GRID DIP OSCILLATOR

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At some time or other most radio constructors find themselves in need of frequency checking apparatus. Because of this, the familiar g.d.o. is frequently found in amateur stations for, although very precise frequency checking is scarcely possible with the device, it is a most useful one and is sometimes considered handier than a signal generator.

The usefulness of a g.d.o. is dependent on its calibration accuracy and holding stability, therefore in a home-built item care is required, firstly to construct a physical rugged specimen, secondly to ensure reasonably good calibration and thirdly to obtain an attractive unit.

G.D.O. circuitry and uses is already well-known so the emphasis here is on construction, since converting a circuit diagram into a satisfactory practical physical form is not always easy. The prototype is attractive in appearance and it can, with care, be copied easily. A fair amount of work is involved, but only simple tools are needed; to construct the prototype, for instance, a 3in. vice, a hand drill and a few files were the only items used to fashion the metal work.

In the prototype, power requirements are met via a separate power supply unit which is also used to power various other items from time to time. Space does exist, however, for an internally fitted power unit where considered necessary.

Circuitry

Looking at Fig. 1, valve V1 is arranged in an oscillatory type of circuit, coil L and capacitor VC1 forming the main frequency-determining components. At switch-on, the oscillator produces valve grid current and this is recorded by meter M inserted at the earthy end of R1. Adequate sensitivity demands use of a meter of 500μA f.s.d. or better, VR1 ensuring that at no time can the meter be over-driven.

Fitment of the closed circuit jack socket is beneficial, for headphones may be plugged in for monitoring purposes, or an audio signal may be injected to modulate the r.f. signal being generated. When no jack plug is inserted the g.d.o. functions normally.

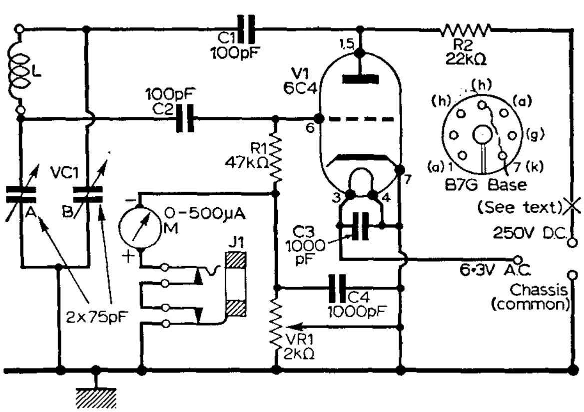

Fig. 1: Circuit of the oscillator.

The g.d.o. may also be used as an absorbtion wavemeter if its h.t. supply is disconnected and if this facility is required a simple toggle or slide switch should be inserted at point "×". Such a switch may be mounted on the front panel to the left of the indicating meter. Since an excellent absorption wavemeter already exists at the author's location the facility was not necessary.

No calibration of the meter scale is necessary. Calibration scales are associated with VC1 plug-in coils (L) enabling unbroken coverage of the frequency range 1·75-150Mc/s this embracing virtually all amateur bands. U.H.F. bands are not accommodated, a separate device being recommended at these frequencies.

Capacitor VC1 consists of a 2 x 75pF specimen pruned from a discarded RF27 unit, but other types are usable—the Jackson 02 for example, or a suitable split-stator item.

Constructional

The main casing consists basically of two L-shaped pieces of 16 s.w.g. aluminium—Fig. 2*a*, *b*—section *a* carrying most of the assembly. The final length of each section is 9¼in. but it may be beneficial to commence with pieces 12in. long and 4in. wide, making the bends as indicated but leaving an oddment to be cut away from *both* ends of each piece later. In this way neatness is assured and matching sections result.

The front panel and end-plate cut-outs may then be marked out as is shown in Fig. 2*a*. In the absence of more refined tools, a series of small holes should be drilled along the inners of the cut-outs marked, after which the unwanted metal may be carefully pruned away leaving ragged edges which may be cleaned up with a file.

The panel becomes progressively weaker as the work proceeds but this is not too important for rigidity returns with the fitment of components. The

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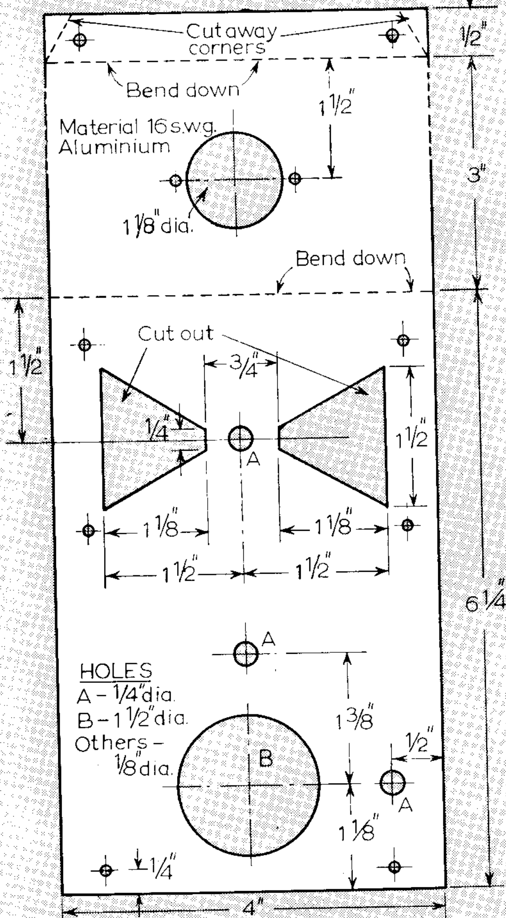
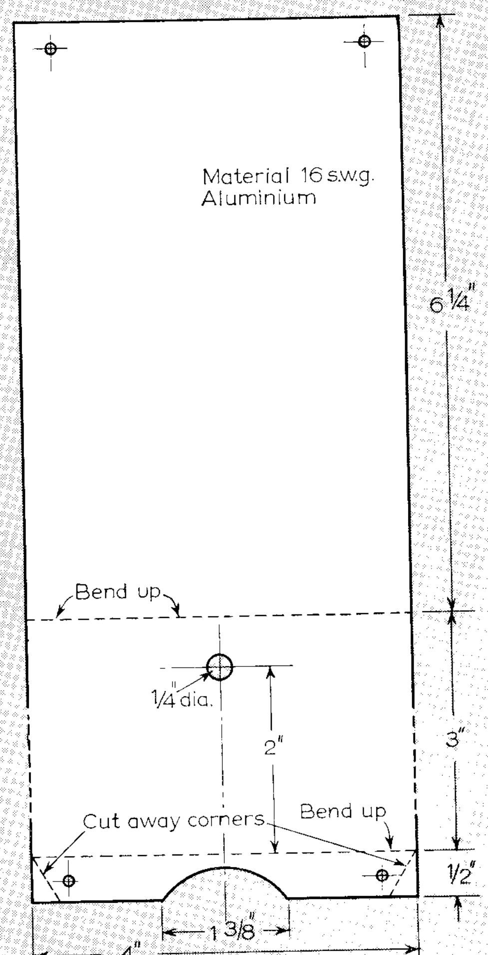
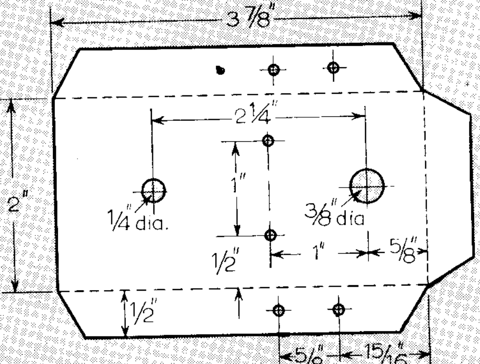
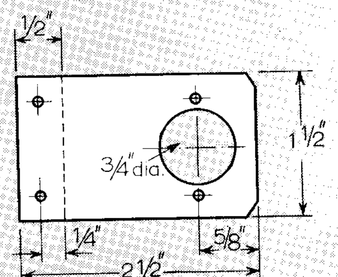


2b







MATERIALS: 16 s.w.g. Aluminium
All small holes 1/8" dia.
Bend all flanges up at dotted lines.

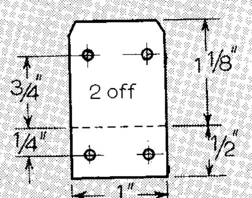


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Fig. 2a: Details of the top main casing.
Fig. 2b: Other part of the main casing.
Fig. 3: Metalwork details relating to the main chassis.

section shown in Fig. 2*b* is also prepared along the lines indicated.

The Main Chassis

To avoid defacing the front panel unduly, the bulk of the construction is carried on a small chassis, the scheme being shown in Fig. 3. This chassis is constructed and wired separately, eventually being located and held by a pair of retaining brackets. Control shafts of VC1 and VR1 then pass through the front panel, a $2\frac{3}{4}$in. diameter drum of the type used with cord drive tuning mechanisms being first fitted to VC1.

A piece of stiff white card on which arcs are drawn in Indian ink is glued to the drum flat surface. The card measures 3in. in diameter and carries the calibration. A piece of perspex affixed to the front panel affords protection and keeps out dust; a cursor line is scribed and inked in.

Details relating to the main chassis and which completes the metalwork are shown in Fig. 3 and are self-explanatory.

The valve holder may then be fitted as indicated and this assembly wired as far as is convenient. The meter may then be mounted on the front panel casing together with the international valve holder and the jack socket. The main chassis is then affixed after which final connections are made using tags 1 and 5 of the octal valveholder to take the connections from VC1. A tag strip bolted under one of the retaining bracket bolts may be used as an anchor point for the 3-core power supply cable from the p.s.u.

It should be noted that at this juncture no power should be applied, or damage to the valve will result!

Coils

Prototype coils are wound on plastic formers of $1\frac{1}{2}$in. outside diameter and 2in. long, force-fitted on to the bases of discarded octal valves of the 6K8, 6K7, etc., variety, the glass bulbs and internal structures having been removed.

Before smashing the bulb of an unwanted valve it should be placed in a paper bag. Holding the base of the valve firmly the glass bulb is tapped smartly with a hammer! Careful removal of all debris leaves a strong former which, unfortunately, is not long enough for g.d.o. purposes. Plastic, paxolin, or even stiff card, tubing suitable for fitting over the base is now sought and fixed firmly.

At this point a test coil of about 12 turns of enamelled copper wire should be wound up and plugged in to the g.d.o. Power is then applied and VR1 adjusted to give a meter reading of approximately half scale deflection. If the coil turns are now gripped firmly between a finger and thumb the meter reading should decrease, thus indicating that the device is functioning. The g.d.o. may then be switched off and the sample coil removed for subsequent amendment.

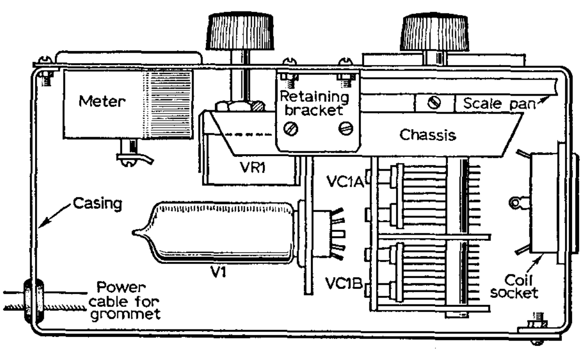

Fig. 4: General layout of main components.

A total of seven coils are needed, plus a loop or hairpin coil, and while details relating to each range are given in Table I, in another construction variations are likely. This is of no importance, the main requirement being to obtain overlapping coverage from range to range.

TABLE I

Coil	Turns	Spacing	S.W.G.*	Range in Mc/s
L1	76	Close	30	1·75—3·50
L2	40	,,	24	2·80—5·50
L3	28	,,	24	5·0 —9·0
L4	12	Wire dia	24	8·50—16·5
L5	5	,,	24	16·0—32·0
L6	$2\frac{1}{2}$	,,	20	31·0—60·0
L7	$1\frac{1}{4}$	,,	20	45·0—80·0
L8	Loop	—	20	70·0—150·0

*enamelled copper wire.

Note: L8 consists of a hairpin loop $\frac{1}{2}$in. long wired across the pins 1 and 5 of a octal valve bases of the type used in metal valves; type 6H6, 6SH7, etc.

The "cut and try" coil winding method adopted was first to wind a former full of 30 s.w.g. enamelled copper wire and then remove turns experimentally using the g.d.o. and a wavemeter which was adjusted to 1·75Mc/s, the vanes of VC1 in the g.d.o. being fully enmeshed. Immediately the signal due to the g.d.o. was detected, the turns left on the coil were counted and these were found to number 76.

This coil was then made L1 and, with the vanes of VC1 opened, a check was made with the wavemeter to find the high frequency point. For L2 slightly over half the number of turns used for L1 were wound on. The wavemeter was then set slightly l.f. of the highest frequency reading found with L1 and VC1 readjusted to full capacitance.

Again a few turns were removed until the wavemeter gave an indication whereupon VC1 was reset to the opposite end of its travel to find the high frequency point for the coil. This procedure was adopted until all coils showed overlapping frequency characteristics although as yet no actual calibration had been attempted. Windings were then sealed and doped.

If no wavemeter exists, a communications receiver could be employed or the oddment of circuitry shown in Fig. 5 used in conjunction with a signal generator. Here, socket SK1 is the generator output socket and *L* is a coil of some eight turns of

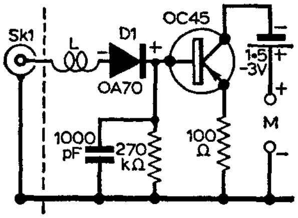

Fig. 5: How a signal generator may be utilised for coil checking in conjunction with an additional oddment of circuitry.

enamelled copper wire about 1in. in diameter. A meter with a full scale sensitivity of around 1mA is connected at the *M* terminals or the workshop testmeter suitably adjusted may be used.

If the g.d.o. coil is brought close to *L* the current reading due to the signal generator and seen on the meter connected to terminals *M* will increase. Immediately the g.d.o. is tuned to the same frequency as the signal generator a violent kick will be indicated by the pointer of the externally connected meter.

Calibration

Before attempting calibration, the perspex cursor plate and the scale should receive attention along the lines shown in Figs. 6a,b. The perspex cannot be placed in position until calibration has been completed so care must be taken to ensure that the line scribed on it agrees exactly with that drawn on the card scale.

A piece of stiff white card is then placed across the g.d.o. scale cut-outs and fixed with sellotape in such a way that one edge occupies the position later to be taken by the scribed line.

Using a pin-sharp pencil point, calibration marks are made lightly on the scale, the final marks being filled in later in Indian ink with a mapping pen. Calibration up to 30 Mc/s is easily accomplished using a communications receiver and cross checking with a crystal marker. The signal generator method previously mentioned may also be employed with rather less accuracy perhaps but may be necessary in any case for the highest frequency ranges. Any crystals that are around can also be made use of, as may MSF and other similar transmissions.

★ components list

Resistors:
- R1 47kΩ
- R2 22kΩ 1 watt
- VR1 2kΩ potentiometer

Capacitors:
- C1 100pF silver mica
- C2 100pF silver mica
- C3 1000pF ceramic
- C4 1000pF ceramic
- VC1 2 x 75pF (see text)

Valve:
- V1 6C4

Meter:
- 0-500μA miniature plastic-type panel meter.

Miscellaneous:
Tuning drum 2¾in. diameter, closed circuit jack socket, B7G valve holder, preferably ceramic, I.O. valve holder, Control knobs (2), 3-core mains type lead, On/off toggle or slide switch—250V d.c., oddment perspex, wire for coils, bases for coils (see text), 16s.w.g. aluminium, paxolin or plastic tubing, etc.

Extras to include P.S.U. item:
Miniature transformer—mains a.c. input. Secondaries: 0-200V at 25mA, 6·3V at 1A. Half-wave rectifier, Electrix contact cooled type 250V d.c. at 50mA. Miniature tubular electrolytic, 16 + 16μF, 275V wkg. One 1500Ω resistor, 1 watt.

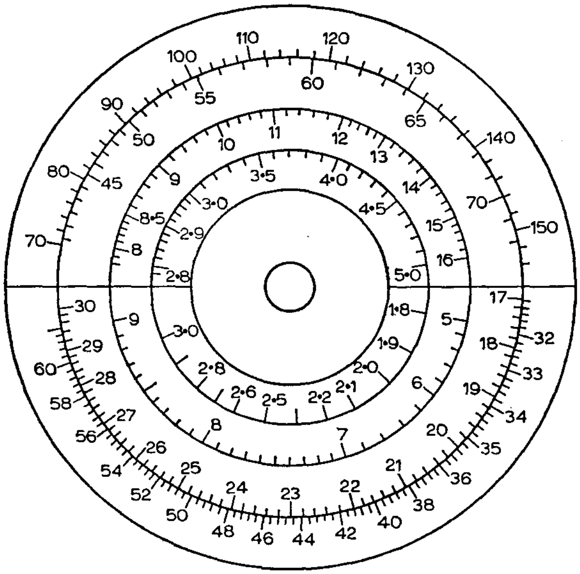

Fig. 6a (above): The calibrated scale. Note that the low frequency scaling is close to the shaft whilst the outside compartments are reserved for the higher frequencies. This scale must not be taken literally; it is merely a guide, and in any case the rotors of the tuning capacitor used were capable of a 360° movement!

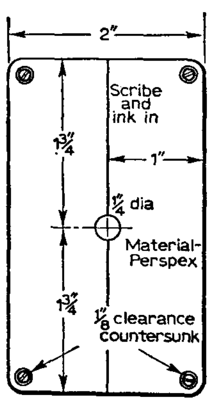

Fig. 6b (left): Dimensions of the perspex cursor.

Finalising the Unit

If a self-contained unit is required, the circuitry and components of Fig. 7 may be inserted, these being placed inside the casing beneath the meter. The sides are easily filled in using expanded metal speaker fret, the edges of which are folded to give increased strength. The casing may then be lacquered or spray painted to taste, after which suitable legends may be applied, preferably through

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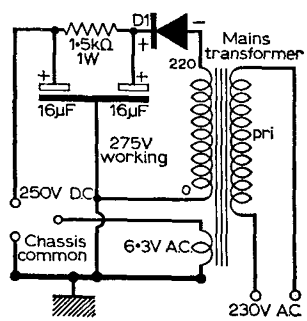

Fig. 7: A suitable power circuit that can be included if required.

the bias supply is a very recent innovation, and is almost an exact electrostatic equivalent of the "cross-field head" for magnetic tape recorders. The cross-field head, invented in the United States and used on several professional-quality tape recorders, the Japanese Akai models in particular.

The use of the shields greatly increases the capacity of the head, and a suitable driving circuit must be used. A cathode-follower is not wholly suitable; the capacity of the head is so high that the cathode-follower ceases to follow on negative-going signals due to the valve cutting off.

This could be overcome by using a power valve and having a very high standing current. Another, better, method is to use the circuit sometimes referred to as the "super cathode - follower", shown in Fig. 4. Since one of the two valves must be driven on at any given time, irrespective of the polarity of the input signal, the output impedance remains low at all times.

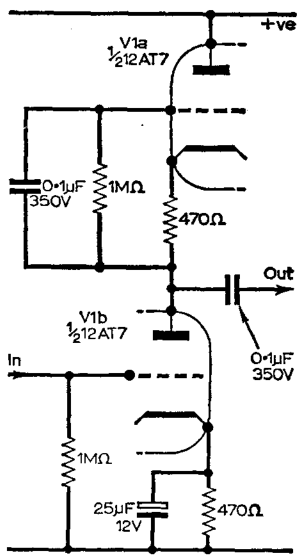

Fig. 4: Super cathode-follower.

The shielded head should not be used for replay, as the high capacity causes a considerable loss of signal at high frequencies.

Some notes on the construction of the shielded head may be of interest. Some selection of razor-blades may be necessary to find three which will not short to one another when glued together. If the blades available have a poor coating, a very thin mica shim may be used as a spacer at the blade end in addition to those used further up.

Mica sheet is very readily split into very thin portions, and with some practice, shims of 0·0001in. can be produced. The best technique of producing such shims is to use a sharp needle to split a piece of good-quality mica at one edge. A drop of water should then be run down the needle into the split.

The water will spread between the natural layers of the mica and assist in the splitting operation. The use of water in this way also helps to prevent trouble caused by the needle crossing between layers. The mica sheets should be gently slid apart when the needle has been passed between them all over the area of the sheet.

The mica shims should be well dried before use, as they tend to retain water. The mica used must be clean and fresh; mica from an old electric iron element is useless, as it is brittle and cannot be worked readily.

The contacts to the blade should be soldered on before assembly. Stainless steel is difficult to solder, and a very hot iron is essential. The outer blades are connected together, and the inner is kept separate; remember to check the insulation between outer and inner after assembly.

The glue used should be good quality polystyrene cement, although "Araldite" is more suitable if the blades can be kept in a suitable clamp while the adhesive sets.

Any normal tape drive from a magnetic recorder is suitable but the tape must press only very lightly against the blades, for obvious reasons. Uncoated tape is available from any manufacturer of magnetic tape (to special order) or from British Visqueen Ltd. (Acetate tape) or Dupont (Mylar tape).

Some recent work has indicated that the permanence of the recordings can be improved by neutralising the excess charge on the tape by passing it through a "bath" of positive ions. This is done by creating a corona discharge near the tape after it has passed the recording head, although other methods such as a radioactive source can be used.

A needle held in a block of rubber and connected by suitable e.h.t. cable to a power supply (such as the e.h.t. generator of a TV set; an old set can be bought for far less than the price of building an e.h.t. supply) of at least 10kV will give a sufficiently brisk corona for this purpose. ■

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the medium of transfers. Finally, the pencilled calibration marks may be erased and the perspex fixed with PK screws.

Uses of the G.D.O.

The uses of these devices are already well known but, briefly, the unit may be used for setting up the tuned stages in either transmitters or receivers, etc., without even having to switch them on! The g.d.o. is merely brought close to the circuit being checked and carefully tuned until a sharp current dip is noted on the meter.

If no dip occurs, the coil in use is the incorrect one or inadequate coupling is taking place. Immediately a dip is noted, the g.d.o. is withdrawn and carefully retuned until only the merest detection of dip is possible. The scale is then read.

As a signal generator the unit may be placed close to the aerial lead of a receiver and if a modulated signal is required, the output from an audio generator may be injected at J1 and will be heard when the receiver is suitably tuned. Harmonics of the signal generated by the g.d.o. will also be tuneable and can also be made use of if required.

The g.d.o. may also prove useful for making c.w. or s.s.b. transmissions intelligible on a receiver not fitted with a b.f.o. No physical connection between receiver and g.d.o. is necessary to do this. Nor is modulation required: the g.d.o. is tuned close to the frequency of the signal sought and front-end injection results.

The g.d.o. may also be used to check the resonance points of aerials. Removing the h.t. supply to the g.d.o. as mentioned earlier enables the device to be used as a 'phone monitor or as an absorption wavemeter or r.f. indicator. In these cases radiated radio frequency is detected.

In conclusion it can be fairly stated that this g.d.o. is well worth the trouble entailed in its construction; it will, quite definitely prove an attractive addition to many stations. ■