

electrical to mechanical energy. These mechanical watts, however, may be divided into two, those which are utilized in doing useful work, and those which are required to overcome the internal resistance to motion.

For example, in all motors a certain amount of work is required to overcome the friction of the bearings, the friction of the brushes on the commutator, the resistance of the air, and such effects known as hysteresis and eddy currents. The energy required to overcome these must evidently be drawn from the supply, and amounts to a certain loss, and the aim of the designer is to reduce these to a small value. The rest of the mechanical watts, usually called the useful watts, are available for useful work; that is, the energy available on the shaft of the motor.

"En resume," we see that, of the electrical horse power delivered to a motor, only the useful mechanical watts are available for doing work; the ratio of these to the electrical input in watts is called the efficiency of the motor. The electrical input is easily measured by means of an amperemeter and of a volt meter.

The mechanical output can be measured in different ways, one method being by a brake, such brake to be in the form of a prony brake, which is well-known. This brake consists in clamping on the pulley of the motor a pair of wooden jaws which absorb the power. Sometimes it consists of a rope passing over the pulley, the pull on the rope being measured by means of a scale. If p is the pull in pounds on this rope, and r the radius of the pulley over which the rope is passed, the twist on the shaft retarding the motion is equal to pr . If the pulley revolves at a speed of n revolutions per second, the speed of the periphery of the pulley is equal to $2\pi rn$. Now, the work is the product of the force by the velocity at the circumference, therefore the work absorbed in foot pounds by the brake $= p \times 2\pi rn$. Now, 550 foot pounds per second equals one horse power, therefore the horse power absorbed by the brake is equal to $\frac{2\pi rnp}{550}$. This measures the output of the motor.

INHERENT REGULATION IN INDUCTOR ALTERNATORS.

By W. A. JOHNSON.

It should not be necessary to call the attention of the buyers and users of electric machinery to the great desirability of having practically perfect regulation in any dynamo, but this important feature is very often overlooked. By perfect regulation is meant that all ordinary changes in load, from the throwing on or off of lamps, should not cause change in pressure of more than 2 per cent. The usual guarantee of engine builders at the best is but a regulation of two per cent., consequently the dynamo builder is limited to this percentage, as the regulation of dynamo can be no better than the constancy of the speed, as governed by the engine or water-wheel, allows of. It is well known that direct current dynamos are turned out by makers of high grade machines that will give a regulation of 2 per cent., but until recently no inductor alternator has been able to show anywhere near the result.

Good regulation means longer life of lamps, greater satisfaction to the customers, less attention to controlling rheostat, and it generally means a cool running dynamo (unless the dynamo is overloaded). Not only is this true of direct current dynamos, but to much greater extent with alternating current can the greater advantages of perfect regulation be claimed as the most essential point to consider in the selection of a machine, as without proper design the false currents generated in the iron of the machine through lack of magnetic balance necessarily result in excessive heat, bad regulation and low efficiency, and especially is this true in the inductor type of dynamo. The principal reason why one or two of the older manufacturers of alternating dynamos have adhered to machines having moving wire instead of adopting the inductor type, is that most inductor dynamos on the market have extremely bad regulation, and necessarily, through hysteresis losses, low efficiency. Therefore, one or two of the larger manufacturers are still adhering to the old type of moving wire machines, obtaining regulation through complicated composite windings, rectifiers, etc., and of course retaining all the attendant disadvantages of such construction. The mechanical and commercial advantages of the inductor dynamos are so obvious, however, that a machine overcoming the objections mentioned should meet with the approval of all users. It is possible to design an inductor alternator of such construction that perfect inherent regulation within two per cent. can be obtained for all ordinary changes in load, such as throwing on or off the

lamps in a theatre, church or any large building, say 250 lamps on a 1000 light machine, and proportionally on larger sizes. In fact, fully one-third of the capacity of a machine has been cut off with a momentary fluctuation of but one and one-half volts, the needle setting back in a few seconds to standard voltage.

This is far closer than has been obtained before with inductor alternators, and absolutely does away with constant attention to the rheostat (except for change in speed) after the dynamo and line is at working temperature. This is a stronger claim than can be made for the composite wound machine under the usual working conditions. Now, how can this close inherent regulation be obtained? Only in a machine having magnetic symmetry.

This is the key note of dynamo design, and if lacking in an inductor alternator, then through the irregular action of the magnetic flux the different parts of the iron frame and the armature core will run hot, communicating this heat to the windings of the armature and field coils, rendering them incapable of carrying at a reasonable temperature the full current load that the cross section of copper provided would otherwise allow, and in some machines this wasteful magnetic heat has been communicated to the bearings, causing these to overheat and necessitate shutting down.

A machine without magnetic symmetry will overheat at even light loads, thus proving the rule as to temperature, whereas a machine of proper design will remain practically constant in temperature at all loads or until the capacity of the copper windings is fully attained.

To sum up, the claim is made that the successful dynamo or motor (following in design the present recognized theories of magnetic changes) having but a single magnetizing field coil, it matters not whether the machine be for alternating or direct current, is yet to be designed, and that any single coil machine is and will be defective, inefficient, regulate badly, overheat through hysteresis, and that a two-coil inductor alternator of proper design overcomes all the objections mentioned.

This theory was enunciated by us as far back as 1885, and has been reasserted in printed matter we have issued at several later periods, and while it is an extremely simple point not in any case claimed as original with the writer, as it has evidently been recognized by designers of multipolar machines, perhaps, however, inadvertently, as the use of the multipolar type of field originally arose from the desire to obtain low speed and subdivision of current in commutation of direct current machines, yet in the inductor type of alternator the use of more than one field has been entirely overlooked by all manufacturers.

A machine embodying the very desirable feature of close inherent regulation is now manufactured in Toronto by the United Electric Company, Limited, and the correctness of the theory as herein stated is proved by the fact that this machine has practically no magnetic heating in the ordinary sense of the term in the iron or steel of any portion of the frame, inductor or armature core, in fact, under test at overload, it having been under 30 degrees Fahrenheit above surrounding atmosphere after a previous full load run of fourteen hours.

PERSONAL.

The congratulations of many friends are being extended to Mr. W. A. Martin, secretary of the Toronto Electric Light Company, upon the occasion of his recent marriage to Miss Bowling.

The exhibitors in Machinery Hall at the late Toronto Industrial Exhibition presented Mr. T. Eversfield, chief engineer of the hall, with a bedroom set and an address expressive of his kindness and consideration during the fair.

The news has been received in Montreal of the marriage in England of Mr. Ernest G. Coker, B.B., B.Sc., assistant professor of civil engineering in McGill University. Professor and Mrs. Coker were expected to arrive in Montreal about the end of September.

Mr. John J. York, chief engineer of the Board of Trade building, Montreal, has tendered his resignation, to accept a similar position at the St. Lawrence Sugar Refinery. He has been succeeded by his brother, Mr. B. A. York, who for the past four years has been inspector for the Boiler Inspection and Insurance Company of Toronto.

Mr. W. J. Johnston, late editor of the Electrical World, of New York, is at present on a tour around the world. Mr. Johnston sailed from San Francisco, the first stages of his journey being the Hawaiian Islands and Japan. In the Orient, Korea, China, Manila and Java will be visited, and about six weeks passed in India. The entire trip will occupy about eight months, and comprises visits to Egypt and Turkey.