ABSTRACTS

DEPARTMENT OF ELECTRICAL COMMUNICATION ENGINEERING

14. EQUIVALENT Π AND T NETWORKS FOR ALL FREQUENCIES. B. S. amakrishna, *Electrotechnics*, No. 22, 1950.

The T and Π networks constructed as equivalent to each other any definite frequency in the usual manner do not preserve their equivalence as the frequency is changed, unless the networks happen to be constructed entirely of a single kind of element, *i.e.*, either entirely resistive, inductive, or capacitive. In this article, a method of obtaining T and Π networks equivalent to each other at *all frequencies* is developed for the case in which the original network whose equivalent is desired, contains more than a single kind of element. This is done by keeping the frequency as an explicitly variable in the relationships determining the impedances of the equivalent network sought for. Such networks would be equivalent to each other not only for steady state signals of any frequency, but also for transient signals. The general possibility of representing a given four-terminal network by means of a T network-equivalent for all frequencies is also indicated.

15. AN IMPROVED METHOD OF DEMODULATION OF WIDTH-MODULATED PULSES. V. Narayana Rao, *Electrotechnics*, No. 23, March 1951.

The paper gives an account of the theoretical and experimental investigations carried out by the author on the demodulation of width modulated pulses. A brief account is given of the spectrum of width modulated pulses and of the edge noise accompanying such pulses. It is shown that an improvement in signal-to-noise ratio is obtained if signal power can be extracted from the sidebands accompanying each of the pulse repetition frequency harmonics. The experimental set-up to check this theoretical improvement is also described.

16. A METHOD OF GENERATING WIDTH MODULATED PULSES. V. Narayana Rao, *Electrotechnics*, No. 23, March 1951.

This paper describes a new method of producing width modulated pulses employing square waves. The modulation characteristics for a typical tube and circuit arrangements are shown. A step by step circuit analysis is also given. Also the harmonic distortion inherent in this system is theoretically examined and curves are drawn of the second and third harmonic distortions as functions of the circuit parameters and percentage modulation.

DEPARTMENT OF METALLURGY

13. STUDIES ON LOWER GRADE INDIAN COALS, Part I. S. S. Ghosh, P. V. Sanyal and V. Aravamuthan, *Brennstoff-Chemie*, 1951, **32**, 368–74. Part II. S. S. Ghosh, P. V. Sanyal and P. K. Subramanian, *Ibid.*, 1952, **33**, 48–55.

The Raniganj and Jheria coals are of different nature. Most of the Jheria coals on account of their high ash content are placed in the category of low grades. The technical developments in India depend on the efficient use of these lower grade coals which occur in unlimited quantities. Detailed analyses of seven typical lower grade coals from Jheria and two typical lower grade coals with high volatile matter from Raniganj fields, and also small-scale tests on low temperature carbonisation and gasification of the cokes thus obtained, are reported. Details regarding their place of occurrence, colliery etc., and also proximate and ultimate analysis, carbon-hydrogen ratio, calorific value, decomposition point, the necessity to introduce Parr's correction, the yields of various products by small-scale low temperature carbonisation, the nature of low temperature cokes, the behaviour of low temperature cokes on small-scale gasification employing carbon dioxide etc., are given. Contrary to popular belief that the lower grade coals from these locations belong to bituminous type, the results of this work show that the coals from Raniganj are younger in age and should be placed somewhere in the sub-bituminous region and the coals from Jheria with higher carbon contents may be included in the semi-bituminous type. The importance of the work lies in revealing their suitability for large-scale low temperature carbonisation, Fischer-Tropsch synthesis or direct hydrogenation.

14. THE HYDROGEN REDUCTION OF ORES FOR THE PRODUCTION OF METALS, V. Aravamuthan. Communicated for publication to the *Transactions of the Indian Institute of Metals*, 1952.

The superiority of hydrogen reduction of iron oxide ores over conventional methods for obtaining iron from different types and sizes of iron ores and fuel are indicated. The possibilities of producing iron economically through the intermediate production of ferrous oxide, employing it for recovering ammonia from the ammonium chloride, by-product of various processes like ammonia soda process and reducing the resulting solid ferrous chloride by hydrogen, with the simultaneous production of hydrochloric acid as a valuable by-product, appear to be highly feasible. The successful production of cheap ductile titanium depends on employing hydrogen indirectly for reducing titanium tetrachloride through the intermediate

production of titanium tetra-iodide from the tetrachloride by reacting it with a mixture of hydrogen and iodine and thermally decomposing the iodide. Pure chromium metal can be prepared by reducing pure chromium oxide or chloride by hydrogen. Aluminium metal can be produced economically by obtaining aluminium fluoride from various raw materials such as bauxite, clay etc., decomposing the fluoride by hydrogen in the presence of a catalyst and obtaining hydrofluoric acid as a by-product for treating more of the raw materials. As bauxites of various types can be chlorinated readily the reduction of anhydrous aluminium chloride by hydrogen in the presence of a catalyst will help to produce aluminium economically. The chlorination of complex sulphide ores, their separation into various groups and finally the reduction of solid chlorides of lead, bismuth, arsenic etc., will eliminate the necessity of subjecting the ores to selective flotation, to roasting or smelting and slag-making operations in the production of pure metals. Hydrogen can be produced economically in India by employing off-peak electricity from hydro-electric systems in the electrolysis of water and utilising the by-product oxygen for producing greater amounts of hydrogen from low grade coal, coke, fines etc., through the intermediate production of carbon monoxide.

DEPARTMENT OF POWER ENGINEERING

1. GRAPHICAL ANALYSIS OF REPULSION MOTOR. M. S. Thacker and H. V. Gopalakrishna, *Electrotechnics*, No. 22, March 1950, pp. 3–20.

This paper presents a complete graphical analysis of the performances of the repulsion motor in the light of the two transformer theory of Puchstein and Lloyd, the interactions of fluxes, currents and voltages, being illustrated by time-phase diagrams. A representative circuit of the motor is also given. A simple and practical procedure is set up for the determination of the performance characteristics of the motor from a knowledge of the machine constants.

2. CURRENT DIAGRAM OF SINGLE PHASE INDUCTION MOTORS. M. S. Thacker and H. V. Gopalakrishna, *Electrotechnics*, No. 22, March 1950, pp. 29–47.

The Circle Diagram developed and presented in this paper makes it possible to study the characteristics of Single Phase Induction Motors in a simple manner. Based on the system of symmetrical components the authors set up accurate equations for the determination of the performance characteristics by grouping an equivalent resistance in series with the magnetizing reactance in the equivalent circuits. Analytical expressions are set up for the determination of the operating data of the motors as functions of slip or per-unit speed; circle diagram equations are derived and a simple but accurate constructional method of locating the operating point on the circle diagram for any slip is presented. The operating data arrived for various slips on the circle diagram agree with the mathematical computations illustrated by curves.

3. SUGGESTED IMPROVEMENTS IN THE PERFORMANCE CALCULATIONS OF SINGLE PHASE INDUCTION MOTORS. M. S. Thacker and H. V. Gopalakrishna, *Trans. A.I.E.E.*, 1950, **69**, pp. 1–7.

This paper provides a complete and accurate analysis of the single phase induction motors by the method of symmetrical components. Equivalent circuits and vector diagrams are given for both the split phase and capacitor types. Previous workers have suggested, so far as the core loss is concerned, either an arbitrary distribution between the main and cross-fields or treated it as constant at all loads similar to friction loss; also, the speed at which the maximum rotor input occurs has been considered to be the

same as the speed at which the maximum power is obtained. These assumptions may not lead to safe results in all cases. This paper takes into account the hystertic lag between the flux and the magnetomotive force and derives separate expressions for the speeds at which the maximum torque and the maximum output are developed.

4. DESIGN OF AUXILIARY CIRCUITS OF SINGLE PHASE INDUCTION MOTORS. M. S. Thacker and H. V. Gopalakrishna, *Trans. A.I.E.E.*, 1950, **69**, pp. 1373–79.

In this paper, mathematical procedures are evolved to arrive at the optimum proportions of the auxiliary circuit constants of single phase induction motors from the starting performance view-point. The methods enable the designs to meet the multiplicity of difficult industrial specifications for the split-phase and capacitor types of motors. The derivations with vector diagrams are based on the equations developed by the method of symmetrical components in the A.I.E.E. paper entitled "Suggested Improvements in the Performance Calculations of Single Phase Induction Motors" by the authors. The results of the investigation are compared with the practices recommended by other authors in the field.

5. MEASUREMENT OF CORE LOSSES IN SHEET STEEL UNDER A. C. MAGNETISATION. M. S. Thacker and B. S. Prasanna, *Electrotechnics*, No. 22, March 1950, pp. 57–79.

Measurement of core losses in sheet steel is a matter of considerable interest. C. Dannatt developed a method which could be used only under sinusoidal flux variation in the specimen. Measurement at higher flux densities where flux variation is not sinusoidal could be made conveniently by using a harmonic analyser in addition. An alternative method would be to use a double beam cathode-ray oscillograph which could be used for measurement of losses at all flux densities and also separation of hysteresis and eddy current losses.

6. ANALYSIS OF SHADED-POLE MOTOR (BY SYMMETRICAL COMPONENTS). M. S. Thacker and G. R. Ranganath, *Electrotechnics*, No. 22, March 1950, pp. 104–20.

The paper presents a general analysis of the shaded-pole motor by the method of symmetrical components, developing current loci equations for the main and the shading winding currents from which output, power factor, etc., can be found out graphically. Equations are derived for torque and

output, and conditions arrived at for zero torque and output. The paper also discusses the effect of variation of certain important motor constants on the starting torque of the motor.

7. SIMPLIFIED IMPEDANCE CIRCLE DIAGRAMS. Prof. Chandrasekhar Ghosh, *Electrotechnics*, No. 22, March 1950, pp. 88–97.

The use of circle diagrams in the analysis of circuit behaviour in electrical engineering problems is well-known. When applied to the determination of circuit behaviour with reference to variation in the impedance of circuits, the impedance circle diagram is very useful in network solutions and in relaying problems. In fact in all problems where mutual impedances are involved, the analysis of circuit behaviour by considering the complete circuit as an equivalent T-section leads to a very useful way of visualising the performance with the help of circle diagrams. The development of the form of relation leading to circular loci is discussed and a practical method of developing the impedance circle diagram for a representative T-section under various conditions is shown.

8. LIGHTNING MEASUREMENTS ON TRANSMISSION LINES. D. J. Badkas, *Electrotechnics*, No. 22, March 1950, pp. 48–56.

The need for obtaining lightning measurements data on Transmission Line is stressed. Various quantities that are required for the complete analysis of lightning stroke have been detailed. The technique of measuring the recording these quantities has been described and the typical oscillograms of lightning wave shape obtained by Cathode-Ray Oscillograph are given.

9. LOAD-FACTORS IN "PROCESS-INDUSTRIES". M. S. T. Narayanan, *Electrotechnics*, No. 22, March 1950, pp. 98–103.

This paper obtains a relation between the produce manufactured in continuous process plants and the electrical energy input and deduces certain useful index-factors helpful in assessing the production capacity and efficiency of given plants.

10. WAVE FORM AND CORE LOSSES. M. S. Thacker and B. S. Prasanna, *Electrotechnics*, No. 23, March 1951, pp. 26–29.

The non-linear bevalued B-H characteristics introduces an asymmetrical distortion of the magnetising field and at higher flux densities of the induced magnetism also. A brief study of the distortion is made in the light of the

hysterisis loop and also the effect of distortion on the core losses. The vector representation of the complex wave-form can only be done by visualising an *n*-dimensional space.

11. NETWORK ANALYSER TO THE SOLUTION OF FIELD PROBLEMS. M. S. Thacker and B. S. Prasanna, *Electrotechnics*, No. 23, March 1951, pp. 65–74.

Field problems which do not yield easily to mathematical investigation can be readily solved by resistor networks. Solution to certain common problems in Engineering through resistor networks is indicated in the course of this paper. Resistor networks are particularly valuable in the analysis of three-dimensional field problems where other methods do not lend themselves to easy analysis.

12. A NOTE ON THE THEORY OF SURGE VOLTAGE DISTRIBUTION IN TRANSFORMER WINDINGS. M. S. Thacker and B. Rakhosh Das, *Electrotechnics*, No. 23, March 1951, pp. 7–25.

The mathematical theory of surge voltage distribution in a transformer winding has been established by various authors. In the differential equations governing the oscillations between the initial and final voltage distributions, the leakage inductance of the H.T. winding plays a very important role. It is shown in the course of this paper that the formulæ used for the calculation of leakage inductance do not take into account the actual leakage field distribution as given by the mathematical theory developed by M. Edouard Roth, for a concentric cylindrical winding, and as such the leakage inductance values differ considerably. The voltage distribution of a test transformer is calculated and differences between the classical equations and the equations developed in this paper are indicated.

13. THE INRUSH OF MAGNETISING CURRENT OF TRANSFORMERS. M. S. Thacker and B. Rakhosh Das, *Electrotechnics*, No. 23, March 1951, pp. 93–103.

The first peak of the inrush of magnetising current when switching in a transformer is several times the full-load current. This may trip over-load or common differential relays if they have been set for fairly low values. The calculation of this inrush has been done by step-by-step process from the magnetisation characteristics of the magnetic circuit of the transformer for flux densities beyond the saturation values of the core used. The first peak of the inrush current has been calculated on the assumption that the trans-

former winding behaves as an air-core inductance, after the core gets saturated and does not conduct any further flux. This air-flux is assumed to have the same frequency as the applied voltage or the core flux. On this assumption the calculated values give several times the values obtained from experiment. But it has been found from experiment that the air-flux has double the frequency of the current or the core flux. Substitution of this value of the frequency in the air-core reactance gives values for the first peak of current which agree very closely with experimental results.

14. SINGLE PHASE OPERATION OF 3-PHASE MOTORS. Chandrasekhar Ghosh and P. Venkata Rao, *Indian Journal of Physics*, December 1951, **25**, pp. 565–74.

"Single-phase operation of 3-phase motor" has been a subject of interest to both design and operating engineers. A large amount of literature exists, in most of which the method of symmetrical components analysis has been used, for the analysis of performances of 3-phase motors with unbalanced voltages. In this paper the method of dyadic circuit analysis developed by Sah is applied to the problem of operation of 3-phase motors from single-phase supply and the necessary relationships have been developed of the complete performance characteristics from standstill and synchronous speed with auxiliary impedances in circuits.

15. SHORT CIRCUIT CURRENT SOLUTION FOR THREE-PHASE NETWORKS. H. V. Gopalakrishna, *Electrotechnics*, No. 23, March 1951, pp. 104–09.

This paper presents the application of the "Short-Circuit Current Solution" to three-phase, four wire unbalanced Y-circuits and to illustrate the mode of solution by a numerical example. The three-phase, three-wire, unbalanced system, Y-circuit is treated as a particularization of the three-phase, four-wire, unbalanced system.

16. ANALOGIC EXPERIMENTAL METHODS IN HEAT TRANSFER. A. Ramachandran, *Electrotechnics*, No. 23, March 1951, pp. 110–15.

It is well known that the solution of certain heat transfer problems defy rigid mathematical analysis as also direct experimentation. However, some of them may be solved by graphical or numerical methods but may require considerable time and labour. Such problems may be tackled by experimental investigations of a "similar phenomenon". This paper deals with the solution of heat transfer problems by the use of analogic experiments.

17. CAPACITOR MOTOR DESIGN. P. Venkata Rao, *Electrical Times*, 6th December 1951, pp. 1015–1019.

This article studies the effect on cost and performance of designing the single phase capacitor motor with stator winding not in quadrature. Equations of performance are set up by dyadic analysis following which a typical design of motor is treated as regards both its starting and its running characteristics. The effect of varying the capacitor is also considered and it is concluded that it is definitely advantageous to design the motor with its stator windings out of quadrature to some ideal value of displacement.