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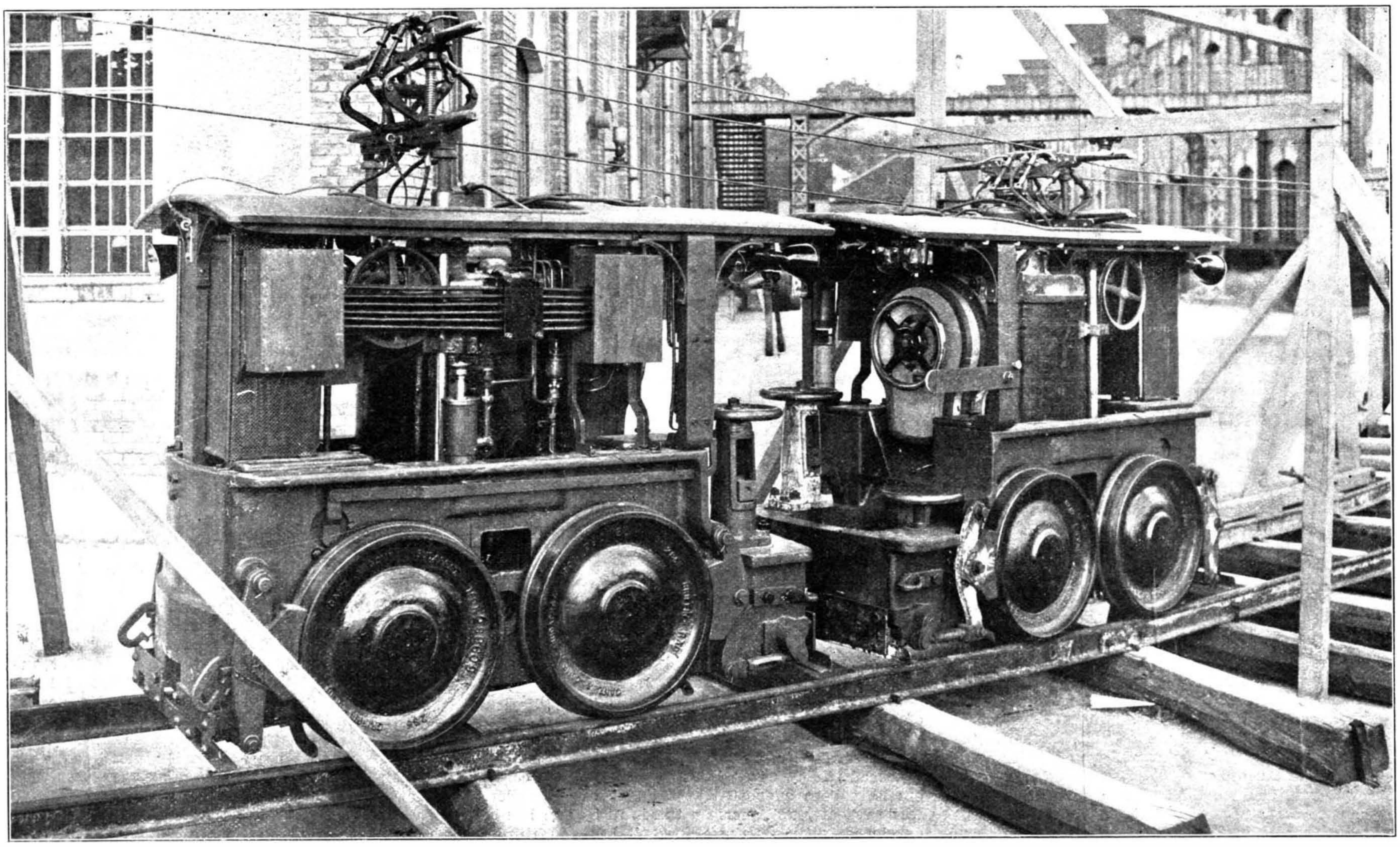
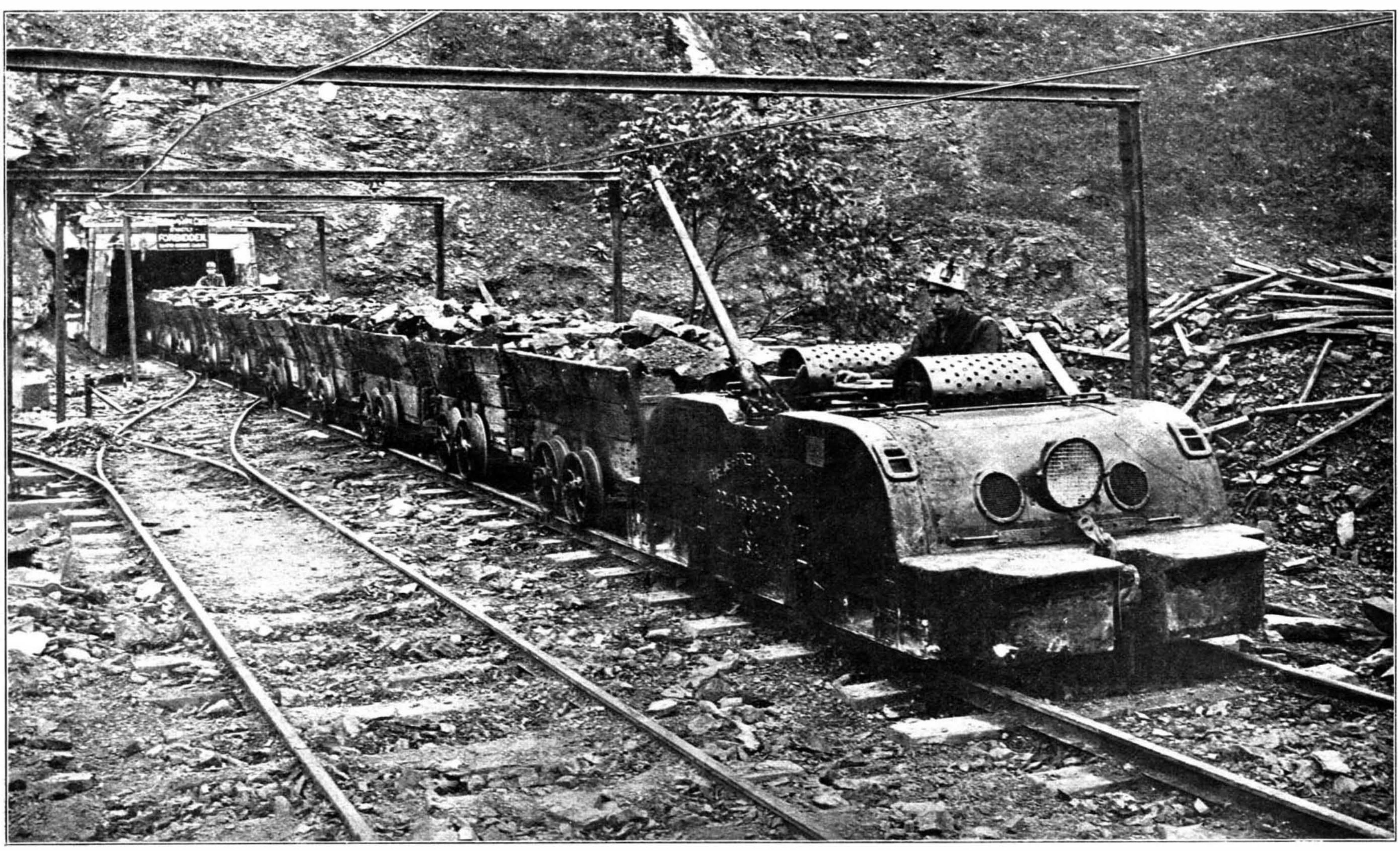


FORTY-HORSE-POWER, THREE PHASE MINING LOCOMOTIVE, USED AT MINES DE LA MURE, FRANCE.



AN AMERICAN JEFFREY MINING LOCOMOTIVE AND TRAIN.

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.

[Concluded from Supplement No. 1477, page 23665.]

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.—II.*

By Frank C. Perkins.

Among the earliest electric mining locomotives used in Germany should be mentioned that installed at the salt mines at Neustassfurt in 1883 by the Siemens & Halske A. G. of Berlin, which, with five others constructed at the same works, is in operation at the present time. This was more than two decades ago, and the development of electric mining locomotives has been remarkable during that time. The accompanying illustrations show types of electric mining locomotives constructed by Siemens & Halske of a gage of 1,000 millimeters (39.37 inches). One of these mining locomotives was built for the Karl-Ferdinand tunnel. By this adit the Minette lode, 6 kilometers (3¾ miles) distant, is opened, and for transporting the full output of this mine about a dozen electric motors are employed. The speed of this German mining locomotive for normal work and full load is 10—15 km. (6¼—9¼ miles) per hour. These locomotives, with gages of 450, 560, 700, and 1,000 millimeters (17.71, 22.04, 27.55, and 39.37 inches), have respectively electric motors of 18 horse-power, 36 horse-power, 56 horse-power, and 82 horse-power. While the smaller types are largely used for the side and main galleries leading to the shafts, those of larger power are utilized in the main adits of great length. In those German mines in which the underground transportation is interrupted by shafts, electric locomotives are frequently employed for transporting the ore above ground to good advantage. While it is well known that the disadvantage of the steam locomotive, such as the smoke nuisance, is not as annoying above ground as in the mines, where it is frequently dangerous, still the electric locomotive is better adapted for this work, and has a greater efficiency than the steam locomotive. Steam locomotives are not so well adapted for trains of small weight, as they have to carry greater weight in proportion to the power developed, it being necessary to carry on them a complete steam plant as well as the required amount of coal and water.

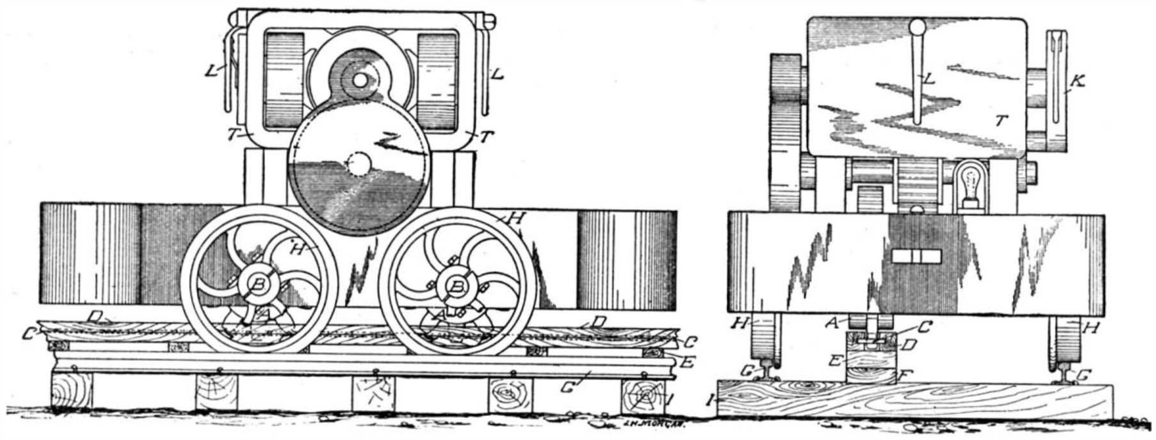
One of the mining locomotives of the Benrather Maschinenfabrik of Dusseldorff, Germany, has a tractive power of 2,500 kilogrammes (5,511½ pounds) and a traveling speed of about 9 kilometers (5½ miles) per hour.

This mining locomotive was designed for a gage of 700 millimeters, and the distance between the wheels is 1,500 millimeters (59.05 inches), while the total weight is about 19 tons. It is provided with two direct-current motors, each having a capacity of from 45 to 50 brake horse-power, and is a double-ender, being controlled from either the front or rear.

A number of direct-current, as well as three-phase alternating-current, mining locomotives have been constructed at Leobersdorf-Budapesth by Ganz & Co. A direct-current mining locomotive was recently built at this plant for the Barry Consols Extended Gold Mine Company, of Melbourne. It was designed for a gage of 16 inches, and is operated by a 10 horse-power continuous-current electric motor, the current being supplied by a single overhead conductor through a flexible cable. A number of three-phase mining locomotives have been installed in Hungary and France, ranging in power from 10 to 40 horse-power. A 10 horse-power three-phase mining locomotive of the Ganz type was recently installed at Perczes, Hungary, and another of 20 horse-power capacity at Gyaler, while a 40 horse-power locomotive of the Ganz & Tarsa type, arranged on two trucks, was recently installed at the Mines de la Mure in France. Most of the foreign as well as the American mining locomotives are constructed very low, the operator controlling the locomotive while seated, although, where there is plenty of overhead room, some foreign locomotives have been constructed with a cab and controlling apparatus sufficiently high for the driver to control the same while standing, notably in a type recently constructed by the Swiss firm of Maschinenfabrik Oerlikon.

Most of the electric mining locomotives in America as well as in Europe are supplied with current from overhead trolley wires, but in some cases the conductors have been supported at the side of the galleries, while recently an American third-rail system has been developed, utilizing the "Morgan" low-vein third-rail locomotive. It is claimed that a great saving is effected in the operation of mines having thin veins by employing this third and traction rail haulage system. It is stated that the extreme height of the locomotive of the third-rail type is 32 inches, the length being 7 feet, and it can be operated successfully in places where mules cannot be used. A great saving is effected, it is claimed, as mules can be dispensed with entirely by using these small locomotives in mines, where men can push the cars out of the rooms.

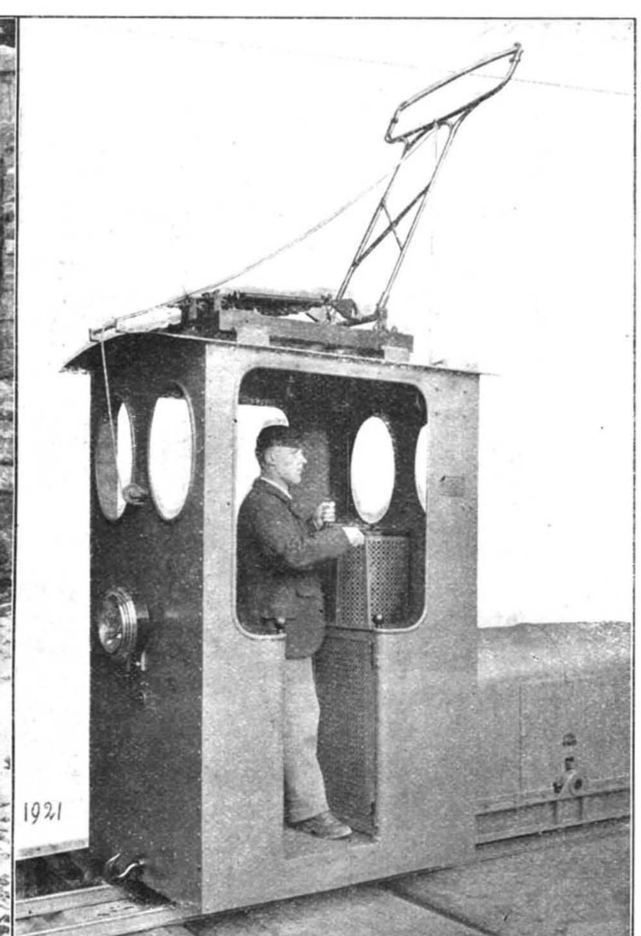
While it is always desirable to make the grades in favor of the loads and very light in opening new mines and in extending old workings, this is not always possible. In some mines the pitch of the veins makes heavy grades unavoidable, and in many cases the use of traction locomotives is well nigh prohibited, and other systems of haulage are found necessary in cases where the haulage roads dip from the shaft or mouth of the mine at an excessive grade. It is said that the low-vein third-rail and traction-rail locomotive is particularly well adapted to climbing and descending the steepest grades, as well as having on the level the flexibility which is of such great importance in mining operations by electric power. This system employs a stationary third rail and a powerful electric locomotive working with it, current being transmitted to the locomotive through this rail. The accompanying diagram shows the cogged traction wheels, *A*, the third rail, *C*, and track rail, *G*. *H H* represents the track wheels, and *B B* the axles. The track rails are used as the return conductor, the third rail supplying current consisting of heavy iron bars perforated at regular intervals throughout their entire length and made into a continuous rail by means of fish plates. The continuous third rail is inclosed and depressed in a wooden casing, which insulates the rail, at the same time protecting persons from the current. It is laid 5 inches off the center of the regular track, and the cog wheel, *A*, which engages the third rail, *C*, serves the double purpose of driving the locomotive along the track and at the same time taking up the current for the electric motor. The small locomotives used on this mining system have a capacity of 75 horse-power, a single motor being used, while the larger engines have two motors with a capacity of 150 horse-power. The gage used is 18 inches, and the smaller locomotive, weighing 600 pounds, has a maximum height of 3½ feet from the top of the rail, while the larger locomotive measures 4 feet as a maximum height from the top of the rail. The latter has a total length of 10 feet, and is supplied with a current of either 500 volts or 250 volts according to the system of light and power employed at the mine. This third-rail mining transportation system is installed by the Goodman Manufacturing Company, of Chicago. The Goodman single-motor mining locomotive, from 6 tons to 10 tons capacity, is arranged with the armature of the electric motor operating lengthwise of the frame, the armature shaft driving the wheels at both ends through bevel and other gearing. The Morgan combined third and traction rail locomotive of 150 horse-power capacity, of the type shown in the accompanying illustration, has been installed in the Bigmuddy coal and iron mines, by the Morgan Electric Machine Company; while the illustration showing the electric mining locomotive, with the operator in the center controlling a train of loaded cars, represents a modern equipment of the Jeffrey Manufacturing Company, of Columbus, Ohio. Some of the latest types of mining locomotives are controlled from only one end, the trolley pole being mounted at the side and at one end of the machine. A single-end locomotive of this type has been in operation for some time at the mines at Moon Run, Pa., constructed by the General Electric Company, of Schenectady, while a double-end Westing-



MORGAN COMBINED THIRD AND TRACTION RAIL SYSTEM AND MINING LOCOMOTIVE.

* Specially prepared for the Scientific American Supplement.

TWENTY-HORSE-POWER MINING LOCOMOTIVE USED AT GYALAR, HUNGARY.



OERLIKON DIRECT-CURRENT MINING LOCOMOTIVE.

THE DEVELOPMENT OF THE ELECTRIC MINING LOCOMOTIVE.

house-Baldwin locomotive was installed at the mine of the Century Coal Company. Both of these have the frame outside of the wheels, and in this way the moving parts are protected thoroughly against injury.

ELECTROLYTIC RECTIFIERS FOR CHARGING STORAGE BATTERIES WITH ALTERNATING CURRENT.*

By CHARLES F. BURGESS.

A RECTIFIED current, properly speaking, is that derived from an alternating source of pressure in which both halves of the complete alternating cycle are utilized. The ideal rectified curve would be produced by inverting the lower half of the alternative curve, the resultant being a curve of unidirectional, pulsating nature. The term, however, is sometimes improperly applied to the interrupted pulsating current produced by suppressing one-half of each cycle, but the newest and most improved rectifiers utilize the complete cycle.

Rectifiers may be divided into three general types: Mechanical; vapor; electrolytic.

Omitting the rotary converter which is essentially a direct-current dynamo driven by an alternating-current motor, and is not a rectifier in the commonly accepted meaning of the term, the mechanical rectifiers include the synchronously driven rotating reversing switch and the vibrating reverser in which the contact maker is maintained in synchronous vibration by energy derived from the alternating circuit. The destructive sparking which it is almost impossible to suppress, and the tendency of the storage battery or other translating device to discharge when its pressure is greater than the instantaneous values of the pulsating rectified pressure, have prevented these devices from being extensively adopted in spite of their low cost compared with the rotary converter. A vibrating rectifier was advertised not long ago by an English manufacturer, but the inertia of the moving part, together with the objections referred to, undoubtedly will prevent this from being of value except for the smallest capacities.

Certain materials have been discovered which have a low resistance when the current flows in one direction and an extremely high value when the direction of the current flow is reversed. Conductors possessing this property have been designated "asymmetric" conductors. It is this property that the vapor and electrolytic types of rectifiers utilize.

The electric arc playing between carbon terminals has for a long time been known to possess the property of asymmetry, but not in sufficient degree to warrant its practical application. In the discovery of the so-called "Edison effect" some twenty years ago, it was shown that a rectified current could be obtained from an alternating current by means of an extra electrode inserted in an incandescent lamp. Various other vapors have been found to possess this property, the most pronounced results being those recently pointed out by Mr. Cooper Hewitt in his remarkable work on the conductivity of mercury vapor. In this Mr. Cooper Hewitt has demonstrated the possibility of utilizing the mercury vapor conductor in the construction of a rectifier or converter having an efficiency of ninety-eight per cent and above. His apparatus is remarkable in its large amount of energy converted per unit of weight and volume and also for the high efficiency, which can scarcely be approached by any other form of electrical converting apparatus. At present these converters are apparently in the development and experimental stage, but hold out great promise as a successful rectifier for various classes of service.

Though for the past twenty years it has occupied a prominent place in scientific and technical literature, the third class, or the electrolytic rectifier, has only recently been placed upon the market in this country. This form of rectifier is sometimes designated as an electrolytic valve, and, as such, has an analogy in the hydraulic check-valve which automatically allows water to flow freely through a pipe in one direction, but prevents its passage in the opposite direction. The discovery upon which the electrolytic rectifier of to-day is based was made a half century ago, when it was found that aluminium in certain solutions possesses the property of opposing in a high degree the passage of the current from it to an electrolyte, and of freely allowing its passage in the opposite direction.

It will be evident that the efficiency of such an electric valve must depend upon the rapidity with which it acts, upon the completeness with which it stops the flow of current in the one direction, and upon the high conductivity which it allows for the passage in the reverse direction. With the commercial frequencies now employed of from twenty-five to over 100 per second, it is evident that this valve must act with great rapidity. Without going into details as to this factor, or the method of determining it, I may state that an investigation of this question in our laboratory has shown that an aluminium plate immersed in a sodium nitrate electrolyte required about 0.1100 of a second for "closing the electrical valve" at each reversal of pressure.

There are many solutions which, in contact with aluminium, allow this electrolytic valve action to become manifest. Some solutions are naturally more efficient than are others, and it is to the study of the relative behavior of different materials that most attention has been given during the past few years.

Among these advantages, which have made the electrolytic rectifier an attractive problem for study and investigation, are the following: In possessing no moving parts it is a close approximation to the static alternating current transformer, requiring little or no attention during operation. Its materials are cheap, and the total cost should be lower than that of the ordinary transformer for equivalent outputs. The electrolytic rectifier has a high power factor. It requires little or no abnormal rush of starting current. It has in its present condition an efficiency in the neighborhood of fifty per cent, and what makes it especially desirable for a certain class of work is that it can be made in small sizes at such a cost as will permit its general use where small storage batteries are to be charged from alternating-current circuits. Where direct-current circuits are available and two or three or more storage cells are to be charged from them, the common, though wasteful method, is to connect the batteries in series with a suitable resistance. With the electrolytic rectifier, advantage may be made of pressure transformation rather than rheostatic control, thus effecting a large saving in the power consumption.

The electrolytic rectifier has certain limitations, one of which is that for a single cell a pressure much greater than fifty or sixty volts cannot be maintained at a high efficiency; and where higher pressures are necessary two or more cells must be operated in series.

Tests which have been made in our laboratories on the efficiency of a large number of electrolytic rectifiers of various types have shown that the best of them operate, under practical working conditions, at an efficiency between fifty and sixty per cent. Tests on various sizes of a certain type of rectifier have shown that this efficiency is practically constant, regardless of size, and in this respect the rectifier differs materially from most types of electrical apparatus, where the efficiency usually increases in value as the size of the outfit is increased. While the efficiency of the rectifier is such as to enable it to compete very satisfactorily with a motor-dynamo or similar form of charging device when small outputs are required, for larger equipments of, say, five to ten kilowatts, the advantage of efficiency is in favor of the latter device.

The electrolytic rectifier will not operate indefinitely without attention, for there is a tendency to electrolytic decomposition, for the liquid to evaporate, and for the electrodes themselves to undergo a certain corrosion which requires their replacement after certain intervals. With certain forms of cells, however, this corrosion and the amount of attention made necessary may be rendered so small as to offer little ground for practical objection. In some extensive tests on a form of rectifier devised in our laboratory we have found that the total cost of maintaining the apparatus in working condition may be covered by a small fraction of a cent per kilowatt-hour, and the amount of attention is limited to a few minutes once in each ten hours of continual operation.

In measuring the efficiency and investigating the properties of this new type of apparatus, certain peculiarities become manifest. On attempting to measure the output of these rectifiers by the use of direct-current ammeters and voltmeters, and multiplying the readings thus produced to give the watts, a value considerably at variance with the true value may be obtained on account of the failure of the ordinary type of instruments to properly record the current having this peculiar pulsating nature. The wattmeter, however, will give more nearly correct indications, and the efficiency should be properly determined by wattmeter readings on each side of the rectifier outfit. It might at first sight seem rather startling, after measuring the rectified pressure by means of a direct-current voltmeter and obtaining a reading of, say, twenty-five volts, to find that when connecting a twenty-eight or thirty-volt storage battery to the terminals a charging current will flow. This, of course, is due to the fact that the voltmeter indicates only average values of current, while at certain portions of the current wave the pressure considerably exceeds this value. It is while the pressure is at the maximum that the storage battery in the above instance will be charged.

Electrolytic rectifiers may properly be subdivided into two classes, one in which an aqueous solution is employed, and another in which use is made of the non-aqueous or fused electrolyte. It has been found that certain soluble phosphates, borates, tartrates, sulphates, and various other materials, when placed in water to a suitable density, will cause aluminium to develop the valve action. It has also been found that in most of these solutions, if the temperature be allowed to rise beyond thirty or forty degrees centigrade, a marked decrease in efficiency results, and it is therefore necessary, in cells of any considerable size, to use a cooling device in which the cell is kept at a low temperature either by flowing water or circulating air.

Mr. Carl Hambuechen, of the University of Wisconsin, has discovered that aluminium acts most efficiently as an asymmetric conductor when placed in molten sodium nitrate, or certain other similar salts. Upon this discovery is based the second class of electrolytic conductors, or those which employ the fused electrolyte. An average efficiency of from ten to thirty per cent higher than that of the aqueous type may be maintained with the fused salt, on account of the more efficient valve action of the aluminium and the lower resistance of the electrolyte. It has a further advantage in that the development of heat is utilized, inasmuch as it tends to keep the material in a condition of fusion and at a high degree of conductivity, while with the aqueous type, the elevation of temperature beyond thirty or forty degrees centigrade causes such a rapid decrease in efficiency that artificial means are necessary for dissipating the heat.

With the fused salt the temperature of operation is limited to the degree of heat at which evaporation and decomposition of the electrolyte begin, and this point, being over 350 degrees centigrade, allows a fairly high rate of radiation by simply exposing the cell to the air. This fact, together with the high conductivity of the fused salt, enables a large output per unit of weights and volume of the cell to be attained.

The essential parts of this rectifier consist in a specially wound transformer, or autotransformer, which allows connection to a 110-volt or other convenient source of alternating supply. This transformer has various terminals by means of which the ratio of transformation, and consequently the pressure, of the rectified current may be regulated, thus avoiding rheostat control. Connections are made, also, from the windings of the transformer to two aluminium electrodes and an iron electrode. The electrodes are contained in an aluminium case surrounded by an asbestos cover, passing through and being held in place by a stone top.

When the rectifier is not in use, the electrolyte is perfectly solid and non-conductive, but by passing a low voltage and high volume alternating current lengthwise through the iron electrodes for four or five minutes, the cell is brought into working condition, after which the heating current is switched off and the cell is maintained at the desired working condition by the natural heat losses when operating within twenty-five per cent of the normal load.

With aluminium electrodes two inches by one inch by one-eighth inch, the normal load is ten amperes, at a rectified pressure of twenty-five to thirty volts. The current may be several hundred per cent higher than this value for a short time without detriment, and a fifty per cent overload causes excessive heating and vaporization of the salt only after several hours run. The total weight of an output of this capacity is about thirty pounds, most of which is in the transformer.

All the attention which the device requires is the addition, once in each day of operation, of a small amount of salt in the form of sticks which are introduced through an opening in a stone cover. This salt is added for the purpose of supplying electrolyte losses by vaporization and neutralizing the tendency of the electrolyte to become alkaline by the decomposition effect of the current.

By thus maintaining the salt in working condition, aluminium electrodes have been operated for over 800 hours without excessive corrosion, and the iron electrodes last a considerably longer time. Estimates of the cost of the additional salt and the renewal of electrodes place the figure below three-tenths of a cent per kilowatt-hour.

The electrolytic rectifier, in its present stage of development, is an apparatus of interest and value to the central station manager, as well as to the large number of customers who desire to obtain, from existing alternating-current systems, current for their electric automobiles or for storage batteries used for other purposes.

* This paper was read by the author before the twelfth annual convention of the Northwestern Electrical Association, Milwaukee, Wis.

REMARKABLE AND RARE EFFECTS OF LIGHTNING.

AN excerpt from the Annals of the German Hydrographic Bureau furnishes us with a bit of information at once interesting and astonishing in its effects. While on a voyage recently from Hamburg to St. Thomas the second officer of the Hamburg-American liner "Galicia," being on the bridge during a terrific electrical display, observed the following phenomena, which he carefully noted, and which it is our privilege to present to our readers. In advance it may be remarked that all the wood and iron work about the bridge had been painted gray. In changing his position he casually removed his hand from a cabinet on the bridge immediately after a particularly brilliant flash of lightning, and what was his astonishment to notice an exact counterpart of it in silhouette upon the cabinet, and to add to his amazement the picture remained imprinted fully five minutes. Such a spectacle was well calculated to incite the officer to further observations, which he carried out with like results. Among others he placed an observation instrument upon the cabinet, and waiting his opportunity removed it just after a vivid flash, to find the shadowgraph perfect in detail, even to the cross-hairs over the objective plainly visible upon the surface.

Since the ship's deck was also painted gray, he determined to try a further experiment; and with this in view threw down upon the deck an annular cork life preserver, allowing it to remain untouched for several successive flashes.

In throwing it down, whether with intent or otherwise, the ship's name and hailing port, "Galicia, Hamburg," painted upon the cork ring, fell downward next the deck. When the ring was removed, the shadowgraph was plainly seen, and what was more, the inverted letters in more somber tones could be distinctly read. Until it had entirely disappeared the watch told off seven minutes, the additional duration resulting from the effect of the several consecutive flashes. Keenly awakened by a spirit of investigation, the officer experimented upon the galvanized ironwork sustaining the bridge, which was, as before said, also painted gray.

From this he failed to elicit any response, while all the woodwork seemed particularly sensitive. Moreover, it was discovered that success depended upon the wet or moist condition of the painted surfaces;

upon dry objects of the same color no pictures were obtained.

In discussing the phenomenon, the annals remark that should an attempt be made to explain the pictures by declaring that the lightning of itself had nothing whatever to do with their appearance, but rather that the different objects placed upon the cab-

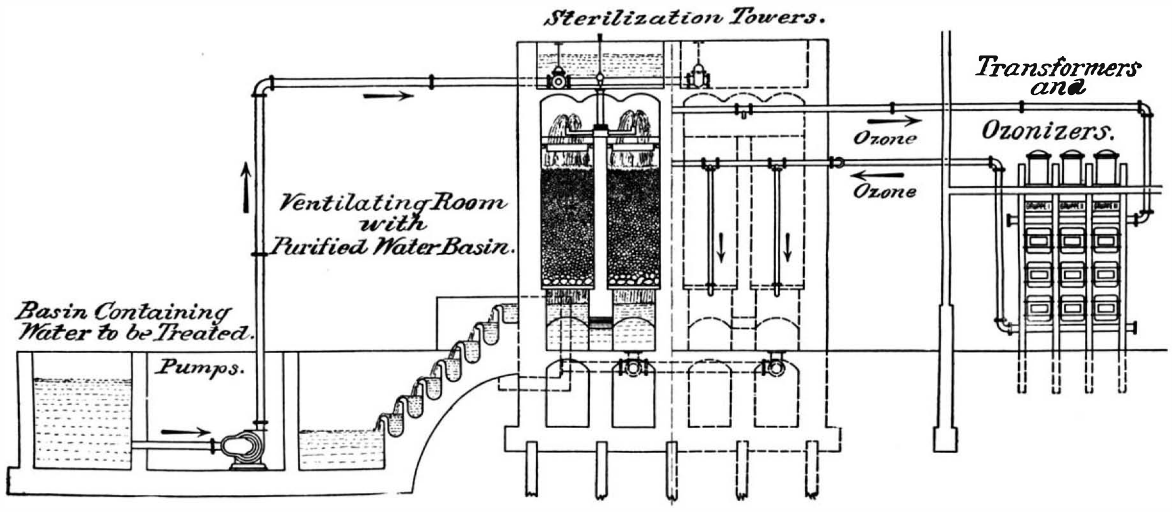


FIG. 1.—THE PADERBORN WATER-OZONIZING PLANT.

inet and the deck had absorbed the moisture, and caused a dry spot surrounded by a wetted surface, making it distinguishable from its surroundings by a shade of color, it would hardly explain the presence of the cross-hairs over the objective, which are contained entirely within the instrument. Nor would such a hypothesis hold when compared with the experiments upon the ironwork.

A more plausible elucidation of the occurrence would derive from a chemical examination of the constituents of the paint used, which might disclose some phosphorescent properties of the ingredients. Upon request the Hamburg-American Line furnished the German Marine Observatory with some of the liquid, which by some inadvertence or carelessness has been lost before it could be used. Having aroused an interest in the proper accounting for such amazing displays, the government desires that observations be continued, and in cases of recurrences, either some of the paint or some object covered with it, which has given the abnormal results, be sent to the Lighthouse Board for official investigation.

PURIFICATION OF POTABLE WATER BY MEANS OF OZONE.*

By DR. GG. ERLWEIN.

(Chief electro-chemist of Siemens & Halske, Berlin.)

To many of you the subject which I have the honor to bring to your notice to-day will be to a great extent familiar. At the same time, I believe it will not be uninteresting to the numerous German technologists who constitute my audience to hear an account based on actual experiments, free from any optimistic or pessimistic bias, showing what may be expected of the employment of ozone in connection with their special province.

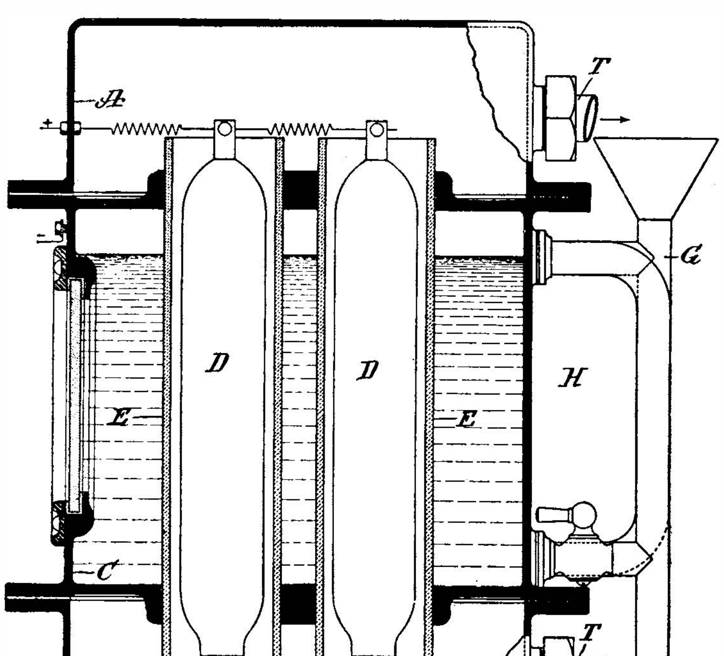


FIG. 2.—SIEMENS-HALSKE OZONIZER.

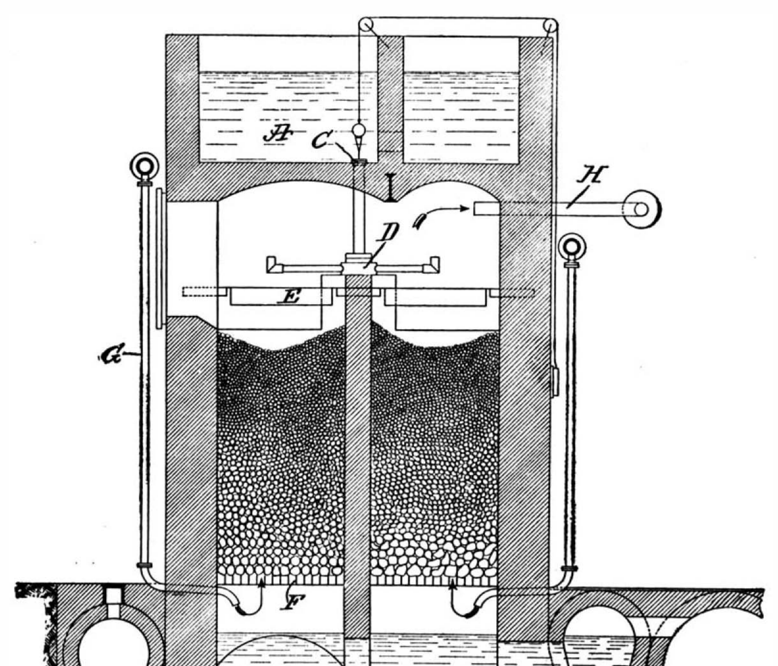


FIG. 4.—STERILIZATION TOWER OF AN OZONE WATER PURIFICATION PLANT.

At the outset it will be well to come to settle this question: When is it actually necessary to sterilize the water of water-works? By sterilization I mean the general purification of water in a hygienic sense. Two kinds of water only need be considered for our purpose—underground and surface water.

* Paper read before the 43rd Annual Meeting of the Deutscher Verein von Gas- und Wasserfachmaennern, held in Zurich, Switzerland, 1904. Translated for the SCIENTIFIC AMERICAN SUPPLEMENT.

Underground water, protected from the inflow of surface water by extensive impermeable layers of clay, and passed through some miles of filtering sand, to render it practically free from bacteria, needs no purification beyond the removal of precipitable iron-salts, with which it often comes in contact. Nor is it necessary further to purify spring-water rising from the interior of mountains free from fissures. Underground water, on the other hand, containing water which has filtered into it through the ground under suspicious conditions, e. g., water from wells in the neighborhood of rivers, brooks, marshes, and inhabited places, must

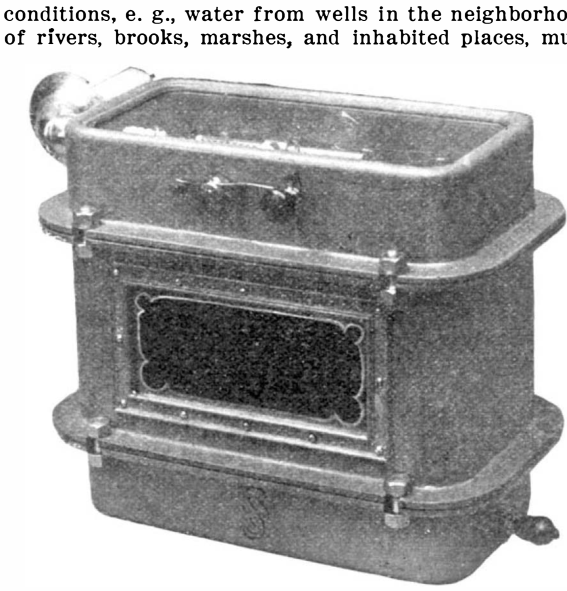


FIG. 3.—A SIEMENS-HALSKE OZONIZER.

be regarded from a hygienic point of view as surface water and requires purification like surface water.

Surface water, i. e., water from rivers, lakes, and the like, always requires careful purification before being used for drinking purposes, not only on account of the presence of animal or vegetable matter in suspension, but also on account of possible pathogenic bacteria.

We must also clearly understand what methods of purification are at our disposal and require consideration. We may divide these methods into the following groups:

1. Mechanical.
2. Purely chemical.
3. Chemical and mechanical combined.
4. Thermic.
5. Electrolytic.

Methods 3, 4, and 5 need not long detain us, as neither the combined chemical and mechanical method, in which chemicals are added before filtering to produce precipitation, nor the thermic process, recently applied with very interesting modifications, nor the method of electrolysis, reintroduced from time to time, with its chemically or mechanically acting electrode products, are now considered of any practical importance in water-works, at any rate in Germany. We have therefore only to consider the mechanical and the purely chemical methods.

By mechanical methods we understand, generally speaking, methods of filtration. In connection with municipal or central water-works the only method we need consider here is the well-known method of sand filtration. The excellent results obtained, as a rule, by this process depend in the first place on the film of slime which forms on the surface, and which constitutes the real bacteria filter, remaining intact, a condition which cannot always be absolutely secured, and in the second place on carrying out the process under competent supervision, which, however, we may readily assume to be the case in the countries to which the members of your association respectively belong.

Of the purely chemical methods we may distinguish two kinds: (1) The former chemical process, in which chlorine, bromine, and other preparations (e. g., permanganate, alum) were proposed as sterilizing and purifying agents. This process, however, has not established a firm footing in water-works, for this reason among others, that it was found very difficult to adjust the quantities of sterilizing agents employed to the varying composition of the water, and also completely to remove the necessary excess of chlorine and bromine after sterilization as to leave no taste in the water. (2) The method of ozonization, which forms the subject of my lecture. As compared with the older methods which I have mentioned, its characteristic feature is this—that the excess of the added sterilization agent disappears after sterilization, partly by spontaneous decomposition, and partly by the oxidation of organic substances in the water, leaving no taste whatever.

I may here mention that ozone is not merely a sterilizing, or bacteria-destroying agent, but that it can eliminate iron, even when combined with humic acid, so easily and effectually that it can, in many cases, be used for this purpose. I will not, however, enlarge upon this point on the present occasion; because experiments in the investigation of this special property of ozone have hitherto only been made on a small scale, and because ozone, being a sterilizing agent, is only in exceptional cases employed in the treatment of ferruginous water, such water being, as a rule, underground water, and therefore not requiring sterilization, except when exposed to the temporary or permanent inflow of water from above or from neighboring rivers. For the same reason I shall not discuss the interesting fact, that by oxidizing organic matter ozone improves the smell and taste of the water.

With regard to the nature of ozone and its preparation, I will begin with the following general observations: Ozone is an active modification of oxygen—a gas with an odor similar to that of phosphoric or nitric acid. It is soluble in small quantities in water, and, thus dissolved, has a sterilizing action on the bacteria contained in it, and at the same time, by oxidizing a portion of the organic substances, removes any color and improves the taste. In regard to its chemical composition, ozone differs from oxygen in this respect—that its molecule contains three atoms instead of two. When uniting with oxidizing substances, it parts with one of these three atoms, and instead of ozone we now have ordinary bi-atomic oxygen, so that after the treatment of water by ozone only ordinary oxygen remains. At the same time it should be noticed that

the quantity of oxygen is not greater than in water when treated by air for the purpose of eliminating iron. There are two methods of preparing ozone, a purely chemical and an electrical method. Of these the only one now used is the electrical method, consisting in the exposure of oxygen or ordinary air to the action of the silent discharge. This process is carried out in an apparatus so constructed that the discharge chamber is inclosed either by parallel plates or by concentric cylinders. The air or oxygen, previously dried to obtain a better supply of ozone, is driven by means of a blowing apparatus with moderate pressure through the discharge chamber, which becomes filled with a blue light, the velocity being so regulated that the air leaves the apparatus with a percentage of ozone sufficient for the purpose of sterilization. The ozone thus obtained is brought into close contact with, and partly dissolved in, water divided into thin streams in the sterilizing towers which I am about to describe.

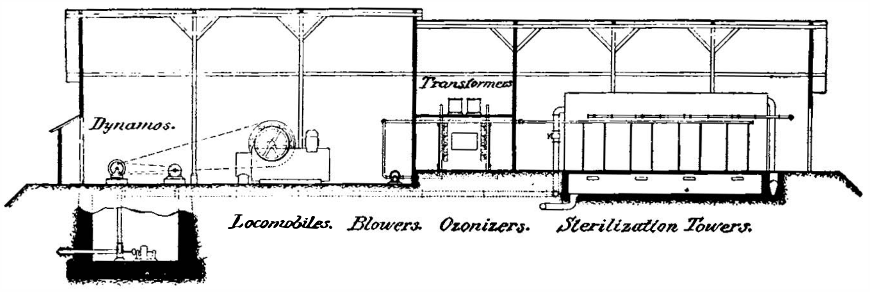


FIG. 5.—THE SCHIERSTEIN-WIESBADEN PLANT.

After these preliminary observations, it will be possible with the assistance of the accompanying drawings of establishments already constructed, to understand the manner in which ozone is utilized for purposes of sterilization; in short, to see what an ozone apparatus looks like.

Fig. 1 shows the ozone works constructed by Siemens & Halske at Paderborn, which, for reasons explained later, is more typical than the Wiesbaden plant. It may be mentioned in passing that it has supplied all the drinking water of Paderborn for nearly a year without interruption. It was constructed to supply 60 to 80 cubic meters of water per hour, the water being drawn from the Pader, and, during periods of great atmospheric precipitation, not free from suspicion of bacteria. The drawings (Fig. 1) show the arrangement of the apparatus. The latter consists of a direct-current dynamo, an alternate-current dynamo, two centrifugal pumps, and a blower, driven from a countershaft connected with a gas engine. A direct-current generator may be connected with a central electric station to drive the countershaft instead of the gas engine if required.

In this installation a battery of nine ozonizers has been placed in a separate room, and two sterilization towers have been erected in an adjoining section. The battery is made up of three independent sets, each consisting of three ozonizers arranged one above the other, as in Fig. 1, on an upright iron frame, with which is also connected the system of pipes for supplying air to the apparatus and for conveying the ozone to the sterilization towers. Each of the three sets, one of which is kept in reserve while the others supply the sterilization towers, receives its high-tension current from a transformer mounted on the support and protected against accidental contact. The leading-in wires of the dangerous high-tension current from the ungrounded pole of the transformer to the ozonizers are well insulated and pass through the hollow, hermetically sealed pillars of the frame, so as to obviate the possibility of accidental contact.

The ozone apparatus represented in the drawing (Figs. 2 and 3) belongs, as regards its construction, to the type of Siemens pipe-apparatus in which the discharge space is bounded by concentric pipes fitted into each other, an outer glass cylinder forming one pole and an inner metal cylinder, cooled by circulating water, the other. The apparatus consists of a cast-iron box with three divisions: a lower compartment for receiving and conveying the air to the pipes, an upper compartment for collecting the ozone, and a hermetically sealed middle compartment into which the ozone pipes are inserted by means of a stuffing-box gland. In the upper compartment is the dangerous ungrounded high-tension pole, insulated and protected against contact. In the middle air-chamber, containing the pipes, cold water is kept in circulation, and, being in contact with the other high-tension pole, conducts the current to the glass cylinder. As the iron box constituting one pole of the high tension rests on the ground, and the other pole is insulated with good porcelain and thoroughly protected in the closed compartment of the ozonizer, the apparatus can be handled and interchanged by the attendant in charge without the slightest danger and without stopping the plant. Plate-glass windows are inserted in the cover, the front, and the bottom of the iron box, so that the blue light in the discharge-chamber, showing that the apparatus is working properly, may be distinctly visible to any one entering the ozonizer-room, which is generally kept dark. The Siemens ozone apparatus constructed for use in water-works are of the form shown in Fig. 3. In large establishments they are arranged in batteries. An ozonizer of this kind carries a current of about 8,000 volts. It requires for its operation 1 horse-power per hour, and gives from 13.5 to 27 grammes of ozone per hour according to the amount of air passed through it and the degree to which it has been previously dried; so that if we take water of the quality of Paderborn or Wiesbaden water as our standard, which requires on an average a consumption of 1.3 grammes of ozone to the cubic meter, one ozonizer can in twenty-four hours sterilize a quantity of water sufficient for a town of from 2,400 to 4,800 inhabitants, reckoning the consumption at 100 liters per inhabitant.

The sterilization towers used at Paderborn, in which the water is brought into contact with ozone-air, are 4 meters in height. They are constructed of concrete, and their action is similar to that of the Gay-Lussac towers, or the well-known scrubbers, long used in chemical and gas works for washing and dissolving attenuated gases by the percolation process, a treatment which is here applied to ozone. The water in the sterilization towers trickles through a layer of pebbles of the size of a pigeon's egg, and thus divided into many little streams presents a large absorbing surface to the ozone current which is forced upward with a gentle pressure through the tower or the layer of pebbles. A quantity of ozone sufficient for sterilizing purposes is thus dissolved. The construction of the tower will be plain on reference to the accompanying drawing (Fig. 4) showing its vertical section. Each complete tower is divided into three parts: (1) a reservoir for water to be treated at the top, *A*, (2) the sterilization compartment, and (3) the receptacle for collecting the ozonized water. The interior of a tower is divided by two partitions into four independent towers or shafts, all of which obtain their water from a common supply pipe with a valve, *C*. Each single tower is in its turn divided by an iron grate into two parts, an upper part, containing a layer of pebbles two meters thick, and a lower part for collecting the treated water. The raw water flows from the common reservoir through a four-branched supply pipe into the single towers. Here it passes through a sieve and falls in a fine shower on the layer of pebbles, percolates through it, and passes, when ozonized, into the collecting basin, whence it flows into the reservoir of the pumps. Each single tower is one square meter in cross section, and about 15 to 20 cubic meters of water and 15 to 20 cubic meters of ozone-air with the requisite proportion of ozone pass through it in one hour. The ozone-air circulates through the ozone-apparatus and the sterilization tower, a ventilating valve for admitting fresh air to replace the consumed oxygen being affixed to a suction apparatus in the circulating system.

At the sides of every tower in the Paderborn establishment cascades are provided, over which the escaping water flows, thus losing any traces of dissolved ozone through contact with the atmosphere. These traces vanish more slowly than usually in the case of river water owing to the great chemical purity of the water at Paderborn.

I may mention that in the choice of sterilization apparatus scrubbers have been adopted instead of the older method of forcing the ozone into higher water columns. The scrubber system, in which only a few centimeters excess pressure is required, is easier in application and more trustworthy: (1) owing to the general advantage of a lower pressure, and (2) because in the scrubber system we have no great counter-pressure to overcome, and therefore do not require to regulate the pressure with great exactness to bring a constant or uniform quantity of air into contact with the downflowing water. We shall, however, return to the old method in certain special cases for which it seems better adapted, e. g., in the case of ferruginous water.

Elaborate precautions have been taken to guard against the consequences of disturbances in the work, arising from interruption either of the electric current or of the action of the blowers. Arrangements have been made whereby in case of such interruption the supply of water to the sterilization towers is automatically shut off, thus preventing any inflow of unsterilized water into the town conduit system. If, for instance, the current in one of the sets of ozonizers should be interrupted, thus stopping the formation of ozone, the lever of an electro-magnet held by the current drops and closes an independent circuit, which in its turn, by electro-magnetic action, causes a floating conical india rubber valve to drop and shut off the water supply to the four towers. If the air-current from the blower fails, a disk of aluminium, inserted into the principal air-pipe and kept raised by the air current under normal conditions, drops and, likewise by electro-magnetic action, shuts off the water supply to the towers. In either case the dropping of an indicator attached to a switchboard displays the number of the set of apparatus and of the tower where the trouble has occurred, while at the same time an alarm signal rings until the cause of the disturbance is removed. It is impossible therefore for unsterilized water to flow into the supply pipes in consequence of a derangement such as I have mentioned. Great care has also been taken, as I have already mentioned, to guard against personal injury from the dangerous high-tension current. The transformers and high-tension connections are in a room accessible only to highly-skilled attendants, and the connecting wires from the transformer to the ozonizers are passed through the interior of the apparatus and provided with a protecting covering, in conformity with the directions of the Society of German Electricians, thus obviating all possibility of accident.

The ozone-works at Paderborn have been constructed for treating water free from iron or matter in suspension, and include neither filtering plant nor apparatus for removing iron.

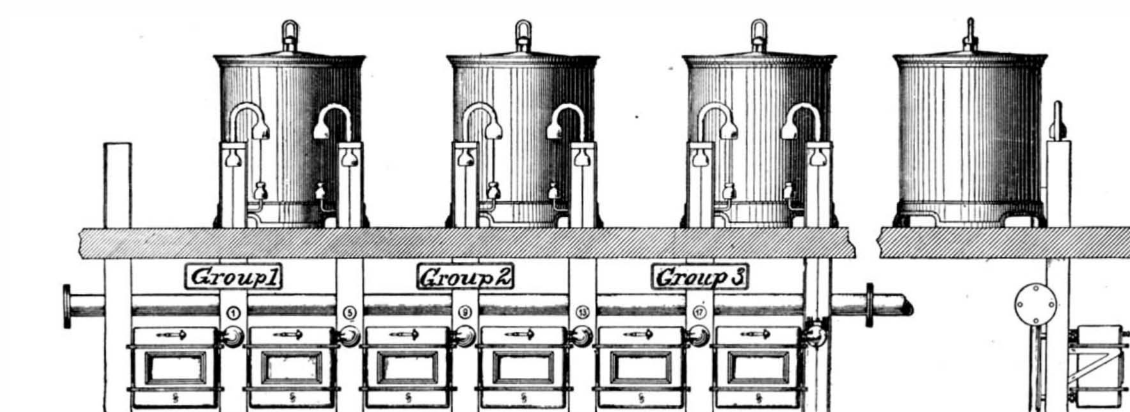


FIG. 6.—A BATTERY OF OZONIZERS.

The ozone-works at Wiesbaden are arranged on almost exactly the same plan as those at Paderborn. They are constructed for treating 250 cubic meters of water per hour, derived from springs situated along a former arm of the Rhine near Schierstein. The water from these springs has been for years used at Wiesbaden for domestic purposes, and, if sterilized, might be used as potable water in times of great scarcity.

The plant consists, as will be seen from the plan in

horizontal and vertical section (Fig. 5), of three divisions: an engine room, a room for the ozonizers, and a room for the sterilization towers.

The whole plant is divided into two exactly similar parts, each capable of treating 125 cubic meters per hour. Only one division is intended to be used at a time under ordinary conditions, so that, except during the hot months, we have a reserve power of 100 per cent. The engine room, therefore, contains two steam engines (60-horse-power Wolfe's locomobile), each with a complete set of direct and alternating current dynamos, centrifugal water-supply pumps, and blowing apparatus.

Corresponding to the two-fold division of the plant, the ozonizer room contains two batteries, each composed of twenty-four apparatus with three transformers over each battery. The room for the sterilization towers also contains two rows of towers, four in a row, one tower in each row being likewise kept in reserve The machinery is so arranged that the two sets may be easily interchanged and that the electric current of the one may be switched onto the connecting wires of the other half. The box-shaped ozonizers are grouped so as to form batteries, each of several rows, as explained in the description of the Paderborn works, and in the manner shown in Fig. 6 already shown to you. With respect to its construction and connections, this apparatus is identical with the Paderborn apparatus already described. The sterilization towers, with the automatic contrivance for securing safety in operation, are also constructed in the same manner as those at Paderborn, except that there are no cascades for the ventilation of the outflowing water, as they are not required by the local conditions.

At Wiesbaden, as at Paderborn, the aim was to construct ozone-works for non-ferruginous water, free from suspended particles. During the preliminary negotiations with the representatives of the municipal water-works, attention was called to the possibility of the water's becoming ferruginous in time. But since, in the experience of managers of the works, the water had not up to that time required to be treated for the elimination of iron, we were directed to disregard this possibility in making our plans, and were even permitted to insert a clause in our contract to the effect that we should not be held responsible for the appearance of iron or for the consequences arising therefrom. Unfortunately, it was found after a long period of working, that iron did in fact make its appearance. This was shown by the discovery that the water issuing from the ozone-towers was no longer clear as at first, but was gradually becoming more yellow in color. Careful experiments showed that this presence of iron did not injuriously affect the sterilization, and also that the consumption of ozone was not appreciably increased. Our latest measurements have even shown that the ozone apparatus in our plant can, if necessary, turn out four times the present quantity of water.

The water at Schierstein now contains so much iron that its treatment is attended with some difficulty. At the present time the water turned out by the works cannot be regarded as a proper substitute for potable water in the way I have mentioned. To be used for drinking purposes it would have first to be cleared of iron in suspension or solution, or at any rate filtered after ozonization. As usually happens, the quantity of bacteria has diminished with the increase in the quantity of iron. so that in this respect also it has been impossible for the works to maintain their normal standard of performance. This change in the situation is about to occupy the attention of the authorities at Wiesbaden.

(To be concluded.)

[Concluded from Supplement No. 1477, page 23667.]

SOME DATA ON THE COST OF OPERATING AUTOMOBILES FOR COMMERCIAL PURPOSES.*

By Hiram Percy Maxim.

Reliable data on the costs of horse service is extremely difficult to get at. Some services are based upon the strictest economy regardless of any other consideration, while others are based upon elegance of equipment, regardless of cost. Every stage between these two exists, and no two seem to be exactly comparable, especially in the cases of the smaller vehicles. On a purely mathematical basis, it is conceivable that it would be difficult to prove the electrically-propelled vehicle as cheap, broadly speaking, as the horse-propelled vehicle. Practice, however, indicates that it is the case in large cities. In almost every instance, where electric vehicles have been substituted for horse vehicles, the service has been more satisfactory. Whether this satisfaction is derived from actual reduction in costs, greater convenience, or what, is impossible to say positively. We simply know that it is the case. In some places, it is claimed to be very much cheaper than horse service, while in other places, barring the erratic, it is claimed that it costs about the same, or possibly more, but is so much more satisfactory as to compensate. It is very probable that, as far as money saving is concerned, in light department store wagons there would not be as great an advantage as in heavier trucking, since in the latter service we find continual instances where things become possible, which with horses were impossible. This of course entirely upsets any question of direct cost comparison.

In the instances we have heard of electric vehicles being condemned on the score of cost and up-keep, it has been almost universally due to extraordinary battery and tire expenses. Except in erratic cases, where gross ignorance and carelessness prevail, the responsibility we know to be in the inadequate batteries and tires furnished. Where these two elements are of decent proportions there is no excuse for the cost of maintenance exceeding the figures which have been given. Indeed, there are cases where a little higher skill and intelligence than the average having been brought to bear on the vehicle, maintenance expenses per year have been considerably below the figures given. Since it is not a general rule, however, the average rather than they, have been given. Now to turn to the consideration of the relationship existing between the elements making up maintenance and the possible effect of improvements now under contemplation.

It is evident from Table No. 1 that the larger share of the expense of maintaining a department store wagon, the one-ton size in the table, is due to battery, tire, and depreciation items. The same is the case with the three-ton and five-ton trucks. The three items amount to, roughly, 70 per cent of the total maintenance expense. It is plain, therefore, that future improvements should lie in the direction of these three conditions. From the details of the repairing of a battery, it is apparent that the cost of the new plates, the losses sustained on account of the breakages of rubber jars, and the labor involved in doing cleaning, are mainly responsible for the magnitude of the battery account. It is plain that if a battery could be obtained which would require less cleaning, or the plates of which would last longer, or the jars of which would not break, the maintenance expense would be greatly lessened. Developments along these lines are under way, and we have two batteries at present being weighed in the balance for the determination of these factors. These are the battery of Mr. Edison, and one of the old type of Planté batteries which has again come to the front for commercial vehicles when used in connection with a new negative plate.

This latter is a lead battery of conventional form, but, owing to its construction, its active material sheds less rapidly than in the pasted type of battery used in existing vehicles. The plates, therefore, last longer. The battery costs the same, however, and it requires rubber jars the same as the existing battery, so that the reduction it promises is in the frequency of renewal of the plates. The battery in the main is an old one, having the most creditable record of any storage battery that has ever been constructed.

In the case of the other battery, the Edison, it is not quite the same. The manufacturers claim that the plates need no renewing in the sense which we are considering. They tell us that the battery is indestructible, meaning, of course, as apparatus generally is considered indestructible. Assuming that this is so, let us see what it would mean. The purchase of new plates would be avoided, the labor connected with cleaning would be avoided, and the losses due to broken rubber jars would be avoided. The Adams Express Company is operating at the present time four of these batteries in four of their thirty-four electric wagons. They have been in service some four months to date, and there is every reason to believe that up to the present time all of the manufacturers' claims have been equaled. It must not be lost sight of, however, in considering this, that even one year's work in actual service has not yet been done, and that it is solely the manufacturer's claims, and what we know we have a right to expect from the theory of the battery that forms the basis from which we are reasoning. The battery is, theoretically, directly in the proper line of improvement, and regardless of anything else, is therefore worthy of our most careful consideration.

In calculating the probable performance of this battery, in order to compare it with existing batteries, we find there are two features in which the battery suffers. These are its high price, and the consequent elevating of the interest charges against it, and the large amount of charging energy which is lost in recharging, and which elevates the charging current account against it.

On the score of price, the status of a wagon fitted with this battery may be judged when we say that if given the same watt hour capacity, a 2,000-pound wagon which now sells at $2,500 would have to sell at $3,000. A 3-ton wagon, the average price of which is $3,700, would have to sell at $4,222, while a 5-ton truck, the normal price of which is $4,000, would have to sell at $4,820. The interest account upon these higher figures, of course, increases the cost per vehicle mile and per ton mile. These will be taken up later.

In this connection should be mentioned the question of weight saving. Obviously, if the battery weighed enough less than the corresponding existing batteries, it would be possible to reduce costs in the vehicle. For example, if enough weight were saved, we might use the next smaller size tire axles, wheels, and springs. As a matter of fact, however, the actual saving is not enough to make this practical. In a 2,000-pound capacity wagon the saving in battery weight would be only 375 pounds, not enough to warrant any reduction in tire or axle dimensions. In the 3-ton wagon the saving would be 650 pounds, while in the 5-ton it would be 740 pounds. Neither of these would amount to as much as the variations in load which have to be provided for, so that it does not seem reasonable for us to count upon any reduction in the vehicle parts as the result of this battery.

On the score of charging current, the data available from actual service has been taken. Laboratory data in profusion is of course available, but it is desired to confine these figures to those taken from actual practice. As far as can be judged in the vehicles in use, we should expect them to require about 66 per cent more energy to charge them than it requires to charge vehicles with existing lead batteries. In a 2,000-pound wagon this means $204 per annum instead of $122.70. In a 3-ton wagon it means $295 instead of $177.12, while in a 5-ton truck it means $310 instead of $186.

On the score of depreciation of the battery, an arbitrary figure must be assumed, since there is nothing positively known on the subject as far as service conditions go, and the entire matter must be taken upon a basis of the claims of the manufacturer. As indestructibility is claimed, the battery has been classed with the rest of the vehicle which is indestructible in the same sense, and 10 per cent per annum taken.

There is a point in this connection which should be borne in mind. This is that, on the basis of a ten years' life with the Edison battery, the entire vehicle, battery and all, would be done for at the end of ten years, whereas, in the case of existing battery, and our basis of calculation, the battery itself would be in a good state of repair at the end of ten years even though its vehicle were entirely done for. This variation is, however, not much more than are several others which cannot be avoided in trying to strike an average of widely varying figures, so it is neglected.

On the score of repairs of the Edison battery, it would seem to be fair to expect more repairs upon it than there would be on the vehicle part, since the latter have had the benefit of long experience in service and the battery has had very little. The vehicle repair figure seems to be something about 4 per cent on the price of the apparatus. It would not seem unfair to take 6 per cent for the battery. Six per cent on $990, the price of an Edison battery of equal capacity to the existing battery in a 2,000-pound wagon, would be $59.40 per annum, or 6.88 per vehicle mile.

Now to compare the performance of vehicles fitted with Edison batteries and the performances when fitted with Exide batteries. Tire maintenance, vehicle repairs, and vehicle depreciation would be unchanged. In Table No. 2 the figures corresponding to Table No. 1 show the relationship.

TABLE NO. 2.

RELATION BETWEEN ELEMENTS OF COST OF MAINTENANCE. WAGONS FITTED WITH EDISON BATTERIES.

	1-Ton wagon.		3-Ton wagon.		5-Ton wagon.	
Elements.	Veh. mi.	Per ct.	Veh. mi.	Per ct.	Veh. mi.	Per ct.
Battery department and repair	1.84	16.7	3.24	15.8	4.36	16.3
Tires	2.09	19.0	4.37	21.3	6.05	22.6
Depreciation	2.12	19.3	3.86	18.8	4.84	18.1
Interest	1.74	15.8	3.2[illegible]	15.6	4.18	15.6
Charging current	2.36	21.4	4.26	20.8	5.29	20.1
Repairs	.85	7.8	1.54	7.7	1.93	7.3
Total	11.00c. per. V. M.		20.47c. per V. M. 10.23c. per T. M.		26.75c. per V. M. 7.64c. per T. M.	

A comparison between these two tables indicates at once a marked change in the relationships between the different elements of maintenance expense. The totals indicate a net gain per ton mile for the Edison battery amounting to quite a considerable amount, assuming that the generous assumptions we have made for it are anywhere near the truth. The gain would of course be much higher than it is were it not for the higher price and the greater amount of charging current necessary. In the 2,000-pound wagon this gain is 13 per cent, while in the three-ton wagon it is 12 per cent, and on the five-ton truck 12½ per cent.

In considering this gain the question of the other battery referred to comes up. This battery is known as the Manchester box type. It has a strictly Planté positive plate, and what is called a box negative plate, and represents a type of battery which is standard in stationary work. It is made by the same makers as make the Exide battery—the Electric Storage Battery Company, of Philadelphia. It is unquestionably the longest lived and most rugged lead storage battery in existence.

Before the advent of the present form of pasted plate, it was the standard for automobile work. Having a greater weight per unit of capacity, however, than the pasted, it eventually became superseded for pleasure work, and when the commercial wagon came along it was inherited by it. It is now up for consideration again, since the fact has come to be generally understood that a little more battery weight in a business wagon is not as serious a matter as battery repair expense.

From records in existence of the performance of this battery, maintenance expenses have been worked out in the same manner as those of the Exide and Edison battery. The important details are as follows:

* Paper read before the Automobile Club of America, on March 22. This paper treats of electric, gasoline, steam, and gasoline-electric vehicles, those of the first two types being treated with great thoroughness, and much valuable information being given regarding storage battery maintenance and its cost on present-day commercial electric vehicles.

The number of days' work which the positive plates would be good for would be somewhere about 400. We have taken the Exide as 288, it will be remembered. The number of days' work from the new negative over the existing Exide negative would follow as between the life of the Manchester positive and the Exide positive.

Four hundred days for the positives means 12,000 miles. The yearly mileage being 8,640, the positives would last considerably over a year. The cleanings of the battery would probably be about as follows:

The first after 130 days' work, or 3,900 miles.

The second after 120 days' work, or 3,600 miles.

The third after 90 days' work, or 2,700 miles.

The fourth after 60 days' work, or 1,800 miles.

This means an average of 2.88 cleanings per year, which, of course, materially reduces the labor, supplies, breakage of separators, and rubber jar charges. The maintenance of this battery would probably be something in the vicinity of the following for a 2,000-pound wagon:

		Existing Exide.
New positive plates	$89.00	$155.00
New negative plates	48.30	84.00
Rubber separators broken in handling	4.72	4.55
Rubber jars broken in service and handling	21.70	21.70
New wood separators	4.72	4.55
Labor	38.90	65.00
Supplies	37.20	48.50
Total per annum	$258.67	$404.85

This brings the vehicle mile to 3 cents when the Exide is 4.68 cents.

In the case of the three-ton wagon the details would probably be something as follows:

		Existing Exide.
New positive plates	$124.00	$217.00
New negative plates	67.50	117.50
New wood separators	26.50	36.60
Rubber separators broken in handling	6.50	6.37
Rubber jars broken in service and handling	32.80	32.80
Labor	53.40	92.50
Supplies	52.00	67.80
Total per annum	$362.70	$570.57

This brings the battery maintenance charge to run the vehicle a mile 5.25 cents, where the Exide is 8.25 cents. In the case of the five-ton truck the figures would probably be very close to the following:

		Existing Exide.
New positive plates	$140.00	$244.00
New negative plates	76.00	132.00
New wood separators	29.70	41.00
Rubber separators broken in handling	7.40	7.15
Rubber jars broken in service and handling	35.00	35.00
Labor	59.50	102.00
Supplies	57.50	75.00
Total per annum	$405.10	$636.15

This brings the battery maintenance charge for a vehicle mile to 7 cents, where the Exide is 11.50 cents.

The weight of this battery would be approximately 30 per cent greater than the weight of the existing Exide battery, the same watt-hour capacity being assumed. This increase does not amount to much increase in the total weight of the vehicle with load, as will be seen from the following:

The 13-plate MV cells in a 2,000-pound wagon weigh 1,640 pounds. The entire vehicle weighs 5,200 pounds. Loaded, this becomes 7,200 pounds. The cells are then 22.8 per cent of this total weight. When the new Manchester type of battery is used the battery weight would be increased about 490 pounds, which is just 6.9 per cent increase in the total weight, which, for instance, the tires, axles, and springs must bear. It, of course, amounts to something, but it is not enough to make it necessary to use the next larger size of axles or tires. In the larger trucks it is much less than this, being but 3.7 per cent increase in the total weight of the five-ton truck, loaded.

The price of the battery is the same per watt-hour capacity, so that all other charges in the maintenance of the vehicle will remain the same as in the existing Exide battery, except the charging current, which is but a negligible amount greater, due to the slight increase in the total weight of the vehicle.

Arranged in the same manner as in the other tables, the relations between the different elements of maintenance expense appear as is shown in table No. 3:

From this table we see that the net gain effected is practically identical with that of the Edison battery. For instance, in a 2,000-pound wagon it will cost for maintenance, as far as we are able to estimate, on a generous assumption for the battery, 11 cents to run a vehicle a mile; while, with a Manchester box battery, it will cost 10.93 cents. In a three-ton wagon it would be 10.23 cents to haul a ton a mile, as against 10.18 cents with the Manchester. In the five-ton truck it would be 7.64 cents to haul a ton a mile with the Edison battery, as against 7.40 cents in the Manchester.

It suggests many very important possibilities. It must, however, be remembered that it is largely assumption, since we have no actual service wagon records to go back to in the case of the Edison battery, and only of the positive plates in the case of the Manchester battery. It would be very interesting to dwell further upon this matter, but there is not time for it if the other motive powers are to be considered. Before leaving the question of maintenance of the electric wagon we should, however, glance at two of the elements in maintenance expense which are important. These are the tire expenses and the depreciation and interest expenses.

In the case of the tires, it is seen that the tire repair expenses amount to 6.08 cents for every mile a five-ton truck runs with three tons of load upon it. This seems high arbitrarily compared. Compared with the 25 cents and 30 cents per ton mile statements which are frequently heard, it is, however, a very decent figure. These extravagant ideas of the cost of the tire up-keep have been based upon early experience when not only were inadequate tires furnished on vehicles, but the tires themselves were not as good as they are at the present time. We cannot, of course, entirely overlook the past, although in the question of rubber tires it ought not blind us to the improvements of the present. On an up-to-date truck, a figure of 6.08 cents per ton mile is a very conservative one, and, when the entire cost of a truck maintenance is taken into consideration, with the work that it performs, the tire cost will be seen to be well within the bounds of practicability.

This should not be taken, however, as indicating that the rubber tire is good enough. The table shows that in existing trucks the tire maintenance is approximately 20 per cent of the total maintenance of the vehicle. This is not anywhere nearly the case in horse-drawn trucks where iron tires are used, the tire maintenance account being a very small percentage of the entire maintenance account. Certainly, a great reduction in the cost of operation would be possible if we could find a cheaper and more long-lived tire material than rubber. Rubber is inherently expensive and so relatively fragile that, wherever the weight of service is very severe, a large amount of it is necessary. When we come to think of it, considering using anything else for tire material takes us on to entirely new ground, upon which we have never before trod. Never before have we had to move vehicles over uneven pavements by the revolving of their wheels, unless the latter were shod with rubber. Practically all vehicle propulsion accomplished to-day by the revolving of driving wheels, which are not shod with rubber, is done on the smooth and even surface of a steel rail.

The conditions under which a tire must operate in a wagon or truck are by no means easy ones. For example, a tire must give traction on hard and extremely uneven stone surfaces, regardless of whether the latter are wet or dry, covered with greasy mud or slippery ice. On the other hand, it must not stick or drag enough to seriously increase power consumption, as the iron tire does on hot asphalt in the summer time. It must be slightly elastic, so as to permit fair speeds over rough surfaces without unduly increasing traction, or injuring the vehicle. It must not slip sidewise, but must insure steerage way under all circumstances. It should be comparatively noiseless.

Rubber very curiously meets every one of these requirements. It is a great pity that it is so expensive, and that a substitute for it cannot be produced. Iron has been tried for tire material on electric wagons, and is being used in several cases to-day. It gives a precarious traction on uneven stone pavements except when the latter are covered with ice or snow. Under such circumstances it seems to give absolutely none at all. It is entirely non-jar-absorbing, and hence is very noisy, severe upon the vehicle and wasteful of power at speeds above six miles per hour on ordinary stone pavements. It drags seriously on softened asphalt and its frequent slipping makes steering doubtful enough to reduce to a certain extent the mobility which the vehicle would otherwise have.

In some cities it seems to work better than in others. For example, in Pittsburg iron tires without sanding arrangements on a 2,000-pound capacity wagon have given entire satisfaction for upward of three years, except during winter months. On the other hand, iron tires will slip in midsummer on Rector Street, New York, and certain parts of West Street. The paving in these places consists of peculiarly large sets which are extremely uneven and badly rounded over their tops, presenting about the surface that a lot of derby hats would present. Plentifully sanding the surface gives both traction and steerage way, but it is not always practical to sand both the front and rear wheels at the critical moments when they need it. For instance, a stop in some places will require sand to get a start, where, if no stop had been made, no sand would have been needed. In the experience of the writer, hardly anything is more difficult to accomplish than the sanding of the wheels of a heavy truck on which there is a heavy load and which is standing stalled in a hollow or against the car track in West Street, New York. The entire face of nature would seem to be able to be sanded with ease compared with the few square inches under the wheels where it is needed. The iron tire, to sum up, while by no means impractical, does not enable a motor vehicle to give its best performance. Very wide tires of the softest possible iron give better results than any other.

The other thing which the tables of maintenance expense suggest as worthy of consideration was depreciation. The depreciation and interest charges together in existing wagons seem to be something in the vicinity of 28 per cent of the total maintenance expense. In wagons fitted with the Manchester box battery, the estimates show 32 per cent. They are, of course, both determined by the price of the vehicle. Where the price of the vehicle was lowered, the total cost of maintenance would be considerably lowered, but the prices on electric wagons cannot be lowered as things stand to-day, and render the building of them a profitable business. Therefore, it would seem that, since the design has arrived at what is approximately a fixed and possibly a final one, the electric wagon must remain somewhere about where it is in so far as these two items in its maintenance expense are concerned. (To be continued.)

THE STEAM TURBINE.*

By H. M. GLEASON, Assistant Naval Constructor, United States Navy.

THE steam turbine, although old in principle, is comparatively young in its application to commercial power generators. Since Watt's development of the reciprocating engine, all inventive energy has been employed to perfect a form of power generator which is wrong in principle. If Watt had achieved as great success with a primitive form of rotary engine or steam turbine as he did with the reciprocating engine, it is safe to say that to-day we should have a highly perfected form of steam turbine, and the reciprocating engine would have been looked upon as one of the many queer inventions of the past.

So great has been the inventive genius of the age, that to-day we have a very efficient reciprocating engine, as efficient, perhaps, as this kind of engine will permit of; but who, with any idea of mechanical simplicity, can go into the engine room of any modern steamer without wondering at the ingenious complexity represented there.

To be sure, any machine should be designed for the use intended, and in this way the reciprocating engine is especially adapted for use on certain machines using power exerted in a straight line. The great majority of machines, however, require circular motion, and here the reciprocating engine is handicapped. It may be said then that the chief aim in power generation is to develop it along the line of circular motion. For this purpose, leaving other considerations aside, the steam turbine is eminently fitted.

The advantages of the steam turbine over the reciprocating engine are, in general, as follows:

1. The effort of the steam is applied directly without any intervening mechanisms for conversion of motion. This avoids their attendant friction, their costly fitting, and probable lost motion.

2. There being no reciprocating parts, there is no inertia to overcome at the beginning of the stroke, with the necessary consumption of energy required to accelerate them.

3. The absence of reciprocating parts makes it possible to run the shaft at vastly higher speeds than are attainable in a reciprocating engine.

4. The turbine engine becomes very compact from the absence of converting mechanism, and it consequently occupies very little room.

5. The engine has no dead-center, but will start from rest in any position.

6. The engine has either no valve gearing, or that which it has is of the simplest character.

7. The simplicity of the engine and absence of expensive mechanism make it cheap to build, and, therefore, it should be cheap to buy.

8. Very little skill is required to run the engine, and fewer engineers are needed, and there is a consequent saving in the cost of handling.

9. The absence of reciprocating rods and dead-centers results in a construction in which the pressure of condensed steam in the engine does no harm. Water does not stop the engine from turning; it cannot endanger the engine casing. The engine can be started, even if under water, by simply opening the valve which admits pressure to the turbine blades; it will start with solid water, as in the case of the water turbine.

10. Its incased construction and the above peculiarity

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

TABLE NO. 3.

RELATION BETWEEN ELEMENTS OF COST OF MAINTENANCE, WAGONS FITTED WITH MANCHESTER BOX BATTERY.

	1-Ton wagon.		3-Ton wagon.		5-Ton wagon.	
	Veh. mi.	Per ct.	Veh. mi.	Per ct.	Veh. mi.	Per ct.
Battery	3.00	27.4	5.25	25.9	7.03	26.0
Tire	2.09	19.1	4.37	21.6	6.05	22.0
Depreciation	2.12	19.4	3.86	19.0	4.84	18.0
Interest	1.45	13.3	2.67	13.2	3.46	13.0
Charging current	1.42	13.0	2.57	12.7	3.24	12.0
Repairs	0.85	7.8	1.54	7.6	1.93	7.0
Total	10.93c. per V. M.		20.36c. per V. M. 10.18c. per T. M.		26.55c. per V. M. 7.44c. per T. M.	

adapt it for outdoor service and places exposed to low temperatures. Weather does it practically no harm, and its protection from outside injury makes it particularly serviceable in mining and stone quarrying.

11. The turbine is easily controlled; it is stopped by simply turning off the steam by means of an ordinary valve, and started again by turning on the valve.

The above advantages apply to its use in general, but for the propulsion of ships it has especial advantages:

1. The absence of vibrations, which are so troublesome in reciprocating engines. The study of vibrations in a reciprocating engine has called forth many valuable and scientific papers by engineers who have made this subject a special study. The necessity of the balancing of engines in ships need not be commented upon, for who has not suffered from it, even on the largest and best designed of our present-day passenger steamers. The continual shaking which the hulls and fittings of ships are subjected to is one great cause of their frequent need of repairs, some, it is true, of minor consequence; but the loss of time incurred in making these seemingly minor repairs results in an appreciable decrease in the vessel's earning capacity. And, when balanced at one speed, it does not follow that the same condition will follow at other speeds; in fact, it generally does not follow. With the turbine engine all this loss of time and inconvenience is done away with.

2. The use of the turbine engine effects a great saving in weight of machinery. The question of weights on a ship is a very important one, and where a saving can be made in the propulsive machinery, a consequent gain can be effected in cargo or passenger accommodation, in the case of a merchant vessel, or in the case of a warship, a gain in guns, armor, or coal. The weight of machinery per indicated horse-power in the case of the "Turbinia" is 21.3 pounds, while in the best designed modern vessels the average weight per indicated horse-power is about 150 pounds. These figures show what advantages the turbine has in this connection. Where the weight problem is so vital, as in the case of a battleship, the use of turbines would mean a great gain in offensive or defensive qualities.

3. The perfect balancing of the turbine engine does away with increased weight in construction of engine bedding and hull fittings, which are necessary to withstand continual vibrations and strains.

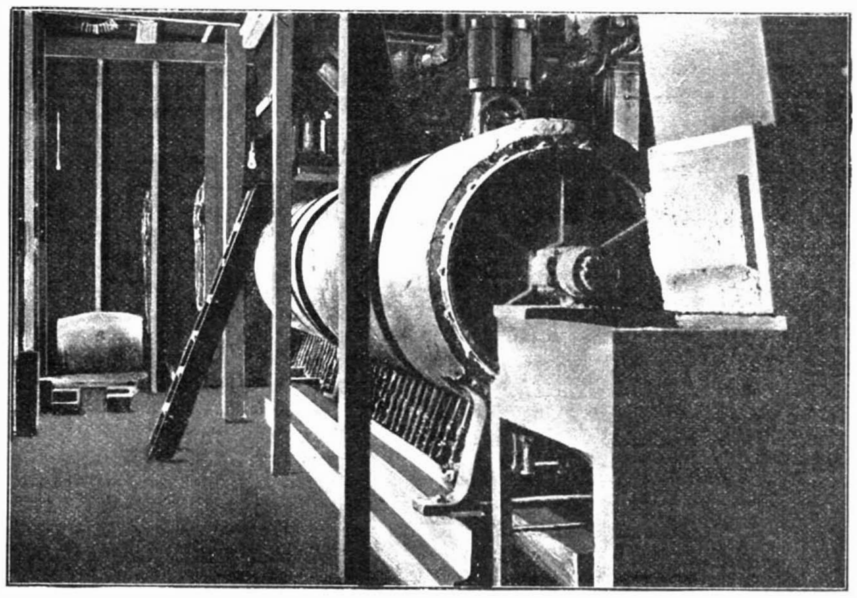
4. The increase in stability gained by the use of the turbine is greatly due to the low position of the center of gravity of the engine. This is a very important feature in the turbine, as it enables vessels to carry heavy weights on the upper decks without endangering the stability of the vessel. In the case of a warship this would allow heavy guns and armor to occupy a position of greater elevation than is admissible now; and, in the case of a merchant ship, would enable her to go to sea in a light condition in greater safety. The turbine situated well down in the ship's body would be protected from injury in action without the necessity of armor decks, beyond protection from falling projectiles.

5. The lives of the engine-room crew are not endangered by intricate, fast-moving parts. It is not necessary to call to mind the marine disasters that have been caused by the breaking of a shaft and the consequent racing of the engines, resulting in completely wrecking the engine room and not infrequently injuring the hull seriously. From all this the turbine is free.

6. A much smaller engine-room force is required. This results in a great saving in running expenses, and, in the case of a warship, would enable more men to be carried to man the guns.

7. Last, but not least of all, the turbine requires very little lubrication, resulting in a great saving of lubricating oil, which in a large vessel is no small item.

The best-known turbines to-day are the Parsons-Westinghouse, the DeLaval, and the Dow. All these different classes of turbines are designed to derive the maximum effect of the kinetic energy of steam under expansion, and this requires that the turbine revolve at a very high speed. This makes the turbine specially adaptable for electric generators, and its use in this connection is becoming general.



CONTINUOUS STEAM-COOKER, USED BY FISHERIES COMPANY AT PROMISED LAND, NEW YORK.

For marine propulsion a high speed of revolution of the propellers is not desirable beyond a certain limit, at which cavitation results. Thus, in some cases, it is necessary to reduce the speed by gearing down. The propellers of the "Turbinia," at a speed of 34½ knots per hour, made 2,000 revolutions per minute. From the limited experience with high-speed propellers, it has been found that under certain conditions the ship does not answer to her helm in the usual way; but this difficulty can be overcome by putting the rudder forward of the propellers.

The question of efficiency is one to be considered. Comparing it with a compound or triple expansion condensing engine, the steam turbine is quite as efficient. The engine that will perform efficiently over the widest range of loads is, for general purposes, the most desirable. This the steam turbine has done, as proven by trials, in which the efficiency from full load to half load varied but 8 per cent; this is a far better performance than any attained by reciprocating engines. With the improvements in design that are sure to be made, the turbine's efficiency will be demonstrated even to the most skeptical engineers.

The great problem in steam turbine design is to devise a perfectly reversible one. This is done in marine turbines at present by having a separate turbine on the same shaft—the reversing turbine running idly in a vacuum when the ahead turbine is working, and *vice versa*.

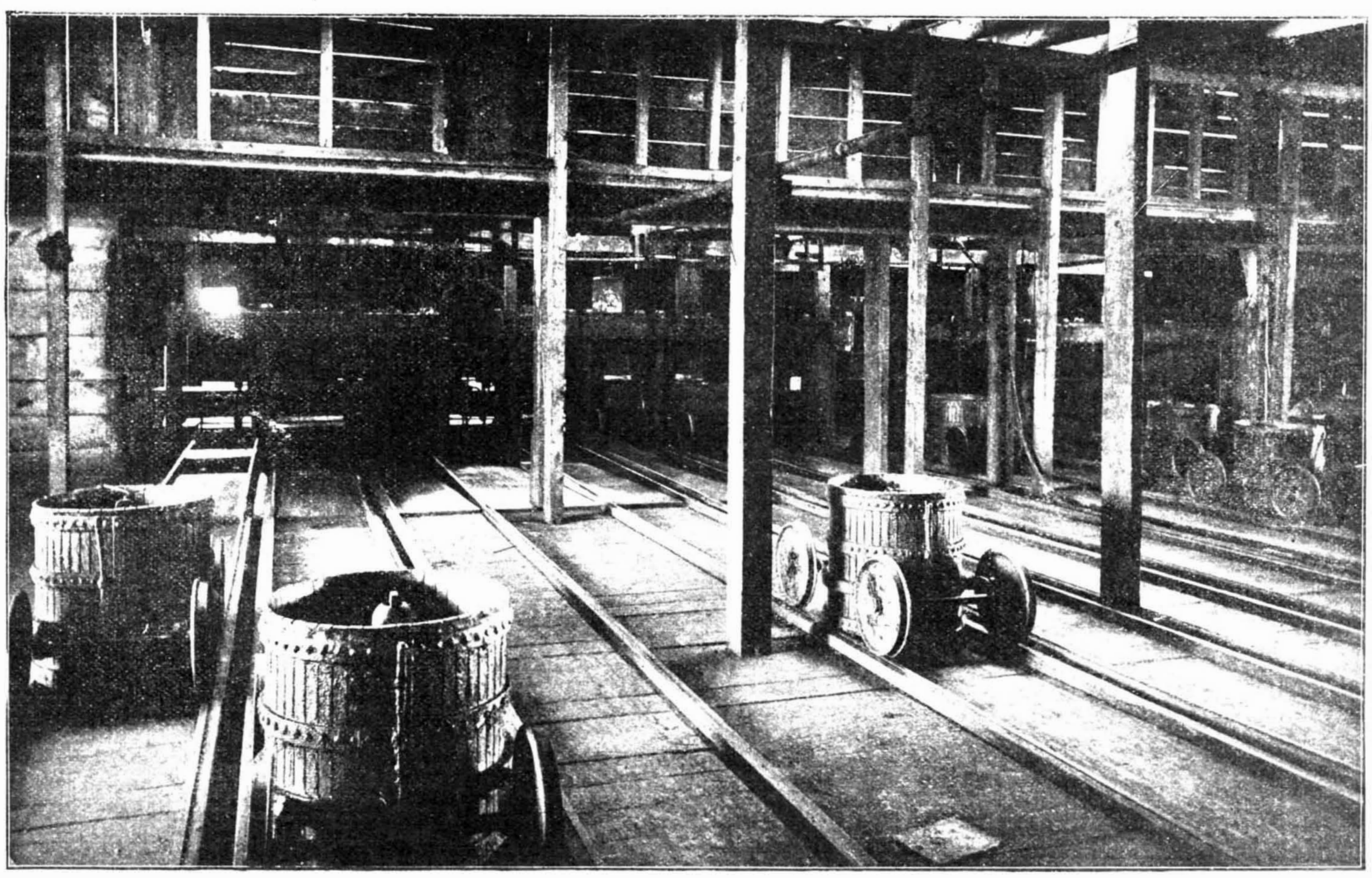
There is nothing that can stay the improvement and popularity of a machine or process which saves money; thus we can see for the steam turbine a great future both in commercial power generation and marine propulsion. The reciprocating engine, although very highly developed and universally used, has a dangerous rival in the simple turbine, and there is nothing that appeals to the American mechanic more than simplicity.

THE MENHADEN INDUSTRY.*

By CHARLES H. STEVENSON.

THE menhaden belongs to the *Clupeidæ* or herring family, and is about the size of the common herring of the New England coast, but somewhat deeper and more robust. It is not considered a food-fish and is rarely eaten, owing to the abundance of bones, although the flavor is not unpleasant. However, it is one of the most important of all of the species on the coast, being the principal source of bait during the summer, in addition to its use in the manufacture of oil and fertilizer.

The menhaden occurs all along the Atlantic coast of the United States from Maine to Texas, and most abundantly between Cape Cod and Cape Henry, except that during certain years it seeks the coast of Maine in enormous quantities. It appears on the approach of warm weather, ranging from March and April in Chesapeake Bay to May and June on the Maine coast, and remains until late in autumn. Its bathymetrical range extends from the inland limits of salt water to the Gulf Stream, but probably 95 per cent of the catch is made within 2 miles of the coastal line. It is captured principally by means of purse seines, operated



PRESS-ROOM OF MENHADEN FACTORY, SHOWING ARRANGEMENT OF TRACKS, CURBS, PRESSES, ETC.

THE MENHADEN INDUSTRY.

* From U. S. Fish Commission Report for 1902.

from steam vessels with carrying capacity for several hundred thousand fish.

About a quarter of a century ago several important reports relative to the menhaden were issued. The first was that of Messrs. Boardman and Atkins, made to the Maine Board of Agriculture in 1875.* Three years later was issued the report of Mr. Luther Maddox.† Each of these related especially to conditions existing in the State of Maine.

In 1879 the United States Fish Commission published the important report of Dr. G. Brown Goode, containing voluminous notes on the natural and economic history of the menhaden, with many extracts from previous reports on the subject.‡

Many changes have been made in the methods of utilizing the menhaden since those papers were written, but they are yet the principal authorities in regard to the natural history of the subject, and the present writer is prepared to add little. Indeed, such additional matter would scarcely be in place in this paper, which is restricted to the economic use of menhaden in the preparation of oil and fertilizer.

HISTORY AND EXTENT OF THE INDUSTRY.

A century and more ago, when a much larger number of the home requisites were prepared by consumers than is the case at the present time, it was a part of the duties of many farmers along the Middle Atlantic coast to devote a few weeks each spring to taking menhaden for the purpose of fertilizing the cultivated land. Large shore seines made of cotton twine were employed, and in some localities these were owned jointly by several farmers of the vicinity. The length of some of these seines was 3,000 feet or more, and frequently the catch at a single haul numbered several hundred thousand fish, although the average quantity was nearer 10,000 or 12,000. This farmer-fishery has continued up to the present time, but its extent is now very much reduced, owing to the ease with which prepared fertilizers may be purchased.

Following upon the development of this use of fresh or green menhaden came the discovery that the oil was valuable for painting, leather dressing, etc. Some of the farmers would provide a few casks or hogsheads which they partly filled with fish, adding water to cover them, and with weighted boards placed on top to keep the mass down. On the disintegration of the fish through putrefaction they were occasionally stirred with a long pole to break up the mass and liberate the oil which floated to the surface of the water and was skimmed off from time to time. After several weeks the oil ceased to flow, and the residuary mass was used as fertilizer. For many years the extent of this business was very small and the product was entirely for home use.

The first improvement in the above process consisted in boiling the fish in kettles to facilitate the extraction of the oil, the boiled fish being then placed in casks, as above noted, resulting in a much larger product. By 1830 the cooking of the fish was quite general among the few persons engaged in extracting oil from menhaden. The oil was dark and crude, and used only for rough painting and leather dressing, the market being restricted to the neighbors of the manufacturers. The use of kettles, however, involved a great waste of heat, and the business was of very little consequence until the introduction of steam in cooking the fish. The first steam factory, according to the late Capt. E. T. Deblois, was a small one built in 1841 near Portsmouth, R. I.

In 1850 Daniel Wells built a factory on Shelter Island, N. Y. That was the first factory of considerable size on the coast, and the quantity of fish handled amounted to 2,000,000 or 3,000,000 in number annually. In 1853 Mr. Wells built a new factory on Shelter Island, and the old one was removed to Groton, Conn., being the first steam factory in that State. The first factory in Maine was put up in 1863 at South Bristol, and in 1866 eleven factories were built in Maine. In 1869 the factory at South Bristol, Me., was removed to Fairport, Va., and was the first factory in that State.

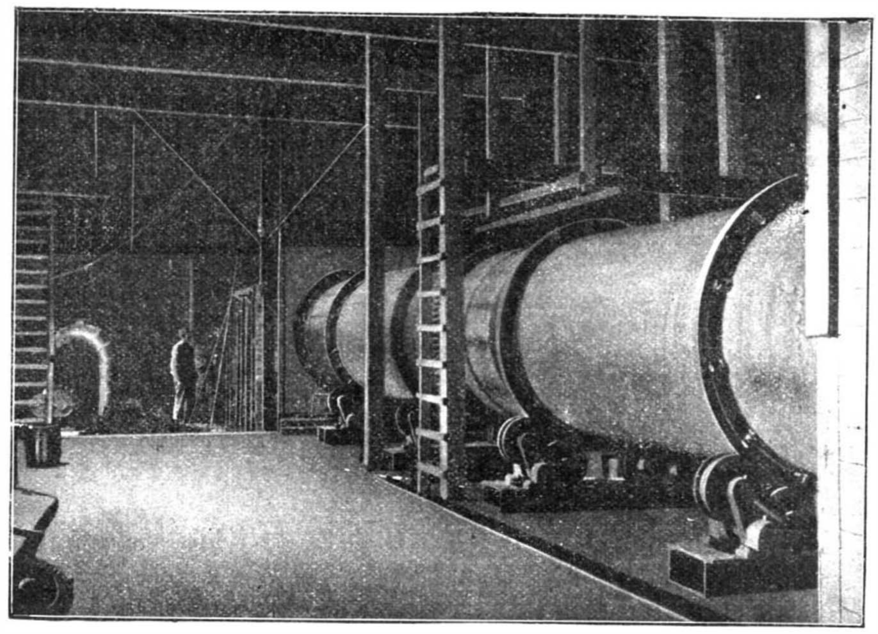
In the meantime the purse-seine had been improved and adopted in the menhaden fishery, permitting the capture of fish in much larger quantities, and without which the menhaden industry could never have reached its present proportions. The next improvement consisted in pressing the scrap to extract a greater percentage of the oil. The first press, operated by hand power, was built by Charles Tuthill at the Wells factory, on Shelter Island, in 1856. This worked so satisfactorily that soon all the factories were pressing the scrap, and in 1858 hydraulic presses were introduced for the purpose. The high price of oil during the sixties, when it reached $1.40 per gallon, resulted in much profit in the business and a large increase in the number of factories, their location extending from Maine to Virginia. Then came the preparation of the scrap in the form of portable fertilizer, the adoption of large cooking tanks instead of kettles, and the introduction of steam vessels in the fishery.

In 1876 floating factories were introduced. These consisted of boilers, cooking tanks, presses, etc., mounted on steamers, sail vessels, or scows, for convenience in going from place to place to follow the movements of the fish. Probably half a dozen of these were in use in 1880; but owing to the lack of convenience for drying and handling the scrap, this form of factory was soon abandoned. Another disadvantage of a floating factory is that the constant movement of the vessel prevents the oil from settling, and it remains cloudy and fails to fetch the best market price.

The business continued to expand until it reached high-water mark in 1884, when 858,592,691 fish were caught, yielding 3,722,927 gallons of oil and 68,863 tons of scrap, valued at $2,800,000. Since that time great improvements have been made in the methods of the industry, but owing to the low price of oil and scrap, resulting from competition with other products, the profits have not been so great, and many factories have been dismantled. The largest catch of fish in any one year, according to figures of the United States Menhaden Oil and Guano Association, was 858,592,691, taken in 1884; the smallest was 223,623,750, secured in 1892, and the average catch during the last thirty years approximates 500,000,000 annually. The incomplete returns for 1902 indicate that the catch exceeded 900,000,000, a greater quantity than for any previous year.

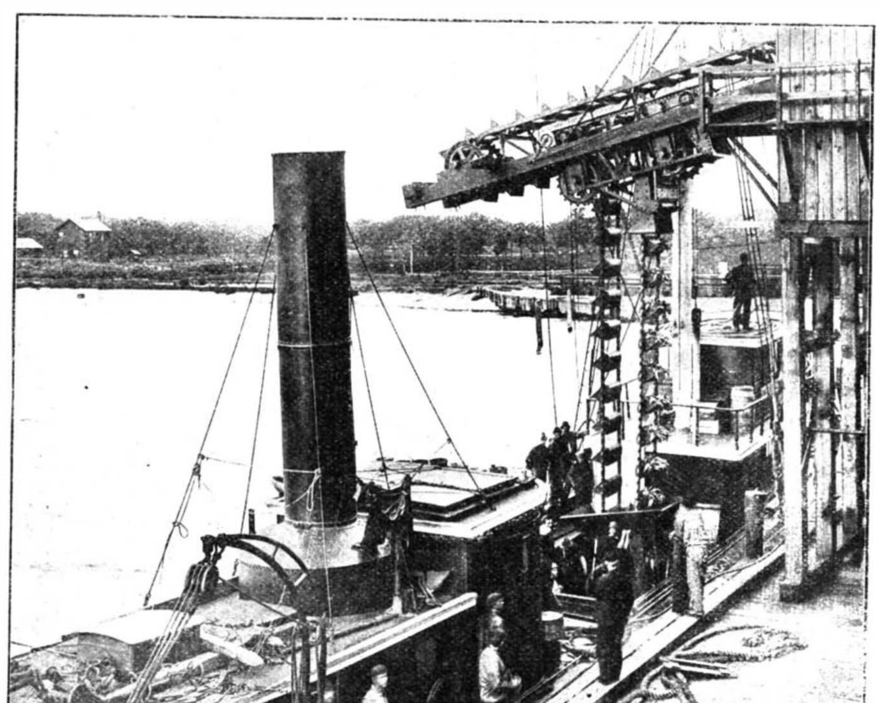
There are two separate and distinct sets of figures showing the extent of the menhaden industry during recent years. The first comprises the returns made by

RECEIVING-BIN FOR FISH AT MENHADEN FACTORY.



ARTIFICIAL DRIER IN FACTORY OF FISHERIES COMPANY, PROMISED LAND, NEW YORK.

DISCHARGING MENHADEN FROM VESSEL BY MEANS OF TUBS.



DISCHARGING MENHADEN FROM STEAMER BY MEANS OF BUCKET ELEVATOR, AT PROMISED LAND, NEW YORK.

THE MENHADEN INDUSTRY.

* The Menhaden and Herring Fisheries of Maine as Sources of Fertilization, by Samuel L. Boardman and Charles G. Atkins, 1875, pp. 67.

† The Menhaden Fishery of Maine. Portland, 1878, pp. 46.

‡ The Natural and Economic History of the American Menhaden, by G. Brown Goode. Report U. S. Fish Commission, 1877, pp. 1-529.

the United States Menhaden Oil and Guano Association, organized in 1873, and covers the operations of the factories in the United States during each year from 1873 to 1898, inclusive. The second series represents the returns made by the agents of the United States Fish Commission for certain years from 1880 to 1902. Slight differences exist in these figures, but in the main they agree closely.

Although very small quantities of other fish are used, practically the entire catch in the menhaden fishery consists of that species alone. The principal species other than menhaden are sea-robin, skates, and bellows-fish. These are secured mostly in pound nets, especially in those set in Gardiner Bay. They sell for 50 to 80 cents per 1,000, and two or three million are used each year. The sea-robin yields 3 or 4 quarts of oil to the barrel. This oil is of good color and is readily sold for menhaden oil, but the scrap is not quite so desirable for fertilizer as that from menhaden. Skates and bellows-fish are comparatively dry, yielding less than one pint of oil to the barrel of fish.

Owing to much contention resulting from the claim that with the menhaden large quantities of choice food-fish are taken and rendered at the factories, the United States Fish Commission, in the season of 1894, made a thorough inspection of the catches made by two representative steamers of the fleet. This examination showed that in a catch of 27,965,756 fish only one-third of 1 per cent were food-fish, and only a very small proportion of this percentage was of choice and popular varieties. "As a general thing not enough desirable food-fish are taken by the menhaden steamers to keep the vessels' crews regularly supplied with fresh fish. As a rule, all the food-fish caught are eaten either by the crews or by the factory hands, but it occasionally happens that schools of bluefish, butter fish, shad, river herring, etc., are taken and more fish are thus provided than can be consumed."*

The menhaden factories are distributed along the coast at points convenient to the fishing grounds. They vary in size and equipment according to the amount of invested capital and the degree of modernness. Some are of primitive type, consisting of two or three large kettles or try-pots and a simple press, the whole, with the accompanying equipment, costing only a few hundred dollars, and are capable of handling only 300,000 or 400,000 fish annually. From that they increase in size and capacity until the amount of invested capital in a single plant reaches half a million dollars, giving a working capacity of 200,000,000 fish annually.

COOKING AND PRESSING THE FISH.

The following account of the methods of the menhaden industry represents observations and inquiries made by the writer during the last four years, and especially in the season of 1901. Most of the factories were visited either in 1901 or previously, and all details in the process of manufacture were inspected. The writer wishes to acknowledge in this connection the courtesy of Capt. N. B. Church, general manager of the Fisheries Company; Mr. H. H. Luther, superintendent of the Promised Land plant of that company, and of Capt. J. F. Bussels, of the Atlantic Fisheries Company.

There are two principal processes involved in the manufacture of oil and scrap from menhaden, viz., (1) cooking and pressing the fish and (2) drying or otherwise preserving the scrap, the methods varying according to the facilities of the plant. The great bulk of the fish are handled at large factories thoroughly equipped with modern machinery, including bucket elevators, automatic conveyors, continuous steam cookers, hydraulic presses, artificial driers, etc.

Some of the factories, especially in Virginia, are quite small, with primitive methods of work. In one of them a fire is made under four cast-iron stationary boiling vats holding about 2 barrels of fish each. By means of a trough leading from a pump, water is permitted to run into the vats. After sufficient cooking, the fish are scooped out with large dip nets and put on a platform, whence they are pitched into tub presses having a lining of coarse canvas. By means of a vertical screw operated by a horizontal lever, pressure is applied to the mass, and the exuding oil runs through a trough to the oil vats. Another Chesapeake factory has six iron cooking vats, in which are suspended an equal number of iron latticed baskets containing the fish. After cooking, the baskets are transferred by means of a crane and the fish placed in an hydraulic press. This method of cooking was formerly in general use all along the coast frequented by the menhaden.

In the best-equipped factories the fish are removed from the hold of the steamer, where they have been stowed in bulk, by means of a bucket elevator. This contrivance, so important in the handling of grain and coal, was not introduced in the menhaden business until 1890, when a factory at Tiverton, R. I., was equipped with one. At present, however, they are in use in all the principal factories. Before their adoption the fish were shoveled into measuring tubs in the vessel's hold, and these raised and dumped in elevated receiving bins, or into cars holding 15 or 20 barrels each and running on inclined tramways to the receiving bins, requiring five or six hours to discharge 1,000 barrels. By using the bucket elevator, with four men to feed it, 1,000 barrels of fish may easily be discharged in an hour. This decrease in length of time required for discharging is frequently a matter of great importance when fish are abundant, as it enables the steamers to speedily return to the fishing grounds.

The elevator dumps the fish into one of a pair of automatic weighing hoppers, with a dial-scale indicator of 1-ton capacity. When the required weight is in the hopper, by means of a lever the incoming fish are directed into the other hopper, and the bottom of the full one is dropped, thus dumping its contents into a conveyor, which deposits the fish into a receiving bin with capacity of 6,000 or 8,000 barrels.

The weighing of the fish is necessary to secure a record of the quantity received, furnishing a basis for compensating the captains of the vessels, and for other purposes. It thus appears that this method of discharging changes the standard of measurement from bulk to weight. Although it is customary to reckon the quantity of menhaden by so many thousand, the fish are not counted. An arbitrary size of 22 cubic inches is the standard measurement for each fish, or 22,000 cubic inches to the thousand. Two hundred pounds represent one barrel, and 3 1-3 barrels represent 1,000 fish. The size of the fish varies considerably, and the actual number required to make "one thousand" in measure ranges from 500 to 2,000 in number.

The floor of the large receiving bin slants toward the longitudinal middle, where is stationed a trough or chute with a covering movable in sections of short length. In this trough runs a conveyor, consisting of two parallel endless chains, between which, at intervals of 2 or 3 feet, are attached pieces of board which act as buckets to push the fish along through the trough when a section of the covering is removed. This trough with endless carrier is in use in practically all the large factories, irrespective of the method of cooking. It carries the fish to the cooking bins, or to the steam cooker in case the latter is employed, traps or slides in the bottom of the trough permitting the distribution of the fish into any of the tanks desired.

The cooking bins or tanks are large rectangular wooden boxes having capacity of from 50 to 100 barrels each and arranged with a lattice platform, about 4 inches above the bottom, on which the fish rest. Between the lattice platform and the bottom there is a nest of steam piping connected with a pipe leading from steam boilers. A water pipe also leads into the bin, through which salt water for cooking the fish is pumped into the tanks to a depth of about 1 foot or more. For convenience in handling the materials, the bins are commonly arranged in two adjacent rows, and above them runs the endless carrier conveying the fish from the receiving bin. On the outer side of each of the two rows of tanks runs a track leading to the presses, to be described later. When the bins are filled with fish, steam is turned into the piping in the bottom and heats the water, thus cooking the fish, reducing them to pulp, and breaking the oil cells. The amount of the cooking determines the extent to which the oil is removed. If carried to an extreme point, nearly all the oil can be pressed out. But severe cooking results in greatly damaging the quality of the oil and in loss of a certain amount of the nitrogenous compounds so important in determining the commercial value of the scrap. It is, therefore, important that the heat be so regulated as to extract as much oil as practicable without injuring the quality and with a minimum loss of nitrogen. The requisite degree of cooking is reached when the fish crumble to pieces easily. A high degree of temperature is maintained for about fifty minutes, when the mass of fish is broken up and then permitted to simmer for four or five hours. The free oil and water are then drawn off and the fish permitted to drain for several hours.

During the last two or three years the largest factories on the coast have been using continuous steam cookers. The most popular form is constructed so that a conveyor transmits the fish into a steam-tight receptacle, into which a large number of jets of steam are introduced, which thoroughly cooks the mass. The process is continuous, requiring about fifteen minutes for the fish to pass through, and the capacity of each cooker is about 600 barrels per hour. From the cooker the mass of fish is carried by means of a screw conveyor into an upright elevator casing, whence a bucket elevator carries it to receiving tanks, where it drains over night. These tanks are usually about 10 feet square and 5 feet deep. Most factories use for this purpose the bins used in cooking before the adoption of the steam cooker. One factory has a total of 52 tanks for draining the fish.

The oil and water draining from the cooked fish is pumped or led off through pipes or troughs into the oil room, where it is received into large vats. After draining for ten or twelve hours, the mass of cooked fish is forked out of the tanks and thrown into curbs for pressing.

The curbs are of various designs. The most common form is a cylindrical tub with a hinged bottom firmly attached to axles, which are provided with wheels so as to run on a tramway. The staves are made of metal slats and are held together by stout bands. They are set at a convenient distance apart to allow the oil and water to pass through, and increase in width from the center to the bottom enough to overcome the enlargement of the opening between the slats consequent upon their outward slant. This outward slant commences at about the middle of the curb and extends to the lower end, and its effect is to give the curb an increasing diameter as the bottom is approached, so that the hard cake remaining after pressure is relaxed can be readily forced out at the bottom. Through the center of the curb runs a hollow core, stoutly constructed of metal slats. The bottom is attached by means of hinges to the lower end of braces, which are firmly fastened to the lower band of the curb, the axle, and the middle band. The opposite side of the bottom is suspended by means of latches which are caught and held by a bolt sliding freely within the braces and actuated by a lever pivoted upon the axles. The axles are also braced by stays on either side of the tub, which pass from one axle to the other, and, being curved to fit closely to a section of a band, are firmly attached thereto. The capacity of each curb is about 7 barrels. A metal shield surrounds it to protect the workmen from the spattering oil and water when pressure is applied.

The curb, having been filled with cooked fish, is run along the rail and placed under a solid stationary head made to fit closely inside the curb and against which the fish are pressed as the curb is slowly raised by a powerful hydraulic press. This forces out most of the remaining oil and water, which exudes from between the slats, and by means of troughs and pipes is conveyed to the oil room. On relaxing the pressure the curb resumes its position on the railway and is moved from the press stand and the core removed; the bottom is swung out of the way, and the hard cake remaining in the tub is forced through the bottom, falling into receptacles underneath.

Under ordinary conditions from 5 to 7 per cent of the oil is left in the pressed fish, it being difficult to remove all the oil and water, owing to the gelatinous or gluey state of the fish as a result of the cooking. In some factories the chum or pressed fish is washed with hot water and then repressed, but this is scarcely profitable if the first pressing is properly performed. The chum now passes to the scrap room and its further treatment is described later.

About two-thirds of the total amount of oil obtained runs from the cooked fish, while it drains in the vats, the remaining one-third being extracted by the presses. The former is a trifle better than the latter, as it is somewhat lighter in color. The two grades are sometimes kept separate, but such is not the general practice.

Among the many methods of extracting the oil which have been tried but not adopted is the use of fumes of benzine or bisulphide of carbon. When these are brought in contact with the fish in air-tight chambers, they absorb the oil, the liquid result collecting in tanks at the bottom of the receptacle and the benzine being subsequently expelled by evaporation.

Much attention has been paid to devising a continuous process of cooking and pressing, in which the elements of labor are reduced to a minimum. When the Stanley process was invented, about five years ago, it was thought that the problem was solved, and the patent rights were sold for a very large sum of money. In this process the fish are cooked in boiling water in a large, comparatively shallow, semi-cylindrical tank, the lower portion of which is fitted with a worm conveyor, while near the top is a perforated plate or grating, above which the fish or other solid matter cannot pass, but through which the water and oil rise. The material is fed in through a hopper at one end and is discharged at the other end, being carried forward by the worm conveyor, which also reduces the material to a finely divided state, thus enabling the action of the water upon all parts of the material freely to liberate the oil. The oil rises to the surface of the water in the cooking vessel and escapes through a pipe in the end into a settling tank. From the bottom of this tank whatever water has come over with the oil is pumped back into the cooking vessel, entering at the opposite end from the outlet through which the oil flows and at a point near the surface of the level at which the water in the boiler is constantly kept, thus creating a current which carries the oil constantly forward toward the outlet. The scrap from which the oil has been liberated is carried forward to an outlet in the bottom of the cylinder by the worm conveyor and falls into an upright elevator casing having elevator buckets running upon an endless chain, which carry the material up and over, dumping it into a receptacle suitable for removing for further treatment. The liquid matter is carried up by the elevator buckets, drains through them, and returns to the liquor in the cooking apparatus. This process, however, has not yet been found sufficiently practical for general adoption.

As long ago as 1858 the Ocean Oil and Guano Company, of Southold, N. Y., used a steam cylinder cooker somewhat similar to the continuous cooker now in use. This is said to have been invented by a Frenchman named De Molon, and is described in a pamphlet issued by the above company in 1860 as follows: The raw fish, in quantities of 1 2-3 tons, are placed in the inner chamber of a revolving cylinder, with double walls, the space between the inner and outer walls being filled with steam at about 80 pounds pressure. Before admitting steam the cylinder is put in motion, so that as it revolves each fish is constantly changing its position. A uniform temperature is maintained by means of one head of the inner cylinder being perforated to permit the steam generated in the mass to escape through a safety valve.

In the oil room of the menhaden factories is a series of receptacles into which the oil and water are received from the draining tanks and the presses. The combined mass of oil and water is first subjected to a temperature of 150 deg. F., which causes them to separate, the oil rising to the surface. It is permitted to overflow to other tanks containing hot water, where it is brought to the boiling point by means of injected steam. It is important that the oil be separated from the water before the impurities begin to ferment, fermentation causing it to be dark and of lower grade. After settling for a while the oil is withdrawn into another tank and thence pumped into the storage tanks.

A contrivance for withdrawing the oil from the surface consists of a jointed pipe with open end at top,

* Bulletin United States Fish Commission for 1895, p. 297.

which in some cases is funnel-shaped. This passes up through the bottom of the vat, and the top of the pipe is so arranged that it may be raised or lowered to any desired distance beneath the surface to receive and guide the surface oil into the next vat. Sometimes there is a series of as many as five vats, from one to another of which the oil passes, each time becoming purer and purer as it is cooked and drained. The oil is led into the first of the cooking vats through the bottom, the pipe leading nearly to the surface. A second pipe passing through the bottom and terminating with an open top not a great distance above the bottom carries off the water-oil or less pure oil as it settles and conducts it to near the top of the second vat, where the oil and water are further separated.

At the bottom of each settling tank is deposited a quantity of finely-divided fleshy substance known as "gurry." This is removed from the tanks to the gurry room, where it is treated or sprinkled with sulphuric acid to facilitate the separation of the oil from the flesh fiber. It is then placed in bags, 2 gallons to the bag, and these placed in pairs under a press and subjected to great pressure, resulting in a small quantity of oil. The residuum in the bags, consisting of a hard cake, is broken up and either discarded or mixed with the scrap.

When thoroughly separated from the water, the oil is pumped into suitable storage tanks or barreled. The refining or bleaching of the oil is rarely done at the factories, but is performed by the oil refiners of New York, New Bedford, Boston, etc.

The yield of oil varies greatly, ranging from less than 1 pint to as much as 15 gallons or more per thousand fish, or rather for each 22,000 cubic inches of fish. As a rule, it is much greater in the autumn than in the spring, and also greater in Northern than in Southern localities. Even in the same locality the fish are very much fatter throughout some years than in others. For instance, the average yield of the fish taken in Chesapeake Bay in 1887 was nearly 6 gallons to the thousand, whereas in 1888 it was a little over 2 gallons, and early in that season it was less than 1 pint to the thousand fish. Some years ago one of the Shelter Island factories secured from one lot of fish a yield of 24 gallons to the thousand. The largest yield brought to the notice of the writer was derived from some menhaden that had been inclosed in Shinnecock Bay late in autumn. By feeding in the brackish water of that bay these became so fat that they yielded at the rate of 48 gallons of oil per thousand fish. Considering the entire Atlantic coast for a series of ten years ending in 1898, it is found that each thousand fish yielded 4.59 gallons of oil and 138 pounds of scrap containing 10 per cent of moisture. During the ten years ending in 1888 the yield per thousand fish was 4 gallons, and during the six years ending in 1878 it was 5.26 gallons.

From official figures it appears that the largest yield per thousand fish was 6.84 gallons in 1874. The yield in 1887 and also that in 1886 were large, being 6.81 and 6.38 gallons, respectively. The smallest yield per 1,000 fish was in 1880, 2.62 gallons, and in 1881, 2.79 gallons.

Not only does the yield of oil vary from year to year, but it also differs greatly in different sections of the country. As a rule, the Northern fish, or rather those taken in Northern waters, especially off the Maine coast, are the fattest, while those from off the Southern coast yield the smallest quantity. In the year 1900, for instance, the yield of oil at the Rhode Island factories was 5.76 gallons per 1,000 fish; in New York it was 6.39 gallons; in Delaware 4.92 gallons, and in Texas 3.51 gallons to the 1,000 fish. The menhaden taken off the coast of Maine are by far the fattest, and in the few seasons when the fish are obtainable there the menhaden fishermen from other States hasten to that coast. In 1888 the Maine fish yielded 11.85 gallons of oil per 1,000; in 1889, 10.83 gallons; and in 1898, 9.73 gallons to the thousand measure. Menhaden have not been taken to any extent on that coast since 1898.

TREATMENT OF THE SCRAP.

As it leaves the press, fish scrap contains 45 or 50 per cent of water, which cannot be removed by compression owing to the gelatinous condition of the fiber. Although suitable for immediate application as a fertilizer, the moist condition of this scrap renders it undesirable for economic transportation or for storage for a great length of time, and necessitates further treatment. Previous to 1875 most of the scrap was sold in a green state, just as it came from the press, but since 1878 practically all of it has been dried or treated with sulphuric acid.

Formerly in drying it was customary at all the factories to spread the green scrap upon platforms, where it was exposed to the action of the sun for several days. While this is the common method at present, most of the large factories have discarded it and are using artificial driers. The platforms are made of tight or matched boards laid flat upon a stout framework or upon the level ground, and are sometimes of a large area, covering two or three acres. The scrap is transferred from the bin beneath the presses by means of screw conveyors and carried to a receiving bin, where it is dumped into hand carts with a capacity of one-half ton each and carried to the platform. It is there spread to a depth of from 3 to 6 inches and is frequently turned or raked over, so as to expose all particles to the sun's influence. In threatening weather and when the night dews are heavy, the scrap is raked into windrows or heaps and, if necessary, covered with canvas to protect it from moisture. After two or three days' drying it is piled in heaps and left to sweat for a time, and then is again spread to evaporate the free moisture generated in the heaps. This second drying reduces the amount of moisture in the scrap to about 10 per cent, and the material may be safely bagged and stored for market, though that operation is usually deferred until immediately before its shipment. Frequently the dried scrap is ground, especially when it is to be sold direct to the farmers without further treatment, in order that it may be sown in drills with wheat and other grains.

If good weather could always be depended on, platform drying would possibly be the most economical and satisfactory method; but owing to uncertainties of the weather much difficulty is frequently experienced in this process, resulting in a great waste of material and extra expenditure of labor and loss of ammonia in the scrap. This has resulted in the adoption of artificial driers at the largest factories. Several forms of apparatus have been employed, but the principle in most of them is similar, the scrap being subjected to a current of heated air by means of a blower. The drier adopted in the largest factories consists of an iron cylinder about 30 feet long and 5 feet in diameter, so mounted as to revolve horizontally. On the interior surface are shelves or paddles which, as the cylinder revolves, lift the scrap fed in at one end and permit it to fall to the bottom. A strong current of heated air is forced through the cylinder, extracting the moisture and gradually driving the scrap out at the further end.

Another form of drier in use consists of a large double cylinder of iron set on an incline, into which the scrap is fed through an opening at the higher end and guided along to the lower end by means of a revolving screw. The space between the inner and outer walls of the cylinder is filled with steam, which heats the scrap, thereby evaporating most of the moisture.

Labor-saving devices make the handling of the scrap almost automatic. From the presses it is transferred to the drier by means of screw conveyors and bucket elevators, and is fed intermittently in quantities of 200 pounds at intervals of 45 to 60 seconds. The capacity of a drier is 2½ to 3 tons per hour, and the largest factories usually have two drying machines. From these the scrap is conveyed to the storage room.

Although the term "dried" is popularly applied to all scrap from which a large portion of the moisture has been removed by evaporation, its use in a technical sense refers to scrap containing not to exceed 12 per cent of moisture. In modern factories, green scrap fresh from the presses contains from 45 to 50 per cent of water. When desiccated so that only 10 per cent of its weight is water, each ton of chum or green scrap yields about 1,156 pounds of "dried scrap." It is not always that so large a quantity of water is eliminated, and sometimes the finished scrap contains 25 or even 35 per cent of moisture. Owing to its tendency to lose nitrogen in the form of ammonia and its unsuitability for storage or transportation, the scrap containing a high percentage of moisture is for use principally in the vicinity of the factories.

Not all the scrap, however, is dried, a large percentage being treated with sulphuric acid for the purpose of "fixing" the ammonia, preventing fermentation, and dissolving the bones. To every ton of scrap, from 80 to 200 pounds of sulphuric acid of about 50 deg. strength is added and thoroughly commingled, the quantity of acid used depending to some extent on the state of the weather and the extent of decomposition of the fish. This is conveniently done by depositing the green scrap in handcarts of 1,000 pounds capacity, wheeling these to an elevated platform and dumping the contents beneath, when the heap is immediately sprinkled with about 60 pounds of sulphuric acid contained in a leaden pot. After a short while the bones dissolve and the mass becomes homogeneous and of a rich brown color, instead of the former grayish color. The ammonia is fixed by the acid and the tendency to decomposition overcome. The scrap is then conveyed to the storage room and shipped in bulk as required.

Instead of sulphuric acid, the solid granular sodium sulphate has been used to mix with the scrap, about 90 pounds being thoroughly combined with each ton. While this method is somewhat cheaper than applying sulphuric acid, it is not so satisfactory, and sodium sulphate is now little used for this purpose.

Owing to the difficulty in drying the scrap, most of that prepared at the Northern factories is acidulated, while the bulk of the Southern product is dried. In the last year for which data are available, the product of the entire coast was 48,853 tons acidulated and 36,977 tons dried, with a total selling value of $1,539,810. Of the 45,711 tons produced from Delaware northward, 33,458 tons were acidulated and 12,253 were dried, the average price of the former being $12.87 per ton and the latter $26.22 per ton. South of Delaware the product of green and of acidulated scrap combined, according to the latest returns, was 15,395 tons, while 24,724 tons were dried, the respective values per ton being $12.95 and $23.79.

Only a small percentage of the fish scrap is used by the farmers in the condition in which it leaves the factories; most of it is ground and serves as an ingredient in compound or so-called "complete" fertilizers. Compound fertilizers are prepared at some of the menhaden factories, but as a general thing their preparation is in the hands of persons who have nothing to do with catching and rendering the fish.

The value of commercial fertilizer is dependent mainly on their content of nitrogen and phosphoric acid, which are the most important foods usually lacking in the soil. The nitrogen necessary is supplied mainly by fish scrap. Various other materials are also used, as dried blood, meat scrap, and other slaughter-house refuse, cotton seed, sulphate of ammonia, nitrate of soda, Peruvian guano, etc. The phosphoric acid is supplied by fish scrap to some extent, but principally by the phosphate rocks, boneblack from the sugar refineries, bone meal, etc., the solubility of the phosphate being increased by treatment with sulphuric acid, thus making superphosphates. The value of fish scrap varies according to the percentage of ammonia and phosphoric acid contained therein. As a general rule, dried scrap contains about 8 per cent of nitrogen and 8½ per cent of phosphoric acid. On a selling basis of $24 per ton, the nitrogen costs about 10 cents per pound and the phosphoric acid about 3½ cents per pound for compounding purposes. Other necessary plant foods are potash, lime, magnesia, sulphuric acid, and iron. These usually exist in sufficient quantities in the soil itself, but are added under special conditions, especially the potash. The nature of the ingredients and the respective proportions required vary according to the soil and the crop for which the compound is intended.

Although the agricultural value of dried fish scrap is nearly equal to that of Peruvian guano, the market price is much below that article. In explanation of this fact it may be stated that fish scrap is not in such compact and good mechanical condition for shipment and general use. Its value as a fertilizing agent has not been so widely known as that of Peruvian guano, and thus its principal use is largely limited to the manufacturers of superphosphates, who are forced by competition to exercise great caution in the cost of manufacture. And, furthermore, there is a tendency to reduce the quantity of ammonia and increase that of phosphoric acid and potash in complete fertilizers to meet the requirements of the soil. Other ammoniated materials now compete with fish guano in the making of superphosphates, among which are cotton-seed, sulphate of ammonia, nitrate of soda, tankage, meat scraps, slaughter-house refuse, etc.

The product of fish scrap, reduced to basis of dried weight, produced from 1873 to 1900 approximates 1,048,000 tons, or an annual average of 37,428 tons. As it is estimated that in a ton of compound fertilizer ready for the soil the usual proportion of fish scrap is 25 per cent, it is seen that the industry has contributed the ammoniate for 4,192,000 tons of fertilizer, or at the rate of 149,712 tons annually. In growing cotton, for which these fertilizers are largely used, 250 pounds are generally employed to raise one bale.

ELECTRICITY AND THERAPEUTICS.

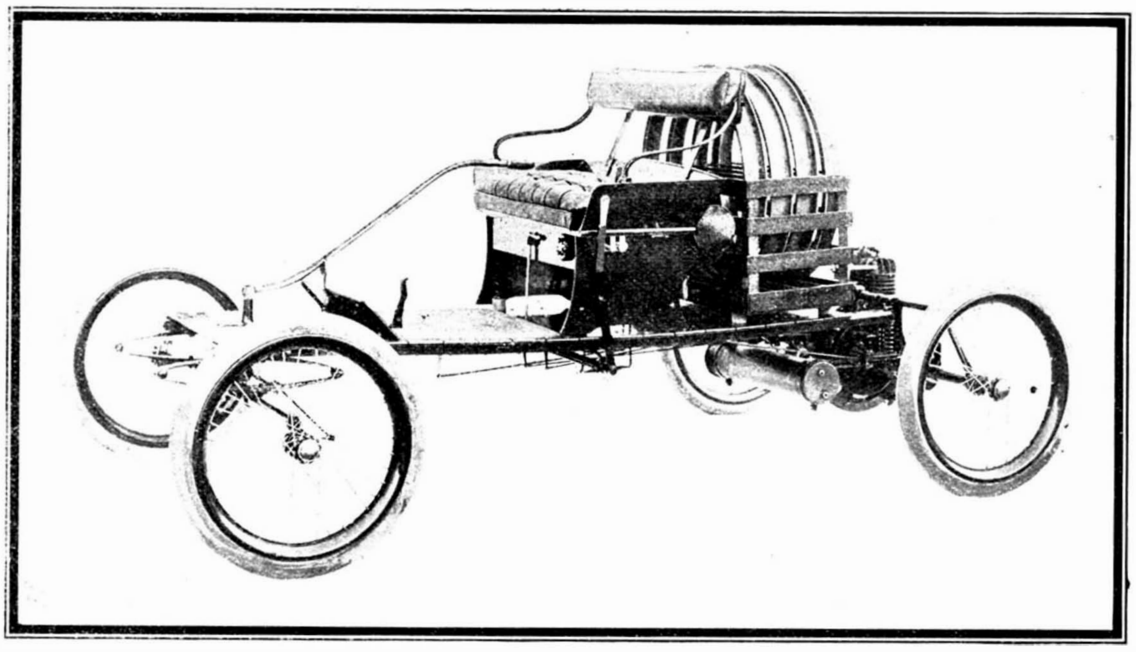
AT a recent meeting of the Edinburgh Medico-Chirurgical Society, Dr. Alexander Bruce, at the request of the council, gave an interesting demonstration of electrical currents of high frequency, with their mode of production and therapeutic applications. He said that for several reasons electrical treatment has been received by the medical profession with indifference and even contempt. The result had been, however, the discovery by the laity that there was something in such electrical treatment, and consequently all kinds of companies had been started to carry on this treatment, and most of these were run on commercial and unscientific lines. High-frequency currents were periodically alternating currents, and the frequency of this alternation was exceedingly high. Such currents stimulated both nerve and muscle, and the degree of stimulation bore a definite relation to the frequency of the alternation. The slower the alternation (within certain limits) the greater the stimulation—as, for example, from 2,000 to 3,000 per second. With currents of from 5,000 to 10,000 per second there was a gradual diminution in the effect produced, and with alternating currents above 10,000 per second hardly any stimulation was produced. No mechanical means that had been devised enabled them to obtain currents of a greater frequency than 10,000 per second. Having thus described how high-frequency currents were obtained by means of Leyden jar discharges, the lecturer went on to show the use of such high-frequency currents when obtained. He stated that they act as a general tonic to the system, as well as in lessening congestive conditions of the mucous membrane and relieving the pain of neuralgia, neuritis, and locomotor ataxia; in rheumatic arthritis even permanent relief might be obtained. In acute muscular rheumatism the relief might be also immediate, as in the case of lumbago. In chronic rheumatism benefit also resulted. In neurasthenia the pains were often greatly relieved and a general improvement resulted. In hysteria, however, such a benefit was not obtained—even in some cases the pain had increased in severity. There was also good reason to hope that it might do good in some form of muscular atrophy, especially if primary. In the treatment of most cases not only a local but a general improvement in health resulted. In alimentary diseases, Dr. Bruce had noted a marked improvement in cases of dilatation of the stomach when due to atony or neurasthenia. In the acute stage hæmorrhoids rapidly improved, as did also fissure of the anus and pruritus ani. Severe cases of cardiac disease with degeneration of the heart muscle did not seem to be benefited. He had not had experience of the treatment in tuberculosis, gout, diabetes, or cancer. We are indebted to the Lancet for the above condensation of an interesting lecture, and trust that it will do much to remove the indifference and contempt with which some doctors have received electrical methods of treatment. The same subject has also been treated recently by Sir Oliver Lodge at the Birmingham University, where he has delivered a series of lectures to medical practitioners on physics applied to medicine. These lectures

were also accompanied by experiments, and at the conclusion of the last series a vote of thanks was passed to Sir Oliver Lodge for the service he had rendered.

THE ADAPTATION OF AN AUTOMOBILE TO A RAILWAY TRACK.

The three accompanying illustrations show a novel arrangement for quickly adapting an ordinary, pneumatic-tired, light-weight automobile so that it can be run on a railway track as an inspection car.

This device was designed by the Waltham Manufacturing Company for use with their Orient buckboard, and a patent on it has been applied for. It consists in casting and machining flanged wheel-rims properly concaved inside to fit over the pneumatic tires. When it is desired to run on the track, the tires are deflated, and the rims slipped over them. Upon blowing the tires up again, the rims are held firmly in place, and the machine can be lifted and run upon the rails. A speed of 30 miles an hour is obtainable on steel rails with this little machine, and the rims, which weigh about 25 pounds apiece, can be carried in a crate and attached or detached in about 10 minutes.



THE ORIENT BUCKBOARD AS A ROAD MACHINE, CARRYING CAST-IRON WHEEL RIMS IN CRATE.

WIRE-ROPE TRAMWAYS.

The first question to be considered in regard to installing a wire-rope tramway is, will a tramway best fulfill the conditions and requirements of the case presented? More than 50 per cent of the inquiries addressed to builders of tramways go into the waste-paper basket, for the reason that so many people have an exaggerated idea of the possibilities of tramways and a very inadequate conception of their cost. Never advise a client to build a tramway unless you can show him that he ought to have it. Very few days pass with the tramway builder that do not bring up propositions for tramways, which one is obliged to advise against.

A distinction should be made between single-span tramways, or cableways, as they are called in this country, and tramways proper, which consist of a number of spans and of a number of intermediate supports.

Wire-rope tramways, in their very simplest form, have a single moving rope, which serves to support and advance the load at one and the same time. This rope passes over suitable sheaves at the intermediate supports, and the load, which is carried in buckets or other convenient receptacles, is suspended by gooseneck hangers from it. If the grades are light, the hangers are provided with box heads filled with wood or leather and rubber, which rest on the rope; the rubber or wood providing sufficient friction to prevent the hanger slipping. With this system, long spans are evidently out of the question, because with a long span the angle of the rope in the vertical plane, at the supports, becomes so great that the friction will not hold the box head. For all practical purposes, grades exceeding 1 to 4 are to be avoided, and for steeper grades, to prevent slipping, we must use a clamp to fasten the hanger to the rope.

The single moving rope tramways carry loads not exceeding 200 pounds. The speed of the rope for the variety in which the hangers are fastened to the rope may be as high as 450 feet per minute, and for one in which the hanger is loose, 200 feet per minute. The single moving rope tramway has a capacity up to 200 tons per day, and may be built, say, 1½ to 2 miles long.

The more satisfactory and substantial kind of wire-rope tramways has one or more fixed ropes, which constitute the permanent way, and an endless traction rope. When there is but one fixed cable, the carrier both advances and returns along it, but this application is so rare that it may be neglected, or better classified under modifications of cableways.

We will confine our discussion to tramways consisting of two fixed cables and an endless traction rope, the loaded carrier traveling outward on one fixed cable and returning by a parallel one, suspended from the opposite side of the same supports, because they are more general in application and embrace the principles of all the others to a greater or less degree.

In wire-rope tramways, we have machines, nothing more or less, extended over a considerable territory, and the simpler, stronger, and cheaper they can be built, the better. Simplicity is the prime requisite. Automatic devices are good, provided one does not have to set a man to watch them. Strength is an absolute necessity, and cheapness, which means economy, is the complement of the other two.

Wire-rope tramways are provided at the terminals with suitable apparatus for loading and discharge purposes, and also with driving gear for imparting motion to the traction rope, or with braking devices for checking it in case heavy grades exist in favor of the load.

The intermediate supports are built of wood or steel framing, with saddles of cast iron, in which the fixed cables rest. The traction rope is supported (in the absence of a bucket) by the rollers set conveniently on the supports. The load is carried in buckets or other contrivances suitable for the purpose, which are suspended from a trolley, which runs on the fixed cables, the wheels of which are large enough to pass over the rope couplings, to be described later, and also to clear the saddles. Grips attach the carriers to the traction rope.

The carrier consists of two wheels mounted in a yoke, from which is suspended, from one side only, the hanger, for carrying a bucket or other convenient receptacle. Either at this point or below the bucket, is located the grip which attaches the bucket to the traction rope. The carriers pass along the cables over the saddles, the hanger being on the outside. An automatic trip is provided, which dumps the bucket when it meets an obstacle placed in the way for the purpose.

The terminals are built of timber or steel, and contain an anchorage for the fixed cables, a track, on which the carriers run after leaving the fixed cables, a detaching arrangement for releasing the grip and the sheaves around which the traction rope passes, and the necessary bins, gearing, etc.

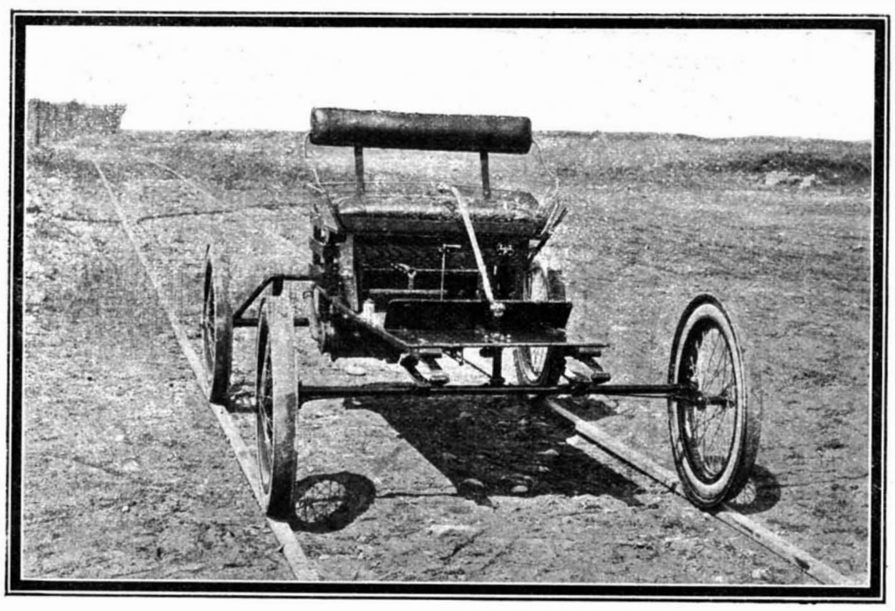
This kind of tramway is capable of carrying individual loads up to 1,400 or 1,500 pounds, not including the weights of the bucket and hanger itself. The speed of traction rope may be from 150 to 350 feet per minute. The capacity is from 200 tons to 1,000 tons per day of 10 hours. One thousand tons delivered per day means, supposing each load is 1,500 pounds, a load every 27 seconds, a rate which keeps things going very lively.

These figures represent good, safe practice, but they are not, of course, inflexible.

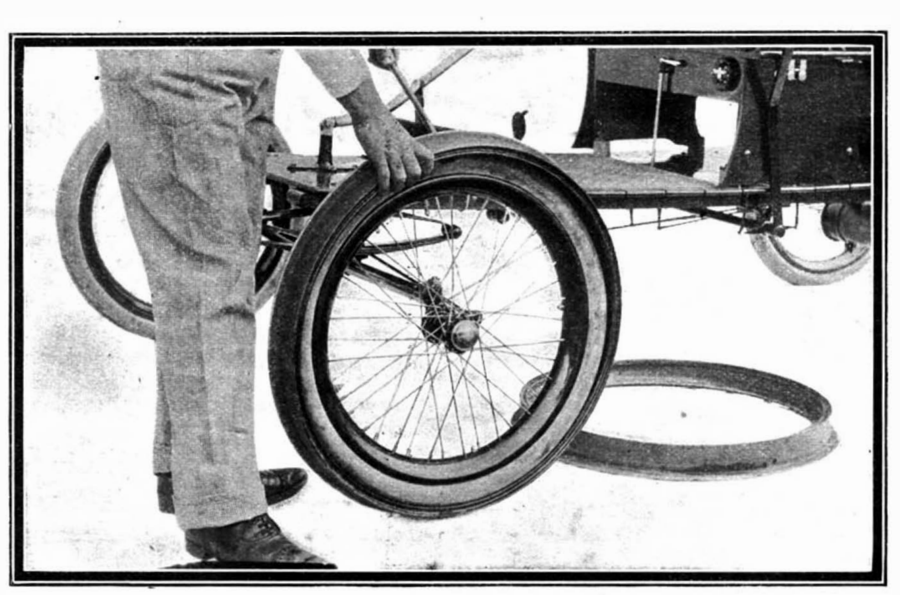
The maximum length of line which may be built in one section varies largely with conditions of load, spacing of supports, contour of ground, etc.

Wire-rope tramways work under great difficulties, and probably 2½ miles is the economical limit. This has been exceeded, but the trouble is that for a much greater distance the friction becomes too great for economical working of the traction rope. This does not, however, limit the length of tramway which may be built, as the power station may be located at a convenient intermediate point, dividing the line into sections. Several intermediate power stations may be used, and the length of the line greatly increased above the limit given.—Mines and Minerals.

That large amounts of energy produced from natural sources are continually running to waste is, of course, well known to every engineer, but members of the general public as a rule entertain exaggerated and erroneous views of the commercial possibilities which such sources contain. Untrained imagination plays a large part in their estimation of physical phenomena, and prompts occasionally amusing suggestions in the way of power development schemes for professional friends. A large river moving steadily but slowly under an insignificant head impresses the general observer with a sense of majesty and power that is altogether out of proportion to the energy available, and it is not easy to convince him that an attempt at realization would be a commercial failure, and that for practical purposes it is not to be compared with the thin stream that comes down a hill in a 6-inch pipe under a head of 100 feet and operates a turbine at its base. The potential energy of such a pressure does not impress him. Actual kinetic energy is the only kind he understands. Hence he so often asks, "Why don't engineers use the energy of the tides for useful purposes?" and "Why do they not bridle the thundering waves?" only he realizes that, like the wind, they are fickle. It is this uncertainty of action that to him alone accounts for the general absence of windmills, which are in his imagination giant sources of power, but, unfortunately, cannot be always depended upon, and hence are comparatively useless. His conceptions, however, of the real power capacities of these motors is lamentably weak, and he listens with a smile of incredulity to the statement that a 10-mile-an-hour breeze and a 25-foot wheel would probably not generate more than one horse-power. He is equally surprised to learn that the positions where the necessary reservoir accommodation could be constructed so as to utilize the energy of the tides for power purposes on anything like a practical scale are exceedingly few, and even then, with the most favorable arrangement for securing continuous output and two storage reservoirs, only



THE BUCKBOARD AS AN INSPECTION CAR, WITH FLANGED RIMS ON THE WHEELS.



SLIPPING THE CAST-IRON FLANGED RIM OVER THE PNEUMATIC TIRE.

about two-thirds of the rise of the tide could be utilized, so that a tidal range of 10 feet would require about one-third of an acre of reservoir area for each horse-power produced. It requires, indeed, very little close reasoning to arrive at the conclusion that the places where the rise and fall of the tide can be used for power producing purposes are few and far between. They do not afford any temptation to resort to this method of producing useful work with advantage, and are likely to remain so as long as coal or other fuels can be obtained at present prices and converted into useful work by existing heat motors, inefficient though the process of conversion may in some senses apparently seem.—Mechanical Engineer.

CALIFORNIA HOLSTEINS.

By Janet Macdonald.

At the California State Fair in the year 1902 Fidessa won first prize as the best Holstein cow, sweepstake in the Holstein class, and grand sweepstake cow; Holstein, Jersey, Alderney, Ayrshire, and Durhams competing. In her official test as four-year-old for the advanced registry, she gave in seven days 570 pounds milk, it making over 25 pounds butter; in her 30-day official test she gave 2399.2 pounds of milk, making 95 pounds butter; she has recently in her 60-day official test made 170 pounds butter.

De Natsey Baker won first prize and sweepstake as a two-year-old. In her official 7-day test, in her two-year-old form, she produced 377 pounds of milk, 17 pounds 7 ounces butter; in her 30-day official test she produced 1,690 pounds milk, making 70 pounds 10½ ounces butter, this being the world's record for her age, winning first prize in the Holstein-Friesian Association of America in both the 7 and 30-day test, 136 animals competing.

Juliana de Kol, a two-year-old heifer, is the latest California wonder. By virtue of her appearance and of her performance, she is entitled to be considered the finest Holstein in the world. She is beautifully marked, has a beautiful head, dainty feet, and a generally intelligent and natty style. Her best record for one day's milk yield is 66 pounds. In seven days she gave 437 pounds, in thirty days 1,852 pounds, and in sixty days 3,512 pounds. The following table of butter-fat yield of this remarkable heifer will be read with interest. Best one day's yield, 3.1851 pounds, equaling 3.98 pounds 80 per cent butter, or 3.71 of 85 per cent.

Best 7-day yield 18.0449 pounds, equaling 22 pounds 8.9 ounces 80 per cent butter, or 21 pounds 5 ounces of 85.7 per cent.

Best 30-day yield, 73.9762 pounds, equaling 92 pounds 7½ ounces 80 per cent butter, or 86 pounds 5 ounces of 85.7 per cent.

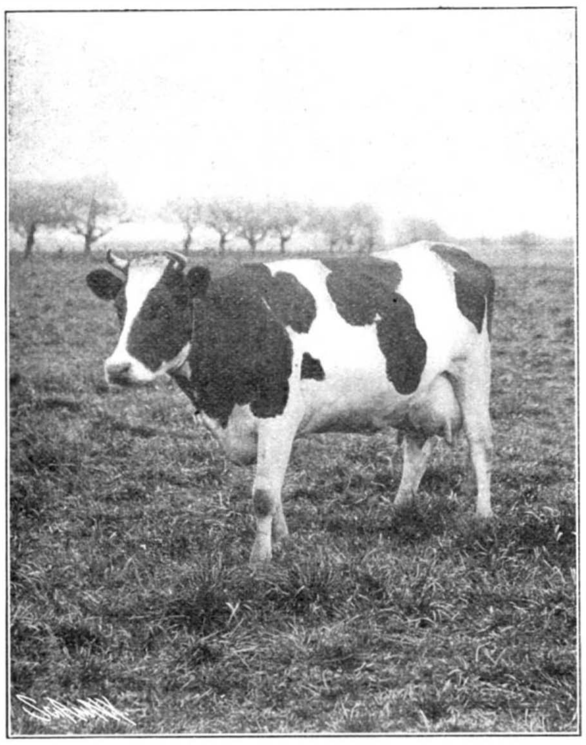
Best 60-day yield 140.4752 pounds, equaling 175 pounds 9½ ounces 80 per cent butter, or 163 pounds 14 ounces of 85.7 per cent.

The former world's record for 30 days was held by Homestead Aggie de Kol, owned by W. A. Matteson, ex-president of the Holstein-Friesian Association, which was 1,572 pounds of milk and 58.520 pounds of butter fat yielding 73 pounds 2.4 ounces of 80 per cent butter and 68 pounds 4.4 ounces of 85.7 per cent. Figuring then on 80 per cent butter, Juliana de Kol raised the record by 19 pounds 5 ounces.

There being so many members of this herd with phenomenal records, we cannot give space to enumerate further. It is sufficient to say that Mr. Chas. D. Pierce, of Rough and Ready Island in the San Joaquin River, near the city of Stockton in California, who is the president of the company owning it, holds the first prize in a 7-day test, age limit, the first in a 7-day test for two-year-olds, second in a 7-day test for two-and-one-half-year-olds, and the first in a 30-day test for two-year-olds, winning no less than 14 ribbons, 7 firsts, 2 sweepstakes, 1 grand sweepstake, and 4 seconds. The Riverside Dairy is one of which California may well be proud. The scenery suggests Holland. High dikes surround the land, which is below water level, and border the narrow channels of the river, through which sloops and shallow fishing boats and steamers ply their ways between Stockton and Sacramento. The island comprises twelve hundred acres, of which one-half belongs to the Riverside Premier Dairy Ranch, stocked with Holstein-Friesians. It is irrigated by means of flood gates, which let the river water into the ditches, and a pump of a capacity of 60,000 gallons per minute precludes any danger of a flood.

After the foregoing record of the achievements of Fidessa, one may readily understand that a blue ribbon or so is of small consequence to her. Looking into her pathetic eyes, I could but wonder if she would not willingly exchange her rank and her fame for the pleasures of real motherhood; for all of the calves of this royal household on Rough and Ready Island are at birth taken from their mothers' care. Two photographs are taken of each calf, a careful record is made of its birth, name, parentage, and date of its birth, and all are placed on file. In case by accident the ornamental little tag stamped with correct data should be lost, which at birth is clasped upon its royal ear, then this new-born baby is taken to the orphan asylum, otherwise known as the calf barn, and tied in its stall, where it remains for more than two months; no green fields or blue sky or bright sunshine or mother's love for this calf of high degree. But right here science slips a cog, for nature demands for the new-born calf its own mother's milk for the first few days of its life, under penalty of sickness, possibly death; but it is administered by strictly scientific methods, for the calf is taught to drink, from its first meal. Within a few days the diet is changed to mixed milk, from which the cream has been removed to swell the record of the herd.

This calf barn is 84 by 180 feet in size, is absolutely wholesome, cleanly, and well lighted, and there I saw more than two hundred orphans carefully watched and tenderly cared for, ranging in age from one day to over two months. Science declares that these calves are more protected from sickness and neglect than the plain ornery calf who lives with his mother in the open. From the stall the calf is promoted at the proper time to a small square room or pen, with clean sweet

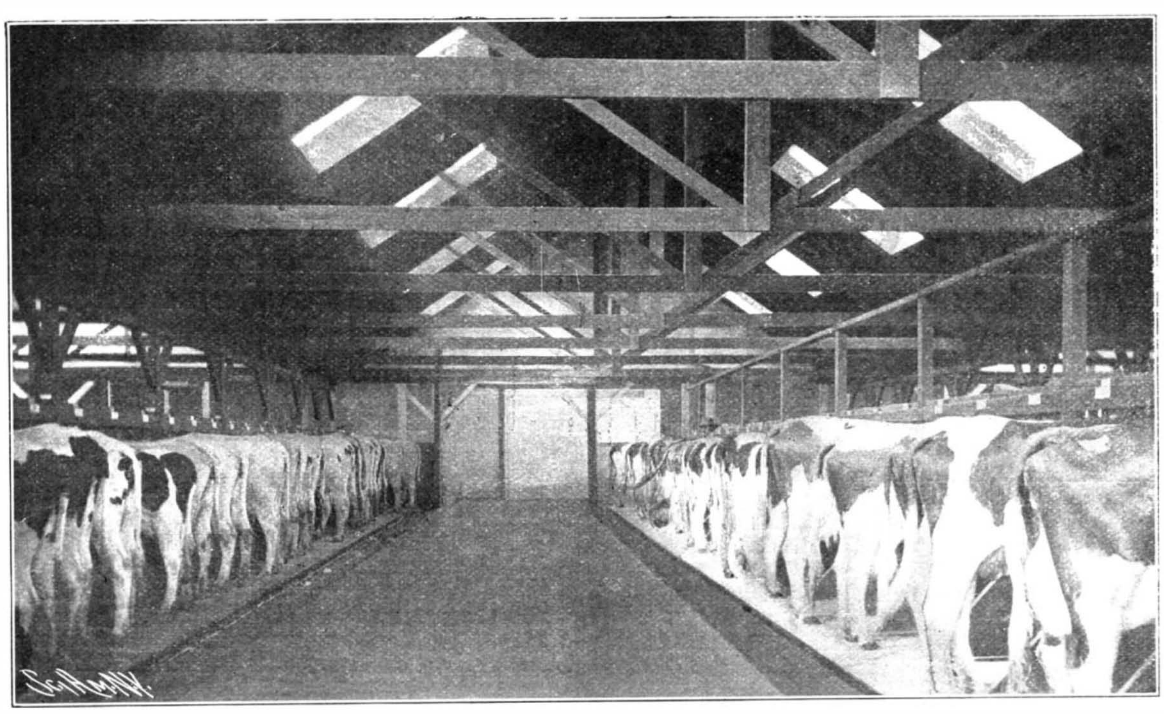


A CALIFORNIA HOLSTEIN, JULIANA DE KOL.

straw on the floor; but two calves are kept in each pen, and when they are from four to six months old they are permitted to walk out in the paddock, the entrance door to which remains open, so that they may pass in or out at pleasure. When childhood's days are quite finished, they are turned into the field, quite grown, sedate, well-bred, finished, dainty, and beautiful to look upon.

Our steps were next directed to the milking barn, where record-breaking cows were leisurely filing in, mechanically taking their accustomed stalls. I observed an air of expectancy, and almost immediately an attendant appeared, who dexterously brushed their beautiful coats and dainty feet until they looked perfectly groomed, when they were ready to be milked. The milker now appeared with two buckets, one of which he used for milking purposes; the other was filled with clean water, in which he carefully washed his hands after having milked every second cow.

The milk from each cow is carefully weighed, and religiously recorded to the credit of each Lady Holstein, under her own name and title. The milking barn is 176 feet in length by 145 in width, where every practical sanitary measure has combined to compel the most satisfactory result. It is circled by windows and lighted from above by skylights, is a model of cleanliness, and an object lesson in practical dairy farming. In addition to the numerous box stalls in which the sires of the herd are housed, there are two hundred stalls for the milking cows, a large room for milking utensils, another for the accommodation of beets, carrots, etc., and the hay barn containing two hundred tons of hay.



THE HOME OF NOTED HOLSTEIN CATTLE, RIVERSIDE DAIRY, ROUGH AND READY ISLAND, CALIFORNIA.

After having seen the milk weighed and recorded, we follow it to the creamery, which is as nearly perfect as science and a generous expenditure of money can compass. Mr. Pierce has here constructed an ample stone building which is a model of neatness and sanitation, with its porcelain tubs and tanks for holding the milk and cream, its cement floor and tiled walls, two cold-storage rooms, a commodious office, and in fact a thoroughly up-to-date structure. At the Riverside Dairy the cows are milked three times daily, and the milk is officially experted by a graduate from the school of agriculture at Berkeley. Mr. Coke has spent more than four months at Riverside, and is very enthusiastic concerning the result of his work.

In the official test, he sees the cow, whose milk he is to test, milked dry, and at each milking takes a sample, which he tests with the Babcock tester, keeping all samples under lock and key. A composite sample is sent to the University, where it is also tested, and this must corroborate the results at the ranch.

After the milk and cream are separated, the latter is shipped by boat to San Francisco. Leaving the dairy at night, it arrives at the Palace Hotel, which hostelry takes the entire output, and is served to guests in butter at 11 A. M.

CONTEMPORARY ELECTRICAL SCIENCE.*

Combined Coherers.—A. Turpain combined a number of coherers in parallel attached to the same antenna, and found that they preserved their relative sensibilities whether in open or closed circuit, but that the sensibility of each was much less in an open than in a closed circuit. The order of sensibility may be rapidly determined by producing waves which just make the most sensitive coherer respond, and then cutting out that coherer while increasing the strength of the waves until the last coherer is cut out in the same manner. The author also connected several coherers in series, and again determined their relative sensibility by exposing them to the same wave-train, and then measuring for each coherer separately the amount of cohesion as indicated by its conductivity. In this case the order of sensitiveness of the various coherers changes with the connection, since the coherer which is directly attached to the antenna has a greatly-increased sensibility. The author has adapted these results to the measurement and automatic registration of thunderstorms, and also to the construction of very sensitive detectors, both for wireless telegraphy and Hertzian wire-wave telegraphy, but he gives no details of these applications.—A. Turpain, Comptes Rendus, October 12, 1903.

Absorption of Light by Colored Flames.—According to Kirchhoff's law, the ratio between the emission of a flame to its absorption for a certain wave-length is a function of the temperature alone, and equals the emission of the absolutely black body at the same temperature and wave-length. J. Stscheglayew has tested whether this rule applies to flames colored with metallic vapors, and has found that they do not obey the law. He used a burner in which the illuminating gas was mixed before combustion with air saturated with the spray of a solution of a metallic salt, such as lithium chloride. In this way colored flames of a constant intensity are obtained. The author found that the logarithm of the ratio of emission to absorption is a linear function of the reciprocal of the absolute temperature, but the slope of the line is much steeper than is warranted by Kirchhoff's law, the Wien constant being 23,000 instead of 14,550. The ratio of emission to absorption therefore increases much more rapidly with the temperature than does the radiation of the absolutely black body. This result might have been expected if we consider that Pringsheim's experiments proved that metallic vapors are only luminous when there is a chemical reaction. Kirchhoff's law supposes the glow to be solely due to high temperature.—J. Stscheglayew, Ann. der Physik., No. 11, 1903.

* Compiled by E. E. Fournier d'Albe in the Electrician.

ELECTRICAL NOTES.

E. Bichat has examined a number of metals for their transparency to N-rays, and found that they show a well-marked selective absorption. Aluminium and silver are the only metals which transmit all the N-rays. On the other hand, palladium, nickel, and iridium intercept them all. Copper, glass, and zinc are opaque for all waves whose index of refraction in aluminium lies below 1.48. Pure lead is, strangely enough, transparent for some of the greater wave-lengths. But this transparency is masked, as a rule, by the opaque film of carbonate which clings to the commercial metal. Zinc oxide, on the other hand, is transparent, and the author can tell a piece of wood painted with white lead from another piece painted with zinc white by means of the N-rays. The selective absorption of N-rays offers a ready means of isolating definite homogeneous beams.—Comptes Rendus.

O. Lummer points out a source of error in the observation of N-ray effects which may easily mislead the observer. It is the conflict between the rods and cones of the retina in viewing a faintly luminous object. According to Von Kries, the cones are the color-seeing light apparatus, and the rods are the color-blind "dark apparatus." The rods have the faculty of considerably increasing their sensitiveness in the dark. But they are absent on the fovea centralis, and are, therefore, inactive when the eye is fixed upon an object. On interposing a lead screen between the faintly luminous object and the N-rays, the observer would naturally fix his attention more sharply upon the object in order to observe the effect. The rods are thus placed out of action, and the object would naturally appear to lose in brightness. The author admits that this view leaves many of the effects described unexplained, and that any objective proof of the effects of N-rays would dispose of the argument.—Phys. Zeitschr.

The British Consul at Trieste reports that the Kerka (Dalmatia) electricity works, developing 20,000 horse-power, will be opened shortly. A great part of the power generated will be transmitted to Sebenico, where a calcium carbide works has been erected. The transmission line will be 7½ miles long. The central station at Jaruga contains two 3,500-horse-power sets, and it is anticipated that the annual production of carbide will be 5,000 tons. The consul states also that the company formed for the utilization of water power of Dalmatia, under the name of the Società Romana, has also commenced operations on the Manojlovac waterfall, from which it is hoped that 25,000 horse-power will be obtained. There will be altogether 30,000 horse-power from the four Kerka falls, and the annual production of calcium carbide will be 30,000 tons. The electric works will when completed absorb a capital expenditure of about $750,000.—Electrical Engineer (London).

Vacuum tubes are frequently used as detectors of electro-magnetic fields, the presence of which is indicated by the luminescence of the tube. To this effect, the intensity of the field must be upward of a certain minimum, which is characteristic of each individual tube. As pointed out by D. M. Sokoltzew in a paper recently read before the section of physics of the Russian Physico-Chemical Society (meeting of November 11-24, 1903) the sensitiveness of a similar vacuum tube may be increased when taking into account the phenomena occurring in such a tube, whenever a luminescence is produced under the influence of a potential difference. In fact, an ionization of the gas contained in the tube will take place, attended by a discharge phenomenon through the gas corresponding to the luminosity observed; the field thus acts as an ionizer. Now, if the field intensity be insufficient to produce this ionization, the action of another ionizer may be resorted to. On these views it occurred to the author to use radium to increase the sensitiveness of the tube. The latter was placed under the influence of an electric field, which was so weak as to make any luminosity impossible; as soon, however, as radium rays were allowed to act on the tube a luminosity was noted, increasing with an increase in the effectiveness of the radium.—A. G.

The records kept by insurance companies in Canada and America clearly show that electrical work is not so well organized from a safety point of view in those countries as in England. For instance, the Fire and Light Committee of Montreal for the last three months of 1903 record no less than 150 electrical fires. An analysis of the Montreal report shows that 22 fires were due to crosses of telephone, telegraph, and low-potential wires with high-tension circuits. Seven pole and tree fires are also recorded. It is clear that underground wires would have prevented these fires. Nineteen were due to wires grounded on gas-pipes; 11 to defective wiring of fixtures; 5 by flexible cords wrapped round gas-pipes, the current having punctured the pipe and, the gas had ignited; 3 by short-circuits in moldings; 3 to open-link fuses in porcelain cut-out brass; 15 to overheated resistance coils and heating devices, and nine to incandescent lamps coming in contact with inflammable material. It will be seen that all these fires were due to preventable causes, and this fact emphasizes the necessity of adopting some method of better supervision in the carrying out of electric light fitting and wiring, and also of educating the public in exercising proper care in the use of electrical apparatus. It will be seen also that a large number of these fires, the cause of which could be traced, were due to the use of overhead distribution systems, which are not allowed, as a rule, in this country.—Electrical Engineer (London).

ENGINEERING NOTES.

A new method for increasing the density of steel ingots was described recently in Stahl und Eisen. The object is to allow for the escape of occluded gases in the metal by keeping the upper part of the ingot in a fluid condition until the mass of the ingot has solidified. To accomplish this, a burner cap is placed on the top of the ingot mold and a gas blast flame is directed downward upon the metal; vent-holes at the sides of the cap allow the gases to escape. The flame is so proportioned as to keep the upper part of the ingot considerably above the melting-point, thereby causing the ingot to solidify progressively upward. The metal can thus follow the contraction in volume and the gases are free to escape.

By far the most important of the new ordnance which is being introduced into the British navy is the 7.5-inch gun with its charge of 77¾ pounds of cordite, projectile of 200 pounds, and muzzle velocity of 2,860 foot-seconds. For the present this is relatively the most powerful gun they possess, and it cannot be matched for range, penetrative power, speed of working, facility of loading, and general all-round usefulness by the ordnance of any other nation, says the Naval and Military Record. The guns coming forward for proof are of 45 calibers in length, that is, 337½ inches, and the mountings, although yet necessarily in an experimental stage, are of the handiest possible description, the gun and mounting being under the complete control of the gun layer, while the breech mechanism is of the simplest character.

Mr. George T. Wickes, who took an active part in running the line from Kansas City to Denver during the civil war, thus narrates some of the difficulties encountered in his day: My earliest far western experience commenced at Wyandott, now Kansas City, Kan., in the year 1862-63. Kansas City, it now seems to me, could not then have had a total population over 3,500—Wyandott, not half that. Leavenworth was then the metropolis of the "border," from which the freight teams in large trains, loaded for the West and New Mexico, were sent. Leavenworth could not have had a population of over 5,000. Kansas City had evidently seen better days, judging from the then vacant warehouses on the bank of the Missouri River. Beyond Wyandott, west 40 miles, was a small settlement called Lawrence; then a few miles farther was a still smaller congregation of stone houses at Topeka; then came Fort Riley; adjoining this was the true "border," 125 miles west from the Missouri River. Beyond Fort Riley, then the farthest western United States government military post, was a vast rolling plain, 500 miles wide, before reaching the Rocky Mountains, in my recollection, with not a tree in the whole district. This country, though, was covered with a thick matting of buffalo grass, a surprising thing, for it grew from a hard-baked surface soil; from this hard surface would be emitted a rumbling noise like the roll of distant thunder when herds of buffalo were stampeded over it.

It is theoretically possible so to perfect the starting and stopping of elevator cars as to make the higher speeds unobjectionable; but in order to accomplish this the human element in the control of the speed must be almost entirely eliminated. The acceleration must take place in a predetermined number of feet, regardless of the load in the car; the stop must also occur in a predetermined distance, and as a consequence the function of the operator on the car must be to simply push in a starting button and hold it. To stop, either the operator or a person on a landing must push a button corresponding to the proper floor, which will set the stopping device in motion at exactly the right time, without regard to the operator. When a car is at a landing the doors should automatically open and remain open until closed by the operator, and only closing make it possible to again start the car. The mechanical arrangements will not be simple, and will require considerable power. They may cost more than they are worth, when compared to the approximation to these conditions now obtained. The economy—that is, the relation between the pounds of coal burned and work done—by the present appliances is very low; the work should be done with an expenditure of not more than one-quarter of the present amount of energy. From the nature of the service it is probable that some form of hydraulic apparatus must continue to be used, since only in the hydraulic apparatus is there stored up the large amount of energy necessary to produce the high rate of acceleration absolutely required in an instantly available and convenient form. Electric elevators are absolutely unrivaled in their field, but office building service is not their field, nor is there any sufficient mechanical reason for the expectation that in any of their present forms they will ever extend their fields to include this service. The problem is to impart a velocity of from 6 to 8 miles per hour, to a weight of from 175 to 2,000 pounds, in from 1 to 2 seconds, or to bring this weight to rest when moving at this velocity, in the same time. The energy stored up in water under pressure will do the work perfectly. The work may be stored up in the water, provided the tanks are large enough, at the average rate for a day requiring a relatively small amount of power constantly expended. There are two drawbacks: Which are that the expenditure of energy is not proportioned to the load, but must be the same whether the elevator car be full or empty, and that all forms of pumping engines suitable for any but the very largest plants are very inefficient. The line of improvement must take the direction of overcoming these two objections.—Architectural Record.

TRADE NOTES AND RECIPES.

Restoring Faded Photographs.—We find the following information given in a newspaper: "There is reason to fear that, in the faded parts, the delicate silver image has volatilized—that there is, in fact, no latent image which might be developed; nothing except what is actually visible. I recently had an old and valuable silver print sent me to restore, and after taking care to disclaim responsibility, proceeded as follows: As a precaution against a disaster, I first copied the old print in the same size; then I soaked the photograph for several hours in clean water, and, after separating print from mount, immersed the former in nitric acid, highly dilute (1 per cent), for a few minutes. Then the print was kept in a mercury intensifier (mercuric chloride ½ ounce, common salt ½ ounce, hot water 16 ounces, used cold) until bleached as much as possible. Then, after half an hour's rinsing, a very weak ammonia solution restored the photograph, with increased vigor, the upper tones being much improved, though the shadows showed some tendency of clogging. The net result was a decided improvement in appearance; but, at this stage, any similarly restored photographs should be recopied if their importance warrants it, as mercury intensifier results are not permanent. I might suggest that merely rephotographing and printing in platinotype would probably do all you require. I have repeatedly found that the copies of old and yellow prints are a great improvement on the originals."

Metal Polishes.—The substances in general use for polishing metals are prepared chalk, rotten stone, tripoli, and emery. For the finest work jewelers' rouge is employed. This is prepared by calcining precipitated ferric oxide, until it assumes a scarlet color.

Substances like emery are most useful for the harder metals; they scratch too much to be used to any extent on gold or silver. All should be run through a fine sieve before being used.

As examples of mixtures we give the following:

I.

Kieselguhr	80 parts
Oxide of tin	30 parts
Pipeclay	30 parts
Tartaric acid	3 parts

II.

Kieselguhr	28 parts
Pipeclay	10 parts
Sodium hyposulphite	3 parts
Ferric oxide	2 parts

III.

Make Armenian bole into a paste with oleic acid.

IV.

Rotten stone	1 part
Iron subcarbonate	3 parts

Lard oil, a sufficient quantity.

V.

Iron oxide	10 parts
Pumice stone	32 parts

Oleic acid, a sufficient quantity.

VI.

Soap, cut fine	16 parts
Precipitated chalk	2 parts
Jewelers' rouge	1 part
Cream of tartar	1 part
Magnesium carbonate	1 part

Water, a sufficient quantity.

Dissolve the soap in the smallest quantity of water over a water bath. Add the other ingredients to the solution while still hot, stirring all the time to make sure of complete homogeneity. Pour the mass into a box with shallow sides, and afterward cut into cubes.

VII.

Petroleum jelly	42 parts
Refined paraffin	14 parts
Powdered bath brick	14 parts
Powdered pipeclay	14 parts
Powdered pumice	2 parts
Oleic acid	1 part

VIII.

Dried sodium carbonate	5 parts
Soap	20 parts
Emery, in very fine powder	100 parts

Water, enough to form a paste.

IX.

Dried sodium carbonate	5 parts
Soap	20 parts
Levigated emery	100 parts
Water	100 parts

Mix, put on a water bath and heat, under constant agitation, until a smooth homogeneous paste has been obtained.

X.

Jewelers' rouge,
Petrolatum, equal parts.

XI.

Emery flour	50 parts
Jewelers' rouge	50 parts
Mutton suet	40 parts
Oleic acid	40 parts
Petrolatum	1 part

Melt the suet and oleic acid together over a water bath, and when thoroughly mixed remove from the fire. When cooled but still soft, add the powders, and rub until they are evenly distributed throughout the mass.

As an example of a liquid cleanser and polish for ordinary use the following is given:

Prepared chalk	2 parts
Water of ammonia	2 parts
Water, sufficient to make	8 parts

The ammonia saponifies the grease usually present. It must be pointed out that the alkali present makes

the preparation somewhat undesirable to handle, as it will affect the skin if allowed too free contact.—Drug. Circ.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Regulations Concerning Foreign Commercial Agents.*—Japan.—In Japan commercial agents are exempt from all taxation as business agents. Their samples are admitted free of duty if all the prescribed customs formalities are observed and a deposit made as guaranty for the re-exportation of the samples within the time fixed by the customs regulation.

Persia.—In Persia, also, the traveling agent is free from all taxes. He must, however, be in possession of a passport which has been properly visaed by the representative of the Persian government who resides in the country in which the agent has his permanent residence. Thus, an American agent is required to produce a passport which has been visaed by the Persian representative at Washington. Probably a Persian consul in the United States could also perform this duty, but the writer is in doubt as to whether the Persian government has conferred this power upon its consular representatives.

Samples without market values are admitted free of duty. All those which possess a commercial value, as shown by the appearance and general character of the goods, are subject to duty. Textiles whose length and breadth exceeds 30 centimeters (11.81 inches) must pay duty. All woven goods of smaller size are entered free.

Siam.—Commercial agents traveling in Siam are free from all taxes and other fees. It is, however, considered advisable to carry a passport.

Samples are admitted free of duty under observance of certain formalities. It seems that all kinds of samples, irrespective of size and quality, are entered free. On their re-exportation certain customs regulations must also be observed.

Straits Settlements.—It is reported from Straits Settlements that no regulations exist governing the activity of commercial agents. Nor are there any customs laws regulating the entrance and re-exportation of samples of any kind.

Australasia; New Zealand.—In New Zealand commercial agents who solicit orders can enter free from all restrictions, taxes, or fees. They must, however, notify the customs authorities of their arrival and register themselves before beginning their business. On leaving the country every agent must report to the customs authorities with whom he originally registered. He is then required to give a sworn statement of the amount of his orders taken. This having been done he has to pay an income tax as follows: The profit on his orders is calculated to amount to 5 per cent of the aggregate amount of the orders taken, and the agent is then taxed on this income to the extent of 5 per cent. The income tax must be paid prior to the agent's departure from the country.

All agents who wish to solicit orders from private individuals in their homes must also possess a trade license, which costs £1 or £2 ($4.87 or $9.74), according to the size and importance of the cities visited in the course of business.

No regulations requiring a special passport or other identification card exist. Samples are admitted upon deposit of the duty to which they are subject, with the privilege of having such deposit refunded in case of their re-exportation within a prescribed time. The intention to re-export the same must have been declared on the entry of the samples.

New South Wales.—Commercial agents are not required to produce any trade license or identification papers. Where samples are carried which from their size and general make it is plain that no intention exists to place them upon the market, they are entered free of duty. In other cases the regular duty must be paid. There does not appear to be any provision for the refundment of the duty in cases where samples are re-exported.

Victoria.—Traveling agents are free from all taxation. They are not required to be in possession of a trade license, and may solicit orders for all kinds of goods and from all kinds of individuals. Samples without a market value are free of duty. Those which possess a commercial value are admitted upon deposit of the amount of the duty. They are properly labeled in this case, and in the event of their re-exportation the duty is refunded. When once entered the samples can be carried through the country free from all other restrictions.

West Australia.—Traveling agents are not obliged to pay any license fees or other taxes. Samples carried which possess a market value are subject to the regular duty. On their entry a certified list must be executed showing all the samples carried. If within the limit of two months such samples are re-exported the duty upon the same is refunded, provided the aggregate value of the samples which were originally entered exceeded £50 ($243.32). No refundment of duty takes place where the total value of the samples is less than this amount, no matter when they are re-exported. The identification of the samples must be out of the question, and generally the original form of packing must have been adhered to. The duty on jewelry and watches must either be paid at once on the entry of the articles, or they must remain under the control of the customs officials.

Tasmania.—Except for wholesale trade in wines and liquors, for which a license of £25 ($121.66) must be taken out, commercial agents are not subject to any tax in Tasmania. Samples without market value are admitted free of duty. Those which possess a commercial value must pay the regular duty. No refundment of duty takes place, as is so commonly customary.

South Australia.—Traveling agents are free from all taxes and fees, and need not take out a trade license. Samples of all kinds which possess a market value are subject to a duty, which is, in certain cases, refunded on the re-exportation of the goods. Samples of dutiable goods which consist purely of cuttings are admitted free.

Queensland.—No taxes, licenses, fees, or other dues are exacted from commercial agents in Queensland. Samples are subject to duty when they possess a market value. If such duty exceeds the sum of £2 ($9.73) the same is refunded on the re-exportation of the samples, provided all the samples which were originally entered are re-exported. If any of them have been sold or disposed of in any way the right of refundment is lost. For certain commodities, such as supplies for vessels, grain, tobacco, liquors, wines, beer, and jewel, no refundment is made under any circumstances. Samples without any market value are admitted free of duty.—J. F. Monaghan, Consul at Chemnitz, Germany.

American Retail Stores in Germany.—The following is a translation of an article from the Taegliche Rundschau (Daily Review), regarding the establishment of American retail stores in Germany.

It certainly has not escaped the careful observer of our economic development that American commercial enterprises are systematically trying to gain a firm and lasting footing in the larger cities of Germany for the sale of American products by the establishment of retail stores.

Wandering through the business streets of our large cities, these efforts of Americans become self-evident. Generally speaking, this was heretofore only the case with branches of a specifically American nature.

Of late, however, the Americans appear also as competitors in the most varied branches of our home, large-scale industry.

American competition has almost paralyzed some of our industries—for instance, those of typewriters, sewing machines, and cash registers. Photographers' articles and musical instruments also form an important branch of American competition. Now the experiment is added to establish American shoe stores. The tendency of all these American establishments is above all this; to deal directly with the purchasing public, avoiding as far as possible all middlemen.

The Americans try furthermore to simplify their business by dealing in only one article which they have specially prepared for the German market. On the other hand, they endeavor, of course, to attract customers with all the cunning which American business men are known to use so well. At the same time, they often do not hesitate to employ means which are considered unusual here.

The main strength of this American competition, however, comes from the fact that these American enterprises in every way call attention to their American character in the most striking manner. This is quite in contrast with the German usage, according to which the German business man abroad seeks to avoid as far as possible his German personality.

Considering the great liking which our sometimes more than naive public entertains in general for everything non-German, the Americans find their game an easy one.—Richard Guenther, Consul-General at Frankfort, Germany.

Trade Between Austria-Hungary and the United States.—The volume of trade with the United States is not large. Austrian products are not sold in the United States to any great extent, though the trade seems brisker this year. On the other hand, Austria-Hungary is compelled to buy American cotton, but her consumption of other articles produced in the United States is somewhat limited. There is a considerable variety of American manufactured products sold in the empire, but it can not be said that this sale is on a large scale. However, the outlook is encouraging. As compared with a few years ago the introduction of American goods has made great progress. The merits of a number of American products are now recognized, and there is a demand—to be sure, a limited demand—for certain commodities that promise to expand gradually. The policy of the government and the inborn instinct of the people are to patronize home industries, so that when certain American articles make their way in spite of these obstacles it is a signal triumph. Such American goods as sell in Austria, and there is a large variety, though the sales of many are as yet insignificant, are generally admitted to be of superior quality. American goods are popular in spite of some effort to arouse prejudice against them. Thus, public speakers and writers do not hesitate to declaim from time to time on what they term the "American danger." Eventually, these speakers allege, the large American producers will transfer part of their attention to Europe. This will result in the capture of the bulk of trade. One hears this occasionally alluded to as a possibility, and it is used as a bugbear against American trade.

Among the more prominent articles of American manufacture that now sell to some extent in Austria-Hungary may be mentioned the following: Typewriting machines, boots and shoes, sewing machines, cash registers, tools and hardware, agricultural machinery, patent medicines, kodaks, fountain pens, phonographs, canned goods, novelties, etc. Most of these articles have been introduced with considerable success. American typewriting-machine manufacturers are largely represented in Vienna, as well as throughout the empire, and their business has increased very much in the last few years. The agent of a popular machine informed me that he sells fifty machines now in the same time in which he sold one ten years ago. This indicates to what extent they have come into use in recent years. They are being generally introduced in public and private offices, and the increase in their sales is bound to be much larger in the near future. American cash registers are being adopted, too, an American company having opened a store in Vienna, which is doing a large business. In fact, wherever an American firm has a store of its own in this country the business develops in a satisfactory manner. A boot and shoe store, where only American-made foot gear will be sold, is to open December 1, and its success seems assured. Vienna is the center of the Austrian shoemaking industry and it is a significant event that a store should be opened where only American shoes will be sold.

American tools and hardware are well liked and have been introduced to some extent. Agricultural machinery of American make is recognized as the best, but the competition of Austrian, German, and English machinery is extremely keen, and it is difficult to meet the prices of such competition. American sewing machines find a fairly good market and there is a good opportunity for still further enlarging it. American medicinal preparations are to be seen in many drug stores now, and it is reported that they are becoming popular. Such manufactured products from the United States as already sell in Austria-Hungary and others not yet introduced may find a good market here. It is principally a question of getting the goods before the public, and as American manufacturers begin to study foreign markets and to acquaint themselves with the methods for doing business outside of their own country they should acquire a fair share of trade in Austria-Hungary.—W. A. Rublee, Consul-General at Vienna, Austria.

House Heating in England.—United States Consul Leo Bergholz, of Three Rivers, Canada, under date of February 19, 1904, writes as follows:

The Canadian commercial agent at Manchester thinks that a good trade can be built up by manufacturers of hot-water furnaces, radiators, and gas and oil heaters, and in this connection writes:

"The average house in England is dependent for its heat upon grate fires in parlor, dining room, and bedrooms. The halls and bathrooms are cold and uncomfortable. It is true the temperature rarely falls below 32 deg. in the middle and southern portion of the Kingdom, yet the houses are the reverse of comfortable. Many of the large office buildings have no system of heating installed and the occupants must rely on a small grate fire and gas stove. A few private houses have a crude system of heating by hot air (in conjunction with grate fires), and I am confident, in my knowledge of the cost of hot-air heating, that a business in this line also could be worked up in supplying houses of the better class with indispensable comfort in the winter months."

Wood Pulp in France.—Wood pulp for the manufacture of paper is always in demand in France, and the American article might easily find a considerable market at Nantes. The varieties desired are (1) *la pâte mecanique*, which means simply the wood pulp, not chemically treated; and (2) *la pâte chimique au bisulphite*, or, in other words, the wood pulp which has been chemically treated. The first must be sold here at not more than $2.50 per 100 kilogrammes (220 pounds), and the second at $3.86 per 100 kilogrammes. The customs duty on the first is 29 cents and on the second 48¼ cents per 100 kilogrammes. If any of our manufacturers of wood pulp think the matter of interest, I will be glad to put them in communication with persons in Nantes who are anxious to take the matter up.—Benjamin H. Ridgely, Consul, Nantes, France.

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* Based upon Export-Handbuch, vol. 1, by Dr. August Etienne. This completes the series of reports upon regulations respecting commercial travelers in foreign countries. The series will be issued as a special number of Consular Reports.

SELECTED FORMULÆ.

Wall Paper Cleaner.—The following recipe for one form of these rolls:

Powdered pumice stone .... 1 part
Wheat flour .... 6 parts
Water sufficient.

Make into a stiff dough. Roll out into a roll of two or three inches in diameter, cut in lengths of from four to six inches, and inclose each piece in a tightly-fitting bag of muslin, closing the ends by sewing. Have ready a pot of water in active ebullition, and into it drop the rolls, much as they used to do in making old-fashioned dumplings. Let them seethe from three-quarters to one hour, then pour off the water, remove the rolls, and put them in a cool place to stand for twelve hours before removing the bags, when they are ready for use.—Nat. Drug.

Rose Tooth Powder.—The following recipe yields a satisfactory tooth powder:

Powdered chalk .... 4 ounces
Powdered orris root.............. 2 ounces
Carmine, No. 40................... 1 drachm
Oil of rose geranium..............15 minims
Oil of sandal...................... 5 minims

Triturate the carmine thoroughly with a small portion of the chalk, and when well mixed add the remainder with the other ingredients.

As to the base of this powder—chalk—we can suggest no improvement. Chalk is chosen purposely because of its low power as an abrasive. A powder or paste for general use should manifestly contain nothing which would scratch the enamel of the teeth.—Drug. Circ.

Substitute for Vanilla Extract.—A substitute for vanilla extract is made from synthetic vanillin. The vanillin is simply dissolved in diluted alcohol and the solution colored with a little caramel and sweetened perhaps with syrup. The following is a typical formula:

Vanillin .... 1 ounce
Alcohol .... 6 quarts
Water .... 5 quarts
Syrup .... 1 quart
Caramel, sufficient to color.

An extract so made does not wholly represent the flavor of the bean; while vanillin is the chief flavoring constituent of the bean, there are present other substances which contribute to the flavor; and connoisseurs prefer this combination, the remaining members of which have not yet been made artificially.—Drug. Cir.

Paint for Blackboards.—The following formulas for giving a slate-like surface to wood or plaster, have been published:

I.

Shellac .... 1 pound
Alcohol .... 1 gallon
Lamp black (fine quality).......... 4 ounces
Powdered emery .... 4 ounces
Ultramarine blue .... 4 ounces

Dissolve the shellac in the alcohol. Place the lamp black, emery, and ultramarine blue on a cheese-cloth strainer, pour on part of the shellac solution, stirring until all of the powders have passed through the strainer.

II.

Ivory black .... 2 ounces
Emery .... 1 ounce
Ultramarine .... 1 ounce
Shellac .... 4 ounces
Alcohol .... 2 pints

Mix well and agitate until the shellac is dissolved.

III.

Lamp black .... 1 ounce
Pumice stone .... 4 ounces
Boiled linseed oil................. 8 ounces
Turpentine to make................. 2 pints

IV.

Shellac .... 8 ounces
Lamp black .... 1½ ounces
Ultramarine .... 3¼ ounces
Rotten stone .... 4 ounces
Pumice stone .... 4 ounces
Alcohol .... 4 pints

Dissolve the shellac in the alcohol, and add the other ingredients, in fine powder. Shake well before using.

V.

Slate .... 7 ounces
Lamp black .... 1 ounce
Aqueous solution of water glass, 1 in 8, a sufficient quantity.

In preparing these paints it is essential that the insoluble substances be reduced to very fine powder and that they be thoroughly incorporated in the mixture, and also that they be kept in a state of suspension during the process of application, by constant agitation.

Of course, much depends upon the skill of the painter, for unless he prepares the surface of the board or wall before putting on the paint, the latter cannot be expected to appear to the best advantage. Two coats are usually to be preferred to one, and uneven surfaces after either coat has been applied should be rendered smooth by rubbing with sandpaper or emery cloth.—Drug. Circ.

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