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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.

MUNICIPAL ARCHITECTURE AND THE ELEVATED RAILWAY.

The series of articles on the Berlin underground and elevated railway, of which the last is published in the current issue of the SUPPLEMENT, teach a forceful lesson in good taste in engineering work, by which Americans may well profit. Probably in the whole world there is no engineering structure that so admirably harmonizes with its architectural environments as this newly-opened Berlin road. Each section of the line was carefully planned to correspond in style with the particular quarter of the city through which it passed; every precaution was taken to relieve the coldness and rigidity that are necessarily found in every trussed iron structure. Artistically designed masonry piers have been introduced wherever possible; arches and towers have been employed, notably at the Oberbaumbruecke, with a singularly happy effect. Here and there, as at the Schlesisches Thor, a station has been built, the formal charm of which immediately arrests attention.

It must be conceded that the Germans and French have a finer sense of architectural fitness than we. Perhaps not in all Europe, assuredly not in Germany and France, would a Manhattan Elevated Railway, obtrusively hideous, with machine-made stations, built with no pretense to beauty, be allowed to disfigure a beautiful public park and to mar street after street with its commonplace iron pillars and frames. In Europe good taste is never forgotten—or rather the municipal authorities will not allow it to be forgotten. Not how cheaply, but how artistically, can a public work be carried out seems there to be the official criterion.

From its very inception the Berlin road was the object of municipal care. It was stipulated that no station should be a blemish to the city; that the traffic of the streets should be interfered with in no way. As a result of this rigid control, the builders of the road were prevented from resorting to many a structural convenience, which, commendable enough from the engineer's standpoint, would have been an architectural blot on a beautiful city. As an example of this fine municipal vigilance, we have but to cite a single example. The western branch of the Berlin line passes through a series of wide, handsome boulevards in the newest and finest residential portion of the city. Between the driveways of the broad central esplanade, it would have been a most convenient makeshift to build a viaduct, and thus to have saved millions of marks. Such an overhead structure would have ruined that quarter of the city architecturally. The company was, therefore, compelled to lower the grade from the Nollendorfer Platz westward, to run beneath the boulevard, and to conceal its road until the terminus at Charlottenburg was reached. The construction of this subway entailed an enormous outlay. Quicksands were encountered which rendered it necessary to drive piles —a work which involved months of delay. How beneficial to the city this authoritative rigor has been is shown tellingly enough by the present condition of that section of the road. The excavated channel is walled in, roofed with earth resting on steel girders and arches of masonry, and surfaced with graceful walks on which shade trees have been planted.

In a city which is growing more beautiful as its old buildings are torn down and better designed structures erected in their place, the architectural enormity of a Manhattan Elevated Railway becomes all the more glaring. Bad from the very begining, it apparently grows worse as finer structures are erected along its line. And yet American engineers seem slow to profit by the lessons which have been taught. The new East River Bridge, stupendous though it be, can surely not be considered an architectural adornment. Artistically it is distinctly inferior to the old Brooklyn Bridge with its noble masonry piers. Here again Germans have shown us what can be done. The traveler who steams up the Rhine must feel how vastly superior are the handsome bridges that span Europe's most beautiful stream. Time and time again we have commented upon the excellence of the design which characterizes these Rhine bridges. At Düsseldorf and at Worms, structures span the river, which have been executed so as to harmonize architecturally with the towns on either bank. Mediæval towers and battlements have been used wherever the cities themselves were mediæval in character. The harsh discord of an intensely modern structure and a mellowed old town has thereby been avoided.

The architectural fate of New York city is in the hands of the Municipal Art Society, which has undertaken to correct, so far as it possibly can, the mistakes made two decades ago. A total rebuilding of existing elevated structures can hardly be asked in reason; but surely the Society might see to it that the overhead structure which is to form a part of the new Rapid Transit line, and the proposed bridges which are to span the East and Hudson Rivers, shall be commensurate in dignity and beauty with the metropolis of the greatest industrial country in the world.

THE ARNOLD SYSTEM OF ELECTRICAL TRACTION.

The question of the employment of high-tension alternating currents for long distance or heavy traction has not received the attention that the subject deserves from the American engineering fraternity at large. As a result, the German and other Continental engineers, who have been continually striving to reconcile the demands of the traffic problem with the limitations of the alternating current motor, have, until recently, made much more progress toward a satisfactory solution of the problem than has been made in this country.

It has, however, gradually come to be generally conceded even here, that the direct current, embodying though it does tremendous advantages along the line of speed regulation of the motors, is hardly to be looked to as presenting in the present state of our knowledge a satisfactory solution of the traction question. The difficulties in the way of an economical distribution of the current have thus far proved an insuperable obstacle. In the attempt to conquer this difficulty various expedients have been resorted to, but expedients they have remained. Even the combination of high-tension alternating currents converted to direct low-tension working currents by rotary transformers has proven unsatisfactory to the man who pays the bills, since the loss of energy at conversion, the first cost of substation installation, with the subsequent cost of substation maintenance, together with the cost of the copper wire which it was even then necessary to string between substations if the traffic were at all heavy, almost entirely neutralized the advantages obtained by the initial employment of the alternating current.

At the same time the single-phase alternating current motor has presented, until recently, even less hope of a final solution of this problem than the direct current motor. Practically unalterable as regards speed, low starting torque, and an inability to adapt itself to an overload have rendered it almost impossible as a railway motor, and while the three-phase machine removed many of the difficulties enumerated above, the complexity of conductors presented so many difficulties in the way of transferring the current to the motors that the last state of affairs was but little better than the first.

With traction engineering affairs in this condition the importance of the announcement of Mr. Bion J. Arnold at a recent meeting of the American Institute of Electrical Engineers can hardly be overestimated.

The simplicity of his basic idea illustrates how easily mankind, by continued contemplation of almost any given series of conditions, becomes convinced that the conditions are necessities.

The proposition, somewhat in detail, is as follows: Each motor car is to be equipped with a single-phase alternating current motor of which *both* the armature and field are capable of revolution about the common shaft, either separately or together. Attached to armature and field are two engines, one to each, which are so constructed that they may be used either for compressing air which is stored in a reservoir carried on the car or for driving by means of the compressed air the portion of the motor to which they are fastened. The motor, which is designed to fulfill the average propulsion requirements of the car, is intended to be maintained at a constant speed (synchronous with the driving dynamo) and at a constant load.

Let us now consider the behavior of the device under normal running conditions with the field magnet at rest (with respect to the car) and the armature, to which is attached the car wheels, rotating at its constant speed. (A constant speed is, of course, undestood to mean that a given point in the armature passes a given point in the field a given number of times per second; whether this relative motion is obtained by the rotation of the field or of the armature is of no consequence.) If it be now desirable to slow down the motion of the car the field is released from the clutch which holds it motionless (with respect to the car) upon its shaft and the reaction of the force which until now has been driving the armature causes the field to rotate in the opposite direction. The engine attached to the armature is, at the same instant that the clutch is removed from the field, started compressing air; this increase of the load would tend to decrease the speed of the armature in an ordinary type motor with fixed field, but as the field is here free to revolve, the effect of the increased load on the armature is simply to accelerate the backward motion of the field, and thus the synchronism or relative speed of motion of the parts is maintained. By gradually applying the brakes the actual rotation of the armature is gradually diminished while a proportional increase in the velocity of the field is taking place until such time as the car comes to rest, when the armature has ceased to rotate and the field is revolving at the constant speed necessary to maintain synchronism with the driving dynamo, and incidentally, during all this time the field has been actuating the air-compressing engine attached to it and consequently has largely succeeded in storing the kinetic energy which the moving car possessed. During the whole time of car stoppage the field continues to revolve, and the field engine to compress air in the reservoir.

To start the car again in motion the brakes are released and the field engine gradually throttled, and as this latter, of course, has a tendency to slow down the rotation of the field, the armature in order to maintain synchronism is compelled to revolve, thus starting the car. In addition the connection between the armature engine and the reservoir is changed so that the engine is actuated by the compressed air and this of course assists in rotating the armature. By gradually throttling the field engine, the field revolution is eventually entirely stopped, at which time the speed of synchronism is that of the armature. Speeds greater than this may be secured by changing the connection of the field engine and the reservoir in such way as to actuate the engine by the stored air, so that, as the engine is made to drive the field in the same direction as the armature is rotating, and as the armature is compelled to maintain a given speed with respect to the field, the resulting speed of the armature will be the sum of the synchronism speed of the motor and the actual speed of the field.

In this way an infinite number of speeds may be secured while the relative motion of the parts of the motor remains constant. In ascending a grade the natural capacity of the motor is augmented by the energy of the armature engine, which, connected with the reservoir as in starting, assists the armature rotation. While in descending a grade the energy of the motor may be entirely converted into energy of compressed air by the proper connection of the engines.

Another tremendous advantage which this system offers is that each car, after having been run for a given time, is independent, by virtue of the energy stored in the air tanks, of the main line, and being an independent unit can be shunted and switched across tracks not electrically connected with the main line for a time dependent upon the capacity and contents of the reservoir. In passing through communities where it is undesirable, for any reason, to have the high-tension wire or contact-rail, the car can proceed under its stored energy without any electrical connection whatever; or if the district to be traversed is so extensive as to introduce the possible danger of the air reservoir being emptied it would be possible to provide a static stepdown transformer at the territorial limits which would supply a working current of such potential—say 200 volts—as to be well within the danger limit. The motor would then work directly from the line.

Requiring, as the system does, only a single-phase motor, the ordinary third-rail or overhead construction can be used, always provided that the high potential required be met by proportionately high insulation. In fact, this latter condition seems to be the one weak point in the scheme; a 15,000-volt potential hardly being a desirable accompaniment for any third-rail system now in vogue, and even an overhead naked conductor will present difficulties in the way of insulation, particularly in wet or winter weather, that will make a most careful consideration of this subject absolutely necessary.

It is the present intention to take the current direct from the high potential conductor at 15,000 volts and transform it through a static transformer situated on each car to a working voltage of 200 volts. Under conditions which did not necessitate the use of the high potential conductor the transformer might be done away with, but even under such conditions which would eliminate the saving occasioned by the transfer of energy, at high potential, the system would still show a greater efficiency than any now in use.

The saving of energy at the car end of the line does not by any means represent the major portion of the saving effected. In consequence of the fact that the motor is maintained at constant speed under constant load, it is quite evident that the variations of load usually so exceedingly noticeable at the power station will be done away with. It will be, therefore, possible to build and equip the power house of such a line of such units that it may be constantly working at its maximum efficiency—a condition toward which the engineering effort of to-day is constantly striving.

To discuss the situation as briefly as possible, the advantages are these:

1. By keeping the motor at constant speed under constant load it is possible to have it always working at maximum efficiency.

2. By having the various line motors always carrying the same load, the variations usually evident at the power house will be considerably decreased.

3. By the use of the alternating current motor, the elaborate system of rotary converter substations will be eliminated which will effect a considerable saving both in installation and maintenance.

4. A very large saving in energy will be effected, due to the fact that the energy now wasted at the brakes and in descending hills is stored up for future use.

It is of course needless to say that in view of the high potential of the working conductor a very considerable saving in the installation of long distance roads will be effected.

The only defect evident from a theoretical consideration of the case seems to be the difficulty of properly insulating the working conductor. It will be necessary also to watch very closely over the metallic continuity of the return rail, since even in fairly moist ground a break such as does occur sometimes in spite of the most careful bonding would introduce an element of danger not to be neglected. It may be said, however, from a consideration of the plans that the system opens a new era for traction engineering, and Mr. Arnold is to be congratulated for the ingenuity which he has displayed in surmounting the difficulties which beset his path.

VOCAL SOUNDS OF FISHES.

BY PROF. CHARLES FREDERICK HOLDER.

In the latter part of the summer of 1899 the fishermen brought me two very interesting fishes, which were kept in the tanks for months. They were known to science as *Porichthys notatus*, the popular names being midshipman, singing fish and star gazer. In a general way the fish resembles the cat fish. It is about fifteen inches in length; the head flat, the eyes on top of it and capable of being depressed out of sight when the fish is touched. The prevailing color is a deep blue; the mouth is large and armed with an array of sharp recurved teeth, a remarkable series of pores, and a still more remarkable series of silver spots almost identical with the so-called eye spots seen in Scopelus and others so far as appearances go, yet so far as known not phosphorescent organs. These silver spots are arranged along the sides and upon the lateral ventral surface in a curious design, and resemble the heads of pins driven into the flesh. Each is a round piece of silver-colored membrane, which shows through the skin, above which is a pair of flaps with fringes; between each flap lies a pore.

The fishes habitually lay on the bottom of the tank, rarely moving except when fed; but occasionally they would wriggle to the surface and lie there, displaying the wonderful arrangement of pearly or silver "buttons," which have given the title of midshipman to the fish. The building in which the fishes were kept was sixty feet in length, and while standing at the end one day I heard a loud "umph"-like sound—with heavy accent on the *m*. As I stood and listened, it came again—"umph," so loud that it could have been heard twice the distance away. I turned in the direction of the sound, and when I reached the tank of the midshipman I saw that the jaws of one were stretched outward, and again came the remarkable sound, "umph," which resembled the "word" many monkeys utter when grunting their displeasure or pleasure, but so loud and resonant that although I had heard various fishes utter sounds, I was amazed.

Later I took one of the fishes from the tank and carried it the entire length of the building to a dissecting room, and during the passage the fish uttered the sound continually, attracting the attention of the visitors. This sound is made with the air bladder of the fish, but is not so remarkable as what might be termed the musical sounds of the fish. An acquaintance while walking on the sands of San Diego Bay, very early in the morning, heard a singular murmuring sound. It evidently proceeded from the water, and presently so increased in volume that the listener stood for some time trying to trace it. Finally with the aid of a boat he discovered that the sounds came up from the sea, and emanated from a school of midshipmen. To the observing fisherman along shore, and especially at San Pedro, the music of the fishes is familiar, but it rarely happens that a landsman has the opportunity of hearing it.

My informant stated that the sounds were perfectly musical—a murmuring sound, which rose and fell with a certain rhythm, and that it was a remarkable performance not alone for the loudness of the notes, but for their musical quality.

A very intelligent Venetian fisherman at Avalon informed me that he had often heard the sounds of this fish, and at times in deep water; the peculiar murmuring notes rising and falling, then dying away suddenly to come again.

The late Spencer H. Baird once told me that he had heard the remarkable sounds made by the drum fish of the Atlantic. Wishing to investigate the subject, he made inquiries among the fishermen and learned that they frequently heard the sound, and they willingly agreed to take him to a spot where he was amply satisfied that the drum fish utters sounds—sounds so like a drum, a strange uncanny "boom-boom-boom," that not a few sailors have ascribed them to a more superstitious cause than the common drum fish, which utters them partly by grinding together its pharyngeal bones.

The drum fish is not the only one of its group which utters sounds. Nearly all produce them to a greater or less degree; some being just audible, others loud and distinct. Some years ago a British officer reported that a fish of this group uttered such loud noises that the fishermen at a certain point were alarmed, and attributed it to some supernatural cause. He heard the sounds and described them as resembling the twanging of an immense harp and the beating of a drum. As with those previously described, the sounds varied, being low, a sort of murmur at first, then increasing until there was a babel of strange sounds. It was thought in this instance that the fishes must have clapped their jaws together to produce them, so loud and resonant were they.

One of the most remarkable sound producers it has ever been my good fortune to listen to was a Haemulon of the Gulf of Mexico—one of the wide-mouthed, highly-colored grunts so common on every portion of the reef. I never succeeded in hearing this sound beneath the water, though I passed many hours lying on a platform I had built at the surface, beneath which were hundreds of grunts unsuspicious of my near proximity. They were constantly engaged in games, chasing each other about, now approaching one another, opening the mouth wide and standing perfectly still; then retreating, and at this time, if any, the sounds must have been uttered. The moment I took one of these fishes from the water it began to grunt: "Oink-oink-oink"; now with one prolonged "o-i-n-k," then strung along rapidly, as though to intensify its agony; all the while it rolled its large eyes at me in a comical manner. No one in listening to such a remarkable outcry from a fish could refrain from wondering whether it had any significance; in other words, the impression was created that it was barely possible that the sounds were repeated in the water, and that they represented a very primitive attempt at vocal communication among fishes; but, as I have said, the sounds were never heard rising from the multitude of grunts, which swam about beneath my improvised screen, and the most plausible theory is perhaps that the sound *oink* is the only one the fish can utter, and that it is accidental or involuntary, though in the case of the midshipman, whose voice I heard sixty feet away, and which appears to "sing," there must be some different explanation. The murmuring sounds have some significance or meaning.

Several years ago I witnessed a sudden run of dog fish—a small shark on the New England coast. In the morning the men were cod-fishing on the banks, but suddenly the dog fish "set in." They came in countless thousands, destroying the fishing; a ravenous horde, fairly filling the water and eating even jelly fishes to satisfy their hunger. No sooner did a bait strike the water than several rushed at it, and the boat near me had the sail, which was dragging overboard, torn in pieces by them. The fishermen immediately changed their tackle and began fishing for dog fish for the livers, which were valued at a cent apiece, soon filling their boats. As the fish were hauled in they uttered loud croaks sounding like "r-o-i-k, r-o-i-k," and this was heard from scores of snapping mouths in concert. In this instance it seemed to require no little effort to produce the sound, and it may have been, in all probability was, the accompaniment of a convulsive gasping for breath.

The sounds produced by fishes—and sixty or seventy or more are known to utter them—it is supposed are caused by the action of the pneumatic duct and swimming-bladder, or produced by the lips or pharyngeal or intermaxillary bones. The curious puff shark uttered a deep grunt when it was taken from the water. I heard this sound one day while on the beach at Avalon, and although I recognized it, I could not see the fish. Finally after hearing it repeated a number of times I traced it to a hook near by where a fisherman had, with the usual indifference to the feelings of sharks, hung the fish by the gills. The grunt may have been involuntary, but I chose to construe it into a plea for mercy and unhooked the shark and placed it in the water, where it swam away, its voice, in this case, having saved its life.

The carp utters a low sound, and a sunfish which I kept, often came to the surface and uttered an audible clicking sound. Some of the gurnards utter a murmuring sound; many of the cat fishes produce sounds and the eel and moray are said to have the same power. On the Maine coast, near Ogunquit, I once found a remarkable eel settlement, and spent much time drifting over the spot, listening for the sounds made by them, handling many as they crossed the rocks at ebb tide to reach the sea, but I was never repaid. Dr. C. C. Abbott, who has heard the sounds uttered by eels, states that they are the most musical of those of any fish observed by him. I have handled and experimented with Florida and Southern Californian morays, with a similar object in view, but without results. It is believed that the sounds are produced by forcing air from the swimming-bladder into the oesophagus, and according to the authority quoted, the note of the eel is often repeated and has a slight metallic resonance.

The little sea horse has a note, though I have always failed to hear it; but I have listened to the low growling croak of the semotilus of the St. Lawrence, and more than once tossed a fish back for its pains and I might say its vocal reproaches, and I have heard the croak of the California "big head." A whirring sound is said to be uttered by the gizzard shad—*Dorosoma cepedianum*—while the chub has a single note, probably produced by the air-bladder, as a discharge of bubbles has been noticed after it. When the sounds of fishes can be caught in the phonograph, and some careful observer devotes his attention to the subject and makes an exhaustive study of it, the results will be of more than ordinary interest.

SCIENCE NOTES.

Bessel in 1831 first determined the mass of the rings of Saturn by observing the motion of Titan, his largest satellite. The approximate mass obtained is admittedly large. Professor Hall, in a recent number of the Astronomical Journal, has determined the mass of the ring to that of the planet as 1 to 7,092. This gives the ring a mass only two-thirds that of Titan, whose mass is to that of Saturn as 1 to 4,500.

Desmoulieres has examined the coloring matter and sugars contained in apricots. He finds that the former can be removed from both acid and ammoniacal solution by amyl alcohol, and appears to be identical with carotin. The sugars extracted were saccharose, invert sugar, and glucose, the proportion of the latter being small in ripe fruits, but larger in unripe fruits (0.353 and 0.771 per cent respectively).—Bull. des Sci. Pharm.

The captain in charge of the lightship situated at the southwest channel of the bar at the entrance of San Francisco Harbor recently reported to the United States Lighthouse Commissioner that on the 15th of September a large number of land birds took refuge on board the vessel. A dense smoke from northern forest fires hung over the locality and completely obscured sea and land. Evidently the birds had lost their way and, exhausted by their long flight, the wanderers lighted on the ship undeterred by the presence of the crew. At one time sixty of the feathered guests were counted on various parts of the ship. Owls, cranes, humming birds and other non-marine species were noticed during the time. The swarm continued during the prevalence of the smoke, but vanished when the weather cleared.

Lieut. Peary has brought home news of a mysterious epidemic which is raging among the Esquimaux. Indeed, so terrible were the ravages of the disease, that many of the Esquimaux at Smith Sound begged him to take them south. Twelve years ago the Esquimaux numbered 300. In 1897 Peary found that their number had been reduced to 234. It is now probable that these most northern inhabitants of the globe do not exceed 200 in number. This is but one instance of a great number that may be cited. All through the Arctic region the inhabitants are fast disappearing. The Alaskan Esquimaux have been decimated. When explorers first went among them, their number was believed to be from 2,000 to 3,000. Now it is thought that hardly more than 500 people can be counted from Point Barrow to the Aleutian Islands. The lot of these unfortunate natives has been made harder to bear by reason of the destruction of sea life by the whalers who harried the Alaskan coast. The extermination of the seal, walrus and polar bear have likewise done their share to embitter the cup of the northern races. In southwest Greenland a similar condition of affairs exists. The ten thousand natives are barely holding their own, although largely aided by the Danes. Labrador natives are likewise decreasing. Twenty years ago they numbered 30,000; now they number barely 15,000 souls. Two decades ago the entire population of the North was estimated at 30,000. It is probable to-day that the number has been almost cut in two.