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ITEM Nos. 7 & 9

SOUND RECORDING, REPRODUCING AND OTHER ELECTRO-ACOUSTIC TARGETS

B/TK/283

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BRITISH INTELLIGENCE OBJECTIVES SUB-COMMITTEE

LONDON—H.M. STATIONERY OFFICE

SOUND RECORDING, REPRODUCING
AND OTHER ELECTRO-ACOUSTIC TARGETS.

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INSTRUMENT PANEL, MINISTRY OF SUPPLY

R.A.T. PARTY NO.43

BIOS. Target Numbers See
Sections. I, II, III & IV.

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INTRODUCTION

This report covers investigation into several aspects of the production of Sound Recording, Reproducing and other Electro-Acoustic Equipment.

The investigation covered the following:-

- Section 1. The German Gramophone Record Industry.
- " 2. Tefi Sound Recording & Reproducing System.
- " 3. Report on Georg Neumann and Eugen Beyer.
- " 4. The Neumann Damping Recorder.

The Magnetophon Sound Recording and Reproducing System is the subject of a separate report and can be obtained from the Stationery Office. (BIOS. Final Report No. 951)

SECTION I

THE GERMAN GRAMOPHONE RECORD INDUSTRY

Report by R.A.T.43 - December, 1945

Factories visited:

C7/533. C9/726.	Carl Lindstrom A.G., 27, Schlesische Strasse, BERLIN, S.O.36. (in the American Sector)	Manager:	Mr. W.Schiele
C7/534. C9/724.	Deutsche Grammophon, Podbielski Strasse, HANNOVER. (in the British Zone)	Managing Director: Manager: Works Engineer:	Mr. Haertel Mr. Blanke Mr. Schmidt

Prior to 1939, Carl Lindstrom A.G., manufactured 75% of the gramophone records pressed in Germany, whilst Deutsche Grammophon were the second largest concern. Carl Lindstrom, owned by The Gramophone Company, of England, made discs which were recorded by Odeon and Electrola; Deutsche Grammophon made discs recorded by Polydor, Die Stimme seines Herrn, Brunswick and Siemens.

Carl Lindstrom A.G.

The visit to the Lindstrom Factory showed that about 80% of the works and office buildings are damaged by war action, principally by fires.

The office building is about 75% useful, the basement being used as a recording laboratory. The Matrix Plating Department is badly damaged although the basement has been cleared and a number of plating baths installed.

The Wax Shaving, Chemical Laboratory and Power Transformers are in a separate building which is in fair condition, but the packing and Despatch Department, Canteen and Rest Rooms are badly burned. The Matrix Stores are partially damaged but there are a large number of "mothers" and matrices still in good condition.

The Boiler House and automatic stokers for raising steam for record pressing are in good working condition. The chimney has received damage but is quite operable.

The main Record Factory building is badly damaged by fire, but the basement and ground floor are usable. A number

of record presses have been reclaimed from the damage and assembled to make a battery in this basement. The remainder of the basement is taken up with record material crushing, grinding, sifting and weighing apparatus, all of which is practically undamaged and ready to run.

During the war the record material has consisted largely of broken up records which have been returned from the public. These have been mixed with about 10% of synthetic plasticiser. There are sufficient stocks of old records and mixing materials to manufacture immediately a million records, whilst there are considerable further stocks of materials in stores near the factory.

There are at present 58 employees (51 men and 7 women) who are principally engaged in reclaiming machinery and material in preparation for small production of gramophone records.

A permit to commence the actual pressing of quantities of records was expected shortly from the Control Authorities in Berlin.

After allowing for sufficient plant to be retained at the Lindstrom Factory to satisfy adequately the production planned for the next twelve months, the investigator prepared a list of items of plant for record manufacture which were considered to be useful to the British gramophone record industry for home and export record requirements. (Appendix I Page 26)

Deutsche Grammophon

A visit to the factory showed that about 50% of the premises was badly damaged by bombing and fire, the principal damage occurring in the Record Pressing building. The offices and Recording Laboratory are almost undamaged, whilst the building housing the milling, mixing and rolling plant is little damaged.

Ten record presses have been equipped satisfactorily in a small building where they are in small scale operation.

In the Recording Room there is a Neumann type recording machine with amplifiers in good operating order, together with one model H.T.S. Magnetophon Portable Type Recorder. (Further details of this device are given in a separate report by R.A.T.43 entitled "The Magnetophon Sound Recording and Reproducing System.")

contd.

The plating baths are in working order and there is also a special vacuum silver evaporation plant installed by Siemens for silvering recorded waxes. (Described in later paragraph).

There are sufficient stores of scrap records and synthetic plasticisers to manufacture about a million records.

A feature of the materials grinding plant is a large Rohrmühle for "tumbling" the materials with a few tons of small steel billets, the finely powered materials being extracted by air suction.

The steam and power supply are in good operating order but there is a serious shortage of fuel, and the factory are proposing to work during alternate months of the coming year.

There are at present 90 employees and the output of records is about 4,000 on each working day.

The records are principally sold to members of the British Army of Occupation, the Control Commission and other services.

This factory turned out, since the occupation, a number of pressings of speeches of Nazi leaders, many of which were dubbed from Magnetophon tapes, for the purpose of producing evidence at the Nuremberg war trials.

The control of output of this factory is operated by the British Control Commission, Econ 14, at Hannover.

The Siemens Process of silvering recorded waxes is the work of Dr. Deuhme of Siemens. It consists essentially of an evacuated chamber in which the record waxes are exposed to silver vapour for a short time, the vapour being formed by boiling silver billets in a molybdenum boat which is heated by the passage of heavy current at low voltage. The wax face is not exposed until the vapour has been fully generated, when a screen is withdrawn and the vapour is allowed to become deposited on the recorded grooves on the face of the wax. The vacuum is stated to be of the order of 10^{-5} mm. of mercury. It was stated that the advantages arising from the use of this process as compared with other known silvering processes are a reduction in surface noise and a greater vitality of response in the region of 10,000 c.p.s., the improvements being more noticeable towards the centre of the disc. It is alleged that the deposit of silver particles is more even and with less "clumping" than with other known methods.

The investigator prepared a list of items of plant for record manufacture which were considered to be useful to the British gramophone record industry for home and export record requirements. (Appendix I Page 26).

Conclusion

The German Gramophone Record Industry has been very badly stricken by war damage, it being reduced to approximately 10% of its pre-war potential, particularly in respect of record presses and good quality record materials.

There did not appear to have been any development work or technical progress made in the German gramophone disc record industry since the outbreak of war.

Almost every recording studio and hall in Germany, especially in Berlin, have been destroyed. Provided that artistes and a few acoustically-good recording studios are made available to the industry there would appear to be nothing to prevent the building up of a small gramophone record industry, possibly 2,000,000 records in a year, in Germany, dependent upon the amount of plant which is left after Reparations adjustment and the quantity of fuel and power available.

SECTION II

THE TEFI SOUND RECORDING AND REPRODUCING SYSTEM

Report by R.A.T.43 - December, 1945

Factories visited:

C7/535.

C9/717.

Tefi-Apparatebau Dr.Daniel, K.G.,
Porz, nr. Cologne.
(in the British Zone)

Inventor, Owner
and Manager: Dr.Daniel.

and at

Business
Manager: Mr.Brunswicker.

1, Martin Strasse,
Dieringhausen, nr.Gummersbach.
(in the British Zone)

The Tefi System consists briefly of sound recording by lateral cut tracks on a flexible band which may be reproduced by passing the band under a needle held in a pickup.

The Porz Factory was badly blitzed towards the end of the war and the Tefi plant was removed from Porz to Dieringhausen early in 1945. The Dieringhausen Factory was itself badly damaged by bombing in the spring of 1945, and the damaged Tefi plant was being returned to a less damaged factory at Porz at the time of the investigation.

Tefi was invented and the special plant designed and built up by Dr.Daniel himself, who was keen to discuss his product.

The Tefi System has different forms, such as, dictaphone, telephone message recorder and home entertainment apparatus, using band sound records, there being a lateral cut sound track upon a flexible cellulose endless band, the band carrying a number of consecutive grooves forming a continuous sound track.

Machines such as dictaphone and home recording mechanisms cut their sound tracks by means of a simple recording head using a steel or sapphire cutter on cellulose acetate band, the play-back being an ordinary type of lightweight pickup using a sapphire needle. The cellulose acetate band is similar to that used for 35 mm. photographic film, the sound waves being cut into the surface of the film. This may be played back several times without appreciable wear, but it is primarily for speech frequencies. One hundred sound tracks may be cut upon either side of the band, the length of which may vary between 2 metres and 50 metres, but the velocity of band is standardised at 45.6 cm. per second. The maximum playing time for a 50
/metre

metre band is six hours.

The system used for domestic reproduction of music is more elaborate, being on the general lines of disc recording but utilising band instead of shellac discs, as is described hereunder.

The original sound recording is carried out by microphone, amplifier and wax cutter head, the latter being the Neumann moving iron type with steel cutter, 2 mm. diameter, lapped with 0.03 mm. radius tip, the frequency range covered being from 50 to 6,000 c.p.s.

The recording wax is made from wool fat spread on an endless cellulose acetate flexible band for 10 or 15 metres long and 0.7 mm. thick, the spreading being done by hot pouring and the point of overlap at the two ends of wax being smoothed by hand.

The flexible waxed band passes over drums without cracking the wax and is recorded upon at a velocity of 45.6 c.m. per second - the same velocity as used for sound on motion picture films. The 35 mm. wide band is divided down the centre longitudinally to provide two recording channels each about 17 mm. wide.

The cross section of sound groove is approximately the same as for ordinary disc recording, and the cutter is fed across the face of the wax producing a series of 28 music grooves on one of the two above mentioned channels, the recording time being about 15 minutes. A separate item of music is then recorded on the second channel for a further 15 minutes.

The recorded band is cut diagonally, location marks having been impressed into the edges of the wax on each side of the cut. The band is then covered with a thin deposit of silver in a vacuum chamber followed by immersion in a copper plating bath for production of a flexible copper "master", which is stripped away from the silvered wax. In a similar manner a "mother" tape is grown and a matrix from the "mother". The matrix is of thin copper with a steel backing for strength.

The tape which is used for the finished band record is made of polyvinyl chloride supplied by I.G. Farben. A length of, say, 15 metres of this tape is pre-heated to a

temperature at which the tape will take a moulded impression, and the matrix and tape are rolled under pressure round a fly-wheel of about one metre diameter, the pressure being applied by means of a spring-loaded pressure wheel. The matrix and tape continue round half a turn of the heavy flywheel in intimate contact with each other, after which they separate, the matrix and band being wound up on separate spools. The temperature of the band has dropped to the solidifying point just before the matrix is separated from it.

The method of joining the band after pressing is briefly as follows:-

Before cutting the recorded wax loop, a short piece on each side of the proposed jointing place is immersed in a plating bath and a short stamper is made. The two ends of P.V.C. band are trimmed diagonally at the extreme ends of the sound tracks and butted together under pressure at about 80°C. A hand engraving tool is then used to join up each of the sound tracks as carefully as possible, after which the portion of jointed band between the location marks is warmed up and stamped with the short stamper mentioned above. In this way it is stated that a perfect sound track joint is made.

A demonstration of the Tefi apparatus in its most recent form gave a quality of reproduction approximately equal to that of an ordinary domestic disc record player.

The endless band is wound on a special spool in the reproducing machine, a loop of the tape being brought out to a driving pulley and tracked underneath the reproducing needle of a lightweight pickup, which is connected electrically to a suitable amplifier and loudspeaker. The band is drawn by the driving pulley from the centre of the spool, over the driving pulley and back to the outside of the spool. In this way a remarkable constancy of speed and freedom from "wows" are achieved, although at any instant the whole of the 15 metres of band is in motion, each turn on the spool sliding gradually over its neighbour. The noise of the turns of the film rubbing against each other is noticeable unless the film carrier is well enclosed. The Tefi concern market their bands in a readily handled cassette measuring about 5 inches square and 2 inches thick in order to minimise the extraneous noise.

A playing time of 15 minutes is sufficient to reproduce most of the movements of opera without interruption, but it is possible to record, say, half-a-dozen musical items

on one band, and in order to be able to pick out a desired musical item or a portion of an opera movement a pointer is arranged on the reproducing machine to slide over an indicating scale, the pointer being geared to the reproducing pickup so that it indicates the exact position of the needle across the band. A quick cross-reference can be made between the indicated position and the musical item recorded.

The principal advantage of the Tefi system of domestic record production over the existing disc system appears to be the long playing time of 15 minutes.

A list of British and German Patents on the Tefi Apparatus is shown at Appendix II (Pages 29 and 30).

contd.

SECTION III

C7/480.
C9/1069.

Report on Georg Neumann and Eugen Beyer

C7/536.
C9/1195.

Berlin on 8 December 1945.

Neumann's factory in Berlin (Michaelki-Strasse) has been completely destroyed. He has another factory in Thuringia (Russian Zone) in fairly good order with some plant, and he hopes to be able to get this transferred to Berlin to start operations in part of the factory of Mix and Genest in the British Sector.

Beyer is in Bavaria (American Zone) and hopes to get permission to start operations there.

No samples of Neumann's products are available and very little technical or other data. It appears that little development has taken place in disc recording or reproducing equipment except for a light-weight pick-up, but that some work has been done on microphones and loudspeakers.

Disc recording machines. Types previously manufactured were 78 r.p.m. only, for wax or acetate. No stocks are available; Neumann will possibly recommence manufacture, and machine will be capable of recording at either 78 r.p.m. or $3\frac{1}{3}$ r.p.m.

Disc recording heads. Well-known type in rectangular case had been superseded by a slightly improved type (moving iron) in a case with a rounded top. No stocks or samples available.

Disc Reproducing heads (pick-ups). A new pick-up had been developed, of the dynamic type, for which a very high standard of performance was claimed, both as regards frequency response and freedom from distortion. This had been achieved in part by reduction in mass of the armature. No stocks available. Technical data and samples were asked for.

Wax shaving machine. Neumann had no further improvement to offer on the wax shaving machine as previously known, a sample of which is in operation at Radio Hamburg. The turntable is weight driven and the cutterhead is moved across the face of the wax by a weight drive, the feed being controlled by an adjustable oil dash-pot system. The turnings are removed by ordinary suction means. No stock is now available, but may be manufactured later. Pre-war price 2,300 marks.

Microphones

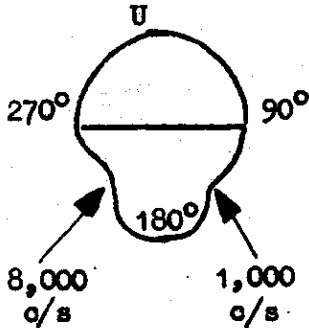
- (a) The well-known Neumann condenser microphone, with pre-amplifier, as manufactured pre-war has been continued with slight improvements to the amplifier, but a further development of this, described in a technical paper by Dr. W. Weber, is of interest. Briefly, the model in question has two diaphragms on either side of a central electrode thus forming a 3-element condenser. By means of a switch in the base of the microphone body either one or both sides of this 3-element condenser are connected to the pre-amplifier. In the former case the horizontal polar diagram is a cardioid (i.e. markedly directional) whilst in the latter it is circular over the majority of the frequency range (i.e. omni-directional). The frequency response range (+ 2 db) was stated to be 30 - 10,000 c/s. No stocks are available
- (b) A very small condenser microphone (12 mm. diameter) has been developed which is said to have a very high standard of performance and to have been designed primarily for calibration purposes, use with Pegelschreiber, etc. No stocks are available.
- (c) Herr Eugen Beyer demonstrated a moving coil microphone of his manufacture, known as Type 19B, which he said was roughly equivalent to the dynamic microphone made by Western Electric. It is intended to be used in a vertical position which gives it a circular horizontal polar diagram. It has a reflecting screen within the case and is effective out of doors when fitted with a windshield. It appeared to be of robust construction.

Other data was as follows:-

Impedance - coil wound to give a d.c. resistance of 200 ohms; no transformer included.

Sensitivity - 0.1 to 0.15 mV per μ bar at 200 ohms.

Frequency Response - ± 3 db from 50 to 10,000 c/s
Polar Diagram - Horizontal: circular
Vertical: circular for frequencies up to 1,000 c/s, slight deviation at 8,000 c/s and over.



No further details or stocks available.

- (d) Beyer said he had, during the war, worked on microphone for use in aircraft. These were of two types, the laryngophone and a type to be used in an oxygen mask. He claimed that his laryngophone had proved better than the corresponding American and British articles. The oxygen mask type was capable of giving good quality even at great heights where quality usually deteriorates due to the reduction of air pressure. He had no samples available.

Pegelschreiber. According to Neumann there had been no developments in this since the war. He thought he had parts available to make up one or two, which might be done within the next few months. A technical write-up on this (in German) has been obtained from Radio Hamburg and is contained in B.I.O.S. Library.

Loudspeakers. Both Neumann and Beyer mentioned a high-grade loudspeaker designed by Eckmiller of R.R.G. and manufactured by Konski and Kruger, Chaussee Strasse, 117, Berlin, N.4.

Headphones. Beyer said he had been manufacturing moving-coil earphones.

Addresses. The following addresses of firms manufacturing recording materials before the war:- were given:-

Acetate discs and flexible discs (as used by R.R.G.)
known as DECELIT -

Deutsche Celluloid Fabrik
Eilenburg, Saxony (Russian Zone)

Sapphire-tipped cutters -

Hage Diamant Fabrik
Wilhelmstrasse, Berlin

(also Moser, Biel, Switzerland)

Montan Wax -

Herr Wilke
1 and 2 Kolonie Strasse
Reinickendorf
Berlin N.

SECTION IV

The Neumann Damping Recorder

30 to 20,000 Hz.

Rel mse 124a.

1. Scope of Application
2. Electrical Values
3. Operation and Construction
4. Instructions for use
5. Accessories, Measurements
and Weights

Siemens & Halske A.G.,

G7/211.
9/98.

Wernerwerk for Amplifier Apparatus

Berlin-Seimensstadt

January, 1942

1. Scope of Application

The damping recorder, Rel mse 124a (Fig.1) is an exceptionally simple and reliable device for the logarithmic recording of voltage values. It is particularly suitable for electro-acoustic measurements. The apparatus is used for determining voltage differences in sound frequency generators such as receivers, microphones, etc., especially for recording changes in time when the frequency remains constant, but it also has accessories for recording changes dependent on frequency. By using various potentiometers, measurements can be made either in decibels or nepers (e.g., degrees of amplification of amplifiers). With calibrated microphones, measurements of the sound field (loud-speaker testing, resonance measurements, etc.) can be made.

When certain definite conditions are present, the apparatus can also be used as an automatic regulating unit, especially for acoustic measurements. Details of this use will be given in description Rel besche 1017 "Messplate fur elektroakustische Gerate".

2. Electrical Values

Frequency range 30 to 20,000 Hz

Range of voltage measurements

With Pot.	Tz1	(approx. 10 mV to 120 mV)	...	0 to 2.5 N
"	"	Tz2 { " 10 mV to 1.5 V }	...	0 to 5.0 N
"	"	Tz3 { " 10 mV to 18 V }	...	0 to 7.5 N
"	"	Tz4 { " 10 mV to 180 mV }	...	0 to 25 db
"	"	Tz5 { " 10 mV to 3.1 V }	...	0 to 50 db
"	"	Tz6 { " 10 mV to 56 V }	...	0 to 75 db

Probable error at 1000 Hz $\pm 2\%$ of the full deflection corresponding to ± 1 mm on the scale.

e.g., in voltage measurements and with potentiometers Tz 1 or Tz 4 ... 0.05 or 0.5 db
 p% fluctuations in the voltage of the system p%

Frequency of recording from 30 to 10,000 Hz ± 1 db
 from 10,000 to 20,000 Hz - 3 db

Input resistances

at 1000 Hz	...	...	...	...	40 k  $\pm 10\%$
at 20,000	...	...	...	...	30 k 

Minimum input voltage approx. 10 mV

Time of indication from 0 to max. value recorded at 50 cycles per second ... approx. 150 ms

Paper speed at 50 cycles per second ... 50, 10 & 1 mm/s

Supply mains:

Supply frequency 50 Hz

Supply voltage A.C. 110, 125, 150, 220 and 240 V

Power consumption approx. 35 Watt
 Fuse (out out) for 110 to 150 V: 600mA
 for 220 and 240 V: 300mA

3. Operation and Construction

The circuit of the damping recorder (Fig.1) represents an arrangement of amplifiers, the alternating input of which is adjusted to a constant value by automatic regulation of the input potentiometer and in which the setting of this potentiometer serves as a measure of the input voltage.

The alternating voltage applied to the potentiometer P , is conveyed to the amplifier by the sliding contact K , amplified by two valves AC2 and rectified by a valve AC2. The continuous current as grid bias controls the first of the two end valves RE 134 working in opposed rhythm.

In these the adjustment of the grid voltage is so chosen that when the A.C. grid voltage in the rectifying valve increases, the anode current in the first regulating valve falls and in the second increases. These anode currents flow through the corresponding fixed coils S_1 and S_2 which enclose an iron disc M_1 revolving

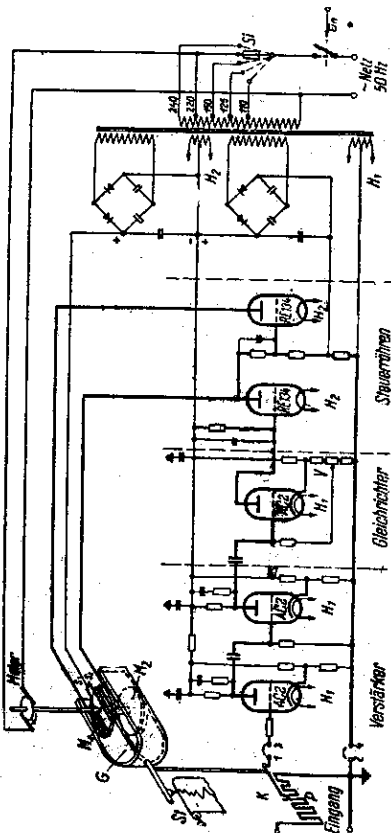
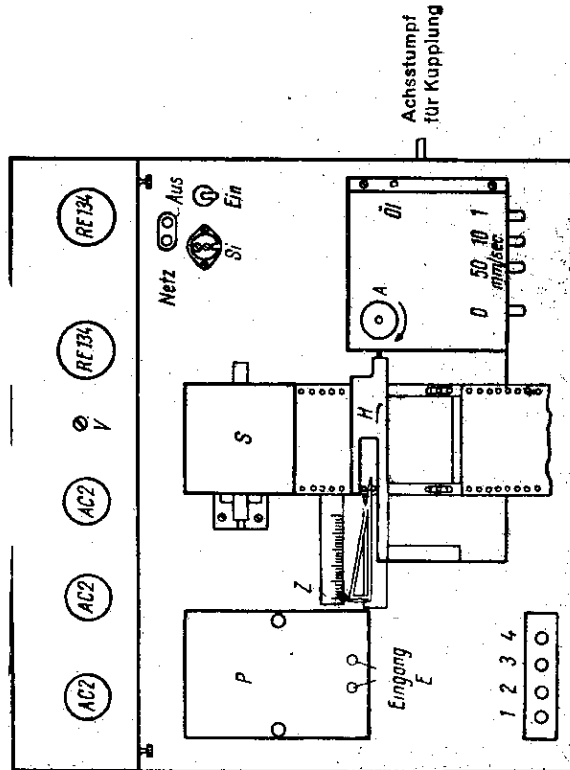


FIG: 1

Schaltung



Ansicht

FIG: 2

timually in a clock-wise direction. M_1 is fixed to the shaft of a synchronous motor. The disc M_1 along with a second disc M_2 is enclosed in an iron fork G which moves easily in a horizontal direction and the shaft of which is rigidly connected with the sliding contact K of the potentiometer P, a style St and the pointer Z for the indicating scale. The magnetic fluxes emanating from the two coils S_1 , S_2 is closed by the iron disc M_1 the shaft, the iron disc M_2 and the prongs of the fork G. If I_a in $S_1 > I_a$ in S_2 , that is to say, if the input voltage increases, the coil S_1 magnetises more strongly that part of the iron disc M_1 which is on the left in Fig. 1, so that the left prong of the fork is attracted by the disc. As the disc revolves, the fork is moved sharply to the right. If, on the other hand, I_a in $S_2 > I_a$ in S_1 that is to say, in the case of a very small measuring voltage of, for example 8 mV, then the coil S_2 magnetises only the right half of the disc. The right prong is attracted and the fork moves quickly to the left to the beginning of the contact path. The fork comes to rest only when as a result of the automatic regulation, i.e. the regulated increase or decrease of the initial voltage through the potentiometer contact connected with the fork, the current in S_1 and S_2 are equal. The new setting of the potentiometer is a measure of the applied voltage. Its fluctuations are recorded by the style St on the wax-coated recording paper.

The recording time of the style is very short. It is determined mainly by the peripheral speed of the coupling discs $M_1, 2$ and the length of the scale, that is to say, the path traversed by the style. As the driving motor makes 180 revolutions to the minute, and the discs $M_1, 2$ have a diameter of 4 cm., their peripheral speed is 37.8 cm/s, thus, for a scale of 5 cm. (width of the available space between the perforations on the waxed paper) the recording time for the maximum traverse from the beginning to the highest value indicated is 132 milliseconds. This is increased by the electric time constants of the single switch elements and a slight slip between the coupling discs and fork prongs to 150 milliseconds. The speed of recording is thus approx. $\frac{5 \text{ cms}}{150 \text{ ms.}} = 33.3 \text{ cm/s}$ and is independent

contd.

of which of the three potentiometers, 25, 30 or 75 db is used. On the 50 db scale this represents $\frac{50 \text{ db}}{150 \text{ ms}} = 333 \text{ db/s}$ that is

to say, the pointer requires, in order to follow a sudden change of 18 db for example $\frac{18 \text{ db}}{333 \text{ db/s}} = 55 \text{ milliseconds}$. Thus,

only those changes are correctly recorded where the velocity of the change is less than the writing speed of the damping recorder. Thus, for example, a peak with a maximum value of 18 db and a duration of 140 milliseconds (rise and fall each 70 ms) will be correctly recorded, as the velocity of change $\frac{18 \text{ db}}{70 \text{ ms}} = 258 \text{ db/s}$ is less than the writing (333 db/s).

On the other hand, a peak of 50 db and 240 milliseconds duration has a velocity of change of $\frac{50 \text{ db}}{120 \text{ ms}} = 416 \text{ db/s}$. As the pointer

can move with a velocity of only 333 db/s it will reach the highest point in its sweep only after the voltage has already somewhat decreased. The maximum value will, therefore, be recorded too late and will be too low.

The logarithmic indication of the measuring voltage in the decibel or neper system is effected by appropriate construction of the potentiometer P. As a result of its sub-division into hundredths, one degree for example, for a range of 50 db, corresponds to a difference of 0.5 db.

For use as an automatic self-regulating apparatus, the potentiometer P and one valve are connected to two pairs of terminals which are normally connected together by links. To these terminals, if necessary after the removal of the links, the system of apparatus to be regulated is connected.

The measuring device is fitted into a case. The valves, consisting of three A.C.2. valves and two RE 134 valves, are covered by a metal hood. In the foreground on the left, (Fig.2) is the interchangeable potentiometer P and also the four terminals, and the paper feeding device with a press button speed control. On the right side is an axle stump to which a buzzer can be coupled. The knob A which is visible above the driving mechanism serves to start up the synchronous motor.

4. Directions for use

(a) Preparation. Before connecting up to the mains, attention must be paid to the supply voltage and to the type of current. The damping recorder may be connected only to an alternating current system of 50 Hz and 110, 125, 150, 220 and 240 volts at will. It is normally adjusted to 220 volts. In the case of mains with other voltages, the fuse Si must be set to the corresponding voltage. For this purpose the fuse is unscrewed, and the middle screw of the fuse element so far loosened, that the disc in which there is a notch can be turned. It is turned until the value appearing in the notch corresponds to the supply voltage available. Then the disc is screwed tight again and the fuse for the appropriate current (600 or 300 mA) inserted in the resulting opening.

After removal the hood protecting the valves, by loosening the screws to right and left, three A.C.2. and two RE 134 valves are fitted in the order described. The third valve (in the middle of the valve chamber) is one that is specially selected. Then it is determined whether the potentiometer P (Fig.2) is suitable for the desired measurement range. If this is not the case, then the potentiometer box which is provided underneath with three guide pins is carefully lifted from the base plate after the two screws have been loosened, and replaced by the correct one. In this operation, great care must be taken not to touch the contact springs exposed during the changing, as the accuracy of the apparatus may otherwise be impaired. The terminals 1, 2, 3 and 4 are usually connected as shown in Fig.1.

Next a roll of waxed paper is placed on the unwinding device S, the hand lever H on the cover of the writing device is pressed to the left and the writing system with a window to the left, raised. The end of the recording paper which has been unrolled a little is laid with its perforation in the correct position against the winding rolls, and the writing system closed again by pressing down the lever H. By means of 11 comb-like engravers beneath the upper part of the window the ordinate divisions (in N or db) are marked, at the same time as the record is traced, as a number of parallel lines. The abscissa is first of all a time co-ordinate. If an oscillation-buzzer is coupled to the drive of the damping recorder, then the abscissae can also be divided into frequency scale (see under c) measurements.

The pointer Z, rigidly connected with the writing system, serves for the adjustment of the apparatus to a scale sub-divided into 25 equal parts.

(b) Operation. The apparatus is connected by means of the flex housed in the lid of the case to the supply system, switch turned on and the driving motor started up by turning o'clock-wise the knob protruding from the paper driving chamber. The proper functioning of the recording system depends within certain limits on the characteristics of the valves used, so that before apparatus is put into use, the writing system must be exactly adjusted. For this purpose an alternating current is applied to the input terminals to bring the pointer to about 10 divisions up the scale. The bias potentiometer V (screw drive) in such a way that according to the potentiometer used (e.g. 0 - 25, 0 - 50, 0 - 75 db) a sudden increase or decrease of 0.5, 1 or 1.5 db can be shown.

In unequal deflections to both sides appear, this may be due to an unsatisfactory third valve (rectifying valve) A.C.2. This valve must then be exchanged for one specially selected by the works and designated by the name A.C.2 (3). The correct speed for the paper is obtained by means of the press buttons on the front of the feed drive. When the left button (0 mm/s) is pressed, the paper is halted.

When in constant use, the apparatus must be regularly oiled with a drop of the special oil delivered along with it and kept in an oiling can in the lid of the case. The oiling hole is to the right of the paper feed.

Excessive oiling should be avoided as among other things it tends to decrease greatly the friction between the coupling discs and the fork.

(c) Measurements. The main use of the damping recorder is for the measurement of differences in voltage appearing, for example in microphones and sound receivers (with frequency measuring plates). With a fixed calibration pressure (voltage field) absolute voltage measurements are also possible.

In measuring the degree of amplification of an amplifier in relation to the frequency, the voltage given

contd.

off by an oscillation buzzer connected with the damping recorder is momentarily interrupted at fixed frequencies. At the frequency marks thus produced (steep fall and rise of the frequency curve on the waxed paper) the frequencies are correspondingly marked. If the same oscillation buzzer is frequently used, then it is an advantage to use a cut stencil which one can easily make for oneself. The buzzer coupled to the apparatus requires a definite time for the passage of the individual frequencies, corresponding to a fixed length l on the waxed paper. Suppose after a time that the frequency f has passed, to which corresponds the path l on the waxed paper. This determines the mark for the frequency f and this is cut on to a pattern. The same method is followed for the other frequencies to be marked. According to the potentiometer chosen, the change in frequency of the amplification can be read off in decibels or neper logarithms. Damping measurements are carried out in a similar manner.

Whether or not a recorded curve reproduces the correct movement of the voltage in time can be recognised from the steepness of the recording. If this is everywhere less than the steepness resulting from a suddenly applied voltage, then the curve may be taken as correct. If at any point the maximum of steepness is attained, it is possible that at this point the voltage was different from that shown by the recording. The steepness of the maximum writing speed can at any time be easily obtained or tested. It is necessary only to switch on or off suddenly a sound frequency.

The velocity of the paper is always chosen in such a way that the fluctuations measured appear with sufficient clearness. Where there are rapid fluctuations a speed of 1 mm/s is not to be recommended, as the style would move in a line almost perpendicular to the direction of the paper feed. To make such fluctuations apparent, this line must be drawn out into a curve by a more rapid movement of the paper (10 or 50 mm/s, which can be regulated by the press buttons).

High paper speeds are employed particularly for measurement of echo. In the room to be tested the sound from some sound source is picked up with a microphone and a sound pressure gauge. The voltage from this gauge which is proportional to the sound is conducted to the damping recorder. The source of the sound is then cut off, and the steepness of the falling curve provides a measure of the period of echo. The period of echo is obtained

contd.

directly from the slope of the falling curve or from the time in which a fall of 60 db takes place. The period of echo is measured correctly as long as it is greater than 0.2 s (measured with the 50-db-potentiometer.)

Further the apparatus can be used for the measurement of oscillation phenomena when the beginning of the scale is exactly determined by means of auxiliary devices. Voltage impulses are produced on an amplifier and recorded by the apparatus. When the recorder is properly adjusted, the time of rise is equal to that of fall for the recorded impulse in the case of an amplifier with the onset time equal to 0.

For measurements of permanent sound the damping recorder can be used as it stands. In the measurement of short sound impulses, for example, care must be taken that the writing speed is not exceeded, i.e. that the report lasts long enough for the pointer to follow it. In general that is the case only in rooms which have an echo.

5. Accessories, Measurements and Weights.

Acoustical level meter Rel mse 124a 380 x 350 x 220 14 106752
by Neumann (30 to 20,000 Hz)

Accessories:-

3 Valves # A.C.2. 106927
2 " R.E.134. 105917
with 3 fuses 2 as
substitutes 1 mains
connection cable
600 mA for 110 to 150V 0.6/250 Din 41571 108442
0 " " 220 and 240V 0.26/250 " 41571 108440

Potentiometer

0-2.5M Rel mse 124 tz 1 115 x 80 x 80 0.7 106754
0-5.0M " " " 2 " " " " " 106755
0-7.5M " " " 3 " " " " " 106756
0-25 db " " " 4 " " " " " 106757
0-50 db " " " 5 " " " " " 106758
0-75 db " " " 6 " " " " " 106759

1 roll of chart paper (50m) 90 x 65 0.3 106753

1 Alternating current
supply unit

ZB Floating summator Rel sum 51a 460 x 340 x 220 17 107621

Parts for the measuring ZL antr.10a - - 107717
box with coupling # Rel sum 49a 320 x 225 x 210 11 107609

is a rectifying valve particularly chosen by the works and should be used
with A.C.2.(3) marked Valves.

for connecting the summation and writer to an independent wave expiration
device.

APPENDIX 1.

CARL LINDSTROM A.G.

PLANT SUITABLE FOR BRITISH RECORD INDUSTRY

All these items are required by the British Gramophone Industry to fulfil orders for pressing gramophone records for export and home. All machinery is damaged by exposure to weather, debris from fallen buildings and fire to a varying extent.

(1) Description of Plant	(2) Location of Plant (Full Address and Zone)	(3) Estimated Weight in Tons	(4) Estimated 1938 Re- placement Value	(5) Present Value
Thirty (30) Record Presses of Semi-Auto- matic type	Carl Lindstrom A.G. Berlin S.O.36, Schlesische Str. 27. In American Sector of Berlin.	1 ton ea. (30 tons)	£150 each	£25 each
One (1) Grüber type mill with fan & electric motor drive.	"	20 tons	£1,250	£500
One (1) Elrich type mixer with electric motor drive	"	10 tons	£1,250	£300
Two (2) Roller mixers forming a pair driven by one electric motor	"	20 tons total	£600 each	£200 each

APPENDIX 1 (CONTD.)

CARL LINDSTROM A.G.

PLANT SUITABLE FOR BRITISH RECORD INDUSTRY

All these items are required by the British Gramophone Industry to fulfil orders for pressing gramophone records for export and home. All machinery is damaged by exposure to weather, debris from fallen buildings and fire to a varying extent.

(1) Description of Plant	(2) Location of Plant (Full Address and Zone)	(3) Estimated Weight in Tons	(4) Estimated 1938 Replacement Value	(5) Present Value
One (1) Calendar Rollers with blanking roll complete with electric motor drive	Carl Lindstrom A.G. Berlin S.O.36, Schlesische Str. 27. In American Sector of Berlin.	5 tons	£300	£100
One (1) Hydraulic pump & accumulator to provide water pressure for record presses at approx. 200 atmospheres complete with elec. drive.	"	2 tons	£200	£75
One (1) 2 head pump for cold water for presses complete with electric drive.	"	1 ton	£150	£50
1000 prepared wax discs in cartons.	"	2 tons	£100	£100

APPENDIX 1 (CONTD.)

DEUTSCHE GRAMMOPHON

PLANT SUITABLE FOR BRITISH RECORD INDUSTRY

All these items are required by British Gramophone Industry to fulfil orders for pressing records for export and home. All machinery is damaged by exposure to weather, debris and fire in varying degree.

(1) Description of Plant	(2) Location of Plant (Full Address and Zone)	(3) Estimated Weight in Tons	(4) Estimated 1938 Re- placement Value	(5) Present Value
Twenty-eight(28) Gramophone record presses of semi- automatic type	Deutsche Grammophon G.M.B.H. Podbielski Str. Hannover.	1 ton	£150 each	£50 each
One (1) Kek mill with electric drive.	"	1 ton	£200	£50
One (1) Vertical mill (Gruber type) with elec. drive	"	25 tons	£1,250	£750
Three (3) Roller mixers with electric drive.	"	8 tons each	£600 each	£200 each

APPENDIX 1 (CONTD.)

DEUTSCHE GRAMMOPHON

PLANT SUITABLE FOR BRITISH RECORD INDUSTRY

All these items are required by British Gramophone Industry to fulfil orders for pressing records for export and home. All machinery is damaged by exposure to weather, debris and fire in varying degree.

(1) Description of Plant	(2) Location of Plant (Full Address and Zone)	(3) Estimated Weight in Tons	(4) Estimated 1938 Re- placement Value	(5) Present Value
Two calendar rollers with blanking roll complete with electric drive	Deutsche Grammophon G.M.B.H. Podbielski Str. Hannover.	5 tons each	£300 each	£100 each
Four (4) weighing machines with drive.	"	2 tons each	£100 each	£20 each
One (1) Special vacuum silvering plant including vacuum chamber on stand with pumps and connection with electrical and mechanical accessories.	"	2 tons	£600	£400

The vacuum silvering plant is urgently required by British Gramophone Industry for research purposes. The apparatus has been slightly damaged by bombs.

APPENDIX II

A list of the British and German patents on the Tefi apparatus is given below:-

Patented by Dr. Daniel:

English Patents

<u>No.</u>	<u>Year of Application</u>
417924	1933
477396	1936
482252	1937
501994	1938
503375	1938
504327	1938
504503	1938
516279	1938
523851	1939
527365	1939
527557	1939
528763	1939
528764	1939
530265	1939
532028	1939
532029	1939

APPENDIX II (Cont.)

German Patents

<u>No.</u>	<u>Year of Application</u>	<u>No.</u>	<u>Year of Application</u>
579997	1932	746661	1941
648209	1937	747218	1938
666926	1937	747219	1941
672264	1938	747751	1938
681188	1939	749671	1940
693681	1938	750025	1938
698255	1938	751289	1940
701816	1938	753252	1937
703253	1937	753825	1941
703489	1937	754158	1938
722357	1941	754687	1941
722358	1939	755431	1937
722359	1937	756696	1938
732102	1942	757234	1938
733617	1938	758035	1938
743185	1940	758068	1939
743250	1943	758310	1939
743412	1938	758766	1941
746221	1940	758832	1941
746292	1937	759451	1939
746391	1939	759751	1940
746392	1939	760417	1941
746393	1939	762633	1942
746463	1940	764561	1940
746659	1940		