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SCIENTIFIC AMERICAN SUPPLEMENT

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## THE DIFFICULTIES AND PROBLEMS OF THE ELECTRIC ENGINEER.

One of Germany's greatest philosophers, now many years dead, affirmed that electricity was destined to serve the minor uses of life. Up to a recent period this observation was wonderfully just. In spite of the work of Page and others the electric motor remained for years little better than a toy. In metallurgy the deposition of thin coatings of metals was all that electricity effected; in the production of light and heat its work was nothing; and the electric telegraph was the most impressive exhibition of its power. Now all is changed. In all technical departments the work of electricity appears—often on the greatest scale. In welding metals and in the arc light the larger class of heating and lighting operations are effected; in the Cowles and other electric furnaces, metallurgy and heating find their exponent, while in the transmission of energy electricity is with out a rival in the magnitude of its operations and in the number of horse powers of energy conveyed to points distant from the place where the energy is generated. The effect of the new *regime* and of the unprecedented developments upon the public has had its effect, and electricity is believed to be almost omnipotent.

Yet the German philosopher's observations have even to-day a glimmer of truth in them, because of the limitations of electricity. None of the phases of energy has drawn for it more provoking limits. Repeatedly experiments in the larger class of operations have been tried only to fail, because the limitations of the subject were poorly understood. By a survival of the fittest, and by gradual improvement in detail, the present appliances of what may be termed electric engineering have been produced and have found their place in the world's work.

In the transmission of energy one of these limits is found. Ordinarily a mechanical transmission system works more economically, as it does more work. Thus a cable traction plant kept in motion and propelling no cars works at a total waste; every car put upon the line increases its efficiency, and the efficiency keeps approaching the hundred per cent limit as car after car is added. In the electric transmission of power, as usually conducted; the case is exactly the reverse. Every increase in energy transmitted involves a greater waste upon the line. The only way to bring about economy is to have the resistance of the line low as compared to that of the lamps and motors absorbing the energy transmitted. Of course, this may be counteracted to some extent by the greater economy in generation of large quantities of energy at the station, but the limits to the economy of transmission proper remain. A line supplying lamps or motors in parallel with each other will work to constantly increasing disadvantage as greater draughts are made upon the line. The case is comparable to the "wire drawing" of steam, where a large engine is fed by too small a pipe. For a given steam pipe, the larger the engine supplied by it, the greater will be the waste.

Recently many attempts have been made and carried out to use the current as a heating agent. Again the question of economy appears, and for the present seems to preclude the extensive use or any except special applications of the current for heating purposes. The generating plant is usually run by steam. Coal is burned and its energy is employed to drive a steam engine which drives a dynamo. The dynamo may have an efficiency of ninety-eight per cent; the boiler may have an efficiency almost as great; but the steam engine, subject to the second law of thermo-dynamics, at one fell swoop reduces the efficiency of the system to perhaps only two or three per cent. Burning coal under a boiler and using the steam power to generate electricity, and using the current as a heat producer, is comparable to running a hot air furnace on such principles as to send nearly all the heat up the chimney.

It would seem as if the thought that a horse power of energy is required to keep a few feet of fine carbon filament white hot would be a subject almost of mortification to the electric engineer. This is the case with incandescent lighting. That it is a subject of thought with him, that he does hope for improvement in the future, is evidenced by the eagerness with which researches on the direct production of light are watched. The electric world, in a sense, is waiting for the inventor or scientist who will produce the Hertz waves of frequency sufficient to affect the eye. The inefficiency of the incandescent lamp is so fully recognized that the glow-worm, firefly and curculio are looked upon as models of efficiency in light production—examples too near perfection perhaps for man to aspire to follow —yet as examples which may show the way to better results in the future.

The want of suitable refractory material for the incandescent lamp filament, the high capitalization required for electric generating plants, the poor economy of the steam engine as a prime motor for driving dynamos, are a sample of the difficulties which the electric engineer has to contend with. It is to be hoped that the inventor will dispose of enough of them to make electricity take the place it is fairly entitled to.

## BAUXITE MINING IN ALABAMA.

The growing importance of aluminum gives interest to the ore from which it is obtained. This ore derives its name, beauxite or bauxite, as it is more commonly called, from the town of Beaux, or Baux, near Arles, in southern France, where it has been found in large quantities.

Within recent years it has been discovered in Tennessee, Virginia, both the Carolinas, Georgia, Alabama and Arkansas.

An article by Henry McCalley, in *Science*, is our authority for the following statements concerning the present status of the mining of the ore in the South.

Of the four companies which have been engaged in the industry, only two are now operating. They are known as the Republic Mining and Manufacturing Company and the Southern Bauxite Mining and Manufacturing Company.

But three mines are being worked at present; they are all near Rock Run, Alabama. An average sample of the ore from one of these mines shows on analysis about this composition:

| | |
|---|---|
| Alumina | 61·00 |
| Ferric oxide | 2·20 |
| Silica | 2·10 |
| Titanic acid | 3·12 |
| Water | 31·58 |

Samples from the other mines differ a little from this; they yield from three to five per cent less of alumina. The mining is easy, as the ore is soft and can generally be taken out with a pick; it is, however, rather expensive, as the ore varies so much in quality that it must be carefully sorted by hand and with the screen.

The diggings are on side hills, and are drained by open ditches. The ore whose analysis has been given is about 35 feet thick in the mine. It is concretionary; the best of it is found in a middle seam four or five feet thick.

Owing to its hydroscopic property all the ore has to be dried before it is shipped.

This is done by spreading it out in the open air, for the action of sun and wind.

When favorable tariff legislation makes it safe to increase the working capacity of these mines, artificial means of drying and better drainage facilities will be adopted.

At present only the best grade of ore is shipped. It is used for the manufacture of alum, which could as well be made from the inferior ore now lying in heaps about the mines, but to compete with the cheap imported ores, sent over by men who had the entire business in their hands, before these mines were open, only the best product can be put upon the market.

## EXPERIMENTS WITH TELEPHONES.

The telephone invention now being public property, no impediment is offered to the free use of the instrument for business, social and scientific purposes. This, together with the fact that the very best telephone can be bought for less money than is required for the materials or parts from which it is made, places everybody on an equal footing as regards the use of this interesting instrument.

The telephone is incapable of producing any very striking physical results beyond transmitting speech, as the current generated by the telephone used as a transmitter is almost infinitesimal. Still there are many interesting experiments which may be performed by means of two telephones with suitable line connections.

To use the telephone to advantage, a call of some kind is required for signaling. The simplest device for this purpose known to the writer consists of a battery at each end of the line, a ratchet bar mounted so as to act as a switch for cutting out the telephone, and a battery having one pole grounded while the other is furnished with a blade of spring metal which may be drawn quickly along the ratchet bar, making a series of rapid interruptions of the current, producing a rattling sound in the distant telephone, which can be readily heard at a distance of from 25 to 40 feet from the instrument, especially if a trumpet-shaped resonator be placed in such relation to the telephone as to allow the mouthpiece of the telephone to rest upon the smaller end of the resonator. A toy tin horn cut off at the proper diameter answers well for this purpose. A screw-threaded rod serves very well indeed for the ratchet bar.

An interesting experiment is transmission by telephone of the vibrations of a tuning fork at one end of the line to a tuning fork at the other end of the line. The mouthpieces and diaphragms are removed. At one end of the telephone line a tuning fork is supported on a resonator with one of its prongs very near, but not in contact with, the pole of the telephone magnet. A tuning fork of the same pitch is vibrated in front of the telephone magnet at the opposite end of the telephone line. The fixed tuning fork is made to vibrate by the variations of magnetism produced by the current induced in the transmitting telephone by variations of magnetism produced by the vibration of the fork at the transmitting end of the line.

By means of two telephones, one with a diaphragm, the other without, the speed of machinery may be indicated at a distance. The telephone without the diaphragm is placed with the pole of its magnet very near the iron arms of a revolving wheel, or it is placed near a wooden wheel carrying a number of armatures. As the wheel revolves, the arms or armatures in passing the pole of the telephone produce changes of magnetism which induce electric pulsations in the winding of the telephone magnet. These electric pulsations affect the strength of the magnet of the distant telephone, thus causing the diaphragm to vibrate, producing in the telephone a musical sound, the pitch of which depends on the speed of the machinery. The pitch being ascertained by comparison with a pitch pipe or similar instrument, the speed is found by a very simple calculation.

By attaching to the mouthpiece of a telephone a cork having in it two perforations, in one of which is inserted a small glass tube drawn down so as to form a gas jet, having an aperture as fine as a cambric needle, while in the other perforation is inserted a right-angled tube for receiving a small rubber gas tube, a manometric flame apparatus is constructed in which the vibrations of the receiving diaphragm will be shown by vibrations of the gas flame, these vibrations being analyzed by means of a revolving or swinging mirror, according to the well known method. Probably the best material for fastening the perforated cork in the telephone mouthpiece is beeswax.

### Excavations in the Caucasus.

A lecture was given recently before the Glasgow Archæological Society by the Hon. John Abercromby, on "Some Recent Excavations in the Caucasus." He said the Caucasus had long been a wonderland. In Greek fable it was famed as the land of the Golden Fleece, as the place of punishment of the overbold Prometheus. It used to be considered the center of dispersion of European peoples, and until recent times it was regarded as the region where the art of metallurgy originated. His paper was devoted to a description of some of the more recent excavations that had been made on both sides of the great chain of the Caucasus, and on the adjoining district of Russian Armenia. Premising that archæologists are inclined to the belief that the Caucasus was uninhabited before the arrival of the use of metals, he proceeded to describe in detail the results yielded by the examination of places of interment, and afterward summarized the conclusions of M. Chantre with regard to those belonging first to the earlier period, which he placed between 1500 B. C. and 700 B. C., and second to the later or Scytho Byzantine period, which dated from about 700 B. C. to 700 A. D.

The majority of the forms and decorative motives of the cemeteries of the iron age in the Caucasus and in all Europe were, if not identical, so analogous that we were bound to attach them to the same civilization. It was interesting to find incrustations of iron in bronze in the Caucasus, in Switzerland, and Austria; to find daggers with antennæ identical with those of Hallstaldt; to find torques like those of Bosnia and Jura, belts of thin stamped bronze and pendants of forms thought to be peculiar to the Tyrol, spirit armlets like those in the Alps and on the Danube.

While this was the opinion of M. Chantre, Professor Kondakoff, Count J. Tolstoi, and M. Reinach, with fuller knowledge and writing six or seven years later, came to the conclusion that a number of objects found north of the Caucasus showed an analogy with others from southern Russia belonging to the first centuries of our era. They would not admit that the Caucasian finds were anterior to the Christian era. Mr. Abercromby next proceeded to describe the explorations of M. De Morgan in the years 1887 and 1888 of five cemeteries situated to the south of the Caucasus in a line drawn from Batoum on the west to Baku on the east. These cemeteries represented four distinct periods, the oldest from 2500 B. C. to 3000 B. C., and the latest belonging to the seventh and fifth centuries B. C. M. De Morgan divided the 250 tombs opened by him into four classes—(1) dolmens of large dimensions containing bronze weapons; (2) kists or small dolmens containing bronze arms of a later period; (3) kists of a transition period in which iron began to be used; and (4) kists containing iron alone. The oldest dolmens were found on mountain tops, even at an elevation of 9,000 feet, either isolated or in groups. In these the arms were of bronze, consisting of long two-edged swords, daggers, lanceheads, arrowheads, and axes. Ornaments were rare, and included necklaces of cornelian beads and blue porcelain bangles and pins of bronze. One necklace contained a well polished agate engraved with *Vos zebu*, which seemed to indicate relations of some kind between India and the northwest of Persia in the bronze age. The pottery was coarse and without ornament. The mortuary furniture of the second class was rich and artistic, that of the third less so. With the appearance of iron a great change took place. Bronze weapons were gradually replaced by swords, poniards, and spears of iron. Pottery affected the forms of birds, oxen, and horses. From the similarity of the dolmens of the first inhabitants with those found in India, throughout Europe, and in the northwest of the Caucasus, M. De Morgan believed that they were probably all constructed by different tribes of the same Aryan race.

### School Athletics in Relation to Mental Training.

The mere circumstance that discussion has long been and still is active in seeking to define the true position of physical exercise in relation to mental training should suffice to prove the essential nature of the connection which binds together these diverse methods of education. Each is in its own place indispensable, and this fact happily is in a greater or less degree recognized in every school curriculum, even the most humble. The reason is not difficult to find when we consider how closely and inseparably associated is the health of the mind with that of the body. It is not in the nature of things that we should be capable of sustained and vigorous mental activity unless due provision be made for the purification and nutrition of tissue, including that of the brain, by means of an active blood circulation. The relation between the latter and muscular energy requires no explanation. It is true that bodily activity does not confer mental power or even encourage mental exertion. It is also true that exceptional powers of mind have displayed themselves in persons physically weak; but neither of these admissions affects our present argument, which maintains the certain advantage resulting to all mental processes, ordinary or exceptional, from that which promotes the health of their nidus in the brain. A further benefit conferred by physical training is its influence upon character. A host of mushroom frailties, vices, and foibles break down in the presence of such vigorous growths as the resolution, the endurance, and the manly self-reliance engendered by a habit of orderly and energetic action. Justice, fairness, and fellow-feeling are developed by the same wholesome training, and thus many a boy at school acquires almost unconsciously that living force of character without which intellect is but a brittle gem. For obvious reasons our public schools have taken a leading part in promoting physical education in this country. The pupils trained in them are, in very many cases, resident, and the consequent responsibility for their bodily health imposed upon teachers who act in loco parentis has no doubt had to do with the formation of a compulsory system of exercise. Administered with due regard to individual fitness or unfitness, we regard this arrangement as beneficial, and we welcome the development of a similar, though naturally somewhat less stringent, method in the management of day schools throughout the country. Into the comparative merits of the particular means employed we cannot now enter. It is enough that the principle which they express is generally admitted, and that those who now administer education are for the most part firmly convinced of its importance as a power to be regulated and employed for the mental as well as the physical well-being of those under instruction.—*The Lancet.*

### Maple Flooring.

Among the noteworthy features of recent lumber trade development is the rapidly increasing demand for maple flooring. Improvement in the method of manufacture has kept pace with the growth in demand for product; or perhaps it is more exact to say that the recognition of maple flooring has been forced on the attention of consumers by the enterprise of manufacturers in turning out a perfected product and urging it on public attention. A few years ago all the maple flooring used was worked out on orders by a few planing mills. The hardwood dealers carried maple strips in their yards and had them dressed and matched when they happened to receive an order for flooring. Now great manufactories have been established for the sole purpose of producing maple flooring. Exact, strong and swift machinery has been invented to work out the stuff. The boring machine has rendered nailing easy, and now comes the end-matching invention. Maple flooring has come to be regarded as the thing indispensable in most public buildings and is used largely in private dwellings. Such an extent has the demand reached that the larger dealers are obliged to make contracts for millions of feet far in advance of requirement, the same as is done with pine or any other wood of extensive sale and consumption in the building trades and manufacturing.

The demand for maple flooring in its phenomenal growth suggests that the timber out of which it is produced cannot last forever. There is a limit to the supply of maple, almost in sight, unless the forests shall be bought up and reserved from denudation by farmers, who see more value in the soil than in the timber. But if maple must go rapidly, there is consolation in the fact that yellow pine and Pacific coast fir are both good flooring woods, while oak is not to be despised. Come to think of it, several generations yet unborn will be able to tread on good hard floors before the timbers to make them shall be exhausted.—*N. W. Lumberman.*

### A New Quick-firing Gun.

The new Salvator mitrailleuse, or quick-firing machine gun, having been adopted by the Austrian military authorities, a number of pieces have been manufactured, and are reported to be ready for distribution. The gun is not intended for use in the field, as in the case of the English Maxim and Nordenfelt machine guns, but will be mounted stationary on the outworks encircling important fortresses. It is said to be only half the weight of the Maxim, and its average rate of discharge is about the same—300 rounds per minute, with a maximum of 320. The diameter of the bore is 8 millimeters, being similar to that of the Mannlicher repeating rifle now in use in the Austrian service. The barrel is not incased in a water jacket, and 1,200 continuous rounds can be fired before it shows the effects of the excessive heat. The cartridges are supplied, as in the Nordenfelt, from a large hopper fixed above the firing chamber. The gun is fired by means of an ordinary trigger, with trigger grip, and a recoil spring supplies the automatic action. But the principal point of interest in respect of which the new gun differs entirely from the mechanism of similar weapons now in use in other countries is the oscillating pendulum regulating the speed of fire. There are two firing commands with the Maxim—single fire and continuous fire. The discharge is regulated by the turning of the crank handle. The single fire is as the fire from an ordinary repeating rifle, while continuous fire represents the most rapid discharge of which the machine is capable. With the Salvator mitrailleuse, however, the great advantage is gained of sustaining a moderately heavy discharge of 30, 50, to 100 rounds per minute, and increasing it by means of a faster oscillation of the pendulum to 300 when a dangerous phase of attack has been developed.

### Shooting Through Solid Steel.

The futility of piling steel armor plates on war vessels is being demonstrated at the new testing ground of the Cramps, says the Philadelphia *Record.* There, at intervals of a few days, conical steel shells are fired through four inches of solid steel armor plate with as apparent ease as though the plates were the flimsiest cardboard. The range is on the Lewis farm, above Wheatsheaf Lane, along the Delaware River. The shells, which are three inches in diameter and ten inches long, are forged from the finest hardened steel and fitted by the Cramps for use in the United States army and navy, and it is to test the quality of the steel in different lots that these experiments are being conducted.

A heavy abutment of railroad ties has been erected as a fender to hold a bank of earth, and in front of that is placed a heavy oak plank box, five feet square and ten feet long, which is filled with sand.

Against another fender in front of this box is set up one of the armor plates, such as are used on the armored cruisers and battleships now being built. One hundred feet distant from the plate is the firing house—a plank building about thirty feet long by ten feet wide, and double lined to deaden sound. Two three-inch rapid-firing Driggs-Schroeder guns are used in the tests. When everything is ready for firing, a lanyard is passed out of the back of the building and through an aperture in a pile of heavy spruce joist, the gun having previously being sighted.

When the gun is fired, the wall of steel is pierced by the projectile, leaving only a fringe around the hole where the shot passed out on the opposite side. It is then sought for in the sand in the box and examined closely as to condition. Of course the shell is not charged, or it would explode and blow up the box and all around after going through the steel. Not all the shells fired at the steel armor plate go through it, and this is considered sufficient cause for condemnation of that batch of projectiles. The experiments are all conducted by the Cramps' regular staff of ordnance officers.

### Aluminum.

It is true that every brick in a house and every bank of clay contains a considerable quantity of that beautiful metal aluminum. But science has not yet discovered any economical way of extracting the metal from clay, because in the form it there exists, namely, aluminum oxide, it is combined with silicon oxide, and these two substances behave like a pair of Siamese twins; they are so strongly bound together it is next to impossible to separate them. Therefore, in the production of aluminum, chemists do not use clay, but turn to some material which contains the oxide of alumina free from silica. The best material is a mineral known as cryolite, which comes chiefly from Greenland. It is a double fluoride of aluminum and sodium and an artificially prepared sesquioxide of alumina; these are suspended in a bath of molten chlorides of the alkaline earths and then subjected to electrolysis by powerful dynamos. The sodium salts are decomposed, the metallic sodium seizes eagerly upon the oxygen that was in combination with the aluminum, and as a result the white metal aluminum is freed and settles to the bottom.