

A SOUND DELAY SYSTEM FOR LARGE
MULTIPURPOSE HALLS

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A SOUND DELAY SYSTEM FOR LARGE MULTIPURPOSE HALLS

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0. ABSTRACTS

Introductorily premises are listed up for optimum sound technology and sound quality in large multipurpose halls.

Essential dates are given on a new large multipurpose hall in the GDR, with a short information of the different main sound systems.

A new sound system ("DELTA-STEREOPHONY-SYSTEM") is described which works so that coincidence of optical and acoustical directional impressions can be assured and which overcomes the shortcomings of other methods (as intensity stereophony etc.)

1. PREMISES FOR OPTIMUM SOUND TECHNOLOGY AND QUALITY
IN LARGE MULTIPURPOSE HALLS

Considering experiences with public address systems in several halls, we found the following premises necessary:

- highest reliability with rational operation and least employment of personal;
- high sound quality for music and speech, especially as for timbre, clearness, signal-to-noise-ratio, freedom of non-linear distortions and security against feedback;
- balanced sound distribution and sound supplying of the auditory with sufficient loudness (different for special genres, up to ca. 105 dB) and adequate sound supplying of the stage and action area;
- adequate loudness balance between individual sound sources at any auditory place;
- high sound system comfort:
 - . by means of localization of the sound sources to assure coincidence of optical and acoustical directional impressions,
 - . by means of optimization of the subjective room impressions by extending the reverberation time for special cases and by means of producing the perception of spaciousness,
 - . by means of producing sound effects for special places of the auditory, inclusive "panorama-effects".

To fulfil these complex conditions it is necessary to choose new concepts for sound systems.

2. CONDITIONS FOR A SPECIAL 5.000-PERSONS-MULTI-PURPOSE ROOM (PALAST DER REPUBLIK, BERLIN, GDR)

For illustrating the advantages of the new "DELTA-STEREOPHONY-SYSTEM" in a large hall, the conditions of a new hall in GDR shall be shown, in which the new sound system is used for the first time.

2.1. GENERAL CONDITIONS

The fundamental form of the large hall is a hexagon, with the action area at one corner part.

The largest diameter of the hall is 67 meter, the max. height 18 meter. The action area can reach a width up to 45 meter.

The hall can be transformed into several room and action variants by means of telescope and roll walls for 1.000 to 5.000 people.

Some variants shows fig.1:

- | | |
|---|----------------|
| - Small podium (for concerts) | - 1.800 people |
| - Panorama podium | - 4.200 people |
| - Diagonal variant (for concerts) | - 2.800 people |
| - Amphitheater stage (for great shows etc.) | - 3.800 people |

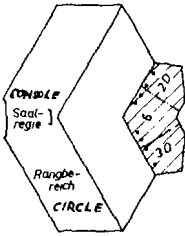
The ceiling consists of 24 individual plafonds which can moved in different height in a 6-meter-range and in different angles.

In general the acoustical room conditions show high absorption because of the ascending auditory floor area and very small surfaces of walls and balcony front.

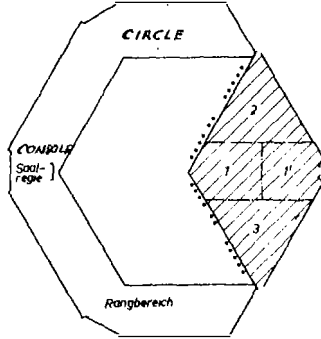
That means, the hall shows only small spaciousness and diffuseness if a public address system is not used.

The reverberation time of the largest variant is about 1,4 sec. The volume is about 40.000 m³.

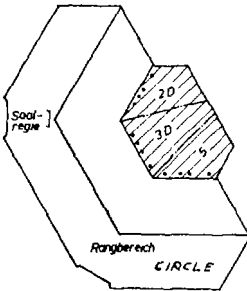
SMALL PODIUM
1.800 PERSONS



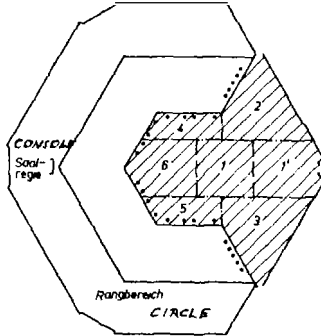
PANORAMA PODIUM
4.200 PERSONS



DIAGONAL VARIANT
2.800 PERSONS



AMPHITHEATER STAGE
3.800 PERSONS



//// ACTION AREAS

1, 1', 2, 3, 4, 5, 6, 2D, 3D: "SOURCE AREAS" FOR DELTA-STEREOPHONY
... PORTAL LOUDSPEAKER GROUPS

FIG. 1 GROUND PLANS OF MAIN VARIANTS FOR THE LARGE HALL (~40.000 m²) WITH THE "SOURCE AREAS" AND PORTAL LOUDSPEAKER GROUPS

2.2. SOUND SYSTEMS

Several sound systems are installed. In connection with the delay system (see §3) the following main loudspeaker groups are used:

- Main groups A, B and C:
 - 4 portal groups A with 24 columns, each 100 W;
 - 6 arena groups B with 4 front groups (16 columns, each 100 W) and 2 back groups (10 columns, each 25 W);
 - one central group C with 6 columns, each 50 W.

The columns show high frequency range and only few frequency irregularities.

Figs.2 and 3 show the arrangement of the loudspeaker groups and columns.

- Stage system

For sound sources which are too weak it is necessary to amplify the loudness of sources because in other case the source will be localized at the ceiling portal loudspeakers nevertheless their signals are delayed for 22,5 msec.

We found 3 cases to be provided:

- loudspeakers are attached directly to the actor (orchestra, speaker, electronic instruments),
- loudspeakers are arranged in groups over several points of the action area (for play-back),
- a group of small loudspeakers is fixed at the breastwork of the podium.

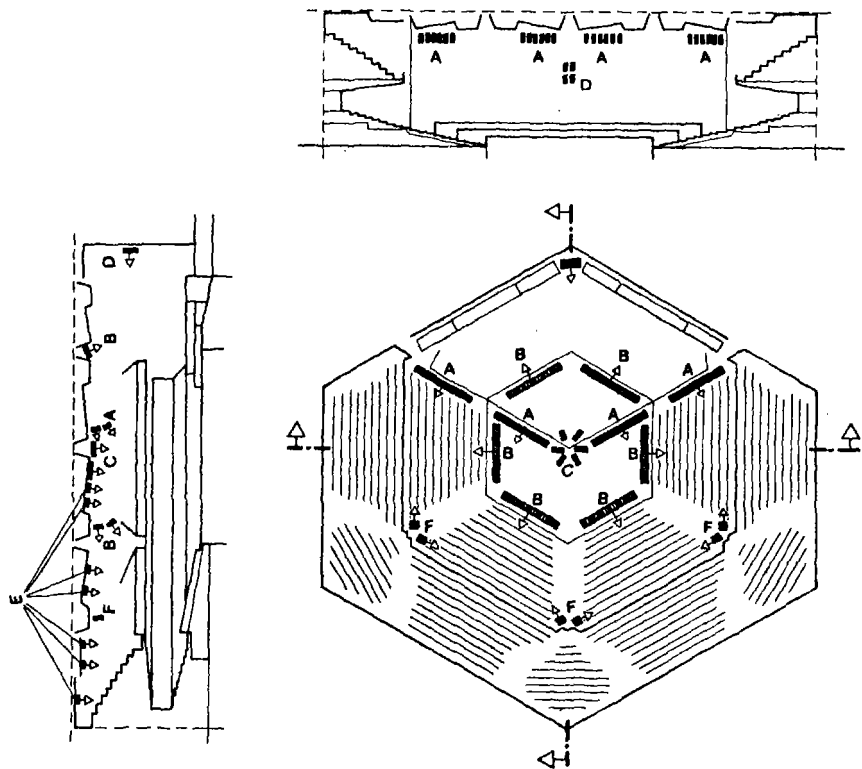


FIG. 2 GROUND-PLAN AND CROSS-SECTIONS OF THE LARGEST VARIANT OF THE HALL
ARRANGEMENT OF LOUDSPEAKER MAIN GROUPS A...F

. Other main groups are:

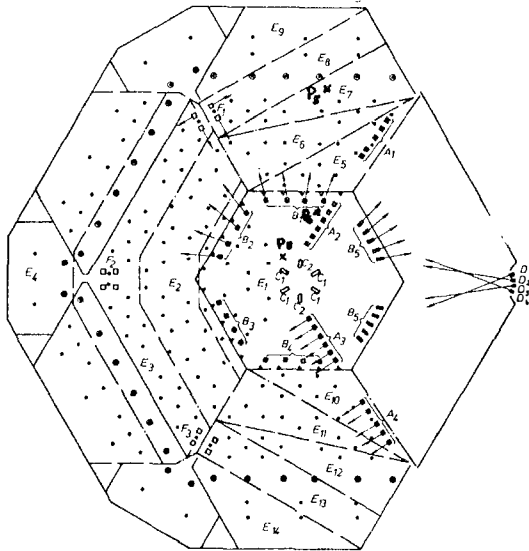
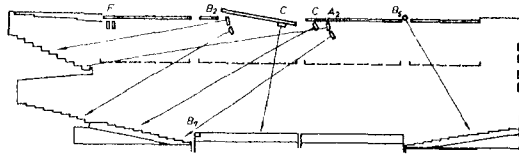
- effect groups - F
- cinema and back group - D
- chair loudspeaker system - G
- information system - H

. Ambiophony system E

This sound system E is used for enlarging the spaciousness, diffuseness, liveness and reverberation time. Therefore 300 loudspeakers are distributed over the ceiling (fig.3). Their signals are delayed for 4 groups in the deepness of the hall and in 3 groups in the lateral axis, as it can be seen in fig.3. This was necessary to get coincidence of the delay time conditions of the large portal groups in the special hall variants.

The reverberation time can be varied with system E as shown in fig.4 (see on page 14) for example

- a. amphitheater variant (3.800 persons)
normal concert case, about 2 sec.
(instead of 1,5 sec.)
- b. diagonal variant (2.800 persons)
up to 2,5 sec.
instead of 1,2 sec.
- concert case - about 1,5 sec.



- ⁰ loudspeaker column 50 VA
- loudspeaker column 100 VA (A, B)
- ▨ loudspeaker column 25 VA
- loudspeaker 10 VA
- loudspeaker 10 VA (Ambiphony system)
- additional loudspeaker for panorama variant

FIG. 3 CEILING PLAN OF LOUDSPEAKER ARRANGEMENT AND OF RADIATION DIRECTIONS OF MAIN GROUPS A, B, C, D. SITUATION OF TEST PLACES P₅, P₆, P₈ (SEE FIG. 6)

3. DELAY SYSTEM

The correct localization was demanded by the builder and owner. It was a very difficult task in that case with those dimensions and form of the hall. From the distances between sound sources from left to right delay times up to 120 msec. follow.

It was therefore necessary to develop the new "Delta-stereophony-system". The principal idea shows fig.5.

The system consists of

- a multichannel arrangement of microphones or other sound sources;
- a multichannel mixing console;
- a special delay network;
- an arrangement of loudspeakers in groups divided as the number of sources channels and depending on the deepness of the hall.

As fig.5 and before fig.1 shows the stage/action area is divided in a number of segments - we say "source sections" (source districts).

In such a section no direction distinction is more necessary. In each individual source section the original signals are picked up in normal way with one or more microphones and mixed, processed, amplified so, that for each source section a summarized signal results. The different sum signals feeds a special delay system. The delay system works in that manner, that at any auditory place the sequence of the sound signals coming from that loudspeaker group which has the shortest distance from the connection line between listener place and original sound source arrives earlier than the sound of all the other loudspeaker groups, but nethertheless later than the sound of the concerning original source.

The sum signals of the individual sections, each processed in that manner, are summarized in groups of the same number as main (portal) groups exist.

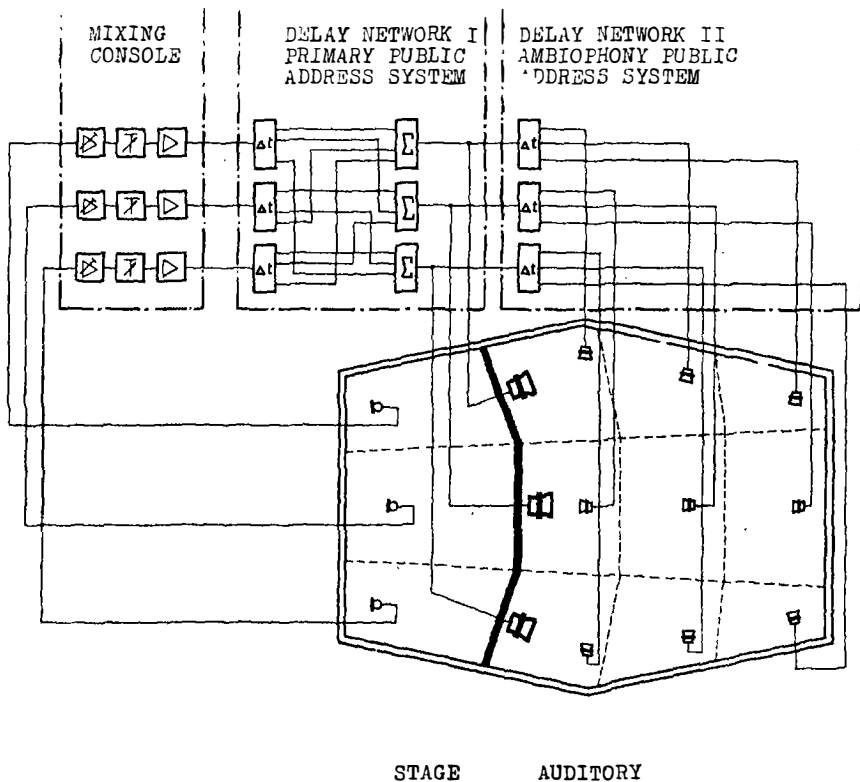


FIG. 5 DELTA-STEREOPHONY DELAY SYSTEM

Principal arrangement of microphones in individual source sections and of signal processing for any hall

With that method we get the security, that the original sound source can be localized according to the law of the first wave front. Beside the directional distribution also the distance impression is maintained.

Furthermore at each place of the auditory a good loudness balance exists because of each loudspeaker group radiates a sum signal derived from the individual source signals with equal amplitude parts for the concerned auditory part.

In cases where the sound sources have to move over the stage, for solists etc., the source signal feeds special directional regulators, which connect the concerning source sum signal to the different delay channels.

The ceiling groups E are connected to that localization delay system so that all the delay times are correct.

Additionally the signals for the ceiling groups can be reverberated - together or independent of the portal groups - (with 4-channel-reverberation-unit) or added with especially delayed room signals.

Figs.6 and 7 show the delay times and the series of reflections at three different places:

- P 5: left, side area
- P 6: left, center floor (near A 2 - group)
- P 8: center place (arena, below C - group)

It can be seen that the original sound comes at first, then appears the sound from the stage edge loudspeaker group A 5, then that from the portal group with the shortest distance (for instance A 2), and then sound from the other portal and ceiling groups comes.

For special places we have calculated and measured such reflectograms to avoid echo effects or single reflections which could be listened. All groups of loudspeakers could be adjusted for that reglement in delay time and level.

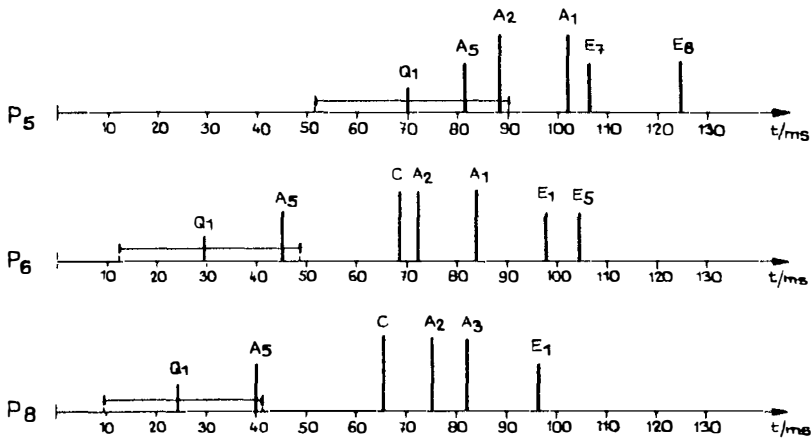


FIG. 6 : DELAY TIMES OF THE FIRST WAVE FRONT FOR SOUND OF THE SOURCE Q₁ AND THOSE LOUDSPEAKERS, WHICH ARE THE NEAREST FOR THE PLACES P₅, P₆, P₈

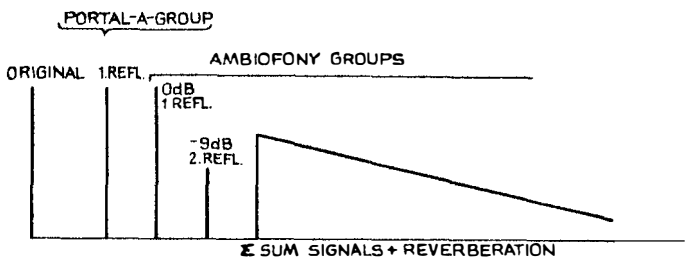


FIG. 7 : SERIES OF REFLECTIONS (SIMPLIFIED)

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Technische Mitteilungen des RFZ, 21 (1977), 3, 49-73

2. HOEG,W., STEFFEN,F., STEINKE,G., REICHARDT,W.,
AHNERT,W.

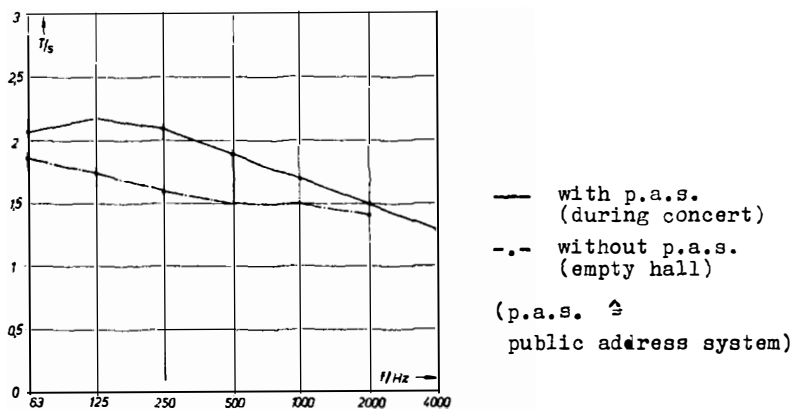
Anordnung für die Beschallung eines großen Raumes
oder einer Freifläche (richtungsgetreue elektro-
akustische Schallübertragung) (Special sound rein-
forcement system for a large room or a free area)

DDR-Wirtschaftspatent	WP 120 341
BRD-Offenlegungsschrift	Nr. P 2605056
Austria Patent	Nr. 345 363
Japan Announcement	No. 027590/76

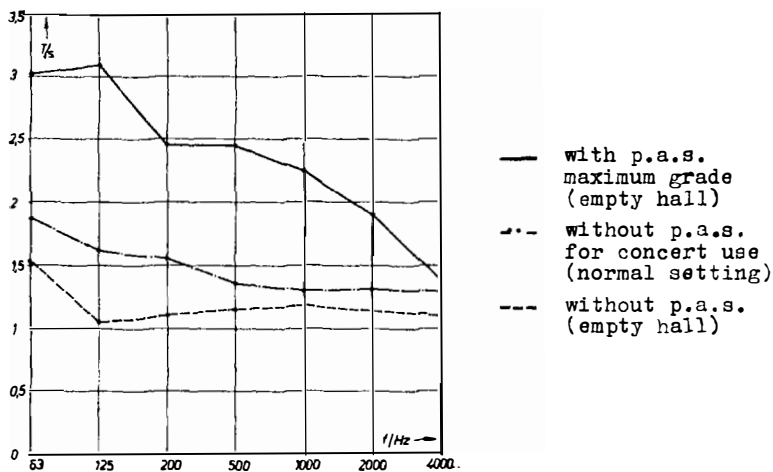
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für große Mehrzweckräume (Technological conditions
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rooms)

Technische Mitteilungen des RFZ, 21 (1977), 2, 32-36



4a LARGE HALL IN "AMPHITHEATER" VARIANT; 3.800 PERSONS



4b LARGE HALL IN "DIAGONAL" VARIANT; 2.800 PERSONS

FIG. 4 REVERBERATION TIMES OF THE LARGE HALL
 IN "PALAST DER REPUBLIK", GDR