.

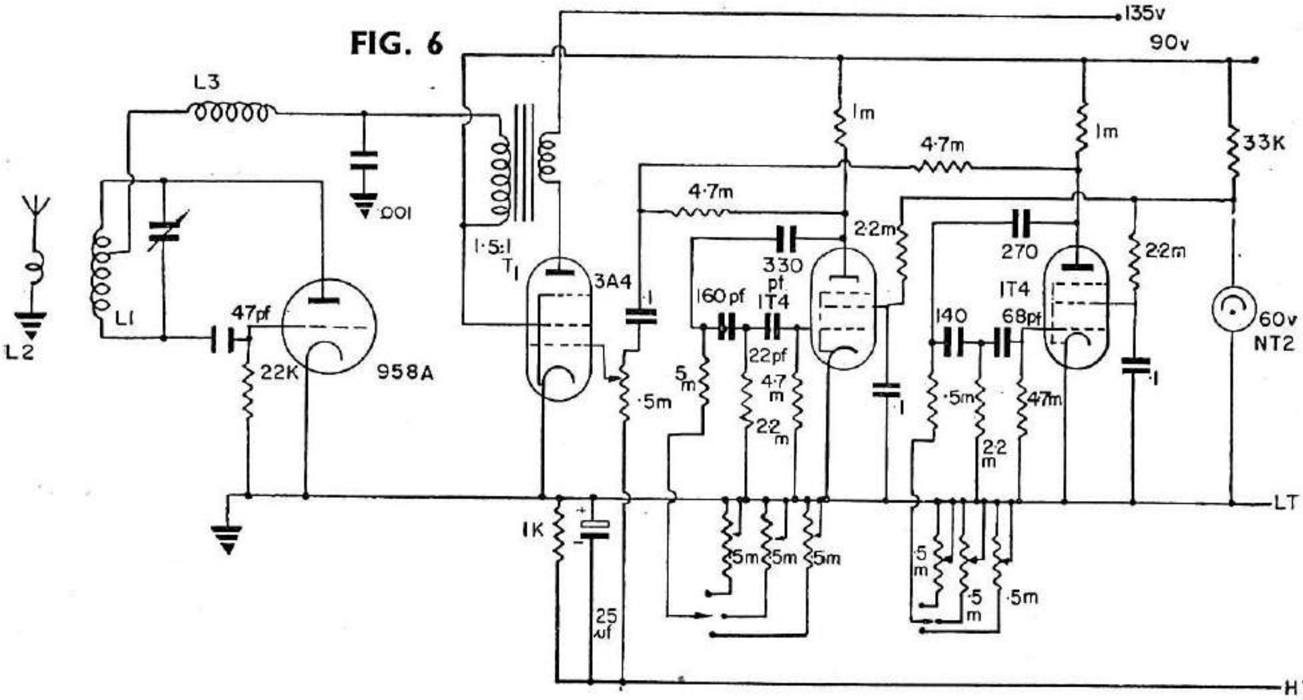
It features a crystal oscillator 3A4, screen modulated by a 3S4. The tone generators once again are phase shift oscillators but of the inductance load type, and are stabilized by a neon. Tone mixing is similar to that in Fig. 6.

It is noteworthy that less audio power is used in this circuit, presumably because a modulation depth of less than 100% is intended.

The circuit of Fig. 8 shows a transmitter which is considerably more complex than the previous circuits, and is intended for high speed pulse operation of subcarries of 6, 8, 14 and 20 Kcs.

The type of modulation employed here is grid bias modulation of a class C amplifier. L.C. tone generators IT4s run continuously and are fed into gating circuits (IR5s) which serve to interrupt the tone generators as demanded by the switching circuits and also to mix the outputs into the

FIG. 6



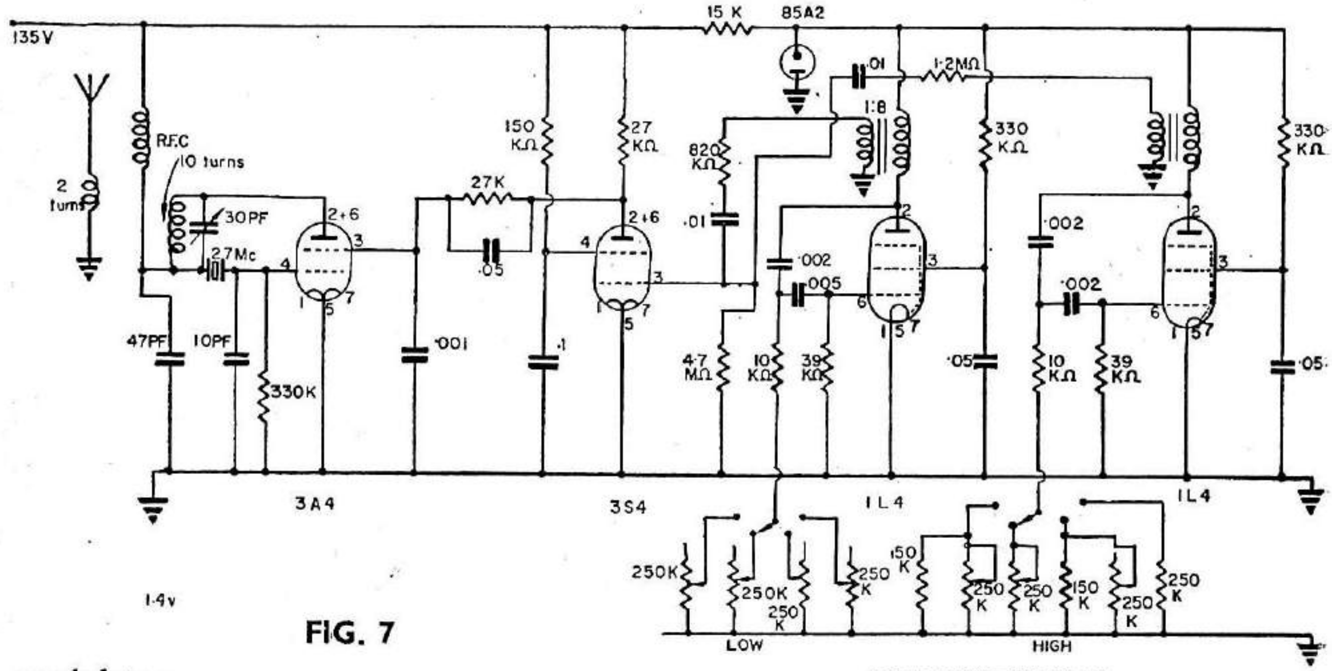


FIG. 7

modulator.

A particularly good example of "anode" modulation of a Class C amplifier is the Bellaphon Transmitter which was described in a recent issue of this magazine. Fully transistorized, the circuits and methods are analogous to those described in this series of articles, and it is worthy of closer inspection.

Finally should any reader be unwilling to modify his equipment to any one of the methods described above, there is always the time saving method, where the tones are transmitted sequentially at a frequency of 2—3 cycles (8).

Although this is by no means an admission of defeat, it should be noted that, due to the lags necessarily introduced in the reed/relay circuit, the fast manual pulsing indulged in by our leading exponents is degraded and some of the more subtle manoeuvres are not possible.

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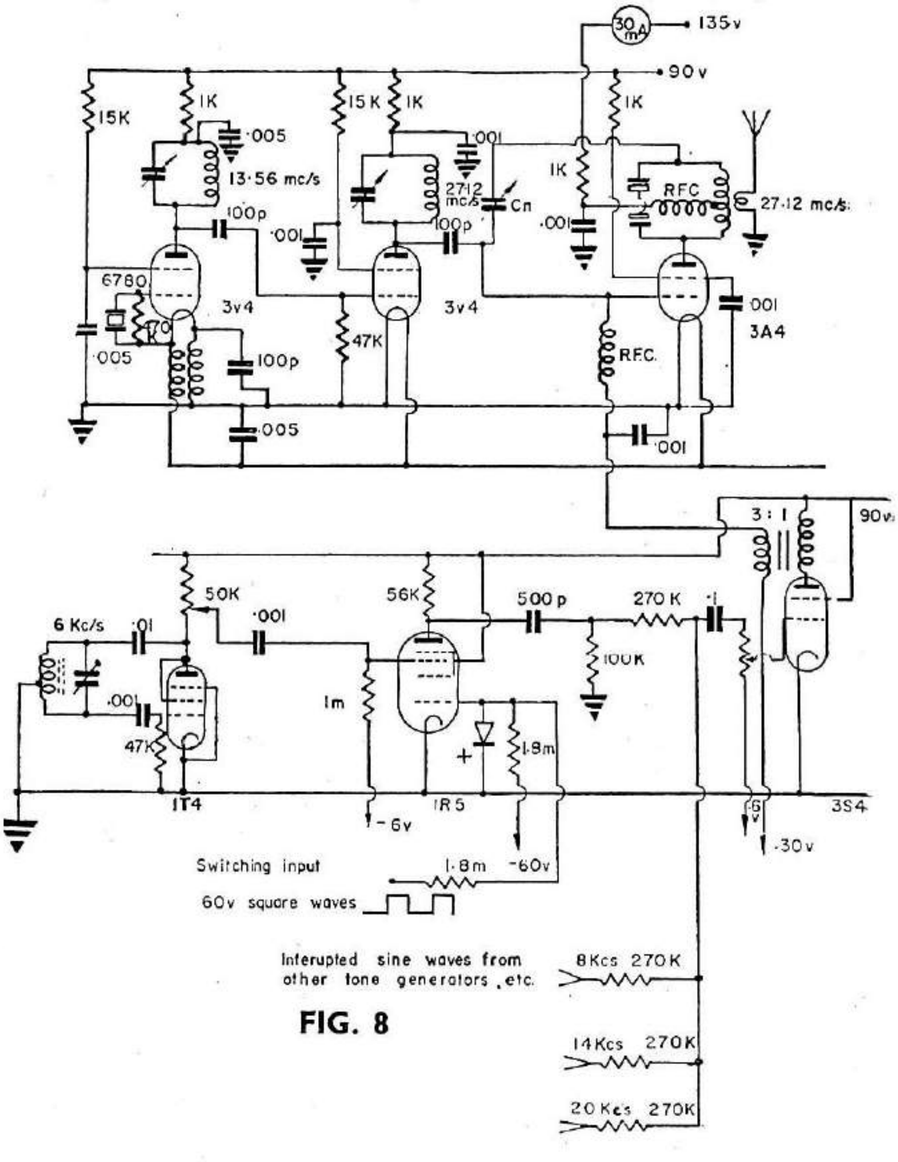


FIG. 8

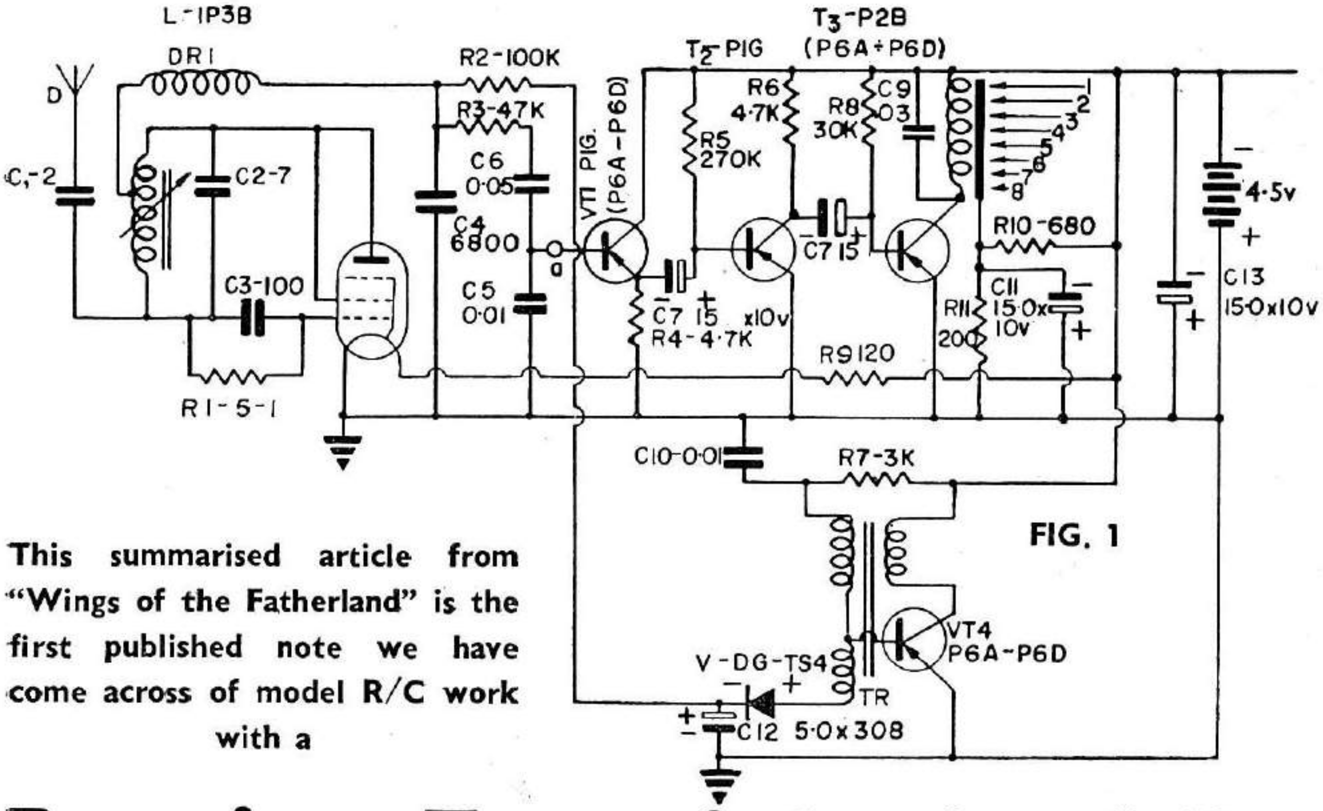


FIG. 1

This summarised article from "Wings of the Fatherland" is the first published note we have come across of model R/C work with a

Russian Transistorised Rx.

THE diagram of the receiver containing an eight-channel apparatus (Fig. 1) is similar to the diagram of the receiver described in issue No. 2, 1959, of the journal *Wings of the Fatherland.* It differs only in the fact that a reed unit replaces relay and feed-back diode (similar to the Aerotone).

The receiver is mounted on a paxolin panel measuring 70 × 130 mm. and 2–2.5 mm. thick. The valve V, the transistors (semi-conducting triodes) Vt_1 — Vt_4, the transformer T, and the reed unit R.U. are distributed on the upper side of the panel, on the lower side are situated all the remaining details, including the coil of the super-regen.

The coil L (Fig. 1) has 17 turns 0.5 mm. on a dust-cored former. The former is made of organic glass with a thickness of 1 mm. The dust core times in the frequency range of 27-29 megacycles. The core is equipped with a spindle with a handle for adjusting, in the form of a star.

The choke DR1, has 50—70 turns of enamelled wire 0.12 — 0.15 close wound.

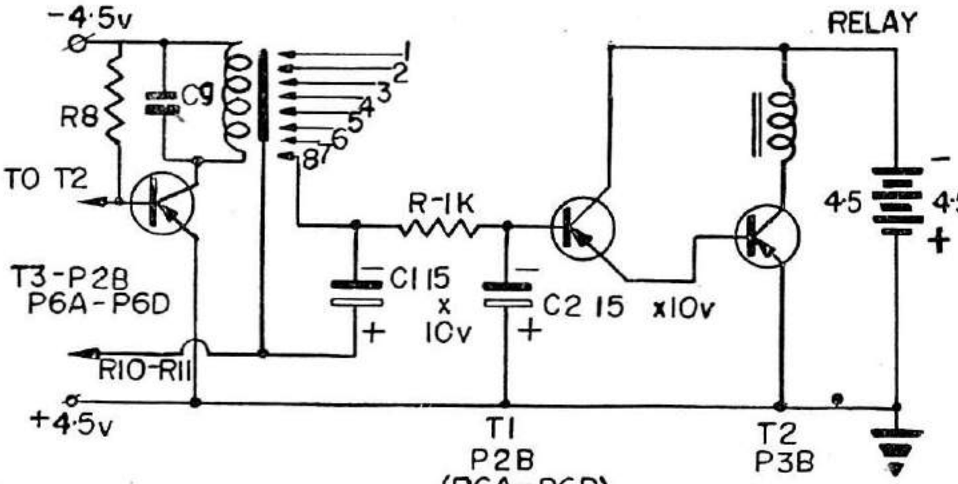
The transformer TR. is wound on to a permalloy doughnut (toroidal) core with an internal diameter of 12 mm. The cross section of the core is 0.2 sq. centimetres. Coil 1 has 80 turns of enamelled single silk covered wire 0.2, wound in one layer around the toroid. The coils II-III contain 80 turns of this same wire.

With several modifications, the reed unit from the receiver RUM-1 can be used. The coil of the reed unit in our case is wound full with enamelled wire 0.12 — 0.15. It is also possible to use the reed unit described in *Wings of the Fatherland,* No. 4, 1958, but with those modifications as for the relay RUM-1.

Before connecting to the receiver, the source of supply (KBS—0.5) must be made accurate not only as to voltage but also in the correct polarity. In contrast to the electronic valve, where any alternations of the source of the anode voltage, the current in the anode circuit of the valve is broken, the current in the circuit of the collector of a semi-conducting triode—when the polarity of the voltage is altered (that is when feeding the positive voltage into the collector) increase very rapidly. Therefore, if the leads of the battery are wrongly connected, the transistors will be put out of action.

Besides this, before connecting to the battery supply, it is necessary to check the accuracy of the mounting carefully, and the reliability of the contacts between the transistors and the remaining details. Before making connection the supply must be switched off.

FIG. 2



When checking the operating condition it must be remembered that transistors carry the shock of a current badly. Because the receiver described has a sufficiently rigid mounting, the test prods of the measuring instruments can accidentally come across at the same time two rows of wires, with different potentials, which often causes the transistors to be put out of action.

For efficient working of the audio-frequency amplifier CH of the receiver (the feed at point "A" from the audio frequency oscillator is 10 mv. with a frequency of 2/300 c.p.s.) the reed unit must operate reliably. If the telephones are connected in parallel to the R.U. a loud tone can be heard distinctly. If the tone is not heard then one of the transistors may be faulty. When the R.U. is not working reliably enough, it is necessary to vary the value of the resistance R_8 for VT4 biasing.

In order to exclude any possibility of fixing faulty transistors in the receiver they are checked beforehand according to the diagram shown in Fig. 4. Having gradually increased the strength of the resistance R_2 (when switching on in the diagram of the triode the slider of the potentiometer must be situated in the lower position) the dependence of the current of the collector is found from voltage between the base and the emitter.

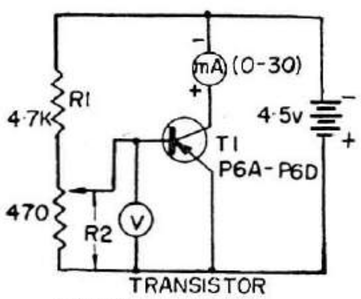
With an alteration of the voltage (base—emitter from 0 to 0.25 volts) the current of the collector changes from 0 to 10 milliamps.

What are these faults? (1) When the slider of the potentiometer is in the lower position, the needle of the milliameter swings to the limit of its range. This is evidence concerning a short circuit in the inner triode. (2) After switching on the triode the collector current spontaneously slowly increases. (3) The current of the collector is affected by light taps on the body of the triode.

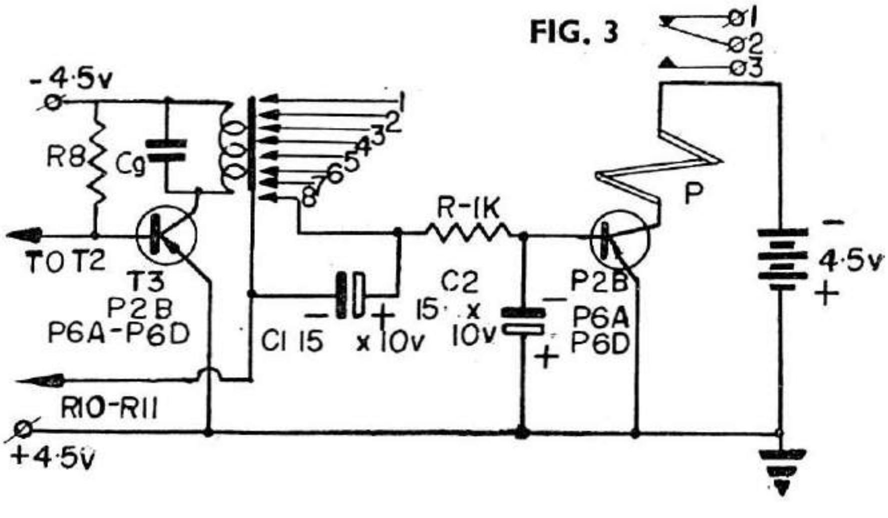
The latter fault acts particularly destructfully during the operation of the engine due to vibration.

If a power relay is used as the operating mechanism in the multi-controlled apparatus then these connections are carried out as shown in Fig. 2. In this instance a negative voltage is produced during the vibration of the appropriate reed of the R.U. at the base of the triode P2B (P6A—P6D) across the filter

FIG. 4



TRANSISTOR CHECKING CIRCUIT.



RC. The triode P2B works as an emitter follower. The output from the mitter of this V.T. is connected to the base of the power V.T. type P3B in the collector circuit of which is included the coil of the actuator.

When the resistance of the winding is 50 Ω the current passing (during the vibration of the reed) is equal to 80-100 milliamperes. In this instance the current in the circuit of the appropriate reed is equal to 0.6-0.8 milliamperes, which prevents any burning of its contacts. When the reed is not vibrating the collector current is equal to 1-5 milliamperes.

When the steering device from the apparatus RUM-1 serves the 200 Ω relays operating mechanism, then it is necessary to switch on according to the diagram in Fig. 3. The low resistance relays, type RSM, work excellently in this instance as an intermediate relay, because the collector current of the appropriate terminal, when vibrating is equal to 20 milliamperes.

But what is to be done, if the electronic relay, assembled according to the diagrams in Figs. 2 and 3 does not produce in output the necessary change of current? In this instance it is necessary to decrease a little the resistance of the filter R_1 having in view that the transistors, as also the electronic valve operate reliably only when the voltages, the currents and the power dissipated in the electrodes, does not exceed the permissible values.

The limit voltage in the collector is usually indicated in the data for the transistor. Regarding the maximum power of dissipation and the maximum current of the collector, these parameters are closely linked with the temperature factor of the transistor and must not allow overheating.

The full supply of the receiving apparatus (Fig. 1) is carried out from one small battery with a current consumption 45-50 milliamperes. This small battery can be used for feeding the electronic relay (Figs. 2 and 3).

Operation & Tuning of Xtal Controlled Tx.

Technical Bulletin by Noel Hill from "Relaytor" hectographed newsletter of New South Wales R.C.M.C. and really first class material !

THERE are now a number of crystal controlled transmitters in use and an almost equal number of queries as to how they work and how to tune them.

First let us discuss brieflly why crystals are used then a very brief description of the action of the crystal in its circuit.

There are quite a number of excellent self excited oscillators giving good frequency stability but when viewed over long periods of time, rough handling, and with an eye on future requirements there is no doubt whatever of the superiority of the crystal controlled circuit.

Types of Crystals

Several crystalline materials, such as quartz, rochelle, salts and tourmaline have the ability to produce an E.M.F. when mechanically strained, also there is a reverse action when an electric charge is placed across the crystal it changes its shape, this is called "piezo-electric effect". Of the crystalline materials mentioned quartz shows several advantages both mechanical and electrical over the others.

Now you can see that if an alternating voltage is applied across a quartz plate it will cause the crystal to vibrate and if the alternating voltage is made to coincide with the mechanical resonant frequency of the crystal, the vibrations can reach very large amplitudes.

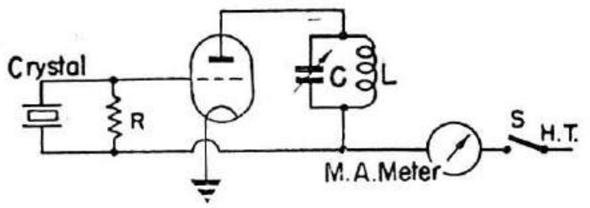
Before continuing, remember that it is not a whole crystal used, but a section of the raw quartz cut to certain dimensions and specifications, normally this will mean a small flat slab of the material. These slabs are cut from the mother quartz with reference to the axis of the crystal and have been given letters to indicate the type of cut, i.e. X, Y, AT, GT, etc. Each of these cuts exhibits some different characteristic to the other, but in the end one should end up with the three desirable characteristics of the piezo-electric resonators:—

(*a*) High Activity (ease with which oscillations can be started);
(*b*) Low Temperature Coefficient (smallest variation of frequency with temperature changes);
(*c*) Absence of Parasitic Oscillations (Oscillations or signals other than the one required);
(A departmental requirement).

The quartz plate can be mounted in a variety of ways, mentioning two: Mounted between two flat metal plates or the quartz metallic plated and leads attached directly to this coating, either way allowance must be made so that the crystal is free to mechanically vibrate.

Crystal Oscillator

Now let us see if we can apply the above information to a crystal oscillator, the circuit of which is shown:



This circuit is basically an amplifier, and in order to make it oscillate, it is necessary to provide a method of taking some of its output and feeding it into the input. This is done in our circuit by the capacitance that exists between the grid and anode of the valve. (This can be verified by a check with any tube data handbook).

The capacitor "C" and inductance "L" provide the resonant circuit, the crystal determines the operating frequency. Bias being supplied automatically by the resistor "R".

Suppose we see what happens when the switch "S" is closed the condenser "C" is charged it then tends to discharge through the coil "L". (This is the ordinary oscillatory circuit action).

By study of the circuit it will be seen that at the same time this voltage is built up it would appear across the anode and cathode of the tube and because of the capacity we spoke of earlier, the anode-grid capacity, this voltage, being of an alternating nature, also causes a voltage to appear across the grid-cathode circuit, which really means it appears across the crystal.

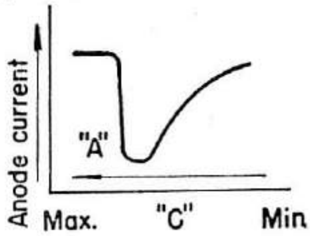
The voltage sets up an electrostatic field around the crystal causing it to change its shape mechanically. When the impressed voltage dies down the crystal returns to its normal shape, this in turn now produces a voltage across itself, thus across the grid and cathode of the valve.

This voltage is amplified in the anode circuit and some energy is feed back into the grid circuit, then across the crystal causing it to vibrate again, applying a varying voltage to the grid, this action continues until the circuit is switched off.

It is interesting to note that to produce stable oscillations in the circuit it is necessary to tune the output to a slightly higher frequency of operation than the crystal frequency.

It is a very easy circuit to adjust, there is little one can do to change the frequency or to adversely effect the frequency stability, tuning is mainly a matter of obtaining the optimum amount of power.

Using the milliammeter as the tuning indicator, and presuming that the circuit is not in oscillation, the meter will be found to give a steady reading, now rotate the condenser "C" through resonance, at the crystal frequency, it will be noted that there is a variation in the anode current on the meter, as shown in the diagram:



As the capacitor is increased from minimum there will be a gradual decrease in anode current when oscillations commence. This decrease continues until point A is reached when the current will rise sharply followed by a cessation of oscillations.

Now when power is taken from the circuit this dip is less pronounced, the greater the power output, the less the dip.

If this loading is still further increased oscillation will cease, this is because there is less and less voltage fed back to the grid circuit for excitation.

Amplifiers

If the transmitter being tuned is of the common MOPA, that is master-oscillator power amplifier type, the next step is to tune the amplifier stage. We will have to assume that the stage does not need neutralisation, that we are running in such a manner that the grid circuit is on a different frequency to the anode or that if the grid and anode are on the same frequency we are using a tube with a screen grid and/or it does not need neutralisation. A tube not properly neutralised will behave erratically.

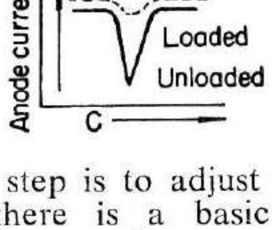
There is one more assumption we will have to make, that is that the correct grid coupling has been found by the manufacturer.

The transmitter is switched on and the anode tuning condenser rapidly tuned through resonance when there will be a very pronounced dip in anode current, this adjustment should be made quickly as the valve can be damaged by running it off resonance.

This off resonance anode current will normally be much higher than the rated anode current for the valve, up to several times as great, but at resonance should drop to 10 or 20 per cent of the rated value.

Before it was mentioned that we had to assume that the grid coupling was correct and delivering the correct excitation. The higher the excitation the greater will be the dip at resonance, if the dip in anode current is not pronounced the excitation may be low or the valve may need neutralising.

The output load circuit may be connected to the amplifier, that is the antenna, when the lead is connected the anode current will rise, the anode tank circuit should be retuned for minimum anode current again, this will now no longer be the low value as before, but a value somewhat nearer the rated anode current. The current changes will follow approximately the diagram:—



The last step is to adjust the antenna coupling—there is a basic rule here, start with the coupling very loose, then couple tighter in steps until one of these things happen—

1. The anode starts to glow or show colour (not likely with our small tubes).
2. The anode current reaches the maximum allowable for the tube.
3. The antenna current stops increasing with an increase in antenna coupling. (Not particularly helpful with our little transmitters unless you have a radio frequency ammeter, but this information has been included as a helpful tip those that have).

If the antenna current stops increasing with an increase in coupling before the anode current reaches maximum it shows that there is insufficient capacity in the tank circuit, take some of the L (less turns on the coil) out of the circuit to obtain resonance.

The L to C ratio can be checked thus:—Tune the anode condenser through resonance, and if the maximum antenna current occurs at exactly the same point as minimum anode current the C is correct, if not so, then more C and less L is required.

You will notice that the tank tuning is quite sharp without load but becomes broad when the load is increased, if the Q (circuit "goodness") is low it is quite possible to overcouple the antenna which reduces drastically the power output.

On the other hand there can be too much C in the anode tank circuit, this can be checked by measuring the minimum anode current without any load attached. By the minimum unloaded anode current does not fall below 10 per cent of the anode load when properly loaded there is too much loss in the tank circuit.

Provided the coil has low losses and has no high resistance joints there is every chance that the "C" is too high —the remedy is obvious, add more L and less C should be used to obtain resonance.

Remember the following:—

The tighter the antenna coupling *the more harmonies are radiated,* the lower are the losses in the anode tank circuit.

The tighter the antenna coupling, the higher the anode current, the greater the power output, the greater the anode losses.

ARE YOU LICENCED?

Just in case newcomers to Radio Control are not aware of it — you need a licence for operating remote control equipment. No tests, just fill in a form and pay £1 for five years cover. Application form and full particulars from Radio Branch, Radio & Accommodation Dept., G.P.O. Headquarters, London, E.C.1.

McQUERY COLUMN

DAVE McQUE WILL ANSWER QUERIES THROUGH THIS COLUMN EACH MONTH, AND WE WELCOME GENERAL INTEREST PROBLEMS. AT THE MOMENT WE CANNOT UNDERTAKE TO ANSWER QUERIES THROUGH THE POST, NOR SHOULD SETS BE SENT TO US UNLESS SPECIFICALLY REQUESTED.

REGARDING the Aerotone receiver, could I use the DL67 instead of the XFY34, and, if not, what changes should I make in the circuit?
L. P., MILAN.

The DL67 may be used in place of the XFY34, but it may be necessary to vary the grid capacitor or resistor in order to obtain maximum sensitivity.

Reduce the capacitor (not below 15 pf.) and vary the resistor from 1 M Ω to 4.7 M Ω.

I HAVE an E.D. crystal 6 complete. My Rx. works perfectly on five of the six reeds. But— (No. 5 REED SECOND LONGEST) pulls in on signal and stays put, even when one switches one returned to the off position.

Could this be residual magnetism, and what is the solution to this disconcerting problem?—J. E. F., LEIGH.

The reed unit of the receiver you have is made with a polarising magnet incorporated in the base and it is probable that increasing the airgap in the magnetic circuit by raising the reeds up and thus increasing the distance between them and the core of the coil would cure your trouble, this adjustment would have to be done very carefully as the increase in gap needed will be very small and too big a gap will cause lack of sensitivity.

As the unit is a commercial product, however, it is suggested that you contact the manufacturers before doing anything else as any guarantee they might give would certainly be voided if the unit was tampered with.

I WOULD like to know what length, diameter, and how many turns are on the R.F.C. for the Hill Tx. Also, of what material is the former made?
—G. P. C., MANCHESTER.

The R.F.C. for the Hill receiver is wound on an iron-dust former, the original is a proprietory make but a suggested substitute would be a "Radiospares" 2 amp. suppressor choke, stripped and rewound over its full length with 32 s.w.g. enamelled wire close wound. The former is about ⅞ in. long and ¼ in. dia.

I HAVE lately become interested in radio controlled model aircraft, and it would seem that the path to success is strewn with pitfalls. We are told to begin with a rudder only model and keep the model simple. However . . .

In my case there is no difficulty in building a decent model, being fairly widely experienced and lately, in middle age, having the time and money to indulge. A "Rattler" is on the stocks now. But what would be your advice to someone who does wish to progress through to multi-channel, and wishes to install the necessary radio in the first R.C. model and after gaining flying experience, progressively hook up the remaining controls?

I should also like to build my own radio gear, and am fairly widely experienced in this direction, having built domestic radio and Hi-Fi apparatus, but would say that my theoretical knowledge is that of wireman standard only.
—A. T. C. FILTON.

The pitfalls are by no means insurmountable and with the requisite amount of patience there is no reason why you should not be successful.

For myself I graduated through single channel as there was nothing else at the time I entered the ranks. As however, you have some knowledge of radio and also have a wide experience of model building, etc., I would say that "multi" is quite within your capability.

Reed systems are more popular and gear for this type of control is available from our advertisers, some of whom do kit their gear I believe. As regards actuators a survey appeared in *Aeromodeller* for December, 1959, and a further report in our first issue.

I would suggest that you obtain an eight reed unit in the first place and use three reeds to start with. Two for rudder and one for engine control. Additional channels can be included as you suggest once experience has been gained.

Some of the problems arising in "multi" are as follows:—Transmitter stability and modulation depth. Modulator frequency stability. Receiver gain, reed and relay contacts. Servo switching and batteries. Practice in the use of several controls is essential especially where elevator is included.

In the absence of some fail safe arrangement it is essential that each link in the chain is 100% and it will be obvious that it is necessary for the operator to make himself familiar with the operation of the R.C. gear and the effect on the control surfaces.

I AM having difficulty with my new Ivy A.M. Tx. as featured in the October issue.

When the Tx. is keyed, in an attempt to back-tune the unit to a receiver which has already been tuned to a Tx. of known frequency, all I get is a kick in the needle of the Rx. meter. Another kick is apparent when the key is released. I have checked the circuit and valve filaments and all are O.K. To me it would appear as if the circuit was failing to trigger one half of the valve. This is pure speculation.

The unit is exactly as specified with the exception that the panel is double width to include a Reptone Modulator unit.—J. G. S., EDINBURGH 9.

You do not say which type of receiver you are using but from the contents of your letter it would seem that you are trying to control a tone receiver with a carrier transmitter.

If so all you would get would be a kick on keying with another kick on release.

I see that the panel has been enlarged to accommodate a modulator but you do not say whether or not it has been connected up. If so I would suspect that the Tx. is not being modulated and in such a case you should test the modulator and the modulator coupling.

I AM contemplating fitting radio control, steering and throttle in to a 6 ft. tinplate constructed model destroyer.

Would you be kind enough to give me your advice on the suitability of R/C in a metal hull, type of boat.

—D. L. R., PERIVALE.

With reference to your letter of the 26th September, provided the aerial is outside the hull and properly insulated there is no reason why the receiver should not function perfectly.

If possible arrange for it to be at right angles to the waterline and as long as possible without detracting from the appearance of the boat.

MY boat is driven by a Taycol Meteor electric motor. I recently purchased an OMU 205E Rx. but cannot use it because with the Meteor switched on the current rise is only 4 to 5 m.A. and dithers all over the place. (With motor switched off the current rise is about 8 m.A.).

An 0.1 condenser is connected across the brushes of the motor and I have tried varying a resistance in series with it from 0 to 100 ohms without any improvement.

Connecting the L.T. neg. to the prop. shaft of the motor makes matters much worse. An aluminium screen between motor and Rx. is also ineffective.

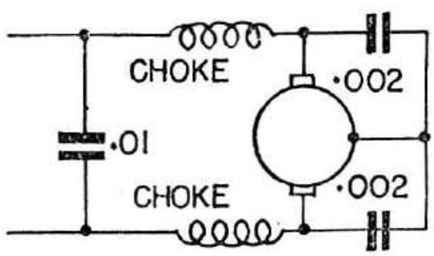
I do NOT get this interference trouble with my old Rx., an E.D. Transitrol, nor do I get nearly so much interference on the 205E when using a Sallis PM3 type motor or a 5U/2710 motor. However, I want to be able to use the much more powerful and efficient Meteor with the 205E, which if only the interference can be stopped, has a much greater range than the Transistrol.

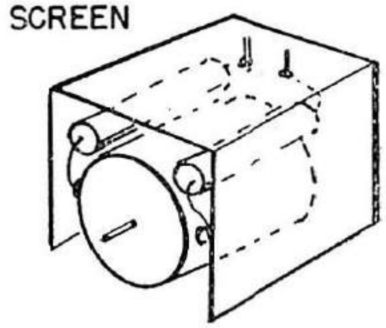
Can you please tell me how to do it?

—G. F. B., WINCHESTER.

It's a hard life! As soon as you get a more sensitive Rx. it picks up more motor noise. The only effective way to deal with this sort of interference is to suppress it at its source. With these low voltage motors chokes in series with the leads are by far the most effective way of suppression.

The chokes can be made by rewinding T.V.I. suppression chokes (Radiospares) so as to put twice as many turns on as they have when bought. There were two sizes of these 1 amp. and 2 amp. and the latter works quite well with actuator motors. A 5 amp. model has been introduced now and although I have not yet seen one, is similar to the smaller ones, i.e. single layer winding on a dust iron core; it





would be the best size for your heavy current motor.

The chokes should lie horizontally spaced by their diameter from any metal surface. For really complete suppression the motor could be completely enclosed in a light alloy case, with clearance for the chokes and the connections brought out via 1,000 pF. feed through capacitors.

Other points in reducing interference are:—

1. Keep Rx. batteries and wiring away from motor and its batteries and wiring.
2. Use a vertical aerial well away from motor.
3. Use an insulating coupling between motor and prop. shaft.
4. Bending or earthing everything in sight unless accompanied by elaborate filtering and screening can often make matters worse I have often found. Choke the noise at source and try the other things, one at a time, to clear up any residual.

IN the June issue on pages 89 *and* 91 *Potpourri of Gadgets and Gimmicks is described under item B a motor driven actuator. I have made this and it gives selective left and right very satisfactorily. I would like to add engine control to be achieved by "press, press and hold" NOT quick blip. Can you please indicate correct position of third brush and insulated parts on gear wheel ?*—G. F. B., WINCHESTER.

With reference to your letter of the 20th August may I suggest that your proposal to using a two pulse and hold signal is not the most satisfactory way of achieving engine control.

In the process of sending signals for right and left rudder (particularly for aircraft) one does not want to include a complicated signal for this control. This has been proved in practice where quite often it is necessary to change engine speed quickly whilst using the rudder control. Also the quick blip method is simple to include that the trouble of the other is not worthwhile.

With the first method you rotate the gear until the rudder is at the second neutral place. The position of the outer brush will indicate where the insulating point is to be. The third brush can be fixed anywhere so long as it makes contact when the gear is in this second neutral position. However, you will find that a current is present whenever you pass over this position and the use of an actuator here would be no good.

With the quick blip method all you do is rotate the gear a fraction away from the first neutral and arrange the third brush to make contact at this point. The third brush, however, is connected to the back contact of the relay so that it does not conduct for normal signalling. Engine control is applied therefore only when a quick blip is sent so that the relay back contact is restored before the third brush makes.

I HAVE been using five DEAC cells, type 225, *with my Cobb Hobby Selector* 4. *This has a* 7½ *ohm coil, described as low drain by the retailer, and I found that two active flights of about ten minutes each exhausted the cells.*

I now find that three of the cells are oozing a liquid past the gasket, which is turning the casing black.

Presuming the cells have had it, and confident that the charging rate was as specified, could the high discharge rate be responsible ? Can they be repaired ?

—C. D., TIVERTON.

With reference to your letter of the 27th August I am afraid the cells you are using are not capable of supplying the current needed for the Selector 4 for any great period.

If in fact the coil is 7½ ohms with 5 cells in series (i.e. 6 volts) you will get a discharge rate of 800 m.A. As the cells are type 225 they will only give 225 m.A. for one hour. The maximum you can expect at 800 m.A. will be just over 15 minutes continuous use. I should have thought that two flights of 10 minutes, when the actuator is not on all the time, would not have exhausted the cells, but they are probably not fully efficient now.

Although you have not exceeded the charging rate these cells begin to gas when fully charged at their normal rate and will force a leak by pressure alone. This is what is happening in your case and the electrolyte is now creeping out thus reducing the effective capacity.

In the absence of a constant voltage charger the only way is to trickle charge at say 5 m.A. when due to a side effect the current merely passes through the cell when it is charged without affecting it.

I am afraid they cannot be repaired when damaged.

I INTEND building myself a new Tx. and am undecided whether it shall be the "Simpletone" or the "Versatile".

I want it to fulfil the following requirements:

(*a*) *It shall be crystal controlled.*

(*b*) *I would prefer it to be 'hand-held'.*

(*c*) *I would also prefer the Tx. to be capable of plain CW and 'Tone' signals, as I already have three ordinary super-regen. Rx. which I do not wish to scrap, whilst at at the same time, I intend build- a 'Tone' Tx.*

(*d*) *It should have sufficient range for model aircraft work. As I see it, from the circuits and description of "Simpletone" and "Versatile" neither meet all the requirements. "Simpletone" meets requirements* (*a*), (*b*) *and possibly* (*d*). *"Versatile" meets requirements* (*a*), (*b*) *and* (*d*).

Could you advise me, please, on the following points:

1. *Could any simple modifications be made to the circuit of "Simpletone" to enable it to comply with* (*c*).
2. *What is the range* (*in the air*) *that can be normally expected from "Simpletone"?*
3. *Could "Versatile" be built as a hand-held Tx. and if so, would the circuit need any modification if the aerial was reduced in length to say five feet, and how would this affect the range?*

I realise I am asking a number of questions, but would be very grateful for the benefit of your expert opinion and advice.—K. B., ACOMB.

To convert "Simpletone" for CW replace 47 Ω across meter socket by push button and pull audio valve to save L.T.

Range depends on Rx. sensitivity—should be at least 200 yards—fly upwind to check range. To convert "Versatile" for shorter aerials replace C15 with a short and connect aerial to a tap on L5. The shorter the nearer to V2 anode.

Remove R7 and connect C16 1 to 1½ turns up on L5 from earth.

I HAVE built your Quetone Rx. circuit —it doesn't work.

The kit, less valve and relay, I bought from Fred Rising.

The transistors are S.T.C. T31, purchased from George H.R. in an Aerotone kit; these transistors tested as per your test circuit — "Aeromodeller", January, 1959—show a slight leak .2—.3 milliamps.

The condenser C4 I connected wrong way round—I thought black end would be neg. in absence of red.

I have renewed C4....

The result when I switch on Rx. is a standing current of 10 m.A. with 300 Ω relay and 25 mfd. condenser. Also have Tx. (*carrier*) *switched on or off makes no difference, when I key tone on Tx. the current rises slightly.*

When I connect a self-exercited headphone into Rx. without Tx. there is a very loud rushing or crackle.

When I key tone the note can be distinguished and the noise is deafening.

Also I have two pukka V10/30a transistors, are these O.K. to use in the above circuit?

—F. C., TWYFORD MOORS.

Your set sounds to be working too well. To reduce the standing current with the Tx. switched off replace either one or both TR's. with lower gain specimens. (Fred usually supplies a suitable tested pair.) Alternatively increase the values of one or both 0.003 mF. capacitors to 0.005 mF. or even 0.01 mF.

If the current does not drop when an unmodulated carrier is tuned in then you have a noisy valve, transistor or other component in the early stages which can be found by substitution.

Introduction to TRANSISTORS

In Part 6 Dave McQue discusses the common collector or emitter follower connection.

In this arrangement the input is applied between base and collector and the output taken between emitter and collector. It gives no voltage gain but does provide current gain. It can be used as a coupling device having a high input impedance and low output impedance.

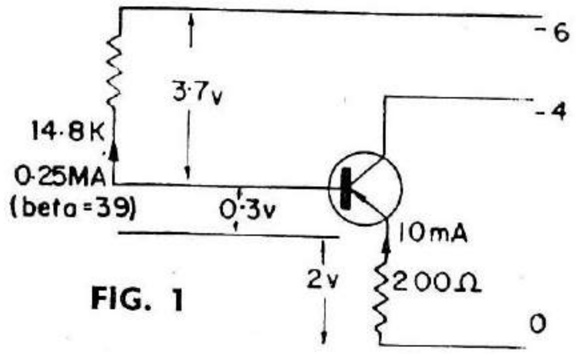


FIG. 1

Referring to Fig. 1 you will see that to produce a charge in load current of, say 10 m.A., only a change of $\frac{10}{\text{Beta} + 1}$ is required, for nearly the same voltage change across the load as is applied to the input. For most practical circuits the input and output voltage changes can be taken as equal with the input current equal to the output current divided by beta.

The reason it is sometimes called an emitter follower is because the emitter voltage follows the base voltage, i.e. as the base voltage goes more —ve so does the emitter unlike the common collector circuit where the collector voltage goes +Ve as the base goes —ve.

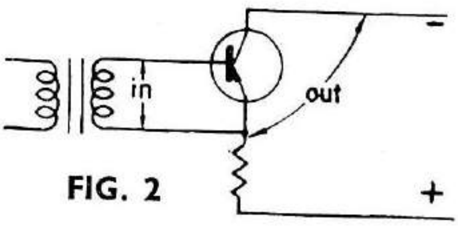


FIG. 2

This arrangement is not to be confused with a version of the common emitter circuit known as the bootstrap, see Fig. 2, where for convenience in a particular circuit the load is connected between emitter and battery +Ve.

Where the current gain of one transistor is inadequate, two can be cascaded to produce, effectively, a super transistor by means of the Darlington connection (see Fig. 3) where the labelled terminals are those of the super transistor having a current gain equal to the product of the individual gains.

We are not limited to connecting two PNP transistors or two NPN, it is

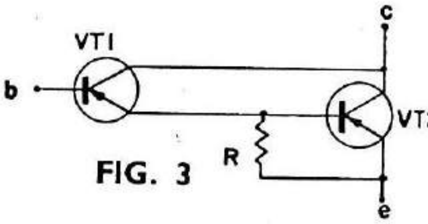


FIG. 3

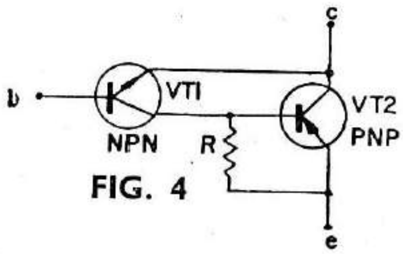


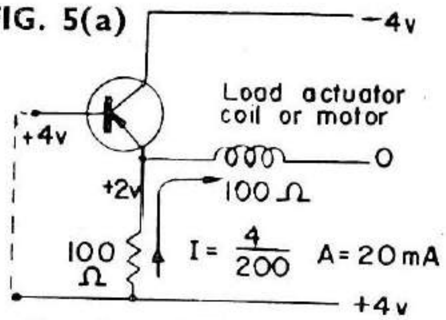
FIG. 4

possible to use one of each as in Fig. 4.

In a practical circuit VT1 can be a small transistor and VT2 a power type. R is required to cope with leakage currents.

Practical values of R lie in the range 100—470 Ω using the lower values when VT2 is a power type. With the V 15/20 IP a value of 220 Ω is satisfactory.

FIG. 5(a)



Transistor OFF current flows via R through load.

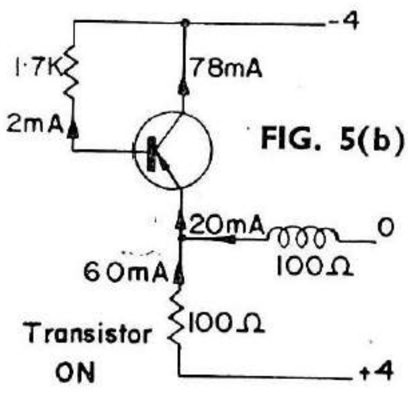


FIG. 5(b)

Transistor ON

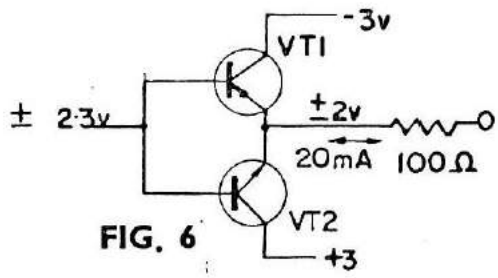


FIG. 6

To return to the emitter follower if this is required to supply large currents in both directions to an external load connected to the emitter. The load resistance must be adjusted to supply the load current as shown in Fig. 5(a). Although this gives only 20 m.A. in the directions shown when the transistor is turned ON, it has to pass a total emitter current of 80 m.A.!

An elegant alternative is to use a complementary emitter follower, Fig. 6. Here each transistor is switched on in turn and only passes the load current. I have used such an arrangement with VT1, OC76 and VT2, 2N35 to control a Micromax motor.

Supply voltage is limited to 1.3v. each way from single Deac cells in place of the 3v. of Fig. 6.

Do not use more or the transistors will be damaged if the motor stalls. It is unnecessary anyway and to obviate any risk of damage to motor or transistors, a resistor of 5 Ω can be added in series with the motor which will limit the stall current to less than 100 m.A. as in Fig. 8.

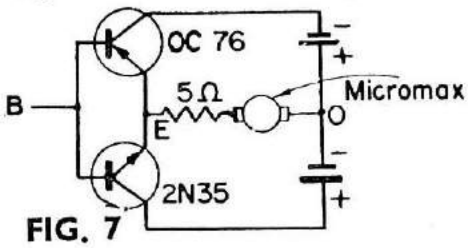


FIG. 7

When the input voltage is applied between B and O the circuit acts as an emitter follower and the batteries can be used to supply other similar circuits. However, if point E is made common instead of O we have a common emitter circuit with voltage as well as current gain, but it is then no longer possible to use the batteries for other circuits at the same time.

To supply the current requirements of other motors such as the Mighty Midget, Frog Tornado Ever Ready T.G.18 etc., the two transistors can be replaced by their 'super' equivalents by combining the circuits of Fig. 5 to give that of Fig. 8. This is the set up that

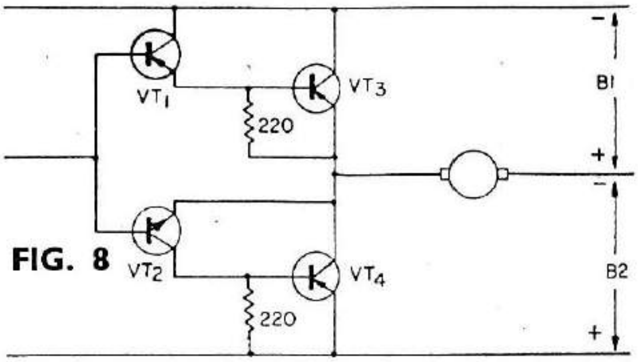


FIG. 8

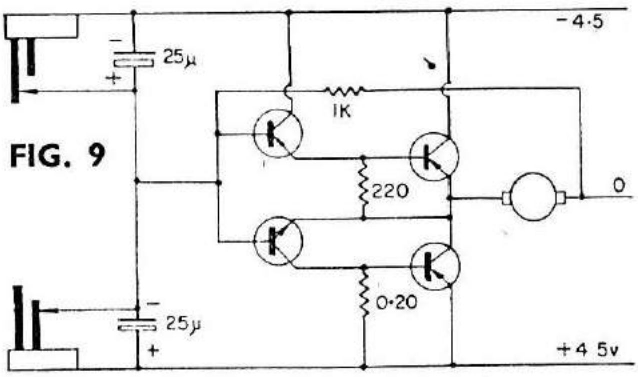


FIG. 9

Pete Lovegrove and I have used in place of a relay for 'Simpl Simul'. For this purpose VT3 and VT4 are V 15/20 IP and B1 and B2 are 2.6v. each obtained from a total of four DEACS. For VT1 we have used V10/30, OC 71, etc. and for VT2 a 2N35. A load current of up to 500 m.A. for an input current of 1 m.A. in each direction is typical. It can also be used as the output stage of a closed loop servo and with a little modification as an audio output stage for feeding a loudspeaker direct without the need for either input or output transformers. A reed unit could also be used to supply the input voltages but would require a split comb as in Fig. 9 which is for use with a spring neutralised servo of the Pike type. A tentative circuit for a self neutralising servo is shown in Fig. 10. This is offered as a starting point as I have not yet had time to rig it up and test it.

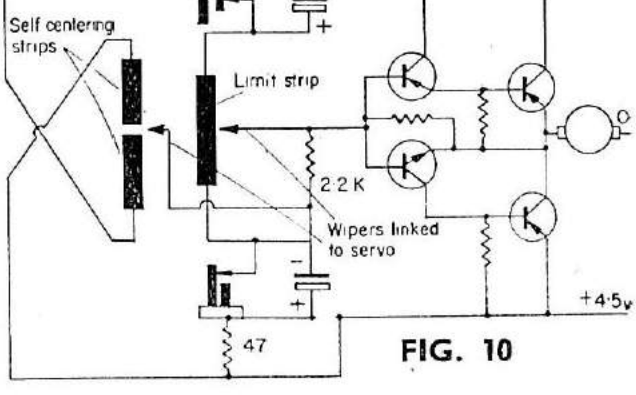
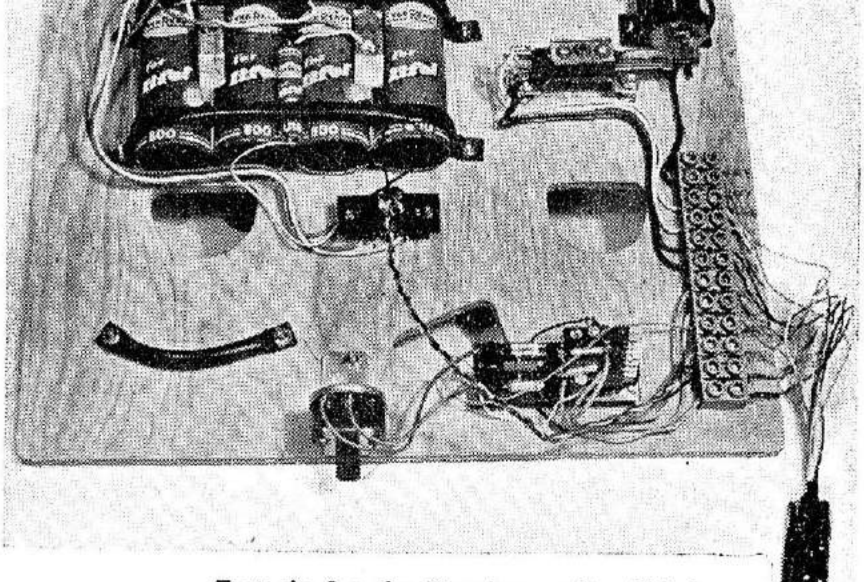


FIG. 10

D.C. Amplifier & Relay Eliminator



Test rig for the Mannings unit which is fully encapsulated and is shown on lower right of picture.

DEVELOPMENTS in the electronic field and in its application to model radio control are so rapid these days that one experiences no surprise when something new appears on the market.

Relays have long been the bugbear of the R/C modeller and it is gratifying to learn of the introduction of a really efficient D.C. amplifier which completely replaces the relay. The makers are Mannings and although they are new to the model world there is nothing new about their approach to the problem.

The unit which is the first of a number of miniaturised units for R/C work is extremely small and light in weight and will handle peak currents of 1 amp.

It can be used for single channel or multi, but for single channel with an escapement a simpler version with fewer transistors would appear to be desirable. The unit tested contains 5 transistors and 2 diodes, i.e. 3 OC 71's and in the output stage 2 OC 84's (switching transistors). Its size is $1\frac{7}{8}$ in. x $\frac{5}{8}$ in. x $\frac{1}{2}$ in. deep and weight is under 1 oz. It is completely encapsulated.

As it replaces two relays, from the point of view of size and weight alone it scores. When one considers other advantages such as complete reliability and virtual immunity from shock, absence of sparking contacts, etc., there can be no doubt as to its superiority. A further advantage is the fact that if two reeds for one servo make contact no damage can occur, but in the central position the motor is stalled and full current passing. This may be regarded as a minor point of criticism.

It is not a cheap unit but in view of its absolute reliability it is well worth the money. For those with a shallow pocket it is understood that a kit will be available and cheaper transistors could then replace the OC 71's. Also separate units which clip together and clip on to the Rx. can be purchased thus enabling the modeller to increase the flexibility of his control system by degrees.

The application of the present unit for various methods of control is as follows:—

Single channel—
- motorised actuator.
- escapement.

Single channel—
- Pulse systems (proportional) with signal on servo rotates in one direction signal off rotation in the opposite direction.

Multi channel—
- Each unit controls two directions of servo (i.e. 2 reeds or filters). Automatic centring on cessation of signal. If desired automatic centre can be omitted without alteration to the unit.

It thus replaces the relay in all its uses and does not call for a centre tapped coil for proportional control. It does need two servo batteries if it is desired to reverse the servo.

Brief details are as follows:—

Input current .... .75 m.a. max.
Peak output current .... 1 amp.
Steady current .... .5 amp.
Max. volts .... 5 plus. 5
Nominal volts .... 3.8 plus 3.8
Longest rise time on reeds— 20 milli. secs.
Longest rise time on reeds proportional .... 30 micro secs.

With suitable Tx. and Rx. simultaneous 4 channel is possible. Tested with a Mighty Midget servo the unit was 100% positive in action.

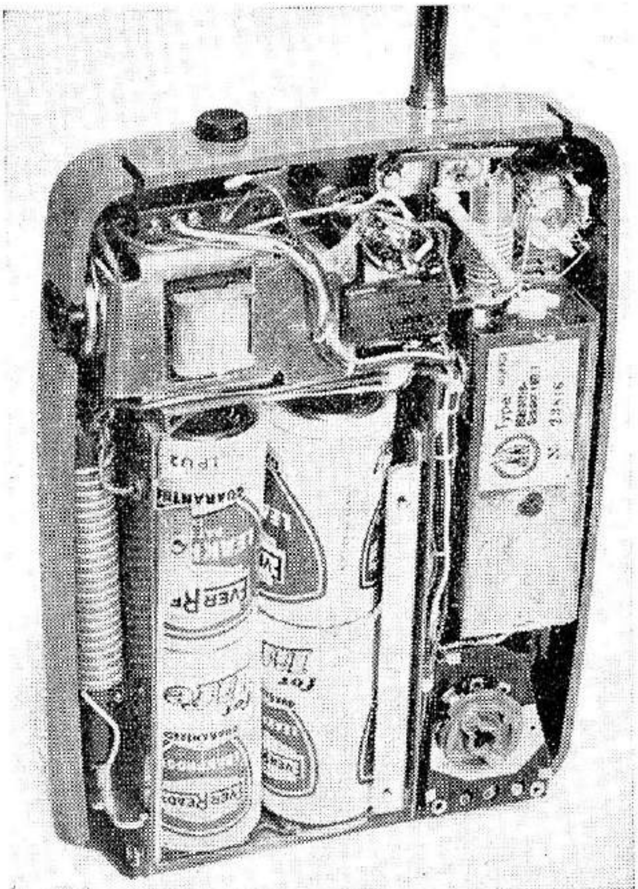
It is recommended for any use with every confidence.

Metz Mecatron Transmitter & Receiver

WITH 3-CHANNEL ADAPTER

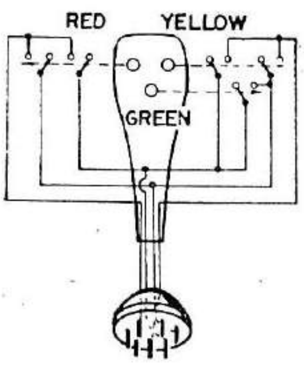
Digest of technical report by Hans Diete Heck of MODELL to whom we are also indebted for Tx. and Rx. circuits.

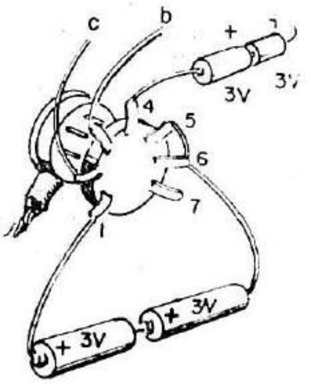
Above : Beautifully moulded Tx. case, with clip-in battery replacement panel removed. Below : More of the Tx. works. On right : Tx. with selector switch and Rx. with 3-channel adapter in place.

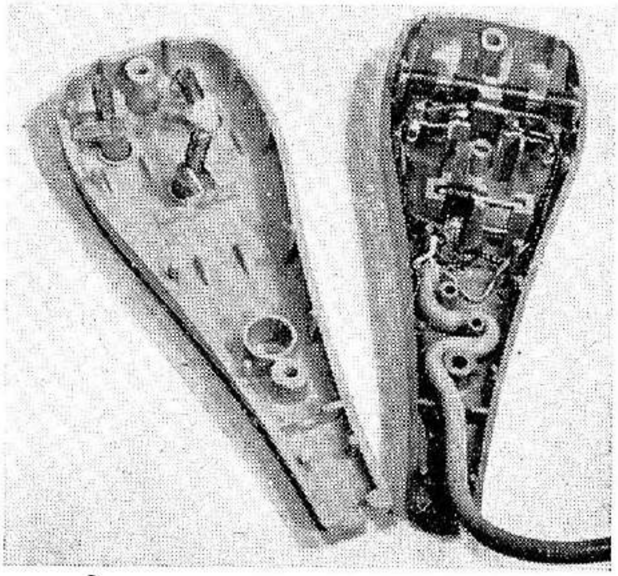


THE construction of the Mecatron opens up an entirely different development in the R.C. field, in which outfits can no longer be classified as either single or multi channel. The original Nuremburg Toy Fair description went something like this:

"Single or three channel without reeds, completely transistorised Rx, can be switched to three different channels, 3.5 Watt Tx. output from four Monocells, modulation tone so high that even the highest soprano couldn't reach it. Tx. without D.C. convertor or H.T. battery".







Above and right : Details of the triple-button channel selector, a particularly fine piece of equipment. Centre : Connections for the two 3-volt batteries for Rx. via one 7-tag plug. Below : Tx. circuit.

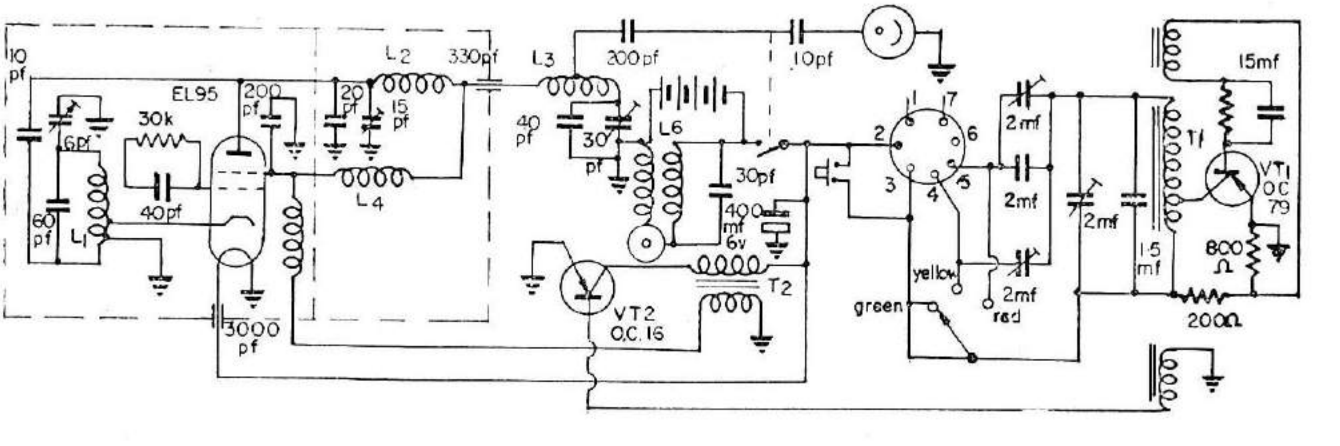
When the Metz people started thinking about designing their own R.C. outfit, they thought as we have a modulator in the Tx., why not use it to obtain three different tones.

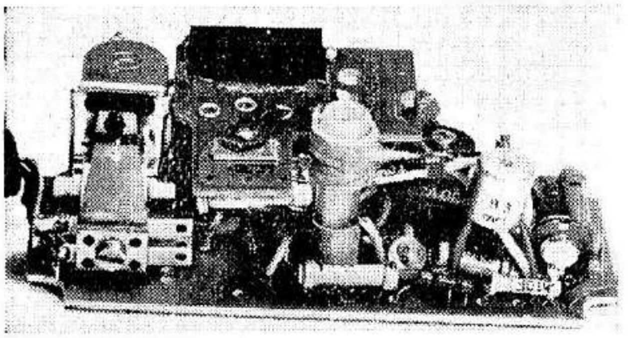
If one now makes the Rx. such, that it can be tuned to three tones, the way is opened to control one model on Channel 1 and a second model with a similar outfit on Channel 2. By making it possible to switch the Tx. modulation and equipping the Rx. in the same way, the three tones can be separated and each tone fed to a separate relay, the three channel outfit thus becomes possible.

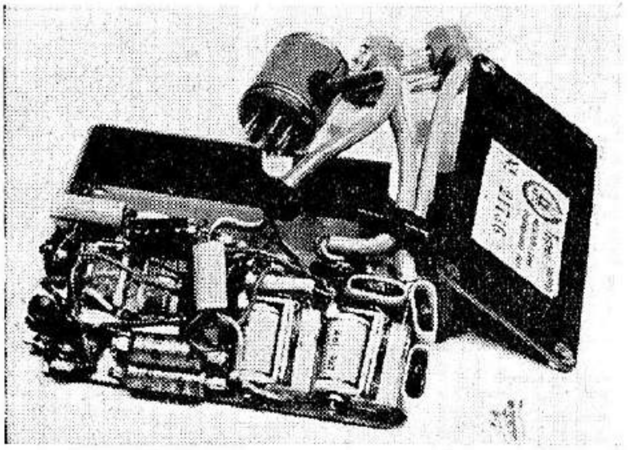
Summing up, we now have a single or multi channel outfit which can be chosen at will, without any parts which have already been bought becoming superfluous.

It is nowadays taken for granted that an outfit will be ready for use straight away, without having to be retuned to the Rx. and that the tuning will be held even during rough handling. The most interesting thing in the Mecatron outfit however is the L.F. selectivity of the Rx. The tone modulated Rx.s using 400 modulation which have been used up till now were not very selective; they operated satisfactorily even with considerable deviations from the nominal modulation frequency. With the Mecatron Rx. things are, however, very different. For example: when the Tx. modulation is switched to red and the Rx. modulation to green, the Rx. will not work even when the aerial is held close by. Measurements have shown that the switching transistor shows no sign of any action in the presence of 'foreign' modulation tones. This is very important, as the selectivity of the tuned modulation frequency, is the decisive property for the correct functioning in the multi control operation and the three channel control. The Mecatron system is the first to provide this. *(Editorial note: Reeds will do and have done the same for years.)*

The high selectivity brings about another advantage, i.e. *the possibility of switching the H.F. carrier of the Tx. between signals,* without running the risk that the Rx. relay starts to chatter due to noise. The Tx. of the Mecatron outfit transmits only during the pressing of the Tx. button, in the pauses between signals it is switched off saving current and money.







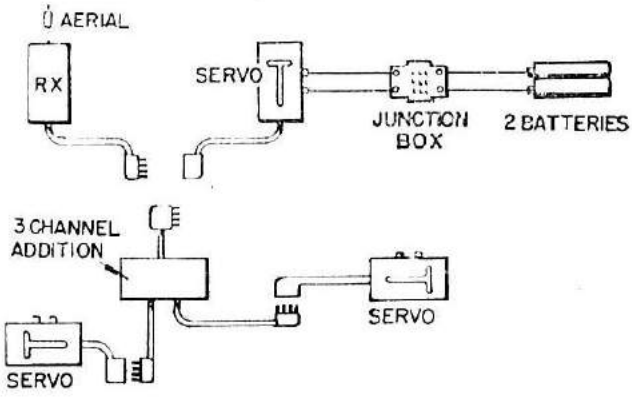
Single channel Rx. with three-channel adapter shown with covers removed. Connection is very simple via four extended bolts through both cases.

This has been achieved by drawing the anode voltage as a modulation voltage direct from the modulator, i.e. one has only anode voltage for as long as the modulator is working. This principle is already known from 'do it yourself' descriptions, but has never been advocated for the usually used tone modulated Rx., because of the missing carrier between signals. In the case of the Mecatron, however, it has its full justification. On opening the Mecatron Tx. every little corner of the handy little box is found filled with radio gear. It is a first class professional job, which has very little in common with the semi-professional outfits which were turned out as R.C. Tx. during the early years. As can be seen from the circuit diagram the Mecatron is not crystal controlled. The valve EL 95 is used in ECO (Edectron Coupled Oscillator cct.), with a π coupler, for suppression of harmonics of the 27 Mc/s, coupling to the 1.2 m. long telescopic aerial. The Tx. circuit proper is fully shielded in a copper box, even the leads into the box are carefully decoupled by lead through capacitors.

The transistor modulator has two stages. An OC 79 generates the tone and is controlled by an LC resonant circuit. This circuit can, via a switch U on the Tx. box, be connected to the parallel capacitors C 18 or C 15 and C 16, which alter the modulation frequency accordingly. In addition to the switch on the Tx., this switching can also be done by means of the plug Bu 2, for multi channel keying. It then connects pins 3 with 4 or 5 and at the same time 2 with 3. Coupled to this tone oscillator via a winding on T1 is a transistor OC 16. In its collector is T2 a step up transformer, which supplies the modulated anode voltage to the Tx. valve. As the Tx. valve can only work during the positive ½ cycles, the transistor VT2 needs no bias and operates Class B.

It amplifies only the negative ½ cycles of the tone oscillator which comes out as a positive ½ cycle to the valve, by means of appropriate connection of the Transformer T2. A sine wave modulation curve can not be expected under these circumstances. The oscillogram shows a rounded impulse, whose form is, however, no worse than the modulation curves of the usual tone modulated Tx.

The Tx. batteries consist of 4 Monocells (B) in the Tx. case. The Tx. can also be fed via a special plug in B 1 from a 6 volt car battery or an external accumulator (approx. 6 Ah). A good sales point is the fact that the Tx. is switched on automatically via switch S 1 when the aerial is extended. However this is not really important from the functional point of view. Very useful, however, is the neon lamp GL 1, which is controlled by the aerial voltage and which lights up on pressing the Tx. button. This will obviate in many instances the opening up of the Tx., when the fault obviously lies with the Rx. Metz gives the Tx. output at the base of the aerial as 3.5 watt. This is a very high value. However it does not represent the average output, but only the momentary peak output of the Tx. at the instant when the anode voltage modulation curve reaches its highest point. As, however, for practical purposes, the modulation amplitude is of prime importance, there is nothing against this method of performance determination. The Tx. draws 200 m.A. from the batteries between signals, this is the heater current of the Tx. valve, during the signals the voltage rises to 700 m.A. The Tx. is not very sensitive to small voltage changes. We



Connecting up the single channel Rx. with 3-channel adapter and servos actuated thereby. The 7-pin plugs make this very straightforward.

have reduced the voltage to 3 volt and the Tx. still worked. Of course, in practice, it is inadvisable to let the battery voltage sink that low.

Receiver

The Rx., with its polystyrol case makes a very good impression. Obviously the Metz people were of the opinion that mechanical reliability was more important than a few grams of weight. This 4 transistor set with all its refinements and built on a printed circuit comes to 100 grams. If one had saved on weight at the expense of strength the buyer would not really have been served. Besides even in small models 30 grams is neither here nor there.

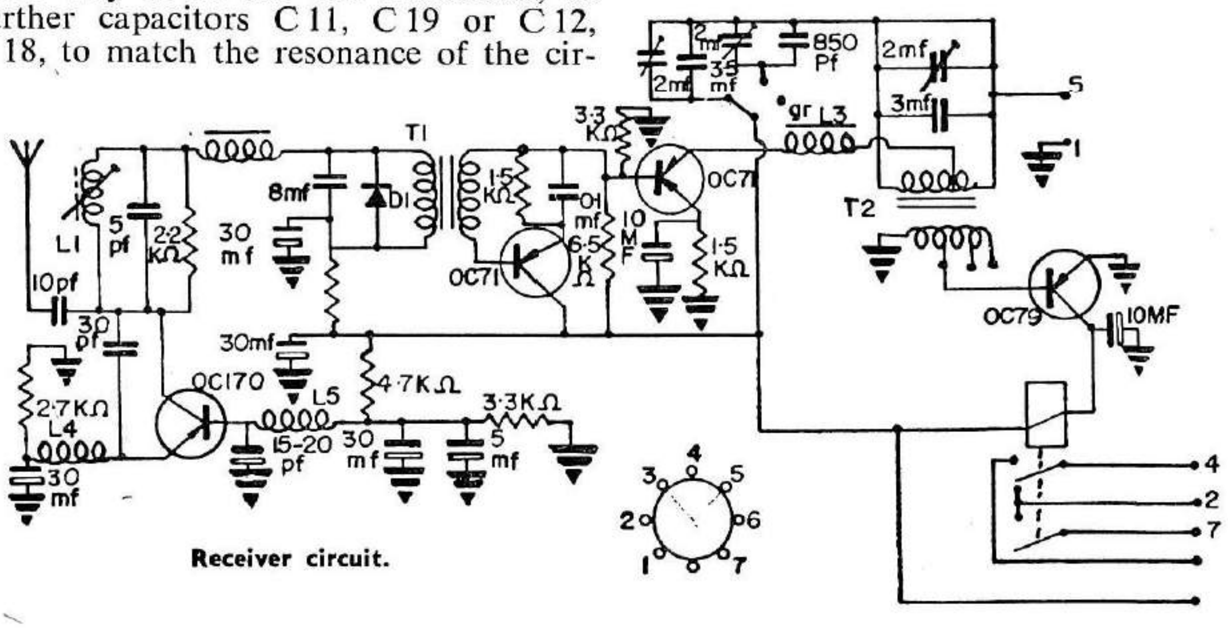
The Rx. works with a super-regen. detector using the H.F. transistor OC 170. Unusual here is the mounting of the chokes L4 and L5, which are wound on the top end of the tuned circuit coil former.

The 50 to 60 cm. long aerial is capacitively coupled to the collector. The de-modulated signal is coupled to the first AF transistor, which uses the same base voltage divider R 5, R 4 in common with the second transistor, via transformer T 1. Both stages work in common emitter so far as the audio is concerned. The diode D 1 prevents overloading of the AF amplifier. The third transistor is fed via an AF filter circuit whose inductance is the primary winding of T 2, and its capacitance can be varied by the selector switch, in the same way as in the Tx. modulator, as further capacitors C 11, C 19 or C 12, C 18, to match the resonance of the circuit to that of the Tx. All one has to do is to set the selector switch on the back of the Tx. to the same colour spot as that of the Tx., and the circuit resonance matches the Tx. modulation.

The last transistor, the switch transistor OC 79 works in the usual Class B to switch on the relay. For single channel use, pins 5, 6 and 7 are bridged on the socket the Rx. plugs into.

Over this bridge the third transistor receives its collector voltage. An earphone plug can be connected in place of this bridge. This earphone is part of the outfit for checking the air for interference of pirates. It is connected with an adapter plug. The Rx. works with this purely as a radio Rx. for 27.12 Mc/s. Through such an adapter plug the multi-channel part can later be connected. The entry of this part lies between the connections 5 and 6, whereby the modulation selector switch is set to green.

On the whole the Mecatron outfit is of a very interesting and modern construction, but one in which one can have the fullest confidence and one which will not be subject to teething troubles.



Receiver circuit.

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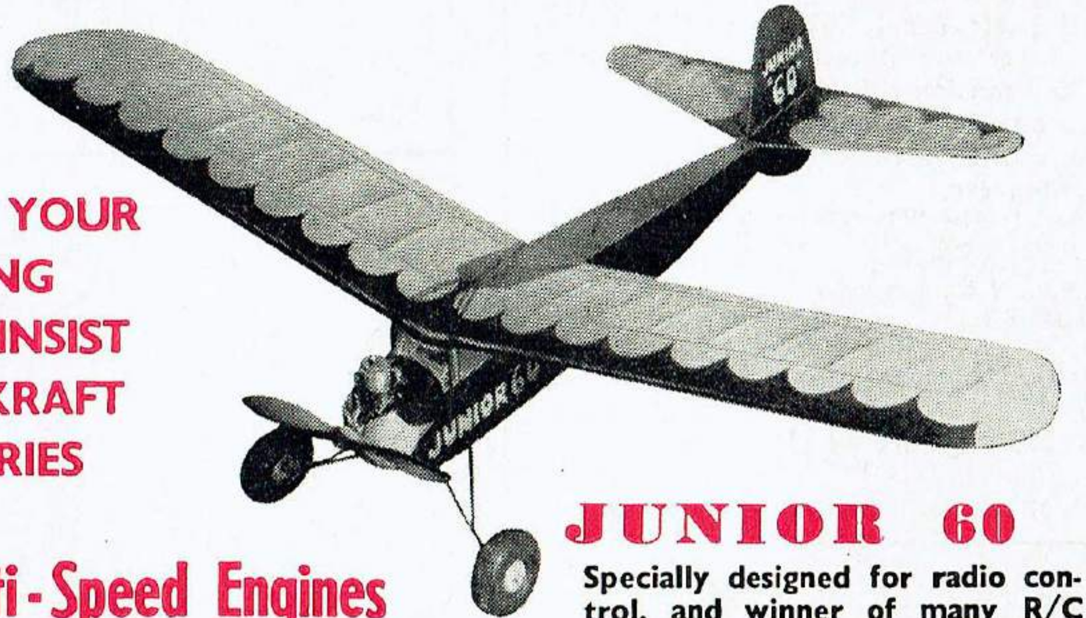

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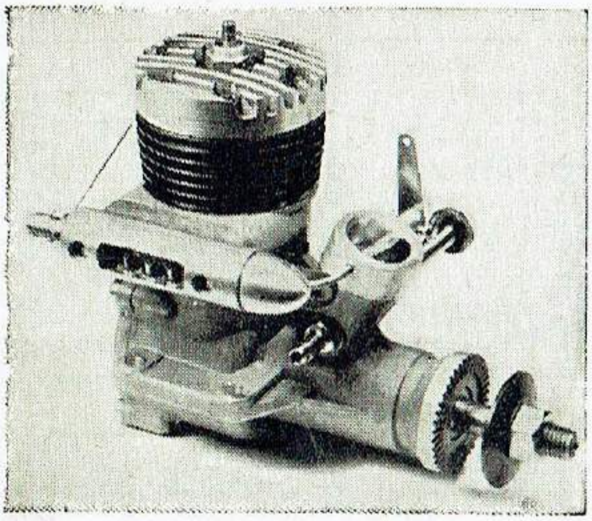

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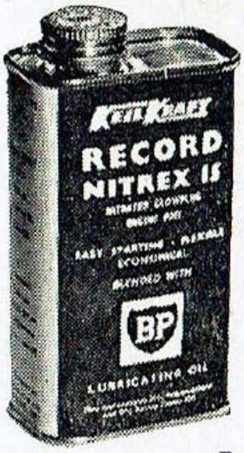

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