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The editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

COLOMBIA AND THE PANAMA CANAL.

Not a little anxiety has arisen among the advocates of the Panama Canal because of the disposition of Colombia to make trouble over the canal treaty which has been submitted for her consideration. After the treaty had been subjected for many months to the devious ways of South American diplomacy, the announcement was cabled that it had been rejected by the Colombian Senate. Later advices, however, are to the effect that another proposition is under consideration, and that the President of Colombia will be authorized to negotiate a treaty with this country along certain lines which will be agreeable to the interests, fancied or real, of the South American republic.

As far as they are intelligible to the average citizen of this country, the objections of Colombia are due, first, to its reluctance to give up its absolute sovereignty over the strip of land through which the canal runs, and, secondly, to the conviction that in letting this land go for ten million dollars it is not making the most of the occasion; in other words, that it is selling too cheaply to a country whose treasury is overflowing with abundance. The first objection is invalid, for the reason that the treaty was framed so as to safeguard the interests, or rather the sensibilities, of the South American republic on the question of sovereignty, the transfer being in the nature of a lease and not of an out-and-out sale. With regard to the second difficulty, it is hard to see that ten million dollars is, under the circumstances, anything but a fair rental; and in view of the fact that the construction of the canal will be of untold advantage to the republic in the introduction of capital and the promotion of commerce, the terms are decidedly liberal.

The greatest danger in connection with the present hitch in the negotiations is that political capital may be made out of it in our legislature, and that the Colombian Senate may thereby be encouraged to prolong its opposition. It is sincerely to be hoped, however, that the opponents of the Panama Canal will be prepared to take a broad and patriotic view of the whole question, remembering that the choice of routes was decided upon by an overwhelming majority, and that was made after a more thorough and searching investigation of the problem than was probably ever before given to a great engineering scheme of the kind. As to the suggestion which was recently made in the daily press that we still have Nicaragua to fall back upon, it may be dismissed with the statement that since the Panama route was chosen, there has been a growing conviction that the Nicaragua route was not merely the more difficult of the two to construct, but that there were certain physical features inseparable from it, which rendered the construction of a safe and durable canal impossible.

A PROBLEM FOR THE AIR-SHIP BUILDER.

The information which is attainable regarding the dirigible balloons which are to compete at the coming St. Louis World's Fair, makes it evident that there will be a great increase of power over any machines that have previously been tested.

This increase will introduce some problems of strength and resistance which the builders are liable to overlook. So long as motors ranged from 6 or 8 to 20 horse power, the speed of the balloon was necessarily so low that the question of head resistance did not enter seriously into the problem; but with the introduction of more powerful engines and higher speeds, builders will do well to make provision against distortion of the front end of the cigar-shaped balloon, either by transverse buckling, or by the whole head being forced back and flattened upon the balloon itself. Moreover, should the cigar-shaped structure be suddenly deflected from its course when at high speed, the transverse strains would be so serious as to require especial provision of longitudinal strength in the body of the balloon. Just how to provide this strength in the silk and net-covered envelope is a question which is certain to occupy the attention of aeronauts very closely in the immediate future. We are aware that at present dependence is placed upon the longitudinal stiffness of the car or operating platform, which is usually built of a triangular cross-section, with a view to its affording, through the supporting stays and guy ropes, the necessary stiffness. Count von Zeppelin was working along the proper lines when he constructed his balloon entirely of metal, but like Brunel with the "Great Eastern" he was many years ahead of the art. His machine was altogether too large for the limited power that it carried. Nevertheless the indications are that if the dirigible balloon is to be the type of airship of the future, some form of light but strong metal shell, provided with internal trussing, will have to be adopted in place of the present silk fabric. Such a balloon, built of the proper form and strength, in conjunction with a motor that weighed not over a pound to the horse power, would go far to make the dirigible balloon a practical and useful invention. But even when that time is reached, if it ever is, the perfected balloon will not be comparable in its speed or efficiency to a perfected airship of the aeroplane type, for the latter is Nature's own method of flight, and it has every scientific consideration to speak in its favor.

DIRECT CURRENT VS. INDUCTION MOTOR FOR ELECTRIC TRACTION.

Alternators that supply energy to transformers and rotary converters located in substations make it practicable to operate direct-current motors at any distance from a generating plant that can be economically covered by transmission at high voltage. In many cases electric cars with such motors are operated at 30 to 50 miles, and in a few instances at nearly 100 miles from the stations where the power is generated.

The amount of power that may be delivered as direct current at 500 volts through a single trolley contact, when the current comes from a substation, is limited by the ampere capacity of the contact, just as when the current passes directly from generators to car motors. Cars operated by a substation at 500 volts are under similar limitations as to distance from that substation to those which would apply with a generating station at equal voltage. As long as the continuous-current car motors are supplied by a station where the voltage is held substantially constant, the torque of these motors is obviously independent of the fact that the station voltage is maintained by dynamos or by rotary converters. A substation with transformers and converters is frequently designed for the operation of a much smaller number of cars than a generating station would be. From this it follows that a bunch of heavily loaded cars at some point on a line is much more apt to cause a drop of voltage at a converter station than at a generating station. When the station voltage goes down under an overload, the possible current in car motors, and consequently their torque and power of acceleration, is rapidly reduced. High-voltage lines with alternating current may deliver their energy directly to each car or train instead of to substations, and this energy may be changed to continuous current by a transformer and motor generator or converter on the car. This plan raises at once the limit to the power that may be delivered through a single trolley contact to a point above present requirements. Thus if continuous current motors working at 2,000 horse power are supplied with energy through transformers and rotary converters on their car or train, the efficiency of the combination being 80 per cent, then the trolley contact will carry only 125 amperes if the line voltage is 15,000. There is little doubt that current at 15,000 to 20,000 volts can be collected from an overhead trolley wire over a private right of way. If two trolley wires are used, as is necessary with three-phase currents, the best plan is to mount one trolley wire on each side of the track, so that an arc between them will not be possible. With these voltages at the trolley wire cars may be operated more than 50 miles from the generating plant without an excessive loss in or weight of conductors. Continuous-current motors operated by a motor generator or rotary converter on the same car or train have all the capacity for torque that they would have if operated directly by continuous-current generators. As each car or train thus carries its own substation, the motor torque will not be cut down by an overload of cars on one section of a track.

The continuous-current, series motor, constructed with a laminated magnet frame, operates with its usual torque and other properties when supplied with single-phase alternating current, except that there is excessive sparking at the brushes. A prominent manufacturer claims to have overcome this sparking, and if this claim proves to be correct, the continuous-current motor may be operated with alternating current of single phase either direct from generators, from transformers at substations or from transformers on the car driven by the motor. Such a motor evidently does away with the necessity for either motor generators or rotary converters.

Induction motors operating with alternating current of two or three phase, when supplied from transformer stations at about 500 volts, are subject to similar limitations as to the power that may be delivered through a single trolley contact, and the radius of transmission, with continuous-current motors under like circumstances. If transformers are carried on the car with induction motors, the limits as to the length of transmission and power delivered through a trolley contact again correspond to those for continuous-current motors, but the motor generators or rotary converters are dispensed with. As induction motors have no commutator, and their windings, which are in electrical connection with the line, may be stationary as to a driven car, it is practicable to distribute alternating current from generating stations or substations directly to the car motors at voltages much above those that can be safely applied to continuous-current motors. This application of comparatively high voltages to induction motors gives their cars a longer radius of operation from substations or from generating stations where no substations intervene than can be had for cars driven by continuous-current motors. If rotary converters and motor generators are omitted from substations or cars and induction motors used instead of continuous-current motors, the capacity of transformers must be materially increased beyond what it would be with the continuous-current motors. This increase is necessary because for a given increase of torque a much larger current is required by an induction than by a continuous-current motor. The saving as to converters or motor generators must be invested in part at least for transformers. Where induction motors are used for traction, a limit must be applied to line losses that is not present with continuous-current motors. As the torque of continuous-current motors depends simply on the amperes in their windings, the line losses in traction systems that employ such motors are designed to give good average economy, while the maximum loss of pressure in these lines at times when cars are started with heavy loads may be very large. The lower voltage thus available at continuous-current motors when starting simply cuts down the car speed for the moment. On the other hand, the torque of an induction motor varies with the square of the voltage at its terminals, so that a moderate increase in the loss of pressure on the line results in a great reduction of motor torque. The maximum loss that can be permitted on lines supplying induction motors for traction purposes is thus very limited. The most serious limit encountered with induction motors in traction work is that of torque and power of acceleration. At most the three-phase motors in traction work are able to give a torque two or three times that at rated load and speed. Continuous-current motors are usually designed to operate at full rated capacity when driving a car with average load and maximum speed on a level. When a car is required to start with a heavy load, the inherent capacity of the continuous-current motor gives a torque of five, ten, or more times the normal as may be required. On electric lines, where cars make a large number of stops and yet maintain a fair average rate of speed, the acceleration of cars at starting is often at the rate of three to four miles per hour per second with continuous-current motors, and can readily be made still higher if desired. With induction motors designed for average car loads the highest rate of acceleration that can be got when starting under load is about 1.5 miles per hour per second. This limit on the torque and accelerating power of induction motors unfits them for the great bulk of present work in electric traction. It may of course be suggested that the motor capacity on each car be so increased that the necessary starting torque can be obtained. One objection to this plan is the fact that under it the induction motors would be working on partial loads and at poor efficiency most of the time. Another objection is the increased cost of two or three times the present motor capacities on electric cars. Induction motors with their narrow torque limits thus lack one of the strongest elements in the present success of electric traction.

A. D. A.

On July 24 the last chain connecting the Dayton & Western Traction Company with the Richmond Street and Interurban Railway was laid, thereby completing one of the longest traction lines in the world. The line extends from Indianapolis, Ind., to Dayton, Ohio, a distace of 150 miles. In a short time the service will be extended to Columbus, Ohio. A through service from Indianapolis and Dayton will be established as soon as possible with the largest make of interurban cars. As the line runs parallel to the Pennsylvania Railroad all the way it is expected that company will be given stiff competition.