NEW ELECTRO-PNEUMATIC SYSTEM OF ELECTRIC RAILWAY CONSTRUCTION.

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During the past three years, as many of the members of the INSTITUTE know, I have advocated the use of the alternating current motor for certain classes of railway work somewhat earnestly, and have often been asked by my friends why I believed so thoroughly in the alternating current motor, and have been questioned rather closely at times for particulars regarding a certain system which I have been working upon.

I wish to state that long before I had any fixed ideas as to a system of my own, a study of the railway question from an engineering standpoint partially convinced me of the necessity of the ultimate abandonment of the direct current motor for heavy and long-distance service, due to the low working voltage to which it was necessarily limited, the resulting heavy investment in transmission lines thereby required, and the many translations between the power station and the car when any great distance was taken into account.

An active connection with the development and construction of electric railways in this country impressed me with the correctness of my preconceived ideas to such an extent that they finally crystallized into a system of electric railway construction upon which I have been working for several years, and to which I have alluded from time to time without giving, to those not interested with me, any definite information regarding it, for reasons well-known to those working upon new devices.

I have constructed twenty miles of road for this system, together with the necessary trucks and motor equipments, and as I am reasonably sure of the interest you will take in this system, I feel warranted in presenting it to this INSTITUTE.

As I have previously stated before the INSTITUTE, I am particularly anxious that American engineers shall keep abreast with European practice in the development of the alternating current electric railway, and while some of my brother engineers may not agree as to the practicability of my ideas, there are others in the INSTITUTE who, I think, believe as thoroughly as I do in the alternating current motor for railway work, and whether my system proves the correct solution of the question or not, I firmly believe that the alternating current motor will finally prevail for heavy railway work.

The recent discussions of this question that have been going on between engineers in Europe and the United States have made the subject a live one at present, and this is my reason for presenting a brief description of one embodiment of my system at this meeting.

The principles underlying the system which I advocate and which I call an Electro Pneumatic System, are as follows:

1st.—A single-phase or multiphase motor, mounted directly upon the car, designed for the average power required by the car, and running continuously at a constant speed and a constant load, and, therefore, at maximum efficiency.

2d.—Instead of stopping and starting this motor and dissipating the energy through resistances, as is customary with all other systems known to me, I control the speed of the car by retarding or accelerating the parts usually known as the rotor and stator of the motor, by means of compressed air, in such a manner that I save a portion of the energy which is ordinarily dissipated through resistances, and store it to assist in starting the car, helping over grades, for use in switching purposes, and for the operation of the brakes.

3d.—By this method of control I secure an infinite number of speeds from zero to the maximum speed of the car, which may or may not be at the synchronous speed of the motor, for with the air-controlling mechanism working compressing, the speeds below synchronism are maintained, and by reversing the direction of the air through the controller speeds, above synchronism may be attained for reasonable distances. This feature gives to the alternating current motor the element absolutely essential for practical railway work, for it permits a car or train to ascend a grade at any speed with the motor working at its maximum efficiency, and imparting its full power to the car. When descending the grade, the motor may utilize its full power drawn from

the line in compressing air, or it may be used to compress air with the stored energy of the train, thereby acting as a brake.

4th.—By virtue of the air storage feature, each car becomes an independent unit and is capable, in case of loss of current from the line, of running a reasonable distance without contact with the working conductor, and this without the aid of storage batteries. This feature will enable a car to work on a high tension trolley wire or active conductor over private right of way, and allow the active conductor to be stopped where the private right of way ceases, and the car to proceed through a city or town on any tracks, whether electrically equipped or not, until it reaches the outskirts of the city or town where it can take up the working conductor again on private right of way. This feature is also valuable in switching work, for each car being independent it may leave the main line track and operate over switches or sidings without complicating the yards with additional overhead or third rail conductors, thus necessitating through line conductors over main line track or tracks only.

5th.—Since a single phase motor can be used, the motors can be supplied with current from a single overhead wire or third rail, and with a single rail return circuit, thus permitting the overhead construction, or third rail construction, to conform to the standard of to-day, except that a much higher working voltage can be used, provided the insulation is taken care of. Furthermore, in steam railway work, this system by virtue of its single phase feature, will require the use of only one of the track rails for the return circuit, thus leaving the other rail for the use of the signal system, which, up to the present time, does not seem to have been satisfactorily solved without the use of one of the track rails.

6th.—The current will be taken from the working conductor at any voltage up to the limit of the insulation, and in case this voltage is high (I am building my line for 15,000 volts), a static transformer will be carried upon each car and the pressure reduced from the line voltage to the voltage of the motor, which in the case under construction is designed to be 200 volts. Where it is unnecessary to utilize so high a line pressure, the motor may be designed for the working voltage, and the current fed directly from the working conductor into the motor, thus eliminating the static transformer. When a high voltage working conductor and static transformer is used, and it is thought advisable to use a working conductor through cities or towns, this working con-

ductor will be supplied with energy through a stationary transformer at each city limit, thus making the working conductor through the cities or towns safe.

7th.—By virtue of the speed of the motor and its constant load, either when the car is in motion or when it is standing still and the motor is compressing air, the variable load now customary in electric railway power plants is eliminated, and the power station works at practically a constant load, thereby eliminating a large part of the investment at present requisite in power station and line construction. Furthermore, by virtue of the air storage feature, each car, in the particular apparatus I have designed, is capable at any time when current is on the working conductor, of delivering to the car wheels a much greater torque in proportion to the capacity of the motor than is possible with any electrical system known to-day.

I believe that by the adoption of this system the following results will be accomplished:

1st.—The entire elimination of the present standard system of rotary converter sub-station plant, together with the maintenance thereof, and the cost of the necessary attendants.

2d.—The absorbing and rendering available for useful work in starting, or otherwise, of a large percentage of the energy stored in the moving mass which under the present methods of operation is dissipated at the brake shoes.

3d.—A large reduction in the first cost of electrically equipping long-distance railroads, thereby making it feasible, from an engineering and business standpoint, to equip many roads which cannot now be shown to be advisable, thus opening up the steam railway field to the industry in which we are now engaged.