Model 70

a significant advance on existing loudspeaker systems

B&W electronics
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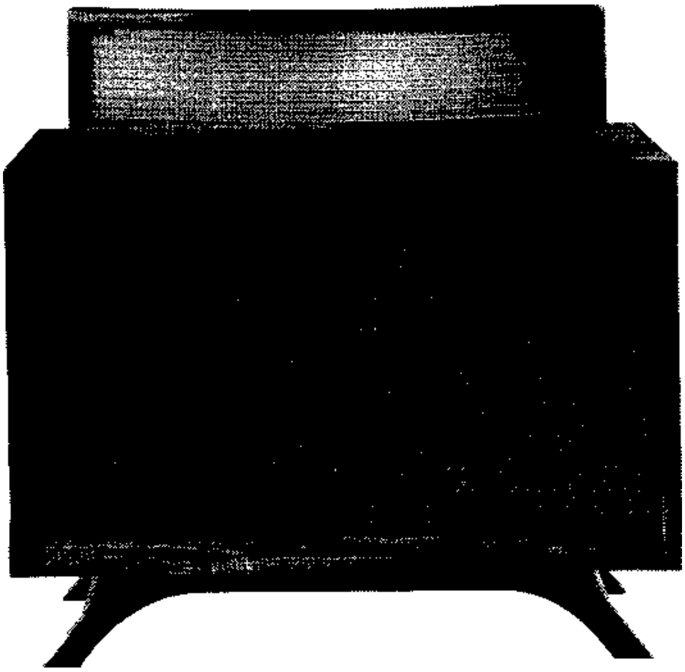
Model 70

USERS INSTRUCTION HANDBOOK



CONTENTS

INTRODUCTION.

Each Model 70 loudspeaker system comes to you in two seperate cartons. The larger carton contains the main cabinet and an accessory bag containing plugs, spare fuse and fixing screws. The main cabinet is complete with leg assembly and electrostatic power supply/filter unit, both of which are fixed in position. The smaller carton contains the 701 electrostatic unit which is ready for insertion in the sockets provided on the top surface of the main cabinet.

WARNING.

IT IS IMPORTANT THAT THE ASSEMBLY AND INSTALLATION

INSTRUCTIONS BE CAREFULLY READ BEFORE CONNECTING

THIS SYSTEM TO THE MAINS OR AUDIO SUPPLY.

ASSEMBLY INSTRUCTIONS.

Unpack the larger of the two cartons and remove the accessory bag from the underside of the main cabinet. Unpack the electrostatic unit from the smaller carton. We suggest you retain the special Polystyrene pack from the smaller carton for possible future transportation of the electrostatic unit.

The electrostatic unit should now be inserted in the sockets provided on the top surface of the main cabinet. Spigots on both feet of the 701 electrostatic unit locate in the corresponding sockets and they can only be assembled in the correct manner.

Having inserted the electrostatic unit make secure by screwing through the hole provided in the rear of each foot with the special instrument-head wood screws and cups included in the accessory pack. The system is now ready, after checking mains supply voltage, for installation.

UNDER NO CIRCUMSTANCES SHOULD THE ELECTROSTATIC

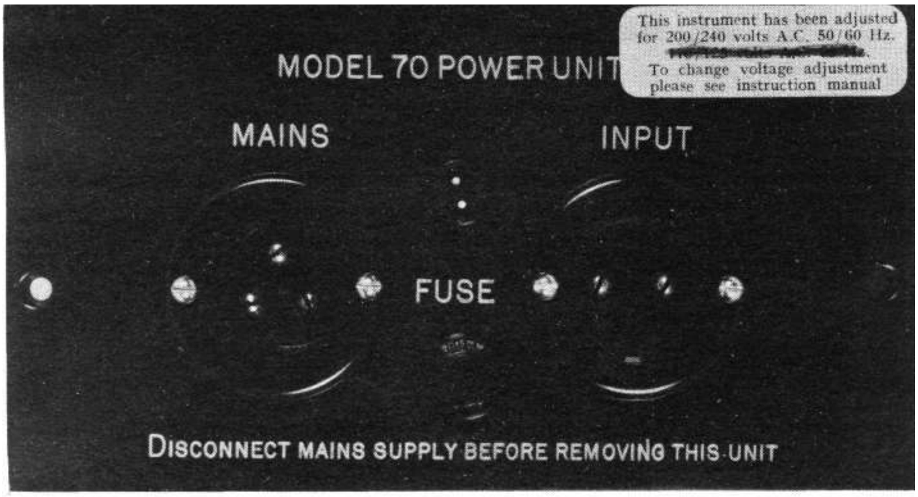
UNIT BE REMOVED WITH MAINS SUPPLY CONNECTED OR WHILST

THE SYSTEM IS IN OPERATION.

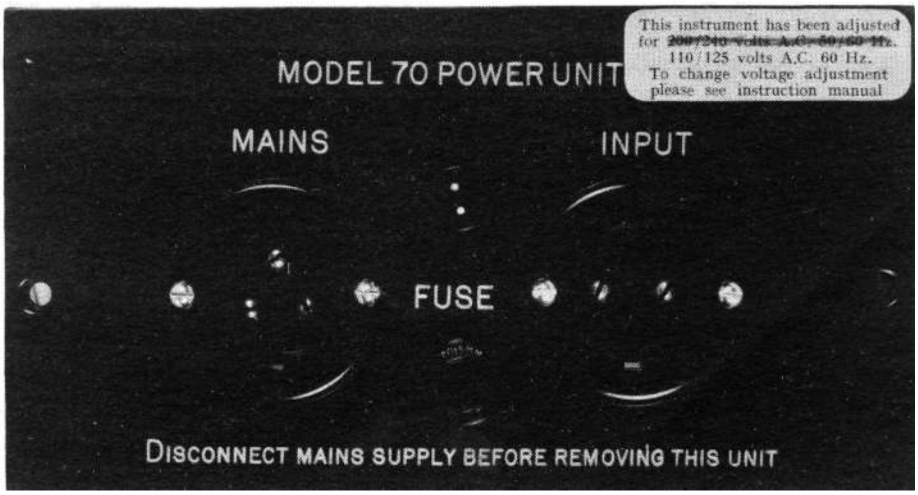
INSTALLATION INSTRUCTIONS

MAINS.

Before attempting to connect the mains supply to your Model 70 please check your supply voltage and see that this agrees with the adjustment made to the system before leaving our factory. A small red label is attached to the power supply panel (rear main cabinet) giving this indication



<u>Adjusted for European (200 - 240 volts 50 Hz.) AC.</u>



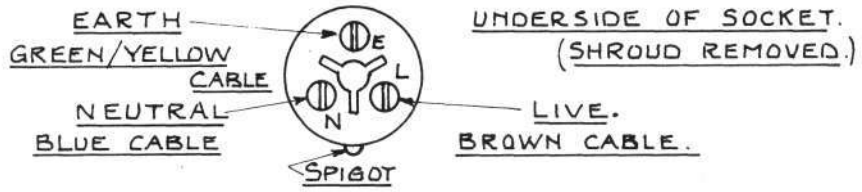
<u>Adjusted for American (110 -125 volts 60 Hz.) AC</u>

Due to the good regulation of the EHT power supply adjustment of mains voltage will not normally be necessary. All systems are set before leaving the factory for the market concerned as shown above.

(Assembly Instructions - Mains - contd.)

Should mains voltage adjustment be necessary this is carried out by removing the power supply and repositioning one wire on the mains transformer termination board. This work should be carried out by your dealer who is provided with the necessary instructions.

Model 70 requires connection to an alternating current mains supply with the special three pin plug provided with your accessories. Under normal operating conditions the current drain is negligible, the load being only some 10 watts (one tenth that of a normal reading lamp) and provided three core cable is used for mains connection the core diameter is in no way critical. The mains cable connections to the three pin plug are illustrated in Fig. 3 below.



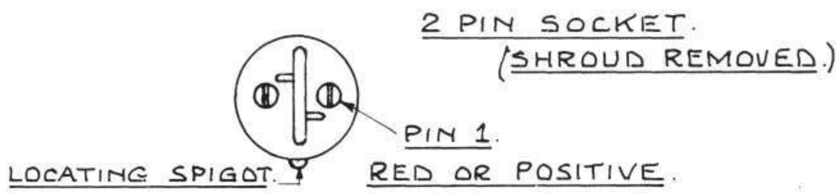
An outer metal screen is built in to the electrostatic unit for safety purposes. It is important therefore to ensure that three core cable is used together with a three pin plug to your mains socket.

AUDIO

The output from your amplifier is connected via the special 2 pin non-reversible plug provided to the socket marked ' INPUT ' on the power unit rear plate.

The cable (twin or two core) usea for the audio lead should have low resistance and if more than say ten feet of cable is required for this lead we would recommend an inner conductor of 7/029 or similar.

When two loudspeaker systems are operating for stereo reproduction it is important that the audio connections to the 'INPUT' socket are correctly phased. The red (or positive) terminal of your amplifier should be connected to pin one of the input plug on your loudspeaker.



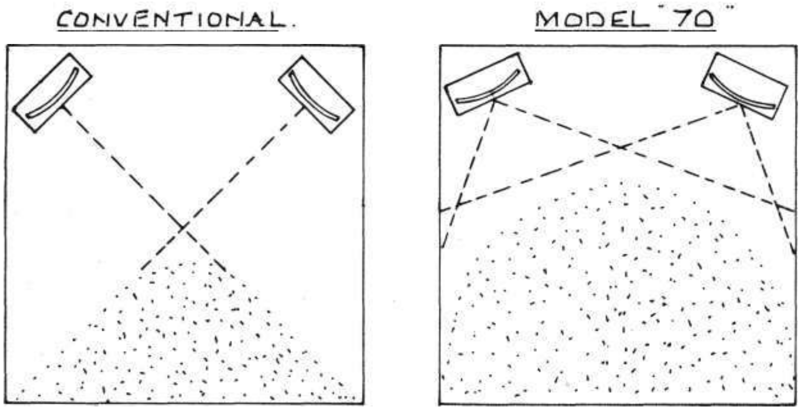
Assembly Instructions - Audio - contd.:-

If phasing is correct this is evident by a relatively small central image when the listener is seated on a centre line between the loudspeakers and both loudspeakers are fed from a monophonic signal. If phasing is incorrect the sound image will be much broader and less well defined. A reversal of the amplifier or loudspeaker connections from one channel will confirm the correctness of phasing and illustrate this point.

POSITIONING OF LOUDSPEAKERS IN LISTENING ROOM.

Due to the wide horizontal dispersion of the Model 70 system loudspeaker placing to obtain an even stereo image is not as critical as with many conventional systems. It will also be found that the stereo image is preserved over a wide listening angle. The suggested placing for a pair of Model 70 reproducers is illustrated in Fig. 4 below.

Fig. 4.



LISTENING AREA SHOWN IN DOTTED.

It is important to realise that the bass response is controlled under listening conditions by the room dimensions and the position (relative to walls or corner placing) "which the loudspeaker occupies. The closer the system is placed to a wall or corner the greater will be the coupling to the room. As a general rule those rooms with similar dimensions (i.e. a square room) are the most difficult from the viewpoint of obtaining extended resonant free bass response. If your listening conditions are such that the bass response is excessive within a narrow band of frequencies it may be it may be found desirable to withdraw the loudspeaker from the corner or wall by some twelve to twenty-four inches.

OPERATION,

At the rear of the electrostatic unit will be found a removable absorbent pad, the function of which is to reduce rear radiation in locations where the loudspeaker is placed close to a wall or corner. This pad provides a useful method of varying the distribution pattern of the electrostatic unit above 400 Hz. (lower mid. freguencies) to suit both ambient conditions and the user's personal preferance in terms of the ratio of direct to reflected sound. This absorbent pad can be readily withdrawn with the fingers from its recess in the rear of the 701 electrostatic mount.

With the rear pad withdrawn greater ambience will be experienced and, depending on the reflective nature of the walls and furnishings behind the loudspeaker there will be a slight increase in sound level above 400 Hz with the electrostatic operating in this condition. If it is desired to operate Model 70 at very high volume levels or where high powered continous sine wave inputs are applied the rear absorbent pad should be placed in position.

It will be observed that on the rear panel of the Power Unit there is a neon indicator. This shows that mains supply is functioning. If the neon does not light up when mains is connected the fuse should be checked. A spare fuse is provided but repeated replacement should not be made and if this fails you should consult your dealer.

ANCILLARY EQUIPMENT.

Model 70 probably adds less in terms of colouration and distortion than any other loudspeaker system in existance. It will be analytical of the signal which it receives and therefore benefits from use with ancillary equipment of the highest available quality.

from B&W electronics

manufacturers of electronic and acoustical equipment

THE DESIGN & DEVELOPMENT OF THE MODEL 70

MODEL 70, the first of our loudspeaker systems where all units are designed and built within our own factory, represents what we believe to be a successful attempt to produce a loudspeaker system for the perfectionist which is a worthwhile advance on existing systems.

INTRODUCTION

In contemplating the design and manufacture of Model 70 certain guide lines were laid down some two years ago at the commencement of the design programme :-

1) New thinking on the acoustical distribution pattern, especially within the vitally important mid frequency region of 400 Hz to 5 kHz, aiming towards exploring the advantages of a distribution pattern approximating to spherical.

2) A mid frequency unit capable of handling input powers in the region of 25 watts r.m.s. with distortion factors to the order of 0.5% or lower.

3) A really low distortion bass radiator capable of truly complementing aspects 1) and 2) above without occupying an unduly large enclosure volume.

4) Exploration of the listening advantages by increasing reverberant to direct sound.

5) All units be designed and built within our own factory to ensure maximum quality control and retention of the exclusive original design.

6) Styling and general appearance to be acceptable in a wide range of domestic furnishings.

It was further decided that the concept of Model 70 should be one of an international product and, whilst paragraph two detailing a high power handling capacity was consistent with World markets, certain other design and constructional features were laid down as being essential :-

a) That the system be in a modular form allowing easy assembly by overseas agents.

b) That the bass chamber loading, consistent always with the ultimate performance, be relatively simple and capable of being accurately copied in distant markets where it is obviously uneconomical to ship complete systems.

c) As an extension of 2) that all units be easily removable to facilitate speedy servicing in overseas markets where technical service facilities are limited.

DESIGN PERAMETERS

It has been generally accepted for reasons too well known to be repeated that, if a loudspeaker system is aiming at optimum performance, the frequency spectrum should be split. The precise division of frequencies to be handled by the various units and reasons for the crossover frequency chosen will be discussed later in this release, but initially let us survey the alternatives dealing first with frequencies below 400 Hz.

The alternatives are electrostatic or moving coil units and it was decided at an early stage in the design that the latter method showed obvious advantages. For example, on an existing full range electrostatic loudspeaker very careful measurements were made and total harmonic distortion at 60 Hz with 15 watt r.m.s. input was in the region of 50%. On an alternative full range electrostatic American design which was sampled, the dimensions of this unit were such as to exclude its use in the majority of home installations. Whilst a very selected few may accept panels in their lounge some seven feet high and three feet Wide it was felt that on appearance alone the points discussed in the introduction were in no way catered for.

As a result of long discussions between the writer and Mr. Dennis Ward it was felt that the moving coil system should be capable of meeting the initial design requirements set out in paragraph three above with an enclosure size of some 2 - 3 cubic feet.

In so far as the mid and upper frequencies were concerned the choice of units was threefold - Moving coil, Electrostatic or Ionic. It will be noted that the Ionic unit is currently used in our P2 monitor.

At an early stage in development new alternative Ionic units were manufactured in prototype form with a view to increasing power handling capacity and extending the frequency response at least two octaves below that provided by the existing Fane unit. Whilst certain progress was made, both the physical dimensions of the horn loading and the R.F. oscillator power requirements showed that, although improvement in the Ionic unit was possible, the disadvantages were those of physical size and adequate R.F. screening. For instance, one prototype had a horn length of some two feet and an R.F. oscillator of 70 watts, a totally unmanageable quality both in terms of size and adequate screening to provide freedom from T.V.I. For these reasons the Ionic method was dismissed and attention focused on Electrostatic and Moving coil units.

Although considerable advance has been made in the design and development of Moving coil units they do not, in the writer's opinion, approach the Electrostatic transducer in so far as low distortion, transient behaviour or flexibility of broad polar distribution.

Evaluations carried out by Mr. Harwood on a somewhat similar 'state of the art' project and, for those interested, reference may be made to three articles published in "Wireless World" in 1968 where it was shown that even offering an idealised Moving coil unit to a slot radiator, the polar characteristic was not well maintained above 3 kHz. It was decided, therefore, to explore the possibility of making an electrostatic unit, working from first principles with a view to comparative measurements between the Electrostatic and Moving coil units which could be developed.

Some six months after the design programme was originated a series of prototype units were produced which enabled a prime decision to be taken that the Electrostatic transducer, subject to performance being the first consideration and price secondary, was the best method to approach the final design. The following conditions on the basic design were, therefore, decided upon :-

1) That the bottom four octaves should be dealt with by Moving coil unit and that a development programme be launched to meet the stringent requirements laid down.

2) That an Electrostatic transducer be developed for frequencies above 400 Hz with the possible addition of a "super tweeter", should this be found to be necessary. That within this basic design considerable work would be needed in terms of improved distribution pattern and increased power handling capacity on Electrostatic units. Existing samples which were measured showed this to be two of their weaker features.

DETAILED DISCUSSION ON BASIC UNITS FORMING THE COMPLETED MODEL 70 SYSTEM

Mid High Frequency Electrostatic Unit.

It is not the intention of this release to provide production techniques or information which have been expensive both in terms of time and effort and which have made it possible for us to successfully manufacture an Electrostatic unit. Sufficient to say that at an early stage full reference was made to all existing patents on Electrostatic units as it was in no way our intention to infringe these and to produce new material on which we ourselves could lay patent claims. The problems which we overcame concerned such matters as diaphragm stability, methods of diaphragm coating, A.C. protective insulation as between fixed plates, mechanical stability and many other factors which, to the uninitiated, may seem simple but formed a major part of the considerable development expense in which we have been involved.

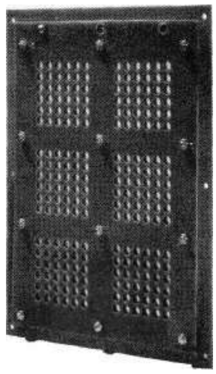


FIG 2

Early experimental electrostatic unit comprising 6 separate modules

Fig 2 illustrated above shows one of the early experimental Electrostatic units which we made. This assembly, consisting of some six modules, was the prime factor in deciding to proceed with the Electrostatic transducer. Tone burst oscillograms and freedom from harmonic distortion were quite superlative. Its principal limitations were, however, threefold :-

1) High diaphragm resonance

2) Poor polar distribution

3) Low acoustical output

Early prototypes of the Electrostatic unit consisted of various assemblies comprising from four to sixteen of the experimental plates illustrated were arranged in every imaginable combination. As the majority of these units were individually produced this part of the development took some two months. Whilst yielding much useful information it pointed to the inescapable truth that the Electrostatic transducer, behaving as it does in a true piston fashion, must offer a curved surface if freedom from serious phasing problems within the mid frequency.region- is to be avoided.

The outcome of all the foregoing work was the decision to develop an Electrostatic unit

a) of adequate area to provide the acoustical output required

b) with a continuously curved surface to provide the smooth horizontal distribution required, making the vertical dimensions relative to length sufficiently small to approximate to a live source.

Handmade prototypes were constructed of various dimensions and the initial concept was that this unit should be mounted vertically. It was found however, that whilst excellent results could be obtained, the practical dimensions of such a unit made it totally impossible to accommodate. For instance, a vertical curved unit one inch in width would become very directional at 10 kHz and would require a length of some eight feet to provide a similar radiating area to that of the final 701 assembly.

Parallel with the work which was being carried out on shape, size and configuration of the Electrostatic unit the possibility of providing a curved free-standing horizontal radiator became an increasingly obvious solution. Figs. 3 and 4 below illustrate the final Electrostatic assembly.

FIG 3

Model 701
Electrostatic unit
front view

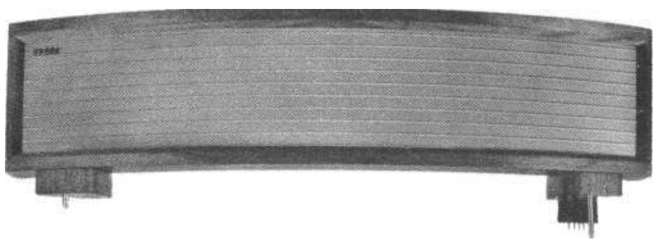
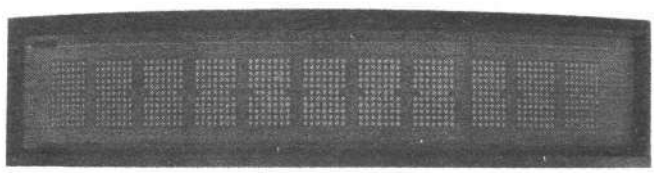


FIG 4

Model 701
Electrostatic unit
with *WtM* cover
removed



The polar diagrams, illustrated in Figs. 5 and 6 indicate the wide and extremely even polar response achieved from the final 701 assembly. Even at 15 kHz, over an 80 deg. arc - 2 db. is maintained. All measurements taken in our anechoic chamber with all B & K equipment, using type 4133 half inch calibration microphone

FIG 5

General polar diagram of Model 70 illustrating wide and even horizontal distribution

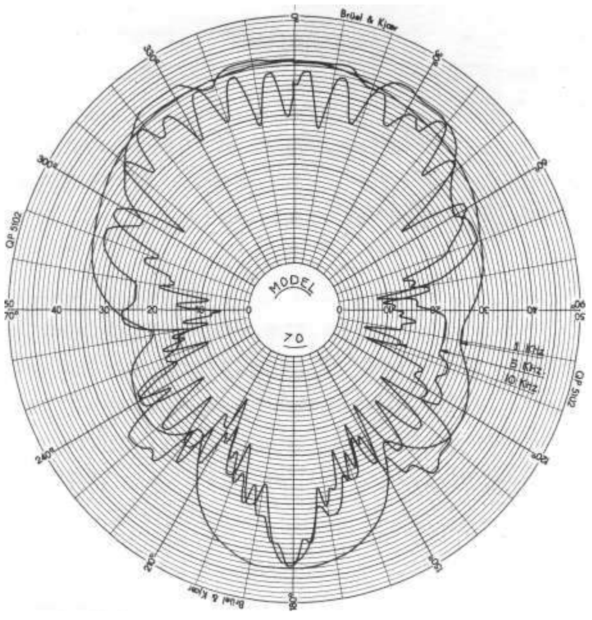
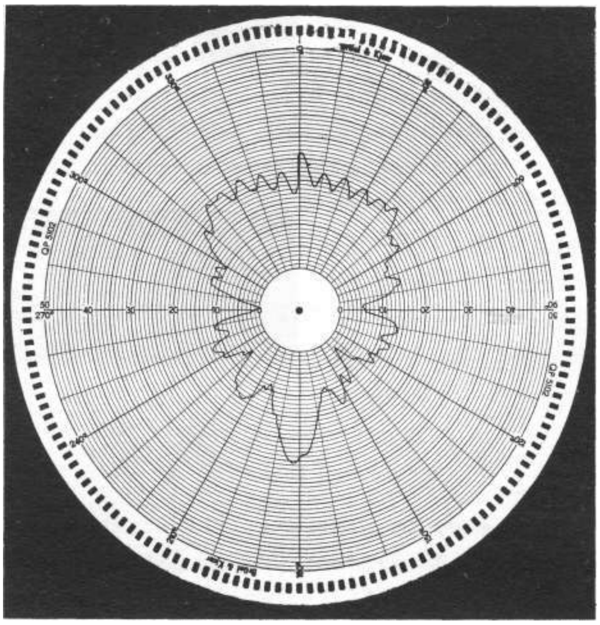


FIG 6

Horizontal distribution Model 70 at 15 kHz



With the 701 and an experimental bass radiator it was immediately obvious that the stability of the stereo image was improved beyond any other system we had tested. There was an excellent absence of 'source* in so far as the loudspeakers were concerned. If reference is made to the Hass effect it will be noted that one of the prime criteria laid down for stability of stereo image is that an in-phase equal amplitude signal be received from a wide frontal arc in a horizontal plane with particular reference to the mid frequency region. Considerable work was carried out on various degrees of curvature before design was finalised, but as much of this work concerns production techniques it will not be discussed in detail.

Hunt ("Electroacoustics" Harvard University Press) has been the starting point for most workers on the Electrostatic transducers and this is an opportune point in the development story to mention the acoustical load. At the end of this detailed treatment Hunt proved mathmatically that the ambient air provided 85% of the load on the diaphragm and this fact was confirmed emphericall y throughout the development. We instance the original XP prototype which showed a drop in sensitivity of 3 db. when mounted on a small Jig testing baffle. On the current 701 assembly an appreciable change in white noise can be detected as soon as it is lowered to top of the cabinet. This effect is somewhat frequency discriminating due, presumably, to another factor contained in the original work by Hunt. The fact that at frequencies above say 10 kHz diaphragm mass tends to become a dominant factor.

To prove the latter point one only has to add supplementary diaphragms. In the case of the 701 E.L.S. one supplementary cover reduced the output above 9 kHz appreciably.

A colleague who was working with the writer at this stage of the development remarked, "It would seem that the ideal mounting for an electrostatic unit is suspension in space." This would appear to be a fair submission of fact but one which in practice has to be somewhat modified. It will be noted, however, that the mounting for the 701 assembly is free-standing with as little surrounding enclosure as possible.

The writer has an objection to the reproduction of soloists appearing some twelve to eighteen inches from the floor and for this reason the E.L.S. unit on Model 70 is located approximately at ear level when seated.

The whole project of developing the electrostatic unit has proved so extensive that it would require a work of much greater scope than this short article to deal with even a reasonable proportion of the subject matter. The writer does, however, feel some satisfaction in setting out in print certain basic principles which few other manufacturers have attempted to discuss.

CROSSOVER & FILTER NETWORK

The crossover and filter network of the Model 70 is split into two sectors. These are illustrated by Figs. 7-10 below.

FIG 7

Model 70 power assembly unit E.L.S. matching and .filter network, removed from cabinet and' mated with 701

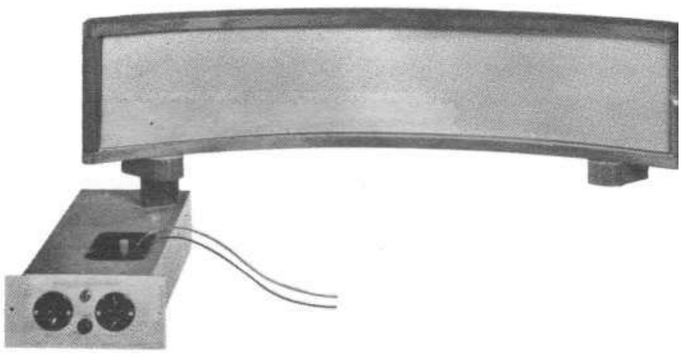
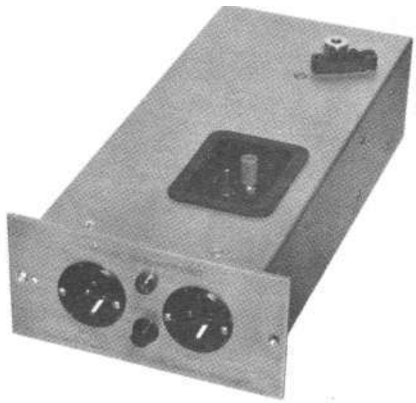


FIG 8

Model 70 power supply unit as above, top view



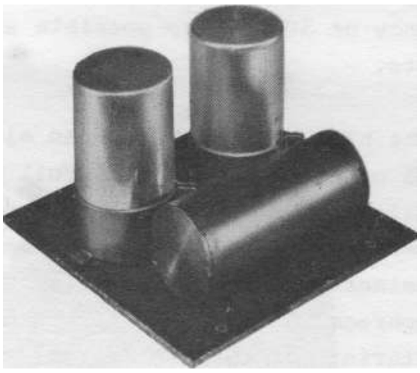


FIG 9

Model 70 Bass Radiator low pass section

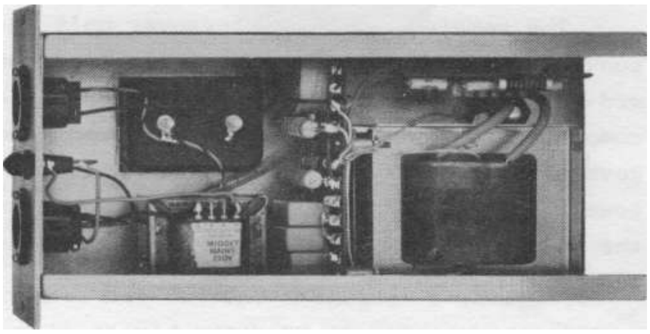


FIG 10

Underside of Model 70 power supply showing E.L.S. matching transformer and various component parts.

Before discussing all design and electrical characteristics of these units it may be of interest to note from Figs. 7-10 how stray capacities have been reduced to a minimum by careful design and positioning of units. This factor plays an important part in sensitivity and "top octave" performance of electrostatic units.

A poor crossover unit or incorrectly chosen crossover frequencies can mar an otherwise good loudspeaker system. The writer has always felt that somewhere in the 400 Hz to the 600 Hz region was the correct one in terms of minimal intermodulation distortion within the all important mid frequency band. Due to the successful completion of the 701 design, a crossover frequency of 500 Hz was possible and proved successful in all respects.

The high pass filter of an electrostatic unit requires special consideration if the full potential of the unit is to be realised. Attention must be paid to tailoring the stop band response to the required slope rate. The natural response of an electrostatic assembly is to rise very steeply immediately at diaphragm resonance and produce an almost impossible matching characteristic for the bass radiator. This rise is controlled partially by accurate diaphragm tension but one must also restrict input within the first octave above resonance and, coupled with the falling impedance characteristic of the capacity load, the E.L.S. presents different and somewhat exacting requirements in terms of filter network.

The remainder of the crossover unit on Model 70 is conventional but it is worth mentioning that no less than 74 mfd. of paper is used in this circuit - at a cost of one component that would almost buy a cheap loudspeaker system. Reversible electrolytic capacitors whilst satisfactory at A.C. powers for a limited period of use become conductive and render the filter network useless under the stringent conditions laid down for a system such as Model 70.

One final component worthy of mention is the series feed inductor on the high pass section. This component can seriously modify the controlling feedback applied to the voice coil and, because it handles considerable current, we designed a special ferrite inductor which reduced the D tot. at 25 watts input to well below 0.5% at all frequencies from 30 Hz. Conventional components sampled showed figures in the region of 2.5%

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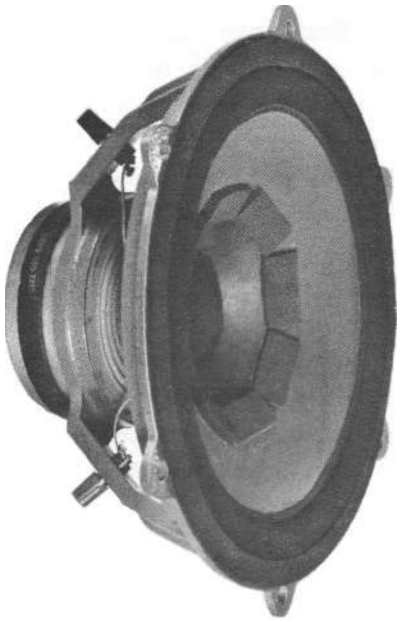
BASS RADIATOR

FIG 11.

DW 13/3, final production version as used in the Model 70



It was mentioned earlier in the introductory discussion the reasons for choosing the moving coil as opposed to the electrostatic principle for the lowest four octaves of the system. The requirements set out for the final performance of this unit were that it should match as closely as possible in all respects that of the 701 electrostatic unit. The writer's colleague, Mr. Dennis Ward, despite some twenty years experience in the design and manufacture of moving coil units felt that a distortion factor in the order 1% with inputs of 25 watts was a somewhat impossible task. However, work was commenced on prototypes with a view to exploring the possibility of a very long throw linear suspension unit working as a true piston.

A piston area (nominal 12") was chosen as being reasonably consistent with the enclosure volume to build a final system with a resonance below 40 Hz and a free air resonance in the region, of 18 - 22 Hz.

Expanded polystyrene seemed the obvious choice for cone material as medium and high freguencies were not involved and indeed a number of early prototypes were made with this material. Extended listening tests proved, however, that the polystyrene cone material showed 'read out' colouration within the 200 - 400 Hz region. Experiments were then made with an exactly similar unit minus the polystyrene slab and girder assembly and it was determined by relating frequency response curves to the two units that energy generated primarily at the apex of the cone was largely being lost, presumably due to kinetic conversion within the polystyrene, and in turn the polystyrene was partially breaking up and providing this small but objectionable colouration.

The final cone assembly does, in fact, consist of a laminated structure in order to provide the required stiffness and is further braced and mass adjusted by small rectangular sections of synthetic rubber affixed at critical positions on the front face of the cone.

One of the relatively untouched aspects of bass radiator design has been the effective 'Q' at resonance. A simple bridge method was evolved for this measurement and considerable work carried out in terms of suspension compliance and diaphragm mass to reduce this figure well below unity. Until ambient room measurements were taken it was not fully realised how 'room gain' could play an important part in magnifying a relatively small rise in the response as shown on an anechoic plot to an objectionable one note thump.

LOUDSPEAKER MEASUREMENTS

The writer is a firm believer in measurement at all stages of design and production. Although designers in the past have suggested that the measurement of loudspeaker response is of secondary consideration, we feel that this view is taken because the art of interpretating loudspeaker measurements is a subject on which there is considerable scope for development. For instance many manufacturers and designers proudly publish a beautiful axial plot of their system and whilst a straight line response is a good starting point this measurement is almost meaningless without reference to the polar distribution,, the frequency response of the system at points considerably off axis, tone burst oscillograms, pulse oscillograms and a very complete set of distortion measurements.

At an early stage in the development of the electrostatic unit it became obvious that the axial plot became less smooth as the dispersion was increased. Two factors contributed to apparent increase in the irregularities of the response plot. Firstly, our test chamber which was not truly anechoic. As dispersion of the unit was increased so minor reflections within the chamber were shown. These reflections were not even excited with the more limited distribution pattern of conventional units. The second factor which became obvious was the size of the diaphragm on the calibration microphone. Where this approached half-wavelength at the frequency under measurement standing waves were built up and the response plot degraded.

In co-operation with Messrs. B & K Laboratories these problems were thoroughly investigated and resolved. We subsequently purchased the complete range of B & K microphone equipment including no less than five calibration microphones allowing pressure and grazing incidence measurements,to be taken both with and without free field correction.

The foregoing somewhat lengthy exposition only sets out to point the way to new and more complete thinking in terms of measurement associated with loudspeaker units and it is not the writer's intention within this article to do more than touch on the subject.

PRESENTATION

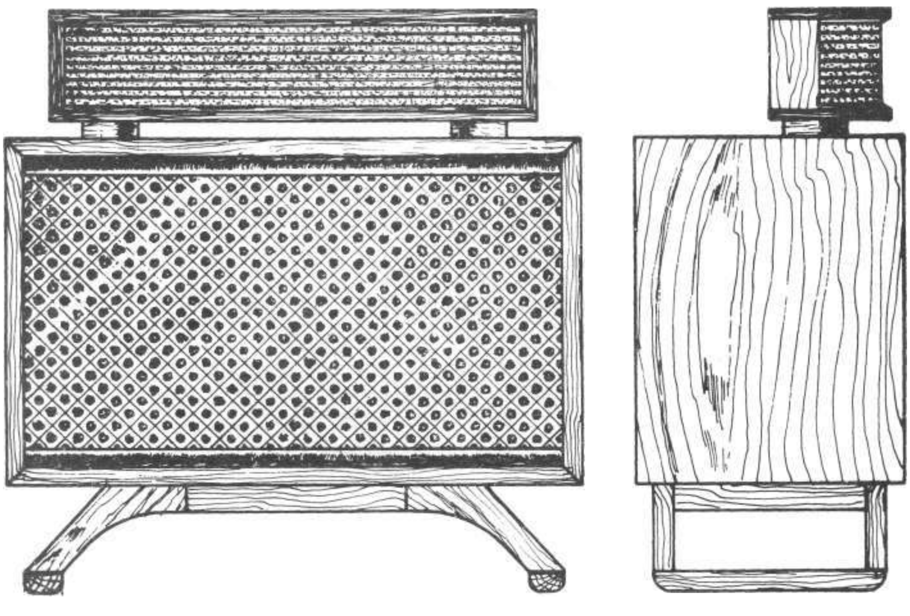
Conflicting requirements must always be reconciled with a loudspeaker design which is primarily required for domestic use. This is especially true of the larger systems where there is a frequent interchange of requirements as between the stylist and the acoustics engineer. There is no escaping the fact that however good an acoustical design may be it must also be accepted in the home furnishing scheme before it is a success.

mm

At a fairly advanced stage in the styling programme it was decided to offer a limited number of alternative designs for public comment at both the Amsterdam and London International Exhibitions and from customer opinion sampled it was decided to produce the horizontal styling detailed in Fig. 12 below.

Fig. 12

MODEL 70, Horizontal Styling - Front and Side Elevations



It is our intention, towards the middle of 1970, to produce a free standing vertical styling for Model 70.

The line drawings in Fig. 12 and the half tone photograph at the beginning of this release will provide a reasonable indication of the final horizontal styling. A few additional comments may however be helpful. The fabric covering the main Bass Chamber is of an unusually interesting texture, of a golden beige colour it matches well with the oiled teak or American Walnut veneers. For reasons of safety the electrostatic unit is sealed in a grounded expanding metal cover but this has been anodised to colour match the fabric of the main enclosure.

The proportions of the Bass Chamber and its leg assembly minimise detraction effect and the height of the finished loudspeaker system allows the electrostatic unit to be at ear level when seated.

To assist movement on a carpeted surface and to distribute the not inconsiderable weight the leg structure has a return member which may be seen from the side elevation of Fig. 12. Although fitting castors was contemplated it was found that the centre of gravity was somewhat too high for stability.

Considerable attention has been paid to both enclosure finish and construction. The main Bass Chamber is constructed of 24 mm 650 density chipboard, veneered on both surfaces. The cabinet is veneered on all surfaces including the back in high guality matching veneers and the electrostatic top mount and leg structure are also in matching veneers or solid timber.

RESPONSE CURVES, OSCILLOGRAMS AND FINAL MEASUREMENTS

The following reproduction of response plots and oscillograms have been taken from a standard production sample of the completed Model 70. They will serve to indicate the performance of the complete system and illustrate aspects of loudspeaker measurement discussed earlier in this release.

Fig. 13

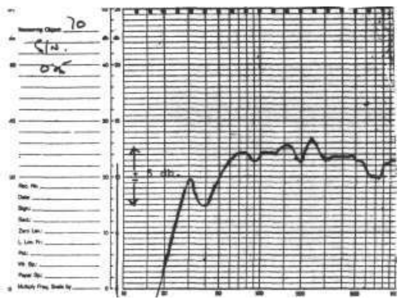
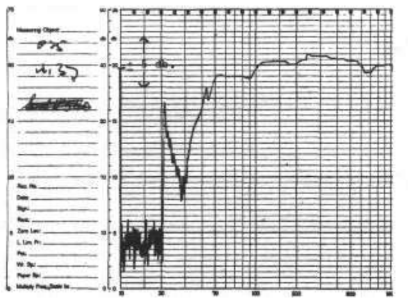


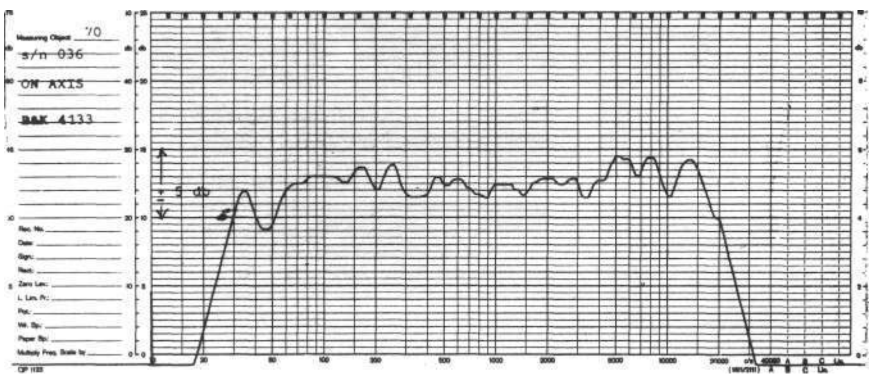
Fig. 14



Figures 13 and 14 above are of special interest as they show the difference in the bottom three octaves between our own anechoic chamber (Fig. 13) - note 'room gain' below 100 Hz and the Northern Polytechnic (Fig. 14) which is very much more accurate at these low frequencies.

All the following measurements are taken in our own anechoic chamber where allowance must be made for the difference illustrated above.

Fig. 15



The above response plot indicates 'on Axis' standard Model 70, B & K Model 4133 microphone pressure operated.

Fig. 16

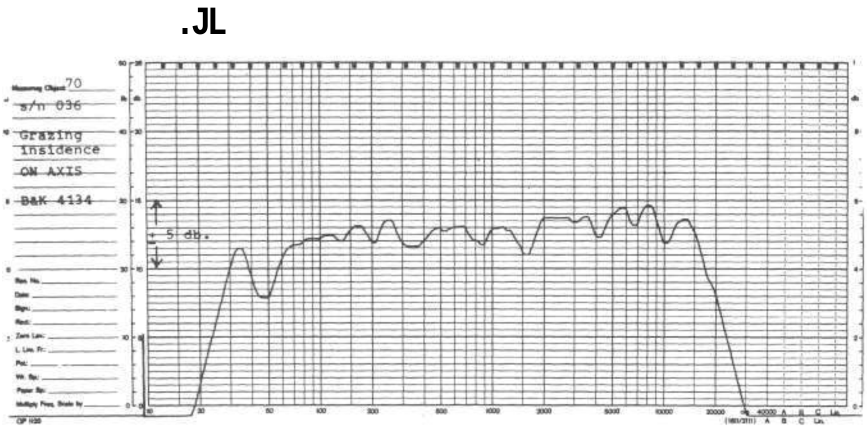
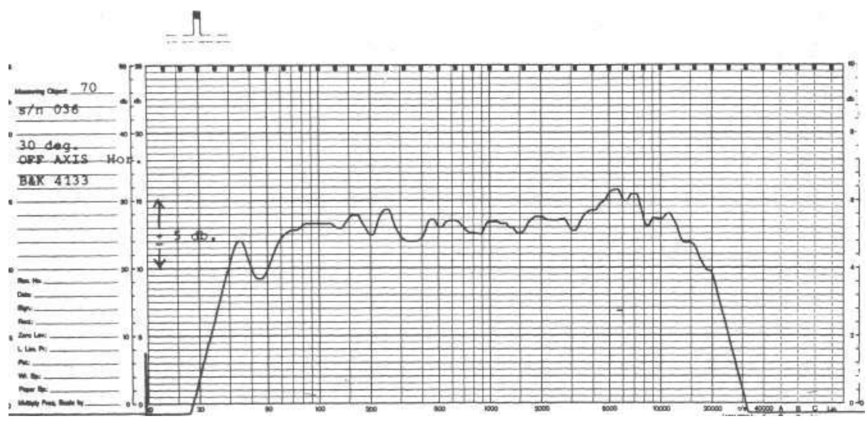


Fig. 16 above illustrates the identical loudspeaker and microphone position but in this case the 'grazing incidence' method of measurement has been made.

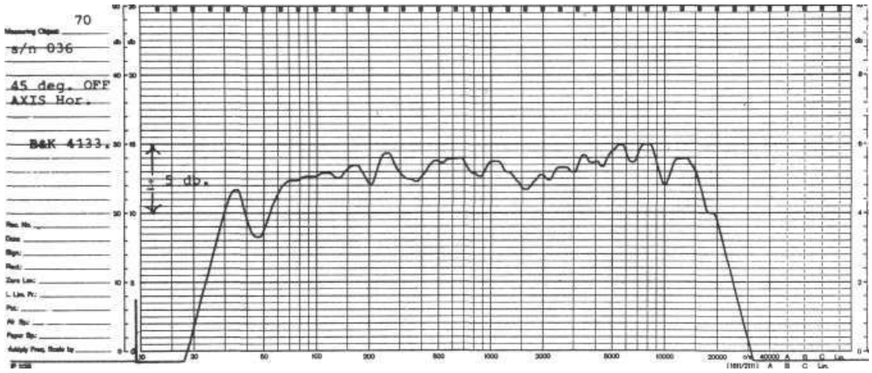
As mentioned earlier in this release, in order to fully illustrate the performance of a loudspeaker system a number of 'off axis' response plots must be taken and the following illustrations indicate the performance of Model 70 under these conditions.

Fig. 17



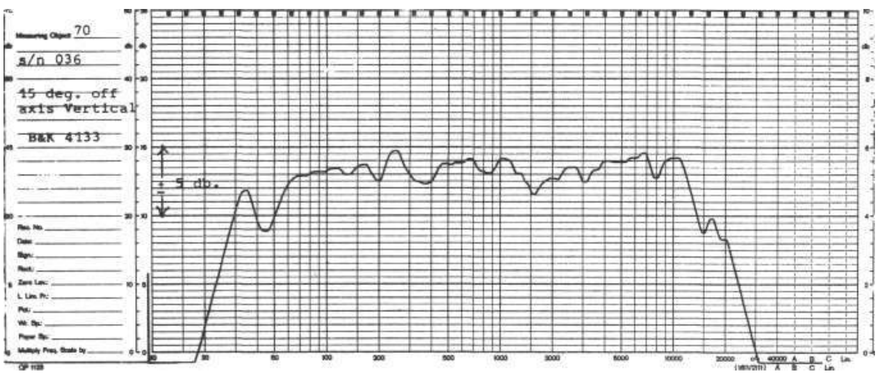
30 deg. off axis in a Horizontal Plane.

Fig. 16



45 deg. off axis in a Horizontal Plane,

Fig. 19

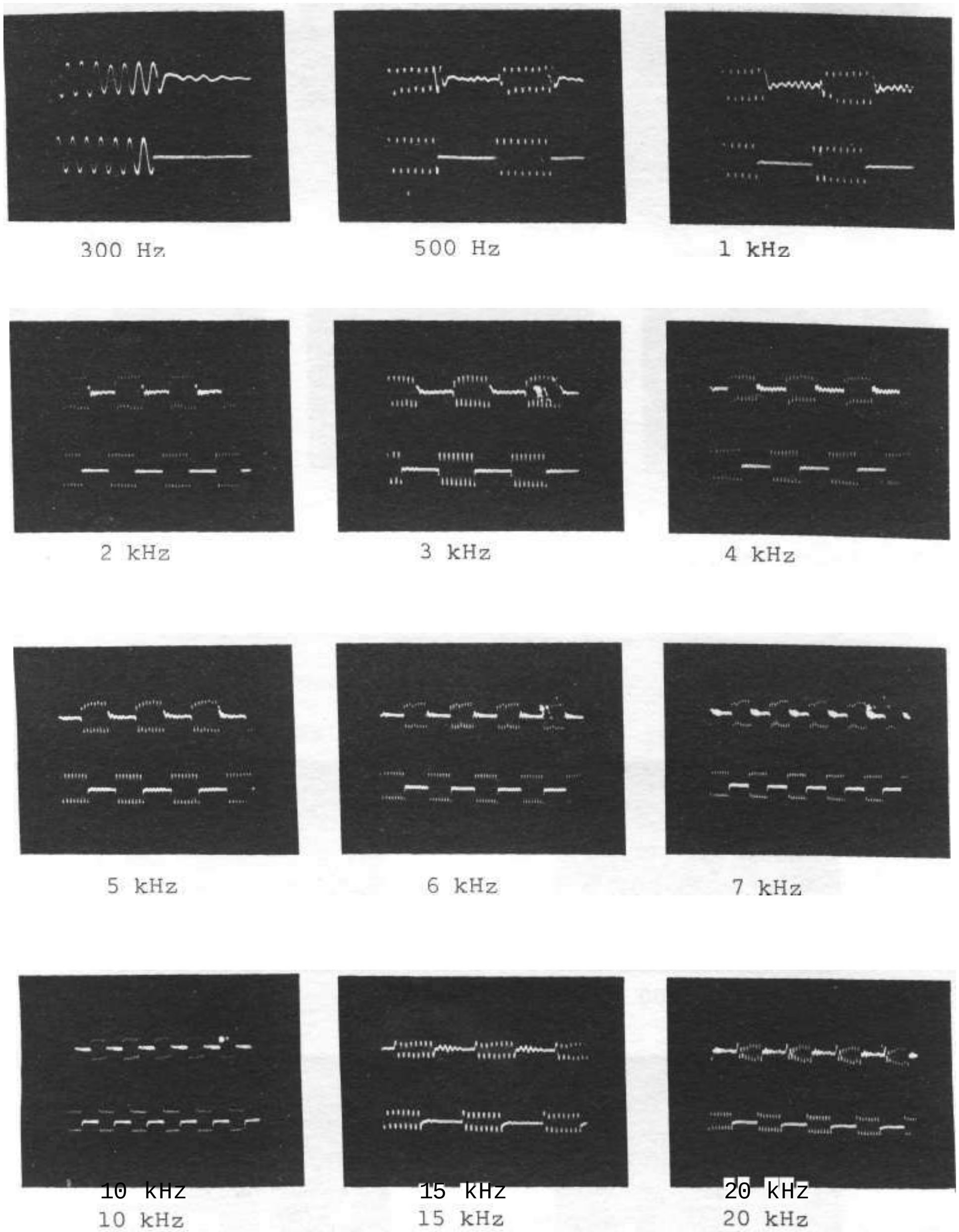


15 deg. off axis in a Vertical Plane.

We now follow the range of frequency response plots with tone burst and pulse oscillograms. These oscillograms have all been recorded in our own anechoic chamber using the B & K •J inch calibration microphone type 4133.

Fig. 20

Group I T.B. Oscillograms on 8 off

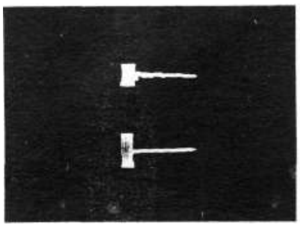


10 kHz 15 kHz 20 kHz

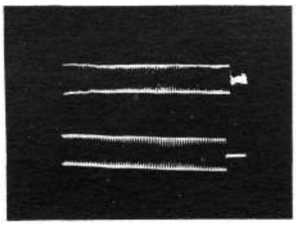
Bottom trace indicates input, upper microphone output.

Fig. 21

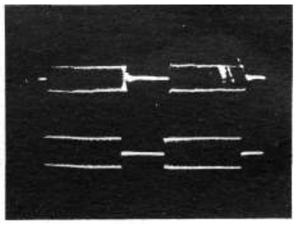
Group 2 T. B. Oscillograms 64 on 32 off



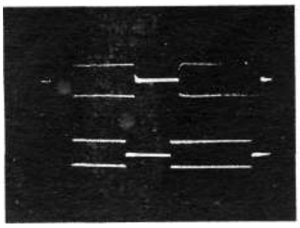
500 Hz



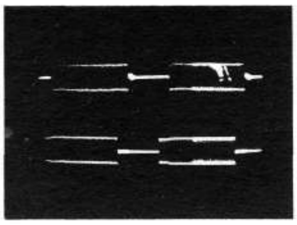
1.0 kHz



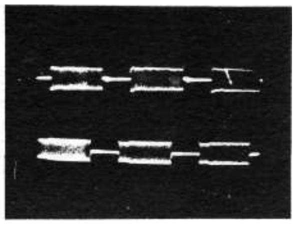
5 kHz



3.5 kHz



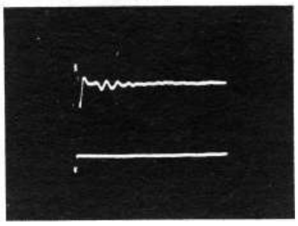
10 kHz



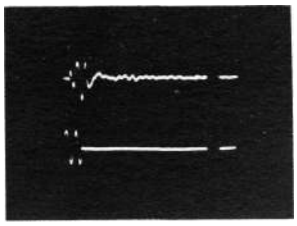
15 kHz

Fig. 22

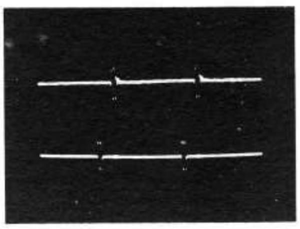
Pulse Response



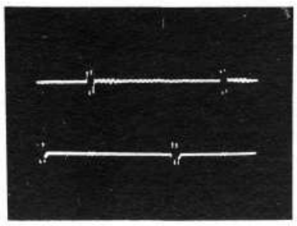
300 Hz



500 Hz



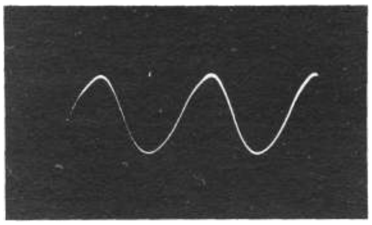
5 kHz



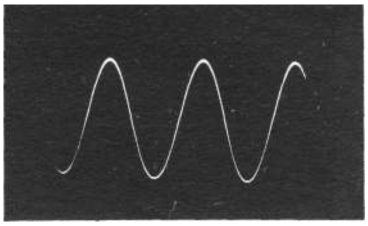
10 kHz

Fig. 23

Power Oscillograms 25 watts R.M.S. in to 8 ohms.



60 Hz



1 kHz

A more meaningful indication of distortion under power is given from the following table : -

D tot. with input pf 25 watts R.M.S. (8 ohms)

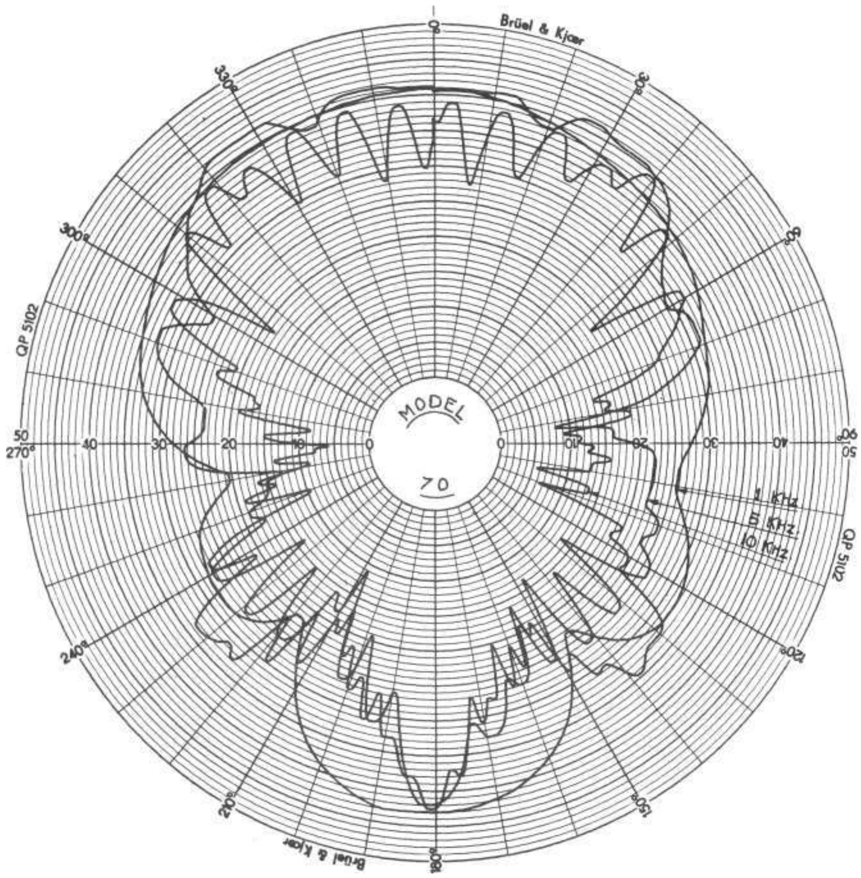
B & K 4113 -J" Quad 33 B & K Line and Mic. Amps

30 Hz	40 Hz	50 Hz	60 Hz	100 Hz	200 Hz
12%	10%	8%	2.5%	1.5%	1.4%
300 Hz	400 Hz	500 Hz	500 Hz	1 kHz	3 kHz
1.4%	0.5%	0.3%	1.0%	1.1%	0.3%
5 kHz					
0.8%					

POLAR RESPONSE

By way of further illustrating the extremely wide dispersion of Model 70 we now exhibit all polar diagrams in Fig.24.

Fig. 24



General polar diagram of production Model 70 showing 1 kHz, 5 kHz and 10 kHz polar response.

SUMMARY OF DETAILED SPECIFICATION

UNITS

Nominal 13" diameter circular Bass Radiator with laminated and specially reinforced cone - Type DW 13/3. Eleven module wide dispersion electrostatic unit, Type 701, covering freguencies above 400 Hz. Model 70 power supply unit together with high and low pass section, electrostatic matching transformer and bass low pass filter assembly contained on separate board.

ACOUSTICAL LOADING

Bass unit infinite with multiple bracinq and synthetic fibre absorbents. Electrostatic unit free standing plug-in assembly with removable rear absorbent pad allowing polar distribution to be modified depending on ambient conditions.

CABINET

Constructed throughout of 24 mm. 650 density chipboard veneered on inner and outer surfaces. Cabinet foot assembly and 701 electrostatic unit covered in matching veneer of oiled Teak or oiled American Walnut with main cabinet body veneered on all surfaces including the back.

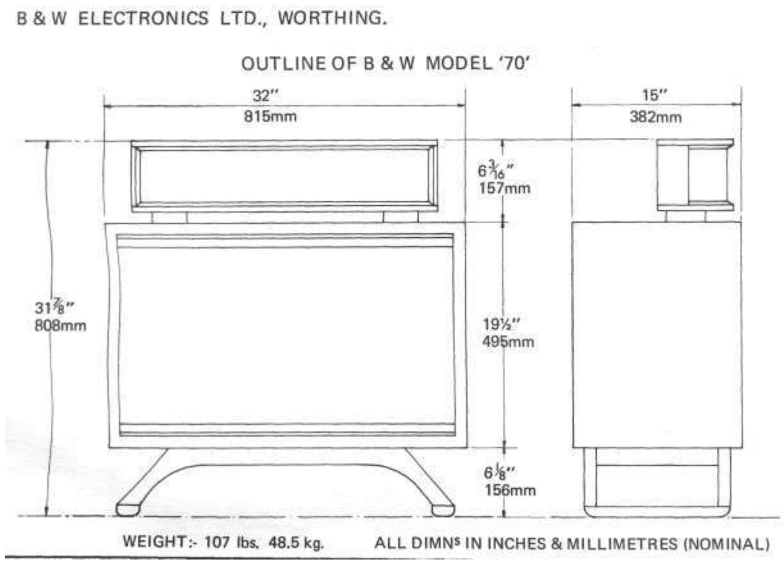
IMPEDANCE

Nominal 8 ohms rising approximately 25 ohms at 1 kHz but not falling below 4 ohms at 20 kHz.

POWER HANDLING CAPACITY

25 watts R.M.S. (50 watts music) throughout entire frequency range.

DIMENSIONS



FREQUENCY RESPONSE

50 Hz to 15 kHz better than 4 db.

40 Hz to 20 kHz - 5 db.

AXIAL RESPONSE

90 degrees arc horizontal in the order of - 2 db. of an axis response at all frequencies up to 15 kHz.

DISTORTIQN

D tot. with input of 25 watts R.M.S. (8 ohms)

B & K 4113 -J" Quad 33. B & K Line and Mic. Amps.

30 Hz	40 Hz	50 Hz	60 Hz	100 Hz	200 Hz	
12%	10%	8%	2.5%	1.5%	1.4%	
300 Hz	400 Hz	500 Hz	500 Hz	1 kHz	3 kHz	5 kHz
1.4%	0.5%	0.3%	1.0%	1.1%	0.3%	0.8%

SYSTEM RESONANCE

40 Hz ± 1%

(System ?Q! below unity in the order of 0.9)

AMPLIFIER REQUIREMENT

The Model 70 is capable of handling large inputs without distortion but to obtain the full benefit from this very low distortion system it is recommended that amplifiers with an R.M.S. output of over 30 watts per channel be used.

With modern amplifiers stability with capacity load is usually well maintained but it is important to note that, due to the unavoidable impedance rise at mid-frequency, amplifiers of generous power output (normally specified in the 8 ohms load) should be used. The following amplifiers have been used in our Laboratory and Listening Room throughout development and have proved completely satisfactory.

QUAD 33	DYNACO 120	SONY 1120
QUAD 50	SUGDEN 25 watts Class A	RADFORD 100 watts valve

GENERAL PERFORMANCE

The detailed frequency response plots and oscillograms reproduced in this release indicate a very high standard of performance achieved in the final product.

CONCLUSION

In concluding the design story I should like to pay particular tribute to the hard and untiring efforts of my colleagues, Mr. Dennis Ward and Mr. J. R. Greenwood, without whose help the project would not have been possible.

We feel considerable pride in announcing this, the first generation of loudspeaker systems where all units are designed and manufactured within our own Factory and we confidently offer this system as representing a worth while advance in the search for ultimate perfection.

Printed in England

The manufacturers reserve the right to amend or modify this specification without notice.