Mainly about Construction

BY "MEGOHM"

The Marconi Screened Valve Type S625

These valves will very shortly be on sale in New Zealand, and there appears to be quite an impression that this will prove superior in use to the screen-grid valve of American manufacture. Certainly the arrangement of the electrodes in the British pattern appears to be based upon thoroughly sound principles, and so far as can be judged from articles in recent magazines to hand, is giving good service. An American radio journal considers that the mechanical arrangement in the British valve is the better, as it seems, in the opinion of that journal, to have been worked out with more thought toward ease of use. However, we shall see.

This valve has four electrodes, but must not be confused with the four-electrode valve. The valve is designed so that the capacity of control grid to plate is quite negligible when the screen is connected to a point of fixed potential such as earth or the plate circuit battery, and its plate impedance and amplification factor are of quite a different order of magnitude from those usual for the ordinary types of valve.

The harmful effects of grid to plate capacity in the three-electrode valve are well known as causing an almost chronic state of instability in radio-frequency amplifiers. However we remove stray coupling between leads, coils and condensers, there would always remain this comparatively high inter-electrode capacity in the valve, requiring neutralisation that might or might not be very nearly perfect. In order to obtain stability it is frequently necessary to sacrifice a certain amount of amplification, and perhaps selectivity also.

The screened valve does away with the necessity for neutralisation. The impedance is about 300,000 ohms, and the amplification factor 135, but this figure must not be taken as the amount of amplification obtained, as this depends entirely upon other factors in the circuit. Published curves show that as the plate voltage is increased, the plate current rises from a small value until, at a certain point, it decreases rather rapidly, only to rise again and to remain practically steady for the higher plate voltages. It is clear that, given an output circuit of suitable design, the voltage amplification obtainable is very large indeed. Magnification depends upon the impedance of the plate circuit, and the amplification increases with the impedance, so the question is how to obtain the necessary high impedance in a practical circuit.

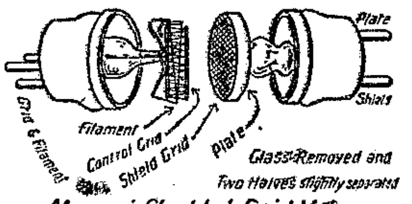
Impedance connected to plate.	Calculated magnification.
600,000 ohms	90
300,000 ohms	67
200,000 ohms	51
100,000 ohms	34
50,000 ohms	19
25,000 ohms	10

The above table shows how magnification falls off as the impedance connected to the plate circuit is reduced. If the impedance of the plate circuit is made equal to that of the valve, the voltage amplification should be 135 divided by 2, or, say, 67.

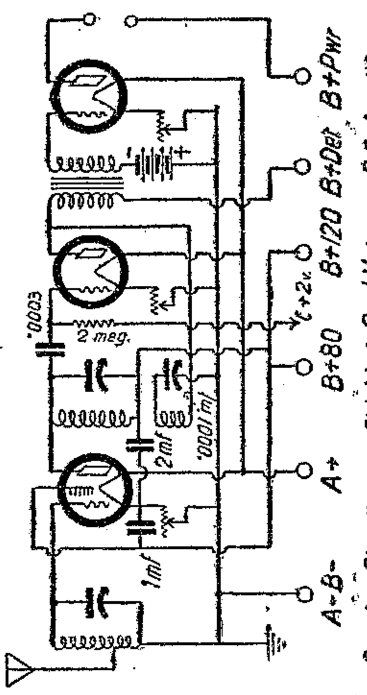
Four firms now produce the shielded grid valve—Marconi, Osram, Cossor, and Mullard, the arrangement of the latter being slightly different to the others in regard to leads, which appears to be rather a mistake. This latter has an ordinary four-pin base, the usual plate pin being connected to the screening grid, and the plate connection to a single terminal at the top of the valve.

Normal filament current is 0.25 amp. at 6 volts, and for an average may be taken 120 volts on the plate, 80 on the shield, and 9 volts on the control grid.

As the internal resistance is high, it is desirable to use "litz" wire for shore wavelengths (up to 600 metres) coils to obtain maximum impedance when tuned, and to reduce losses to a minimum. The best type of coil is the single layer solenoid, 2½ to 3 inches in diameter. A single stage of R.F. amplification, it is said, presents no constructional difficulties, and for broadcast reception does not require elaborate screening, a partition through which the valve passes being in many cases sufficient. Where reaction is used for range the detector tube should be of low impedance (6000 ohms normal), followed by a low ratio transformer and a power



Marconi Shielded-Grid Valve



3-valve Circuit using Shielded Grid Valve as R.F. Amplifier

tube. Some kind of "field-less" winding is advisable for the coils. Captain Round is of opinion that the adoption of this valve in an R.F. stage preceding the detector will reduce the possibility of radiating interference to a negligible minimum.

We reproduce a circuit suitable for this valve as an R.F. amplifier, but only experimenters will be interested in constructing it at present.

QUERIES BY CORRESPONDENCE.

1. Every communication enclosing queries is to be addressed to "Megohm," Box 1032, Wellington, and must be accompanied by a stamped addressed envelope for reply by post.

2. Questions must be written so that a space is left in which the reply may be added.

3. No charge is made for replies.

Short-wave Receivers.

A British journal, commenting on the construction of short-wave receivers, says: "It is one thing to draw a circuit diagram and another to build an efficient receiving set from it. For this reason readers who contemplate the construction of short-wave receivers are strongly advised not to attempt to make their own designs, unless they have had a good deal of experience of short-wave work, but to copy faithfully a published design. If this is done, and no alterations or 'improvements' are made in the design, the necessary smoothness of reaction control will be obtained without difficulty."

VALVES FOR THE LAST STAGE

There are several power-valves suited for the last audio stage in addition to the UX112, 171 and 210 mentioned last week. The PM256 (5.5 volts) and PM254 (3.7 volts) are both excellent where large volume has to be carried. Apart from filament voltage, these two valves have the same characteristics. The impedance, which should be low in a power-valve, is 3500 ohms, filament current ¼ amp., and plate current 16 milliamperes at 125 volts, with a grid bias of 17 volts. At 160 volts they pass 21 milliamps. with a grid bias of 22 to 24 volts. Then for dry A battery operation there is the PM2 (1.8 volts), passing 5 milliamperes at 100 volts H.T. There will soon be on sale the PM252, a 2-volt power-valve with similar characteristics to the PM256 and 254.

In the Philips series we have the B605 (6 volts) with an impedance of 3100, the B406 (4 volts) with impedance 4300 ohms, and B403 (4 volts) capable of carrying large volume, with an impedance of 2100 ohms. In the 2-volt series there are the B205 and B203, the latter a special last-stage valve.

The De Forest DV7 and DL14 are suitable valves for the last stage, and the DL2, DL5, and DL7 for the first stage.

The foregoing valves mentioned are suited for transformer coupling. In resistance-coupled amplifiers special valves are often used in the early stages.

MILLIAMPERES AND IMPEDANCE.

Those who are not familiar with the meaning of "milliamperes" and "impedance" should get used to considering the suitableness of valves by taking these important factors into account. Impedance, expressed in ohms, is the total of several factors opposing the passage of high-tension plate current from plate to filament in a valve. The lower such resistance, the more the plate current that may be passed at suitable voltage, and this increased plate voltage allows the handling of greater volume without distortion, which is the object in utilising power-valves with an impedance as low as 2000 or 3000 ohms, and passing 20 or more milliamperes of current. A "milliampere" is the thousandth part of an ampere.

Thus when we wish to select a new power-valve to carry more volume than the one previously in use, the above characteristics of the old one being known, a valve with a lower impedance and greater plate current may easily be selected. But care must always be taken that the valve is suited to the B battery power available, unless it can be conveniently increased. Super-power valves require both a higher voltage and a larger current, and whilst extra voltage may easily be provided by adding another section to the B battery, the drain in milliamperes must be carefully considered, as it is this demand (or quantity of current (not voltage) that determines the useful life of the battery.

The UX201A as detector passes 1.5 milliamps, and as amplifier 2.5 milliamps, so that a five-valve set with this valve in every stage would require less than 12 milliamps from the B battery, which would be a reasonable demand upon a battery of ordinary capacity (not voltage). By substitution of the last valve for one requiring, say, 15 milliamperes, the total drain on the battery would be increased to 24 milliamperes, or double, so that the same battery would last for half the time. Where a B accumulator is in use, this aspect of power-valves requires much less consideration, especially when charging is carried out at home, and where a B eliminator is employed, one might almost say, the more consumption on the last valve the better.

FIRST AUDIO VALVE.

But in giving consideration to the last valve, we must not lose sight of the first audio valve, which may in many cases be satisfactorily replaced by one of lower impedance. In some cases when a larger power-valve is placed in the last stage, the supplanted valve, if of lower impedance than the one in the first audio (transformer) stage, may well take its place.

ADVANTAGE OF B ELIMINATORS.

If you are situated where electric power is available for a B eliminator, it will prove a good investment whether bought or home-constructed. A full-wave eliminator will run an eight or nine-valve set, and a half-wave one will run four or five valves, but where the plate-current demand is likely to be large, only a full-wave should be considered, as plenty of margin is necessary for quiet operation. A demand too nearly approaching the total emission of the rectifier is bound to cause objectionable hum, but an eliminator that has a capacity well above the work to be done, will be just as good as an accumulator.

Audio Transformer Markings.

When a transformer is marked with the "in and out" of the windings, IP connects to positive B, OP to plate of preceding valve, IS to negative C, and OS to grid of next valve.

Comparison of Wire Gauges, British and American Standards

When purchasing wire for constructional work it is necessary to ensure that the specified gauge is secured. The fact that there is a difference of one or two sizes between the same number gauge of Brown and Sharpe (American) and Standard Wire Gauge (British) is not always taken into account, and quite frequently is ignored altogether. The B. and S. is in every size thinner than the same number in s.w.g. Around 20's the difference between the two gauges is least, being about one size; thus 19's B. and S. exactly equals 20's s.w.g., but in the thinner sizes the difference becomes very great, 37's B. and S. being practically equal to 40's s.w.g. But wire gauges only take the diameter of wire into account, whereas for electrical current-carrying purposes the cross-sectional area is what really counts. It is necessary to realise that taking a small amount off the diameter takes a good amount off the sectional area, and that whereas a 26's s.w.g. is just half the diameter of a 20's, the cross-sectional area of the 26's is only a quarter that of the 20's, so four 26's would be required to equal the current-carrying capacity of 20's. And this rule applies right through, that if you halve the diameter the sectional area is reduced to one-quarter. Now we will examine the result of reducing the diameter by only a small amount, as in the case of 20's s.w.g. being "sold out," and taking the next stock size, 22's, which is about five-thousandths less in diameter. The actual cross-sectional area of 20's s.w.g. expressed in square inches is .00102 and of 22's .00061, which shows that the cross-sectional area of 22's is only six-tenths, or a little over half, that of 20's. Whereas 20's s.w.g. will safely carry 4.1 amps., 22's will only carry 2.5 amps., and if used in place of 20's might get unduly heated and, in addition, add a good amount of unnecessary resistance to the circuit. It should be mentioned here that a mil is the thousandth part of an inch.

Few tables are published giving the same particulars of both gauges of wire, so that comparison is not always an easy matter. Many tables give the diameters in mils, but a most useful factor is the cross-sectional area, which provides a much readier means of comparing the current-carrying capacity, which is often an important consideration. Circular mils are also frequently used, but the circular mil is the square of the diameter in mils, and therefore represents an area much greater than the actual section of the wire, but still forms a handy means of comparison.

In calculating the space to be allowed for a given number of turns of wire, care must be taken not to cut the space too fine, or difficulty may be experienced in getting the required number of turns into the space. Therefore a deduction must be made from the theoretical turns per inch given in the table. Where taps have to be made, space is taken up, and fewer turns can be put on, and in high-tension windings a small amount of space must be left at each end of every layer, and this must be taken into account. Slight irregularity, permissible, and scarcely noticeable, will get away with several turns per inch when winding fine wire.

Wire that has been previously wound for another purpose usually takes more space than new wire, owing to slight irregularities. Such wire may be greatly improved by running out full length out-of-doors and stretching by pulling, but moderation is necessary, as stretching tends to harden the wire, reducing its conductivity.

The table herewith has been compiled by the writer from several sources, and may be taken as approximately correct, as there is a slight variation between the product of different factories. The table is not given with an idea of favouring the use of the B. and S. standard, because s.w.g. is the more widely stocked in New Zealand, and it is better for constructors to adopt this standard and keep to it as much as possible. American magazines give B. and S. gauges in specifications, and it is handy to be able to find the nearest procurable, as shown in the table. Only the even sizes are given, because odd numbers are usually not stocked, although in some cases the odd number would supply almost the exact equivalent for a wire of the other series. Portions of the table are published in various catalogues, but the writer feels that their combination into one table will be appreciated by constructors.

From the "ohms per 1000 feet" column the resistance of any length of

(Continued on page 11.)

PARTICULARS OF ENAMELLED COPPER WIRE

	Diameter, Mils		Cross-Sectional Area		Turns to Inch		Ohms per 1000 ft		Lbs per 1000 ft		
No.	B & S	S.W.G.	B. & S. sq.	ins S.W.G.	B & S	S.W.G.	B & S	S.W.G.	B & S	S.W.G.	No.
12	82·8	104	·005129	·008495	12·1	9·6	1·62		19·8		12
14	66·1	80	·003225	·005127	15·1	12·6	2·58		12·4		14
16	52·8	64	·002028	·003217	18·9	14	4·09	2·491	7·82	12·40	16
18	42·1	48	·001276	·001810	23·8	19·5	6·51	4·46	4·92	6·97	18
20	33·7	36	·0008023	·001018	29·7	27	10·4	7·87	3·09	3·92	20
22	26·9	28	·0005046	·0006158	37·2	32	16·5	13·013	1·94	2·370	22
24	21·5	22	·0003173	·0003801	46·5	40	26·2	21·08	1·22	1·465	24
26	17·1	18	·0001996	·0002545	58·5	50	41·6	31·49	·769	·9806	26
28	13·6	14·8	·0001255	·0001720	73·5	64	66·2	46·56	484	·663	28
30	10·9	12·4	·0000789	·0001208	91·7	71	105	66·36	·304	·465	30
32	8·7	10·8	·0000496	·0000916	115	87	167	87·46	191	·353	32
34	6·9	9·2	·0000312	·0000665	145	102	266	120·5	·120	·2562	34
36	5·5	7·6	·0000156	·0000454	180	123	423	176·6	0757	·1748	36
38	4·4	6·0	·0000123	·0000283	227	167	673	283·4	·0476	·1089	38
40	3·5	4·8	·0000078	·0000181	286	208	1070	443	·0299	·0697	40