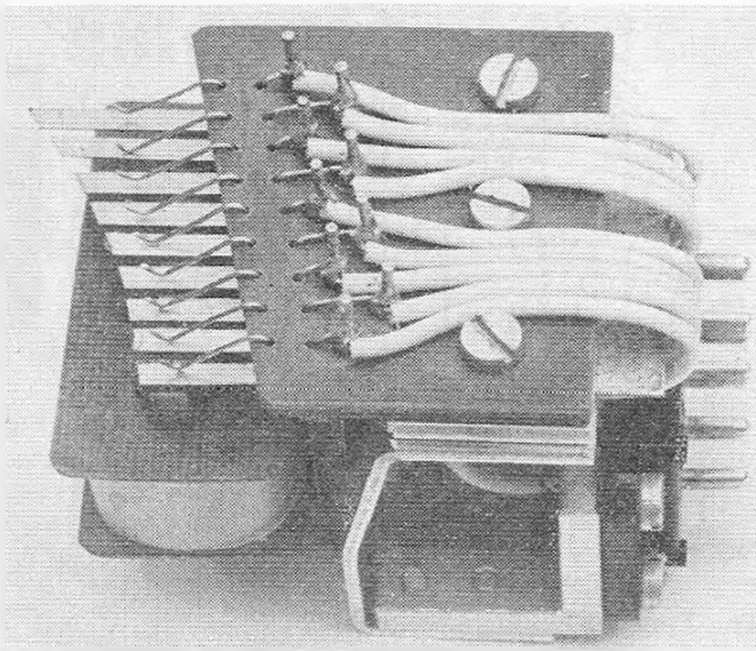
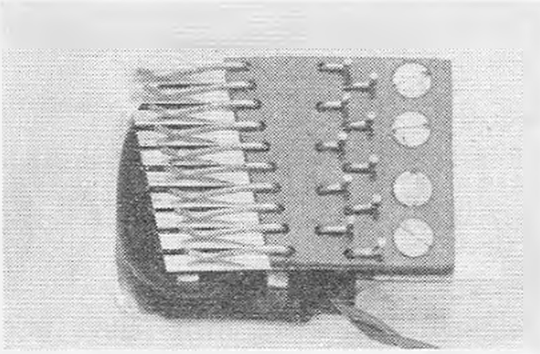
Reed Units



★ LARGE



OR SMALL

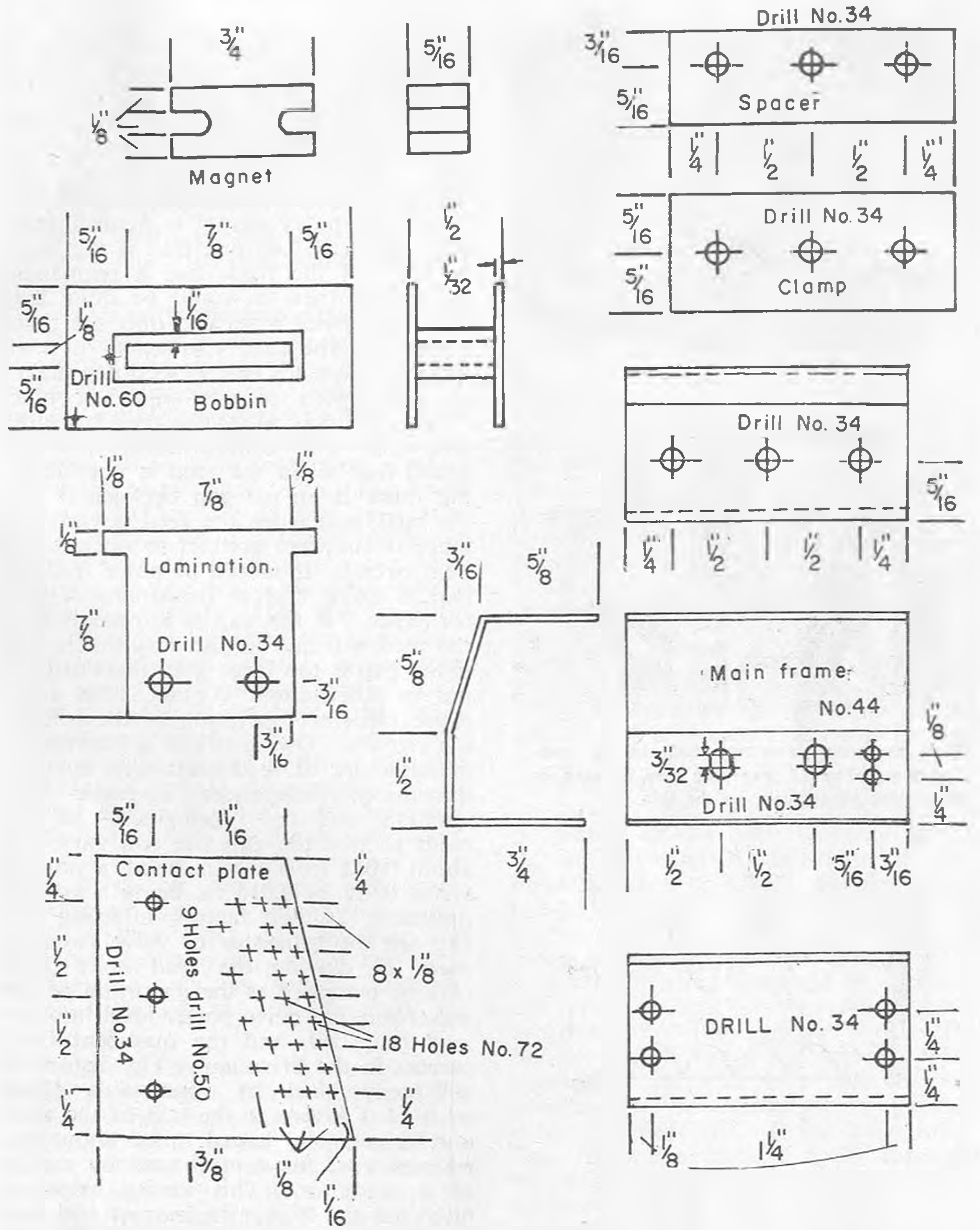
P. T. Bellamy, D.Tech.(Eng.)
Describes his home built Reed Bank

THE reed unit is perhaps the simplest form of multi-channel selector that has so far been designed for radio control purposes. Its main advantages are that it is smaller. lighter and cheaper than other systems. and as a result is found to be quite reliable provided it is protected from mechanical damage and exposure to climatic extremes, salt spray perhaps being its greatest enemy. There are several commercial types available on the market but these tend to be rather expensive when one considers the total materials in the unit; of course the manufacturer must pay design, labour and overhead costs as well as make a profit. However, these costs can be eliminated if one is prepared to spend a few hours and some care, "Doing it oneself"! I have built several reed units, ranging from 3 to 10 channels. and so far not one of these has cost more than 4/- to construct — this assumes of course that in the "oddments and raw materials drawer" there are a few scrap pieces of aluminium, paxolin, etc., which can hardly be charged to the cost as they represent only fractions of pence.

Whilst for aircraft it is best to make a small compact reed unit, it is not necessary to go to the same extremes for a unit that will be used in a boat or land vehicle. the smaller the unit the greater must be the accuracy in manufacture. The two reed units described should meet most needs and if not, then dimensions can be suitably scaled to fit the requirement.

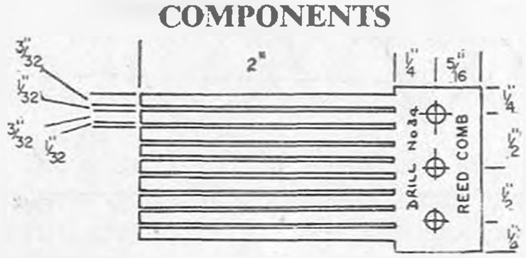
First the general principles and requirements will be discussed in order to establish a specification from which the design can be made. The reed unit is an electro-mechanical unit that is able to select several discreet audio tone frequencies, when driven by an appropriate electrical input, the output being an interrupted contact for each discreet channel, the frequency of interruption being that of the tone for each individual channel.

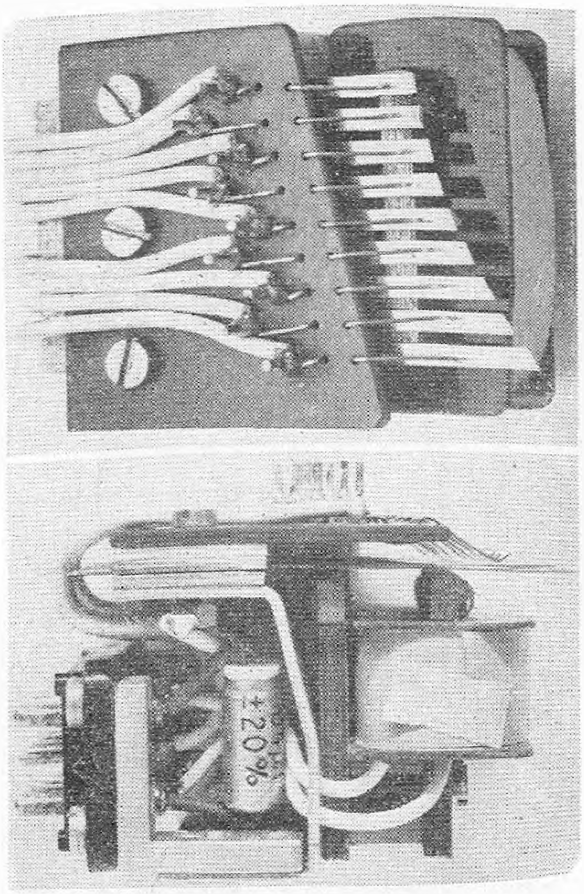
The electrical input is fed into a coil



which has an iron core and thus if the input current alternates. then there will be a corresponding alternating magnetic flux set up in the iron. However, it is simple to see that this alternating current will set up a flux maximum of twice the frequency of the alternating current —see Fig. 1. This would therefore try to make a reed placed in the magnetic field operate at twice the frequency. By polarising the magnetic circuit with a permanent magnet it is possible to make only one flux maximum per cycle of the alternating current—see Fig. 2 (Note: Without a polarising magnet the flux

COMPONENTS





Plan and side views may help in the construction. The 12 way plug may be seen in the lower photograph, on the left.

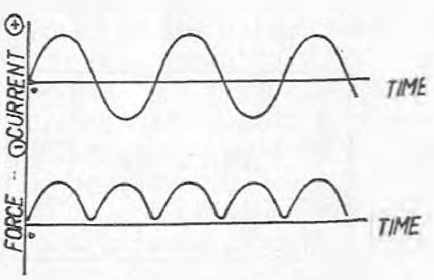
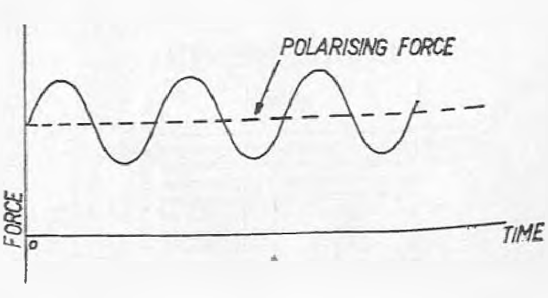


FIG. 1

FIG. 2



produces two maxima corresponding to +ve and −ve values, as shown on the graph, however this may be misleading to some readers as they might suppose at first that the −ve value would have a repelling action for the reeds rather than an attracting action. The +ve and −ve signs, correspond to the North and South poles of a permanent magnet, and thus both poles attract a neutral magnetic material, i.e., one that is not magnetised. If the reeds had a permanent magnetism then it would be quite true that "like poles repel and opposite poles attract"). The reed vibrates at its own natural frequency and in so doing makes an interrupted contact with a contact finger, part way along the reed from the free end. This contact finger is so adjusted that when the reed is not vibrating there is an air gap between it and the reed, and when the reed is vibrating there is sufficient contact to operate the next circuit. It should be noted that the gap is quite critical for optimum performance. If the gap is too small then the reed will not vibrate very much, and if the gap is too large then there will be no, or intermittent contact, both cases cause incorrect operation of the following circuits. Owing to the differences in manufacture of reed units, this includes dimensional tolerances, magnetic field strength, and the "springiness" of the reeds so that the gap size will vary, but about 0.012 in.-0.015 in. being a normal about 0.0I2 in.-0.015 in. being a normal optimum. Other factors affecting the gap are the transistor or valve circuitry used for driving the reed unit; these may be classified as the distortion of the waveform, the drive power level into the reed unit coil, and the quiescent D.C. current in the drive coil. The distortion will only have an appreciable effect when it is severe as the coil of the reed unit is normally broad tuned about the frequency of the central reed by means of a capacitor. This tuning helps to filter out the higher harmonics and just leave the fundamental frequencies for driving the reeds.

The reed unit therefore wants to be mechanically robust in order to maintain its frequency stability and should have some provision for adjusting the air gap between the magnetic circuit and the reeds and the air gap between the reeds and contacts. The first is dealt with quite simply by making the clamping holes in the body slightly elongated as seen in the drawings and by making the contracts from silver wire that can be bent sufficiently to adjust the contact gap. Using slightly springy silver wire for the contacts means that the time of contact is longer than with a more rigid type, and as there is movement of the reed and contact at this point, so that there is a self cleaning action which will prevent bad contact between the elements due to dirt, corrosion and oxidation.

To start with, the larger reed unit will be described as it is easier to construct. Nearly all dimensions have been made in fractions of an inch, however, it is quite a simple matter to convert to the decimal system if necessary. The choice of materials is quite important in order to get the best results. The magnet was taken from an old G.P.O. type telephone handset, it is actually inside the receiver that one holds to the ear. The aluminium alloy that is used for several of the pieces is to DTD 606 specification. Pure aluminium is not suitable as it is too soft and "Dural" is too hard as it cracks easily when bent at right angles. It should be noted that when bending any metal, the radius inside the corner should be one to two times, the thickness of metal, in order that severe stresses are not set up in the bend, which could cause a failure under vibration and shock. The laminations were taken from an old burnt out mains transformer and are silicon-steel about 0.014 in. thick—this is a standard size for such laminations; of course other thicknesses would be suitable, but the material should be approximately the same.

The reeds are made from 0.010 in. spring steel sheet. It is often used for shims and packing pieces and should be obtainable at a good ironmongers or garage. The plastic sheets used for the bobbin and the contact plate were actually Synthetic Resin Bonded Fabric (S.R.B.F.) but a paper laminate (S.R.B.P.) is equally suitable, however rather more care should be taken when using the S.R.B.P. as it tends to splinter and crack more easily when it is being cut or drilled. The bolts that are used for holding the laminations and magnet to the frame must of course be from a non-magnetic material, brass being quite suitable, the other bolts used for clamping the reeds are steel as they are stronger.

Now for the actual manufacture of the components. The bobbin presents a small problem as it should be made with care to ensure that it is square in all dimensions, in particular the thin checks on each side. If these are not square then difficulty will be experienced when winding the bobbin with copper wire after it has been finished. To start with, a piece of metal, steel, brass or aluminium is cut to the same size as the measurements of the core $\frac{7}{8}$ in x $\frac{1}{8}$ in., and is about 2 in.-3 in. long. Then $\frac{1}{16}$ in. sheet paxolin is cut to fit around this core to form a tube; it should not be cut to the $\frac{1}{2}$ in. length but left on the long side (about 1 in. long) the four pieces being Araldited together. It is best to coat the core with wax or some similar releasing agent before glueing so that the bobbin can be removed when it is finished. Next the side cheeks are cut out from $\frac{1}{32}$ in. sheet paxolin or S.R.B.F. and fitted over the core and $\frac{1}{16}$ in. sheet. It is best to cut the centre hole a little on the small side and file it out so that it is an exact fit, then to trim the outside to the dimensions shown in the drawing. When fitting the side cheeks it is easier if a small chamfer is filed on the ends of the $\frac{1}{16}$ in. sheet so that there is a slight lead. When the cheeks are finished they can be positioned on the central portion of the $\frac{1}{16}$ in core and Araldited to it, care must be taken to ensure that the cheeks are at 90 degrees to the core. When the Araldite is quite hard the excess pieces of $\frac{1}{16}$ in. paxolin extending on both ends of the cheeks can be carefully cut off—then the two No. 60 in. holes are drilled for the lead out wires. The bobbin is now ready for winding. The number of turns of wire will vary depending on the circuit being used to drive the reed unit. It has been found that for valve circuits 6,000 turns of 44 s.w.g. enamelled copper wire and for transistor circuits 2,000 turns of 38 s.w.g. enamelled copper wire give good results. It is obvious that depending on the circuit these figures may not give optimum results but are a general guide. The winding can be made very easily with the coil winder described in *R.C.M. & E.* April, 1961, which was constructed by the author for coils of this type.

The core is made from the laminations of a burnt out mains transformer which are 0.014 in. thick silicon iron. Sufficient laminations are cut to size to make two stacks of ⅛ in. thickness each. The space and clamp (two off) are made from a hard aluminium alloy, as is the main frame, the thickness of the material being 0.048 in. (18 s.w.g.). The main frame is first bent to the exact size, this is quite easily done with pieces of hard wood and a normal vice, then the holes are marked out and drilled to the sizes shown.

The contact plate is next made from S.R.B.F. $\frac{1}{16}$ in. thick sheet. It is best to cut the outline after drilling all the holes as shown. The easiest way of cutting this material is with a fretsaw—just a little oversize and then using a file to get the right dimensions. The same technique can be used for the aluminium alloy and has a great advantage over tin snips because the metal is not stretched and distorted by the shearing action. The nine holes which are drilled No. 50 have solder pins riveted into them, the pins used are Type H2101A made by Harwin Engineers Ltd., Rodney Road. Portsmouth. These are single sided pins, they also make double sided pins Type H2101.

Possibly the hardest piece to make is the actual reed comb. There are several techniques that can be used for its construction. A piece of 0.010 in. spring steel shim is cut oversize by about ½ in. all round — then the actual reeds are marked out carefully in the centre of the piece of metal. now with either a metal shear or a good sharp pair of tin snips the gaps are cut between the reeds. After this has been done the surplus material is removed on three sides the actual reeds being left too long — the reeds being trimmed to size after assembly in order to get the correct audio tones. The reeds should now be silver plated for a thickness of 0.0003 in. and then should have a gold flash. The gold flash serves two purposes, firstly it protects the silver—under normal circumstances gold does not tarnish, and secondly small contact pressure is required for a good electrical contact. It must also be noted that gold contacts are only suitable for small currents—for higher currents silver or platinum should be used. and currents of several amperes should be switched with tungsten contacts.

Assembly of the reed units is quite straight forward. The core is inserted in the coil and is bolted to the magnet, the other laminations and the frame with brass nuts, bolts and washers, on no account should steel be used for the bolts as they would short circuit the magnetic flux. Next the contacts are made and fitted to the S.R.B.F. contact plate. They are made from 22 s.w.g., gold. platinum or silver wire, which is obtainable from precious-metal dealers or Silversmiths. First the wire is threaded from the top of the plate through a No. 72 hole adjacent to one of the solder pins. First a right angle bend is made from the end protruding through the bottom of the plate, then a further right angle bend is made ⅛ in. away so as to form a flat bottomed "U" shape. The free end is now fed up through the hole near the edge of the plate, the other end being wrapped for one turn around the solder pin and securely soldered. The free end then has a $\frac{1}{16}$ in. radius bent into the end at $\frac{1}{16}$ in. — this bend actually forms the contact point with the reed.

Now the reeds, spacer and contact plate are bolted to the main frame with 6 B.A. screws and nuts. the reeds should be positioned centrally over magnetic laminations, the gap between the latter and the reeds being $\frac{1}{16}$ in. All bolts and nuts are now tightened and the whole assembly checked for squareness. It is most important to ensure that the reeds are so positioned between the clamp plates that the clamps overlap the gaps by $\frac{1}{16}$ in. minimum and that the clamps are made with sharp edges. The reason being that if this is not so then oscillation of one reed will cause interference with its neighbours.

Now an audio oscillator is coupled to the coil and the oscillation frequency of the reeds, which are as yet uncut, is found—this frequency should be between 100 and 150 c/s. Now with the aid of the oscillator the reeds are cut so that there is a separation of 20 c/s. each from 200 c/s. which is the longest to 360 c/s. which is the shortest for a 9 reed unit. The spacing can be 22 c/s. but over this means that the 9th reed is on the second harmonic of the first reed, i.e.. 400 c/s.

Finally the contact fingers are bent so that there is about 0.012 in. to 0.015 in. clearance between them and the reeds. It should be noted that during manufacture of the reed unit great care should be taken at all times and everything should be kept as clean as possible. by doing this a good reed unit will be made which should give long trouble-free service.

One refinement has been added to the basic reed unit and that is the 12 way plug on the rear. This was so that it is possible to use one transmitter with several boats. The reed unit and transmitter are matched for the audio frequencies. the receivers were also fitted with plugs. then only one control equipment was necessary for several boats. The 12 way plug is a Belling and Lee Unitor as is the mating socket—these are often found on equipment on the surplus market and may be bought for a few pence. However, this is only a refinement and is not necessary for the functioning of the unit as a whole.

SELECTIVE FILTER SWITCHER

(*Continued from page* 63)

C: (this tunes the primary winding) connect from + land to land 2.

OA5: from land 3 to land 4 observing polarity. (Red spot should go to land 2).

1-10 mfd.: from land 4 to + land observing polarity.

1KΩ: resistor from land 5 to + land.

OC71: Base to land 3, Emitter to land 5, Collector to − land.

S1 or GET114: Base to land 5. Emitter to land 6. Collector to − land.

BATTERY SUPPLY LEADS: Red positive to + land. Black negative to − land.

INPUT LEADS: Green (A.F.) to land 1, Red (Common) to + land.

OUTPUT LEADS TO ACTUATOR COIL: Orange to land 6. Red (Common) to + land.

The unit is now complete and ready to test. but as always. it is advisable to check all connections and soldered joints for correctness.

Testing

To test this point an A.F. oscillator having a low impedance output is required. also it should cover the desired frequency range. Procedure for testing is as follows:

Connect a 6 volt 200 mA. bulb across the output leads. connect a 6 volt battery to the supply leads. Set the A.F. output to give 1 milliwatt. If the output impedance is known and an A.C. volt meter is used to measure the voltage output. then the following formula will help calculate the level in milliwatts.

$$W = \frac{E^2}{R}$$

where E = Output Volts. R is the impedance (when terminated) and W = Watts.

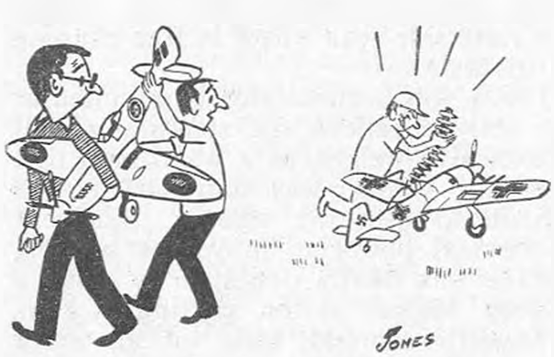
Assuming we have chosen C to tune the filter to 1000 c/s., then as we tune the A.F. oscillator from approximately 800-1200 c/s., so the bulb should light up at approximately 850-900 c/s. and remain alight till approximately 1100-1150 c/s. when it should go out. This indicated a bandwidth of between 200 and 300 c/s. at 1000 c/s.

Current Checks

Total standing current with No Sig.: 1 mA. or less. S1 or GET114 standing emitter current with No. Sig: 200 μA or less. Current in S1 or GET114 emitter circuit with Signal On: 100-250 mA. depending on D.C. resistance of actuator employed.

Conclusion

The unit described is so simple that it should be possible for even a beginner to construct it successfully. The frequency of operation may be altered to suit any requirement by varying the value of (C). as explained earlier. Further I am sure this device will also appeal to even the most experienced R/C fans. both from the point of view of simplicity and reliability as well as the ease with which a single channel receiver employing the circuits described can be converted to multi.



"Just how jealous can you get?"