EQUIPMENT FOR WELDING ELECTRODE MANUFACTURING

By

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The designing and production of welding electrode manufacturing equipment has opened new vistas before the Hungarian machine building industry.

It is a highly significant feature of this equipment that its machines are also used in other fields of technique, but for the manufacturing of welding electrodes they had to be supplied with special devices. One might add that a major part of machinery used for the manufacture of welding electrodes consists of single-purpose machines developed parallel with the technique of electrode manufacturing. This applies, above all, to the so-called extruding machine which serves to provide the wire with its coating.

When analyzing the origin and the development of equipment for welding electrode manufacturing it is very interesting to note that it has been designed and built mostly in the welding electrode factories themselves.

The answer to this question can be found in the special requirements of welding electrode manufacturing. Production is anxious to meet the requirements of the rapidly developing welding industry ; it is possible only by putting welding electrodes of ever higher performance on the market. These efforts are usually connected with a development of coating formulae based on the available raw materials, without, however, altering to a greater extent the technique of coating mass manufacturing which depends on the extruding system. It means in other words, that the trends in the development of coating powders are influenced by the electrode manufacturing equipment. From this point of view it seems particulary advantageous when equipment for welding electrode manufacturing is produced by works disposing of both welding electrode manufacturing and machine building departments. The flow-sheet of an up-to-date welding electrode plant is shown on Fig. 1.

Welding electrodes have been produced in Hungary for 30 years. Their quality meets the world market standards, the different brands are exported to a series of countries. Their high quality is warranted not only by the up-to-date laboratories for product development and welding technique but also by an advanced production standard based on a suitable machine park. Types hitherto developed allow the series production of complete electrode manufacturing plants, both as regards their modernity and output.

Equipment for welding electrode manufacturing can be divided into four main groups, *i. e.* machinery for producing coating powders, machinery for wire processing, electrode extruding machinery and electrode drying equipment.

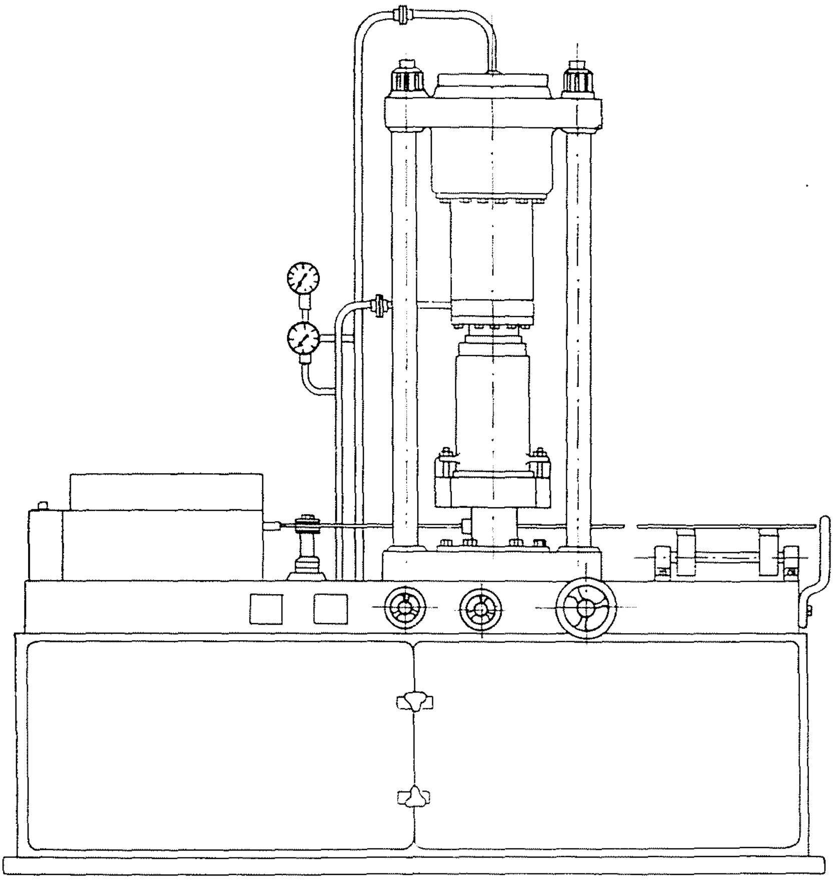

Fig. 1

Coating powders can be prepared either from ready-bought pulverized minerals or from lump ores. In case pulverized minerals are bought, only vibrating screens and powder-homogenizing machines are needed.

Vibrating screens suitable for producing coating powders are of a somewhat different size and design than other standard screening equipment. Vibrating screens are quite closed and, accordingly, run without causing dust. Besides, the quick replacement of the wire cloth is ensured. The size of sieving surface is given by the requirements of economical sieving of the finely ground powder constituents ; the economy of their performance is highly enhanced by adding a feeding device to the screen.

The Hungarian-made powder homogenizing machine is in principle a rotating drum of about 100 litres capacity, provided with a bladed wheel of special shape rotating in opposite sense. The bladed wheel lifts and lets back the coating powder the different constituents of which had been fed into the homogenizer.

This is made in a way to ensure the migration of all grains within the homogenizer space. A batch of 200 kgs powder shows an entirely homogeneous distribution after 5 minutes mixing when testing a component of any specific weight. Feeding and discharging of the machine is practically free from dusting.

If the coating powder is manufactured from lump ores the necessary equipment covers ore driers, crushers, screening and fine pulverizing machines as well as feeding and discharging devices for their continuous or batch-like operation. These machines and devices are the same as are in use for standard mineral pulverizing, thus their detailed description seems unnecessary in this paper. It should be mentioned, however, that the formation of dust has been largely eliminated with all powder-processing machinery, rather an important feature when considering the fine grain of the powders used for electrode manufacturing. It involves that dust impairing the health of the operators is eliminated. Such danger is signalled by automatic devices while the machinery is protected by safety protectors. An important point within the powder producing shop is also the economical handling of raw materials of various shapes and specific weight inside the shop. This problem can be solved by cranes or pneumatic devices, according to the capacity of the shop.

Wire processing starts from wire drawn to exact size and arriving in coils. The wire must be processed to very close tolerances regarding both straightness and length ; the cuts be clean of burrs. These requirements are very important since the concentricity of the coating during the extruding operation greatly depends on them. This is why the straightening machines for electrodes differ greatly from similar machinery used in standard wire processing. Perfect straightness of the wire is ensured by a suitable setting of the straightening jaws inside the straightening body as well as the several pairs of synchronously rotating wire-transporting rolls. Exact cutting lengths can be achieved only by cutting mechanism with forced operation and not with the standard stop mechanisms. A special device is also needed for attaining cutting surfaces without burrs, especially with the wire of a dia less than 4 mms. Besides, the tools must be also of best quality with lasting edges. The device ensuring cleanness from burrs is produced on client's special requests. Of all these quality requirements are observed that the wire straightening machines generally employed have an output about 50 per cent lower than that of the electrode extruding presses. Using the *single-purpose machines* developed for wire straightening and cutting, it was possible to step the output by about 20 per cent. By the use of auxiliary equipment, the down-times were considerably lowered, so these machines have, after all, a yield of nearly 75 per cent of the extruding presses.

Coating mass is manufactured by homogeneously mixing the coating powder with waterglass (solution of alkali silicate). For this operation, special mixers with two rolls and a disc rotating in opposite sense should be used since they work very satisfactorily and ensure within a very short period a consistency of the mass best suited for the extrusion operation.

The extruding press is the most important unit in welding electrode manufacturing. It is in this equipment that the coating mass is pressed onto the wire and the electrode assumes its final shape.

The electrode extruding press is in fact a complex aggregate consisting of several machine units : the press proper operated by mechanical or hydraulic power with its wire-feeding device, different transporting and distributing constructions and the equipment for forming the contact end of the electrode. The latter is necessary because the extruding press applies the coating onto the full length of the wire. The coating must be removed on a certain length to ensure contact of the electrode holder and it seems practical to do so while the mass is still in the plastic condition.

The most important requirement to be met by the extruding machine is to yield a coating which is smooth, continuous and adheres well to the wire. A most important factor is further the concentric position of the coating on the full length of the wire since the welding performance of the electrode depends highly on this fact.

From the many extruding presses, there are three principal types to be distinguished.

The first is characterized by the fact that the direction of movement of the mass and the wire include an angle of 90 degrees. These extruding presses are built in both vertical or horizontal design (see Fig. 2).

A characteristic of the second type is that the direction of movement of the mass and the wire include an angle of less than 90 degrees. These extruding presses are built usually in a horizontal design (see Fig. 3). The third type shows a coincidence of both directions of movement. It is the so-called co-axial extruding press and is built exclusively in a horizontal design.

With all these three extruding presses the coating mass is forwarded either by mechanical worms or by hydraulic pistons, but in any case periodically. The extruding presses described above show a different rate of mass flow thus affecting in varying degrees the concentricity of the coating. According to the laws of fluid mechanics, the flow properties of the coating mass can be expected to be most favourable when the section of the extruding tool is decreasing so gradually that it secures a steady speed of the mass flow. This may be achieved if friction along the walls of the extruding toll and within the particles of the mass may equalize. This can be ensured best by

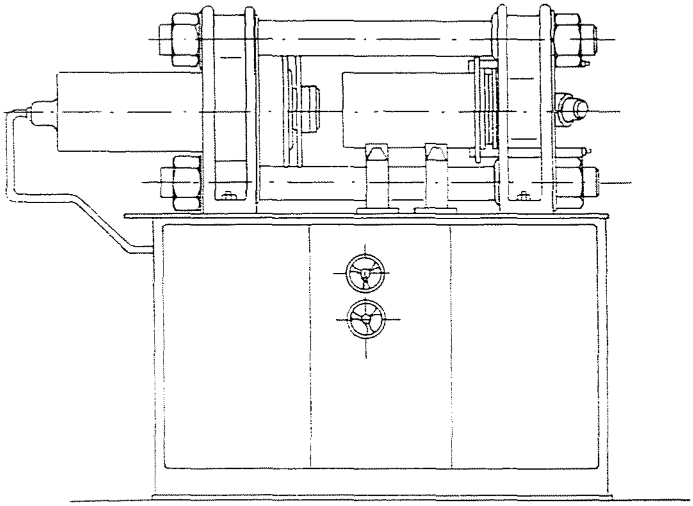

Fig. 2

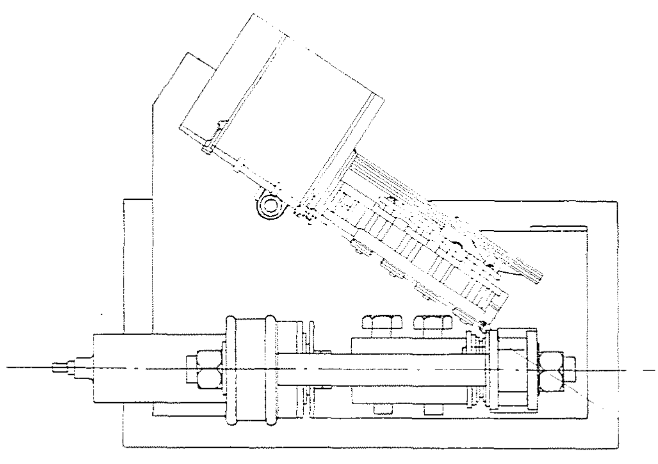

Fig. 3

the extruding press types showing an angle of less than 90 degrees between the direction of movement of the mass and the wire or even a coincidence of these two directions. In Hungary extruding press type with an angle of 36 degrees is being used at present.

The mass is pressed onto the wire by a hydraulic equipment.

Subsequent electrode plants are expected to be equipped also with extruding presses working on the principle of screw conveyors. A principle of these machines can be seen on Fig. 4. It shows the following advantages :

The axis of mass-forwarding coincides exactly with the axis of the wire to be coated,

the mass is forwarded continuously and without changes of direction, thus the concentricity of coating is ensured as far as possible,

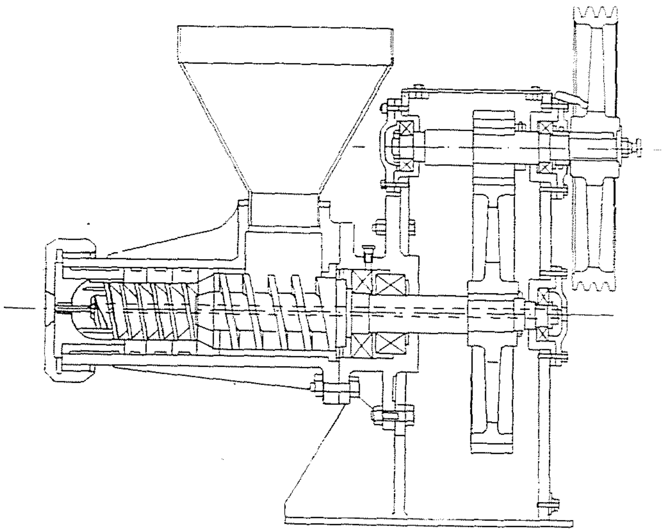

Fig. 4

the extruding press is operating continuously, ensuring a production increase of about 20 per cent, when compared to the periodically operating extruding press,

costly auxiliary equipment (mass cylinders) and mass briquetting equipment, necessary with other press types, can be dispensed with since this press can be fed with mass of no shape whatever.

As compared to extruding presses with hydraulic equipment, pumping equipment with its costly running and maintenance expenses can be omitted. The weight and place requirement of the extruding press is considerable decreasing.

Summing up, one may see that the mechanically operated screw-conveyor electrode extruding press is the most up-to-date and, at the same time, it is the most simple welding electrode manufacturing unit, developed by the use of experience gathered by Hungarian electrode manufactures over three decades. After the operation of electrode extrusion, the coating has a humidity of 6—8 per cent to be lowered by drying to a figure of 1.0—0.5 per cent. After extrusion, the coating is still in a plastic condition and can be easily damaged, therefore it is important that no mechanical force is acting on it during drying. It is not advisable to dry electrodes piled up in several layers. A further important requirement is the uniform heat transfer to the full coating surface during drying.

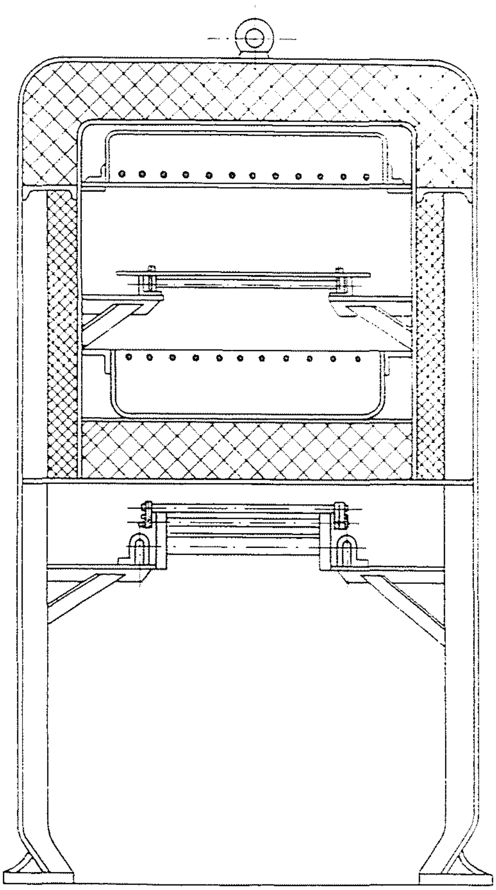

Fig. 5

Up-to-date electrode drying equipment has a powerful heating source which may be sensitively and gradually controlled within the necessary temperature ranges. The heating equipment consists of dark radiating electric heating tubes. Owing to the special design of the heating tubes, they have a long operating life. These tubes have a power consumption as low as 60—65 per cent of standard resistance-heated equipment. The electrodes are forwarded by an infinitely variable continuous conveyor. The distance between the individual electrodes may be predetermined and thus the output of the aggregate synchronized with the output of the extruding press. In a section of the drying part, the igniting end of the electrode is formed. The whole aggregate has a length of about 30 metres. This relatively short drying path could only be reached by the use of dark radiating electric heating tubes. Owing to its simple design, the drying equipment needs no special handling or maintenance, and electrodes of all usual lengths may be treated on this equipment (see Fig. 5).

The main electrode manufacturing units discussed above show the trends in modern Hungarian electrode manufacturing. Under the production programme, there are further to be found auxiliary equipments such as complete crushing, pulverizing and grading machinery, special powder storing and feeding devices, together with adjoining material handling facilities. It should be especially stressed that in the course of designing the powder processing and forwarding equipment special care was paid to avoid the dust formation, caring hereby for the health of the operators (coating powders include the danger of silicosis and manganese poisoning).

The use of up-to-date controlling and measuring instruments deserves special attention. Among these, just one type should be mentioned: the instrument determining continuously the dielectric constant of the coating and determining hereby quickly and simply its moisture contents. This instrument is also produced as a portable type for shop purposes and allows frequent control both in the electrode manufacturing works and at the consumer's.

With respect to the limited space, this paper could not aim at a detailed description of the mentioned electrode manufacturing equipment. Specialists will be able to see from the details given that Hungarian craftsmen know how to cope with their problems and are familiar with the latest trends on a world scale. It was not without importance to consider these problems since the consumption of electrodes has increased these last five years, even in the most advanced industrial countries, by yearly 8—10 per cent. This is given by the ever increasing application of arc welding, in spite of the many automatic arc-welding processes already in use. Design and execution of modern welding electrode manufacturing equipment of Hungarian origin has not been restricted, as can be seen, to the development of single machines or aggregates. On the contrary, the greatest efforts have been made to elaborate a manufacturing technology for welding electrodes meeting the welding requirements of to-day. This paper has been written with the aim to call the attention of all those interested in the performance and the level attained in Hungary and at the same time to make our readers visualize the modernity of our manufacturing equipment.

BOOK REVIEW — BUCHBESPRECHUNG

Recent Advances in Atmospheric Electricity

Editor: L. G. SMITH, M. A., Ph. D.

Pergamon Press, 1958. 631 p. 425 Figs.

The book contains 59 papers and short contributions, as well as discussions on them, i. e. the proceedings of the Second Conference on Atmospheric Electricity held at Portsmouth, New Hampshire, May 20—23, 1958. Being published in September of the same year, it ought to be praised as a top performance of editing efficiency. It is well known to people who have confronted the job of publishing the material of a conference with so many lecturers how much work is needed for making from the lectures a publication in form of a book; I think that such people might be able to appreciate the work of the coordinator, in this case the Wentworth Institute, and also that of the Pergamon Press.

So I believe that this extraordinary performance in itself would deserve a digest longer than usual. But there is yet another reason for a longer review: if we want to inform our readers as completely as the topic and the book deserve, we have to enumerate the authors and the titles of all papers and contributions which are to be found in the book. After this, we will point out some of them, which seem to be of particular interest to electrical engineers.

The proceedings are divided into three parts: fair weather electricity, thunderstorm electricity and lightning discharges.

The papers and contributions in these three groups are as follows:

I. Fair weather electricity

1. E. T. PIERCE: Some Topics in Atmospheric Electricity.
2. P. J. NOLAN: Small Nuclei Produced by Discharge at a Point.
3. R. C. SAGALYN: The Production and Removal of Small Ions and Charged Nuclei over the Atlantic Ocean.
4. L. W. POLLAK and A. L. METNIEKS: The Diffusion Coefficient of Large Ions.
5. G. A. FAUCHER: A Study of Air Flow in a Large-Ion Chamber.
6. J. F. CLARK: The Fair-Weather Atmospheric Electric Potential and its Gradient.
7. J. H. KRAAKEVIK: Electrical Conduction and Convection Currents in the Troposphere.
8. S. P. VENKITESHWARAN: Measurement of the Electrical Potential Gradient and Conductivity by Radiosonde at Poona, India.
9. L. KOENIGSFELD: Observations on the Relations between Atmospheric Potential Gradient on the Ground and in Altitude, and Artificial Radioactivity.
10. H. O. CURTIS and M. C. HYLAND: Aircraft Measurements of the Ratio of Negative to Positive Conductivity.
11. H. HATAKEYAMA, J. KOBAYASHI, T. KITAOKA and K. UCHIKAWA: A Radiosonde Instrument for the Measurement of Atmospheric Electricity and its Flight Results.
12. H. W. KASEMIR and L. H. RUHNKE: Antenna Problems of Measurements of the Air-Earth Currents.
13. H. ISRAËL: The Atmospheric Electric Agitation.
14. M. KAWANO: The Local Anomaly of the Diurnal Variation of the Atmospheric Electric Field.
15. R. REITER and M. REITER: Relations between the Contents of Nitrate and Nitrite Ions in Precipitations and Simultaneous Atmospheric Electric Processes.
16. H. DOLEZALEK: Problems in Atmospheric Electric Synoptic Investigations.
17. R. MÜHLEISEN: The Influence of Water on the Atmospheric Electrical Field.
18. R. H. D. BARKLIE, W. WHITLOCK and G. HABERFIELD: Observations of the Reactions between Small Ions and (a) Cloud Droplets, (b) Aitken Nuclei.

Contributions

19. H. ISRAËL: The Man-made Radioactivity of the Atmosphere at Aachen on April, 1, 1958 and its Origin.
20. O. C. JONES, R. S. MADDEVER and J. H. SANDERS: Radiosonde Measurements of Vertical Electric Field and Conductivity in the Lower Atmosphere.
21. R. C. SAGALYN: Significance of the Ratio of the Polar Conductivities in Regions of Variable Pollution Content.
22. G. P. SERBU: Atmospheric Electricity and Advection Fog Forecasting.
23. D. L. HARRIS: Atmospherie Artificial Radioactivity.

Thunderstorm Electricity

1. D. R. FITZGERALD and H. R. BYERS: Aircraft Observations of Convective Cloud Electrification.
2. Y. TAMURA: Investigations on the Electrical Structure of Thunderstorms.
3. S. CHAPMAN: Corona-Point Discharge in Wind and Application to Thunderclouds.
4. H. HATAKEYAMA: The Distribution of the Sudden Change of Electric Field on the Earth's Surface due to Lightning Discharge.
5. L. G. SMITH: Electric Field Studies on Florida Thunderstorms.
6. B. VONNEGUT and C. B. MOORE: Preliminary Attempts to Influence Convective Electrification in Cumulus Clouds by the Introduction of Space Charge into Lower Atmosphere.
7. C. B. MOORE, B. VONNEGUT and A. T. BOTKA: Results of an Experiment to Determine Initial Precedence of Organized Electrification and Precipitation in Thunderstorms.
8. R. M. CUNNINGHAM: Cumulus Circulation.
9. P. B. MACCREADY JR.: The Lightning Mechanism and its Relation to Natural and Artificial Freezing Nuclei.
10. M. BROOK: Laboratory Studies on Charge Separation During Ice-Ice Contact.
11. J. P. KUETTNER and R. LAVOIE: Studies of Charge Generation During Riming in Natural Supercooled Clouds.
12. B. VONNEGUT and C. B. MOORE: Giant Electrical Storms.
13. P. B. MACCREADY JR.: Equipment for Forecasting Lightning Danger.

Contributions

14. J. A. CHALMERS, J. E. MAUND and J. W. MILNER: Recent Results on Point Discharge.
15. T. W. WORMELL and C. J. ADKINS: Effects of Splashing of Raindrops at the Ground.
16. J. C. WILLIAMS: Some Properties of the Lower Positive Charge in Thunderclouds.
17. V. J. SCHAEFFER · The Electrification of Oil and Water Clouds.
18. R. REITER: Observations on the Electricity of Nimbo-Stratus Clouds.

III. The Lightning Discharge

1. D. ATLAS: Radar Lightning Echoes and Atmospherics in Vertical Cross-Section.
2. C. E. R. BRUCE: Terrestrial and Cosmical Lightning Discharges.
3. E. L. HILL: Free Electrons in the Lower Atmosphere.
4. M. M. NEWMAN: Lightning Discharge Channel Characteristics and Related Atmospherics.
5. N. KITAGAWA and M. KOBAYASHI: Tidal-Changes and Variations of Luminosity due to Lightning Flashes.
6. H. NORINDER and E. KNUDSEN: Combined Analysis of Daylight Photographs of Lightning Paths and Simultaneous Oscillographic Records.
7. H. NORINDER, E. KNUDSEN and B. VOLLMER: Multiple Strokes in Lightning Channel.
8. H. L. JONES: The Identification of Lightning Discharges by Spheric Characteristics.
9. D. J. MALAN: Radiation from Lightning Discharges and its Relation to the Discharge Process.
10. A. KIMPARA: Atmospherics in the Far East.
11. H. ISHIKAWA and A. KIMPARA: Lightning Mechanism and Atmospheric Radiation.
12. C. G. STERGIS and J. W. DOYLE: Location of Near Lightning Discharges.
13. R. E. HOLZER: World Thunderstorm Activity and Extremely Low Frequency Spherics.
14. M. J. LARGE and T. W. WORMELL: Fluctuations in the Vertical Electric Field in the Frequency Range from 1 Cycle per Second to 500 Cycles per Second.
15. W. L. TAYLOR and L. J. LANGE: Some Characteristics of VLF Propagation Using Atmospheric Waveforms.
16. H. W. CURTIS: The Nature of Lightning Discharges which Initiate Whistlers.

Closing Remarks by P. H. WYCKOFF.

Among the papers quoted above, the following seem to be of particular interest to electrical engineers:

I. 1. about the currents flowing in the lightning return stroke, which is given by the formula

$i_t = i_0 (e^{-\alpha t} - e^{-\beta t})$
with $i_0 = 28 \cdot 10^3$ A,
$\alpha = 7 \cdot 10^3$
and $\beta = 4 \cdot 10^4$
as parameters.

I. 21. about fog forecasting.

II. 2. about investigations on the electrical structure of thunderstorms.

II. 4. about the distribution of the sudden change of electric field on the earth's surface due to lightning discharges.

II. 12. about giant electrical storms.

II. 13. about an equipment for forecasting lightning discharges (also very interesting for many branches of industry handling explosives and fuels etc.). The equipment described has been found to be capable of giving usually a 20—90 minutes warning of dangerous lightning conditions.

III. 2. about terrestrial and cosmical lightning discharges.

III. 7. about the multiple strokes in lightning channels.

III. 11. about lightning mechanism and atmospheric radiation.

III. 12. about the location of near lightning discharges.

III. 16. about the nature of lightning discharges which initiate whistlers.

We think that this brief survey is sufficient to show how much interesting information is given in the present book, which will be useful in a wide field of industry and science.

Prof. J. EISLER, El. Eng., D. Eng., D. Sc.