The Taylor Pre-Selector Tuner

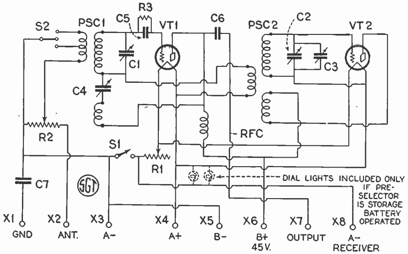
THE Taylor Pre-Selector Tuner, consisting essentially of a "modulator" and oscillator unit similar to the arrangement employed in the super-heterodyne receiver, was designed primarily to provide a high degree of selectivity with existing receivers that are deficient in this important quality.

It may be connected ahead of any broadcast receiver of the tuned radio frequency type to increase selectivity and sensitivity. Its use transforms the ordinary type of receiver having three or more controls into a highly efficient two control installation, without any need for changing the receiver itself.

One of the extraordinary features of this unit is the fact that it permits the operation of a receiver which is located at some distance from the actual tuning unit or Pre-Selector, thus making it possible to locate a bulky receiver and power unit in a convenient closet in some other room, giving all the advantages of remote control.

The remarkable selectivity which it makes possible permits the use of an extremely long antenna up to 200 feet in length to bring in very distant stations.

In operation, the unit is simply connected ahead of the usual type of receiver employing one or more stages of tuned radio frequency amplification. The receiver proper is tuned to one wave length or frequency and becomes in effect a highly efficient "intermediate" frequency amplifier, performing the function of an intermediate frequency amplifier in a super-heterodyne receiver. The Pre-Selector acts as the oscillator and "first detector" unit of a superheterodyne receiver.



A demonstration of the tuner in New York City is typical of its effectiveness in increasing the selectivity of any average radio receiver. During a limited test period, broadcast stations were tuned in on 31 consecutive channels, including every channel from 1,100 to 760 kilocycles. Of the 31 channels assigned in this band, six were occupied by local stations and 25 by out-of-town stations varying in distance to well over 1,000 miles.

Only four of the 25 distant stations suffered from any interference from the local stations. This means that 27 out of a possible 31 distant stations on frequencies adjacent to the locals were received entirely free of interference during the hours of nine to eleven P. M.

List of Parts Required

C1: Hammarlund ML-17, .00035 mfd. Midline variable condenser.
C2: Hammarlund ML-11, .00025 mfd. Midline variable condenser.
C3: Hammarlund Type EC, equalizer condenser.
C4: Hammarlund MC-11, 50 mfd. Midget variable condenser.
C5: Aerovox .00025 mfd. moulded condenser with grid leak clips.
C6: Aerovox .0001 mfd. moulded condenser.
C7: Aerovox Type 250, .5 mfd. moulded by-pass condenser.
PSC1: Hammarlund No. 1 Pre-Selector coil, auto-couple type.
PSC2: Hammarlund No. 2 Pre-Selector coil, fixed type.
R1: Carter M50-S, 50 ohm rheostat with filament switch (S1).
R2: Electrad Type "A" Tonatrol, graduated variable resistance.
R3: Aerovox Type 1092, 2 megohm grid leak.
RFC: Hammarlund Type RFC-85, 85 millihenry choke.
S1: See R1, above.
S2: Carter No. 22, single pole double throw "Imp" short jack switch.
VT1, VT2: Benjamin No. 9040 Cle-Ra-Tone tube sockets.
X1 to X8: X-L push type binding posts, engraved bakelite. Marked respectively: Gnd, Ant, A —, A +, B —, B + 45, blank, A —.
2 National Type "E" Velvet Vernier dials with Type 28 illuminators.
1 Westinghouse-Micarta drilled and engraved Pre-Selector panel. 7" x 14" x 3/16".
1 Westinghouse-Micarta drilled Pre-Selector binding post strip. 1" x 10" x 3/16".
1 Corbett Pre-Selector cabinet.
1 Wood baseboard, 6⅞" x 13¼" x ½".
2 Cunningham CX-299 tubes.
2 1" x ½" angle brackets, solder, hook-up wire, wood screws, etc.

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Construction Folders—Free

It is of course impossible to give a detailed description of this unit in the limited space available in this folder. A complete description giving photographs and layout of parts is contained in a folder which may be had free on request by sending in the coupon below.

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The Aerovox Research Worker

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Principles of Voltage Divider Design

PART 1

By Sidney Fishberg
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EVERY battery eliminator consists of a transformer, a rectifier, a filter, and a voltage divider. The function of the voltage divider is to take the single valued voltage delivered by the rectifier-filter and render it available at a plurality of lower voltages for use with detector and amplifier tubes. This function is accomplished by causing the current to flow thru a resistance of such magnitude that the voltage is reduced to the desired value.

The calculation of a voltage divider is not as simple a matter as some people regard it to be; but once the principles are understood, it is easy enough. In order to properly calculate a voltage divider, the following data must be had; regulation curve of the eliminator, current drain at each desired voltage, and waste current. The regulation curve of an eliminator is a fixed factor, over which the designer has no control, once he has set the size of the first filter condenser. The current drain, and the waste current, however, are factors which are set by the designer, and may be of any magnitude. Ideas on the subject vary widely, and the total lack of any standards is deplorable. However, before discussing this phase of the subject, we will show the right and wrong methods of calculating a voltage divider.

A widespread, but totally erroneous impression exists that the way to calculate a voltage divider is as follows: the total resistance of the divider is found by dividing the output voltage by the load current. Then, to obtain the resistance of any tap, the following formula is used:

$$\frac{E}{E1} = \frac{R}{R1}$$

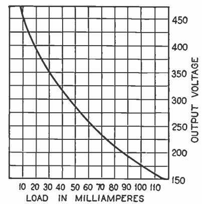

Fig. 1

where "E" is the output voltage, "E1" the voltage at the desired tap, "R" the total resistance of the voltage divider, and "R1" the resistance of the tap. For example, suppose we have an eliminator whose load characteristics are shown in Fig. 1, from which we wish to draw 44 mils. According to this method, the resistance of the voltage divider should be 301/.044 equals 6850 ohms. Then, using the above formula, the resistance of the 180 volt tap would be 301/180 equals 6850/X or X equals 4100 ohms. Figuring in the same manner, the resistance of the 90-volt tap would be 2050 ohms, and the resistance of the 45-volt tap would be 1025 ohms.

Now, as long as no current is drawn from the various taps, the calculated voltages will obtain. But the moment current is drawn from any or all taps, the balance will be upset, and entirely different voltages will be present at each tap. Suppose, for instance, that we draw 10 mils from the 90-volt tap of this incorrectly calculated voltage divider. This is equivalent to putting a resistance in parallel with the 90-volt tap. This arrangement upsets our calculations completely, and the voltages at the various taps are now 41, 82 and 145. This result shows the utter ridiculousness of such a method, which is essentially wrong because it neglects the effect of any current drain.

Now let us take the same eliminator and calculate a voltage divider for it properly. We will arbitrarily assume the following load: 20 mils at 180 volts, 12 mils at 90 volts, 2 mils at 45 volts; and we will allow 10 mils for waste current. Consulting Fig. 1, we see that the output voltage for this load is 301 volts. The first section

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of the voltage divider will evidently be a resistance to cut the 301 volts down to 180. It will have to cause a 121 volt fall of potential with 44 mils flowing thru it. Hence its resistance, according to Ohm's law, is E/I equals 121/.044, or 2750 ohms. This part of the voltage divider is represented by "R1" of Fig. 2. At the 180-volt tap, the current divides, 20 mils going to the external load, and 24 mils going to the 90-volt tap thru "R2." "R2" will have to cause a 90-volt drop with 24 mils flowing thru it. Hence its resistance is 90/.024 or 3750 ohms. At the 90-

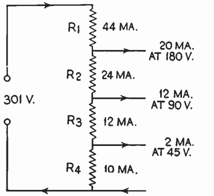

Fig. 2

volt tap, the current divides again, 12 mils going to the external load and 12 mils to the 45-volt tap thru "R3." Figuring "R3" as before, its value is 45/.012 or 3750 ohms. At the 45-volt tap, the current divides finally, 2 mils going to the external load, and 10 mils being "wasted" in "R4," whose resistance is 45/.010 or 4500 ohms.

This method of calculation is the only correct one, and it is employed by every engineer worthy of the name. The other method, and quaint variations of it, are correct only when no current is drawn from the eliminator; but we cannot see the use of making up an eliminator and then not drawing any current from it.

Now that we have described the proper method of calculating voltage dividers, we will next consider the proper allowances for current at each tap. As we have said before, there is a total lack of uniformity in the amount of current allowed for each tap. There is very little engineering information available, and designers seem to work more on the basis of personal opinion than anything else. Some engineers will allow a current drain of 2 mils at 45 volts, 10 mils at 90 volts, and 20 mils at 180 volts as the average set load. Others will claim that this is all wrong, and that it should be 5 mils at 45 volts, 20 mils at 90 volts, and 15 mils at 180 volts for the same set. And since no one can present authoritative figures showing the current drain for 50,000 sets

TABLE 1
5 Mil Voltage Divider

Tap	45V.	90V.	180V.
45V.	4.25	1.85	negligible
90V.	2.20	3.98	1.88
180V.	0.53	1.40	1.25

TABLE 2
10 Mil Voltage Divider

Tap	45V.	90V.	180V.
45V.	3.02	1.37	negligible
90V.	1.53	2.95	1.30
180V.	.38	1.05	.87

TABLE 3
20 Mil Voltage Divider

Tap	45V.	90V.	180V.
45V.	2.05	.96	negligible
90V.	1.12	2.03	.93
180V.	.25	.73	.63

TABLE 4
30 Mil Voltage Divider

Tap	45V.	90V.	180V.
45V.	1.75	0.56	negligible
90V.	.92	1.17	0.77
180V.	.21	.50	.50

TABLE 5
Currents in the Voltage Divider
(See Fig. 4)

I_5	I_1	I_2	I_3	I_4	I_6
10	48	38	37	32.5	1
20	53	33	32	31.5	1
30	58	28	27	30.5	1
40	63	23	22	29.5	1

selected at random over the country, any argument is useless, and eliminators are designed more or less on an arbitrary basis. It should be said at this point that this criticism applies to general purpose battery eliminators, which may be used on anything from a two to a twelve tube set. The power pack built into an electric set is made for that one set only, and hence can be designed in a correct manner.

The importance of approximately correct current allowance is brought out by a study of voltage variation at the various taps of a divider as the load at each tap is changed. A detailed study of this phenomenon was made with the apparatus shown in Fig. 3. By means of jacks "J1," "J2" and "J3," the current flowing thru each section of the voltage divider could be ascertained. By means of jacks "J4," "J5," "J6" and "J7," the current at each tap could be determined. "M1" was a 0-50 d.c. milliammeter, and "M2" a vacuum tube voltmeter to determine the voltage at the various taps. This type of meter was used because it was found that even a high resistance d'Arsonval type voltmeter drawing but one mil at full scale would pull down the voltage more than was tolerable for this study.

The procedure of the experiments was as follows: the load was simulated by means of variable resistors, which were adjusted to take the calculated load. Then, holding all other conditions con-

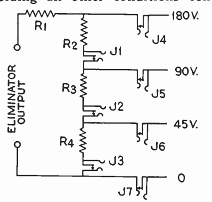

Fig. 3

stant, the 45-volt load was varied, and the effect upon the current and voltage of all taps was measured by means of "M1" and "M2." The same procedure was then repeated with the 90- and the 180-volt taps.

These studies were made with eliminators having a wide range of regulation curves, and with voltage dividers having waste currents of 5 to 30 milliamperes. In all cases the calculated load was assumed to be 20 mils at 180 volts, 12 mils at 90 volts, and 2 mils at 45 volts.

Some of the results obtained are shown in Fig. 4, and Tables 1 to 5. Tables 1 to 4 show the regulation at various taps for voltage dividers having bleed currents of 5, 10, 20 and 30 mils respectively. The figures in these tables show the voltage change produced at any tap of the voltage divider by an increase or decrease of the load by one milliampere. It may be seen for instance in Table 1, that increasing the load resistance at the 45-volt tap to produce a decrease of one milliampere at the 45-volt tap, will cause an increase of 4.25 volts at the 45-volt tap, an increase of 2.20 volts at the 90-volt tap and an increase of .53 volts at the 180-volt tap. A decrease in the load resistance with a corresponding increase in current of one milliampere will produce drops in voltage instead of increases. These tables

bring out several interesting points. Firstly, they show that better regulation may be obtained by increasing the amount of waste current. Table 1, for instance, shows that a 5 mil voltage divider is very sensitive to any unbalance. Increasing the waste current to 10 mils makes the divider appreciably more stable, and increasing the current to 20 mils almost doubles the stability. The reason for this behavior will be explained below. These tables also show that the 90-volt tap is the one most easily and most greatly disturbed by any change in the load. The tap least disturbed is the 180-volt tap, which feeds directly from the filter without passing thru the divider; and the 45-volt tap is between the two in sensitivity. This tap, however, is very sensitive to changes of load at 45 volts. It is for this reason that many eliminators fail to work satisfactorily when feeding a super-heterodyne or other type of set which has an unusually large 45-volt load.

Table 5 and Fig. 4 show how the voltage divider functions when a change in load takes place. Currents of 10, 20, 30 and 40 mils were drawn from the 90-volt tap, and the changes in the system were measured. The following changes were found to take place in the system:

1. The total current drawn from the eliminator increased, but not as much as the current at the 90-volt tap.

2. The current supplied to the 180-volt tap decreased, and this extra current, together with the extra current from the eliminator itself, flows to the 90-volt load thru "R1."

3. The waste current flowing thru "R3" decreased, and this extra current flows to the 90-volt load through "R2."

It is seen, then, that only part of the increased load current comes from the eliminator itself. The remainder of the increased current comes from the external system at the expense of the other taps and the waste current. This manner of functioning of the voltage divider explains why the voltages decrease as the load is increased. For, the voltage at any tap depends upon the "IR" drop in the voltage divider, and since the current in sections "R2" and "R3" is decreased by an increased load, the "IR" drops are correspondingly reduced. Altho the current thru "R1" is increased, the voltage at this tap, nevertheless, is also decreased, for this voltage is the sum of "R3xI3," "R2xI2" and "R3xI1." Since the first two drops decrease more than the last one increases, the net result is a drop in voltage. However, this increase in "R1xI1" serves to make the regulation at this tap much better than it would otherwise be.

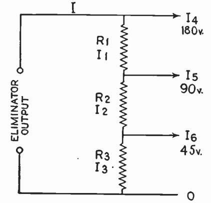

Fig. 4

This manner of functioning also offers an explanation of the superior regulation of high-current, low-resistance dividers. We have seen that the extra current for an increased load is obtained in large part from the waste current. Now, when the change of waste current is the same in two resistances of different value, it is obvious that the smaller change will occur in the smaller resistance—in this case the low resistance divider.

These results show the extreme importance of fitting the eliminator to the load. For instance, referring to Table 2, we see that the current-voltage slope at the 90-volt tap is 2.95 volts per milliampere. That is, for every milliampere more or less than has been assumed, the voltage at the 90-volt tap will be 2.95 volts lower or higher than has been calculated. It is evident that a miscalculation of 4 or 5 milliamperes will throw the voltage off at the 90-volt tap very badly, and also affect the other taps very appreciably. It is also evident that statements like the following are absurd: "This eliminator will deliver up to 40 mils at 90 volts and up to 20 mils at 45 volts." A correct statement would be: "This eliminator will deliver up to 40 mils AT THE 90-VOLT TAP and up to 20 mils AT THE 45-VOLT TAP; but the ACTUAL voltages will depend entirely upon the load." While at this point, it may be said that a regulator tube will maintain the voltages at the 45- and 90-volt taps almost absolutely constant within a considerable load variation. The use of these tubes will be discussed in a forthcoming article.

The conclusions to be drawn from this study are as follows:

1. The voltages obtained from battery eliminators not equipped with regulator tubes are variable, and equal to the nominal voltages only when the presupposed conditions assumed in design are obtained. For other conditions, the voltages will be higher or lower than the nominal voltages, depending upon the amount and nature of the variation from normal.

2. These voltage variations are not due to the regulation of the battery eliminator alone, but are mostly due to the inherent nature of the voltage divider. This is proved by the fact that a voltage divider connected directly to a 220-volt power line had appreciable regulation even tho the line itself had perfect regulation for the load that was being drawn.

3. The variations due to variable loads may be minimized by using as heavy a waste current as possible. A waste current of 20 mils or more will produce a quite tolerable regulation, and also introduce other desirable characteristics in the eliminator. It will require a low resistance voltage divider, which is cheaper and easier to make than one of high resistance. At the same time, the heavy current pulls down the eliminator voltage, so that the strain on the filter condensers is materially lessened. In addition, the rise in voltage due to removing the load is minimized.

4. When the current at any tap is increased, the extra current comes mostly from the waste current and the other taps, and the rest is supplied from the eliminator itself.

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