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A SURVEY OF SOVIET RADIO TUBES

A. Baklanov

/Tables referred to are appended./

Our vacuum tube industry is manufacturing hundreds of types of radio tubes, many of which are obsolete, although the demand for vacuum tubes could be satisfied by fewer types of tubes. Hence, it would be desirable to unify the groups and types of electron tubes in use and eliminate obsolete types. Reducing the number of categories would permit industry to increase the number produced, lower the price, and improve the quality of the tubes.

Because of its complexity, the problem of deciding on the necessary categories of vacuum tubes can best be determined by taking up each one separately. In our opinion, it would be well to begin by working out categories for the most popular types of radio tubes.

For purposes of discussion this article will attempt to determine the necessary assortment of radio tubes for AC and battery broadcast receivers, low- and medium-power amplifiers for wired radio centers, sound motion picture amplifiers, etc. (Tubes for television apparatus will be discussed in a separate article.)

The nomenclature for the prospective types of tubes should be worked out by the Ministry of the Communications Equipment Industry. Cooperation of the consumers in debating this problem would assist in finding the best solution.

In a preliminary classification we must be guided by:

1. Requirements for modern equipment. Since any classification should be valid for a long time, the requirements for such equipment and, consequently, for tubes should be raised where possible.

2. Existing classifications of radio tubes.

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The best method is to examine these classifications one by one, dividing them into groups according to their uses: for example, tubes for HF amplifiers, frequency conversion, low-power circuits of local oscillators, detection, etc.

High Frequency Amplification

A tube intended for HF amplification should have a high transconductance characteristic, high plate resistance, low interelectrode capacitance, high input resistance, and a low level of tube noise. For automatic sensitivity control, a tube must have a remote cutoff characteristic of the appropriate form. In addition, it must satisfy the general requirements for all receiver and amplifier tubes -- economical filament power consumption compactness, and durability.

All these requirements are fulfilled by the HF pentode -- considered the basic tube for HF amplification. A triode is preferable only in super high frequency amplification.

A list of HF pentodes put out by us and suitable for modern radios is given in Table 1. Column 5 shows the cathode current I_k; Columns 10 and 11, the value of K_{st} -- the stage amplification corresponding to the given values of transconductance S and input resistance R_i and obtaining a resonant load resistance of 100,000 and 10,000 ohms in the plate circuit. Column 12 shows the value of K'_{st}, indicating the maximum stable amplification produced by one stage at a frequency of 460 kilocycles for the given values of S, R_i, and C_{pg}. If K'_{st} is excessive, oscillations may occur. The value of K' in Column 13 refers to the per-stage HF amplification when two stages are used. The value of K'_{st} characterizes one amplification stage for a frequency of 18 megacycles both for a single-stage amplifier (Column 14), and a two-stage amplifier (Column 15).

It may be seen from Table 1 that the 6SJ7 and 6SK7 tubes make the 6Zh7 and 6K7 tubes unnecessary, since all characteristics of the latter are inferior to those of the former. The 6K9M-type tube is a glass equivalent of 6SK7 and is cheaper to produce; it may, therefore, be retained.

With regard to transconductance, the miniature pentode 6K1P is considerably inferior to the miniature pentode 6AZh5. It should be replaced by another type resembling the 6AZh5 in its parameters but with a remote cutoff characteristic. The miniature pentode 6BA6, with a transconductance of 4.4 ma/v for a cathode current of 15.2 ma, may be employed for this purpose. After making the above reductions in the group of tubes with indirectly-heated cathodes, the remaining tubes are the single-ended metallic pentodes 6SJ7, 6SK7, 6SH7, and 6SG7, the miniature pentodes 6AZh5 and 6BA6 with sharp cutoff and remote cutoff, and the 6B8M duo-diode-pentode which can be classed as a HF tube due to its low value of plate-grid capacitance.

The seven tubes mentioned above have excellent electrical characteristics and are suitable for HF amplification in all classes of AC broadcast receivers.

The production of the 12BA6 together with the 6BA6, which differ only in the amount of filament current and voltage (12.6 v and 0.15 amp instead of 6.3 v and 0.3 amp), makes it possible to use the 12BA6 in AC/DC receivers with a 150 ma filament current.

The 6B8M duo-diode-pentode is currently used in reflex circuits of mass-produced, low-cost radios. Even in the case of the 6B8M, it would be desirable to have a duplicate tube with filaments for twice the voltage and half the current.

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Table 1 shows only five directly-heated HF pentodes, one of which, the 1Zh2M tube, cannot be considered as mass-produced. The 2Zh2M and 2K2M pentodes are quite satisfactory with respect to their parameters, but are not sufficiently economical since their filament heater consumption is 0.12. The 1K1P miniature pentode is more economical but its parameters are not so good. In deciding on the advisability of using the 2Zh2M and 2K2M tubes for new radios, the efficiency of these tubes at reduced filament battery voltage must be taken into consideration, as well as the service life.

The 1K1P pentode may be included in the number of prospective tubes but it is not sufficiently economical in heater consumption (0.072 w), while the 1Zh2M pentode, for example, required only 0.036 w. We must begin to make full use of modern techniques in order to mass-produce battery tubes with filament current of 30 or even 25 ma.

The excessive plate-grid capacitance of the pentode part of the 1B1P tube makes it difficult to obtain sufficient IF amplification in a reflex circuit which is most suitable for mass-produced, battery-operated superhets. For this reason, the 1B1P diode-pentode must be replaced by an HF diode-pentode with a semiremote cutoff characteristic and a plate-gride capacitance not exceeding 0.02 mmfd.

Hence, of the various tubes under examination, only the 1K1P pentode can be considered a prospective type. The LF diode-pentode must be replaced by an HF diode-pentode.

Frequency Conversion

Tubes for frequency conversion must have high transconductance, both in conversion and in the oscillator part, a high plate resistance, a remote cutoff characteristic, the least possible coupling between the HF circuit and the oscillator and IF circuits (the coupling through the interelectrode capacitance and the electron flow), a sufficiently large input resistance, and as far as possible, a low noise level. Moreover, during operation of the automatic sensitivity control, the transconductance of the oscillator plate current with respect to the voltage on the signal grid must not be greater than several hundredths ma per volt.

The tubes used for frequency conversion are the 6A8, 6A10, 6SA7, 6L7, SO-242, and 1A1P. The 6A8 pentagrid converter is characterized by an inadmissibly large, for short-wave reception, dependence of the No 2 grid current (oscillator plate) on signal grid voltage (equal to minus 0.4 ma/v); moreover, the transconductance of the oscillator part of the tube is too low (1.1 ma/v). Hence, the 6A8 is greatly inferior to the single-ended 6SA7 pentagrid converter and might well be excluded from this category.

The 6A10 is no better than the 6SA7 tube and could easily be abolished as far as consumers are concerned. But there is some reason for retaining it because of cheapness of production.

The 6L7 pentagrid mixer could be satisfactorily replaced by the 6SA7 employed in circuits with separate oscillators. So the 6L7 can also be eliminated.

Thus, the admissible types for prospective converter tubes for AC superhets are the single-ended pentagrid tube with remote cutoff of the 6SA7 type and its cheaper alternative, the glass 6A10 tube. To these types should be added a miniature pentagrid converter, analogous in its operating principles (grid construction and grid connection system) to the 6SA7. The 6BE6 can be considered such a tube, while for transformerless receivers, the 12BE6 tube with a filament current of 150 ma.

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The 6SA7, 6A10, 6BE6, and 12BE6 pentagrid tubes have a satisfactory transconductance -- 0.45 and 0.47 ma/v -- and operate well on all broadcast frequencies.

Because of its inadmissibly large heater consumption, 0.32 w, the small SO-242 pentagrid converter must absolutely be excluded from the prospective type of tubes.

The miniature 1A1P pentagrid converter with a filament consumption of 0.072 w may be considered among the prospective tubes. But steps should be taken to reduce its heater consumption.

Low-Powered Oscillators

Local oscillator tubes must have an adequate transconductance characteristic to maintain oscillations at all broadcast frequencies during reductions in filament voltage supply.

Any of the prospective pentodes with a sharp cutoff characteristic or any triode suitable for the purpose, for example, the Type 6Zh5C triode, may be employed as an oscillator tube. There is, therefore, no need of deciding on individual oscillator tubes for future production. This is even more true in the case of battery-operated apparatus where there is little demand for separate oscillators.

Detectors

Diodes are used as detectors for amplitude-modulated transmission and also to obtain the direct current voltage for various types of automatic control, especially for automatic sensitivity control. The current and power used for these purposes is so small that the dimensions of the diodes can also be very small and, consequently, two diodes can easily be put in one envelope or even in the envelope of another tube, for instance, a triode or pentode.

The existing assortment of tubes includes combination tubes of the 6G7C, 6B8M, 6SQ7, and 6SR7 types and the 6X6M duodiode. As the diode parts of the first four tubes are much alike, it makes little difference which of these types is retained in this category. A selection will be made in considering these tubes for preliminary LF amplification.

The 6X6M duodiode, consisting of two separate diodes with different cathodes, is the only tube which permits setting up any system of automatic sensitivity control. In addition, it can rectify a considerably stronger current (up to 8 ma) than a combination tube-diode and may, therefore, be employed as a low-powered kenotron in radiometric apparatus. For this same reason, a glass duodiode of the 6X6M type must be considered a prospective type.

Visual Voltage Indicator

The Type 6E5 visual voltage indicator (electron-ray tube) is sufficiently sensitive but in a receiver it operates satisfactorily only at small voltages in the automatic sensitivity control. With strong signals, the shadow sector closes even before accurate tuning is achieved. Thus, the 6E5 tube should be replaced by a new type with two or more shadow sectors which react to both low (5--6 v) and high (25--30 v) voltages. The Type EM-11 visual voltage indicator is an example of such a tube. It would be desirable, however, to have a tube with better characteristics.

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For reasons of economy, there is no point in using visual voltage indicators on battery-operated radios.

Low Frequency Preliminary Amplification

The parameters of tubes for LF preliminary amplification must ensure obtaining high stage amplification with negligible frequency and nonlinear distortion. To be employed in a multistage amplifier, such a tube must have a low noise level.

Table 2 shows tubes for LF preamplification. Columns 2--7 give data corresponding to static conditions when the load resistance equals zero; Columns 8--10 give the amplification factor per stage in a resistance-coupled circuit. Column 8 gives the stage amplification for a load resistance of 0.1 meghom in the plate circuit and a resistance of 0.1 megohm in the grid circuit (plate supply reduced to 90 - 100 volts). Column 9 shows corresponding data for a 0.25-megohm plate load and 0.5-megohm resistance in the grid circuit, while column 10 gives the same figures for 0.5 and 2.0 megohms, respectively (plate supply increased to 250--300 volts).

The first seven types of tubes in Table 2 are intended for voltage amplification, that is, they operate satisfactorily for high-resistance loads, the resistance of which is measured in tenths of a megohm. The last four types have an average amplification factor and a large plate current consumption with a power output of several hundred milliwatts. This power may be required to excite the final stage, the input resistance of which is usually between 10,000 and 40,000 ohms.

HF pentodes are excellent LF voltage amplifiers. Among the HF pentodes which are prospective types, only two, with small-grid-plate transconductance characteristics are included in Table 2. But it must be borne in mind that, in employing pentodes with increased transconductance, it is possible to obtain much greater amplification with the same load in a resistance-coupled circuit.

It is evident from Table 2 that the presence of the 6SQ7 tube will make the 6F5M and 6G7C unnecessary. Instead of manufacturing two tubes, 6C5M and 6Zh5C, it is only necessary to put out the 6Zh5C which has better parameters. The group of twin triodes, the 6N7C, 6N7M, and 6N9M, should be retained since they have different parameters. The 6SR7-type tube may be found useful in transformer stages coupling a single-stage with a push-pull stage. However, the prospects for this tube are still a matter for discussion.

Table 2 should be supplemented by a miniature duo-diode-pentode with the same parameters as the 6B8M -- or better. The 6AT6 (or 12AT6) miniature duo-diode-triode with an amplification factor of 70 cannot ensure sufficient amplification for playing phonograph records, and it is not adapted to simultaneous amplification of intermediate and low frequencies in a reflex system. A duo-diode-pentode with a semiremote cutoff characteristic must be manufactured for both 6- and 12-volt filament heating.

The list of tubes with indirectly-heated cathodes to amplify LF voltage must also be supplemented by special tubes with a low level of tube noise. It is obviously possible to avoid introducing a new type of tube if, in the course of manufacturing the above-mentioned tubes, for example, the 6SJ7, it is feasible to eliminate the causes of such noises. Tubes with a low noise level should be carefully selected, specially marked, and used only for multistage amplifiers of sound motion picture and broadcasting apparatus.

As regards the directly-heated tubes in Table 2, we must exclude, first of all, the UB-240, which consumes almost 4 watts in filament heating. The remaining three tubes have already been discussed and the conclusions reached as to them are still valid.

Low Frequency Power Amplification

The output radio tube should have good emission qualities, an operating characteristic with a long linear section, and, to ensure sufficient sensitivity of the final stage -- a comparatively high transconductance (not less than 4 ma/v). To prevent occurrence of high nonlinear distortion, the operating sections of its characteristic must be as linear as possible. The amount of power consumed in filament heating in AC equipment is immaterial, especially if there is a power transformer.

Tubes for LF power amplification are shown in Table 3. The last column indicates the sensitivity of the amplifier stage expressed as a ratio of the output power in watts to the square of the effective value of grid voltage in volts. These values are numerically equal to the output power in watts during the action of an effective alternating voltage of one volt in the grid circuit.

The UO-186 triode, which consumes the same amount of power as the 6B4 triode, is greatly inferior to the latter in output power, efficiency, and sensitivity. Consequently, it should be excluded from the list of prospective tubes. (It should be noted that the last triode of the UO-186 type is really a very good tube; but it is not used much because of its unusually large plate current tolerances and relatively low guaranteed output power -- totalling 0.77 watts).

The Type 6F6C tetrode is very inferior in sensitivity to the Type 6V6 beam tetrode which has nearly the same power; it may, therefore, be eliminated. The parameters of the Type 6B4, 6N7C, and 6V6 tubes are satisfactory and these tubes may be retained.

For lack of a more modern tube, the 30P1M tube may be produced for the next couple of years, provided that the insulating strength between the filament and the cathode can be increased.

It is especially necessary to stop producing the Type 6P3 tube, which is an unsuccessful variant of the 6L6C put out before 1940. GOST 1880-44 established the plate current range for the 6P3 tube at 62-95 ma instead of the 62-82 ma of the 6L6C, although there is no difference between them in internal structure. One of the reasons for reducing the amplification properties of the 6P3 tube is that the bending in the crosspieces of the control grid or cathode is such that the turns of the former, although they do not touch, are very close to the cathode at one end. Such a dissymmetrical tube might be described as composed of two parts connected in parallel -- the two parts having different transconductances and different amplification factors. Less than half the total current passes through the section where the distance between cathode and grid is the greatest, and considerably more than half the total current through the part where the grid is near the cathode. Since the current is increased in one part much more than it is decreased in the other part, the total plate current of the tube is increased. To a certain extent, therefore, it is possible to predict on the basis of plate current, the mutual bending of the grid and cathode. Increasing the upper limit of plate current from 82 to 95 ma would allow industry to put out poor tubes as well as good tubes. The 6P3 tube is also inferior to the 6L6C because of the greater permissible screen-grid current.

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Type 6P3 tubes are used both in the final stages of radio receivers and in amplifiers for sound motion picture equipment, the output stages of which operate in a push-pull circuit; here it is particularly necessary for both tubes to be identical. The 6P3 tube should be completely eliminated and replaced by the 6L6C.

In second class radios, the output tube may require considerably more sensitivity than the tubes discussed here. If it be assumed that the voltage is amplified 50 times in the preliminary stage, it will be necessary to apply a signal voltage of 0.11 volt to the input of the first stage in order to obtain maximum power from the 6L6C (6P3) tube. An electromagnetic pickup develops the same voltage for loud sounds in record playing. But this does not permit effective use of negative feedback to improve the frequency characteristic (double or triple amplification capacity would be needed for negative feedback). The obvious solution would be to use tubes with higher transconductance -- about 10-15 ma/v. Hence, it is advisable to supplement the category of tubes with a high transconductance tube like the EL-11 (S, 9 ma/v; U_{g1}, 4.3 v; P_{out}, 4.5 w; and sensitivity, 0.25 w/v2), or the EL-12 (S, 15 ma/v; U_{g1}, 5.0; P_{out}, 8 w; and sensitivity, 0.32 w/v2).

For transformerless receivers with 0.15-amp filament current we should add to our list a miniature output beam tetrode or pentode. The type 50B5 or 50C5 with a 7.5 ma/v transconductance characteristic and an available power of 1.9 w with 110 v on the plate can be used as models.

Table 3 includes data on four small tubes and one miniature pentode for final LF amplification in battery sets. The first four require considerable power to heat the filaments. Consequently, none of these four can be considered among our prospects. Modern tube techniques permit producing tubes which are 3-4 times more economical in power consumption. Work should be started at once in designing an economical twin pentode or twin triode. In the latter instance, an economical tube for the next to the last (driver) stage -- a triode with low plate resistance -- will be repaired.

The parameters of the 2P1P miniature pentode are quite acceptable for battery-operated receivers with an output power of about 4 w. It may be considered a prospective tube for the immediate future. But even now a design should be developed for a miniature pentode with approximately the power mentioned but with about half its power consumption for filament heating.

Rectification

Table 4 represents the kenatron category. Types BO-230 and BO-188 can be eliminated from the prospective list because of the appearance of the 6X5C and 5Ts4 (5Z4) kenotrons. The three remaining types, 6X5C, 5Ts4C and 5U4G, designed for rectified currents of approximately 70, 125, and 225 ma, can ensure proper power supply for all types of AC receivers using transformers.

For AC/DC receivers, the 30Ts1M kenotron (for half-wave rectification) and the 30Ts6C (voltage doubler) may be considered as prospective types in the immediate future. It is only necessary to increase their insulating strength between the filament and cathode.

Third-class AC/DC receivers require tubes with a filament consumption not exceeding 0.15 amp. In this connection, designs must be made for a miniature one-plate kenotron with 0.15-amp filament current and 35 v filament voltage. In our opinion we should have the following set of power line miniature tubes for AC/DC receivers: a variable-mu heptode, a high-frequency, variable-mu pentode, and a duo-diode-pentode with the parameters of the 6B8M tube (their filament voltage should be 12 v); a beam tetrode with $U_H = 50$ v and a kenotron with $U_H = 30$ v. The filament current in all the above tubes should be 0.15 amp and the total filament voltage should equal that of the power line,-123 v.

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Economical Battery-Operated Tubes

Economical supply, the most important qualitative index of battery-operated radios, depends entirely upon the economical performance of the tubes. For this reason, determining the optimum parameters of tubes for such radios is essential.

It must be admitted that we have not yet succeeded in producing a battery-operated radio with sufficiently economical supply requirements. The mass-produced Rodina radio operates on small tubes and therefore requires too much filament current

As a matter of fact, an economical and well-constructed receiver and wired radio amplifier with an output power of 2-3 w could be made by the joint efforts of designers of economical radio tubes, radio apparatus, and electrochemical power sources.

The 1A1P, 1K1P, 1B1P, and 2P1P miniature tubes are the most economical of our present battery-operated tubes, but the LF diode-pentode 1B1P should be replaced by an HF diode-pentode or a diode should be added to the 1K1P tube. The 2P1P pentode is sufficiently economical in plate current consumption (Table 3). Besides, it can operate on half the nominal power both for heating and for the plate circuit; therefore, this tube is acceptable. To reduce power consumption still further, work should be immediately begun on tubes for preamplification with 25-30 ma heater current, and on output tubes with 50-60 ma heater current.

For battery-operated wired radio centers with 2-3 w of output power, a special tube should be designed intended for Class AB_2 operation, approaching Class B_2 conditions. These tubes should be twin pentodes in order to reduce the excitation power and make better use of the plate voltage. Such operating conditions would be very economical since they would make it possible to obtain an efficiency of more than 60 percent at full power, and a sufficiently high efficiency at medium and low power. It might be tentatively stated that such a tube with 1.2 v and 0.25 amp for the filament and a plate voltage of 160 v could produce a power of 2 w; the maximum admissible plate voltage should not be less than 240 v. The coupling between a single-tube and a push-pull amplifier should be made through a transformer; in the driver stage a 2P2M tube or a triode with low plate resistance can be employed.

Rural wired radio centers with an output power of 5 w or over must be supplied by storage batteries, since the problem of saving electric power is not so acute there. In such installations the most economical tubes of the series intended for power line radios and amplifiers can be employed.

Conclusions

The data cited above lead to the conclusion that our industry is meeting the basic demands for modern tubes for power line equipment.

With regard to battery-operated tubes, however, many problems arising from the necessity for maximum economy in electric power have not yet been solved. It is essential to clarify the following problems:

1. The types and the operating characteristics (especially in regard to economy) of electrochemical power supply sources which can be considered for future use.

2. The most favorable nominal heater voltage.

3. The minimum output power for a radio which will provide adequate loudspeaker reception in rural homes; since the amount of power required is in inverse ratio to the sensitivity of the loudspeaker, it is possible to make considerable reductions by designing a low-powered speaker with greater sensitivity.

4. The optimum plate voltage for battery-operated tubes.

5. The best design for the final stage of the receiver, and the optimum parameters and operating conditions for the output tube.

6. The optimum parameters of tubes for the preamplification stages.

7. The question of combining several tubes in one envelope.

The categories and the parameters of modern battery-operated radio tubes cannot be definitely determined until all these problems are solved.

Editorial Comment

Comrade Baklanov's article raises the question of what tubes are needed for current broadcasting apparatus in general use. This is a very important problem because the quality of a radio is largely dependent on its tubes.

The editors request workers of industry, scientific institutions, and wired radio centers, as well as radio amateurs, to participate in discussions of this problem.

Baklanov's problem cannot be solved simply from the standpoint of present requirements demanded of radio tubes. We must also consider to what extent the tubes put in the prospective category by the author can satisfy the higher requirements of the immediate future. This is particularly important with regard to battery-operated tubes whose quality (especially, economical operation) will determine the success or failure of radiofication in rural districts not as yet supplied with electricity.

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Table 1

Tube Type	Characteristic	U_H	I_H	I_K	S Trans-conductance	R_i Plate Resistance	$C_{in} + C_{out}$	C (Plate to grid)	K_{st} (stage amplification) 100,000 ohms	K_{st} (stage amplification) 10,000 ohms	K'_{st}; f = 460 Kc (per stage) One Stage	K'_{st}; f = 460 Kc (per stage) Two Stages	K''_{st}; f = 18 Mc (per stage) One Stage	K''_{st}; f = 18 Mc (per stage) Two Stages
		v	a	ma	ma/v	meg-ohms	mmfd	max mmfd	-	-	-	-	-	-
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
6Zh7 (6J7)	Sharp cutoff	6.3	0.3	2.5	1.2	1.0	19.0	0.005	110	12	406	287	65	46
6SJ7	Sharp cutoff	6.3	0.3	3.8	1.65	1.5	13.0	0.005	154	16	479	338	77	54
6K7	Variable-mu	6.3	0.3	8.7	1.45	0.83	19.0	0.005	129	14	448	316	72	51
6SK7	Variable-mu	6.3	0.3	11.6	2.0	0.8	13.0	0.003	178	20	680	480	109	77
6K9M	Variable-mu	6.3	0.3	11.6	2.0	0.8	15.8	0.005	178	20	525	371	34	59
6SH7	Sharp cutoff	6.3	0.3	14.9	4.9	0.9	15.5	0.003	441	48	1060	750	170	120
6SG7	Semivariable-mu	6.3	0.3	12.6	4.0	1.0	15.8	0.003	367	40	960	676	154	108
6AC7	Sharp cutoff	6.3	0.45	12.5	9.0	0.75	16.0	0.015	795	88	644	455	103	73
6AZh5 (GAG5)	Sharp cutoff	6.3	0.3	9.0	5.0	0.8	8.3	0.025	444	50	373	263	60	42
6K1P	Variable-mu	6.3	0.15	9.4	1.8	0.7	6.4	0.01	158	18	352	249	56	40
6B8M	Semivariable-mu	6.3	0.3	11.3	1.12	0.6	15.0	0.005	96	11	394	278	63	45
2Zh2M	Sharp cutoff	2.0	0.06	2.2	0.95	1.0	13.2	0.02	86	9.4	182	128	29	20
2K2M	Variable-mu	2.0	0.06	2.5	0.95	1.0	13.2	0.02	86	9.4	182	128	29	20
1Zh2M	Sharp cutoff	1.2	0.03	1.5	0.47	1.0	13.0	0.015	43	4.7	147	104	24	17
1K1P	Variable-mu	1.2	0.06	2.25	0.75	0.8	11.1	0.01	67	7.5	228	161	36	26
1B1P	Sharp cutoff	1.2	0.06	2.0	0.63	0.6	4.6	0.2	54	5.9	47	33	7.5	5.3

Table 2

	U_H	I_H	I_K	mu Amplification Factor	S Transconductance	R Plate Resistance	Stage Amplification with Load Resistance in Megohms *		
	v	a	ma	--	ma/v	kilohms	0.05	0.17	0.40
1	2	3	4	5	6	7	8	9	10
6SJ7, HF pentode	6.3	0.3	3.8	700	1.65	1,100	41	131	263
6B8M, HF duo-diode-pentode	6.3	0.3	12.3	450	1.33	600	24	69	145
6F5M, triode	6.3	0.3	1.0	100	1.6	63	28	53	70
6SQ7, duo-diode-triode	6.3	0.3	0.9	100	1.1	91	23	50	63
6G7C duo-diode-triode	6.3	0.3	1.1	70	1.2	58	23	38	47
6N9M, twin triode*	6.3	0.3	2.3	70	1.6	44	18	39	49
6N7C, twin triode*	6.3	0.8	3.5	35	1.6	22	16	24	24
6SR7, duo-diode-triode	6.3	0.3	9.5	16	1.9	10	9	10	11
6Zh5C (6J5G), triode	6.3	0.3	9.0	20	2.6	7.7	13	14	15
6C5M, triode	6.3	0.3	8.0	20	2.0	10	11	13	14
6N8M, twin triode*	6.3	0.6	9.0	20	2.6	7.7	13	14	15
2Zh2M, HF pentode	2.0	0.06	2.2	1,200	0.95	1,000	23	75	135
UB-240, triode	2.0	0.12	3.5	22	1.55	14	12	15	16
1K1P, HF pentode	1.2	0.06	2.25	1,050	0.75	800	25	80	140
1B1P, HF diode-pentode	1.2	0.06	2.0	950	0.63	600	29	90	145

*All data, except heater current I_H refer to one triode. The load resistance of 0.05, 0.17, and 0.4 megohms is obtained for the following respective values of R_a and R_s: 0.1 and 0.1; 0.25 and 0.5; 0.5 and 2.0 megohms.

/Note: Final letters of tube-type designations, as a rule, refer to M - metal or C - glass./

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Table 3

Type of Tube	U_H	I_H	I_K	R_A	λ	S Trans-conductance	R_i Plate Resistance	Max U_{g1}	Pout (Max)	Max Efficiency	Sensitivity
	v	a	ma	w	--	ma/v	1,000 ohms	v	w	%	w/v^2
1	2	3	4	5	6	7	8	9	10	11	12
UO-186, triode	4.0	1.0	60	15	4	3.2	1.25	37	1.2	8	0.0009
6B4, triode	6.3	1.0	60	15	4.2	5.25	0.8	32	3.5	23	0.0035
6N7C, twin triode	6.3	0.8	70	11	35	--	--	6.0*	10	43*	0.277*
6F6C, pentode	6.3	0.7	46	10	200	2.5	80	11.7	3.2	27	0.023
6V6, beam tetrode	6.3	0.45	54	12	210	4.1	52	9.2	4.5	33	0.053
6P3, beam tetrode	6.3	0.9	86	19	135	6.0	22.5	9.9	6.5	30	0.066
30P1M, beam tetrode	30	0.3	80	7	65	10	6.5	5.5	1.5	17	0.050
SO-243, twin triode	2.0	0.24	18	3.0	32	--	--	--	11	50	--
SO-244, pentode	2.0	0.185	5.2	1.5	270	1.8	150	1.75	0.15	24	0.050
SO-257, oscillator pentode	2.0	0.275	--	2.5	200	1.8	110	--	--	--	--
SO-258, pentode	1.8	0.32	13	2.0	160	2.0	80	4.0	0.50	24	0.031
2P1P, pentode	1.2	0.12	8.8	--	160	1.58	100	5.0	0.27	34	0.011

*The maximum values of U_{sl}, the maximum efficiency and sensitivity refer to two-stage amplification for 6Zh5 and 6N7S tubes.

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Table 4

Type of Kenotron	U_H	I_H	Rectified Voltage (U Max)	Rectified Current (I Max)	U_{H-K} (Max)
	v	a	v	ma	v
1	2	3	4	5	6
BO-230	4.0	0.7	300	50	-
6X5C, two plates	6.3	0.6	450	70	450
5Ts4C, two plates	5.0	2.0	500	125	-
.0-188, two plates	4.0	2.05	475	155	-
5U4G, two plates	5.0	3.0	550	255	-
30Ts1C, one plate	30	0.3	-	90	
30Ts6C, two plates	30	0.3	-	90	

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