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ITEM Nos 7 & 9.

ELECTRO—ACCOUSTICS IN GERMANY
PART 1

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

ELECTRO - ACOUSTICS IN GERMANY.

Reported by

T.SOMERVILLE.

BIOS Trip Numbers:2478 & 2478a.

BIOS Target Numbers;
See Table of Contents.

BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE
32, Bryanston Square, London, W.1.

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PERSONNEL OF TEAM.

T.Somerville.
P.H.Parkin.
B.C.Sewell.

1. Nordwestdeutscher-Rundfunk,
Hamburg,
Rothenbaumschaussee.

Investigation by:

T. Somerville
9th,10th,11th,12th
20th & 22nd July.

Personalities: Lt.Col. Findlay
Dr. Körsters
Herr Peters

This establishment was visited first because it was known that every facility for investigation would be provided by the Chief Engineer, Lt. Col. Findlay, and that much useful information would be obtained.

These are the principal premises in the British Zone and have been little damaged during the war. They were built in 1925 and, therefore, the equipment is not modern, but new equipment will be provided, and the necessary preliminary steps are being taken. The general layout of the system and equipment resembles BBC practice, the main difference being that condenser microphones of the Neumann type are used throughout, and this involves the use of head amplifiers attached to the microphones. To provide these amplifiers with power and avoid hum due to A.C. mains they are supplied by D.C. from batteries. The output of the head amplifiers is taken to a mixer in a cubicle next to the studio, and from there to the control room for amplification and switching, after which it is fed through zero gain trap valve amplifiers to the required destinations.

The system in Germany differs from that in use in Britain in that the responsibility of the broadcasting authority ends with the delivery of the programme to the telephone lines, for the transmitters and line network are operated entirely by the German Post Office.

The method of measuring programme level also resembles British practice, the instrument used being a peak programme meter. It has an operating time of 10 m/s compared with the BBC time of 2 m/s, but it is agreed that this is too long and will be corrected in future designs. The recovery time is 2 seconds from 100% to 5% deflection, which agrees with BBC practice. Instead of a normal meter a large edgewise scale is used at the back of the control desk and a beam of light is projected on to this from a mirror on the instrument movement.

In the re-design of the equipment it is intended to use pre-amplifiers after the head amplifiers of the microphones to raise the level before mixing, a system which has been adopted in Britain, and work on a cathode ray type of peak programme meter will be undertaken.

Limiters are only used in the German broadcasting system to prevent excessive peaks reaching transmitters. The operating time is 1 m/s and the recovery time 200 m/s, which were found by experiment to be the most suitable values.

No compression devices are used, the sole responsibility for control being taken by the originating studio.

Line up is carried out at 800 c/s at a level of 1.55 v. across 600 ohms, which is 75% of peak level.

Studios

The studios at Hamburg, although built in 1925, are reasonably good.

No.1, the large orchestral studio, which is shown in Fig.1 with technical details in Table 1, is quite unorthodox. It has a hard wood floor, glass roof and no normal wall treatment intended to absorb bass, although absorption does take place, as will be seen from the level reverberation curve of Fig.2. This may be due partly to the side galleries intended to accommodate variable acoustic panels which are not now in use, partly to a platform and proscenium at one end where there are some draperies, and partly to the glass roof. There may also be some other parts of the structure absorbing bass, but this is not obvious from inspection. The centre portion of the floor is designed to be lowered to give a well in front of the platform, but this feature is not used. Although it is not intended this studio has "live" and "dead" ends for the orchestra plays in front of a solid wall at the opposite end from the stage which will give some absorption.

Listening tests were carried out in this studio, and for this purpose a BBC ribbon microphone Type AXBT with a BBC OBA/8 amplifier and RK loudspeaker were used. The loudspeaker was mounted in a standard German baffle and fed from a German loudspeaker amplifier. The microphone position was not critical and good results could be obtained easily but it was not possible, in the time available, to arrive at the best possible balance. The microphone position found when balancing with the RK speaker agreed with the normal positions used in good BBC studios, the height being 16 ft. and the distance from the orchestra 12 ft. and a position slightly off centre gave best results. A normal internal balance of the orchestra of 50 players is used and it is interesting to note that the standard microphone position used by the Germans is over the head of the conductor at a height of 10 ft. This is, no doubt, due to the poor loudspeakers available, which have a pronounced bass resonance in the region of 200 c/s and a rapid loss of top above 4000 c/s and cause close microphone positions to be adopted to increase the level of strings and woodwinds. There is also a tendency to adopt the multi-microphone technique, usually with regrettable results.

The performance of this studio is excellent but it has not been possible to find out the exact reason, if this is known, because nobody at present in Hamburg has details of the design.

Comparisions of the BBC and Neumann condenser microphones were also carried out in this studio, and the quality obtained from the BBC AXBT microphone was

thought to be slightly better. The Neumann microphone has a resonance of 3 db in the 5000 c/s region, which can be detected easily on an RK speaker. It is not obvious on the German loudspeakers, and, in fact, helps to compensate to some extent for the lack of top. It causes a hardness in the strings which is not present with the BBC ribbon microphone.

It is not proposed to comment in detail on the other studios at Hamburg, but Figs. 3 to 14 and Tables 2 to 7 give the available information. The wall treatments are all orthodox, the bass absorption being provided by slotted plywood panels with glass wool behind, or by absorption panels with a fabric facing. Flutter echoes appear to have been troublesome in some studios between floor and ceiling and have been cured by the adoption of a triangular form of breaking up on ceilings. All normal acoustical materials are used in the normal way, but the studios are not outstanding and could be improved in the light of modern experience.

An extension of the studio accommodation is taking place and for the acoustic treatment new materials, produced by a firm named Goslar, will be tried. This firm makes a range of panelling in fibre-board with various types of surface and also absorbent panelling of compressed glass wool, which is convenient to use because it is delivered in slabs.

Magnetophon

The Magnetophon is an important part of the German broadcasting system, and the only important development in German broadcasting during the war. Much material is recorded for re-broadcasting, although a large percentage of the output from Hamburg is "live". In judging the Magnetophon the conditions of listening are of paramount importance. If listened to on a German loudspeaker the result is quite pleasant, but there is a noticeable lack of top. The BBC loudspeaker enables a more critical test to be made and surface noise and distortion become audible.

This agrees with our experience in testing the equipment, Type H.T.S., in Britain, where we find that good results can only be obtained with the Magnetophon very carefully adjusted. When listening with a wide range loudspeaker of the Altec Lansing type, results are not good because of distortion and surface noise. It has been found in Hamburg that the equipments, which are all of the H.T.S. type, require careful adjustment and maintenance if good results are to be ensured. There is no doubt that the Magnetophon is a very useful device and compares favourably with the disc recording equipment in common use, but it does not compare with the BBC Type D Disc Recorder. It is interesting to note that an excellent frequency characteristic can be obtained with Magnetophon equipment. This point has been checked in the BBC Research Laboratories and it can be confirmed that a level characteristic up to 10,000 c/s is possible, but as listening tests

are made in Germany with loudspeakers cutting off rapidly over 4000 c/s, the real performance of the equipment is not observed. This explains why observers visiting Germany hear apparently good results, but when listening under British conditions with better loudspeakers, are not satisfied. A later model, Type K.7 has been made and it remains to be seen whether it is superior in performance to the H.T.S. models. Tests will be carried out as soon as an equipment is available.

Sound Measurement Room.

A sound measurement room is being constructed for microphone and loudspeaker measurement, and the treatment consists of glass wool 20 centimetres thick, after which wedges of glass wool about 50 centimetres in length are fixed to the walls to absorb the low frequencies. For measurements of acoustical materials a room with hard walls and with one wall and the ceiling sloping is employed. The material to be measured is fitted to the walls, and from the change in reverberation characteristic the properties of the treatment are calculated. To calibrate microphones the piston-phone is used for low frequencies, and for upper frequencies a special Siemens unit with an extra condenser plate on the front is employed. Loudspeakers at the moment are calibrated in the open air, but eventually when the measurement room is complete this will be done indoors. So far, no work has been done on loudspeakers and microphones to determine the transient response, but work of this nature is envisaged. Dr. Körsters intends to make a multiple unit loudspeaker having a high frequency speaker at the centre of a circle of five or six low frequency speakers all mounted on a flat baffle. He awaits a suitable high frequency unit and is adopting this arrangement because of the difficulty of making special horns and cabinets at present.

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2. Reichs-Rundfunk-Gesellschaft,
Berlin (British Sector)
Masuren Allee.

Investigation by:

T. Somerville
15th July.

Personalities: Lt.Col. Malaco (Russia)
Herr Schuster (Technical Director)

In Berlin a visit was paid to the R.R.G. building which was the headquarters of broadcasting in Germany before the war. It is now in Russian hands and permission had to be obtained from the Russian authorities.

It was not possible to make any tests as most of the studios were not in use, so that judgment of characteristics by listening to programmes was not possible.

The large studio which seats 1,200 people is a very fine piece of architecture. The walls are treated with slotted plywood with glass wool absorbent material behind, and the tip up seats must produce considerable bass absorption, but the exact details are not available. Only a small orchestra was playing in this studio, and therefore its performance could not be assessed, but it is probably very good. The studio accommodation is quite modern and great use is made of devices for varying studio acoustics. One system used in several studios is to employ roller blinds of absorbent material in front of hard wall surfaces so that by adjustment of the blinds it is possible to vary the studio characteristics. In other studios hinged panelling is used extensively, arranged so that one side gives a hard reflecting surface and the other side is absorbent. Here again, as in Hamburg, flutter echoes have been troublesome in some studios and have been dealt with by the triangular corrugation of ceilings. Several "dead" studios are available, the method of damping being quite normal, and two very bright echo rooms are used for echo effects. One studio tapers towards one end and the walls and ceilings are corrugated triangularly, the flat surfaces being about 3 ft. wide and the apex of the triangle 1 ft. from the wall. This studio is said to be good for military and brass bands. The Germans have not experienced difficulty with the microphone placing, which is contrary to BBC experience of this type of studio. They seem to prefer this treatment to poly-cylindrical surfaces, but they admit they have not tried the latter. The talks studios are good. The lower 3 ft. of the studio is panelled and the remainder of the walls treated with tiles similar to Cellotex with absorbent material behind. In Berlin moving coil microphones made by Eugen Beyer are used in talks studios.

The control arrangements resemble those in Hamburg but beside each control cubicle there is a talks studio with announcer and replay facilities for Magnetophon and disc. In this respect there is a close resemblance to the BBC system of continuity operation. The programme goes to the control room which is a switching room only, and here the switching is carried out without plugs and cords. A special type of plug is used in conjunction with a special jack field on each bay, by means of which all normal inter-connections can be made, but plugs with cords can be used for testing or abnormal operation. The Magnetophon is used extensively and a certain amount of recording for immediate reproduction is done on wax. Practically all the programmes radiated are recorded.

This studio centre is of great interest, and an opportunity at a later date will be taken to carry out tests similar to those conducted at Hamburg, if the necessary arrangements can be made with the Russian authorities. Complete technical information on the design of the R.R.G. building is not available.

A sample of the Eckmiller loudspeaker was seen here. It consists of two cones, each with its own coil operating in the same gap and the high frequency

cone, which is in the centre, operates into a short horn to give diffusion of the high frecuencies. The performance is obviously better than the speakers at present in use, but although the programme was not suitable for exercising proper judgment, it was considered to be unlikely that it will approach the Altec Lansing in performance. An endeavour is being made to acquire a sample which will be given comprehensive tests.

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3. Siemens-Halske,
Siemenstadt,
Berlin.

Investigation by:

T. Somerville
16th July.

Personalities: Dr. Hoffmann
Dr. Wierke

Siemens-Halske were visited because before the war they made a very complete range of electro-acoustic measuring equipment. Dr. Hoffmann explained that they had lost all their equipment during the period of Russian occupation, and that because of lack of machinery, raw material and staff it would be some time before production, even on a limited basis, could be recommenced. However, he is trying to collect technical data which he will send, in due course. The range of apparatus made included oscillators, filters, attenuators, noise measurers, distortion measurers of several types and reverberation measuring equipment.

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4. Telefunken (Valve Works)
Sickingen Strasse,
Berlin.

Investigation by:

T. Somerville
17th July

Personality: Dr. Zickermann.

This organisation is more or less at a standstill as a result of the war, but it intends to make a piezo electric pick-up when materials are available. The technical details could not be obtained, nor was it possible to find out if the pre-war magnetic pick-up which gives such good results is in the production programme. This information may be obtained later.

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5. Dr. Erwin Meyer,
Rettin,
Neustadt,
Holstein.

Investigated by:

T. Somerville,
B.C. Sewell
P.H. Parkin
23rd and 24th July

Dr. Meyer's work during the war has been largely on supersonics, and only to a small extent concerned with architectural acoustics. The 3,000,000 cubic metre building referred to in a previous report was, it appears, begun but not completed. No special acoustic treatment was proposed and the only possibility of rendering the scheme practicable was by the use of local loudspeaker distribution. It was apparently a "Hitler Fantasy" and was not likely to prove a workable proposition. Dr. Meyer believes that a method of treatment of marble or similar surfaces could be developed by perforation methods. This is no solution, however, to the special problem of vast auditoria.

Dr. Meyer described an acoustically dead room built in the Heinrich Hertz Institute in which the treatment was applied in the form of pyramids about 1 metre long and about 16 cms. apart, thus reducing reflected energy to 1/100 of incident energy from 80 c.p.s. upwards. A description is given in Akustische Zeitschrift, Volume V, 1940, p.352. No mathematical treatment was obtained but Dr. Meyer thinks it could be done and might lead to more economical construction. The room described was 14 metres long and cost r.m. 70,000 to construct. This was a better room than any existing in England.

In connection with the P.A. installation at the Poststadion, delay arrangements consisting of "despatch tubes" were used, but Dr. Meyer now considers that the Magnetophon would be preferable as a delay device.

The Reichspostsfeld had a successful P.A. installation consisting of anti-phased superimposed speakers giving local distribution only.

Dr. Meyer has made articulation measurements, particularly in churches, but has not related them to specific acoustic conditions.

We were informed that Magnetophon stereophonic apparatus had been made by Von Braunmühl, and was now being used by the Russians in Berlin, in conjunction with A.E.G.

Dr. Meyer was questioned concerning the design of the Messerhalle in Cologne, a building of 29,600 cubic metres reputedly good as a concert hall. It appeared that this was treated entirely with plywood, using the principle of air compliance, as the stiffness factor controlling panel resonance. The reverberation characteristic was good, but could be improved in the light of experience by more careful mathematical design.

Contrary to some opinions, Dr. Meyer believes that the method of damping using stretched wires had been satisfactorily applied, and stated that it had been described by Rchevkin in Russia.

Another type of acoustic treatment was said to exist at Radio House, Copenhagen, and was described by Von Wilhm. L. Jordan in Akustische Zeitschrift, 1940. This consists of perforated plywood panels with absorbent material behind the perforations. In this manner the principles of flexural and capillary absorption are combined to give excellent control over the desired acoustic conditions. The details of design were carefully calculated in this instance.

Dr. Meyer did not know of any work in Germany on sound energy distribution, which is concerned largely with proper shaping of auditoria. There has been no recent constructional work and no work is projected.

The subject of distortion measurement was introduced, especially that involving the special triple fundamental heterodyne oscillator due to Von Braunmühl. Dr. Meyer believed this to be a very suitable method of measuring loudspeaker distortion. This matter will be further discussed with Dr. Von Braunmühl.

An important publication mentioned, which should be obtained, is Physik und Technik des Tonfilms, 2nd edition, by Lichte and Narath, 1943. A 3rd edition is in preparation, under Russian auspices.

A complete list of Dr. Meyer's published work is given in Appendix I.

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6. Electro-Akustik (E.L.A.C.) Kiel.

Personality: Dr. Schmitt.

Investigation by:
B.C. Sewell
P.H. Parkin
24th July

The firm of Electro Akustik (E.L.A.C.) in Kiel was visited, and Dr. Schmitt and others were interviewed. They were re-starting measurements, using a Neumann level recorder, but no information of consequence was obtained.

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7. Allgemeine-Elektrizitäts-Gesellschaft, Kiel.

Personality: Dr. Hagemann.

Investigation by:
B.C. Sewell
P.H. Parkin
24th July

A.E.G. have a workshop in Kiel, but are shortly moving to Hamburg. Information on the Magnetophon was obtained from Dr. Hagemann. The distortion is

reckoned as below 2% except at high frequencies, where it is somewhat higher. The flutter was said to be under plus and minus 0.1%, which would be an extremely good performance. The newest type is the K.7, and negotiations are in progress for the supply of one hundred of these instruments to France. One is ordered for Hamburg Radio. We enquired whether the Magnetophon had been used as an artificial reverberation device, and were informed that Herr Peters, an associate of Von Braunmühl, could give information.

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8. Military Government,
Travemunde.

Personality: Mr. Pinks.

Investigation by:

B.C. Sewell
P.H. Parkin
25th July.

A visit was paid to Travemunde where the Military Government Officer, Mr. Pinks, was interviewed. It had been discovered from the files at the Military Government in Kiel that some equipment which appeared to include acoustic measurement gear was located at Travemunde under the charge of Mr. Pinks. This proved to be the case, and evacuation documents were subsequently made out in Hamburg; Document Serial No.2799, dated 26th July, 1946.

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9. Major Killinger,
8 I.C.U.
Hamburg,
67 Rothenbaumchaussee.

Investigation by:

B.C. Sewell
P.H. Parkin
26th July.

Major Killinger, Chief of the Film Section, was interviewed. He had arranged for transport of certain equipment, which we had been endeavouring to trace, from Eutin to Hamburg. This was found to include two Magnetophons of a type unsuitable to Hamburg Radio, and so evacuation Serial No.2800 was made out for these.

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10. Dr. Körsters,
Nordwestdeutscher-Rundfunk,
Hamburg.

Investigation by:

B.C. Sewell
P.H. Parkin
26th and 27th July.

A visit was paid to Hamburg Radio, and with the permission of Lt.Col. Findlay, Dr. Körsters was interviewed. Herr Peters was away and could not be interviewed.

Dr. Körsters had been mainly concerned during the war with the Acoustic Torpedo, but had done some air acoustics work in 1939 and since the war. He has used a multiple Rayleigh disc for acoustic field measurements which appears to be an original contribution, and has not been published.

This was developed in order to extend the calibration range for microphones above 10 kc. and consisted of thirty-six glass discs, 1.3 mm. diameter, 0.2 mm. thick which were distributed over a square grid of glass wires 0.2 mm. in diameter. The length of one side of the grid was approximately 20 mm. so that the spacing between discs was about two diameters. The whole assembly was varnished with shellac.

The grid was on a common suspension at two opposite corners, and was suspended in the field from a magnetostrictive oscillator. The torque on the single suspension was of course thirty-six times as great as from a single disc, and deflections of about 4 degrees were obtained from sound pressures of 100 dynes per square centimetre.

The sound field from the oscillator was calculated and was checked by a small condenser microphone, known to have a flat response up to 10 kc. and with its resonance at 25 kc.

Consistent results were obtained.

It was ascertained that a condenser microphone, similar to the Neumann, was made by him to the design of Von Braunmühl and Weber and marketed by Siemens. These are being made at Hamburg Radio in three main types, omni-directional, bi-directional and uni-directional. Details are as follows:-

Single transmitter for all types.
A back to front discrimination of 16 db. at 1,000 cycles for the uni-directional type, reduced to 12 db. at about 120 cycles, but with somewhat more than 16 db. at 250 cycles.
Sensitivity 1.4 m/v per bar.

High frequency peak of 5 db. at 5,500 cycles, apparently due to physical dimensions.
Polarising voltage 50; no grid leak for following tube (type M.C.L. or R.V.P. 2,800). RV2P800
Transmitter insulation resistance 10^{10}. Capacity 90 cms. for one diaphragm.
Cathode follower output not used because output obtainable without distortion was insufficient.
Diaphragm material collodion and evaporated gold.
Insulation material Plexiglass or Amber.

A number of condenser transmitters have been connected in parallel with a single amplifier tube to give great directivity, and one such unit mounted in each wall of a room has been used.

Tropical tests had been made by Neumann in Berlin and this type of microphone was found to be satisfactory.

Experiments are being started with an electrostatic speaker unit to cover the range 5,000/10,000 cycles. The diaphragm is to consist of a number of small discs cemented to a dome shaped base of diameter 14 cms., and used without a horn. It was hoped later to make a unit covering from 1,000 cycles upwards. Other measurement and calibration work which had been carried out appeared to follow this conventional pattern.

A list of Dr. Körsters' publications is given in Appendix 11.

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11. Dr. Thienhaus,
Hamburg, Blankenese,
Hauptstrasse, 149.

Investigation by:

B.C. Sewell
P.H. Parkin
29th July.

Dr. Thienhaus was at some period an associate of Dr. Meyer. During the war he was mostly concerned with acoustic torpedoes, but did some work on air acoustics as well. He is chiefly concerned with the musical aspect of acoustics, and with the making and interpretation of reverberation measurements.

Dr. Thienhaus has devoted some time to stereophonic problems, and hopes later to be able to publish a book on this subject, of which the manuscript was written in 1941-42. It is considered that this may be an important contribution.

He is at present engaged on the analysis of bell tones in collaboration with Professor Price of Missouri University. The results of these experiments

will probably be published in America. This work has been undertaken for the Hanover Church, and about 300 church bells of all types are being analysed. The method is that of excitation by means of an electro-magnetic element, and measurement of the response at all frequencies. The partial tones are thus found and their decrement is also determined by the Neumann level recorder. The analysis of the relative amplitudes of the partials produced on impact will also be determined separately, by recording on an endless magnetophon loop, and analysing by heterodyne methods. A special method of analysis of the resultant data will be needed in an attempt to determine the conditions productive of the best tone. The low partials of the bells have been found to have a decrement of only 2 to 3 db. per second, and the highest usually approach 80 db. per second, although occasionally they are much more persistent.

Dr. Thienhaus is an expert on construction of organs and certain other musical instruments and has worked with Ferd. Trendelenburg of Berlin on these subjects. This work has been published in Akustische Zeitschrift.

Dr. Thienhaus is in possession of apparatus for reverberation time measurement, using the Neumann Level Recorder, and gave a demonstration at the Ohlstedt Studios. The standard impulse technique is used, with octave or one-third octave band filters as selectors. When a pistol is used at the source, it is necessary for some form of horn loading to be applied in order to preserve the low frequency energy. He is applying the method of statistical determination of reverberation patterns, due to W. Furrer, reference to this being given in Appendix III. By this method, evidence is given of the presence of flutter echoes or "coupled room" effect.

It was mentioned that a new Academy of Music is in course of formation which will include the study of acoustics in music on a broad basis, including some new developments. Dr. Thienhaus may be joining this Academy. This seems to be an advance on the organisation existing in England, where no study of acoustics is made in this connection.

A list of Dr. Thienhaus' publications on the subject is given in Appendix III.

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12. Physikalische-Technische-Reichsanstalt, Göttingen.

Personality: Dr. Grützmacher.

Investigation by:

B.C. Sewell
2nd August.

This laboratory is re-starting its work on primary measurements and standards in acoustics. It will undertake calibrations and performance measurements for

the German Post Office, and also noise analysis and ultra-sonic experiments. The apparatus is not yet complete, since a good deal of the original equipment has been lost.

The apparatus for noise spectrum analysis was in operation. The noise is recorded on a loop of Magnetophon tape and on reproduction the signal is heterodyned with an oscillator and selected by means of an electronic type filter. A pen type recording meter follows, the paper speed being in conformity with the oscillator sweep.

The calibration of a standard Condenser transmitter is soon to be carried out, using the static pressure method. The pistonphone had been used for the lower frequency range at one time, but was not in operation. It was not clear which method would be employed at higher frequencies, but hydrogen atmosphere would be used.

A supersonic generator is in use for experiments in colloidal chemistry, but calls for no special comments.

Dr. Grützmacher gave the following information on interrogation:-

He had no original views to impart on the subject of interpretation (as opposed to technique) of reverberation measurements. He believed that Dr. Schoch had done work on this, reported in Akustische Zeitschrift (4) 1939. It is not specially relevant however.

He did not believe that a flat reverberation characteristic was necessarily desirable, and suggested that the characteristics previously recommended may have been the best obtainable in practice.

On enquiry, he agreed that the method of auditorium or studio construction advocated by Dr. Von Braunmühl and carried into effect at Radio House, Copenhagen, was the most advanced and satisfactory. This treatment had, he believed, been mathematically calculated, at least in the first instance. It consists briefly of a combination of the two forms of damping: flexural damping for low frequencies, contributed by suitably mounted panels, and porous absorption by means of perforations which allow access of sound energy at higher frequencies to the porous material. Drs. Schoch and Kramer were said to have analysed the problem of flexural damping.

He did not consider that there was any future for electro-static loudspeakers for the higher audio frequencies in view of the advances in electrodynamic design (vide Dr. Körsters).

No information was available on stereophony, and we were referred to Dr. Von Braunmühl.

Magnetophon distortion and flutter measurements have been made by Dr. Grützmacher using for the former the apparatus previously described, and for the later a special type of frequency variation recorder described by Dr. Grützmacher and Dr. Lottermoser in Akustische Zeitschrift (4) 1939. This does not appear to have any special advantage over the better known types of American origin. Figures were not available of the results of measurements, but distortion increased at high frequencies, and was not to any great extent dependent on level. The volume range was also limited by the equalization needed to restore the frequency characteristic. Flutter was not thought to be nearly as low as the figure of 0.1% previously given by A.E.G.

Dr. Grützmacher thought that the great virtue of the Neumann Level Recorder was the immediate record obtained. For many types of experimental work this was a great advantage over any photographic method employing a C.R. tube which might otherwise be practicable.

A complete list of Dr. Grützmacher's publications was obtained and is given in Appendix IV.

Dr. Grützmacher has developed a new form of mechanical wave form analyser, operating on a vector principle, which gives an accurate determination of harmonic components and phase angle. It was described in Akustische Zeitschrift (8) 1943. The apparatus has been lost but will be reconstructed when this is possible.

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13. Dr. Georg Neumann,
Berlin - Schoneberg,
Genestrasse, 5.

Investigation by:

P.H. Parkin
2nd August.

Dr. Neumann was in the Russian Zone, but Herr H. Heyda of Friederich Karl Str., 74, Tempelhof, Berlin, who is Dr. Neumann's assistant, was interviewed.

Neumann is now producing an improved version of their level recorder, with a simplified electrical circuit and a more robust clutch mechanism. The price is 3,500 marks, delivery two months. Their only other product is the Neumann and Weber microphone, price 800 marks, delivery two months.

A provisional order for one level recorder and one microphone was placed on D.S.I.R's behalf.

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14. Professor E. Lubke,
Berlin,
Charlottenburg,
Westendallee, 92D.

Investigation by:
P.H. Parkin
3rd August.

Professor Lubke is at present lecturing at the Technical High School, but expects to go to the University at Rostock (Russian Zone) in September. He himself had not done any acoustic work either air or underwater during the war, but two students of his had completed theses on acoustic subjects. These are:-

(1) Vergleichende Untersuchungen von Verfahren zur Messung der Schalldämmung von Wänden und Prüfung des Einflusse der Einspannung dieser Wände auf die Dämmung.

(Von Joachim Thilo)

This paper describes measurements made on transmission through walls and floors, using a microphone housed in a sound-proof box held against the wall or floor to be measured. This ensured that only the sound coming from that particular surface was measured. Detailed corrections to be made for the effect of the box on the microphone are given in the paper.

(2) Beitrag zur Akustik von Kirchen under Sölen.

(Von Albrecht Eisenberg)

This is a comprehensive paper on the reverberation times of many churches and concert halls. An electrical system of measuring articulation had been successfully developed. Three square wave impulses are injected into the room to be measured and the received wave form recorded. From the distortion suffered to the original wave it is possible to calculate quite readily the percentage articulation. Good agreement over a wide range has been achieved, and graphs showing the variation in intelligibility over the area of various halls have been obtained.

Photostat copies of these two theses are being made by Siemens-Halske, and are to be forwarded to D.S.I.R. through F.I.A.T. forward.

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15. Professor Trendelenburg,
Siemens-Halske,
Berlin,
Siemensstadt.

Investigation by:
P.H. Parkin
5th August.

Professor Trendelenburg is at present working for Siemens-Halske, but not on acoustics. Before the war he was responsible, with Thienhaus and

E. Franz, for the well-known multi-channel oscillograph work on the analysis of speech and music. The latest results of this work were published in Vol.5 of the "Akustische Zeitschrift, 1940: An Klangevirung von Klavichord, Cembalo, und Flugel.

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16. Dr. H.J. Von Braunmühl
Bad Homburg,
Guildensollerweg, 44.

Investigation by:

B.C. Sewell,
6th August.

Dr. Von Braunmühl has lost his library and records and is therefore unable at the moment to give a full list of references of his published works. He will provide a list as soon as he is able to do so.

His immediate interest is architectural design for good acoustics, and this and other matters were discussed, from which points emerged as follows:-

He is not fundamentally opposed to a rectangular general shape for an auditorium, provided that the architectural features provide sufficient diffraction.

An instance was given of the Broadcast Studio at Breslau, built in 1939 or 1940, which was considered excellent. He did not consider that flutter echoes were troublesome at low frequencies, and at higher frequencies they were prevented by diffraction as above. When the problem of standing waves was referred to, however, he was unconvincing. It was felt that he was considering the problem from the point of view of a concert audience rather than of microphone pick-up. It should also be noted that he was referring to large rooms or halls.

He was responsible for the designs of the R.R.G. Studios in Berlin and of Königsberg Broadcast Studio. Questioned regarding Copenhagen Broadcast Studio, he stated that this was the work of Dr. Jordan, and represented the most perfect method of reverberation control. The panels in this construction were mostly flat, and depended on air compliance for their stiffness at low frequencies.

Dr. Schoch has written an excellent book on acoustic damping of all kinds. The reference is not available but will be found if possible.

Questioned regarding multi-position reverberation time determination, and statistical examination of departure from the mean value, he agreed that this would give useful information, though he had not considered it before. He also made the point that reverberation time measurements were useless if the decay was not exponential. Non-exponential decay would indicate the presence of echoes or

"coupled room" effect for which the reason and cure would have to be found.

He did not attach much importance to the triple heterodyne oscillator which he has described in his book, but rather to the general principle of intermodulation testing for distortion. This, however, is well known. Siemens made a unit known as the Verzerrungsmessplatz, in which a variable frequency was modulated by 30 cycles. This operates down to 200 cycles. For lower frequencies direct harmonic measurement was the only method.

Dr. Von Braunmühl is a great believer in the value of stereophonic recording of music and broadcast drama. He found two channels adequate, but added a proportion of the signal from a central microphone with each of the side channels to avoid "distant" effect when a soloist was performing. He had adapted the Magnetophon for twin track sterophonic recording, and the performance of "The Mastersingers" at Bayreuth Festival amongst others, had been recorded, and it had been intended to make many such recordings for permanent preservation. He did not consider that any special acoustic conditions were needed for effective reproduction of stereophonic music.

Referring to the Cardioid condenser microphone he stated that there should be no partial failure of back to front discrimination at any frequency, but minor differences were bound to occur between specimens. Super-directional pressure gradient combinations had been used, but were bound to become less sensitive as directionality was increased. The only important use was for very close pick-up.

He stated that Magnetophon harmonic distortion for a given flux modulation was independent of frequency. This statement must, however, be considered in the light of the necessary equalisation required in reproduction. The total harmonic distortion was stated to be under 3%.

Dr. Von Braunmühl emphasised the virtues of the "Wide Band Loudspeaker" produced by Konski and Krüger, Chausee Str., 117, Berlin, N.4. (Dr. Eckmiller). He believed the power input to be limited to 4 watts at present, however, Germany is quite out of touch with the electro-dymanic speaker development in America and England.

TS/ML

APPENDIX I.

Publications by Professor Dr. Erwin Meyer

Reactance of Medium on Resonant Diaphragms

Ann.d.Phys. Vol. 71., p.567. 1923.

Two examples of Two Dimensional Representation of Electrostatic Lines of Force.

Math.Ann. 1924.

Stereo Acoustic Reproduction.

ETZ Vol. 46. p.805. 1925.

Damping Factor on Ear Resonators.

Naturwiss. Vol. 13. p.268. 1925.

Tests on Loud Speakers.

ENT Vol. 3., p.280. 1926.

Sound Field Measurements.

Zs.f.techn.Phys. Vol. 7 p.609. 1926.

As Appendix IV No.2.

Non-Linear Distortion in Loud-Speakers and Telephones.

ENT. Vol. 4 p.509. 1927.

Measurement of Particle Velocity and Pressure Amplitude in Sound Fields.

ENT. Vol. 4 p.86. 1927.

Measurement of the Intensity Ratio of the Tonal Scale used in Qualitative Ear Measurements.

Zs. f Hals-, Nasen- u. Ohrenheikunde, Vol. 19 p. 316. 1927.

Simple Method of Automatic Sound Analysis Combined with Measurements of Non Linearity in Carbon Microphones.

ENT. Vol. 4 p.398. 1928.

Measurement of reverberation time and sound absorption

ENT. Vol. 5 p.293. 1928.

Measurement of total sound energy emitted by sound radiators.

Zs. f. techn. Phys. 10.
P. 309-316. 1929.

Frequency responds of pick-ups and sound-boxes.

ENT. Vol. 6 p.264. 1929.

The principle of the Kathodophons.

ENT. Vol. 6. p.17. 1929.

Measurement of sound absorbent material.

TFT. Vol. 18 P.40. 1929.

Instrument for the measurement of sound insulation.

Schalltechn. Vol.2, p.33 1929.

Measurement of sound insulation and absorption

Z.VDI Vol. 74 p.273. 1930

Measurement on sound insulating materials.

Schalltechn. Vol.3 p.23. 1930.

Optical measurements on records.

ENT. Vol.7 p. 147. 1930

Automatic reveberation measurements.

Zs. f. techn. Phys. Vol.11. p.253. 1930

Threshold measurement with the Beat-Frequency Oscillator.

Zs. f. Hals-, Nasen u. Ohrenheilkunde
Vol. 27 p. 416. 1930

Sound insulation of single thickness walls.

Ber. d. Pr.Adk.d.Wiss.Phys.-Math.
Vol. 9. p.1. 1931.

Prevention of undesired noise transmission in Skyscrapers.

Z. VDI Vol. 75 p. 563. 1931.

Frequency spectrum of needle hiss.

ENT. Vol.8. p.218. 1931.

Frequency spectrum of musical instruments.

Zs. f. techn. Phys. Vol.12 p.606. 1931.

Noise and sound analysis.

Proc. of the Phys. Soc. p.53. 1931.

Frequency spectrum of musical instruments.

Ber.d.Pr.Akad.d.Wiss.Phys. Math.KI.XXXII, p.1. 1931.

Sound properties of glass.

Glastechn.Ber. Vol.10 p.200. 1931.

Acoustic measurement on ply-wood.

Sperrholz. p.135. 1932.

Sound absorption of porous materials related to the angle of incidence and frequency spectrum.

Ber.d.Pr.Akad.d.Wiss.Phys. Math KI. XXVI. p.1. 1932.

Magnetic sound recording on steel.

Zs.f.techn.Phys. Vol.13. p.593. 1932.

L'utilisation de l'electricite pour la lutte contre le bruit.

Comptes rendus du congres international de l'électricite Vol.13.p.159. 1932.

The toll of bells.

Naturwiss. Vol.21 p.697. 1933.

Properties of wood-panelled auditoria.

Zs.f.techn.Phys. Vol.14.p.500. 1933.

Report on progress in acoustics 1930-1933.

Die Physik Vol.2. p.97. 1934.

4.

Vibrational transmission of sound in structures.

Z.VDI. Vol.78 p.957. 1934.

Spectroscopic sound analysis (Diffraction-grating).

Zs.f.techn.Phys. Vol.15 p.630. 1934.

A Method for very rapid analysis of sound: Sound Grating Spectroscopy.

Journ.of Acoust.SocAm. Vol.7 p.88. 1935

Log. Valve Voltmeter and its use in acoustics.

ENT. Vol.12 p.37. 1935

Reverberation of auditoria and sound absorption through the audience.

ENT. Vol.12 p.213. 1935.

Variations in the resistance of thin carbon layers.

ENT. Vol.12 p.237. 1935.

Electro-dynamic vibration pick-up and its use in the examination of vibrations in structure.

ENT. Vol.12 p.404. 1935.

Multi-layer walls as acoustic filters.

ENT. Vol.12 p.393. 1935.

Sound absorption of non porous vibrational materials.

ENT. Vol.13 p.95. 1936.

Physical properties of electric acoustic hearing aids and audio-phones.

Zs.f.Hals-,Nasen-u. Ohrenheilkunde. Vol.40 p.278. 1936.

The activities of the Institute for Schwingungsforschung at the Technical High School, Berlin.

Forschg.a.d.Geb.d.Ing.Wes. Vol.7 p. 248. 1936.

APPENDIX II.

Publications by Dr. Korsters.

Standardisation of Microphone Measurements.

Akust. Zeit. Special Edition, 1938.

Noise Level Chart of a Berlin District.

Akust.Zeit. Vol. 3. 1938. p.310.

Noise Measurements on Looms.

Zentralblatt fur Gewerbehygiene and Unfallverhutung. 1939. p.30.

Publications of the Committee for the Prevention of Noise in Industrial Undertakings.

Akust.Zeit. Vol. 4. 1939. p.352.

Subjective and Objective Noise Measurements.

Verhandlungen der Deutschen Physikslischen Gesellschaft. 1940. vol. 41 p.48.

Fundamentals of Applied Acoustics.

Students Handbook. Beuth-Verlag, Berlin. 1941.

APPENDIX III

Transient Phenomena on Organs.

F. Trendelenburg, E. Thienhaus and E. Franz.

Akust. Zeitschr. 1 (1936) S.59.

Transmutations on Organs.

F. Trendelenburg, E. Thienhaus and E. Franz.

Akust. Zeitschr. 3 (1938) S.7.

Tonal Effects of Klavichord, Cembalo, and Grand Piano.

F. Trendelenburg, E. Thienhaus and E. Franz.

Akust. Zeitschr. 5 (1940) S.309.

Two Channel Stereophonic Transmission Systems.

E. Thienhaus.

Akust. Zeitschr. 6 (1941) p.34.

Transient Recording with the High Speed Level Recorder by Neumann.

M. Gosewinkel.

Akust. Zeitschr. 7 (1942) p.104.

APPENDIX IV.

Publications of Dr. Martin Grutzmacher.

1. Dielectric Consta.ts of Liquid Mixtures.

   M. Grutzmacher.

   Zeitschrift fur Physik, Vol.28 1924 p.34

2. Registration of Response Curves of Telephone and Loud Speakers.

   M. Grutzmacher, E. Meyer.

   Elektr. Nachrichtentechnik, Vol.4. 1928. p.203-211.

3. New Method of Sound Analysis.

   M. Grutzmacher.

   Elektr. Nachrichtentechnik, Vol.4. 1927. p.533-45,
   Also published i.Auzz.i.d.Zs.f.Phys. Vol.8. 1927. p.506.

4. Bandwidth, Phaseshift and Distortion and Long Distance Cables.

   M. Grutzmacher.

5. Sound Analysis with the Single Fibre Electrometer.

   M. Grutzmacher.

   ZA f.techn.Phys. Nr.11, 1929. p.569.

6. Noise Analysis.

   M. Grutzmacher.

   ZS f.Phys. Vol.10. p.569.

7. Distortion in Long Distance Cables.

   M. Grutzmacher.

   Tel.u.Fernspr. Techn., 1939, p.143-148.

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8. Carbon Microphones.

M. Grutzmacher and P. Just.

ENT., 1931, p.104-114.

9. Fourier Analysis of Modulated High Frequency Current.

M. Grutzmacher.

ENT., 1931, p.476-480.

10. Commercial Bridge Measurements of Impedance and Phase Angle in A.C. Circuits.

M. Grutzmacher.

Telegr.u.Fernspr.Techn. Vol.2. p.27-29.

11. Maximum Mutual Loading Factor in Trunk Lines.

M. Grutzmacher.

E.F.D. Vol. 35, 1934, p.90-93.

12., Tuning of Grand Pianos.

M. Grutzmacher, and W. Lottermoser.

Physikal.Z., p.903, (1935) Vol.36.

13. Investigation on Grand Pianos.

M. Grutzmacher, and W. Lottermoser.

Akust. Zeit. Vol.1 (1936) p.49.

14. Inertia Free Recording of Melody Curves.

M. Grutzmacher, and W. Lottermoser.

Akust. Zeit.Vol.2 (1937) p.242.

contd. APPENDIX IV.

15. The use of the Pitch Recorder in Mathematical, Phonetic and Musical Problems.

M. Grutzmacher and W. Lottermoser.

Akust. Zeit. Vol. 3. (1938) p.183.

16. The Recording of Small Variations in Pitch.

M. Grutzmacher and W. Lottermoser.

Akust. Zeit. Vol. 5 (1940) p.1.

17. Pitch Variations in Singing, Speaking and Musical Performance.

M. Grutzmacher.

Schriften d. Sing. u. Sprachkultur Vol.1 p.49

18. Mechanical Harmonic Analyser and new Representation of Mathematical Analysis.

M. Grutzmacher.

Akust. Zeit. Vol.8 (1943)

M. Grutzmacher co-author in the following books:-

Handbook on Telephone Engineering.

Keehlrausch Praktische Physik (Leipzig) Ed.18. Aufl. Abschnitt "Akustik".

HAMBURG RADIO

STUDIO I

Dimensions

Breadth 46 ft. Length 70 ft. Height 32 ft. 6 ins.

Floor Area 3723 sq.ft. End wall Area 1463 sq.ft.
Side Wall Area 2184 sq.ft.

Volume: 11,400 cu.ft.

Acoustic Treatment

Smooth Plaster	86 sq. ft.	
Rough Plaster	678 sq. ft.	
Cellotex Board	6574 sq. ft.	
Plywood Panelling	1937 sq. ft.	- Thickness 0.3 inches
Glass	1678 sq. ft.	
Draperies	1474 sq. ft.	
Linoleum	1711 sq. ft.	
Wood Floor	3723 sq. ft.	

HAMBURG RADIO

STUDIO II

Dimensions

Breadth A-B 21 ft. C-D 32 ft. Length 33 ft. 17 ft. Height 15 ft. 6 ins.

Floor Area 1237 sq.ft. End Wall Areas 1 x 323 sq.ft. 1 x 484 sq.ft. Side Wall Area 2 x 753 sq.ft.

Volume: 19,240 cu.ft.

Acoustic Treatment

Smooth Plaster	1775 sq.ft.
Building Board	839 sq.ft.
Plywood Panelling	344 sq.ft. - Thickness 0.3 inches
Absorption Panels	35 sections - 822 sq.ft. each
Glass	283 sq.ft.
Draperies	710 sq.ft.
Wood Floor	1237 sq.ft.

HAMBURG RADIO

STUDIO III

Dimensions

Breadth A-B 20 ft.	Length 18 ft.	Height 15 ft. 6 ins.
C-D 18 ft.	3 ft.	11 ft.

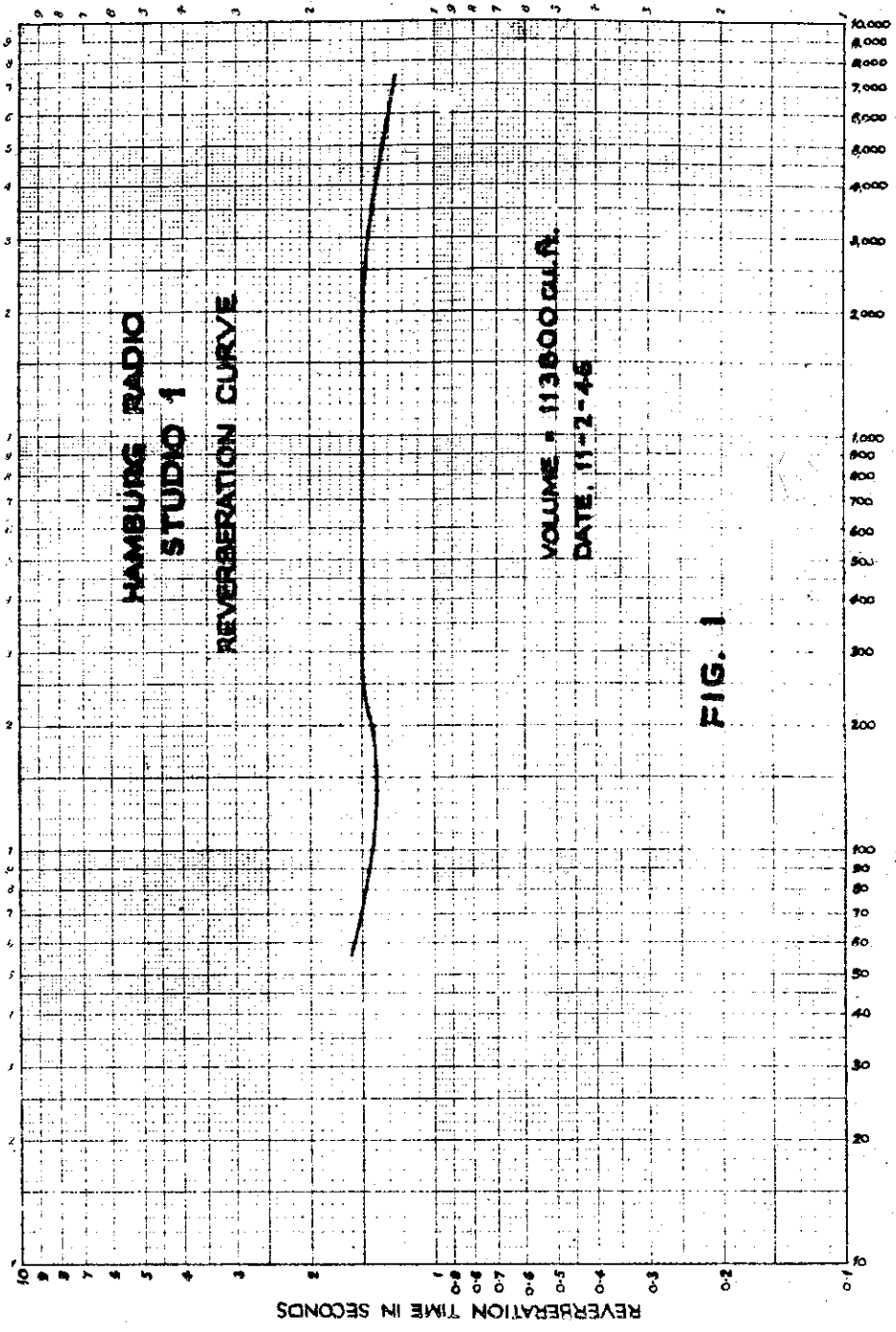
Floor Area 420 sq.ft. End Wall Areas A = 2 x 317 sq.ft.
Side Wall Areas B= 2 x 323 sq.ft.

Volume: 7,484 cu.ft.

Acoustic Treatment.

Smooth Plaster	586 sq.ft.	
Wood Panelling (Pine)	920 sq.ft.	- Thickness 1 inch
Carpet - Velour	301 sq.ft.	
Glass	167 sq.ft.	
Draperies	118 sq.ft.	
Wood Floor	366 sq.ft.	

8 - 8 - 46.


HAMBURG RADIO
STUDIO 1
REVERBERATION CURVE
VOLUME = 113600 CU. FT.
DATE, 11-2-46
FIG. 1
REVERBERATION TIME IN SECONDS
FREQUENCY IN CYCLES PER SECOND