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**Presented at
the 77th Convention
1985 March 5-8
Hamburg**

AES

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AN AUDIO ENGINEERING SOCIETY PREPRINT

NEW DEVELOPMENTS WITH THE DELTA STEREOPHONY SYSTEM

by

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Abstract: The sound system presented at the 65th Convention of the AES was further improved. The true direction and distance perception can now be extended to soloistic sources too without being bound to limited source sections. Furthermore, it is possible to incorporate the reproduction of soloistic moving sound sources into a desired sound field which is to be simulated in a complex manner, and thus get listening events with different impressions of transparency and spaciousness.

1. INTRODUCTION

During the 35th AES Convention, 1968, a forecast was made by C.P.BONER [1] for the development of sound reinforcement systems over a period of time of 20 years, that is, up to 1988. Most of the 20 items of the forecast have proved indeed in the stormy development of electroacoustics; an exact comparison will be appropriate in 1988.

In some aspects the sound system techniques has remained a "neglected child", compared with the illuminating engineering, many things have developed one-sided. Most significant, however, undoubtedly is the fact, that with the general increase of the quality consciousness in audio technology, stimulated by broadcasting and disk stereophony and nowadays by the trend to digital transmission techniques too, higher and higher values of the quality parameters of sound systems are being expected. A growing integration of electroacoustics with room acoustics as a common result for a "good acoustic" in halls can be observed. It is no longer only a matter of improvement of speech intelligibility and pure "sound reinforcement", of balanced sound level distribution and high naturality of the reproducing timbre, meanwhile it is a matter of more sound-system comfort [2] , such as true direction and distance reproduction.

In 1980 [3], it was already pointed to this development and the "Delta Stereophony System" was described as a sound system with true direction and distance perception.

Such sound systems are an evident step forward in the development compared with simple "sound reinforcement" and with so-called "public-address systems".

The terminology formerly criticized by BONER as not being precise has not yet been developed to a suitable term in English making clear the significant step forward in quality improvement, as e.g. in the German term "Beschallungskomfort" (sound-system comfort). The demand for such a comfort has significantly increased, however; so the "Delta-Stereofonie-Beschallungs-System" presented in 1980 has been used meanwhile in seven greater projects or is just being realized, as already stated in [4] (see [6] and [8] too).

BONER in 1968 predicted that sound systems of good quality will reach the state of pipe organs. This development is recognizable indeed. Many institutions responsible for large auditories have realized that the success of an important artistic performance to a large extent depends on the quality, on the technological flexibility and thus on the parameters of true direction and distance perception which can be referred to the term sound system comfort. Only with higher comfort the audience can be included in the artistical atmosphere, can be stimulated to emotional reactions.

In particular, in this connection the prediction of BONER completely proves also right, that the development and the general use of digital delay devices in sound systems is being regarded as an essential improvement. Delay devices allow a significant step forward in the quality improvement of the sound, which permits a manifold complex simulation of acoustical sound fields by a great abundance of variations of the single parameters [7], if the initial acoustical conditions of the room are appropriate to them. Often, however, realizations are still to be met, where e.g. too long a reverberation time of the stage houses in the halls (theatres etc.) can no longer be influenced as desired, whatever sophisticated sound techniques may be used.

It is possible effectively to utilize the various facilities of modern sound systems even with unfamiliar, technologically complicated room configurations. In 4 there was already mentioned the project of the new Friedrichstadtpalast, which meanwhile has been realized successfully and in which the variety theatre conditions require a place for the orchestra, at an extremely left sided stage between the area of action and the audience in order to have available the performing area for the artists, the ballett, water basin, skating-ice etc. in close contact with the audience (see fig. 1). Only when utilizing the Delta-Stereophony System 4 it is possible to master the sound propagation time of approximately 100 ms between the edges of the stage sides, caused by the distance, and to maintain the true direction for the orchestra (left side), background choir (right side) and for soloists moving over the middle of the stage by corresponding signal processing for the single loudspeakers [8].

Almost all of the well-known sound systems can be included in three basic principles:

- centralized sound systems
- de-centralized sound systems
- multichannel intensity or phase stereophony sound systems.

All these methods have considerable disadvantages and are not sufficient for large area sound reproduction, where available rooms can to the maximum possible extent be utilized for action and sound reception regions (assessments concerning this matter see [2].

2. THE DELTA STEREOPHONY SOUND SYSTEM AND ITS FUTURE DEVELOPMENT

The Delta Stereophony System [4], [5] up to now shows the best results of localization, of sound quality and of the spatial impression. As is well known, it uses the precedence effect and is based on the distribution of the action region into several spatially limited source regions with respectively co-ordinated microphones and delay units. The microphone signal components of the source areas, electrically delayed referring to the sound radiator places by respectively more than the natural sound running time (each time referred to a reference point in this source area) are summarized in summation circuits which are co-ordinated with the sound radiators. The movement of the sound sources is realized by means of follow-up devices (panorama controls), which partially consist of well-known switching and fade-over devices, more inverting the localization by changes of the amplitude of the source signal to one or another source area.

As a means for enhancement of spaciousness and transparency, further delay equipment and sound radiators connected to them and distributed in the room are used, the signals of which concerning time and amplitude continuously following the signals of the primary sound radiators. The physical working principle and the fundamental circuit design are shown in fig. 2 and 3. With this principle, coincidence of optical and acoustical directional impressions can be ensured.

A further development of the system [9], [10] , in particular, became necessary as it may occur that the original sound source of low volume, such as announcers or singers, which often even are moving, and also single instruments are localized in a diffuse, insufficient or even flighty manner. Such sources are in the following text called "soloistic sources".

It became evident that for these special cases the reference to discrete, spatially limited source areas and thus a subdivision into single fields of the action area is not suitable and, as well as, that the sound power of the sources is to be appropriately taken into account.

In order to solve the task, the microphones being co-ordinated with soloistic sources, are connected with own controllable delay units and amplifiers and these influenced by means of adjusting or controlling units for differentiated control, approximated proportionate to the sound path, analogous to the sound-propagation paths between the respective source place and the places of the sound radiators. The sound radiators are distributed in the action and reception areas.

The fundamental function of the improved system is based upon the support or simulation according to true time and loudness levels of the sound field propagating from the source over the action area into the reception area so that the sound radiators irradiate with adequate level respectively only after passing of the wave fronts of the original sound source or of the sound radiator simulating the original source. In this case, the time differences and amplifications are to be differentiated relating to power and type of sources.

Thus it is possible to avoid discrepancies also in the transition areas which otherwise could appear between the delay time and amplitude localization, and actually, the original sound source is localized.

Furthermore it is also useful if - in addition to the stationary sound radiators within the areas of action and reception - mobile sound radiators are used close to soloistic sources, which are fed with specially processed signals coming from the relevant soloistic microphones via controllable delay and amplification units.

The better definition of localization thus achievable appears to be advantageous for soloistic sources, while for a closed sound impression of greater orchestras and for the spatial impression to be expected it may be desirable to interconnect a greater source area (recorded with several microphones), in combination with system configuration hitherto used. The microphone signal of the soloistic sources relating to delay time and level is inserted between the delay times and levels of the original sound or of an equivalent sound source simulating the original sound and the summation signal generated by a large source.

The application of the advanced development described is of particular significance for the transition region between the areas of action and reception, i.e. both for the sound radiators and microphones arranged there and for the sources to be localized there and the listeners seated.

In order to provide for the reproduction of soloistic, and especially of moving sound sources in a desired complex sound field to be simulated and thus achieve listening events with different impressions of clarity, Deutlichkeit and spaciousness, the devices for the generation of reflections, in addition to the delay and amplification units of the sources, may be controlled as a function of the location of the sources, whereas the delay times of the more remote sound radiators remain fixedly attributed to the sound radiator local differences.

Depending on the selected degree of simulation of the acoustic sound fields, the energy components of the different signals fed into the more remote sound radiators should be dimensioned such that the factor of clarity $C_{80} \geq 0$ dB, factor of Deutlichkeit $C_{50} \geq 0$ dB and factor of spatial impression $R \geq 0$ dB can be adjusted. In doing so, the condition must be met that the reverberation signals arrive last at the listeners' places.

For controlling purposes, a comparison and control unit as well as an assign panel for source and microphone positions is used.

The control devices for a differentiating control which is approximately proportional to the sound propagation paths consist, in the simplest case, of the simulation of the area of action with an adequate layout of the controls designed for the delay and amplification devices.

In the light of the facilities nowadays available in measuring and computing techniques, automatic tracking devices based on equipment of source localization are also possible. With the help of these technologies, a better control of acoustic feedback is given, since tracking allows appropriate attenuators being connected into the feeders leading to the additional radiators.

3. EXAMPLES OF THE POSSIBLE USE OF THE FURTHER DEVELOPMENT OF DELTA STEREOPHONY

The various possibilities indicated of a further development of the Delta Stereophony sound system are explained in more detail at some implementation examples in fig. 4 to 6.

In fig. 4, the microphone (6) is considered for a movable soloistic source.

The sound signal is carried from the microphone (6) via the mixing console with controllable channel amplifier (5) to a commutation device (10) for the purpose of a differentiated non-reactive pre-summation and preamplification, which is designated in the following as 'source summing distributor'.

This distributor with its further inputs is designed for the connection with other source branches not represented, according to the types of sources, as you will see in fig. 6.

After that, the sound signal passes to a controllable delay unit (9) and another commutation device (4) for the purpose of a further non-reactive differentiated summation and distribution - in the following called 'sound radiator summing distributor' (4) - and to the sound radiators (3a to 3n).

The mixer (5) and the delay unit (9) have control inputs (7), connected with a control unit, which above all contains an assign panel for the data of microphone (8a) and sound radiator positions (8c) as well as comparison and control devices (8b).

Fig. 5 gives an example for a possible arrangement of microphones (6a to 6m) and sound radiators (3a to 3n); as shown in practice, there is a variety of combination possibilities.

Two soloistic sources assigned to the microphones (6a) and (6b) may be moved over the area of action in any way as desired. A low power source of small dimension located on a podium, together with the microphone (6c), sound radiator (3n) and the stage monitor (3i) can be moved to different positions.

A large-scale source of high sound power such as an orchestra is picked up by several microphones (6d) to (6m). From the sound radiators installed within the boundary area between the area of action 1 and area of reception 2, three loudspeaker main groups (3a to 3c) are represented.

In order to support low power sources and to cover the area of action (1), further sound radiators (3d) to (3g) are used in its lateral and rear parts. The sound radiator (3h) is routed as stage monitor for the large source area.

Fig. 6 gives a block diagram of the situation represented in fig. 5.

According to the hitherto known principle of the Delta Stereophony system, the microphone outputs of the fixed sources (microphone location 6d to 6m) are fed via the channels of the sound mixing console (5d) to (5m), via a source distributor (10d), a source summing device (10b) into the delay unit (9d). Their outputs, whose delay times are different but fixedly adjusted, are led to the summing distributor (4a/4b) and to permanently installed sound radiators (3a to 3c).

The source signals of the microphones (6a to 6c) are, however, processed by separate summing and delay units; this subsystem is especially designed for the amplification of low power stationary or variable single or group signals.

As an example, in the case of a freely movable source, the microphone (6b) is connected via controllable amplification channels (5b) in the mixing console with the distributor (10c), in order to minimize the amplifying channels required, whose outputs are fed into the summing devices (10a) and (10b), as well as via the controllable delay units (9b) and (9c) to the distributor (4a) and the summing unit (4b) so that the sound radiators (3a to 3c) as well as (3d to 3h) are fed differently and nonreactively.

The control unit designed for acoustic tracking by means of the control panel (8) acts upon the amplifiers (5b), the distributors (10c), (4) and the delay units (9a, 9b, 9c) as can be seen in fig. 6.

Nowadays it is common practice that during a performance, a great deal of sound-reinforcement is realized by using the so-called playback recording method. This means, that the original sound sources are partly or wholly simulated by sound recordings; the relevant microphones are replaced by the outputs of sound recording systems, in which case it is useful that the main sound radiators within the area of action are each supported by several so-called simulation radiators (3d, 3e) which are installed near the source location concerned.

Further technical approaches are described in [10].

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BLOCK DIAGRAM FOR *DELTA-STEREOFONIE*

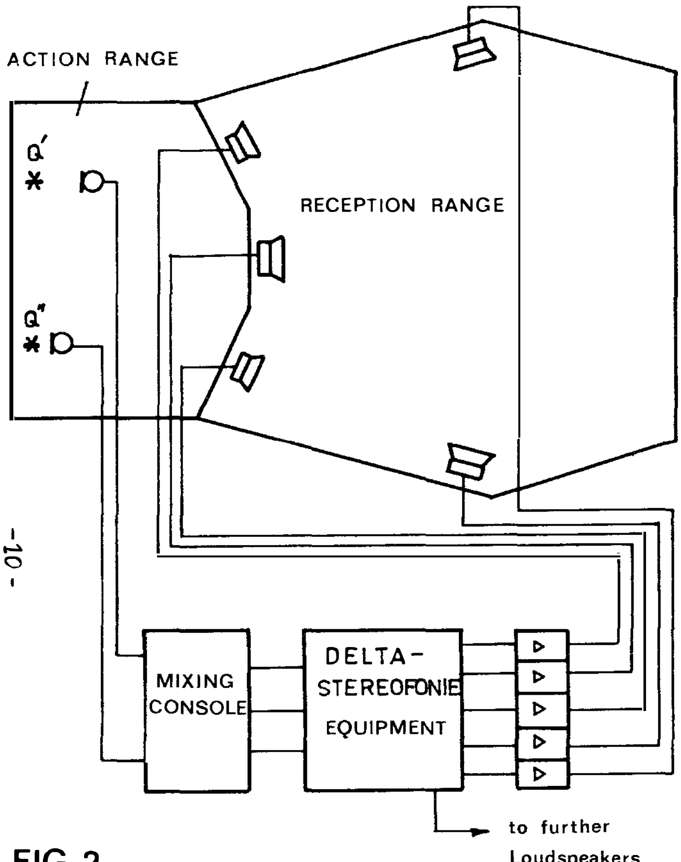
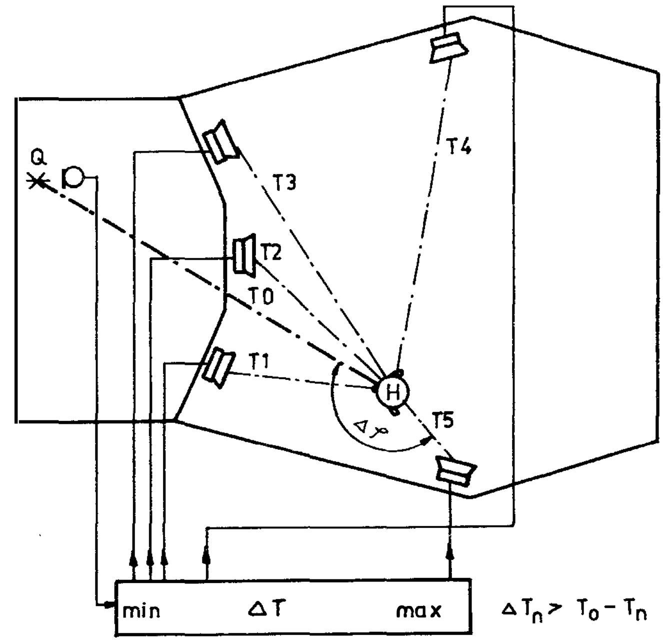


FIG. 2

PHYSICAL PRINCIPLE OF *DELTA-STEREOFONIE*



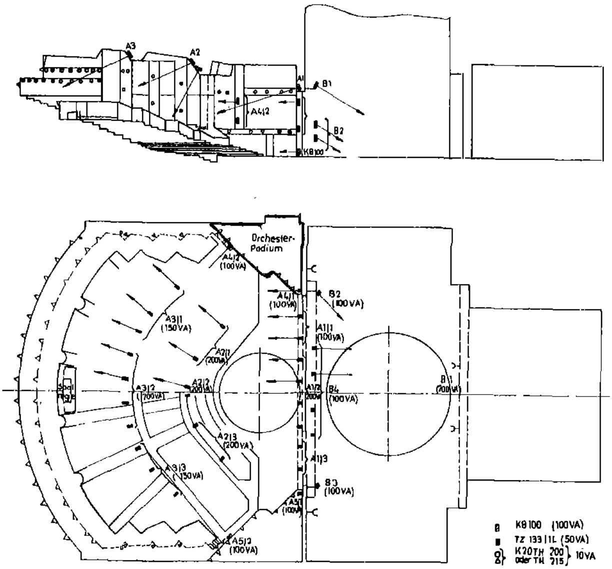
$\Delta T_n > T_0 - T_n$

$\Delta\varphi$ DIRECTION DEVIATON BETWEEN OPTICAL AND ACOUSTICAL IMPRESSION WITHOUT DELTA-STEREOFONIE-System

T_n ACOUSTICAL SOUND DELAY TIME

ΔT ELECTRICAL DELAY TIME

FIG. 3



ARRANGEMENT OF SOUND RADIATORS IN THE LARGE HALL
OF NEW FRIEDRICHSTADTPALAST, BERLIN (DDR)

FIG.1

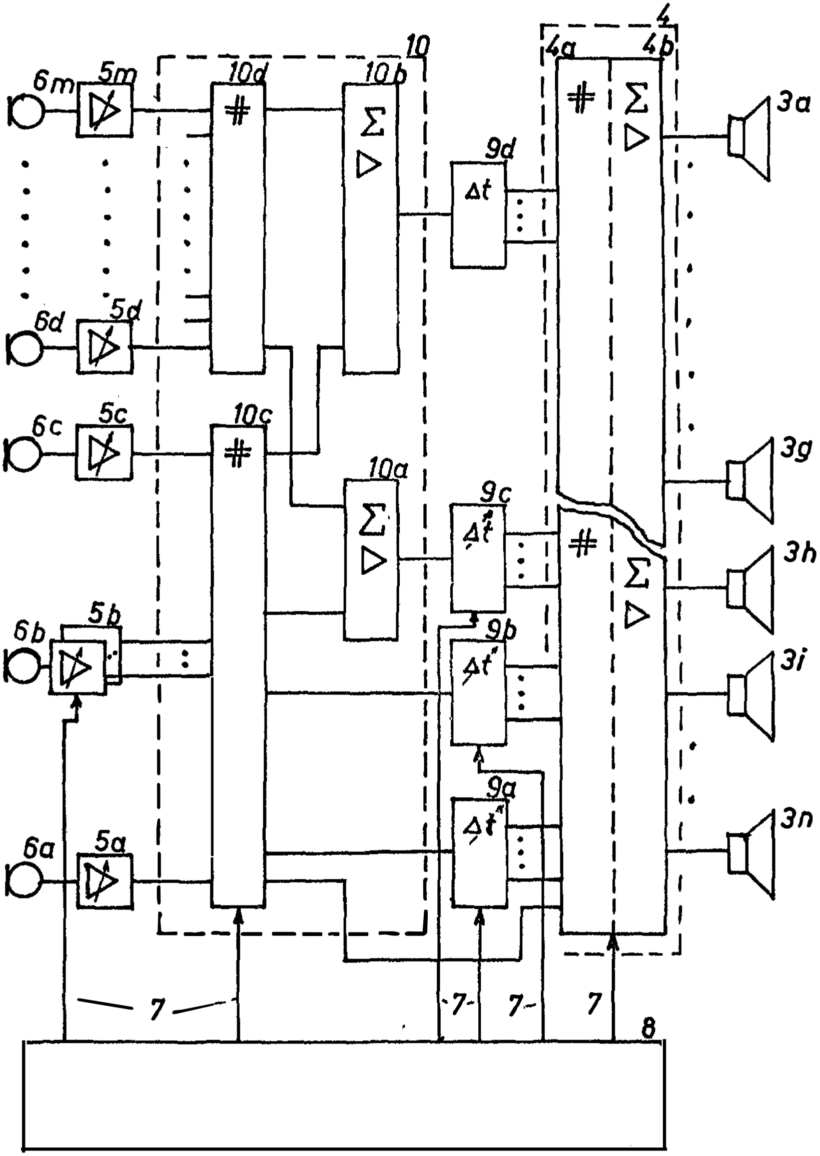


FIG.6

BLOCK DIAGRAM OF THE SITUATION
REPRESENTED IN FIG.5

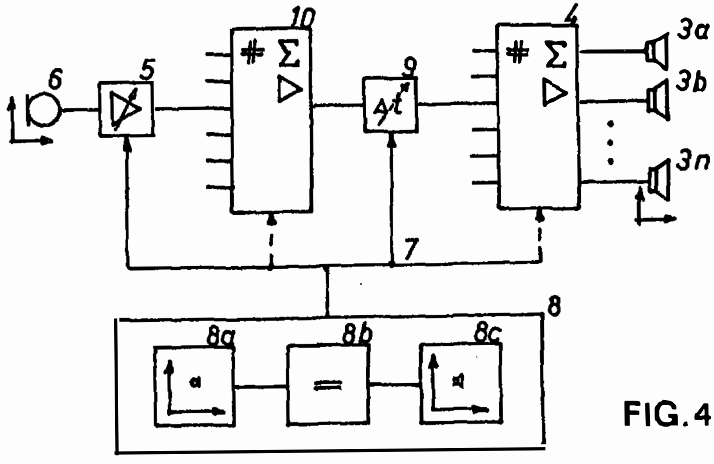


FIG. 4

PRINCIPLE BLOCK DIAGRAM FOR A MOVABLE SOLOISTIC SOURCE

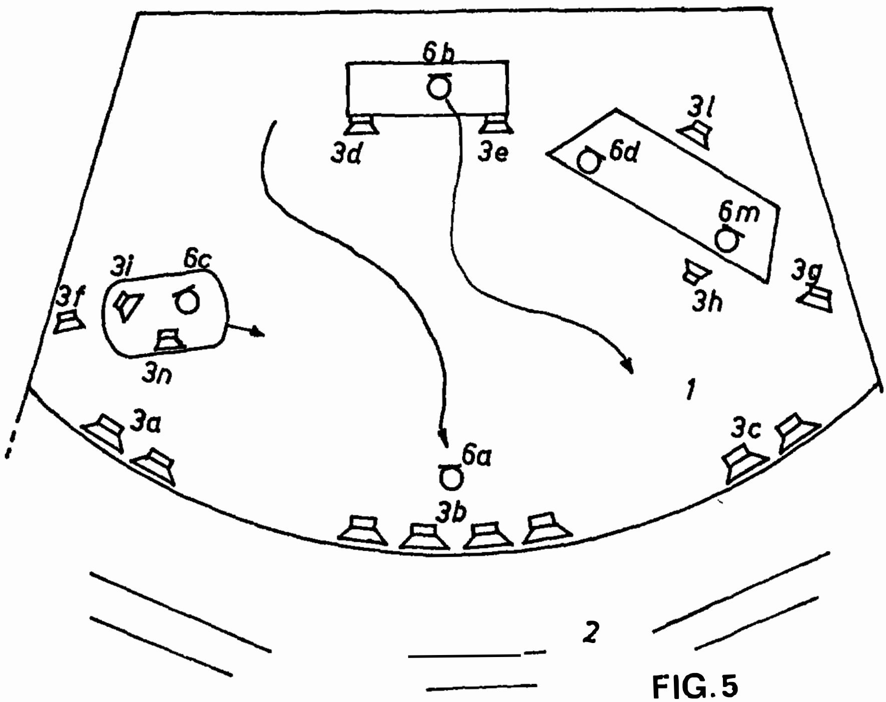


FIG. 5

EXAMPLE FOR A POSSIBLE ARRANGEMENT
OF MICROPHONES AND SOUND RADIATORS

LEGEND FOR FIGS. 4, 5 AND 6

1	area of action
2	area of reception
3a...n	sound radiators (loudspeaker boxes, groups)
4	commutation device: sound radiator summing distributor
4a	sound radiator distributor
4b	sound source summing device
5a...m	channel amplifier in the mixing console
6a...m	microphones
7	control inputs
8	control panel
8a	assign panel for microphones
8b	comparison and control device
8c	assign panel for sound radiators
9a...d	delay unit
10	commutation device: source summing distributor
10a, b	source summing device
10c, d	source distributor