NEW DUAL LOUD SPEAKER

Combining the Best Qualities of Electrostatic and Moving-coil Units.

By H. A. HARTLEY.

THE moving-coil loud speaker as usually sold may be said to be deficient in the reproduction of the higher audio-frequencies, and now at the importance of good "top" is ginning to be realised, many readers of *The ireless World* are wanting to know how this ıy be done.

Without going into the mathematics of ıd speaker operation it may be said that e moving-coil loud speaker has constant ıwer output at all frequencies, but this ılds good only up to a certain frequency, termined by the size of the cone, at which ıint the power begins to fall off rapidly. ıually this frequency is between 2,000 and ɔoo cycles per second, and unless the cone specially designed to give a series of con-ılled resonances there will be a top cut-off.

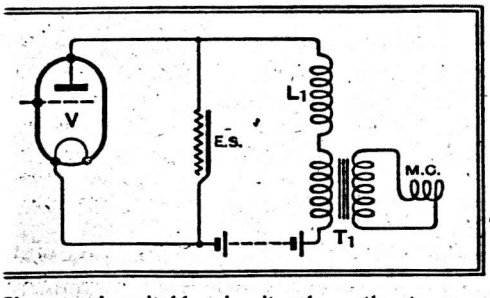


Fig. 1.—A suitable circuit where the transformation ratio of T_1 can be altered at will.

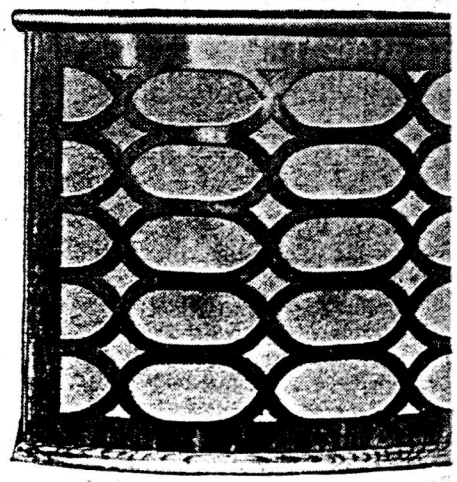
the size of the cone is reduced the fre-ıency at which this cut-off takes place will raised, but, unfortunately, the bass will ffer. The smaller the cone the greater is e required displacement at the lower end the scale, and while a cone of, say, two ches diameter would give excellent top, it ɔuld have to be mounted in such a way at the amplitude of vibration at 50 cycles ɔuld be several inches. This, of course, is ıpracticable, so the cone is usually made ɔout seven inches in diameter as a com-ɔmise.

An electrostatic loud speaker has recently been put into production (see *The Wireless World*, June 1st, 1932, p. 585) which has many interesting points. It may be considered a pure capacity, and its reactance will be determined by the well-known formula $X=\frac{1}{2\pi fC}$. When connected in the anode circuit of a valve whose resistance is R ohms, the impedance of the circuit is $Z=\sqrt{R^2+X^2}$, and it follows that the impedance goes down with increasing frequency, so that there will be good top response; this is further aided by the fact that the diaphragm has small radiation resistance. On the other hand, the impedance increases as we come down the frequency scale, so there is bound to be a bass cut-off. It would seem, therefore, to be logical to use the electrostatic and electrodynamic loud speakers in combination, each making good the deficiencies of the other.

PRACTICAL details are here given of dual speaker equipment combining the exellent high-note response of the electrostatic speaker with full-bass reproduction of the moving-coil type. The combination ensures that each speaker makes good the deficiencies of the other. This article should prove a useful contribution towards the achievement of realistic reproduction.

This, as it happens, is a method of getting quite good reproduction, but the application of the idea is not so simple as would appear on first thoughts.

To render the combination effective, two things must be done. First, we have seen that the electrostatic loud speaker will have a bass cut-off owing to its high impedance at low frequencies, but, owing to the small clearances in the design, the loud speaker will rattle unless the lower frequencies are prevented from reaching it. Secondly, the moving-coil loud speaker, having constant impedance, will act as a short circuit across the electrostatic at high frequencies unless the capacity of the electrostatic is so high that it acts as a short across the moving coil. In practice this is not so, and we must prevent the high frequencies from reaching the moving-coil unit. To take the latter problem first, the desired result can be attained by inserting a choke in series with the moving-coil speaker; this will raise the impedance at high frequencies and so the electrostatic will take up the work at this end of the scale. At the same time we must choose a transformation ratio for the moving coil unit so that, at low frequencies, the



The "primustatic" electrostatic speaker w forms one member of the dual unit.

apparent input impedance of this circuit low compared with that of the electro speaker that all power will be diverted the latter. The arrangement is show Fig. 1 where V is the output valve, T output transformer of the moving-coil sp M.C., L_1 the high frequency "sto choke," and E.S. the electrostatic speaker.

Output Transformer Ratio.

In some cases it will not be possib choose a transformer ratio to achiev desired result, as many loud speakers non-variable transformers built into In such cases it will be necessary to co a choke across the electrostatic speake designed that the circuit formed has a nant frequency at which it is desired the electrostatic takes up the work will be necessary simultaneously to ins condenser in series with this circuit v

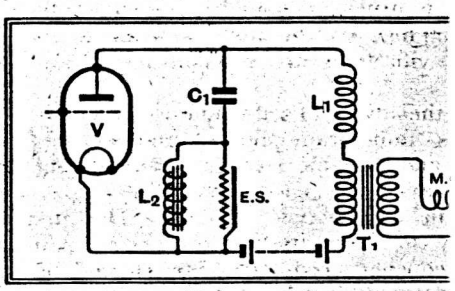


Fig. 2.—When the ratio of T_1 cannot be alte a resonant circuit L_2 E.S. prevents the lo audio-frequencies from rattling the electrost loud speaker.

reactance at low frequencies is substan greater than that of the choke. In F the resonant circuit is formed by E.S the choke L_2. This is insulated fror

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teady anode voltage by the condenser C_1. So much for the theoretical considerations of he separation of the audio-frequency output nto the two desired channels; we must now ut this into practice.

The electrostatic loud speaker requires a olarising voltage of 200 to 250 volts, and in ig. 1 it will be seen that the potential differnce between the anode of V and H.T. – can e used for this purpose. If the circuit of ig. 2 has to be adopted, then this source of olarising voltage is removed; some other neans must also be found in cases where the oltage on the anode of the output valve is n excess of 250 volts, as the electrostatic loud peaker is not designed for such voltages.

Polarising Voltage.

If the moving-coil speaker has a D.C. xcited field of appropriate voltage then this vill form a suitable source of supply, otherwise the polarising voltage must be derived rom the eliminator in some way. If the naximum H.T. is 250 volts and the output alve is directly heated, no special preautions are necessary, but in the case of an ndirectly heated cathode type of output alve it is advisable that the rectifier, if the liminator is of the A.C. type, be also an ndirectly heated valve, to prevent excessive oltages being applied to the electrostatic peaker before the output valve warms up. f the output valve calls for 400 or more volts n the anode, a potentiometer must be added o break down the voltage to the desired gure. These various arrangements are hown in Fig. 3, which also shows a filter ystem in the supply. The choke L_3, as well s reducing mains hum, is essential to preent audio-frequency energy being diverted from the electrostatic loud speaker into the supply system. The resistance R is also required in order to pass a small D.C. current through the choke, otherwise there will be no smoothing of mains hum.

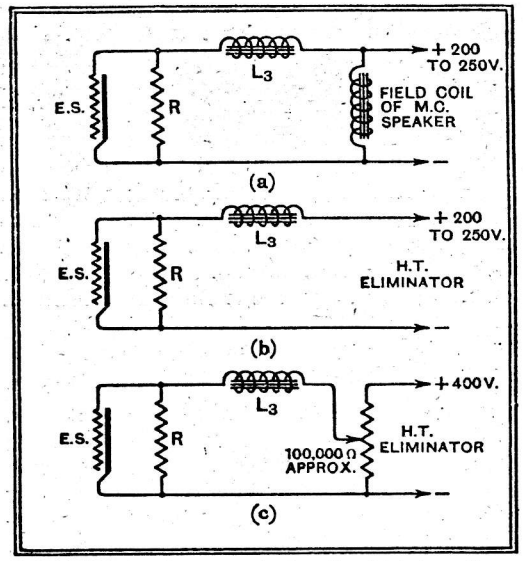


Fig. 3.—Various methods of obtaining the polarising voltage. The potentiometer in (c) should be adjusted so that the voltage applied to E.S. is about 220.

All the foregoing has been based on the assumption that the impedance relation between the electrostatic speaker and valve is such that the speaker forms an efficient load towards the upper limit of the frequency required. Where this is not the case, and, on the whole it will be exceptional, it will be necessary to feed the electrostatic speaker through a step-up or step-down transformer, according to the type of valve used. A step-down ratio will be required for valves of very high impedance, and a step-up fo power valves of unusually low impe especially when such valves are u parallel. For experimental purposes, quality audio-frequency transformer o $3\frac{1}{2}$ to 1 ratio, and of low self capacit be quite suitable. Fig. 4 shows th nections.

Compensating Unit.

We are now in a position to constr compensating unit for the two loud sp Fig. 5 gives all values and connectio the reader is advised to study it close will be seen that a choke of one henry ance, L_1 is connected in series with th and the moving-coil output transf the function of which, as we have see prevent the higher frequencies from ing this unit. The electrostatic loud s is in parallel with this; it is insulate the steady anode voltage by C_1 of one farad capacity. The inductance L_2 henry and the electrostatic loud speak together form a resonant circuit wh tuned to the desired cut-off frequency tappings on L_2. The polarising volta E.S. is obtained from any convenient and is fed through the filter system L_3 L_3 being of 100 henries inductance 250,000 ohms.

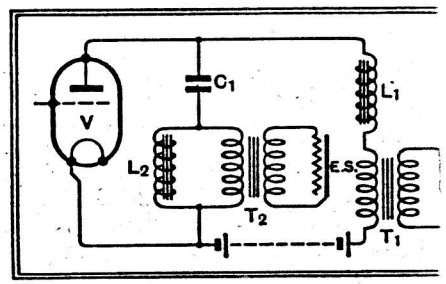
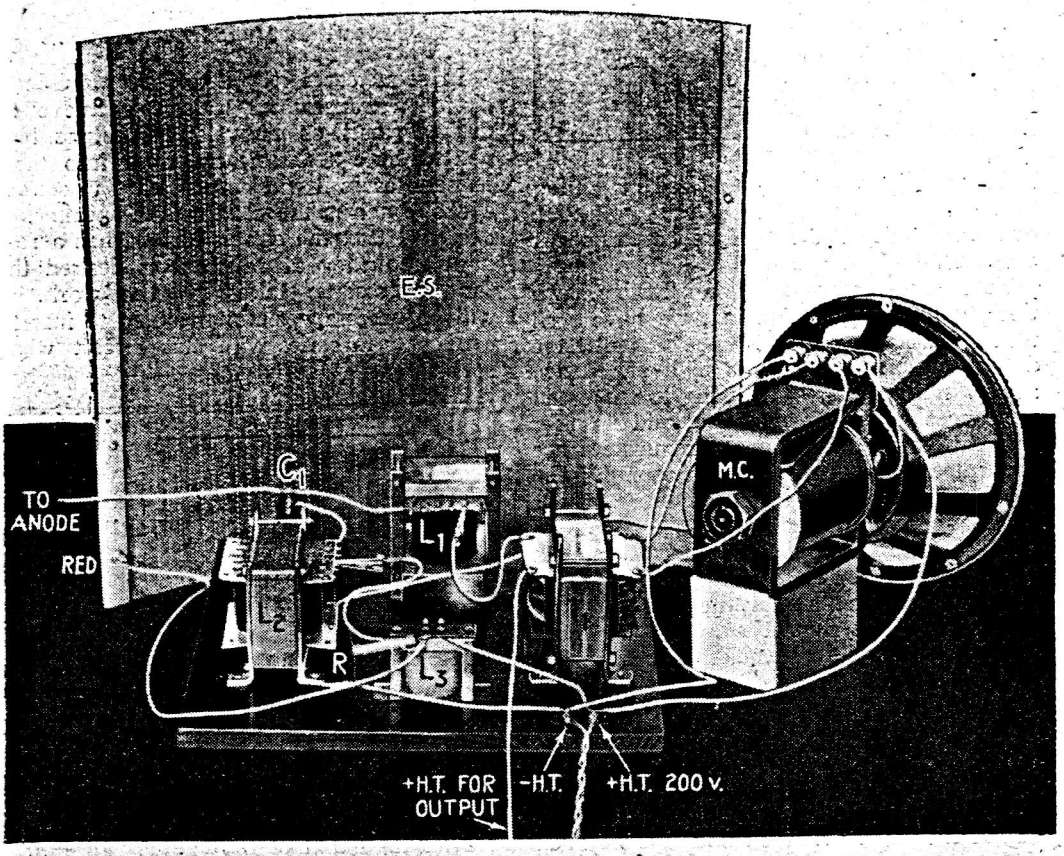


Fig. 4.—Where the impedance of E.S. is too high or too low to act as an efficient on the valve, the transformer T_2 is us match the impedances at high frequenc

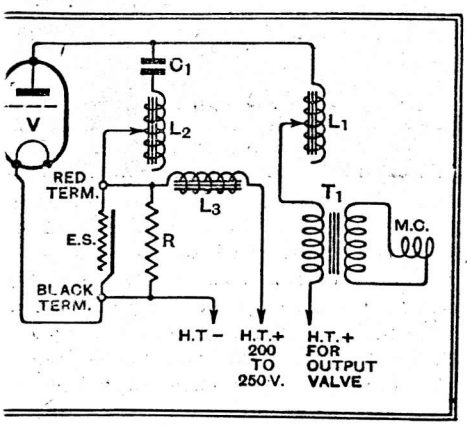
First of all, it is necessary to balan two loud speakers for sensitivity. shows the connections of both speak this test, diagrams being shown fo with direct output transformer feed, or feed. Arrangements should be made the circuits can be broken at the poi Tune in a station with E.S. connect M.C. broken at X (one of the leads fr secondary of the output transformer), t quickly as possible, break the lead b E.S. and H.T.—and connect in M.C. volume of sound, making allowance different character of the reprod appears to be about the same on speakers, nothing more need be done, the moving-coil loud speaker seems to louder of the two an attempt should b to reduce its sensitivity by adding a resistance to the field coil. This m although not the best which can be u ordinary cases, is forced on one here, usual procedure, by adding a resista the output circuit, will affect the perfo of the electrostatic. If of the perm magnet type the sensitivity will proba approximately equal to that of the static. On the other hand, the movi unit may be one of the inexpensive ty so popular, when the sensitivity will de be less; in this case nothing very mu



Experimental layout showing connections of electrostatic and moving-coil units together with filter components.

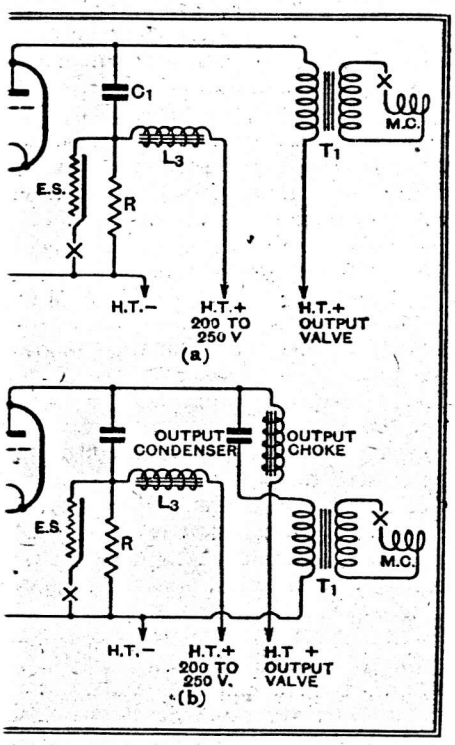
Dual Loud Speaker.—

one, as it is difficult to "desensitise" the imustatic" without impairing its perance.



5.—The complete schematic diagram. L_1, enry (tapped) ; L_2, 0.2 henry (tapped) ; 100 henrys ; C_1, 1 mfd. ; R, 250,000 ıs ; T_1, moving-coil output transformer ; . moving-coil loud speaker ; E.S. "Primuic" loud speaker ; V, output valve. If matching transformer T_2 of Fig. 4 is reed, one winding replaces E.S. in the above ram, and E.S., R and L_3 are connected to the other winding.

suming now that we have the two loud ers of approximately equal sensitivity, that the complete unit has been ıbled, a local station should be tuned in he lead removed from the red terminal e "Primustatic" loud speaker. The ng on the choke L_1 must now be ted until there is a marked cut-off at cycles on the moving-coil speaker. The r may well ask how he will know when ıt-off is at this figure. It can be said speech and music should sound very ılly" and, if the loud speaker normally ks" at about 2,000 cycles (a common , all trace of brightness or shrillness be removed. Now, reconnect the nustatic" loud speaker and remove the



6.—Connecting the two loud speakers for hing sensitivity. (a) Straight transformer output ; (b) Choke output.

field supply from the moving-coil unit ; if of the permanent magnet type disconnect one of the leads from the output transformer secondary winding. Adjust the tapping on the choke L_2 until all trace of lower frequencies has disappeared and the reproduction is so shrill as to be irritating. We can assume, somewhat casually, no doubt, that frequencies up to about 1,000 cycles have been removed. Returning the moving-coil speaker to its normal condition will result in a combination which ought to sound very pleasant indeed, but if the higher frequencies sound weak, it will be advisable to experiment with a suitable transformer feeding the electrostatic loud speaker as suggested earlier in this article and illustrated diagrammatically in Fig. 4.

It should be borne in mind that the dual unit has no better bass performance than the moving coil alone, and if this latter "grunts" at low frequencies, the combination will grunt also. The high-frequency response will, however, be so greatly improved as to commend the dual loud speaker to all discriminating listeners. The moving-coil loud speaker shown in the illustration has been chosen as one not hitherto on market, and it is hoped thus to av criticism from the maker of any partic brand of loud speaker who might object any public attempt to alter the performa of his product, or from competitive mak who might equally strongly object to any make being singled out for rejuvenat treatment. The device will work with moving-coil speaker, and the excellence otherwise of the original bass response will a measure of the total excellence of the wh The normal power-handling capacity of "Primustatic" loud speaker is rather than one watt, but the combination handle 5 watts A.C. without distress, a readers with output valves of the L.S.6a t need have no hesitation in making up arrangement as described. If the two lo speakers are not to be built into one cabin they should be as close together as possib to avoid hearing separately the compleme tary halves of the frequency response of two loud speakers. As there is only sli focusing of the high frequencies from electrostatic speaker, the general diffusion sound will be found very pleasing.

NEWS BY TELEVISION

A New Marconi System.

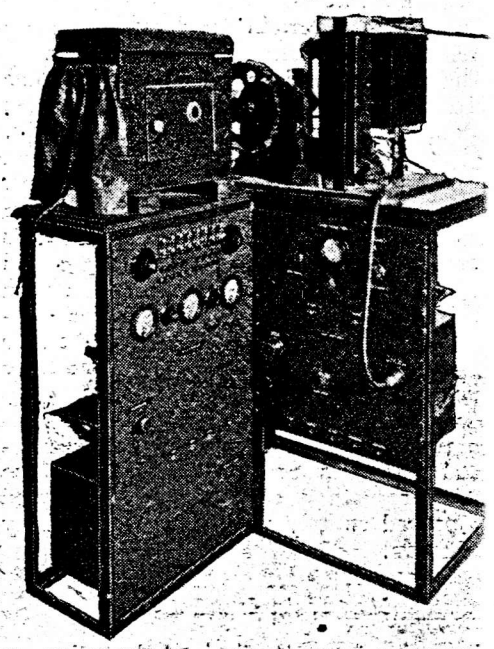
APPARATUS has now been evolved by the Marconi Company for the commercial transmission of news by television. This is one of the applications of television which do not necessarily involve the use of wide frequency bands; the new instrument can be operated satisfactorily on a medium long wave of 1,000 metres.

It is designed to transmit images of a moving tape on which characters are printed by a special typewriter. The light source is a 1,000-watt gas-filled metal-filament projector lamp mounted vertically with a reflector behind it. The light passes through a spherical condenser lens system, on to a reflecting mirror and an aperture, and thence through a system of lenses mounted in a spiral on a lens drum. There are fifteen such lenses on the drum, and the picture repetition frequency corresponding to the speed of the drum is twenty per second.

The Photo Cell Amplifier.

A sharp image of the aperture is projected by each lens on the tape, and is swept over it by the lens drum motion. The tape is carried vertically between two rollers, the bottom one of which is driven through suitable gearing by the same motor that drives the lens drum, and the tape can be given a speed of either 60 or 120 w.p.m. Behind the tape is mounted the photo cell and photo cell amplifier, both of which are contained in a single shielded unit. The lens drum driving motor is maintained at constant speed by means of a synchronous motor controlled by a tuning fork mounted in the bottom of the frame under the lamp house. Above the tuning fork is the fork amplifier unit, and above that is the control unit for the whole system. The frame which supports the lens wheel and tape drive carries two panels, the lower one being the line amplifier and the other the synchronising circuit, which sends out a special signal with the picture signal for the purpose of keeping the receiver scanning motor in step.

In this type of transmitter the frequency band necessary depends on the number of letters shown at the same time in the picture, and a convenient method of adapting the te vision transmission to any width of band av able is therefore to alter the length of the p ture, which alters the number of letters sho accordingly. Thus, the frequency band quired by the apparatus described is 13 k/c but by reducing the distance between t lenses on the drum which shortens the pictu length and reduces the number of letters sho this band width can be reduced to any co venient value.



The new Marconi television transmitter designed for operation on the long waveband. The visual transmission of typed news bulletins is suggested.

The receiver shows a long, narrow pictu having a size dependent on the power of t modulated light source, and with existi facilities pictures can be obtained from a t inches in length up to several feet.