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THE AMS ST 250 STEREO MICROPHONE

K Farrar

A M S Industries plc.

1. INTRODUCTION

The advent of stereo television has initiated a requirement for a compact stereo microphone having facilities for M/S technique and a small control unit with provision for powering from a variety of sources and suitable controls for adjusting the characteristics of the microphone.

The ST 250 meets this requirement.

It does so using established sound-field techniques embracing the experience gained from continuous manufacture of the sound-field Mk 4 microphone built around four precision wide range capacitor capsules.

The industry has already accepted that sound-field technology is the only one to produce low distortion truly coincident outputs and it is well known that these outputs can be electronically manipulated to produce a wide frequency range of accurate polar patterns and angles of point of two (or more) synthesised "microphones".

The task, therefore, of producing left/right or M/S outputs with a range of controls to vary the angle, polar patterns, microphone position (up, down or end-fire), stereo width, mono pattern is a relatively simple one all included in the ST 250.

The paper deals with these parameters and that of the mains, battery or phantom power in a comprehensive way. Included is how the microphone may be used for sound-field music recording if required, either in the sound-field "B" format or stereo.

2. THE SOUND-FIELD PRINCIPLE

The microphone head contains four sub-cardioid capsules set in a regular tetrahedron as shown in Fig 1. Cardioid capsules could equally well be used but it is easier to produce capsules with a very accurate sub-cardioid pattern over a wide range of frequencies. This facilitates matching the capsules closely and the patterns that result from manipulation of the capsule signals can readily be compensated in the associated circuits.

The capsule signals are in fact added and/or subtracted to provide a set of four signals known as "B" Format, as described below.

Closer examination of the capsule array shows that the Left Front and Right Back capsules are back to back, but tilted symmetrically from the vertical. If the signals from these 2 capsules are subtracted then the two sub-cardioid capsules produce a horizontal figure-of-eight pattern with its axis along the line left front to right back as shown in Fig 2 - attenuated slightly from the value if the capsules had been vertical.

Similarly, Right Front and Left Back are tilted symmetrically downwards and when subtracted produce a horizontal figure-of-eight pattern with its axis along that line. The two figure-of-eight patterns are added with Left Front and Right Front in phase to produce a figure-of-eight pattern whose axis lies front/back and this is termed the X component of the "B" Format signal.

Subtraction of the 2 diagonal figure-of-eight patterns produces a figure-of-eight pattern whose axis lies along the left/right axis and this is the Y component (positive left).

Further combination of pairs as seen in Fig 3 produce 2 figure-of-eight patterns at 45° to a vertical axis resulting in a final Z component whose axis lies along the up/down axis (positive up).

The remaining "B" Format component, W, is an omni-directional pattern produced by summing the four capsule outputs in phase.

Thus the "B" Format components are :-

$$W = LF + RB + RF + LB$$
$$X = LF - RB + RF - LB$$
$$Y = LF - RB - RF + LB$$
$$Z = LF + RB - RF - LB$$

The "B" Format signal can therefore represent sound from any point in space by 3 directional co-ordinates X, Y & Z, and the pressure component W, as may be seen in Fig 4.

Note, that each capsule makes an equal contribution to each of the four "B" Format signals and it is this factor which causes a certain amount of cancellation of what capsule errors there are to produce performance characteristics not possible except by the sound-field approach.

Moreover, compensation is applied to the resulting signals in amplitude and phase, to effectively bring the four "B" Format signals to an origin at the centre of the cluster up to about 10kHz. This coincidence of the signal components has remarkable effects on the accuracy of a synthesised stereo microphone which can be set up from combinations of the "B" Format signals and contrasts vividly with other approaches where coincidence is often lost at frequencies as low as 1kHz (if there at all!). How this is done will now be described :-

If a microphone is required to be omni-directional then only the W component is used. If a forward facing figure-of-eight is required the X component is used. An end-fire figure-of-eight would be represented by the Z component.

If a cardioid is required facing forward, then the sum of W and X produces this, (although in standard "B" Format X, Y & Z are enhanced 3db for similar programme levels to W). A cardioid is therefore actually $W + \frac{X}{\sqrt{2}}$

If two cardioids facing left-front and right-front are required then the transverse figure-of-eight component Y (like S in M/S format), is introduced, positively for left and negatively for right as follows :-

$$\text{Left} = W + \frac{X}{2} + \frac{Y}{2}$$

$$\text{Right} = W + \frac{X}{2} - \frac{Y}{2}$$

The reduction in level of the X signal by 3dB allows for the introduction of the Y signal at a similar level to produce a pressure gradient signal of the same level to that for mono to produce cardioid patterns.

It becomes obvious at this point how the "B" Format components may be combined and manipulated to achieve desired effects. For example, trading X for Y and visa versa will alter the width of the stereo pick-up whilst trading the X-Y combination for W and visa versa will alter the patterns from omni-directional through all the cardioids to figure-of-eight.

Controls can be provided to achieve these variations. Moreover, by simply reversing Y, the microphone may be suspended upside down, instead of being placed vertically on a stand, and the signals remain correct. What is more important, is that Z and Y may be used instead of X and Y, and all the aforementioned features may be achieved with the microphone in an "end-fire" mode.

This is particularly valuable in T.V. work on a boom where the microphone can "point" at the subject. Further examination reveals that since it is becoming extremely popular to work in the M/S format, it is probably better to introduce other controls rather than patterns and stereo angle. There can be a variation of the "M" pattern by varying the ratio of W and X and the stereo width by simply varying the amplitude of Y. The combinations are clearly endless and the choices actually made in the ST 250 are revealed in the next section.

3. THE ST 250 MICROPHONE

The stereo microphone and associated control unit are seen in Fig 6. Note that the microphone is unobtrusively small when mindful of its capability, and dark in colour for T.V. application. The similarly coloured control unit is extremely compact such that it may be used in a portable application or fastened to a boom vehicle.

The microphone uses the latest development in polarised circuit low-noise FET amplifier technique. The polarising voltage is actually generated in the microphone from the supply voltage to the amplifiers by a 8Hz invertor. Fig 7.

The control unit shown exposed in Fig 8, is very compact. It provides the necessary multiway connector to the microphone and two XLR3F balanced output connectors for Left/Right or M/S outputs. They may alternatively be switched to provide the four unbalanced "B" Format outputs from the two signal pins in each of the two connectors. Fig 9.

The control functions provided are as follows :-

* Mono (M) pattern control - in the M/S format between Omni, through cardioids to figure-of-eight.

* Stereo (S) width control - in the M/S format. Note these two rotary controls may be recessed when set to avoid inadvertent operation.

* Bass cut button for L.F. roll-off below 100Hz.

* Attenuator button : 20dB for close use.

* "END" button to use the microphone in the end-fire mode.

* "INV" button to use the microphone in the inverted mode., (both operating together merely means that the microphone is turned over in the end-fire mode for correct operation.

* "M/S" button for M/S outputs in lieu of left/right.

* "B" button for "B" Format outputs.

* "BATTERY" button to power the unit from internal "C" type cells. (10 hours minimum use).

* A power LED which flashes when an overload occurs.

* A headphones socket for monitor purposes, together with a gain control (operating only on phones).

The unit may be powered from internal batteries as described, from 110/240 volt mains or by phantom power at 48 volt on both output lines. Battery over-rides both other sources, mains over-rides phantom power. There is no on-off switch : the battery is de-selected to switch it off.

4. THE BONUS

The bonus of using the ST 250 microphone in addition to all the advantages shown in Fig 10, is the fact that the "B" Format output signals are available to the user. This means that the microphone can be used for full surround-sound recording if desired and the signals recorded on a 4-track recorder for later manipulation into stereo if desired, at which time, using a sound-field control unit, the variable controls described above in addition to Azimuth, Elevation and Dominance may be applied to correct or improve the take.

Moreover, the "B" Format signals may be encoded into UHJ 2-track stereo compatible format for decoding to horizontal surround-sound now or in the future.

5. CONCLUSIONS

Clearly, the advantages of this microphone outweigh those of microphones using a more conventional approach. In addition, the microphone is robust and reliable and is based on techniques which have now been in use for more than ten years.

The accuracy and clarity of the microphone provides superb stereo images with the bonus as described of investing in the future.

FIG 1

AMS/Calrec
SoundField Microphone
without hood

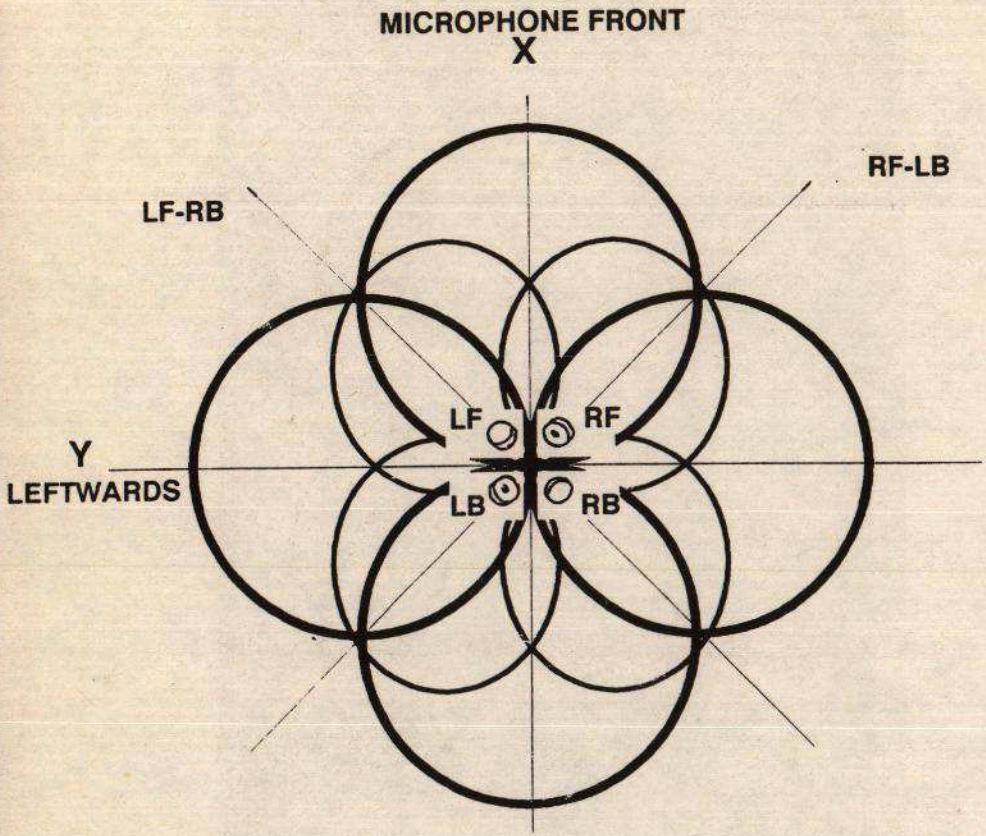


Figure 2 – Horizontal Capsule Pair Outputs

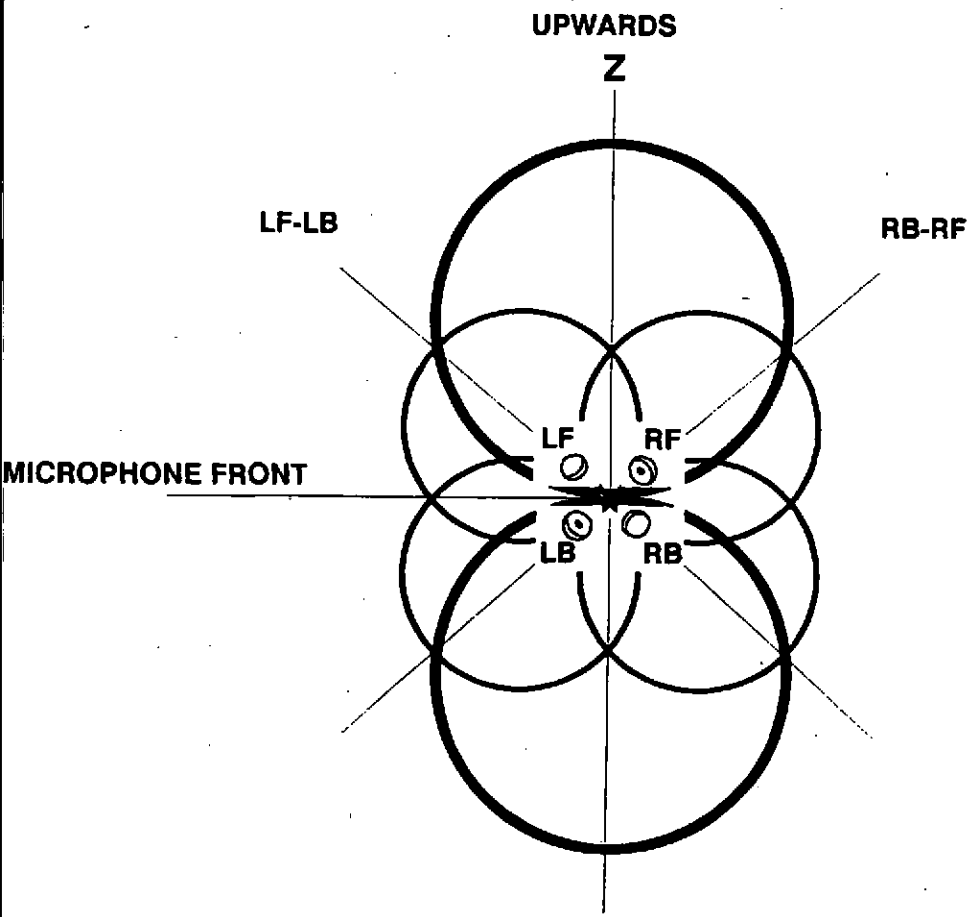


Figure 3 – Vertical Capsule Pair Outputs

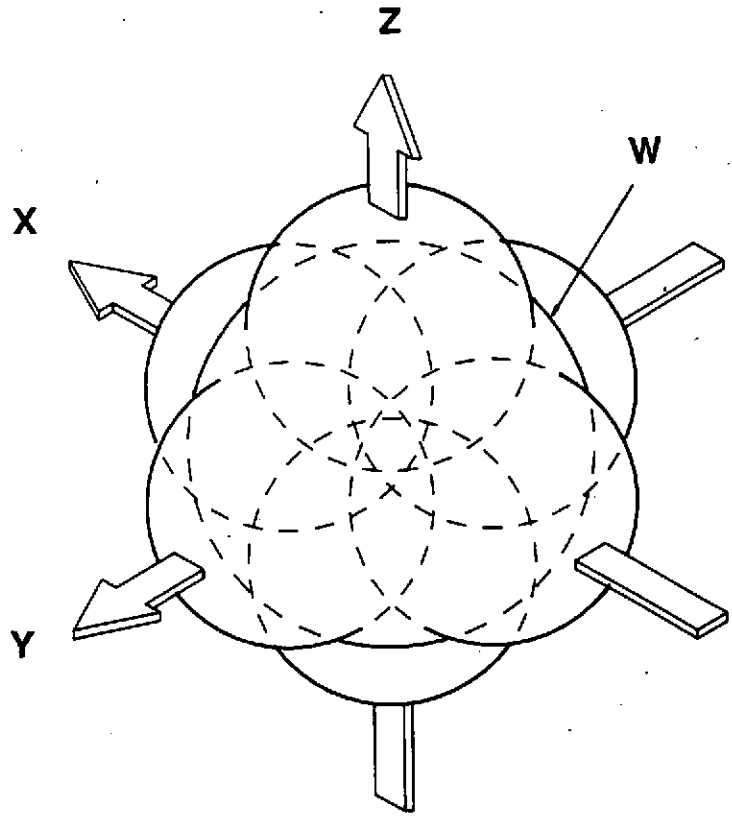


Figure 4

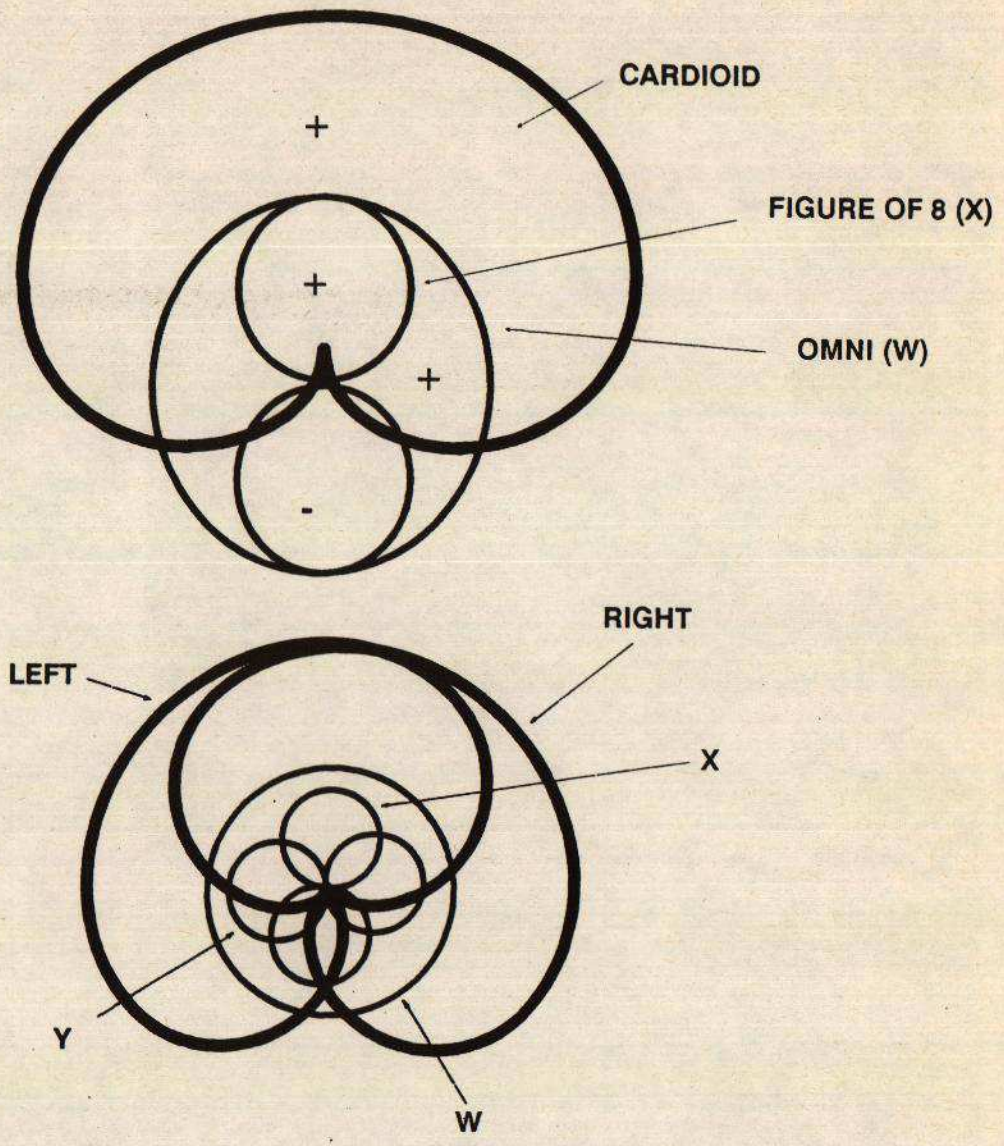
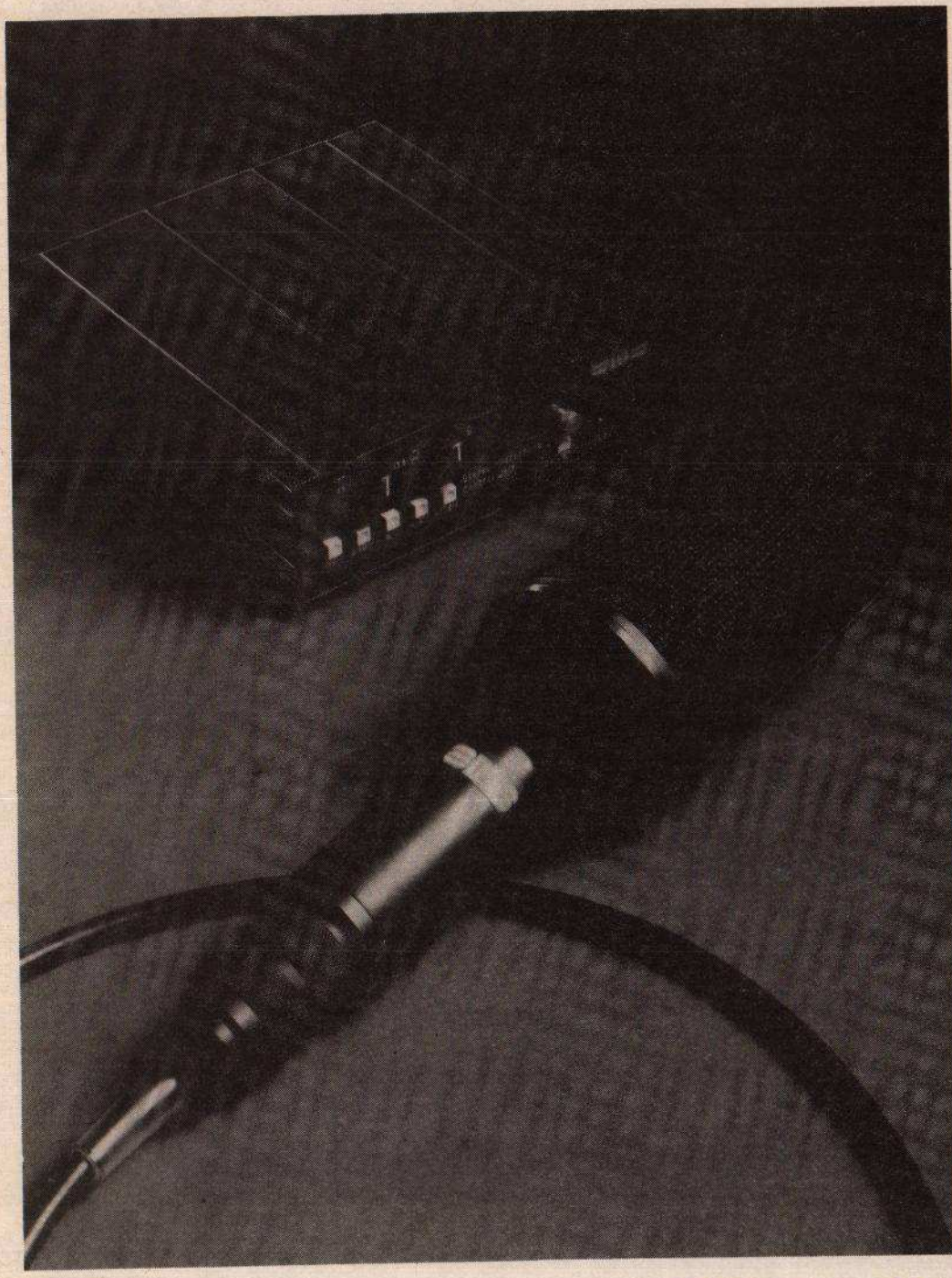
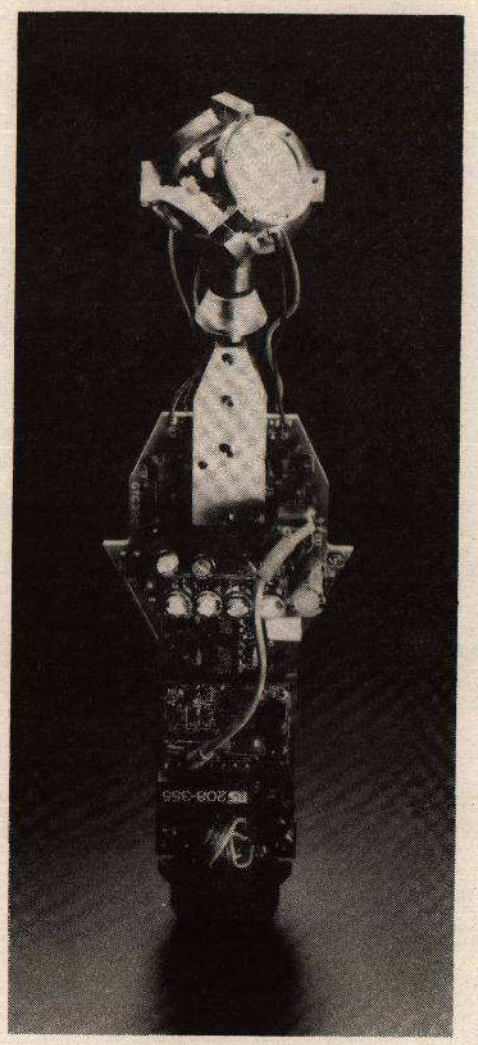
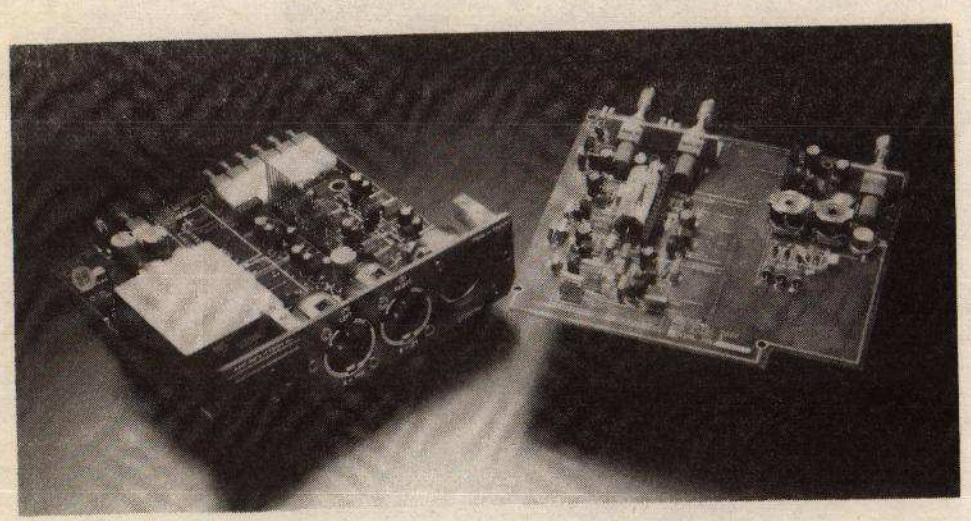
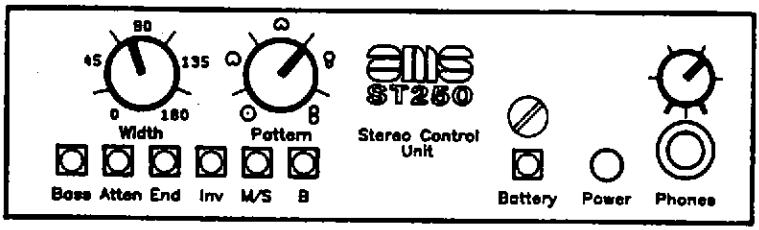


Figure 5 – Mono and Stereo Cardioids








90
45
135
0
180
Width
Pattern
ST250
Stereo Control Unit
Bass Atten End Inv M/S B
Battery
Power
Phones

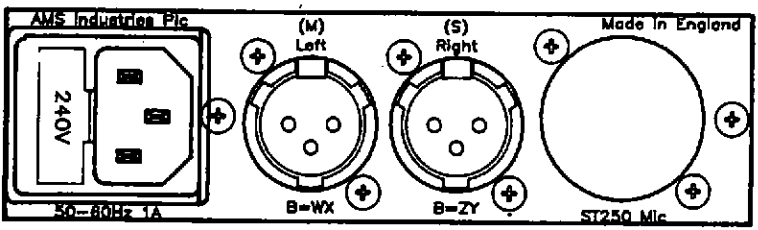

AMS Industries Plc
240V
50–60Hz 1A
(M)
Left
B=WX
(S)
Right
B=ZY
Made In England
ST250 Mic

Figure 9

ST 250 Microphone

1. *Cancellation of residual capsule errors*
2. *Coincidence of basic signals up to 10KHz*
3. *Precise polar patterns at all frequencies*
4. *Wide frequency response*
5. *Low distortion, very low noise*
6. *LEFT/RIGHT or M/S output*
7. *Remote manipulation of patterns, stereo width, angle*
8. *Choice of vertical, inverted or end-fire modes*
9. *Attenuator for close use*
10. *Bass cut control for boom or similar use*
11. *Optional "B" format surround output*
12. *Mains, battery or phantom power*
13. *Overload indicator*
14. *Monitor phones socket with separate gain control*

Figure 10 – Advantages