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THE CANADIAN RADIO AMATEURS' JOURNAL

DECEMBER, 1952

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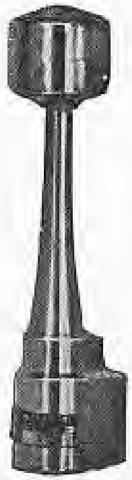

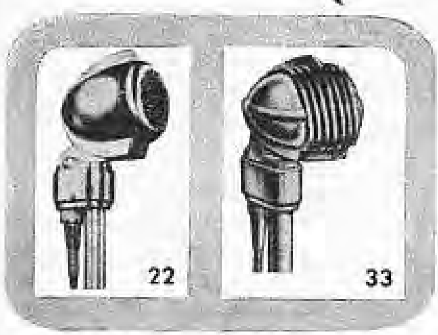
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Editor - Fenwick Job, VE3WO

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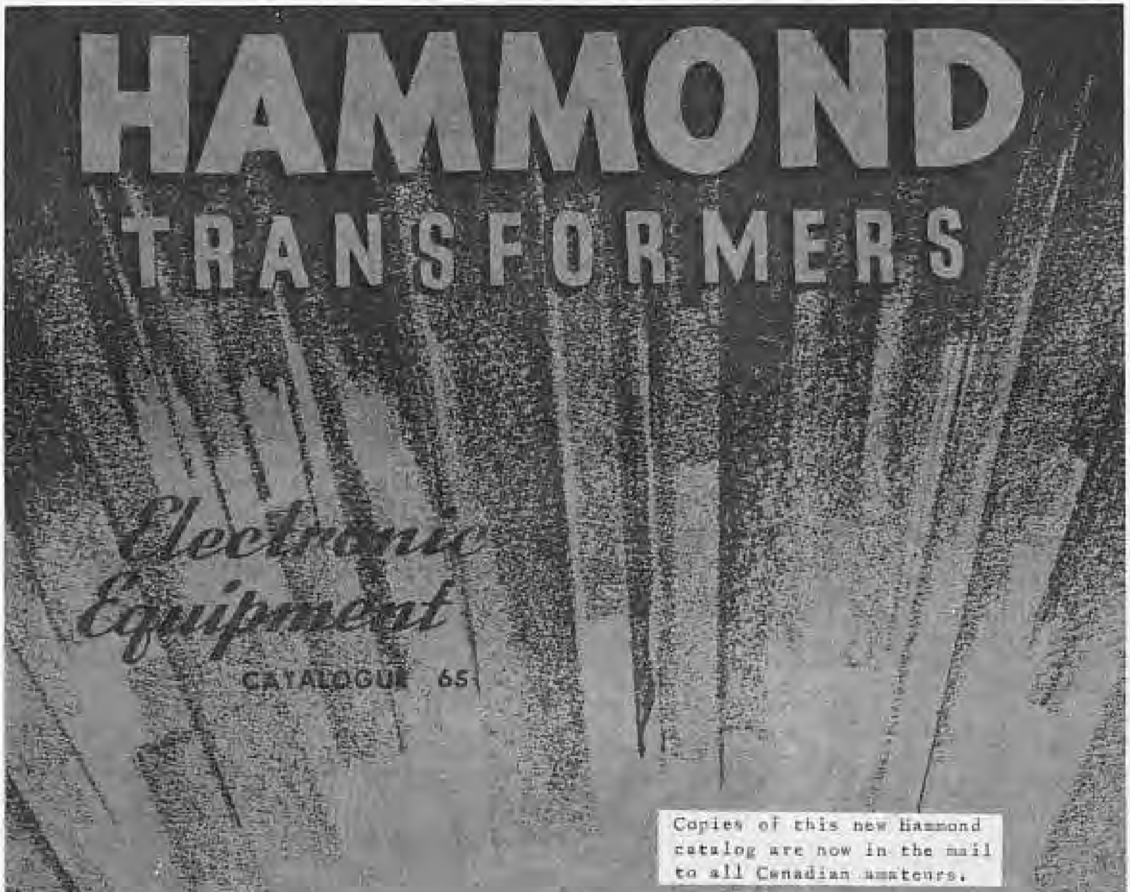
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Christmas Greetings to all VE's

Fenwick Job, VE3WO

Regulated Power Supply Design

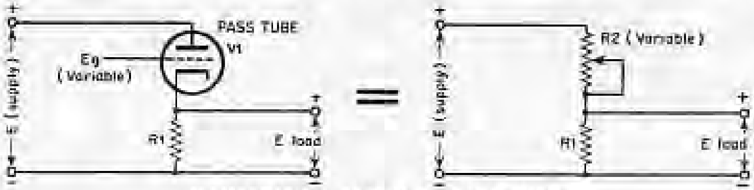
By the Engineering Department, Aerovox Corporation

A source of well-regulated plate voltage is a prerequisite for the modern laboratory, service bench or amateur station. An ever increasing number of electronic devices, such as audio amplifiers, r.f. oscillators, amateur vfo's, oscilloscopes, synchroscopes, timing circuitry, and many others, depend for their proper functioning upon a power supply which is hum free and delivers a constant voltage regardless of load. Fortunately, the development of electronically regulated sources has advanced to the state where their design and construction is well within the scope of the average user. This article outlines the theory, design and construction of a representative supply of this type. With a firm understanding of the design principles to be discussed, the reader should be able to adapt the practical supply presented here to other requirements which might exist.

Modern regulated supplies of the type to be described make available an output voltage which is continuously variable over a considerable range and which will not vary more than a fraction of one percent between no-load and full-load conditions. Normal line voltage fluctuations also have little effect on output voltage. In addition, the regulation may be made of such a high order that ripple voltages in the output are almost entirely cancelled, thus eliminating the need for the usual "brute force" filter. This saving in weight and space helps to compensate for the additional complexity of the electronic regulator.

Theory of Operation

To achieve precise voltage regulation, an electronic voltage control element must be introduced in the conventional supply circuit. In most regulated supplies, this electronically variable element takes the form of a high current vacuum tube, usually called the "pass tube" or "regulator tube" in this application. This tube is connected in series with the load resistance across the output of the supply, as in Fig. 1. Since the resistance of the triode varies as a function of its grid voltage, this combination acts as an electronically controlled voltage divider. A small change in the regulator tube grid voltage changes the effective ratio of the divider and thus varies the voltage appearing across the output load.



ILLUSTRATING ACTION OF PASS TUBE
FIG. 1

The ability to vary the output voltage of the supply by a minute grid voltage change suggests that automatic voltage regulation could be accomplished by feeding any attempted output voltage fluctuation back to this grid at such a polarity as to oppose that change. In other words, if the voltage across the load in Fig. 1 attempted to rise, the grid of the pass tube (V1) should be made more negative so that its internal resistance would increase and lower the load voltage. If the load voltage attempted to decrease, the converse action should occur.

This action is achieved by the circuit shown in simplified form in Fig. 2. Auxiliary circuitry consisting of a second vacuum tube, usually called the "control tube", and a constant voltage source such as a battery or "VR" tube is added to the circuit of Fig. 1. A sample of the output voltage is applied to the grid of the control tube by a tap on the output bleeder R1. The control tube de-

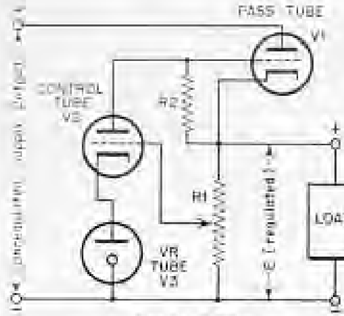
[illegible] tube [illegible] (R2) [illegible] the pass [illegible] for the regulator tube. The [illegible] or perform two [illegible]; it amplifies voltage fluctuations [illegible] its grid by the [illegible] reverses the [illegible] of these fluctuations so that they can be applied to the grid of the pass tube in the right direction [illegible] regulation. The precision of the regulation attained increases with the gain of the control tube [illegible] greater gain, a small [illegible] control tube grid voltage will [illegible] a greater control tube current change and hence a greater change in pass tube bias. Thus, [illegible] output voltage [illegible] will be corrected.

The battery or VR tube maintains the cathode of the control tube at a constant voltage above ground, and thus provides a standard reference voltage to which voltage fluctuations at the output divider (R1) are compared. The voltage at the grid of the control tube is the difference between the voltage at the output bleeder tap and the reference bias voltage provided by the VR tube. This difference voltage sets the "target" voltage to which the supply regulates. By changing the output bleeder tap with a potentiometer at R1, the regulated output voltage of the supply may be adjusted within certain limits.

Summarized briefly, the action of the electronic regulator of Fig. 2 is as follows: The position of the bleeder tap on R1 determines the output voltage level to which the supply will regulate. If the voltage across the bleeder attempts to rise above that level, the bias on the control tube (V2) becomes more positive, causing it to draw more current through its load resistor (R2). The increased current through R2 causes the grid of the regulator tube (V1) to be driven more negative, with the result that the resistance of the regulator tube increases sufficiently to prevent the original attempted excursion of output voltage and return it to the regulated level. If the output voltage attempts to *decrease*, the sequence of events is exactly opposite. The action is practically instantaneous, so that excursions are corrected for while still very small.

Practical Design Considerations

With a working knowledge of the functions of all component parts, the design of regulated power supply equipment is no more complicated than that of other electronic circuitry usually designed and constructed by the user.



SIMPLIFIED
ELECTRONIC REGULATOR
FIG. 2

As with any power supply design, the first step is to determine the desired output voltage and current requirements. This permits the selection of the proper power transformer, filter components, and pass tube. The supply section differs from standard design only in that considerably more voltage than the required output voltage must be provided since there is an appreciable minimum voltage drop across the regulator tube. Usually the unregulated section of the supply must furnish from 50 to 200 volts more than the desired regulated output.

For a sample design, let us suppose that a regulated output of about 300 volts at 75 milliamperes is required for a general utility supply. The practical circuit for such a supply is shown in Fig. 3. Knowing the current requirement, a suitable pass tube may be selected from Table I. Any triode or triode-connected pentode capable of passing the required current at a reasonable voltage drop may be employed. Tubes may readily be used in parallel where greater current is required or when greater plate dissipation is needed. Special types, such as the 6AS7 which was designed for pass tube applications, are also available. For our present design, a smaller tube such as the 2A3 or its 6.3 volt equivalent, the 6A3, will suffice.

TABLE I	
TUBE TYPE	CURRENT (Ma)
6AS7G	250
6A3	75
2A3	75
6B4G	75
6A5G	75
807 *	80
6L6 *	75
6V6 *	45
6F6 *	40
6Y6 *	60

* Screen connected to plate through 500 Ohm, 1 Watt resistor

The power transformer and filter choke must be *conservatively* rated for the full load current. Otherwise, the regulation of the supply will be poor. The required voltage rating for the transformer is determined by finding the sum of the voltage drops around the circuit for the condition of maximum output voltage and current. The drop across the pass tube is minimum for maximum output voltage and may be found by referring to the plate characteristic curves for the pass tube being used. For the 6A3 used in the present design, the minimum tube drop for the required load current is about 80 volts at zero bias. Actually, somewhat greater values should be designed for to provide a margin for low line voltage conditions. For the 6A3, a minimum drop of 140 volts is typical. Thus, the d.c. output of the supply section ahead of the regulator must be about 440 volts; 300 volts for the load and 140 minimum drop across the pass tube. Reference to the rectifier tube operating characteristics will indicate the r.m.s. voltage rating of the power transformer required to supply this voltage when a single section choke-input filter is used. With the 5U4-G employed in the present design, and allowing sufficient margin for voltage drop across the choke, low line voltage, etc., a transformer delivering 550 volts each side of center-tap at 100 ma. is indicated. The choke should also be rated at 100 ma.

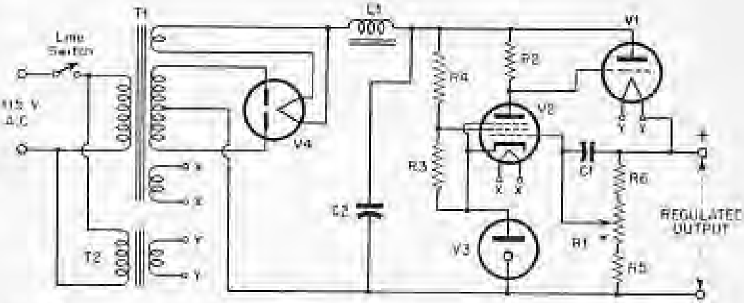
At this point, having selected the pass tube and determined the characteristics of the unregulated supply section, it is well to examine the pass tube operating conditions to determine if the allowable plate dissipation is being exceeded. The 6A3 is rated at 15 watts maximum dissipation. At full current and voltage from the supply, the drop across the pass tube estimated above was 140 volts. The plate dissipation under this condition is 140v. times .075 amps. or 10.5 watts. The low voltage limit to which the supply can safely be adjusted at full current may now be determined, since the voltage drop across the pass tube, and hence its plate dissipation, is maximum at the lowest regulated output voltage. The allowable drop for 15 watts plate dissipation is now calculated as 15 watts/.075 amp. or 200 volts. With a total unregulated voltage of 440v. available, the minimum regulated output of the supply is thus 240 volts. By using a larger pass tube, or several in parallel, the range of regulated voltage adjustment can be appreciably extended.

The choice of a control tube is rather arbitrary. Almost any pentode having a sharp cut-off characteristic may be used. The type most frequently employed in electronically regulated supplies is the 6SJ7, which is chosen for its low cost, ready availability, and high gain. Miniature types having similar characteristics may be used in applications where space is at a premium. The 6SJ7 will do nicely for the design under consideration.

Although batteries may be used for the source of control tube reference bias voltage, the gaseous voltage regulator tube is usually preferred. Tubes of the "VR" series give excellent life and stabilization in this application. The choice of VR type, VR75, 90, 105 or 150, depends on the unregulated voltage available and the portion of this which must be reserved for drop across the load-bias resistor (R2) and the control tube. It is desirable to utilize the highest voltage VR tube possible under these conditions, since this subjects the grid of the control tube to a larger portion of output voltage fluctuations. A VR150 is sufficient for the design being discussed, since the bias developed across R2 to reduce the output voltage to minimum is only about -30 volts, as indicated by the plate curves for the 6A3. The plate load resistor (R2) is chosen to be about equal to the plate resistance of the control tube. Values between .47 and .68 megohm are typical for the 6SJ7.

The by-pass capacitor, C1, is usually about .25 microfarads. It provides a path for 120 cycle ripple voltages and other high frequency fluctuations between the regulated output and the grid of the control tube.

The dropping resistors R3 and R4 are designed to provide 150 volts across the VR tube at the 8 ma. minimum current required for regulation and to provide a tap for control tube screen voltage. In computing the values of these resistors, the minimum unregulated supply output voltage must be used. Allowing for 10% drop in line voltage, this would be 396 volts in the present case. The required drop is then 396 minus 150 or 246 volts. At .008 ampere drain, the total resistance required (R3 and R4) is 246/.008 or 30,750 ohms. The portion of this resistance between the cathode and screen of the control tube to furnish a screen voltage of 100 volts should be 100/.008 or

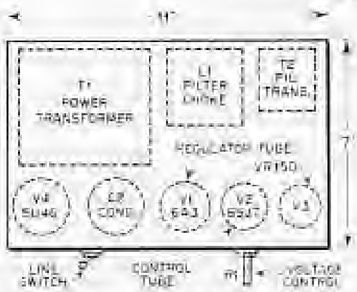


R1, R5, R6 – See text
R2 – .47 Megohm, 1 Watt
R3 – 12,000 Ohms, 5 Watt
R4 – 18,000 " " "
L1 – Filter choke, 8 Hy, 100 Ma

C1 – .25 μfd, Aerovox Type 84
C2 – 8 μfd, Electrolytic, Aerovox Type GL-EP
T1 – Power Transf., 550-0-550 V. @ 100 Ma
5 V. @ 3 A. and 6.3 V. @ 1 A.
T2 – Filament Transf., 6.3 V. @ 1 A

V1 – 6A3
V2 – 6SJ7
V3 – VR150
V4 – 5U4G

PRACTICAL REGULATED SUPPLY
FIG. 3



SUGGESTED PARTS LAYOUT
FOR REGULATED SUPPLY
FIG. 4

12,500 ohms. Thus the nearest standard values of 12,000 and 18,000 ohms will suffice for R3 and R4 respectively.

The total resistance value for the output bleeder is usually about .25 megohm, made up of a 50,000 wire-wound potentiometer for the voltage output adjustment and fixed carbon resistors (R5 and R6) above and below it to complete the total. The exact values of these for any particular regulated supply are most easily determined experimentally by substituting a .25 megohm potentiometer temporarily in place of R1, R5 and R6. Then, with the supply operating, the settings of the potentiometer tap for the minimum and maximum outpu tvoltages allowable under full load conditions can be determined. The potentiometer is then disconnected and the resistances measured with an ohmmeter. The resistance between the slider position for low voltage output and the ground end of the "pot" is the value for R5. Similarly, the resistance measured between the slider setting for high output voltage and the "hot" end of the potentiometer is the value for R6. The correct value for R1 is then R5 plus R6 subtracted from .25 megohm.

Construction

Standard power supply wiring practices apply to all portions of the regulated supply except the control tube section. Since this tube is acting as a high gain d.c. amplifier, it is very susceptable to hum pick-up which will appear as ripple in the output voltage. To minimize this, all leads associated with the control tube, and especially the grid lead from R1, must be as short as possible. The best practice is to mount the voltage control potentiometer adjacent to the control tube socket at a location as far as possible from the power transformer, filter chokes, filament transformers, and other components which produce hum fields.

A chassis lay-out which is suitable for the design discussed above is shown in Fig. 4. All parts are mounted on a 7 x 11 x 2 inch metal chassis. Well-shielded components should be used and all a.c. leads must be twisted in pairs to reduce hum radiation. A separate filament winding is required for the regulator tube since the filament of this tube is operated at the full supply output voltage above ground. When the special 6AS7G pass tube is used, this precaution is not necessary because the heater-cathode insulation in this tube is sufficient to withstand 300 volts.

The completed supply should be checked for satisfactory regulation by varying the load current from the full design rating to zero. Under these conditions, the change in output voltage should be negligible. Ripple content can be checked qualitatively with earphones coupled through a suitable condenser, although an oscilloscope is very much preferable.

Notes on Class C Amplifier Design

Considerable has been written on the theory, tuning, and operation of the classic "class C amplifier". However, we note a dearth of information regarding the important considerations pertaining to mechanical construction. These are just as important as bias, excitation, etc., and some of the things to observe in constructing a class C amplifier stage are given herewith.

R.F. Leads

Do not use tinned wire for leads that carry any appreciable amount of r.f. energy. Use heavy gauge bare copper wire (no. 10 or larger) or enameled if this is not available.

Grounds

Be careful about common grounds. Return all grounds for each *stage* to a common point approximately at the electrical center of the circuit. The point where the filament center tap by-pass condensers are grounded is usually a good point. Then run a lead from each stage ground to a common ground *point* in the *transmitter*. If a good external ground is close at hand, ground this point to it by means of a heavy conductor. If the external ground is too far away (especially on the higher frequencies) it is frequently better not to use it at all. However, all the equipment in the shack should have a common ground lead.

The filament by-pass condensers for each stage should, as mentioned before, be at about the electrical center of the stage. The filament transformer can be located at any convenient place that is consistent with low drop in the filament leads. The center-tap of the filament transformer should be grounded at the transformer.

It is generally a good idea to lay out a stage mechanically very much similar to the electrical layout shown in a good circuit diagram. While this does not always hold true, it will quite frequently give an idea as to the most efficient arrangement.

Push-Pull Stages

In laying out a push-pull stage, do *not* lay it out perfectly symmetrically. Perfect symmetry will almost invariably give place to ultra-high frequency parasitic oscillations. Very often these are quite difficult to detect. Especially is this true in phone rigs where the parasitics will only show up on high modulation peaks. Also, they sometimes show up in a low-level-keyed c.w. rig when the key is up with full plate voltage on the amplifier tubes.

As the shunt capacity in the grid circuit is usually greater than in the plate circuit, the grid leads should either be very much shorter than the plate leads or slightly longer. In the ordinary arrangements the most convenient layout is too frequently the one where the grid leads are slightly shorter than the plate leads. This should always be avoided.

It is generally a good idea to make the plate leads fairly long and approximately symmetrical. The grid circuit, in this case, should not be laid out symmetrically; one lead can best be made very short and direct and the other one considerably longer.

Place the neutralizing condenser or condensers in a position where their leads can be made as short and direct as possible right to the elements of the tubes. Do *not* make neutralizing condenser leads to a tank where the grid or plate lead connects; make them directly to the elements concerned. Where this is not possible, make them as close to the actual connection to the element of the tube as can be managed.

Where a push-pull stage is to be laid out on a metal chassis, make sure that each side of the circuit is balanced with respect to any large mass of metal such as the chassis or the front panel. The capacity unbalance that may be caused by poor layout can easily cause the stage to be difficult to neutralize or cause one tube to take more than its share of the load.

Simplicity

Do not use any more parts in a circuit than are absolutely necessary to its operation. If an r.f. choke or a by-pass condenser can be eliminated without affecting the apparent operation of the circuit, the rig will more than likely be better rather than worse after the operation has been performed.

Stray Inductive Coupling

In laying out the tank coils be careful to make sure that there will be a minimum of mutual induction between them. The following rule may be helpful: When the lines of centers of two symmetrical coils (the line of center of a coil is the line that passes through the exact center of the coil longitudinally) intersect at a right angle in the center of one of the coils, there will be no mutual inductance or inductive coupling between them. Or, more broadly, when the line of center of one coil falls in a plane that passes through the center of the second coil and this plane is perpendicular to the line of centers of the second coil, there will be no coupling between them. The above rules may seem too complicated to some. If they do, sit down with a pencil and paper and draw a couple of coils and lines of centers and so forth and prove the rules to yourself. If these rules are once proven to you, it will be a very much simpler task to reduce the undesired intercoupling in the next transmitter you build. Merely putting two coils at "right angles" does not necessarily eliminate inductive coupling.

One other thing: remember that the above rules still apply to coils mounted on different shelves in a rack unless, of course, they are quite far removed from one another or they are shielded from one another.

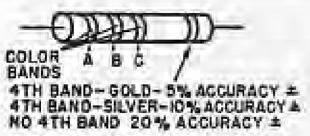
Link Circuits

Use heavy gauge, untinned copper wire in your link circuits. EO-1 cable or a similar product makes excellent links for the higher level stages or for coupling from the final stage to the antenna. Heavy enameled wire, insulated with lengths of spaghetti and twisted, works very well for short distances or for the lower power stages. No. 10 untinned copper wire, spaced about a half inch on stand-off insulators, is advisable for frequencies above 28,000 kc.

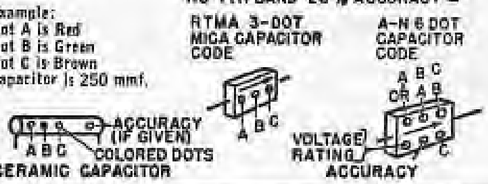
COLOR CODE CHART—FOR RESISTORS AND CAPACITORS

Color Dot A (mmf.) Color Band A (ohms)	Color Dot B (mmf.) Color Band B (ohms)	Color Dot C (mmf.) Color Band C (ohms)
Black 0	Black 0	....
Brown 1	Brown 1	Brown ...... Add 1 zero
Red 2	Red 2	Red ...... Add 2 zeros
Orange 3	Orange 3	Orange ...... Add 3 zeros
Yellow 4	Yellow 4	Yellow ...... Add 4 zeros
Green 5	Green 5	Green ...... Add 5 zeros
Blue 6	Blue 6	Blue ...... Add 6 zeros
Violet 7	Violet 7	Violet ...... Add 7 zeros
Gray 8	Gray 8	Gray ...... Add 8 zeros
White 9	White 9	White ...... Add 9 zeros

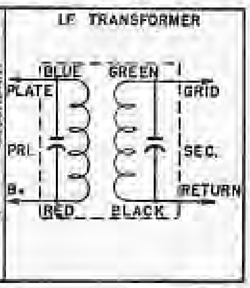
Example:
Band A is Yellow
Band B is Violet
Band C is Orange
Resistor will be 47,000 ohms.



Example:
Dot A is Red
Dot B is Green
Dot C is Brown
Capacitor is 250 mmf.



PUSH-PULL TYPE SHOWN. TRANS. WITH SINGLE PRIMARY AND SECONDARY IS CODED LIKE FOUR UPPERMOST LEADS.



STANDARD RESISTOR VALUES

Except in cases where a very low ohms value is called for, any resistance under 500 ohms, it is usually safe to use the nearest value shown in bold face type in Table A.

TABLE A—STANDARD RESISTANCE VALUES

Identical

All values in OHMS*						MEGOHMS		
1.0	**10**	**100**	**1,000**	**10,000**	**100,000**	**0.1**	**1.0**	**10.0**
1.1	11	110	1,100	11,000	110,000	0.11	1.1	11.0
1.2	**12**	**120**	**1,200**	**12,000**	**120,000**	**0.12**	**1.2**	**12.0**
1.3	13	130	1,300	13,000	130,000	0.13	1.3	13.0
1.5	**15**	**150**	**1,500**	**15,000**	**150,000**	**0.15**	**1.5**	**15.0**
1.6	16	160	1,600	16,000	160,000	0.16	1.6	16.0
1.8	**18**	**180**	**1,800**	**18,000**	**180,000**	**0.18**	**1.8**	**18.0**
2.0	20	200	2,000	20,000	200,000	0.2	2.0	20.0
2.2	**22**	**220**	**2,200**	**22,000**	**220,000**	**0.22**	**2.2**	**22.0**
2.4	24	240	2,400	24,000	240,000	0.24	2.4	
2.7	**27**	**270**	**2,700**	**27,000**	**270,000**	**0.27**	**2.7**	
3.0	30	300	3,000	30,000	300,000	0.3	3.0	
3.3	**33**	**330**	**3,300**	**33,000**	**330,000**	**0.33**	**3.3**	
3.6	36	360	3,600	36,000	360,000	0.36	3.6	
3.9	**39**	**390**	**3,900**	**39,000**	**390,000**	**0.39**	**3.9**	
4.3	43	430	4,300	43,000	430,000	0.43	4.3	
4.7	**47**	**470**	**4,700**	**47,000**	**470,000**	**0.47**	**4.7**	
5.1	51	510	5,100	51,000	510,000	0.51	5.1	
5.6	**56**	**560**	**5,600**	**56,000**	**560,000**	**0.56**	**5.6**	
6.2	62	620	6,200	62,000	620,000	0.62	6.2	
6.8	**68**	**680**	**6,800**	**68,000**	**680,000**	**0.68**	**6.8**	
7.5	75	750	7,500	75,000	750,000	0.75	7.5	
8.2	**82**	**820**	**8,200**	**82,000**	**820,000**	**0.82**	**8.2**	
9.1	91	910	9,100	91,000	910,000	0.91	9.1	

Note:* Values below one ohm are available for precise instrument or laboratory work. They are not ordinarily needed by the radio or TV experimenter.

10% accuracy resistors are less costly and can be used for most applications. All values may not be available from all manufacturers or radio supply houses.

It will be noted that resistors are standardized in *units, tens, hundreds, thousands* . . . reading across table. This simplifies reading of color codes. While standard values stop at 22 megohms, IRC and certain other resistor makers supply values up to 200 megohms for laboratory use.

the "VARI-SLOPE"

Designed for plugging into TL/12 and TL/25A amplifiers.

The "Vari-Slope" replaces the RC/PA/U pre-amplifier, which is discontinued.

A RADICALLY NEW PRE-AMPLIFIER FOR LEAK "POINT ONE" POWER AMPLIFIERS

embodying

A UNIQUE FEEDBACK CIRCUIT DEVELOPMENT

giving the user

AUDIBLY BETTER REPRODUCTION

from records and radio

The new "Vari-Slope" pre-amplifier has a refinement which will doubtless set the pattern for future high-fidelity reproducing amplifiers. This advance consists of variable-slope "electronic" low-pass filters operating on negative voltage feedback principles.

NO INDUCTORS ("CHOKES") ARE USED and all their disadvantages are completely eliminated.

THE PROBLEM.

It is common knowledge that owing to defects in radio transmissions, and (more particularly) in records, the most satisfying results are almost always obtained when the high-frequency response of the reproducing amplifier is restricted. The simplicity of this simple statement of fact hides the very real difficulties of making equipment to meet the need. These difficulties arise from two factors: first, the nature and the magnitude of the distortions inherent in records varies greatly from record to record. Second, with any particular record the magnitude of the high-frequency restriction which is deemed to be required, and the manner in which the restriction is distributed over the frequency band, will depend on three things: the taste of the individual listener, the characteristics of his pickup and loudspeaker, and the acoustic characteristics of his listening room.

From the above it follows that the requirement is for a very flexible system which will vary not only the frequency at which the response begins to fall but also the *rate* at which the response falls off. Creditable attempts have been made to meet these requirements by means of conventional "low-pass" choke-capacitor filters, but even when properly designed and constructed these filters introduce considerable distortion on transients, which is only to be expected from the oscillatory nature of a circuit containing inductance and capacitance. *This transient distortion is very real*: it can be predicted from theory, demonstrated by oscilloscope, *and most importantly, it is audible*, particularly with steep slopes of attenuation. This is the main reason why we have always expressed dissatisfaction with conventional filters of this type, even though we make and market them.

THE SOLUTION to the problem is the elimination of all choke-coils, and this has been achieved by using modified twin-T resistor-capacitor networks in negative-feedback loops. We have evolved an ideal form of continuously-variable slope control which increases the feedback as the slope is made steeper. The obvious advantages of our electronic feedback method over conventional choke-coil filters are :—

(*a*) Improved transient response characteristics and the consequent reduction of "ringing".

(*b*) Extremely low harmonic and intermodulation distortion due to the negative voltage feedback action.

(*c*) No discontinuities in the rates of slope when the slope control is operated, and no change in signal level at frequencies below cut-off. (Both these faults occur in variable-slope choke-capacitor filters due to the slope control altering the terminating impedance and the insertion loss).

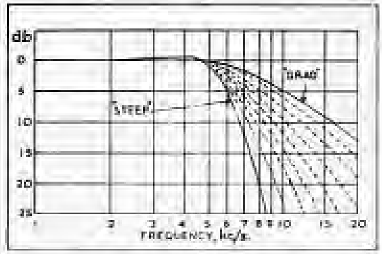
(*d*) There are no chokes to give rise to magnetic hum.

(*e*) Smaller size, lighter weight, greater uniformity in production.

Extended listener-research tests established that the cut-off frequency should be variable between 5kc/s and 9kc/s and that the slope of attenuation should be continuously variable between 5db and 50db over the octave immediately following the cut-off frequency.

FIG. I.

Response curves obtained on "TREBLE —3" position (turnover 5kc/s). The "—2" and "—1" positions give similar continuously variable ranges of slopes, turning over at 7kc/s and 9kc/s respectively.



RECORD REPRODUCTION.

The equalisation for the recording characteristics of records is obtained in all three positions for "RECORDS" by resistor-capacitor feedback networks.

The "78B" position is very accurately the inverse of the E.M.I. characteristic. The Decca 78 characteristic is the same except that treble cut is called for above 4kc/s, and the inverse can be accurately obtained by using the slope control.

The "78A" position is for American records, including LP's, for it very accurately follows the standard playback curve stipulated by The Audio Engineering Society, whose membership includes the foremost American recording engineers.

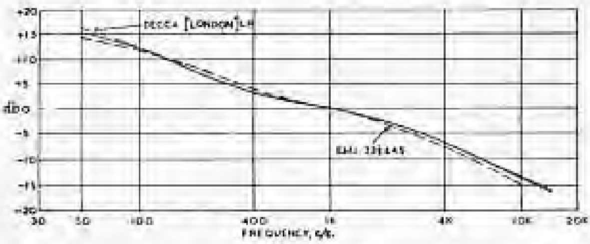


FIG. II.

The "LP" position is for Decca ("London" in the U.S.), the new E.M.I. 33⅓ and 45 records (to be released in Britain later in 1952), and for Columbia (U.S.) LP's. The solid line shows the built-in equalisation, and is compared with Decca and E.M.I. characteristics.

The pre-amplifier will operate from any pickup generally available in the world. The sensitivity is 15mV at 1,000c/s for full power output from the associated TL/12 amplifier. The input impedance is 100,000 ohms.

RADIO.

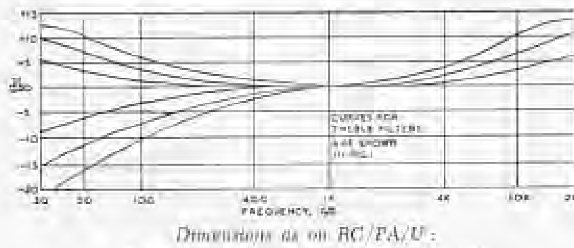
The pre-amplifier will operate from any radio unit generally available in the world, the sensitivity being 60mV. Flat response.

MICROPHONE.

The sensitivity is 4mV, and the input impedance is 200,000 ohms. Flat response.

FIG. III.

The effects obtainable with the feedback tone-control system.



Dimensions as on RC/PA/U:

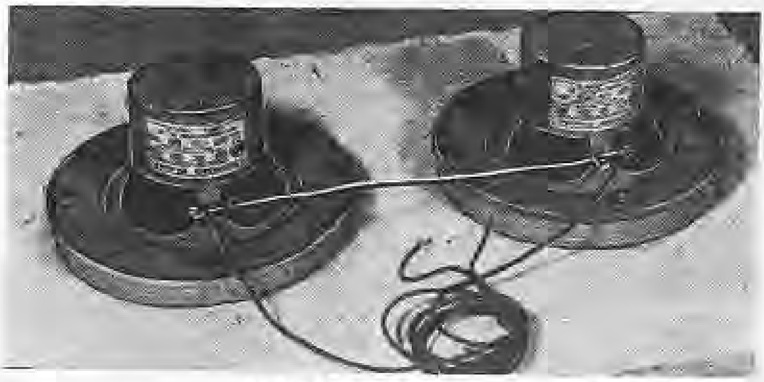
Front panel, 10¾" × 3½" (27.3 × 8.9 cms).
Chassis, 10" × 3" × 2¾" (25.4 × 7.6 × 7.0 cms).
Weight, 4 lbs. 8 ozs. (2.04 kgs).
Valve, ECC81 (12 AT7).

BRITISH USERS OF THE RC/PA/U PRE-AMPLIFIER. Your old model can be re-built as a standard "Vari-Slope" at a charge of 8 gns. Orders will be booked in rotation. Please do not send your pre-amp to us until we advise you of a date.

OVERSEAS USERS. Please contact your national agent regarding the availability of this re-building service, which is dependent on freight and re-import duties being reasonably low.

H. J. LEAK & CO., LTD. (Est. 1934), Brunel Road, Westway Factory Estate, Acton, W.3

Twin Speakers Improve Fidelity

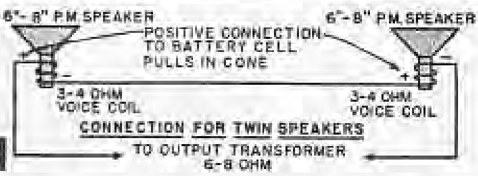


IF YOU have twin 6 or 8 in. P.M. type speakers, it's an easy job to connect them in series at their voice coils, and their combined performance will sound very much like one expensive speaker of twice the diameter. The two-speaker combination will, in fact, reproduce any audio signal with less distortion. Costwise, the two small 6 in. P.M. speakers cost about the same as one large 12 in. speaker.

To connect the small speakers in series, first mount them on a single baffle of suitable size (preferably of ½ in. insulating board).

The important thing to consider when connecting the voice coils is their correct polarity with respect to the operation of the cones. They must work in phase, that is, both cones must be pulled in and pushed out together, on each impulse of the signal, or vibrate together, rather than have one pull in and the other push out. To do this, use a flashlight cell and 2 clip leads to test the operation of each cone (Fig. 1). With the positive, (top of cell) connected to a certain voice coil terminal, the cone will be pulled in. If you reverse the battery polarity, the cone will be pushed out. Mark the terminal used when the cone is pulled in with positive polarity on that terminal. Do the same thing to the other speaker. It is now a simple job to connect the two voice coils in series (Figs. 2 and 3), connecting a positive to a negative. Solder on long leads for connection to the output transformer. Then double-check by attaching the battery to the long leads, and make sure that both cones pull in and push out together, with a reversal of the battery leads. The two speakers will now operate as a single unit, each taking half the power output, which doubles the capacity of a single speaker of the same size.

For good bass reception, speakers should have a rather flexible cone mounting, since bass is at the lower frequencies where the maximum cone movement is evident. Many speakers will be found with very stiff working cones, easily determined by gently pushing in at the center with a finger. Such speakers work all right at the higher frequencies, but may lack good bass response. In the past, speakers were made with a flexible leather mounting ring at the edges of the cone to improve the bass. The two shown in Figs. 1 and 2 have bellows-like construction at the edge, rather than the usual direct mounting to the frame, to provide a more flexible operation of the cones.

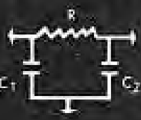


3

For good fidelity choose a good quality output transformer of generous size, since a cheap, small transformer will often fail to cover the wide frequency band of the signals delivered to it, if the full range of the musical scale is desired. The transformer must also match the rated load resistance of the amplifier output tube or tubes in the circuit, to the voice coil impedance. For example, a 6V6 with 250 volts on the plate requires 5000 ohms load resistance. Using the twin speakers, each with a 3-4 ohm voice coil, this becomes 6-8 ohms in series. Thus, you must match 5000 ohms to 6-8 ohms on the secondary of the transformer.

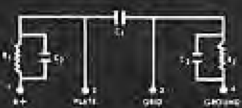
ERIE PRINTED CIRCUITS

DIODE FILTER



1403-01 1403-02
1403-03

TRIODE PLATE COUPLER



1404-01 1406-01
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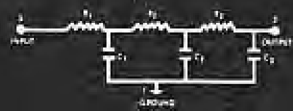
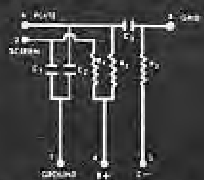
VERTICAL INTEGRATOR



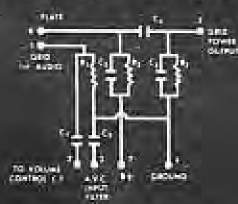
1405-01

PENTODE PLATE COUPLER



1407-01 1407-02
1407-03

AUDIO OUTPUT CIRCUIT



1408-01 1408-02

ERIE PRINTED CIRCUITS
offer these advantages:

- Fewer soldered connections mean less installation time.
- One installation unit replaces several.
- Fewer connections mean fewer wiring errors.
- Circuit stability is improved through simplification.
- Lower costs for procurement and stock maintenance.
- Other material costs are decreased by smaller size, lighter weight.

Save Space . . . Time . . . Cost and Improve Stability

Erie Resistor began the development of Printed Circuits in 1940. Since then the advantages of Printed Circuits have been amply demonstrated and Erie has made important contributions in the field.

By bonding the complete or partial circuit to a ceramic base plate, the work of several capacitors may be combined in one installation unit. Erie Printed Circuits have simplified design and production problems for manufacturers of radio and television receivers, hearing aids, and other electronic products, including various military equipment requiring sub-miniaturization. Such products may be reduced in size, weight, and cost, at the same time that they are made more reliable in service.

1151 ROSELAWN AVE. • TORONTO, ONTARIO

Factories: Toronto, Ontario; London, England; Erie, Pa.

DX PREDICTIONS

Prepared by C.B. McKee, Engineering Division, CBC International Service

PREDICTIONS FOR MONTH OF JANUARY, 1953

Skywire frequency predictions are for amateur communications on various circuits to almost any part of the world. These tables are for five major areas in Canada, and amateurs who are operating reasonably close to the cities indicated will find these predictions quite adequate.

Figures shown are in megacycles and indicate the band to be used. They are for normal F layer transmission and don't consider Sporadic E which may provide unusual DX openings!

Toronto to: EST	00	02	04	06	08	10	12	14	16	18	20	22
Europe	7	4	7	7	14	14	14	14	7	7	7	7
Africa	7	-	-	-	-	-	-	14	14	14	7	14
Caribbean	7	7	7	7	14	14	14	14	14	14	7	7
S. America	7	7	7	14	14	-	-	14	14	14	14	7
Australia	-	-	-	7	7	-	-	-	-	-	-	-
U.S. - West	14	7	7	7	7	14	14	14	14	14	14	14
U.S. - Central	7	7	7	7	7	14	14	14	14	14	14	7
U.S. - South	7	7	7	7	14	14	14	14	14	14	14	7
Vancouver	7	7	7	7	7	14	14	14	14	14	14	14
Watrous	4	4	7	7	7	14	14	14	14	14	14	7
Montreal	4	4	4	4	7	7	14	14	7	7	7	7
Sackville	4	4	4	4	7	14	14	14	14	7	7	7

Sackville to: AST	01	03	05	07	09	11	13	15	17	19	21	23
Europe	7	4	7	7	14	14	14	14	7	7	7	7
Africa	7	-	-	-	-	-	-	14	14	14	7	7
Caribbean	7	7	7	7	14	14	14	14	14	14	7	7
S. America	7	7	7	14	14	-	-	14	14	14	7	7
Australia	-	-	7	7	7	7	-	-	-	-	-	-
U.S. - West	7	7	7	14	7	14	14	14	14	14	14	14
U.S. - Central	7	7	7	7	14	14	14	14	14	14	14	14
U.S. - South	7	7	7	7	14	14	14	14	14	14	14	14
Vancouver	7	7	7	7	7	14	14	14	14	14	14	14
Watrous	4	4	7	7	7	14	14	14	14	14	14	7
Toronto	4	4	4	4	7	14	14	14	14	7	7	7
Montreal	4	4	4	4	7	7	7	7	7	7	7	4

Watrous to: CST	22	00	02	04	06	08	10	12	14	16	18	20
Europe	7	7	7	7	7	7	14	14	7	7	7	7
Africa	7	-	-	-	-	14	14	14	14	14	14	7
Caribbean	7	7	7	7	14	14	14	14	14	14	14	14
S. America	14	7	7	7	14	-	-	14	14	14	14	14
Australia	-	-	7	7	7	7	7	-	-	-	-	14
U.S. - West	7	7	7	7	7	7	14	14	14	14	14	14
U.S. - Central	7	7	7	4	4	14	14	14	14	14	14	7
U.S. - South	14	14	14	7	7	14	14	14	14	14	14	14
Vancouver	7	7	7	7	7	7	14	14	14	14	14	14
Toronto	4	4	7	7	7	14	14	14	14	14	14	7
Montreal	4	4	7	7	7	14	14	14	14	14	14	7
Sackville	4	4	7	7	7	14	14	14	14	14	14	7

Montreal to: EST	00	02	04	06	08	10	12	14	16	18	20	22
Europe	7	4	7	7	14	14	14	14	7	7	7	7
Africa	7	-	-	-	-	-	-	-	14	14	14	7
Caribbean	7	7	7	7	14	14	14	14	14	14	7	7
S. America	7	7	7	14	14	-	-	14	14	14	7	7
Australia	-	-	7	7	7	7	-	-	-	-	-	-
U.S. - West	14	14	14	7	7	14	14	14	14	14	14	14
U.S. - Central	7	7	7	7	7	14	14	14	14	14	14	7
U.S. - South	7	7	7	7	14	14	14	14	14	14	14	7
Vancouver	7	7	7	7	7	14	14	14	14	14	14	14
Watrous	7	7	7	7	7	14	14	14	14	14	14	7
Toronto	4	4	4	4	7	7	14	14	7	7	7	4
Sackville	4	4	4	4	7	7	7	7	7	7	7	4

Vancouver to: PST	21	23	01	03	05	07	09	11	13	15	17	19
Europe	7	7	7	7	7	7	14	14	7	7	7	7
Africa	7	7	7	7	7	14	14	14	14	14	14	14
Caribbean	7	7	7	7	7	14	14	14	14	14	14	7
S. America	7	7	7	7	7	-	-	-	14	14	14	14
Australia	-	-	7	7	7	7	7	14	14	-	-	14
U.S. - West	7	4	4	4	4	4	14	14	14	14	14	7
U.S. - Central	7	7	7	7	7	14	14	14	14	14	14	14
U.S. - South	14	14	14	7	7	14	14	14	14	14	14	14
Watrous	7	7	7	7	7	7	14	14	14	14	14	14
Toronto	7	7	7	7	7	14	14	14	14	14	14	14
Montreal	7	7	7	7	7	14	14	14	14	14	14	7
Sackville	7	7	7	7	7	14	14	14	14	14	14	14

HAMADS

Skywire Hamads must pertain to amateur radio. Rates are 20 cents per word, per insertion for commercial advertisements for profit, and 4 cents per word for all non commercial, non-profit advertisements by experimenters or licensed radio amateurs. Full remittance MUST accompany copy. Print plainly and count address in the total. Do NOT send personal checks unless exchange is included. Mail to Skywire, Toronto.

REAL BARGAINS. Any new or old amateurs will find one of the biggest hot bargains of parts, equipment, surplus, etc. Also complete sets, transmitters, receivers, converters, etc. Have to cut operation to more than half due to bad health. One example - transmitter, complete phone-CW, T-55 modulated with pair of 811's, 2 ½ meter receiver, 16 tubes, 110 VAC, 60 cycle. If you need any ham equipment from a complete unit to the smallest part, contact Pierre Joron, VE2DV, 153 E. Price St. Chicoutimi, P.Q.

FOR SALE - Two SCR-522's, complete with racks, FT-244-A Dynamotors and cables for each. T.J. Birks, Penetanguishene, Ontario.

FOR SALE - 100 watt transmitter - 807 PP final, 806 modulator PP, McMurdo-Silver all band exciter - new, never used, separate power supply for modulator and final. Final, each power supply, and the modulator on 8 x 10 x 2 chassis, with front panels, B and W coils for final grid and plate. AM-NBFM VFO. What offers on this ? VE3CMW, M. Wood, 939 Justice Building, Ottawa.

FOR SALE - Surplus 1155-B receiver, with speaker and blueprints, for $60.00. Converted for AC. Will pay Express costs. L.T. Thomas, VE5ZT, Lampard, Sask. Want HQ-129-X or something similar. Write me.

TRADE - TBS-50 transmitter complete with power supply, in new new condition. The value is approximately $200.00 Will trade for good receiver or use as down payment. VE7XK. Box 88, Coombs, B.C.

TRANSFORMER LAMINATIONS for sale. Few different small sizes for experimenters. 582 Bathurst Street, Toronto, Ontario.

If you have anything in ham gear you want to clear out of the shack Skywire Hamads will do the job.

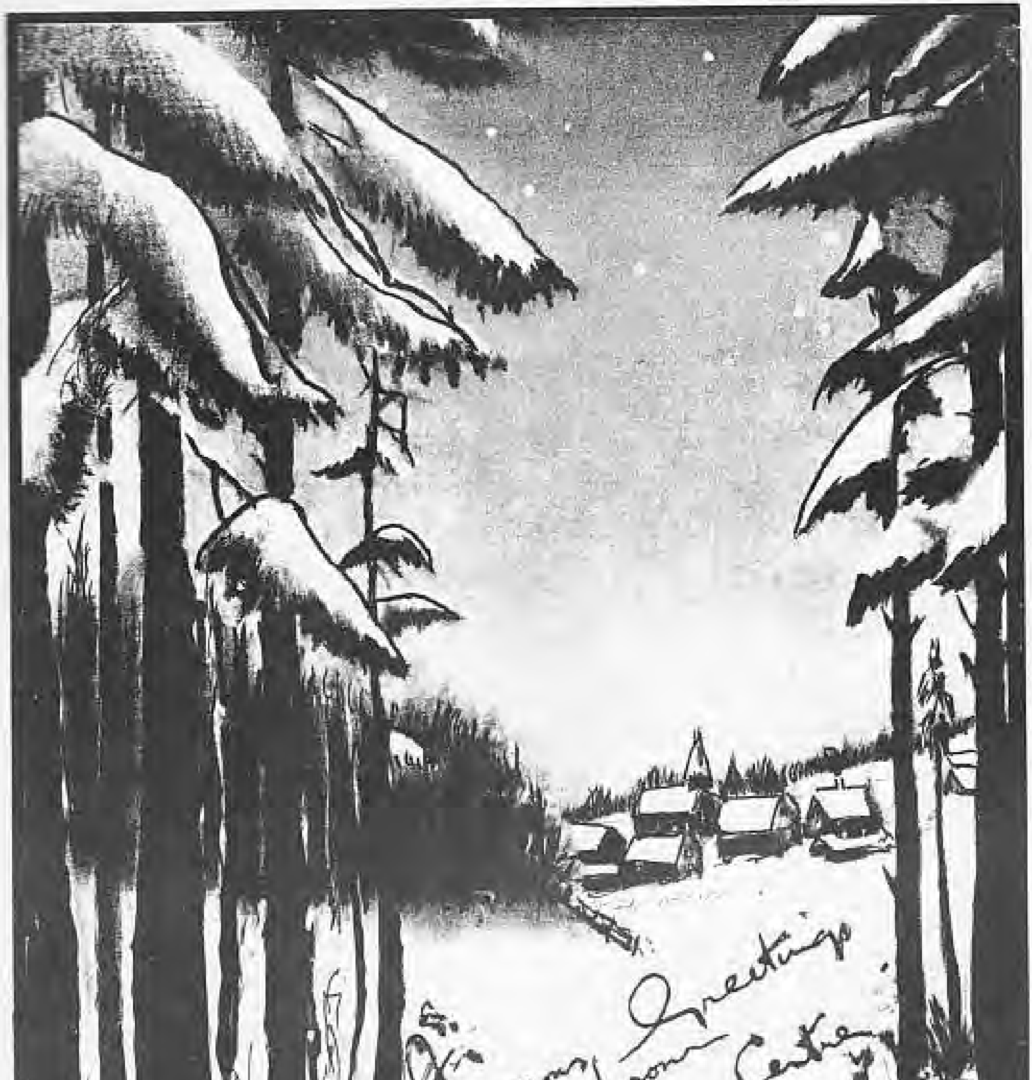
FOR SALE - Meissner Signal Shifter Model EX-1090, complete with 115 VAC Power Supply - $120.00. Phase modulator, NFM, installed in above - $19.00. Speech Clipper, Electro Voice, Model 1000, for the above - $19.00. Final amplifier with a power supply (approx 80 watts) - $30.00 Contact VE3WJ, A.F. Hollinsworth, 93 Queens Drive, Weston, Phone CH 1 - 2173

FOR SALE - National Receiver NC-173 with NFM adapter - $200.00. Receiver NC-183 for $250.00. Converter, RME HF-1020 - $75.00. Receiver 1155 mounted in new Hammond panel and cabinet - $60.00. See VE3CL, R.E. Hadfield, 14 SunnyLea Avenue East, Toronto.

TRANSMITTER ! 75 WATTS, phone or CW Five foot Hammond 1460-K floor cabinet. Contains Millen exciter, with all coils, modulator, 750 volt 25 cycle power supply with Hammond parts throughout. Also BC-696 VFO. Sell whole or part. Make an offer. VE3KW, ORchard 9426.

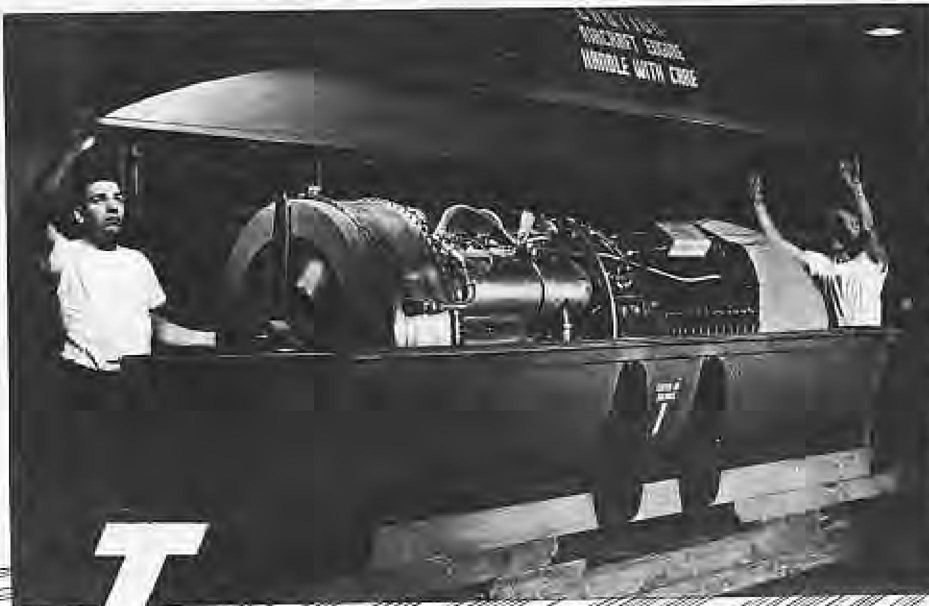
WILL SELL to highest bidder an HRO model M, modernized with new knobs by National, noise silencer, good speaker, PLUS one GE YRS-1 Single-Sideband adapter unit wired in and operating. The whole unit is finished in smart grey-blue crackle. This is a superb piece of equipment giving tremendous selectivity and quiet performance. Outperforms anything on the market today. What offers? Write Box 11, Skywire.

Have BC-696-A transmitter unit, filaments rewired for 12 volts. This is the latest Navy model and is brand new. What offers?? Send replies to VE3WO, Skywire


Seasons Greetings
from
The Radio Centre

Marconi Opens New Toronto Branch

Completion of a new branch office and warehouse building in Toronto is announced by S. Slinger, Ontario Division Manager of e Canadian Marconi Co. The new building will be located in North Toronto at the corner of Bayview Ave. and Glazebrook St. is move to new quarters by the Canadian Marconi Co. was necessitated by the rapid growth and increasing demands of the ectronics industry. The new office, warehouse and shipping facilities will ensure more efficient handling of customers' orders and enquiries.



JETS ARE BIG BUSINESS!

And General Electric has new research facilities for developing their incalculable power

IT WAS a September day in 1941. In England, RAF Spitfires were fighting a desperate battle against Nazi bombers in the flaming skies over London. Jet planes were then only a hope, and a fear. A hope, because the British had just sent an experimental jet plane into the air. A fear, because the Nazis might be developing one, too. (They were, as later intelligence reports proved.)

In Washington, D.C., the late General Arnold, chief of the Army Air Forces, was holding a secret meeting in the Pentagon. Gathered around his desk were five General Electric engineers. One of them had just returned from London, where he had been shown, under Government orders, the blueprints of the British jet engine.

The meeting was brief. "Gentlemen," said the general, "will your company take the responsibility of building the first American jet engine?"

There was no time for weighing pros and cons, no time for conferences back in Schenectady.

"Yes," was the answer.

Thus began, in secrecy and urgent haste, the history of jet propulsion in America. In the nine intervening years—a brief span in the life of an industry—General Electric's jet engine business, now known as the Apparatus Department's Aircraft Gas Turbine Divisions, has grown from nothing into a mammoth operation. At a cost of 22 million dollars the Company has built up a jet center at Lynn River Works that is one of the leading facilities of its kind in the world.* Existing buildings and equipment were modernized and expanded. And a new laboratory for research and development was built from scratch.

How many engines are being built, how many people it takes to build them, are facts which cannot be revealed for security reasons. But it can be said that the AGT divisions is now the biggest of the Apparatus Department's separate businesses—bigger even than the 60-year-old turbine business.

The story of jet propulsion has been an exciting one from the start. History

At Muroc Air Force Base, Manager LaPierre is ready to get first-hand experience in jet propulsion.

* *AGT also utilizes substantial government-owned facilities at River Works and an assembly plant at Lockland, Ohio.*

repeating itself, in a way, when the Air Force asked General Electric to accept the job of jet engine development. During World War I the Army Air Corps turned to G.E. to build the first turbosupercharger, the device which enables piston-engine planes to fly bigger, farther, and faster.

First Choice

General Electric was the logical choice to develop this country's first jet engine, mainly because of the work initiated by the late Dr. Sanford A. Moss. As early as 1903 he had operated the first turbine wheel ever run in America on products of combustion. By the summer of 1918 the first turbosupercharger had been built and successfully tested on the summit of Pike's Peak.

General Electric, co-operating with Army Air Corps engineers, continued developing the turbosupercharger during the 30's. By the time World War II was on, our turbosupercharged planes were flying farther and faster than those of other countries.

Work on the turbosupercharger, now being handled by the Aircraft Gas Turbine Divisions, is still advancing. Announcement was recently made of a new turbosupercharger which will enable commercial airliners to make longer non-stop flights, and carry heavier loads. For instance, a piston-engine airliner equipped with these turbos could fly non-stop from Chicago to London, with a heavy payload aboard.

It was because of the Company's prestige in the turbosupercharger field that it was asked to develop the jet engine, since the two are related in principle.

Things moved quickly after the meeting in General Arnold's office. Key engineers like S. R. Puffer and D. F. Warner were pulled off turbosupercharger work at Lynn River Works, and shop was hurriedly set up in the old enameling building there.

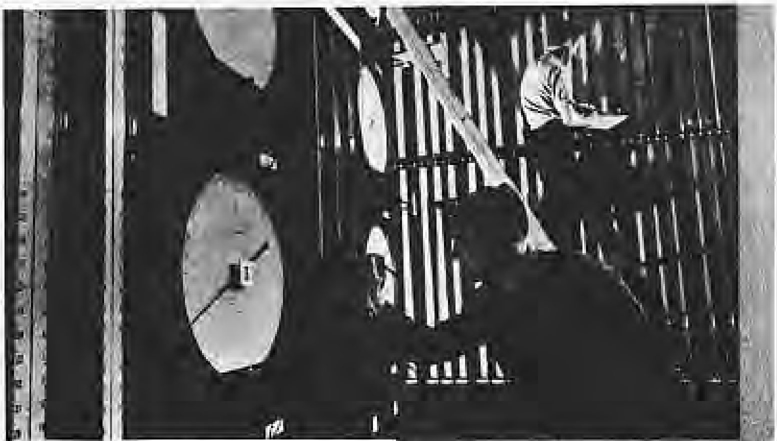
Six months after the work began, the first U.S. jet engine was put on the test block. It was a jubilant success.

Another six months, and a momentous day arrived—October 2, 1942. From the desert sands of Muroc a strange, naked-looking plane rose and filled the skies with a new sound—the hollow roar of a jet engine. Inside the cockpit the pilot saw an amazing thing: the quivering needles of the instruments stood still as the plane sliced the air with absolute smoothness. The plane was Bell's P-59 Airacomet, powered by two General Electric turbojets—type I-A.

That first jet-powered flight was so successful the Air Force decided jet engines should be built in volume.

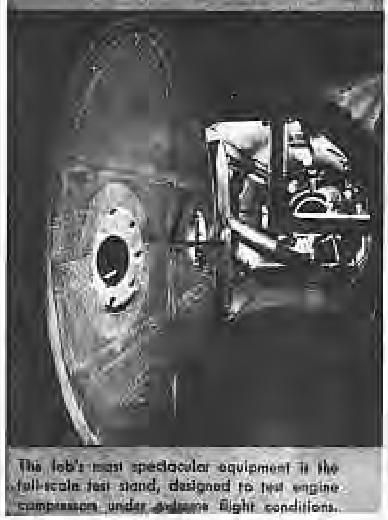
Record-makers

Powered by General Electric's mighty engines, one jet plane after another has written new records in the skies: the North American B-45 Tornado, first operational jet bomber; the Boeing B-47 Stratojet, fastest bomber, with a coast-to-coast record of three hours, 46 minutes; the Republic XF-91, high-speed, high-altitude interceptor; the North American F-86 Sabre, holder of the official world's speed record of 670.981 miles per hour; the North American F-86D, swept-wing interceptor; the Martin XB-51, superfast ground-support bomber. Convair's B-36D, largest and



Hundreds of instruments like these record the progress of research tests on engine parts in the new lab. From a main control room an engineer directs operations by means of an intercommunication system.

A finished engine is ready to go. For protection en route, it travels in a specially designed, re-usable container (see photo, page 2).



The lab's most spectacular equipment is the full-scale test stand, designed to test engine compressors under extreme flight conditions.

The laboratory is built on the banks of the Saugus River, a tidal inlet. At the rate of 80,000 gallons per minute, water is channeled into the building for cooling purposes. Channel is at left behind fence.

Gerhard Neumann, left, shows a new design of an engine part to E. E. Stoeckly, head of advanced design.

The finishing touches are put on the front end of a J-47. An improvement has recently been made in the screen through which air enters the engine.

A guard stands watch at the entrance to the jet engine plant, where work goes on 24 hours a day.

longest-range bomber, carries four G-E jets in addition to six G-E turbosupercharged piston engines.

As in every industry, research is the key to progress. The decision to build a laboratory solely for research testing of engine parts—not the engine as a whole—was reached only after a lot of thought. It would cost several million dollars, and require a large staff. But since the engine is only as good as its weakest part, it seemed that in the long run a lab of this kind would more than pay for itself.

It has. In its first year of operation, enough knowledge was obtained on the behavior of full-scale jet engine components to justify the lab's construction.

Plans for the laboratory began in 1945, under the direction of E. E. Stoeckly, then in charge of test facilities.

Construction began in 1946 and the lab was put in partial operation two years later. Probably its most spectacular feature is the full-scale compressor test. It's a tunnel-like arrangement designed to produce the most uncomfortable conditions a jet engine compressor is ever likely to have to put up with: the heat of an African desert or the cold of an Alaskan mountain; altitudes ranging from sea level to many miles above the earth.

The equipment requires a wiring system that is something to marvel at. Asked how many miles of wire were required, an engineer answered: "Give us a charge number and we'll take a week and figure it out."

In one part of the lab, the visitor might be puzzled by two identical sets of dials. One of the engineers explained it: "During test runs the engine components performed so well people thought the instruments weren't accurate. So we put in a second set of instruments to check the first set. But they're always the same."

Technical facts, however, aren't so impressive to the layman as the physical sight of the lab—the myriads of valves, the array of dials and gages, the giant piping system that looks like a plumber's fantasy.

Synchronized Research

But in spite of its complexity, the laboratory operation is run with clock-like precision. There's a central control room from which an engineer can direct operations at all times. An intercommunication system allows him to give instructions to the men stationed throughout the building. Every valve and every gage—and there are thousands of them—is numbered, and schematic diagrams are posted showing the number and location of each one. So the man in the control room has only to say, "Open valve 4102" into his microphone, and somewhere else in the building a man will locate valve 4102 and open it.

The taking of test data is well synchronized, because of the loudspeaker system and signal lights which flash a "Read!" sign at the proper moment. Hundreds of research readings are taken about every ten minutes during a test run. Half-hourly readings of vital instruments necessary for operation of the

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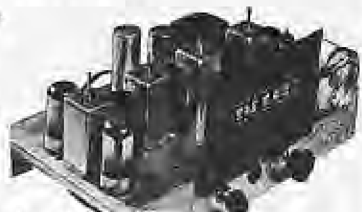
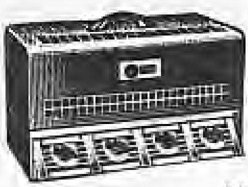
Most hams have wanted a chance to fiddle with TV circuits without spending a lot of dough. Here's your chance. Raytheon-Belmont TV chassis, using 7JP4 pix tube, incomplete. We ship chassis, CRT, schematic and 6 pages of data with this TV kit. You can put it into working shape in a few hours and learn while having fun. Only a few at $25.00

General Electric had a fire in their cabinet factory recently. Because of this we can offer this brand new G.E. 6 tube radio chassis, in factory cartons, with loop antenna, 6V6 output, knobs, dial scale and glass bezel 25/60 cycle model 708 transformer (not AC/DC) type. It's a fabulous bargain at $35.00. Tubes are included in price!! Buy several, for custom installations.



Smart cabinet, 5 tube Deforest battery sets, complete, less batteries for only $15.00. Loctal base tubes - a hot performer.



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equipment are taken simultaneously, and relayed to a central recording station.

If anything goes wrong—like pressures or temperatures getting out of range—an alarm system automatically goes into action. Horns blow and lights flash—and the uproar continues until the trouble has been fixed.

The AGT men are a young group (the average age of the section heads is 32), full of the enthusiasm that goes with a young and booming business. The exciting part of it is the element of the unknown, for no one knows what the future development of jet engines will bring in the realm of space and speed.

C. W. LaPierre has been divisions manager since November, 1949, but his experience with the subject of jet propulsion goes back many years. Formerly with the General Engineering & Consulting Laboratory in Schenectady, he was one of the first men cleared for research work connected with superchargers and jet engines. Today he's in a position to know just about as much about jet engines and jet planes as anybody. Air-minded people have been making guesses at the top speed (it's secret information) that jet planes have now reached; some say it's around 800 miles per hour. LaPierre wouldn't offer a guess—he's one of the few people who know.

Right now all jet engine production is for military planes, but LaPierre has bright predictions for the future of commercial jet flying. His outlook is shared by E. S. Thompson, manager of sales. Thompson believes that in about five years there will be coast-to-coast and transatlantic jet flights. The job of designing the engines to fulfill these predictions falls to the AGT engineering divisions, under the management of R. E. Burroughs.

Fred Brown is the engineer in charge of laboratory test. He's an ex-Marine fighter pilot who flew Corsairs in the South Pacific in World War II. Now he has a wife and child, and he hopes to stay where he is. Otherwise—"I certainly hope I'll be flying a jet plane."

Development work is headed by another young war vet, Hal Jordan. He was in Army Ordnance attached to the Air Force during the last war. While the lab was under construction he helped design facilities for it, mainly the full-scale compressor test. In this he takes a well-earned pride. He remembers the days of its complicated creation, when people were inclined to refer to it as the "million-dollar monster."

Adventurous Business

Gerhard Neumann, who is now head of AGT's preliminary design section, was project engineer in charge of the laboratory's construction during its final stages of completion. Thirty-three-year-old Neumann has the unusual distinction of being an American citizen by Act of Congress. In 1939, rebelling against Nazism, he left his native Germany and joined a Chinese Air Force unit that was to become General Chennault's Flying Tigers. Later he soldiered with the OSS (Office of Strategic Services), but although he was in American Army uniform he was theoretically an enemy alien. So President Truman signed the document that made Neumann one of the few persons in the history of the U.S. to become a citizen without ever having resided in this country. Today, his adventurous spirit seems to be finding satisfaction in the challenge of jet propulsion.

Men like these are the men behind the pilots who fly the jet planes. They're the men who spend their time in painstaking, everlasting research, who test and test again, and turn out jet engines that pilots have confidence in—even at speeds never before known to man. They seldom, if ever, get the chance to experience the thrill of a jet flight. Would they like to? "Sure," said one, looking up from a pageful of test data, "but we haven't got time."

Screens through which seawater enters the laboratory tend to become clogged with seaweed. This instrument, devised by test engineer Dick Bradshaw (above), tells when it's time to have the screens cleaned.

C. W. LaPierre and E. S. Thompson, manager of sales, examine the scale model of a research compressor that may some day add to the jet's power.

Without benefit of official pass, a night-time visitor to the jet engine factory inspects the assembly line.

New Television Receivers

The "Kendall", new TV console in mahogany, walnut or limed oak, has a 17-inch picture tube.

The "Talbot", table-model receiver with a 16-inch kinescope, is housed in a maroon metal cabinet

The "Suffolk" features a 21-inch tube in a cabinet of colonial style, appropriate in any setting.

The "Hampton", new television consolette with 17-inch tube, is modern from top to bottom.

The "Bristol" features a 17-inch picture tube and is available in either blond or dark metal finish.

The "Preston" provides a 17-inch television picture and has two different matching bases.

The "Donley", functional modern television console with full-length doors, offers a 21-inch picture tube.

The "Haywood" open-faced TV console has a 17-inch picture tube and a 12-inch supersensitive speaker.

AN OPERATOR at the Northern Electric Company threads up a spool of tinsel for making tinsel cording on a braiding machine.

Tinsel Thread TELEPHONE TRIMMINGS

THERE is an all-year-round Christmas touch to the cord of your telephone but it is a purposeful, not wasteful, decoration.

Underneath the outer braid of a telephone cord there are three separate conductors each with its own rubber jacket of insulation. In each conductor there are eight or 12 strands of voice-carrying wire known in the trade as "tinsel ribbon" which are flat wires of gleaming bronze one quarter the thickness of a human hair. In appearance they are like many of the tinsel decorations that inundate shop windows the month before Christmas!—but the similarity ends there.

Tinsel threads in a telephone cord are not there for show—apart from carrying current, they are there for flexibility which is the essence of the whole structure of a telephone cord. The cord must be capable of bending and twisting throughout its long and useful life without breaking and the components of tinsel thread—bronze wire consisting of copper and about one per cent tin—possess unusual strength for the job.

Tinsel threads are manufactured in large quantities—after bronze wire has been drawn to the proper size and flattened into ribbon, two strands are wound spirally about a cotton thread to make a tinsel thread. The Northern Electric Company purchases these tinsel threads from outside sources and puts them through further processes. Four or six tinsel threads are wrapped by Northern about another cotton thread to make a "tinsel rope" which is covered by a cotton braid or a cotton serving. The whole is then covered by a rubber insulation and the telephone cord is made.

No Christmas decoration ever got such a specialized treatment or served such a useful purpose.

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