The MS Recording Technique for the Stereophonic TV and Movie Sound

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Summary

It will be shown why the application of MS stereophonic recording in comparison with XY stereophonic recording for stereophonic movie- and TV sound recording is advantageous and which physical aspects have to be considered to obtain good harmony between the width of the scene shown and the width of the stereo base.

As an example serves an MS-shotgun stereo microphone with matrix circuit for XY signals.

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Advantages of the MS Mixing Technique for the Movie Sound

Movies are produced with stereo sound as a matter of course nowadays, and so, to a steadily increasing extent, are television programs. Some recordings are made live, others are dubbed.

For both techniques the sound is either mixed from the signals received by several mono microphones or picked up by stereo microphones, most of which, it must be said, are very heavy and cumbersome and do not always have uncomplicated adjustment facilities for polar patterns or beam width.

In most circumstances - and particularly in regard to TV sound - speech and vocals are required to be at mid-screen, while music and background noises ("atmosphere") are reproduced with a wider base width.

Especially in the case of television, mono compatibility is a further factor for consideration. The best means of meeting these requirements is an MS stereo microphone [1]:

- An MS microphone aimed forward at the sound source delivers a middle signal of good quality. In contrast, sound arriving from the front at an XY microphone facing half-left and half-right impinges at an angle, leading, in the case of many microphone types, to discoloration of the sound.

- If the right and left signals of an MS microphone are added together to form the sum (= mono signal) the portion of the signal delivered by the middle microphone is left over. The middle signal is the mono signal, and its quality is determined solely by the quality of the middle microphone.

- Reverberation comes primarily from the side and rear halfspace. A forward-facing microphone picks up less reverberation than two microphones facing sideways at an angle.
  It is thus advantageous to use a middle microphone for the middle signal - preferably with a directional characteristic, because a mono signal with a strong reverberation component is more troublesome than a lively stereo signal. The brain is able to compute the signals during stereophonic listening and to suppress too strong reverberation components.

A New MS-Stereo Microphone

In the development of a stereo microphone with special emphasis on film and television requirements, the choice of a microphone type for the middle signal fell automatically on one which had already proven its merits on mono recordings in this field of application:

With the help of a shotgun microphone it is possible to achieve effective suppression of sound picked up from the side (approx. 10 dB), together with equally effective suppression of sound impinging from the rear (some 12 dB). This property is what distinguishes a shotgun microphone from a hypercardioid, for example, with its suppression of sound impinging from the rear of 6 dB only (Fig. 1).

Therefore the ability to differentiate between direct and diffuse sound, that is to say between sound impinging from the front and that picked up from all sides is very good with this type of a shotgun microphone.

This relationship - as a logarithmic parameter of the 'directivity index' - also determines how far away from the source a microphone of known directional characteristic may be placed so as to pick up the same proportion of direct and diffuse sound, compared to an omni-microphone. This factor is, for example, 1.7 for a cardioid, 2 for a hypercardioid and about 2.1 for the short interference tube system introduced here. The pickup range with this microphone can thus be approximately twice that of an omnidirectional microphone for the same ratio of direct and diffuse sound.

This interference tube system is used as the middle microphone in conjunction with a transverse figure-8 microphone for the side signal. Similar combinations using two **single** microphones have already been used by various sound engineers, and have incorporated a shotgun and a small figure-8 microphone. [2]

The combination of two systems to constitute the microphone presented here results in the following advantages (Fig. 2):

- The microphone systems can be mounted very close together - the distance between them is no more than 21 mm.
- The systems are installed in line. This means that the directional characteristics are symmetrical to the horizontal plane of the microphone, which is formed by the axes of greatest sensitivity of the transducers.

- The microphone is shorter than a mono shotgun microphone with an interference tube of the same length, as the impedance converters are manufactured as hybrid modules which are very small, and furthermore a part of the electronics is housed in a control box (matrix amplifier) separately from the microphone.

The matrix amplifier is switchable. The microphone signals are available either as middle/side information (MS) or in the form of left/right information (XY).

The side signal level can be varied in six 3-dB steps in relation to the middle signal level. This means that six different directional characteristics with six different pickup angles are selectable.

The Matrixing Process of an MS-Signal to an XY-Signal

It is well-known that a middle/side signal can be converted to the usual left/right signal with the aid of a sum- and difference transformer or by the use of a resistance matrix,

i.e.:

$$\begin{aligned} \text{Left Signal} &= \text{Midsignal} + \text{Sidesignal} \\ X = L &= M + S \\ \text{Right Signal} &= \text{Midsignal} - \text{Sidesignal} \\ Y = R &= M - S \end{aligned}$$

In this way, a forward-facing cardioid microphone, for example (M-signal) in conjunction with a figure-8 microphone at a level some 12 dB lower (S-signal) results, after sum-and-difference subtraction, in two cardioids crossing at 60° (Fig. 3).

Variation of the Stereo Base Width

An increase in the signal level of the side microphone changes not only the directional characteristic, but also the spread (= offset angle) of the right/left components, as shown in Fig. 4.

only within this pickup angle during playback a clear localisation of the signals within the stereo base is possible [3].
Signals outside the pickup angle appear during playback anywhere difficultly to be localized, possibly also on inverse sides because outside the pickup angle the phase of at least one channel is turned by 180°, so that the correlation of the stereo signal becomes negative.

The range of the pickup angle will be projected during playback onto the stereo base width of the loudspeaker arrangements.

- If the pickup angle is selected **too narrow** (too much side signal component) only the middle range of the scene will correctly be localized. This range will then be spread during playback over the whole width of the base. The range on both sides of the scene can not be localized (Fig. 7 a).

- If the pickup angle is chosen **too wide** (not enough side signal component) the original width of the scene is concentrated to the middle of the stereo base and will be filled up left and right with uncorrelated signal components (Fig. 7 b).

The Side Signal Level, Variation of the Pickup Angle

The above-mentioned switch for varying the amplification of the side signal has a direct effect on the output level of Channel II in **MS-mode**. This can be varied in relation to Channel I (middle signal) in six 3-dB steps from -9 dB to +6 dB (Fig. 8).

In **XY-mode**, variations in the amplification of the side signal change the directional characteristic as shown in Fig. 9.

It can be seen that a gradual **rise** of the S-signal level has the following effects:

- The spaciousness and the uncorrelated portion of the sound becomes larger, the pickup angle likewise becomes **smaller**.

It can further be seen that a change in the level of the S-signal component, results in an increasingly large rear lobe of the sum-and-difference signal curve. In this way, the stereo base width can be electrically varied without the need for any mechanical repositioning of the microphone systems. This naturally brings with it the facility of changing the characteristics by remote control.

The Mono Compatible Pick-up Angle

If the right and left signals of an MS microphone are added together to form the sum (= mono signal) the portion of the signal delivered by the middle microphone is left over. The middle signal is the mono signal, and its quality is determined solely by the quality of the middle microphone.

Figure 5 represents the 3-dB limits of the middle signal curve, for example of the shotgun-stereo microphone presented here, and its purpose is to demonstrate that over a range of some 120°, a full-strength mono signal can be expected. This, then, is more or less the mono-compatible working range. This angle is **independent** of the **side signal setting**.

The Stereophonic Pickup Angle

The stereophonic pickup angle or 'field of view' determines the working range around the microphone axis, in which the sum and difference signals are both positive and in-phase (Fig. 6).:

- In the XY representation it is the front angle between the first zero positions.
- In the MS representation the same angle is formed by the two front intersections between the M- and the S-curves.

Through variation of the side signal level the pickup angle can be varied and thus be matched to the desired width of the recorded scene. This matching is important since

- The main axes of the two left/right- patterns are turned away from each other. An apparently **increasing** offset angle between the systems is the result.

- Both directional patterns become **narrower** at the sides in each case.

- The rear pickup area becomes **larger** for each channel.

- The directivity index of both patterns becomes **lower** in each case.

More side signal means therefore on the one hand “more stereo”, on the other hand, however, a narrower pickup angle with less positively correlated signals.

Imageforming on Playback

It can be seen from the curves in Fig. 9 what proportions of a sound source are picked up by the left and right channels respectively. Corresponding to the difference in levels, the image of the sound source on playback will be located at a certain angle within the stereo base width [4].
Ideally it should move steadily from the left to the right loudspeaker or vice versa in the event of a radial movement around the microphone within the pickup angle. This ought to occur in the plane of a straight line connecting the two loudspeakers. Actually, however, the plane of reproduction with conventional coincidence microphones is arcuate, or curved:
This is the case, for instance, when two **single cardioid microphones** are offset at 90°, in the direction **to** the listener, so that the middle signals appear to be **nearer** than those picked up from the side.
Sound sources evenly grouped around the microphone are furthermore often irregularly imaged within the base width, appearing to be compressed together around the loudspeaker locations. These imaging errors can also be frequency-dependent, and can therefore be only partly corrected with the aid of spot microphones.

Fig. 10 illustrates three examples of imaging situations featuring the shotgun stereo microphone presented here:

Five or three sound sources are positioned uniformly within the pickup angle radially around the microphone. They are reproduced uniformly within the loudspeaker base line. When S = 0 dB (see Fig. 9) the plane of reproduction is straight within ± 1 dB (Fig. 10b), otherwise it is curved to the rear by up to 3 dB (Fig. 10 a,c).

The most suitable choice of the S-signal level and the resulting directional characteristic depends, among other things, on the width of the scene to be recorded at a defined microphone distance and on the location of any extraneous sound sources which might be present. Again, the microphone distance and position have to be selected with due regard to the acoustical properties of the premises and also to visual requirements, such as the image area of the camera and the need to avoid in-shot microphone shadows caused by lights.

Conclusion

It is our conviction that, with this combination of a short shotgun microphone with a figure-8 microphone as described, we are able to offer sound engineers, especially those concerned with film and television productions, a light-weight, high-quality stereo microphone which, because of its acoustic properties, is able to deal effectively with the special requirements of these productions and, because of its electrical switching facilities, is able to be matched to the individual problems and is equally suitable for live sound applications and for dubbing purposes.

Literature

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[3] M. WILLIAMS: Reprint 2466 (H 6) of the 82nd Convention 1987 March 10-13, London, Unified Theory of Microphone Systems for Stereophonic Sound Recording
[4] DE BOER: Plastische Klangwiedergabe. (Plastic Sound Reproduction). Philips Technische Rundschau, 5 (1940).

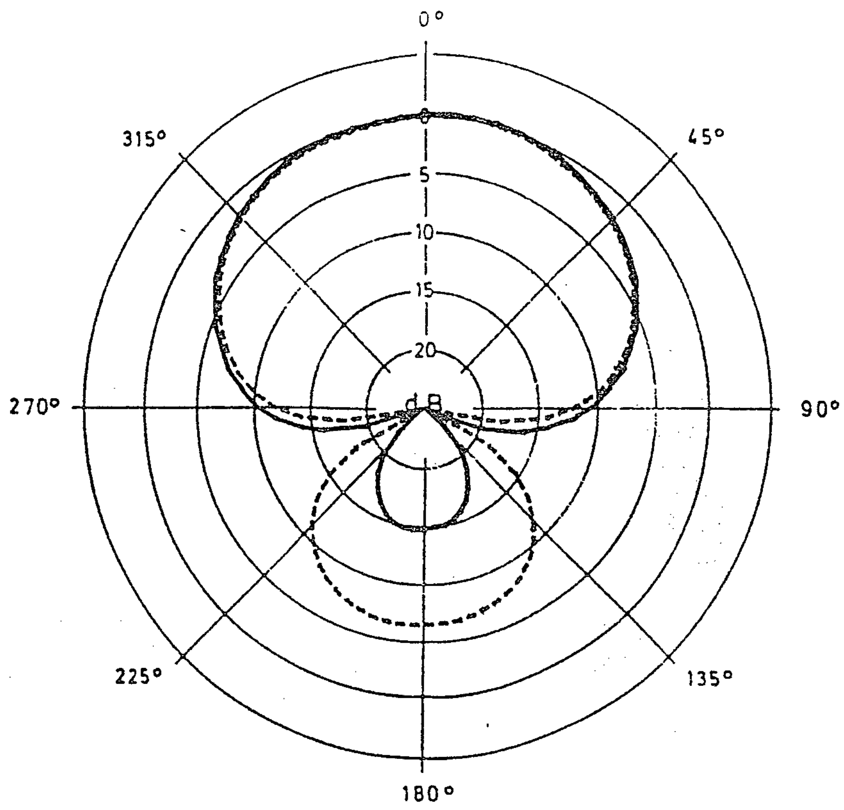

Fig. 1 **Comparision of polar diagrams of a microphone with short interference tube (—) and one with hypercardioid characteristic (– –)**

Fig. 2 The RSM 190 Richtrohr-Stereomikrophon (Shotgun Stereo Microphone) with a standard MTX 190 i Matrix Amplifier

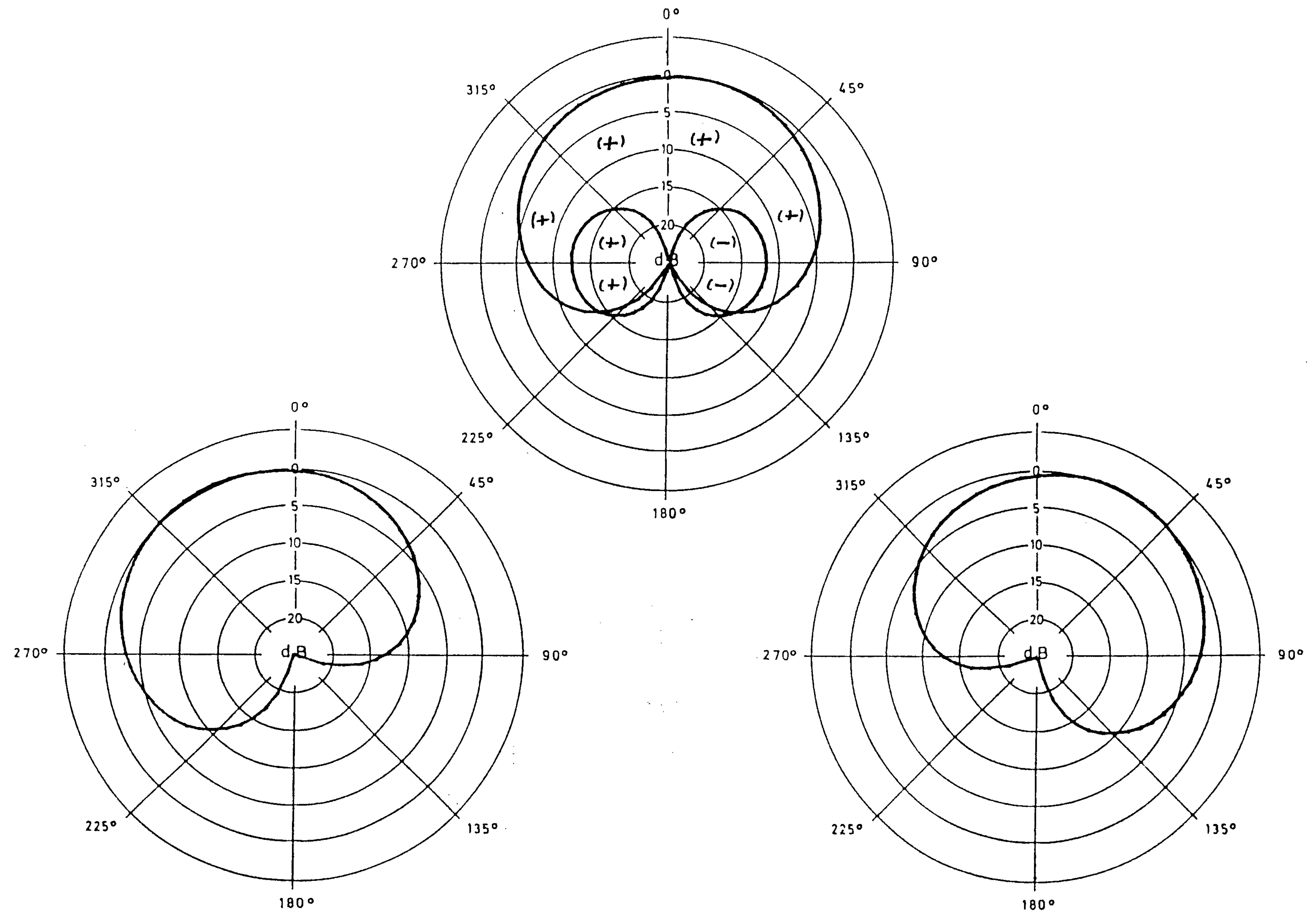

Fig. 3 Addition (a) and subtraction (b) of a cardioid as M-signal and a figure-8 signal for transference from the MS- to the XY-plane. (+) phase relationship of respective signal component

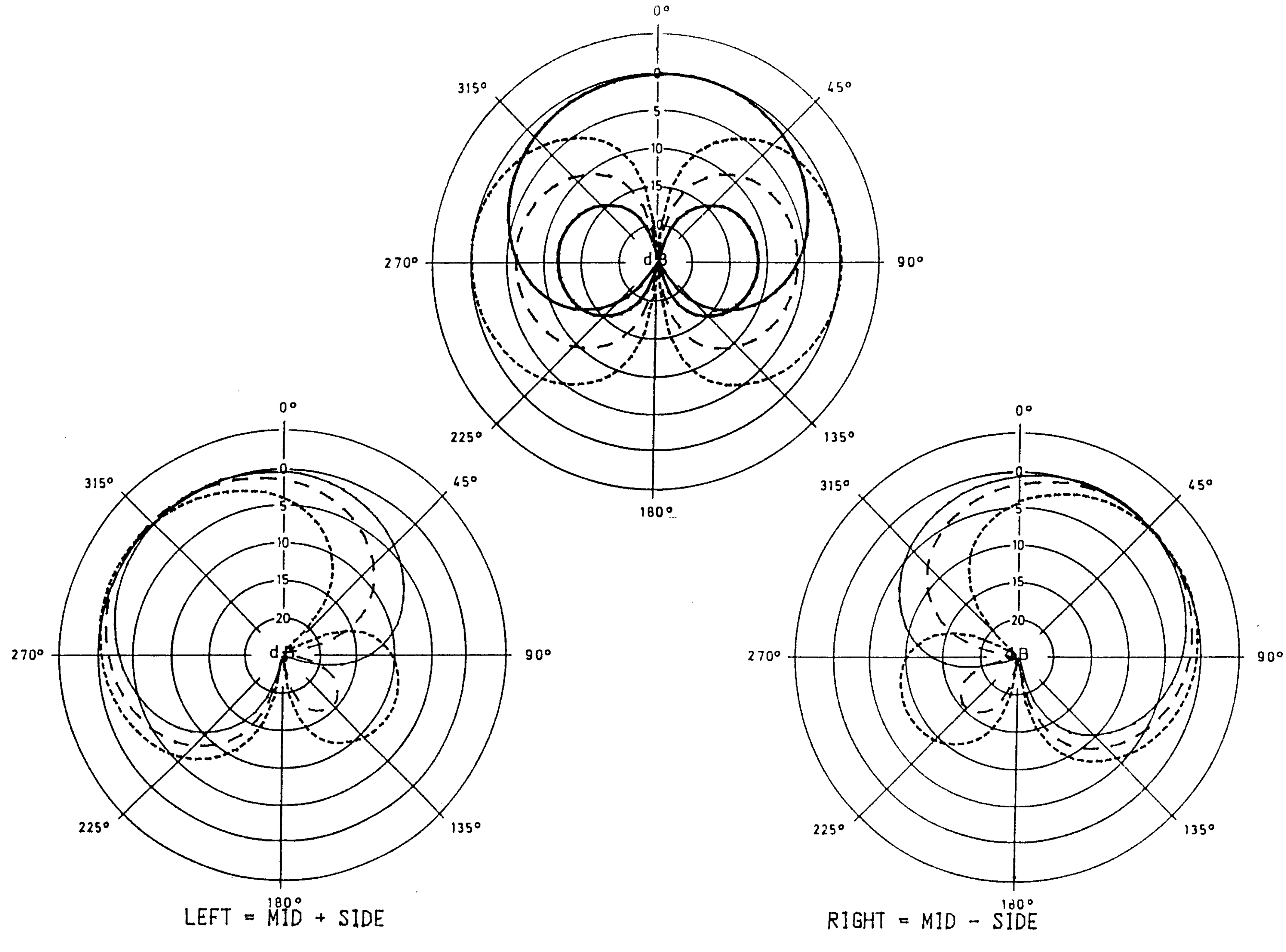

Fig. 4 **As Fig. 3, but with rising side (figure-8) signal level**

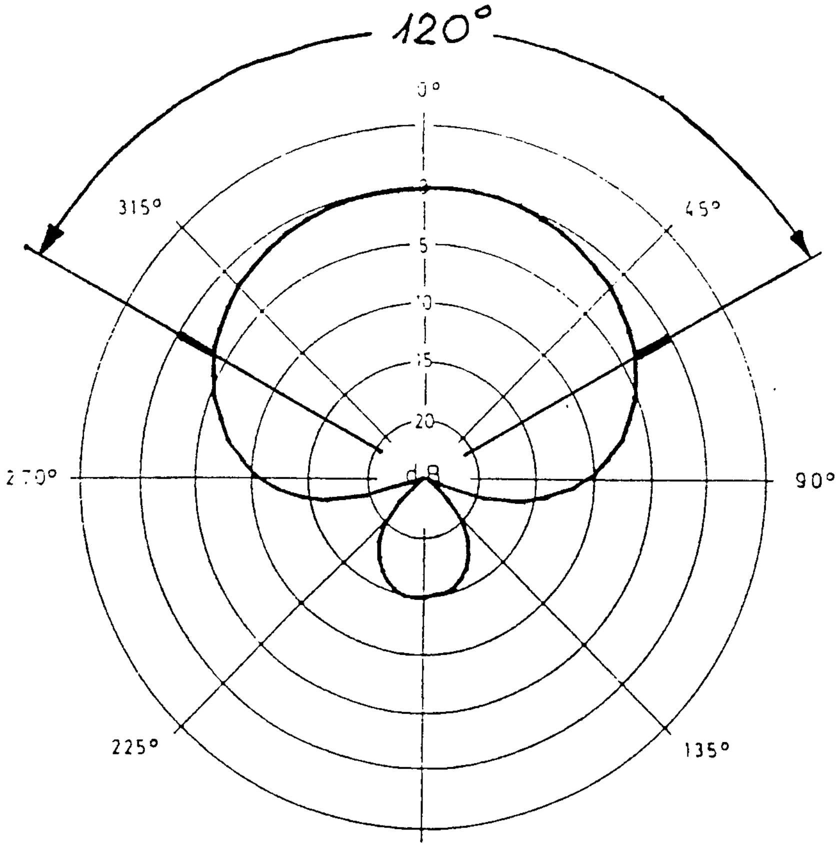

Fig. 5 The 3-dB limits of the middle signal characteristic. Mono-compatible working range

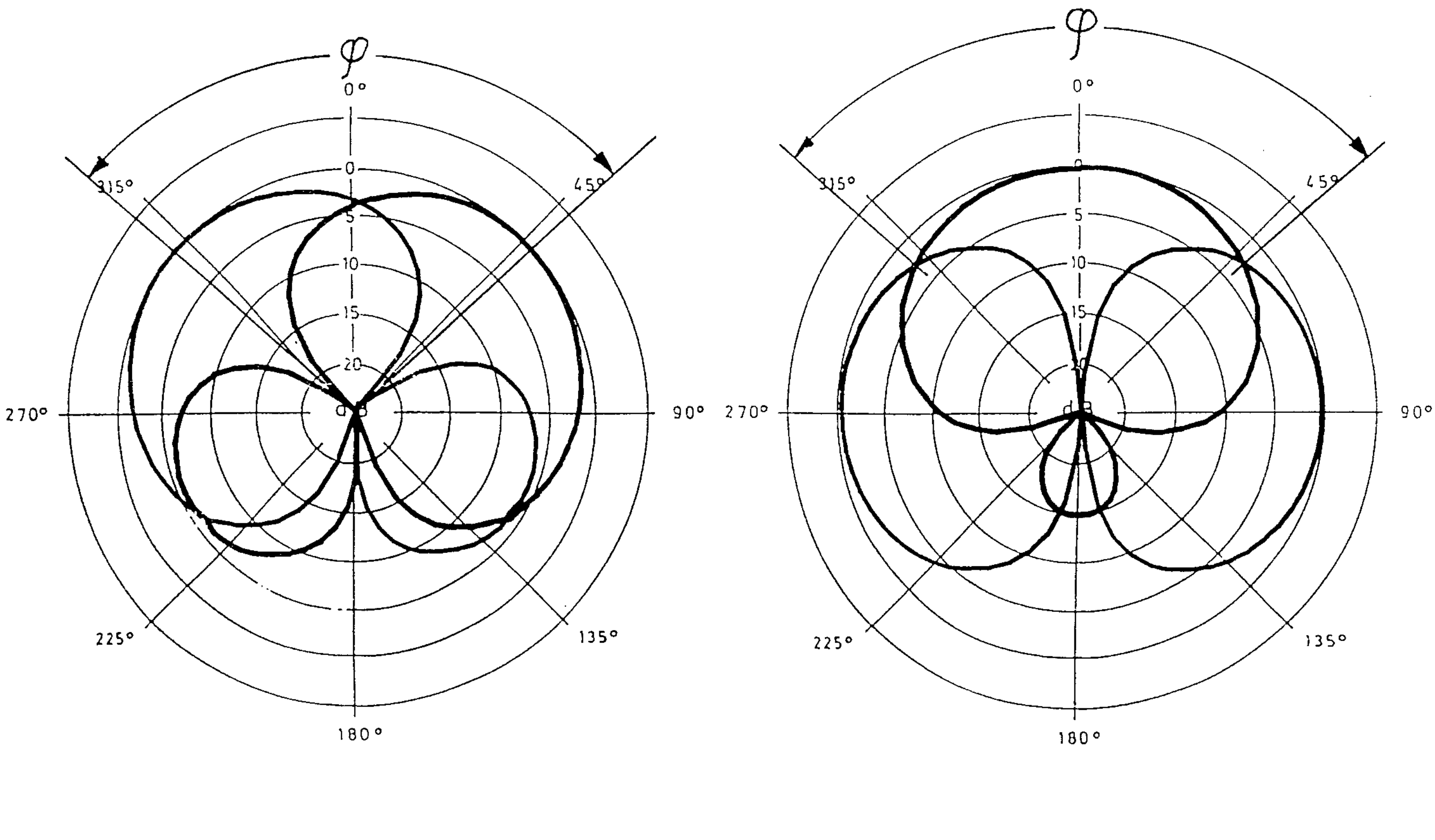

Fig. 6 The pickup angle φ ('field of view') in the XY and MS representation

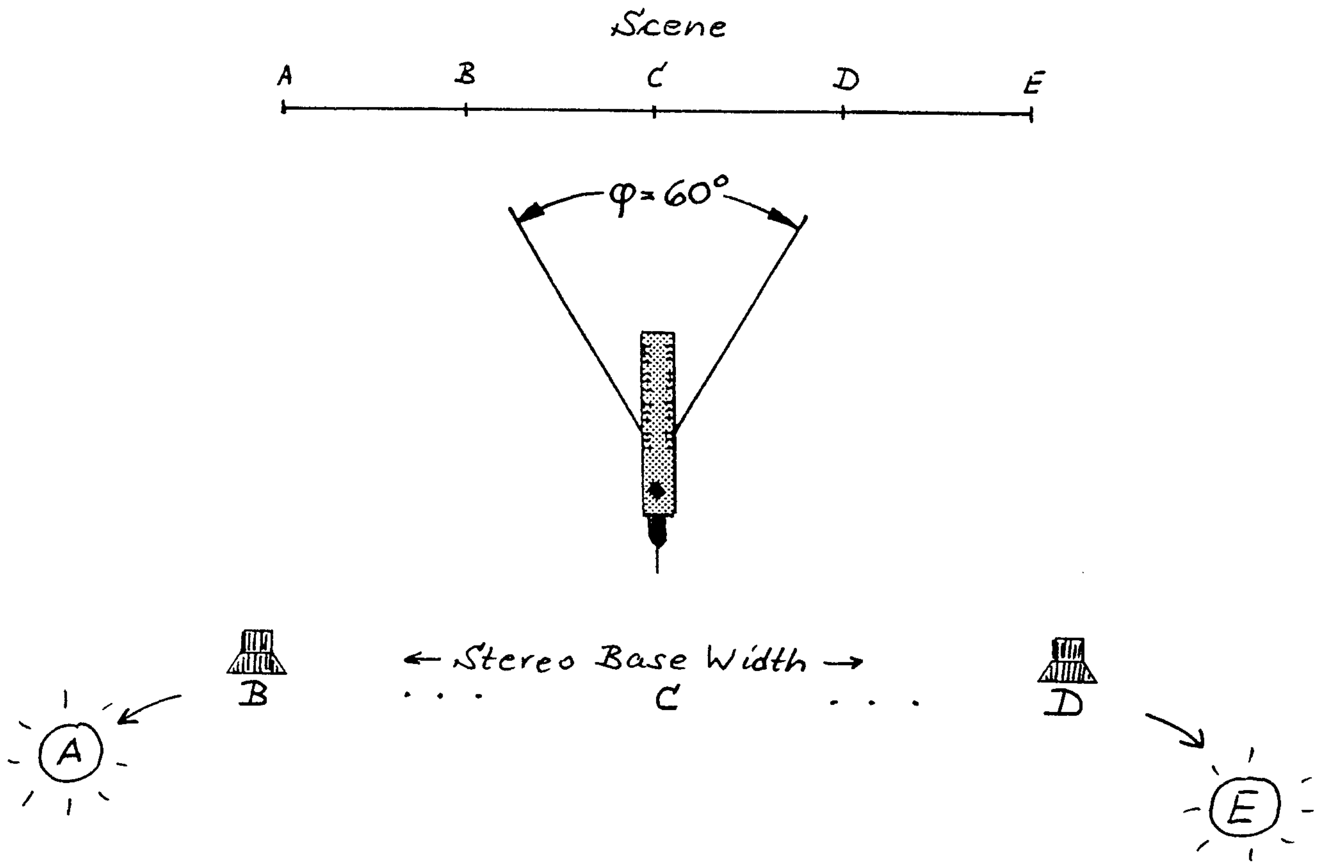

Fig. 7a Playback situation with a too narrow pickup angle
(= too much side signal component)

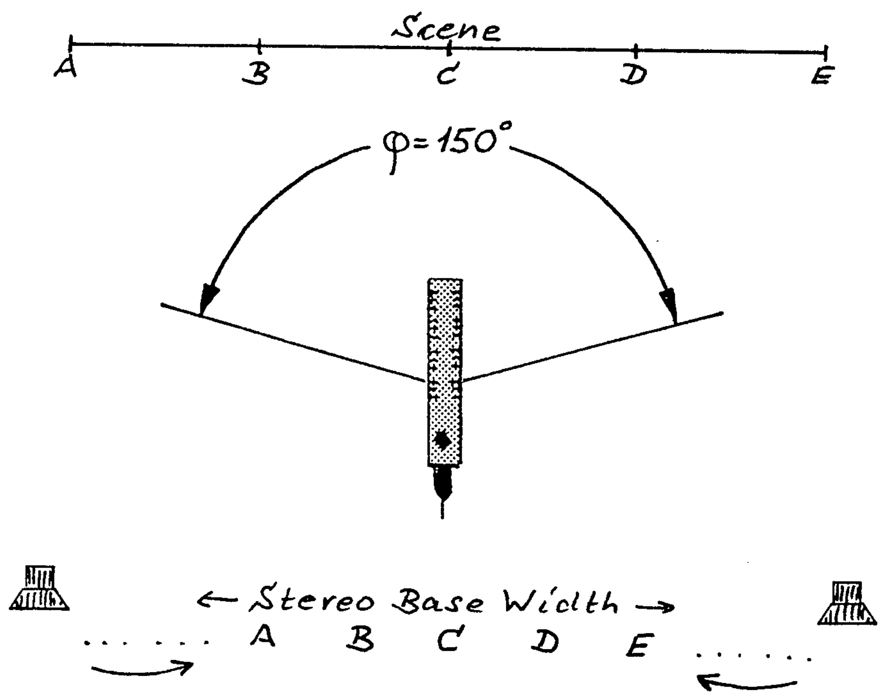

Fig. 7b Playback situation with a too wide pickup angle
(= not enough side signal component)

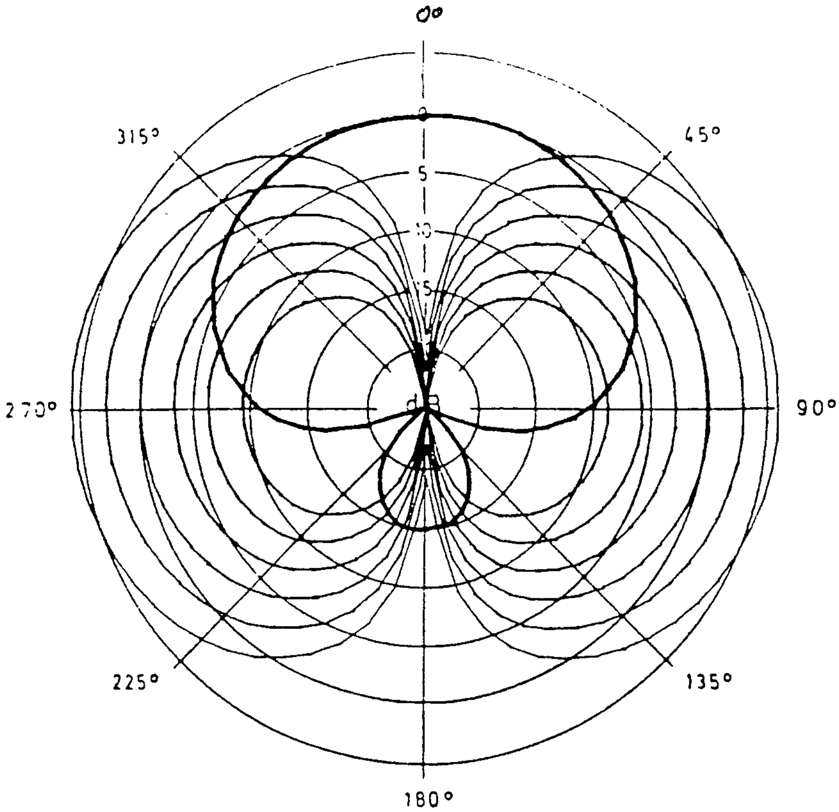

Fig. 8 **The six selectable side signal levels in comparision with the middle signal level (= 0 dB) provided by the shotgun stereo microphone system**

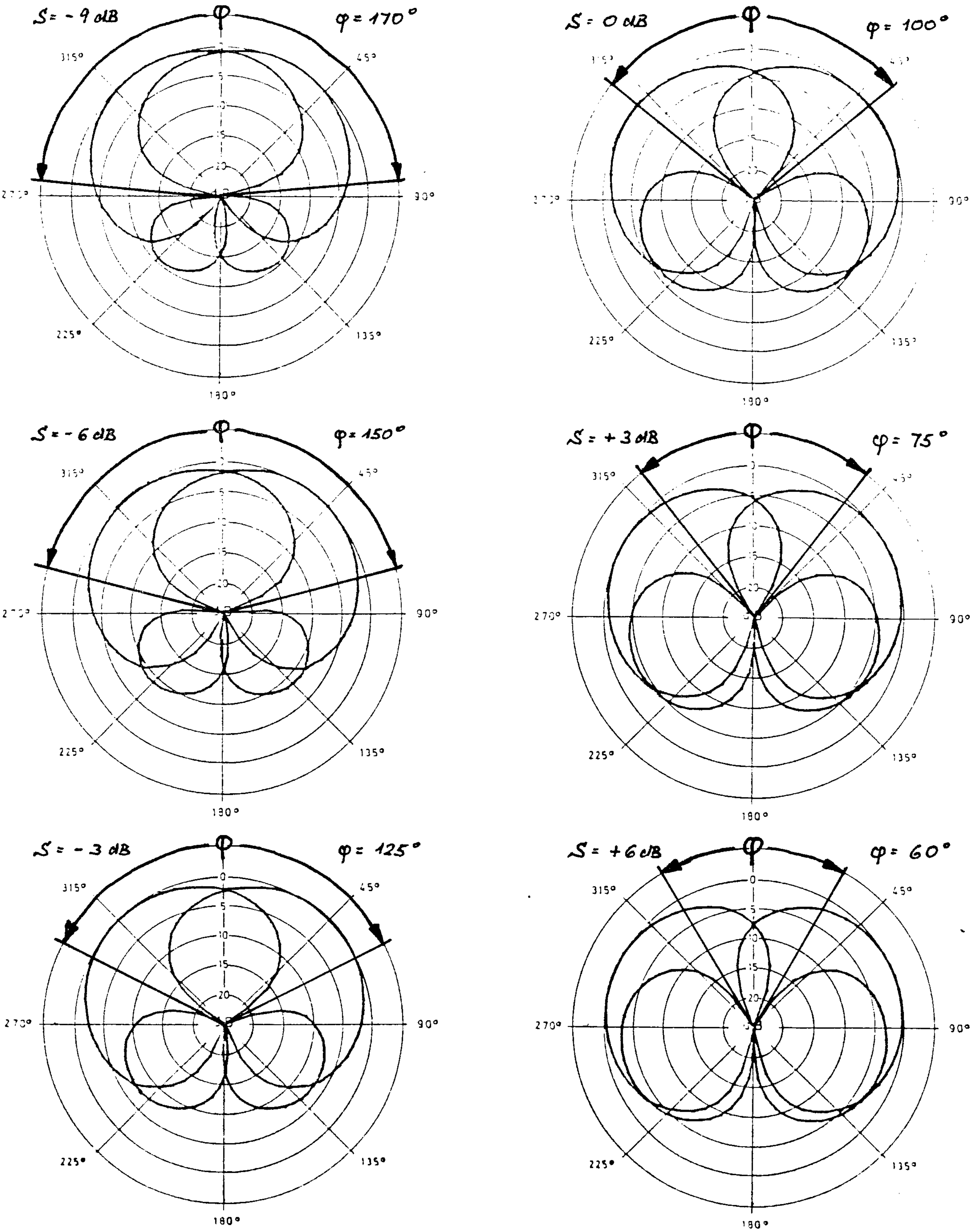

Fig. 9 **The six different directional characteristics derived from Fig. 8 in XY mode.**
φ = pickupangle

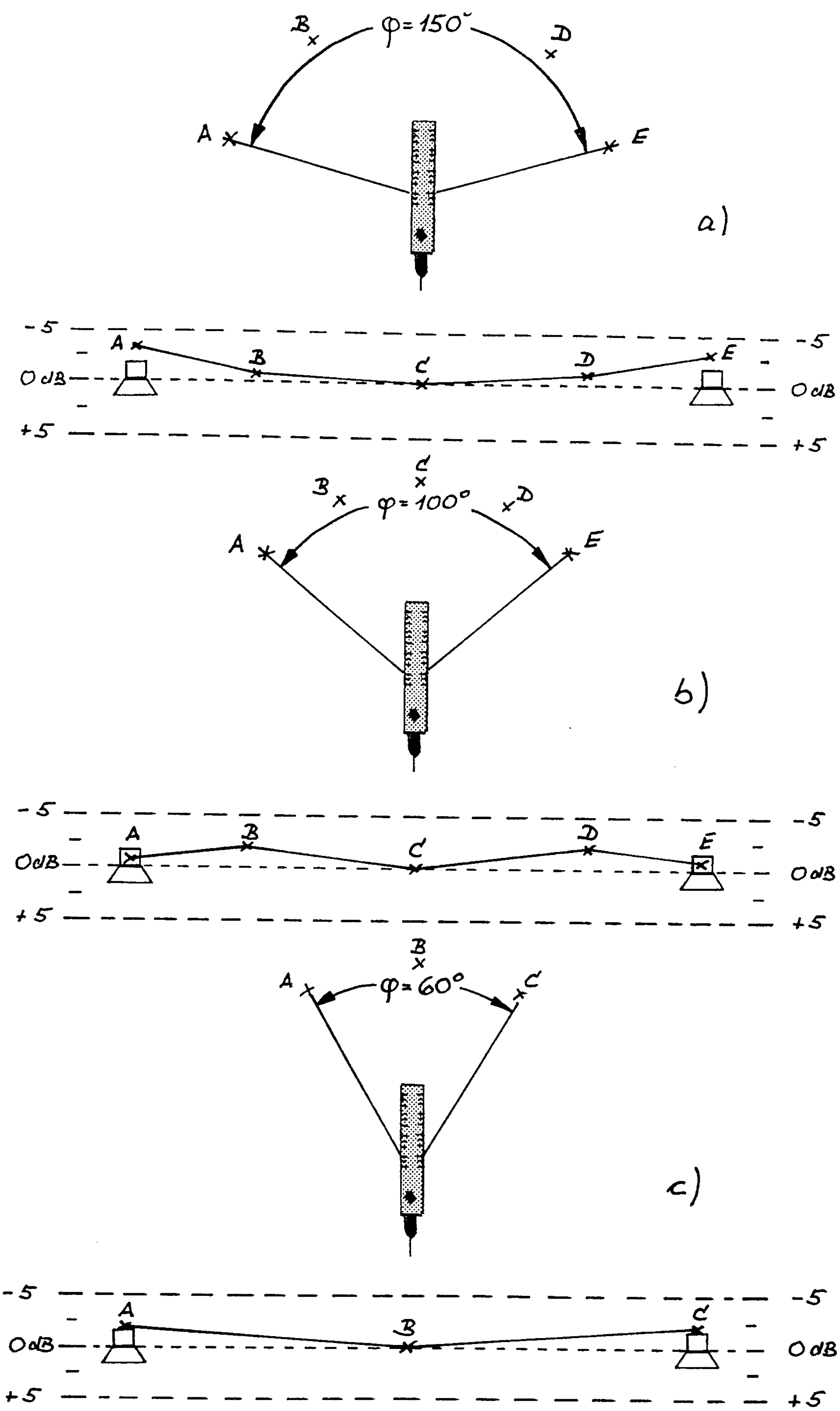

Fig. 10 Image relationship in XY mode for three different S-signal levels.
φ = pickupangle