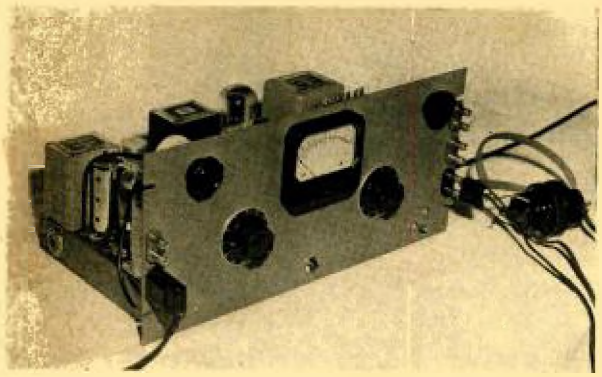

Versatile Amplifier from Junk-Box Parts

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Construction details for a unit which will find myriad uses in laboratories, shops, and in industrial plants which are involved with audio and acoustical equipment.

Small electro-acoustic laboratories are incomplete without several instruments which will serve a variety of uses. Sometimes a pre-amplifier is required which will add no significant distortion or noise; sometimes it is necessary to measure sound level or power output, or to run a curve on a new loudspeaker or pickup cartridge. In the home, we may wish to listen to records through a good pair of headphones without disturbing other members of the family.

About a year ago, an amplifier was designed for just such a variety of uses, and built from parts taken from an overstuffed "junk-box." Compromises which might interfere with the optimum performance of any of these functions were not made. This amplifier has been used as:

1. A wide-range, low-noise pre-amplifier, from 25-ohm, 600-ohm, or high-impedance sources into 600- and 50-ohm loads.
2. A VU and db meter, with or without amplification.
3. A sound-level and sound-pressure meter. In the former application, it was used with a good microphone and ASA weighting networks.[1] In the latter, a small condenser microphone and Sanborn amplifier were fed into the high-impedance input of this amplifier, and the combination used to measure the radiation patterns and single-frequency efficiencies of loudspeakers. (The super-high-fidelity gang may be interested to know that the W.E. 640-A makes an excellent tweeter which is very clean right up to 100 kc.)
4. An ideal setup for auditioning records, and monitoring the cutting of acetate transcriptions. It is used with the W.E. 711-A moving-coil headphones shown; these phones, incidentally, were not out of the junk-box but were selected for their low distortion, excellent transient response, and the absence of peaks in their frequency response curve.[2]
5. A pure-tone audiometer in conjunction with a good oscillator and the 711-A phones, and a speech-tone audiometer with speech-test records.
6. A sensitive, logarithmic vacuum-tube

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[1] Leo L. Beranek: "Acoustic Measurements;" Wiley, 1949, pp 224-9.

[2] Wente and Thuras; Moving-coil telephone receivers and microphones; *Bell Sys. Tech. J.*, Oct. 1931, pp 565-576. Also *J. Acous. Soc. Am.*, July 1931, pp 44-55.

TABLE I

TUBE and TRANSFORMER SUBSTITUTIONS

V_1, V_2	6J7, 6SJ7,6AU6, 5879
V_3	Triode-connected 1603, 6J7, 6SJ7, 1620, 6AU6, 5879
V_4	6X5, 6X4; 5Y3 if 5-v. fil. winding is available on T_4
V_5	OC3/VR105, OB2
V_6	6J5, 6C4
	Triode-connected 6J7, 6SJ7, 6AU6, 5879

	T_1	T_2	T_3	T_4	L_1	L_2
ADC		A-1921				
Chicago	BI-1	BO-1	BO-1	PCC-85		RC-1585
Peerless	K-251-Q	S-215-Q	S-215-Q	R-400-A		C-305-A
Stancor	HF-20	WF-34	WF-34	P-4079		C-1420
Thordarson	T-20A05			T-22R32	T-9009	T-20C53
Triad	HS-1	HS-50	HS-50	R-11A		C-7X
UTC	LS-10 HA-100	LS-27 HA-113	LS-27 HA-113		LS-94 HC-116	CG-44

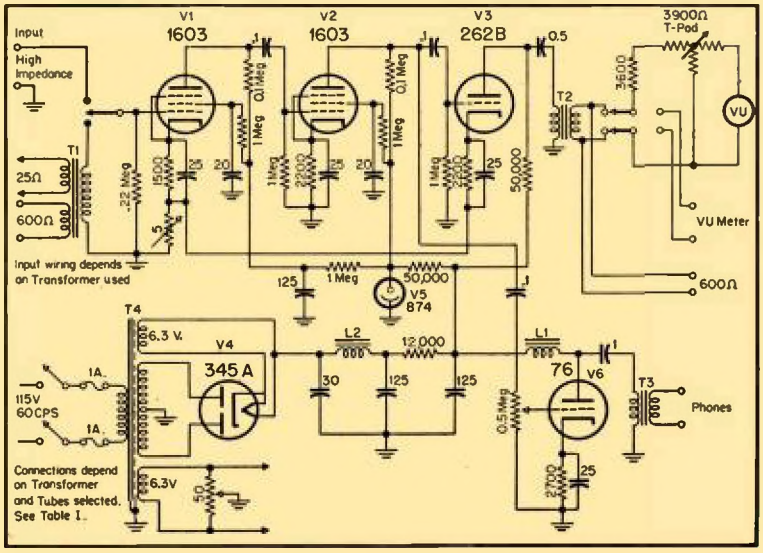

Fig. 2. Overall schematic of the amplifier described. Refer to Table I for list of substitute transformers and tubes which may be employed in this unit.

voltmeter for running frequency response curves on amplifiers, pickup cartridges, and microphones.[3]

Description

Basically, the unit consists of a stable amplifier plus a standard VU meter with scale "A". This combination may seem to resemble an existing vtvm which incorporates a logarithmic pole-shaped meter, but it has several advantages which are important in electro-acoustic work. First, a balanced full-wave rectifier is required if a true indication is to be obtained from an unsymmetrical speech wave. Most speech and music waves are unsymmetrical, and if a full-wave rectifier is not used, reversals of the leads to the meter will give alternately higher and lower readings, neither of which is the true one.

Second, phase distortion in an amplifier, microphone, or phonograph pickup, although slight, will change the wave shape of peaks in the program material, and cause serious errors if the rectifier is not of the root-mean-square type. (Most commercial vtvm's are calibrated in r.m.s. scales but actually indicate peak voltages.)

Third, the dynamic characteristics of this VU meter permit accurate and standard-method monitoring of speech and music. The meter has been discussed in detail in two earlier papers.[4, 5] The traditional temperature errors of copper oxide rectifiers are here reduced to a maximum variation of 0.1 db. for temperatures between 50° and 120° F. The harmonic distortion introduced by bridging the meter across a 600-ohm line is less than 0.2 per cent r.m.s. The frequency characteristic is uniform within 0.5 db from 25 to 16,000 cps. The scale zero is equivalent to a steady sine-wave input of 1.228 volt r.m.s. applied through 3600 ohms in series with the meter. This represents 4 db above a reference level of 1 mw in 600 ohms.

With regard to noise and microphonism, type 1603 tubes still compare favorably with anything of later vintage, and they are used here in the first and second stages. A W.E. 262B was selected for the third stage principally because the ADC 1921 transformer was designed to work out of this tube. A parallel output tube, the 76, feeds the phones. Table I shows possible substitutions for tubes and transformers.

The two pairs of binding posts at the left edge of the panel are the high-impedance and 600-ohm inputs, either of which may be selected by the switch in the upper left corner. The 25-ohm terminals are intended for the low-impedance dynamic microphone which is used with this amplifier, and these terminals are in a microphone input receptacle on the left side of the chassis.

The 711-A phones, of 50 ohms impedance, may be plugged into the pair of binding posts at the lower right. The upper two pairs permit connection to the output of the amplifier, either with or without the VU meter, or the use of the VU meter alone for power level measurements. On 600-ohm circuits, the bridging loss of the VU meter is approximately 0.3 db.

The overall gain, from high-impedance input through 600-ohm output, is 70 db. Noise and hum are about 70 db below the maximum output level of 100 mw. The frequency response of the amplifier alone is ± 1 db from 20 to 20,000 cps, but this frequency range may be extended about an octave on each end by careful choice of transformers for the tubes employed, and by careful construction practices. For all measurements made with this equipment involving steady-state sine waves, the number of VU indicated is numerically equal to the number of db above or below the reference value of 1 milliwatt.

In measurements involving speech and music, no db equivalent is obtainable, and all these measurements must be expressed as VU. The advantage of this system is that the dynamic characteristics of the meter used are standardized, so that measurements made on speech and music circuits in one laboratory may be more accurately correlated with similar measurements made in another laboratory or in the broadcast studio.

The prospective constructor will probably find acceptable substitutes for many of the components indicated by trade names on the schematic. However, he should be sure of the frequency response and harmonic distortion ratings on the transformers he may select. Other components, with the exception of headphones and microphones, are not critical. The general chassis layout is indicated in *Fig.* 1, while *Fig.* 2 is the schematic of the entire unit.

[3] Wente and Thuras: High efficiency receiver of large power capacity; *Bell Sys. Tech. J.*, Jan. 1928, pp 140–153.

[4] Chinn, Gannett, and Morris: A new standard volume indicator and reference level; *Proc. I. R. E.*, Jan. 1940, pp 1–17.

[5] Affel, Chinn, and Morris: A new "VI" and reference level; *Electronics*, Feb. 1939.