RADFORD LOUDSPEAKERS

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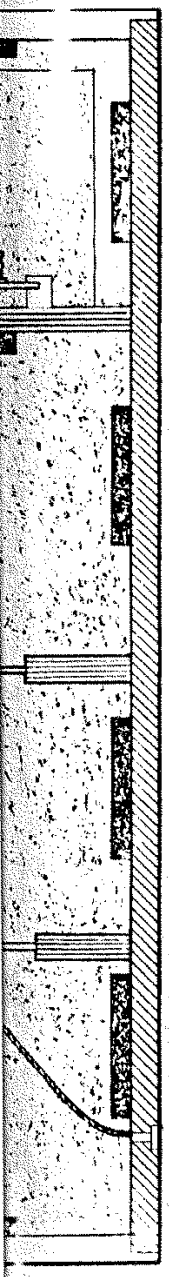
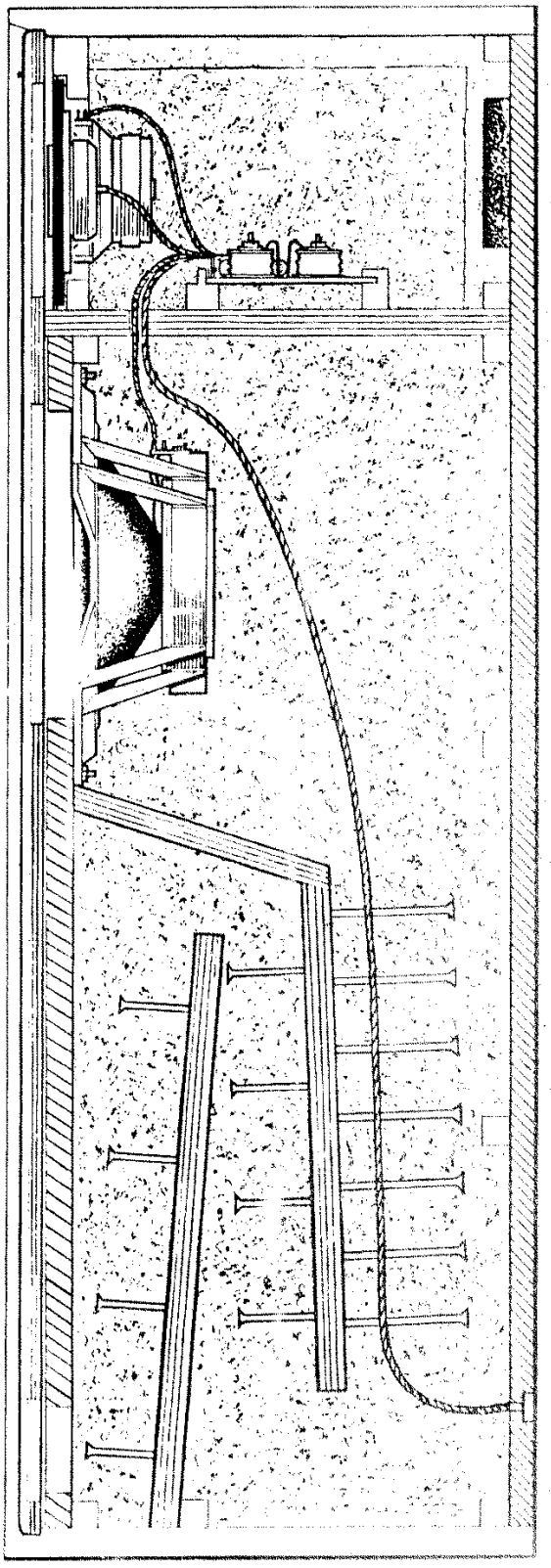
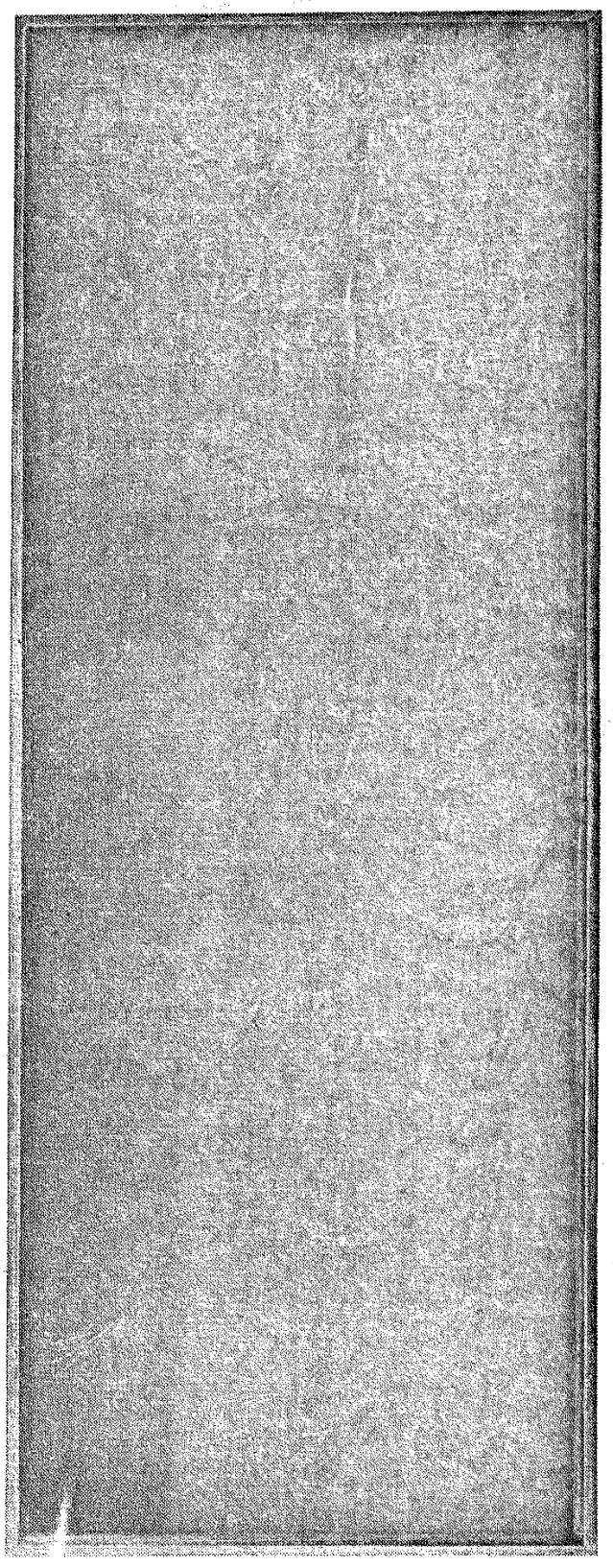






1. INTRODUCTION

It has been stated by many writers during the evolution of high quality sound reproduction that the loudspeaker is the weakest link in the chain of apparatus from the original performance to the listener. Generalising, this is still true to-day.

Due to the enormous range of loudspeakers available today with wide variations in size, styling, finish, and particularly performance, it is necessary for a potential purchaser to extend more time and energy in the selection of a loudspeaker than for any other component. It is a formidable task of choice for the experienced and uninitiated alike. From performance alone the variations exceed those of all other components combined.

Most loudspeakers are merely one or more drive units in a box of reasonable presentation with no aspirations to performance. Money not spent on development is expended in sales promotion, and extravagant claims have been made particularly in respect of the static axial frequency response characteristic and its importance. Due to the general mediocre performance of loudspeakers and lack of reliable testing techniques, magazine reviews have been of little assistance and sometimes misleading. Reviews indicate that loudspeakers are good or very good, never poor. This is not true.

The RADFORD philosophy of advanced design, first class workmanship maximum reliability and outstanding performance is the same for amplifiers, tuners and loudspeakers. The systems described in this leaflet are the result of considerable development and many years experience in the manufacture of loudspeakers.

2. TECHNICAL DETAILS

2.1: Drive Units

The physics of acoustic radiation from vibrating diaphragms clearly shew that wide range reproduction cannot be obtained from a single drive unit. The requirements for radiation at low and high frequencies are so opposing as to make even a two unit system a compromise. Until recently RADFORD loudspeakers used four standard commercially available drive units of differing diaphragm diameters to cover the entire frequency band. Three basic drive units have now been specially designed, however, for specific frequency bands. These with the integrating network cover the whole audio frequency band more satisfactorily than the previous four. Three correctly designed units appears to be optimum as difficulties increase with the integration of four units, and the range cannot be covered without transient colouration at middle frequencies with two units. Details of the three drive units with available variations are given below.

Bass Driver Type BD 25/1

A nominal 12″ type unit with a fully plasticised diaphragm and surround. Heavy coil on aluminium former. Designed for 3 unit systems.

Bass Driver Type BD 25/2

Same chassis as BD 25/1 but with lighter coil and diaphragm. Designed for 2 unit system.

Mid range Driver Type MD 9/1

An open back unit with a 3″ diameter diaphragm terminated with a plastic surround. Designed for operation in separate enclosure from bass driver.

Mid Range Driver Type MD 9/2

Diaphragm and surround similar to MD 9/1 but fitted to a closed back chassis. Designed for use in same enclosure as bass driver.

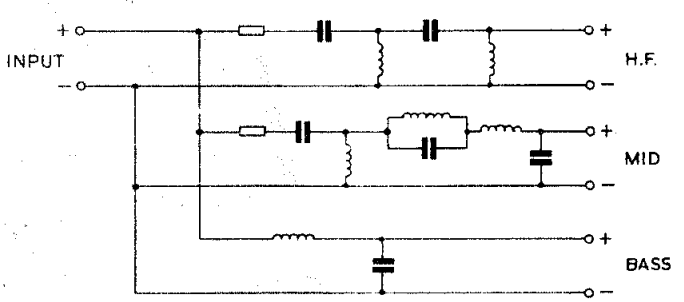
High Frequency Driver Type TD 3/1

A pressure type unit with a dome radiator of approximately 1″ diameter. Designed for 2 or 3 unit systems.

2.2: Integrating Network

This is the vital element in a loudspeaker system. Using the finest drive units available, a loudspeaker will have a poor performance unless an accurate equalising and integrating network is employed. Simple networks are useless if, the highest attainable performance is to be realised.

A network cannot be designed purely as an electrical device due to the varying impedance and radiation characteristics of drive units. It can only be evolved by direct acoustical measurements and translated into electrical characteristics. Simple networks invariably have an unsatisfactory impedance characteristic, highly reactive at some frequencies with a considerable variation over the frequency range. The introduction of ferrites, stable reversible electrolytic capacitors and printed circuit boards have made sophisticated networks a physical and economic reality. Considerable importance is attached to the manufacture and test of networks. To ensure that all loudspeakers sound the same, capacitors are aged before grading and inductors are adjusted on test to the precise value. The circuit of the network used in the 3 way systems is shown in the diagram.



2.3: Impedance Characteristics

A fact frequently overlooked in loudspeaker design is the overall impedance characteristic of drive units plus network as presented to the amplifier. Simple networks invariably have an unsatisfactory impedance response—highly reactive at some frequencies and with a considerable impedance variation over the frequency range. Although an approximately level response may be obtained by acoustic measurement with a low constant voltage input under these conditions, considerable distortion can be introduced at some frequencies by selective overloading of the amplifier when driven at the rated amplifier level.

A frequency selective impedance drop in the load presented to the amplifier will also cause a change in the response characteristic as the amplifier is unable to maintain the output voltage at the low impedance points, when driven to its rated output.

All RADFORD loudspeakers have an impedance characteristic which does not fall below 7 ohms at any part of the frequency band.

2.4: Frequency response and transient distortion

For many years it has been possible to obtain a sensibly flat frequency characteristic on axis from quite simple systems when measured with a single frequency at a time over the frequency band. This is a static measurement condition.

Due to transient distortion, however, the frequency characteristic under dynamic conditions of reproducing speech and music may be considerably different from the static response. Transient distortion is basically due to energy storage which is converted to acoustic radiation at some later moment in time. In practice re-radiation occurs due to resonance storage in drive units, to cabinet vibration, and reflections inside the box re-radiated through the diaphragm.

Another reason why some loudspeakers which are claimed to have a flat frequency characteristic do not sound correct is that at high frequencies the radiation is over a narrow angle only. Under practical listening conditions the ear responds to the total energy response over a wide angle.

3. ENCLOSURE DETAILS

3.1: General Construction

The enclosure structure absorbs energy from the rear radiation of the low frequency diaphragm and re-radiates it causing transient colouration. To obviate or reduce this it is necessary to construct the enclosure from a dense and heavy substance, suitably braced and damped.

The Bookshelf, Tri-star 50 and Monitor loudspeakers are constructed from 12 mm birch plywood and the Auditorium and Studio models from 18 mm birch plywood. The enclosures are sectioned by bracing members and the panels thus formed are damped with a laminated bituminous compound of $\frac{1}{2}$″ thickness. The drawing on the cover illustrates the general construction.

3.2: Bass Driver Acoustic Loading

All the loudspeakers except the STUDIO use a sealed enclosure, sometimes referred to as an infinite baffle. This type of loading provides the minimum low frequency colouration for small and medium size boxes due to the heavy air mass damping. Performance is proportional to size in respect of low frequency output and distortion. For large enclosures considerable improvement in performance is obtained by using an acoustic line termination (Radford patent). A correctly designed line provides acoustically resistive damping at very low frequencies which is terminated by the port radiation resistance of the end of the line. The in-phase end radiation is used to supplement the diaphragm radiation where it is falling due to diffraction and virtual velocity operation. The low frequency response and acoustical loading characteristics are so good in the STUDIO loudspeaker that it is possible to radiate high acoustic power at a fundamental frequency below audibility without audible harmonics.

3.3: Mid-range Driver Acoustic Loading

The back enclosed mid-range unit MD 9/2 has no rear radiation and does not therefore require external rear loading. Rear external loading is provided by a carefully arranged damped air cavity in the unit itself between the diaphragm and its casing. The small enclosure volume considerably increases the mass resonant frequency necessitating skilful design of the integrating network to avoid transient distortion. Delayed response distortion due to the reflected wave is negligible as the cavity dimension is small compared with the wavelength.

The mid-range unit MD 9/1 is an open back type with a low free air mass resonance. In the MONITOR, AUDITORIUM and STUDIO loudspeakers it is fitted in a separate heavily damped enclosure from the bass driver. The size of the enclosure and its acoustic attenuation relative to the wavelength of the frequencies radiated is large, and it operates virtually as a closed end acoustic line.

3.4: Acoustic Absorbing Material

The purpose of lagging is to absorb as much radiation from the rear of the diaphragm as possible. Normally cellulose wadding is used but investigations have shewn that natural fibres are more efficient than synthetic fibres particularly at low frequencies. Long fibre wool is used in all RADFORD enclosures.

4. SPECIFICATIONS

4.1: Bookshelf

A loudspeaker of the smallest practical dimensions to ensure effective low frequency radiation. Intended for shelf mounting and uses two drive units. The type BD 25/2 bass driver used has been specially formulated with a lighter moving system than the BD 25/1 to extend the useful range to 2KHz at the expense of very low frequencies. The TD 3/1 treble driver operates over the range 2KHz–25KHz. The static response characteristic has been corrected in the frequency range 750Hz–3KHz to a flat dynamic response thus alleviating the transient distortion colouration inevitable in a two unit system.

It is an inexpensive system with wide frequency range, low colouration and good power handling capacity.

Frequency range 55Hz–25KHz. Power handling capacity 30 watts* Size 21 x 12 x 9in (53 x 32 x 23 cm) Weight 30 lbs (13½Kg).

4.2: Tri-star 50

Identical in size with the Bookshelf loudspeaker but uses three drive units: bass driver BD 25/1, mid-range driver MD 9/2, and treble driver TD 3/1. The mid-range unit is a closed back type enabling it to operate in the same enclosure as the bass driver and operates over the range 500Hz–5KHz.

This loudspeaker is intended to satisfy the requirement for a true high fidelity performance with very low colouration in a relatively small dimension.

Frequency range 55Hz–25KHz. Power handling capacity 50 watts*Size 21 x 12 x 9 in (53 x 32 x 23 cm) Weight 33 lbs (15 Kg).

4.3: Monitor

Intended for floor mounting, preferably on a suitable stand. Uses three drivers: BD 25/1, MD 9/1, and TD 3/1. The mid-range driver is of the open back type which operates in a separate enclosure from the bass driver. The type MD 9/1 unit has been developed from information obtained from an intensive study over the last three years into transient distortion colouration.

This is a full range loudspeaker remarkably free from colouration with small free standing dimensions.

Frequency range 50Hz–25KHz. Power handling capacity 50 watts* Size 30 x 12 x 10½ in (76 x 30.5 x 25.5 cm) Weight 43 lbs (19.5 Kg).

4.4: Auditorium

A floor mounting loudspeaker (preferably on suitable stand) using the same units and networks as the MONITOR but having larger enclosures for both bass and mid-range units.

For medium and large rooms with enough space this loudspeaker will provide a substantial low frequency response in addition to smooth and relaxed mid and high frequencies, free of colouration.

Frequency range 40Hz–25KHz. Power handling capacity 50 watts* Size 36 x 16 x 13 in (91 x 40.5 x 33 cm) Weight 70 lbs (32 Kg).

4.5: Studio

A floor mounting loudspeaker of suitable height without a stand for optimum listening satisfaction. Uses same units and network as the MONITOR and AUDITORIUM loudspeakers. Bass driver is rear loaded with an open end acoustic transmission line which extends the flat response down to 30Hz. Due to in-phase radiation below 50Hz from spaced sources the wavefront tends to plane configuration giving a higher subjective sensation than a virtual point source velocity wave (due to the diaphragm only) at these frequencies.

A loudspeaker with the highest possible performance for medium to large rooms. Provides a clean response over the whole audio frequency band from below to above audibility.

Frequency range 30Hz–25KHz. Power handling capacity 50 watts* Size 45½ x 17 x 15 in (115 x 43 x 38 cm) Weight 98 lbs (44.5 Kg).

*NOTE 1 **Power handling capacity.** Power handling capacity is the rated power output of the amplifier in r.m.s. watts into an 8 ohms load, when used on speech and music.

2 **Matching impedance.** All loudspeakers are designed to operate satisfactorily from amplifiers having an output matching impedance from 4–16 ohms. Maximum acoustical power is obtained from amplifiers of nominal 8 ohms output matching impedance.

3 **Finish.** All models are available in afrormosia or semi-matt hard epoxy white painted.

5. Loudspeaker Evaluation

The best place to evaluate a loudspeaker is in your own home. A dealer's showroom enables first selection of price, size, finish and general presentation in relation to your home environment. Dealer demonstration facilities will also enable you to eliminate unsuitable loudspeakers in your purchase price range, providing you know what to listen for. This should leave two or three loudspeakers from which to make a final choice. The following notes are intended for guidance in loudspeaker selection.

The evaluation of a loudspeaker requires a skill which can be acquired through practice by anyone keen enough. Hard concentration is required initially to train the ear/brain relationship to the actual SOUND heard and eliminate the emotive sensation if music is used for testing. It must be emphasized that evaluation is a personal matter as experts do not agree about good reprodution. It would appear that we do not hear the original sound in the same way and judgment of reproduction is conditioned by what affects us in the original sound. As an example, if you regularly sit at the rear of the concert hall you may select a dull sounding loudspeaker whereas if you like to be near the sound source you will prefer a 'bright' loudspeaker when judged on orchestral recordings. For this reason evaluation should be made on a wide range of sounds, particularly the speaking voice. Reproduction of the speaking voice is very suitable for testing as everyone is aware of its original sound. A good loudspeaker will sound correct on all types of signal source.

Instant decisions on loudspeakers should be avoided. Some loudspeakers (mainly continental) have a peak in the 10–15 KHz region, producing an artificial brightness which increases excitement temporarily, but results in fatigue as listening is continued. These loudspeakers rely on first impact for sales: they are unsuitable for serious listening. This is why it is desirable to evaluate at home. If a loudspeaker tires you it should be rejected. A desire to continue listening for long periods is a very good sign.

If adjustments to the tone control are necessary frequently or on different programme sources something is wrong. Assuming satisfactory equipment a good loudspeaker will sound best with a level response input signal.

For a more scientific approach to loudspeaker selection, so called 'white noise' or better still 'interrupted white noise' may be used to illustrate colouration. An f.m. tuner, off tune, will provide a suitable white noise signal, and hand clapping of a large audience is suitable as an interrupted white noise signal. RCA. SF. 7525 (Carlos Montoya–guitar) is an excellent test record for transient response and colouration. Hand clapping is provided by an audience between bands. Colouration is not easily detected on first listening without comparisons. Most dealers now have a comparator. Get your dealer to switch loudspeakers on noise and demonstrate the characteristic colouration tones. Once aware, you can do some significant sorting out for yourself.

NEVER, NEVER, if you are a serious listener, buy a loudspeaker 'on spec' from advertisements, manufacturers' sales leaflets, magazine test reviews or on another person's recommendation or judgment.