SCIENTIFIC AMERICAN SUPPLEMENT. No 1482

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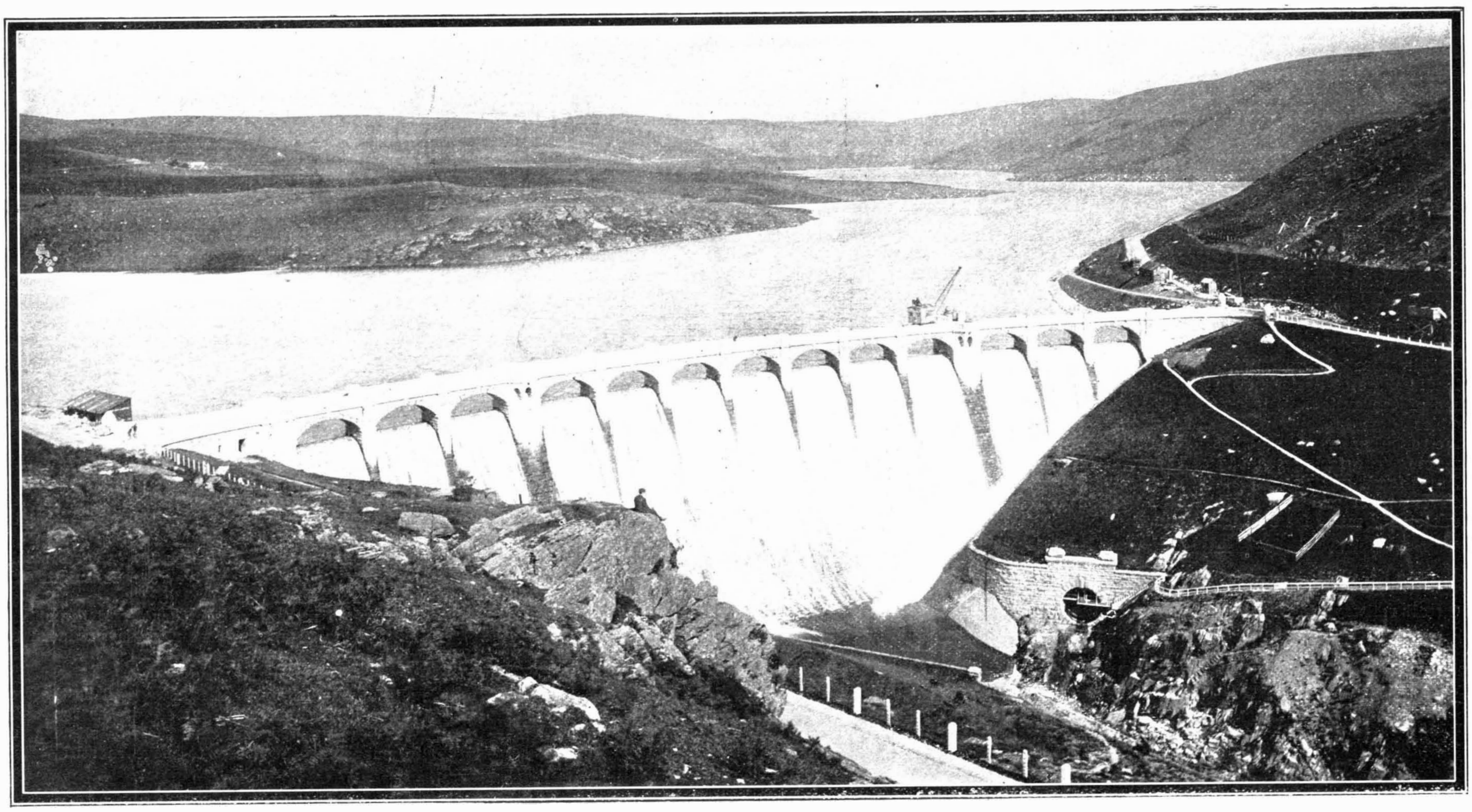
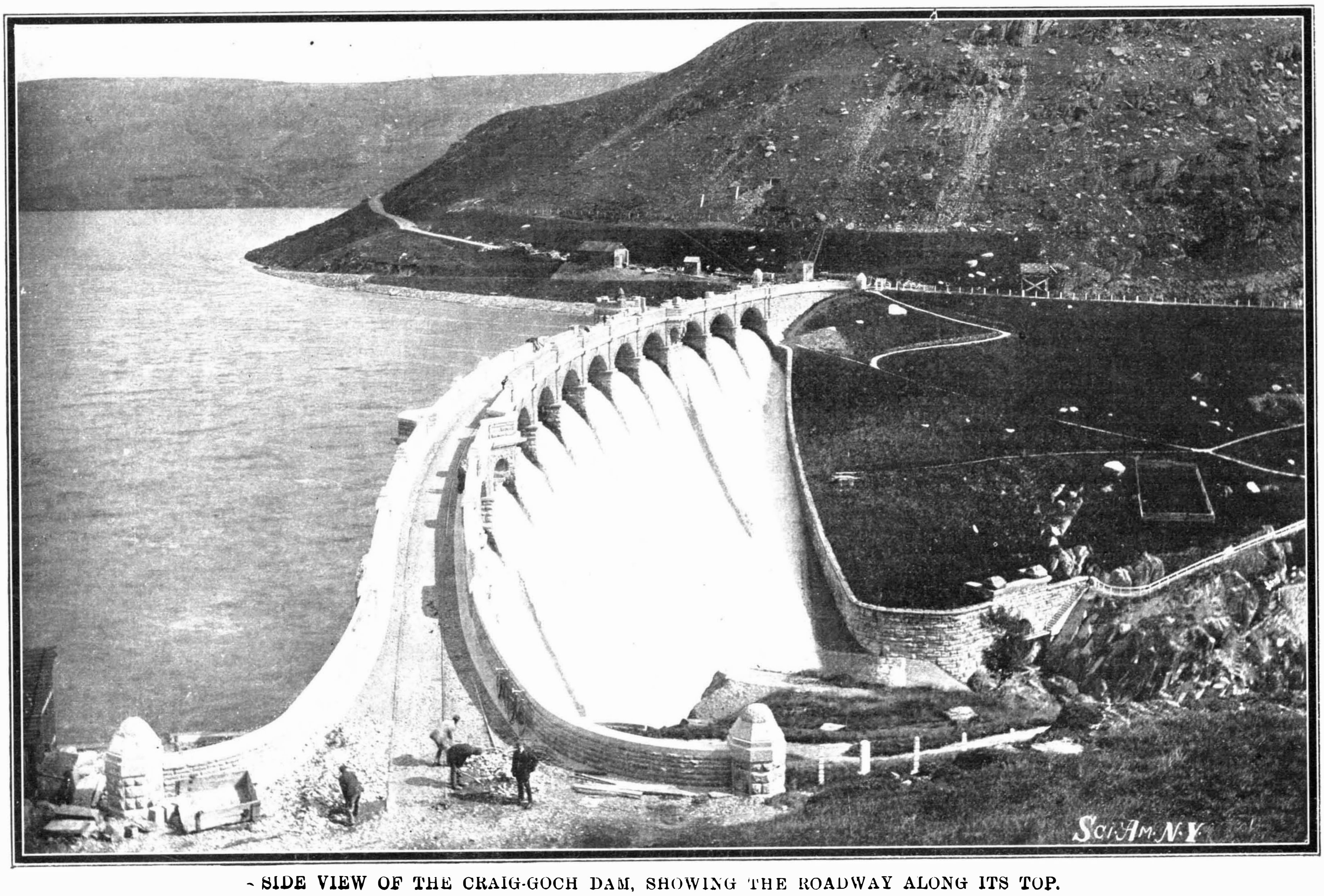
Scientific American, established 1845.
Scientific American Supplement, Vol. LVII., No. 1482.

NEW YORK, MAY 28, 1904.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.



CRAIG-GOCH DAM, BIRMINGHAM, ENGLAND.



SIDE VIEW OF THE CRAIG-GOCH DAM, SHOWING THE ROADWAY ALONG ITS TOP.

CRAIG-GOCH DAM, BIRMINGHAM, ENGLAND.

ONE of the most extensive English water-supply undertakings attempted in recent years is undoubtedly that which has for its purpose the provision of an adequate water supply for the city of Birmingham, England. Through the courtesy of Mr. James Mansergh, the engineer in charge, we are enabled to present two views of a dam which plays an important part in this system, and which is remarkable for its architectural beauty as well as for its engineering features. The structure in question, the Craig-Goch dam, is one of several in course of construction intended to form a series of reservoirs. In this particular instance the reservoir, which is some 2½ miles long, with a depth of water 135 feet below the crest of the dam, is located in Elan Valley, Radnorshire. Owing to the fact that it is impossible at this writing to obtain full details of the work to be carried out, we are able only to present a cursory description of the dam and of the entire water system.

Actual work was begun in the endeavor to supply Birmingham with a better water system some twelve years ago. Although the engineering task undertaken by Mr. Mansergh is very nearly completed, there is still much to be done. The reservoirs of the entire system will have an impounding capacity of about eighteen billion imperial gallons. The principal basin is the Caban-Goch reservoir. A large aqueduct of about 74 miles in length conveys the water from the Caban-Goch reservoir to the two hundred million gallon Frankley distributing reservoir, which lies just outside the city of Birmingham. Part of the system, known as the first installation of the Elan water, includes the works necessary for storing and conveying the waters of the Caban-Goch, Craig-Goch, and Pen-y-Gareg reservoirs.

Architecturally considered, the Craig-Goch dam is a splendid piece of designing. It differs from the other dams of the system in being arched in form, but resembles them in being constructed of large blocks of stone roughly shaped and embedded in Portland-cement concrete. The facing consists of heavy, broken coursed, rock-faced grit or conglomerate, closely jointed on both upstream and downstream faces. The dam is about eighty miles from Birmingham.

USE OF CONCRETE FOR RAILWAY TIES.

ON all railways in French colonies near the tropics the ties are generally of iron, timber being destroyed in a very short time by the climate or insects. In Cochin China iron is used exclusively. In West Africa a very hard native wood is occasionally employed.

Four or five years ago M. Sarda, a cement manufacturer at Perpignan, in the south of France, proposed the use of concrete ties and sent a few samples to the minister of the colonies, but after a careful examination the engineers of the public works department reported that they were unsuitable on account of the cost, size, and extra weight. They were also of opinion that concrete ties were best suited to lines where the traffic was heavy and frequent express trains ran, whereas on colonial railways the traffic is light and all the trains are slow. The ties, however, were satisfactory as far as strength, endurance, and immunity from damage by climatic changes and attacks by insects were concerned, and might be employed if they could be manufactured on the spot in any of the French colonies.

Having failed to get his concrete ties adopted by the minister of the colonies, M. Sarda then applied to the State Railway in France, and in March, 1900, sent four as a sample. They were not made entirely of concrete, but what the French call "ciment armé," iron and cement combined. The framework, or skeleton, consisted of five metal plates, placed vertically and held in position by stout iron wire or thin bars. The interstices were then filled in with cement. A thin layer of compressed felt, about one-fifth of an inch thick, was put between the tie and the boltheads.

These four ties were placed on the line near a small depot, about 12 miles from Bordeaux, in October, 1900. A year or more later the track overseers reported that no fault could be found with them, but it was impossible to judge from such a small sample. The maker was therefore requested to make the number up to 100. These were duly received and laid down between April 20 and July 1, 1902. The manufacturer had made a slight change in the construction so that the bolts could be replaced if necessary without damaging the tie.

The length of line on which concrete ties are at present used is less than 100 yards. The greatest weight concentrated on a single pair of driving wheels is about 14 tons. The rails are 11 meters (12 yards) long and weigh 38 to 40 kilogrammes per meter, or from 77 to 81 pounds per yard; 14 ties are used for each rail of 12 yards. The ties are rectangular, with rounded corners and slightly thicker where the shoe irons are placed; the average thickness is about 4 inches. The weight of each tie is about 308 pounds, and the cost 14 to 15 francs ($2.70 to $2.90). The only means used to reduce shock is the thin layer of compressed felt already described.

It should be mentioned that superficial cracks were noticed in 30 of the 100 ties when they were laid down, but these cracks do not seem to have spread, for no complaints have been received from the track overseers. The experiment is too recent to enable any definite opinion to be formed, for the usual life of a timber tie in France is about fifteen years, and therefore considerable time must elapse before comparison can be made as to whether cement is superior to timber in its power to resist shock, atmospheric changes, replacement of shoes and bolts, wear and tear, etc. At present it is impossible to say whether any economy would be effected in track labor or material, but in the opinion of the chief engineer of the State Railway this is not probable unless the cost of the ties can be considerably reduced.

The price now charged is a serious obstacle to their employment, whatever their advantages may ultimately prove to be.—John K. Gowdy, Consul-General at Paris.

THE AGE OF CEMENT.

THE programme for the regular meeting of the Engineers' Club of Philadelphia, for November 21, 1903, included a discussion of the many new uses and increasing demand for plastic materials. Mr. R. W. Lesley had prepared to open the discussion with remarks from which the following abstract was taken and sent out by the club in advance:

History has recorded the progress of the world by dividing it into various ages, such as the age of stone—the age of iron—the age of copper—the age of steel, and to-day history is about to add another page by the inauguration of the "age of cement," or the "age of plastic material."

While the development of the cement industry since the first discovery of Portland cement in the early part of this century has been comparatively slow for many years, the past decade has seen such a development of cement works and of uses of cement, that a historical epoch is almost at hand. By enormous leaps and bounds the cement industry, in Germany, in Belgium, in England, and in Russia has been developing within the past ten years, and the record of our own country reads almost like a fairy tale.

While the steady expansion of the production of pig iron, which has shown an increase of 100 per cent in a decade, has been the subject of almost universal comment, there is certainly more cause to wonder and to comment upon the production of Portland cement, which, as shown by the last report of the Mineral Industry, was a well-established industry in 1894, with twenty-four factories, and has grown 2,606 per cent in eight years, the factories having increased three-fold, and some of the larger ones eight-fold in capacity. Such a growth is almost beyond description, and when we turn from the growth of the industry itself to the growth of the uses of the product of cement, the mind is still more led to wonder and surprise.

From the ten-story sky-scraper of Cincinnati, with all its walls and carrying members made of cement or cement and steel construction, to the cement railroad ties used upon some of the western railroads; from the enormous concrete dams erected on the Pacific coast to the small cow-stable erected on Pennsylvania farms of this material, there seems to be no known use and no known purposes to which cement in some of its forms of concrete, or steel and concrete, cannot be profitably and successfully utilized.

DISCUSSION.

In the discussion Mr. R. W. Lesley presented some figures which showed the immense growth in the production of cement in this country from 1882 to 1902. More remarkable still were the figures giving the enormous growth in consumption per capita of population, and indicating the tendency toward structures of a permanent character. Twenty-four different systems for the construction of buildings of reinforced concrete were enumerated, as well as many new and old uses for cement classified under various headings, such as railroad work, etc.

Mr. James Christie gave results of some transverse tests of concrete of various proportions, using natural and Portland cements. These tests were illustrated by a rough diagram on the blackboard, and in the case of the natural cement concrete they indicated a decrease in strength after the first week and then a continuous increase. The curve for the hydraulic cement concrete showed a gain in strength up to thirty weeks, and then a decrease. Granulated slag was used instead of stone in the concrete. In reply to Mr. Christie's question as to the cause of the drop in the strength of the natural cement concrete, Mr. R. L. Humphrey stated that there is no law for the hardening of natural cement when it is preserved in air as those specimens were. As to the continuation of the decrease in the strength of a Portland cement concrete after thirty weeks, he stated that it was probably due to the increasing brittleness of the material and to the fact that it was almost impossible to make transverse or tension tests of such specimens without causing a shock of some kind, and thus apparently showing a decrease in strength. The compressive tests of both kinds of cement do not show any decrease in strength with the lapse of time, and Mr. Humphrey dwelt upon the fact that the tests applied to cement are those used for a flexible material such as steel, while cement work is practically stone. The tendency of engineers to specify high initial strength for cement is analogous to the high tests originally required in steel, which were all directed toward high tensile strength without reference to elasticity. Mr. Lesley stated that the high swing of the pendulum in the way of the tests as represented by the Pennsylvania Railroad specifications for cement had probably been reached. The strength required for neat cement, seven days, had been gradually increased until it reached 700 pounds, while the last specifications, those of New York tunnel work, required that the strength should not exceed 700 pounds.

In reference to the relative value of Portland and natural cements in general work, Mr. Humphrey stated that in time the natural would become as strong as the Portland, and that where the load would not be applied for a long time natural cement would answer. In the case of a building, however, where the load was applied gradually as the building progressed, it would be inadvisable to use anything but Portland cement. Referring to the efforts made to make concrete impervious, he called attention to the fact that there would be more leaks through expansion or shrinkage cracks than there would through the body of the concrete, and he gave as his opinion that we would in time reduce the proportion of cement in concrete and thus lessen the tendency of expansion and shrinkage. He noted that it was not uncommon in Germany to use concrete to proportions 1, 8, 12. The president mentioned an experience in tearing down some old masonry which had been built about 1833, which illustrated the increase of strength in natural cement after a long lapse of time. He stated that it was almost impossible to separate one stone from another, and that the stones themselves gave way before the cemented joints.

THE PROBLEM OF THE SCREW PROPELLER.*

By JOHN LOWE, Rear Admiral, U. S. N.

IT has been a continued source of remark and complaint among engineers and naval architects, that the theory of the screw propeller is in a very unsatisfactory state. So high an authority as Sir W. H. White especially has recently given strong expression to this effect. Recognizing this fact, I have for many years made this subject a special study, and now in this article propose to show that the subject, once discovered, is a simple one, capable of exact and easy determination. The reasoning leading up to the conclusions is perhaps a little involved, and will require a little patience to follow; but as I say, the result is simple.

I propose also to test the conclusions reached, by going through the process of designing a propeller for the "Denver" class of six vessels, now approaching completion and trial for the United States navy, and thus, by this conspicuous example, appealing as to a judge, to every naval architect who will read this article.

If the area of the screw is great, the friction will be great, while upon the other hand, the slip will be small, and *vice versa*; so that these losses are in opposition to each other, and the design consists solely in balancing these losses until the result is maximum. To do this, two formulæ are needed.

(1) A formula measuring the thrust and the slip.

(2) A formula measuring the friction produced by its motion.

THRUST AND SLIP.

The slip spoken of, in what follows, will be the real slip, that is to say, the apparent slip after the wake factor has been applied, and thus the real slip will be the slip, supposing the screw to move in still water.

Argument.

Let V be the volume of any body, and y the weight of each volume unit. Then yV is the weight of the entire body. Now let $g = 32.2$ pounds be the weight of one mass unit. Then the number of such units, or in other words, the mass, is $\frac{yV}{g}$ mass units. During one second, in a horizontal direction, apply a force of x pounds to each of these units. This force will produce a velocity of one foot per second; consequently, v times this force, or a force of vx pounds, will produce a velocity of v feet per second, and the total force applied will be $T = vx \left(\frac{yV}{g}\right)$ pounds.

To apply this to the screw propeller, let φ be the projected area of the screw, and let r be its radius in feet. Fig. 1 represents the projected area of one blade divided by radial lines into a large number of elements, while Fig. 2 represents the smallest element which can be conceived of.

This smallest element is a mere radial line, r feet long, which in one revolution sweeps the area of πr^2 square feet, and displaces this area of water through the space of v feet. In other words, a cylinder of water v feet long, with the area of πr^2 square feet, having the mass of $\frac{y}{g}(\pi r^2)v$ mass units, has been set in motion by this one element.

Now each of these elements does the same thing, so that the total mass set in motion by the entire propeller is $\frac{\Phi y}{g}(\pi r^2)v$ mass units. But the impelling force applied to each of these mass units is vx pounds, so that the entire impelling force, or the thrust, becomes:

$$T = \frac{xy}{g}\varphi(\pi r^2)v^2 \text{ pounds.}$$

But instead of one revolution per second, let there be $\frac{R}{60}$ such revolutions. Then $T = \frac{xy}{g}\varphi(\pi r^2)v^2\frac{R}{60}$ pounds. Wherein v is the velocity of the real slip in feet per second. Discarding the term per cent and employing instead the term per unit, representing per unit slip by s, and the pitch of the screw by P, there is obtained thereby $v = s\frac{RP}{60}$. This we substitute, and so obtain

* Specially prepared for the SCIENTIFIC AMERICAN SUPPLEMENT.

another equation for T in every way superior, viz.:

$$T = t\left(\frac{R}{60}\right)^3 P^2\varphi\,(\pi r^2)s^2 \text{ pounds.}$$

Equation 1.

The factor t is to be called the thrust factor, and takes the place of the several factors $\frac{xy}{g}$ — and its value as obtained from patient analysis of steamship performance is log $t = \bar{1}.3450829$.

In revolving a screw propeller, and thus propelling the vessel, the work done is manifestly TRP foot-pounds per minute, which if we insert in (1) and then reduce to horse-power units, we will obtain the useful horse-power, applied to propelling the ship, and in displacing the slip, viz.:

$$UHP = \frac{tR^4P^3\varphi}{60^3 \times 33000}(\pi r^2)s^2,$$

Equation 2.

Or after reducing all the constants into one, we obtain

$$UHP = u\ \varphi\ R^4\ P^3\ r^2\ s^2.$$

in which log $u = \overline{11}.9892650$. Equation 3.

FRICTION OF THE SCREW.

Imagine a metallic plane having the surface of S square feet, the thickness very small, immersed in water, and forced to move therein in the direction of its length. It will experience a resistance, measured in pounds, equal to the effort required to maintain motion. It is generally conceded that the law and the amount of this friction is expressed by the expression $F = fv^2S$, and that the work done per second in giving motion to this resistance is $Fv = fv^3S$ foot-pounds per second.

The screw propeller consists of a number of such planes, and the friction of the entire propeller is the sum of the friction of all these elementary planes. Consider the work expended upon one of these planes situated in radius r feet from the center, in a propeller having the pitch of P feet, revolving at the rate of $\frac{R}{60}$ revolutions per second, the length of the plane being l feet and the thickness dr feet. As suggested by Fig. 3, the path of this plane will be in a helix, its velocity, $v = \frac{R}{60}\left[P^2 + (2\ r)^2\right]^{\frac{1}{2}}$ feet per second, and its surface, including both sides, is $S = 2ldr$.

The work therefore done upon this plane is: $dW = f\frac{R^3}{60^3}\left(P^2 + (2\pi r)^2\right)^{\frac{3}{2}} 2\ ldr$ foot-pounds per second.

Now this differential is a complete algebraic statement of the method employed by Isherwood to find the friction of one element, a number of such differentials being set up as ordinates; the integration or summation was obtained by means of any well-known method. This method, unsurpassed for accuracy, is exceedingly laborious in practice—to a prohibitive degree. The integral calculus furnishes a much easier method, and very much more rapid, as follows: Let l be some fraction δ of the helix. Then

$$l = \delta\left(P^2 + (2\pi r)^2\right)^{\frac{1}{2}}$$

which being substituted gives the equation:

$$dW = 2\,f\,\frac{R^3}{60^3}\,\delta\left(P^2 + (2\pi r)^2\right)^2 dr$$

This differential being first expanded and then integrated, becomes

$$W = 2\,f\,\frac{R^3}{60^3}\,\delta\left[P^4 r + \tfrac{8}{3}P^2\pi^2 r^3 + \tfrac{16}{5}\pi^4 r^5 + 0\right]$$

Now in this equation, δ occurs as a coefficient in simple ratio, and it is necessary to employ its mean value; which mean value is easily proven to be $\delta = \frac{\varphi}{\pi r^2}$ when φ is the projected area of the entire screw. This mean value being substituted, and foot-pounds per second converted into horse-power units, we obtain the equation for friction, viz.:

$$FHP = \frac{2f\varphi R^3}{60^2 \times 33000}\left[\frac{P^4}{\pi r} + \frac{8}{3}P^2\pi r + \frac{16}{5}\pi^3 r^3\right]$$

in horse-power units. For ordinary smooth surfaces, $2f = 0.0145$; and if all constants are unified, then the equation becomes

$$FHP = f\,\varphi\,R^3\left[\frac{P^4}{\pi r} + \frac{8}{3}P^2\pi r + \frac{16}{5}\pi^3 r^3\right]$$

in which log $f = \overline{10}.0865505$.

An inspection of the friction formula thus obtained will make apparent to us a very important corollary, viz.: that when the pitches become coarse, the friction is enormously increased; therefore, fine pitches are to be adhered to in good practice.

DESIGN OF A SCREW PROPELLER.

We have now the necessary formulæ; let us employ them to design a propeller for the "Denver" class of six vessels, now approaching completion and undergoing trial. These vessels are all alike as to hulls and the principal machinery; but singularly enough, no two of the propellers are alike, thus furnishing examples of the utmost value for our purposes. The displacement is 3,200 tons, the speed designed is 16.5 knots, the revolutions are designed to be 172 per minute, the I. H. P. 4,500. One of these vessels made a successful trial upon the first attempt, with a projected area of screw of 20.85 square feet; while still another made one trial with 36 square feet, and another second trial with 45 square feet, or more than double that of the first vessel mentioned. Table 1 is the dimensions of the screws of each vessel as first designed.

Table 1.

Vessel.	Propellers. Diameter	Propellers. Pitch	Propellers. Projected Area.
A	11	11	36
B	10 5	11.33	26 2
C	10 5	11.25	28.7
D	10.5	11.45	29
E	10 5	11.25	29
F	10	11.5	20 9

Proceeding now with our design, we study the conditions laid down, and take up first the pitch of the screw. This is prescribed by the conditions: revolutions 172, speed 16.5 knots. Adding a small amount to 16.5 to cover slip, we reduce to feet per minute, and divide the result by 172, obtaining the pitch, 11 feet nearly. We have already learned that the pitch must be fine, consequently the diameter must not be less than one times the pitch. We have then the pitch, 11 feet, and the diameter, also 11 feet. There remains to find φ, the projected area, which will give us the best possible results.

The easiest way in which to do this is by means of the formulæ to construct Table 2.

Fig. 1.

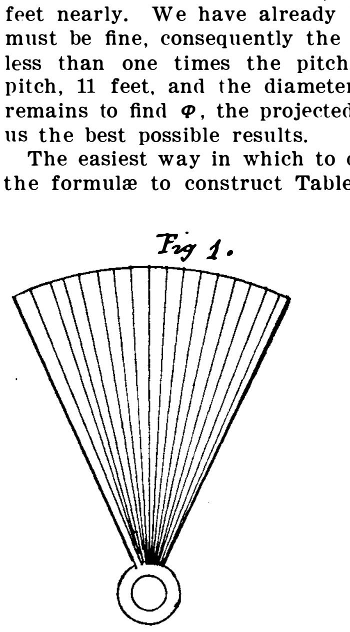


Fig. 2

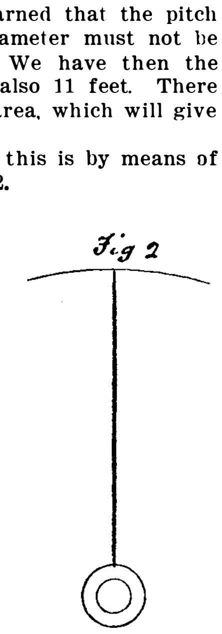


Figure 3

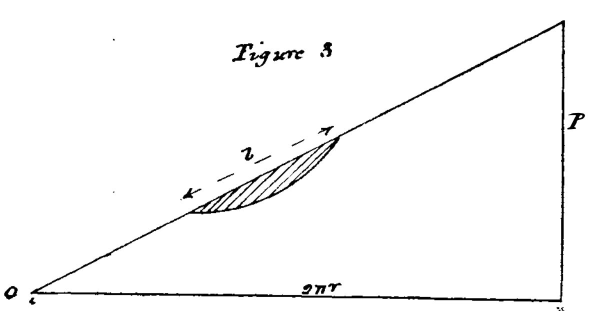


Table 2.

$FHP = A\ IHP$	$B = \varphi = \frac{A \times IHP}{a}$	$C = 0.72 - A$	$D = s = \left(\frac{C \times IHP}{b \times B}\right)^{\frac{1}{2}}$	$E = (1-D) = (1-s)$	$F = C \times E$ Power applied to actual propulsion.	Efficiency of the propeller.
A	B	C	D	E	F	G
0.233	45	0.487	0 0929	0.9071	0.439	0 609
0.20	38.89	0.52	0.103	0.897	0 466	0 648
0.18	34.9	0.54	0.111	0.889	0.480	0 667
0.16	31.00	0.56	0.1201	0.8799	0.490	0.685
0.14	27.10	0.58	0.1375	0.8625	0.500	0.695
0.12	23.20	0.60	0 143	0.867	0.520	0 723*
0.10	19.40	0 62	0.159	0 841	0 521	0 724
0 08	15.50	0.64	0.181	0 818	0.523	0.727†
0.06	11.60	0 66	0 213	0.787	0 519	0 722
0 04	7.75	0.68	0.264	0.736	0 500	0.695
0.02	3.88	0.70	0.380	0.620	0 435	0.603

* Quantities recommended.

† Maximum possible.

The friction of the engines we will place at 0.28 I. H. P., leaving us 0.72 I. H. P. to drive the propeller. Now then, entering all known quantities into our formulæ and then reducing, we obtain:

$$FHP = a\varphi \qquad \log(a) = 1.1518$$
$$UHP = b\varphi\ s^2 \qquad \log(b) = 3.5363$$

First we assume that φ is so large that $FHP = A$ (I.H.P.), A being found in column A of the table. We have then $\varphi = \frac{A\ (\text{I.H.P.})}{a}$, which we tabulate in column B. Subtracting factor A from 0.72, we obtain factor C, which is tabulated in column C. This factor applied to I. H. P. gives $UHP = C(\text{I.H.P.}) = b\varphi s^2$; and since we have already found φ, we are enabled to solve for $s = \left(\frac{C\,(IHP)}{b\varphi}\right)^{\frac{1}{2}}$ and tabulate s, the per unit slip, in column D. Column D subtracted from unity gives $(1 - s)$, the per unit advance of the ship, tabulated in column E. Columns C and E multiplied together gives the per unit of power actually applied to propulsion, tabulated in column F. Lastly, column F divided by 0.72 gives the efficiency of the screw, maximum at 0.727, which under strictly favorable circumstances would give maximum results.

But if one would take the trouble to draw the curve of efficiencies, as tabulated, he would find the descending branch decreasing with great rapidity, hence it is wise to provide against adverse circumstances by stepping back two stages, and make $\varphi = 23.20$, with a corresponding efficiency of 0.723, which is precisely what one of the vessels has done, and obtained excellent results. The vessel which adopted $\varphi = 45$ did so at the cost of a great loss in efficiency, viz., 0.609, a loss of 16 per cent.

Comparing the theory thus advanced, and the calculations made, with the experiments obtained so splendidly from the trials of the vessels quoted, I do not see how the conclusion can be escaped that the theory thus advanced is a correct one, and the problem of the screw propeller definitely solved.

As a final remark, I would say that in every regard the workmanship of modern engines, boilers, and ships is so critically first-class, that I wonder when I consider that we are satisfied with a plain casting for the propeller. Some day they will be machined to a true pitch, and then everyone will wonder why it was not done before.

NOTE ON THE FRACTIONAL CONDENSATION OF AIR, WITH A VIEW TO THE COMMERCIAL PRODUCTION OF OXYGEN.*

By ERNEST A. LE SUEUR, B.Sc.

THE problem of the cheap preparation of oxygen, or of an atmosphere rich in oxygen, has long been recognized as a technically important one. The number of uses to which a really cheap oxygen could be put is exceedingly large. Hitherto, for almost all purposes requiring oxygen, air has had to be used. In the case of the combustion of fuel, for instance, for every ton of coal burned at least ten tons of inert nitrogen are loaded into the flame. This dilution, or some of it, may be advantageous for certain purposes, as in the case of steam-boiler work, but for practically all metallurgical operations it is highly objectionable, and for some it is even fatal, as in the case of the direct production of calcium carbide in a blast furnace. In industrial chemical operations, also, there are many processes demanding oxygen, and as in the cases of the Deacon and Mond chlorine processes, receiving air to their great prejudice.

The development in late years of methods of liquefying air has led to an active investigation as to the practicability of producing cheap oxygen by purely mechanical means. Parkinson took out a patent (Eng. Pat. 44,418, 1892; this J., 1893, 545) for a method of refrigerating air until the oxygen (which has the higher boiling point) liquefied. This was impracticable owing to the fact that the two gases, oxygen and nitrogen, invariably liquefy together in a mutual solution. Some eight or nine years ago, Prof. James Dewar, of the Royal Institution, investigated the relative proportions in which oxygen and nitrogen liquefy when a mass of air is exposed to partial liquefaction. Unfortunately he arranged matters so that the only possible result was a complete liquefaction of a fraction of the air instead of a fractional liquefaction from the whole of it. That is to say, the mass of air as a whole was not only not chilled to the liquefying point, but, say, for the portion withdrawn, was maintained at ordinary temperatures, while the separated portion was not only chilled below the point at which the most condensible constituents liquefied, but far below the condensing point of nitrogen itself. Naturally, the air exposed to this treatment liquefied in its entirety, and the conclusion was drawn that air, in its initial stages of condensation, could only deposit a liquid of its own composition. This conclusion seems to have been accepted throughout that section of the scientific world which has interested itself in this field of investigation. One result of this has been that, if a liquid, and subsequently a gas, rich in oxygen, was desired to be obtained through the agency of liquefaction, it was considered necessary to liquefy air as a whole and then subject it to fractional distillation, when an atmosphere weak in oxygen would leave the liquid and a residue rich in oxygen remain behind. Carl Linde developed, in addition, a process in which he prepared liquid air under great pressure and at a comparatively high temperature, and then, by relieving the pressure, obtained a fractional distillation due to ebullition which accompanied the drop in pressure and temperature. An additional feature of his process consists in the further concentration in oxygen strength by fractional distillation induced on the regenerative principle. His process is undoubtedly the cheapest at present publicly known for preparing atmospheres rich in oxygen. There remains yet, however, much to be desired in Linde's process owing to the great power consumption, and labor and repair charges required when working at the pressures of between 100 and 200 atmospheres.

The following will serve to indicate the lines along which a remarkably cheap and efficient method has been developed. To begin with, in order to attain anything approaching efficiency in the use of a gas such as air (as distinct from a vapor, liquefiable by pressure alone, like ammonia) as the working fluid of the

* Read before the Society of Chemical Industry.

refrigerative cycle, it is imperative that the power represented by the drop of pressure of the gas should be abstracted from it as far as possible in the act of expansion. This fact has long been recognized, and Sir W. Siemens made application of it in the attempt to liquefy air by expanding previously cooled compressed air through an engine. His apparatus, however, was entirely inadequate to attain the extremely low temperature required for his purpose.

Now, inasmuch as it is required to develop power from our compressed gas, the latter must not be in the liquid condition. In the second place, any oxygen separated can only be secured by being first in the liquid condition. Thirdly, if we resort to a partial liquefaction of air so as to get oxygen from the liquid and power from the expansion of the unliquefied gaseous residue, and if, as Dewar believes, the portion liquefied is of the same composition as air, the method presents no notable advantages. Fortunately Dewar was wrong in his conclusions, and the device of working a motor with the unliquefied portion of the compressed air, thereby developing chilling effect, and of using the liquid rich in oxygen as a source of gaseous oxygen, is an excellent one.

A simple experiment suffices to determine the fact that air partially liquefied under a comparatively low pressure is rich in oxygen. I immersed in a boiling mixture of oxygen and nitrogen, richer in oxygen than air is, the lower end of an empty, unstoppered test tube. After immersion for some minutes, examination showed the tube to contain a small quantity of a decidedly blue liquid, and this, on analysis, turned out, of course, to be a mixture of oxygen and nitrogen rich in oxygen. I say "of course" because, since the temperature of the boiling bath was higher than that of boiling liquid air (because it was richer in oxygen than air), it was impossible for liquid air to exist (at atmospheric pressure) under so high a temperature, and the liquid had therefore to be something which could be condensed out of the atmosphere and exist at atmospheric pressure at the temperature in question. It could not be oxygen, because oxygen and nitrogen invariably condense from air together in a mutual solution; in fact, I found on analyzing it that the precipitation was a mixture of oxygen and nitrogen approximating in composition to, but slightly richer in oxygen than the boiling bath itself. I found that no liquefaction occurred at all when the oxygen strength of the bath rose to 50 per cent, because then the atmosphere boiling away from the bath was richer in oxygen than was air, and, obviously, the bath's temperature must be above that at which air can precipitate any portion of itself as a liquid under atmospheric pressure.

In the light of the recent publication of certain results by M. Georges Claude which appear to be along somewhat the same line, it may be proper to mention that I established theoretically the necessity for the occurrence of the above phenomena in 1889, and took steps at that time to make certified disclosures to that effect with certain authorities in Washington.

PUMPING PLANT AT THE MIIKE COLLIERIES, JAPAN.

THE large pumping plant at the Miike Collieries, Japan, is probably the largest ever erected on one shaft. It was designed by Mr. Henry Davey, and consists of four compound "differential" engines and spear-rod pumps, together with a steel pit-head frame, steam capstans, etc.

The pit-gear is shown in Fig. 1. The engines shown in elevation and plan in Figs. 2 and 3 respectively each have cylinders 45 inches and 90 inches in diameter by 12 feet stroke, and actuate spear rods 22 inches square, by means of steel quadrants. Each engine has a surface condenser, and a horizontal double-acting air-pump. The boiler pressure is 100 pounds per square inch. At a speed of six strokes per minute only, the plant will raise 13 million gallons per day from a depth of 900 feet. The pumps are of the plunger type, 22 inches in diameter by 12 feet stroke.

The shaft is 41 feet long by 12 feet wide, and is made to accommodate four winding cages, in addition to the pumping plant. There are also two 30-ton capstans for the purpose of lifting the pump-work. The pit-head frame, Fig. 1, is a good example of modern construction, and of which we give the following particulars:

Height to top platform, 101 feet 3 inches.

Width across front, 70 feet.

Depth from back to front, 96 feet.

Depth of shaft, 900 feet.

Four winding pulleys, 17 feet in diameter.

Thirty capstan pulleys, for sinking and pumping arrangements, 5 feet in diameter.

Total weight of steel work, exclusive of pulleys and fittings, 250 tons.

Pit shaft, 41 feet long by 12 feet wide.

The frame is used for carrying two pairs of winding pulleys for coal-winding; it is also used for carrying 30 capstan pulleys, which are for lifting and lowering heavy weights during the sinking and after the completion of the pit. The winding pulleys are 17 feet in diameter, and are each equal to a working load during winding of 4 tons. The capstan pulleys are 5 feet in diameter, and are suitable for a working load of 30 tons. The rims and boxes are of cast iron, and the arms of wrought iron. The winding rope is 4 inches in circumference, and the capstan rope 5¾ inches in circumference; both are of improved plow-steel wire. The main legs are 2 feet 6 inches square, composed of 4½ inch by 4½ inch by ⅝ inch L's, braced together on all four sides by 3 inch by 3 inch by ½ inch L's and 3 inch by ½ inch flats. These bases are of steel plates and angles secured to foundation with 1½-inch holding-down bolts. The back stays are 2 feet 6 inches square, composed of 4 inch by 4 inch by ½ inch L's, braced together on all four sides by 3 inch by 3 inch by ½ inch L's and 3 inch by ½ inch flats. The girders between main legs are of box section, 2 feet 6 inches deep, 2 feet 6 inches wide, 5-16 inch web plates, stiffened with vertical tees, ⅜ inch flange plates, and 4 inch by 4 inch by ½ inch main L's. The girders at top of framing are of box section, 2 feet 6 inches deep, 2 feet 6 inches wide, 4 inches by 4 inches by ½ inch and 3 inches by 3 inches by ½ inch L's, ½ inch and ⅜ inch flange plates, with 5-16 inch webs, stiffened with vertical tees.

The top platform is of ⅜ inch steel checkered plates, with wrought-iron pipe hand-railing at sides and around pulleys. The two center girders for carrying the capstan pulleys are of box section, 2 feet 6 inches deep by 2 feet 3 inches wide, having ½ inch flange plates and 4 inch by 4 inch by ½ inch angles; the two outside girders are 2 feet 6 inches deep and 12 inches wide, with ½ inch flange plates, 4 inches by 4 inches by ½ inch angles, and ⅜ inch webs; the webs are stiffened with vertical tees. The girders between the main legs are of box section, 2 feet 6 inches deep by 2 feet 6 inches wide; 5-16 inch web plates, stiffened with vertical tees, ⅜ inch flange plates, and 4 inches by 4 inches by ½ inch main angles. The vertical pillars for the 17 feet diameter winding pulleys are four in number; the two center pillars are of box section, 2 feet 3 inches wide, 2 feet 6 inches deep, 4 inches by 4 inches by ½ inch angles, ½ inch flange plates, and 5-16 inch webs, stiffened with tees. The two side pillars are 2 feet 6 inches deep and 12 inches wide, with 4 inches by 4 inches by ½ inch angles, ½ inch flanges, and ⅜ inch single webs, stiffened with tees. Steel plate and angle brackets are attached from the side of these pillars to support carriages for winding-pulleys. The lattice struts in main framing are 2 feet 6 inches square, composed of four angles, 3½ inches by 3½ inches by ½ inch, braced together on all four sides with 3 inches by 3 inches by ½ inch angles and 3 inches by ½ inch flats. Diagonal ties are 2 feet 6 inches deep, composed of 6 inches by 3 inches by ⅜ inch angles, braced together by 3 inches by ½ inch flats. There are three capstan pulleys on one side, and two on the other side of framing; these pulleys are arranged to lead the rope from

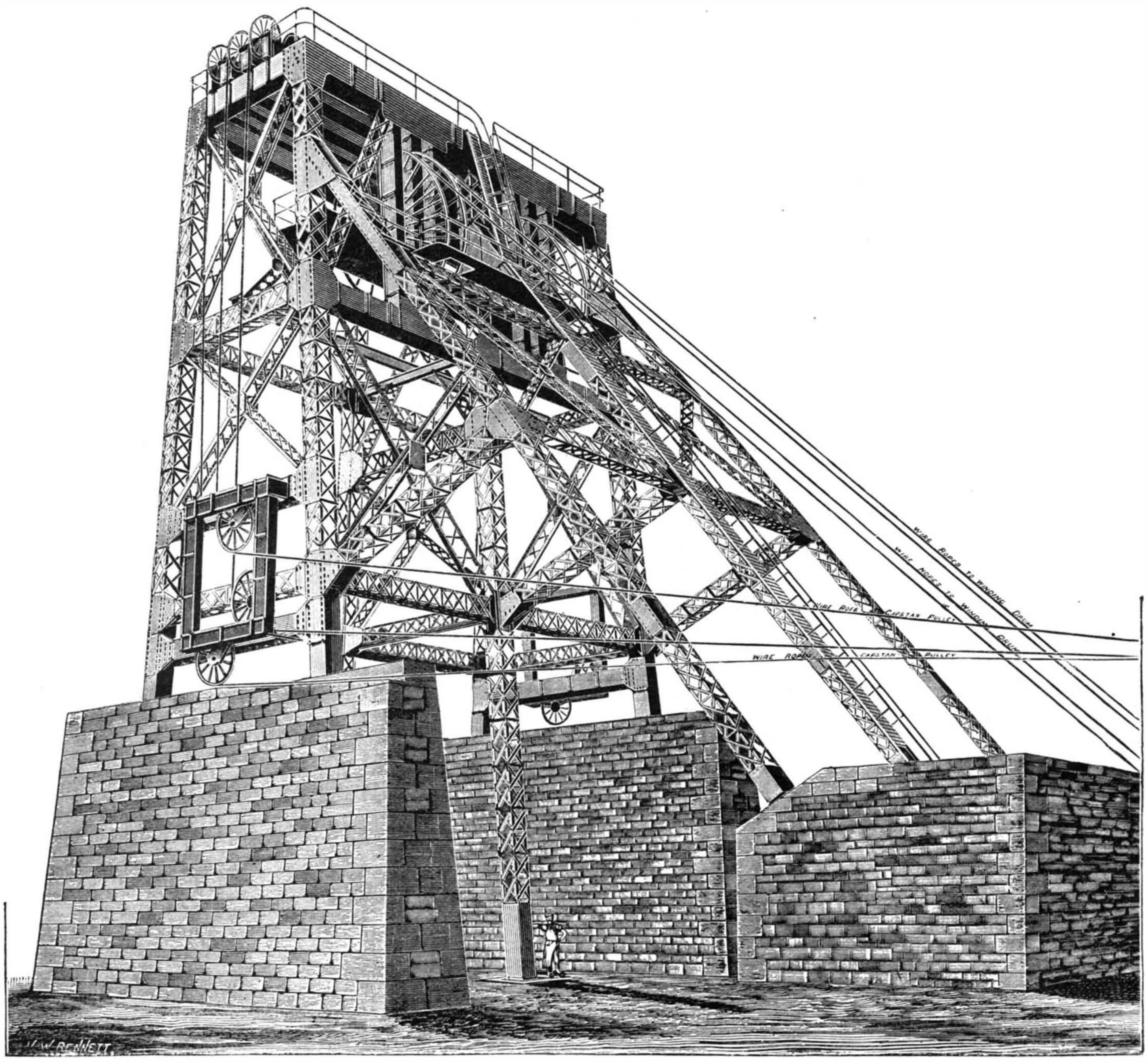


FIG. 1.—PUMPING PLANT AT THE MIIKE COLLIERIES, JAPAN.

the capstans to the overhead pulleys. The center back stay is provided with a stairway consisting of wrought-iron checkered plate steps, 2 feet 6 inches wide, with pipe hand-railing on both sides, for approach to the platform for winding-pulleys, and the platform at top for the capstan pulleys.

As regards the pumping engines, larger engines of the same design are now being built by Messrs. Hathorn, Davey & Co., Ltd., Leeds, who have in hand, for another mine, three engines having low-pressure cylinders, 106 inches in diameter.—Engineering.

THE MATHEMATICS OF MUFFLERS FOR GASOLINE ENGINES.

An ideal muffler should reduce the noise of the exhaust to the least possible, and put no back pressure upon the piston of the engine. It should obviously, also, be large enough to meet these requirements and no more, space being valuable. It may even be desirable in practice to sacrifice a little of each of these points to the desirability of keeping the muffler as small as possible in the case of the motor cycle and some small cars; but they still remain the ideal.

Referring to the first item, the noise to be deadened is caused by the sudden liberation of the exhaust gases under pressure. These expand violently, striking the surrounding air and setting it into vibration, causing the sensation known as a noise or explosion. If gases could be expanded in the cylinder until they came down to atmospheric pressure, the only sound heard would be the hiss of the gas as it passed the exhaust valve. Such a result would be quite possible, and conducive to economy in the engine.

The same result is achieved by making the muffler of such capacity and form that the gas expands in it gradually to atmospheric pressure before being released, and this is the method usually adopted.

There is another method which has lately been tried with fair success, and that is to make the muffler of practically no capacity, but to dismiss the gas through very numerous small openings, the idea being to subdivide the large explosion into numerous small ones, which, not synchronizing, do not produce the same noise; but such silencers must always be inferior to one which allows room for the expansion of the gas to a lower pressure before dismissal.

To avoid back pressure, the holes of either type must be of sufficient combined area to pass all the gas at the pressure at which it reaches them without reducing its velocity, and as the pressure must obviously fall off after passing the exhaust valve, and as the amount of gas passing through any given opening depends directly upon its pressure, the combined area of the holes in the baffles must never be less than that of the exhaust valve.

Before proceeding to actual dimensions the volume of gas to dispose of and its pressure at the moment of release must be known. As no reliable experiments of the pressure in the exhaust pipe are at hand, this can best be determined by making an indicator diagram of the engine to be considered. Assume a piston of 5 square inches area and a stroke of 3 inches, giving about 2 horse-power at 2,000 revolutions per minute, and that the compression space is one-fourth of the cylinder volume, while the temperature at admission is 150 deg. Fahr., thus causing the gas to be heated to 3,260 deg. Fahr., and expanded to its original volume.

From this it will be seen that at the end of the power stroke there is a volume of 15 cubic inches at a pressure of 47.5 pounds per square inch absolute. To expand gas at this pressure down to atmospheric pressure, it must increase 2.3 times its volume, and the capacity of cylinder and muffler combined must be 2.3 times the capacity of the cylinder alone, always supposing that the exhaust valve is large enough, as is generally the case, to liberate the gas practically instantaneously before the piston returns.

As gas at 47.5 pounds pressure passes through an opening ¾-inch square—about the usual size of valve for such an engine—at the rate of 434 cubic feet per minute, and there are only 15 cubic inches to pass, the time occupied will be $\frac{15}{434 \times 1728} = \frac{1}{49800}$ minute, and the piston performs a stroke of 3 inches in 1-4000 minute. Therefore, it will only have moved about ¼ inch; in point of fact, less, as the velocity taken above is its average velocity, and at the ends of the stroke it moves more slowly, so that the emission is unaffected by it and the cylinder may be counted in the available expansion space. It is necessary, then, to provide only for 1.3 times its capacity in the muffler.

If, therefore, there is added to the engine cylinder a muffler of 19½ cubic inches, and the gas is allowed to expand in it, there will be no tendency to expand farther and escape, but it will merely be displaced by the piston during its return stroke, and will put no back pressure at all on the engine except the small amount caused by the friction of the air against the sides of the pipes.

So far the requirements are fully met, but the noise, although muffled, will still remain, as the expanding gas, suffering no check after passing the exhaust valve, will still strike violently against the imprisoned air in the muffler, and there will be experienced exactly the same report as if it were allowed to pass directly into the open air, except that this report will be inside a box, the walls of which will to some extent diminish the communication of the vibration to the surrounding air.

To check this still further, the large explosion must be broken into a number of smaller ones, by passing the gas through a series of holes or baffle plates, and how to proportion these to avoid back pressure must be considered. The theoretical discharge of air through an orifice is given by the following formula:

$$\text{Cubic feet passed per minute} = \text{area} \times 37.8\sqrt{\text{external press. in lbs. per sq. in. absolute} \times \text{diff. of press. on each side of orifice in lbs. per sq. in.}}$$

For pressures up to 50 pounds, experiment shows that only 0.7 of this amount can be counted on, and the following formula used:

$$\text{Cubic feet passed per minute} = \text{area} \times 26.4\sqrt{\text{external press.} \times \text{diff. of press.}}$$

Let it be assumed that three plates are inserted across the muffler, dividing it into four equal parts. The pressure of the gas at each baffle, and from that the area necessary to pass it, can then be found.

With three baffles, the volumes of the expanding gas will be as follows:

At entrance, 1.
At first baffle, 1 1-3.
At second baffle, 1 2-3.
At third baffle, 2.
At exit, 2 1-3.

The pressure of the gas at each baffle can then be calculated on the formula:

$$P' = \frac{P}{r^{1.408}}$$

P being the initial pressure in pounds per square inch absolute, P' the required pressure, and r the ratio of the volume after expansion to the initial volume.

From this it is found that the pressures will be respectively:

At entrance, 47.5 pounds.
At first baffle, 31.3 pounds.
At second baffle, 23.1 pounds.
At third baffle, 17.5 pounds.
At exit, 14.7 pounds.

It is now necessary to proportion the area of the holes in the baffles so that the velocity of the escaping gas may not be diminished. Taking the area of exhaust valve at ¾ square inch, the quantity of gas passed at 47.5 pounds pressure to a pressure of 31.3 pounds by the corrected formula equals 550 cubic feet per minute.

The first opening into the muffler should be obviously

Fig. 2.

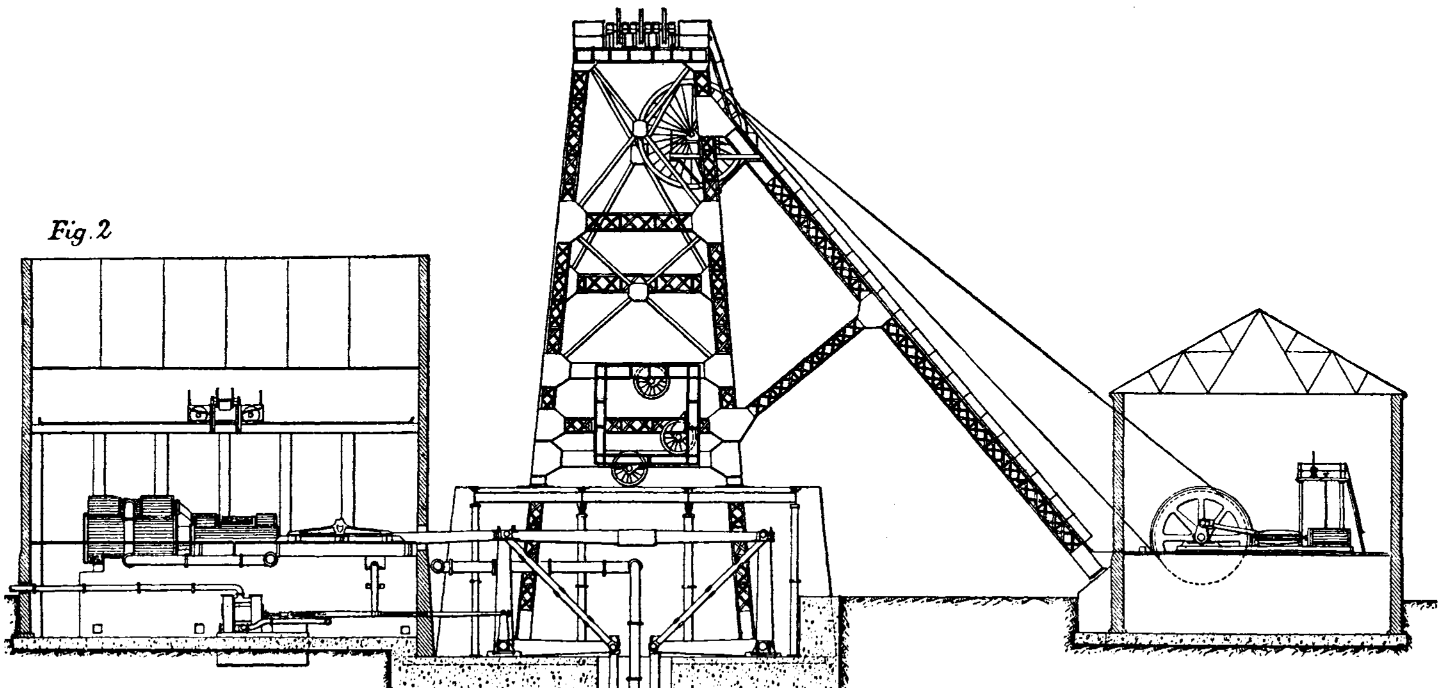
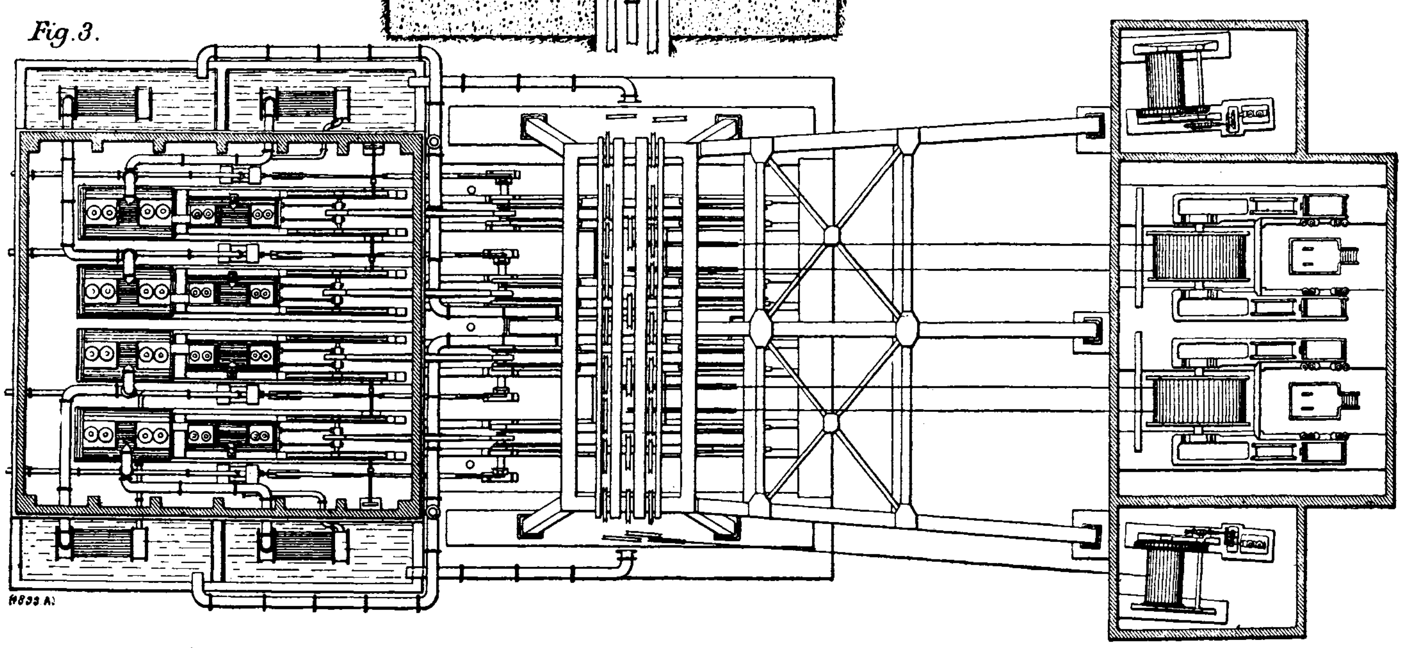


Fig. 3.



PUMPING PLANT AT THE MIIKE COLLIERIES, JAPAN.

at least as great as the exhaust valve, which with a properly-proportioned exhaust pipe it will be.

Calculating by the same formula, the amount of gas passed per minute through a ¾-square inch opening, we have

At entrance, 550 cubic feet.
At first baffle, 316 cubic feet.
At second baffle, 225 cubic feet.
At third baffle, 138 cubic feet.

If the velocity of the gas is to remain constant, the areas of the holes should vary inversely as these amounts, or be

At first baffle, 1.3 square inch.
At second baffle, 1.8 square inch.
At third baffle, 3.0 square inches.

If the total quantity of the expanding gas had to pass through each baffle, these areas would be the right sizes, but when the muffler is completely filled, the last compartment has passed only one-third of the cylinder volume, the next two-thirds, the third three-thirds or one, and the entrance four-thirds, or one and one-third the cylinder volume. Therefore, the areas may be reduced in proportion to the volumes they have to pass, and the final result is:

At entrance, ¾ square inch.
At first baffle, 1.3 square inch.
At second baffle, 1.2 square inch.
At third baffle, 1.0 square inch.

These are the total amounts to which the combined area of the holes must amount, and the more numerous and smaller they are the better for silencing effect, the practical limit to their smallness being set by the liability of exceedingly fine holes to get choked up. In conclusion, the above figures must not be taken as representing any particular muffler, but from the formulæ given, and following the same principles, it is easy to proportion any type, whether tubular, cross baffled, or other, so that it shall allow the gases to expand to atmospheric pressure without back pressure on the piston, and with the maximum of silencing effect.—The Autocar.

OIL FROM LIVERS OF COD AND RELATED SPECIES.*

By Charles H. Stevenson.

SOURCES OF SUPPLY.

Cod oil is obtained from the livers of several species of fish. In its pure state it is obtained from the livers of cod only, but those of haddock, pollock, hake, cusk, ling, and even shark and dog-fish are also used. The last two, however, are not generally recognized as cod-liver oil sources, but are used mainly for purposes of adulteration. In the trade the term "cod-liver oil" is used in a restricted sense, applying to the best quality of oil made from choice fresh cod livers and intended for medicinal purposes; all other oil manufactured from livers of cod and related species, not of quality fitting it for medicinal uses, is designated as "cod oil" or "curriers' oil."

Cod oil is of comparatively recent development as an article of commerce, although it was used locally previous to the nineteenth century. On account of the ease with which whale and seal oils could be secured, cod oil was not in great demand for technical purposes until after the beginning of the nineteenth century. There is nothing to indicate that in the early cod fisheries on the American coast the livers were utilized to any great extent for oil-rendering, and the same is true of the early fisheries prosecuted in the seas north of Europe. The small demand for medicinal and for technical purposes was readily supplied by a few fishermen of economical and industrious habits, but their output bore only a small proportion to the total quantity obtainable. Curriers used a small quantity, and some was employed on fruit trees for destroying insects and fungous growth.

Early in the nineteenth century the production of cod oil became quite general on the New England coast. The livers were placed in butts and permitted to decompose, and the oil exuding therefrom was dipped off from time to time. Not only was this done by the fishermen who landed their catch ashore each night, but also by the "bankers" who carried butts and barrels for the purpose. As the tanning industries developed, the output of cod oil increased, and by 1845 practically all the livers secured were rendered into oil. The output, however, did not keep pace with the demand and during the sixties the price went up to $1.25 per gallon. Mr. Eben B. Phillips, of Swampscott, was one of the pioneer dealers in this product and amassed a fortune in the business.

Gradually other substances were introduced as materials for dressing leathers, especially sod oil, degras, and compound greases, the cheapness of which has greatly affected the market for cod oil. The substitution of machine stuffing for hand stuffing in leather-dressing and the introduction of chrome tannage have also reduced the demand. However, the market for medicinal oil has constantly increased up to the present time. As a result of these combined uses, the rendering of the livers into oil is almost coextensive in point of territory with the prosecution of the cod fisheries. The only exception is in certain market fisheries where the men do not have time to handle the livers properly.

The market price of medicinal oil frequently falls so low that it pays the manufacturer better to prepare only low-grade oil for leather-currying, soap-making, and the like. The common oil is, of course, turned out at much less cost than the white, odorless, medicinal variety. The stearin, which is worth comparatively little and forms a considerable portion of the oil, need not be removed from the manufacturing grade. The use of the expensive refining plant required for medicinal oil is also obviated. And, finally, there is a very considerable saving in the cost of packing, as the ordinary oil is shipped in old petroleum barrels, while for the finer grade expensive new casks or metallic drums have to be provided. For several seasons there was a large overproduction of low-grade medicinal oil, and three years ago it sold in New York as low as 50 cents per gallon. Curriers' oil does not often sell for less than 30 cents per gallon, and the demand for it is fairly constant.

The principal sources of cod-liver oil are the coast of North America from Labrador to Cape Cod, Norway, Scotland, Iceland, the Pacific coast of the United States, and, during recent years, Japan. On account of its greater value, efforts are made on all these coasts to produce the light oil for medicinal purposes; but in most sections, on account of unfavorable natural conditions, only dark or low-grade oils are practicable. Medicinal oil is prepared chiefly on the coast of Norway and to a limited extent on the Massachusetts, Maine, Nova Scotia, and Newfoundland coasts.

Owing to the favorable conditions under which the cod fishery is there prosecuted, Norway ranks first among countries producing medicinal oil, the annual product amounting to about half a million gallons. The fishing grounds are concentrated and situated very near the coast, so that the fish are landed in quantities within a few hours after capture and before decomposition of the livers has set in. Furthermore, the temperature during the fishing season is very low, being close to the freezing point, and this tends to retard putrefaction. In no other part of Europe are the conditions favorable for producing medicinal cod-liver oil. A large quantity of low-grade or curriers' oil is also produced in Norway, amounting probably to as much in bulk as the medicinal oil.

In Newfoundland much attention has been given to the production of medicinal oil, the manufacturers endeavoring to make it as near like the Norwegian product as possible. Freezing machines were introduced and a considerable quantity of white, odorless, and non-congealing oil was made. The general experience, however, was that the difference in market value of the medicinal and the trade oils was not sufficient to warrant the extra care and the additional expense. At present comparatively little medicinal oil is produced in Newfoundland. The livers are mostly all converted into curriers' oil, resulting in an annual output of about 1,100,000 gallons.

The situation in Nova Scotia is pretty much the same as in Newfoundland, although much less oil is produced, the annual output probably amounting to about 20,000 gallons of medicinal oil and 250,000 gallons of curriers' oil.

The bank fisheries of America are situated too far from the land to permit the use of the livers in making medicinal oil; but the shore fisheries during autumn and winter, when the spawning fish visit the coast, furnish good material for that purpose, resulting in the preparation of about 25,000 gallons each year. Much of this is of superior quality, and unsurpassed for color and pleasantness of odor and taste. The livers taken in the bank fisheries are practically all used in preparing curriers' oil, the total annual product of which is about 450,000 gallons.

Considerable cod oil has been exported from Japan for medicinal purposes, but that received in this country has not found favor with the wholesale druggists and has usually been sold for currying. The first shipment of 200 cases, made in 1889, sold at 35 cents per gallon. We have no data bearing on the cod-oil output in Japan, but with an annual catch of 7,000,000 is probably does not exceed 100,000 gallons.

The entire product of cod oil is estimated as follows: Norway, 1,200,000 gallons; Newfoundland, 1,100,000 gallons; Dominion of Canada, 300,000 gallons; United States, 475,000 gallons; Japan and all other countries, 450,000 gallons, making a total of 3,525,000 gallons of all varieties of oil produced from the livers of cod and related species. Of this quantity about 650,000 gallons represent the output of medicinal oil, and the remaining 2,875,000 gallons is curriers' oil.

DESCRIPTION OF LIVERS AND THE RESULTING OILS.

The following description of livers and the account of rendering them into oil are the results principally of an inquiry made by the writer on the New England coast in October and November of 1901. Most of the oil factories were visited and many of the principal fishermen were interviewed. The writer is especially indebted in this connection to Mr. A. W. Dodd and Messrs. George J. Tarr & Sons, of Gloucester, and to Messrs. George H. Leonard & Co., Mr. John B. Baum, and Mr. F. F. Dimick, of Boston.

Normal cod livers in good condition are of a cream color, uniform texture, and very soft, so that the finger may be readily pushed quite through them. Lean livers are frequently found. These are tough and dark in color, the toughness and darkness increasing with the degree of leanness, the color finally reaching a dark brown hue. Lean livers furnish very inferior oil, as well as only a small quantity. A certain percentage of the livers are diseased. This condition is usually evidenced by a greenish color or by the presence of colored spots, which increase in size and number as the disease advances until the entire organ is affected. Diseased livers are never used in the preparation of medicinal oil, but are freely utilized in making curriers' oil. The size of the livers varies considerably, but averages about 12 inches in length and 2½ inches in thickness in the center, the weight being somewhat over half a pound. Some livers weigh only 1½ ounces each, and an instance is recorded by Dr. F. P. Moller of one taken in the Lofoden fishery which weighed 11 pounds, its length being 43 inches and its greatest thickness 6½ inches.

Considerable difference exists in the size, shape, and general appearance of livers of the cod family. Cod livers are elongated, with the large end near the dorsal fin and the small end toward the tail. Haddock livers are much shorter than those of cod, and have little frills or scallops on the edges, whereas those of cod are smooth. Haddock and pollock livers are of a cream color, similar to those of cod, while cusk and hake livers are of a light straw color. The livers of all Gadidæ are usually mixed together by the fishermen, but in the season when any particular species is abundant the livers of that variety are kept separate. On the New England coast of the United States cod livers predominate during the coldest months and pollock are taken mostly in October and November.

In the United States fisheries livers represent about 3½ per cent of the weight of the fish, and they yield about 40 per cent of their weight in oil; consequently 100,000 pounds of fish yield about 180 gallons of oil. On an average, from January to June, 1,000 pounds, dressed weight, of cod yield about 1 bucket, or 2½ gallons, of livers, and during the latter half of the year the yield increases to 4 gallons per 1,000 pounds of dressed fish. A bucket of these livers yields 5 or 6 quarts of oil on an average throughout the year, except that in the spring the product is sometimes reduced to about 3 quarts to the bucket of livers. The yield of hake livers per 1,000 pounds of fish is somewhat larger than in case of cod, but the quantity of oil secured from a bucket of livers is about the same. Haddock yield best from October to December, and during the spring and summer the result is small, sometimes not over 1½ quarts to the bucket. On account of the small yield and the conditions surrounding the haddock fishery, only about 15 per cent of the livers of that species are saved in the New England fisheries. At present pollock do not yield so much as cod, averaging about 5 quarts to the bucket of livers throughout the year; but previous to ten years ago on the New England coast they usually yielded 7 quarts of oil in the fall.

In the Lofoden fishery, according to the official returns, ordinarily 20 to 30 livers are required to produce 1 gallon of medicinal oil. During some seasons the livers are quite fat, and 8 to 12 are sufficient; but when they are very lean, as was the case in 1896, for instance, from 36 to 56 are required for 1 gallon of oil. In that fishery the livers are fatter at the beginning than at the end of the season. They average about 55 pounds to the 100 fish; but during the years when they are unusually lean it is much less, as in 1883, when the average weight of 100 livers was only 12½ pounds. Usually at the Lofoden Islands 250 to 1,100 cod give 1 barrel of livers, and 2 barrels of livers yield 1 barrel of oil; but in 1883 from 700 to 1,100 fish were required for 1 barrel of livers, and 4 or 5 barrels of those were necessary for 1 barrel of oil. Aside from the benefits accruing from the fatness of the livers, anything gained in quantity is always lost in quality in the preparation of medicinal oil.

While it is somewhat difficult to distinguish among the oils made from the livers of the various members of the cod family, yet ordinarily there are certain distinctive characteristics apparent to the skilled oil-refiner. Cod oil is of a greenish yellow color and usually has less pressings or foots than any of the others. Hake oil is almost white, but that made from hake taken on certain grounds has a pinkish color, which may be removed by filtration through a mineral earth. Pollock oil is distinguished by a slightly bitter taste and has a faint reddish cast. Its weather-test is rather lower than that of cod oil, especially when it has been slightly overcooked in the rendering.

Oil extracted from perfectly fresh cod livers is light and odorless, and, owing to its extensive use in medicine, is known as medicinal cod oil or "cod-liver oil." According to the extent of decomposition of the material before the extraction of the oil, the color ranges through all shades of yellow and brown to very dark brown, this color being attributed to the decomposition of the hepatic tissues and fluids. These dark oils are of two general grades; one, the brown, which is inferior to the light-brown or medicinal oil, but is frequently used for such; and the other, the dark-brown or curriers' oil, is the poorest grade prepared, and is exclusively used for technical purposes. Probably it would be better to say that there are two principal varieties of oil, the medicinal and the curriers', and that unusual market conditions may result sometimes in the employment of the poorest of the medicinal oil for technical uses or the best of the curriers' oil for officinal purposes.

The medicinal value of cod-liver oil was known centuries ago among the Laplanders in northern Europe, the descendants of the Norsemen in Iceland, and the Eskimos in Alaska. The use of the oil gradually extended in Europe during the eighteenth century, being a popular home remedy among many seacoast communities and used empirically by physicians. Percival and Bardsley in 1782 recommended its use in cases of gout and chronic rheumatism. In 1841, J. Hughes Bennett, of Edinburgh, published a pamphlet on its medicinal qualities, strongly recommending it in many cases, and this had much to do with the general introduction of the oil as a medicine in England and

* From United States Fish Commissioner's Report for 1902.

America. From that time to the present it has held a prominent place in the confidence of physicians, and is regarded as a remedy of the highest value in diseases which are marked by malnutrition, pulmonary tuberculosis furnishing the most frequent occasion for its employment.

Few subjects connected with materia medica have provoked so much discussion as the comparative merits of the light and the dark grades of cod-liver oil. Formerly, the brown oil was considered superior in efficiency to the paler sorts, and was generally favored for medicinal purposes. In recent years, however, chemists have claimed that analysis does not reveal any substance in the dark oil which would account for greater beneficial activity than the paler grades are supposed to possess. While many physicians yet recommend the brown oil, the drift of public opinion seems to favor the pale oil, and certainly it is more popular with the patients. A discussion of these rival claims is beyond the scope of this paper. For information on the subject reference is made to A. Gautier and L. Morgues' "Les Alcaloides de l'Huile de Foie de Morue," Paris, 1890, and to F. P. Moller's "Cod-Liver Oil and Chemistry," London, 1895.

PREPARATION OF MEDICINAL OIL.

On account of its greater value, it is generally desirable to convert the livers into medicinal rather than curriers' oil. For this grade the livers must be perfectly healthy and fresh, all diseased, lean, or slightly decomposed ones being rejected. On account of the necessity for having the material perfectly fresh, it is impracticable to manufacture good medicinal oil during the warm months, and even in cold weather the sooner the extraction of the oil is begun the better the grade secured. Furthermore, it is desirable that the livers should be from cod only, those from other species being excluded. This, however, is not the uniform practice, and the livers of haddock, hake, cusk, etc., are sometimes thrown in with those of cod. It does not appear that American manufacturers are any more prone to this adulteration than those of other countries. Possibly oil from other livers may be equally as efficient as cod, yet until that fact is demonstrated beyond a doubt those should be rejected.

On the New England coast of the United States, the best medicinal oil is made from livers collected from the shore fishing boats, which land their catches almost daily, and thus deliver them in fresh condition. From May to October only a small amount of the best oil can be made, because of the scarcity of fish along shore during that season and the danger of the material putrefying before reaching the oil factory. From October to May the shore fishermen carefully save the livers in clean barrels, and if landed within a day or two they are sold for making medicinal oil, but if softened or damaged in any way they are used only for curriers' oil.

Second only to the careful selection of the livers is the observance of perfect cleanliness in the entire process of rendering the oil. The livers are thoroughly cleansed from blood and other impurities by washing in several waters, and the gall sacs and attached membranes are removed. Throughout the entire process of expressing and refining the oil, all tanks, receptacles, and the like are kept free from putrefying texture. Some oil-renderers chop the livers into small pieces for the purpose of securing a greater quantity of oil, but this is by no means the general practice.

There are two general methods of cooking the livers, viz., (1) by wood or coal fire under a water bath, and (2) by the use of steam. The first-named is the oldest in use and is also the most economical where the quantity of material to be rendered is small. Two metallic receptacles or pots are provided, one, in which the livers are placed, fitting loosely in the other, with 2 or 3 inches of space between, and the larger one set into a furnace so that a fire may be built beneath. The space between the two receptacles is filled with water during the process of cooking, and this is renewed as required. A fire is built in the furnace and the water brought to a boiling point, thus imparting a moderate heat to the contents of the pan. In order that the cooking may be expeditious the pan should be small, holding not over 50 or 60 gallons. Furthermore, it should be narrow, for greater ease in stirring and to minimize the oxygenizing of the oil. Owing to the cheapness of this apparatus it is quite popular with those who try out only a small quantity of oil.

In the second method of cooking, steam-jacket kettles are used, the steam-chest being provided with a self-acting safety valve by which the pressure can be controlled and regulated. Within the kettle there is usually a stirring apparatus operated by steam power. By means of this apparatus the cooking may be performed much more expeditiously than with the former one, as any desired temperature may be secured and uniformly maintained.

In order to prevent, so far as practicable, the formation of hydroxylated compounds, the alleged cause of the unpleasant eructations or gastric disturbance from which many persons suffer after taking the oil, there was introduced in Norway in 1892 an apparatus for its extraction without permitting oxidation to take place. This apparatus is so contrived that the air can be completely excluded from it during the whole operation, the process being conducted in a current of carbonic acid gas from the moment the livers are placed in the apparatus until the oil is sealed up in the market receptacles.

Whatever process of cooking may be adopted, it is desirable that the oil be forced out of the hepatic cells in a short space of time and by a moderate degree of heat only. The length of time usually allowed for cooking is from 2 to 3½ hours, and at no time should the temperature exceed 200 deg. F. The duration of the cooking process is an item of great importance in the preparation of medicinal oil, and on it is dependent in a large measure the quality of the product. In order to get the largest possible amount of oil, some producers cook the material entirely too long, notwithstanding that beyond a certain point anything gained in quantity is at great sacrifice of quality. In producing a choice grade of oil, the livers must not be exposed to heat any longer than absolutely necessary.

The longer the cooking is continued, the greater the quantity of acids and decomposed albumen extracted from the hepatic tissues. These substances render the oil strong and unpalatable, and detract from its appearance. Further, the longer the livers are exposed to heat, the more oxygenized the oil becomes, making it irritative to the stomach and causing disagreeable eructations. For the production of the clearest and lightest medicinal oil, the livers should not be exposed to a greater heat than 160 deg. F., and that only for about 45 minutes. This, however, is not feasible because the quantity of oil produced in that case would be too small to make the business profitable. The time must, therefore, be extended as far as practicable without detracting too much from the quality. But in order to produce a first-class medicinal oil, the length of the cooking should on no account exceed 2½ or 3 hours, provided the capacity of the liver-receptacle does not exceed 50 gallons.

On completion of the cooking process, the mass of livers and oil is allowed to cool. The oil rises to the surface and is drawn off and filtered. The liver magma is subjected to pressure and yields a quantity of dark oil suitable only for curriers' use. The residuary mass of hepatic tissues is dried and used for fertilizing purposes. Its market value in Gloucester and Boston was formerly $6 or $8 per ton, but at present it is only about $3 per ton.

Filtering the medicinal oil is accomplished by running it through a box fitted with several straining frames covered with cloth of successive degrees of fineness and with a tap at the bottom through which the oil can be drawn. Or the filter may consist of one or two light canvas bags fitted inside of a white moleskin bag with the smooth side out. But in filtering the dark oil, it is better to run it through charcoal.

In the process of refining, the medicinal oil is placed in small receptacles, as 5-gallon cans, and refrigerated either naturally in cold weather or by means of ice and salt, as already described in the process of refining sperm oil. When thoroughly chilled and granulated the congealed oil is compressed through cotton or canvas bags holding about 4 gallons each, for the purpose of extracting the foots, white pressings, or stearin. Two or three bags are placed regularly upon a substantial wooden platform or table provided with grooves for conducting the outflowing oil to a receiving tank. On this row of bags there is laid a thin iron plate or slab, then another layer of bags, and so on, layer after layer, until 15 or 20 bags have been piled up. Heavy pressure is then applied and continued 10 or 12 hours, when practically all the oil drains from the bags, leaving behind an unctuous mass of the consistency of tallow or butter, composed of nearly pure stearin, with a small quantity of débris and fibers. The quantity of stearin removed depends on the temperature at which the congealed oil is pressed. At the usual temperature of 28 deg. to 30 deg. F., about 1¼ pounds are removed from each gallon of crude oil, the latter weighing about 7½ pounds. The stearin is sold at 5 or 6 cents per pound and is used by soap and candle-makers and as a tallow substitute in leather-dressing.

Medicinal cod-liver oil should be exposed to the air as little as possible during the whole process of extraction, filtering, and pressing; and as soon as the last operation is completed, it should be placed in shipping packages and stored in a cool place until marketed. This oil has a greenish tint, is almost tasteless and odorless. For the purpose of making the oil lighter in color, it is sometimes bleached by exposing it in a thin layer to the sun's rays for an hour or more. Bleaching medicinal oil is an objectionable process, resulting in no particular benefit, and, on the contrary, is productive of much harm when long continued.

The style of the package in which medicinal oil is placed is of much importance. Since cod oil readily acquires the flavor of wood and becomes discolored thereby, glass or metal receptacles are preferred. Tin is much the best material when glass is not used. The Norwegians use tin-lined barrels. When wooden barrels are employed, white oak is preferable to other varieties.

During recent years many manufacturing pharmacists have prepared cod-liver oil in such a manner as to overcome the disagreeable flavor and the even more objectionable gastric disturbance which so frequently follows its use. These products are mostly in the form of emulsions, gelatinous capsules, with syrups, creams, jellies, etc.

Furthermore, some pharmacists remove the so-called "active principles" in cod-liver oil, the oil itself being subsequently used for technical purposes. These "active principles" are extracted by means of an alcoholic menstruum, then concentrated by evaporation and dissolved in wine. They are placed in the market under various proprietary names. In some factories the fresh livers, rather than the oil, are used in manufacturing the "active principles," since the latter are alleged to occur in far greater abundance in the liver tissues than in the oil. According to an account given by the proprietor of one of these preparations, the livers are thoroughly minced in a steam-power chopping-machine and macerated for several days in large stirring machines of special design, a menstruum being employed consisting of diluted alcohol containing a small quantity of citric acid. The extract is then drawn off and concentrated *in vacuo* at a temperature of 40 deg. F. When the liquid is reduced to about the consistency of extract of beef, it is removed from the vacuum pan, assayed for alkaloidal contents, and then dissolved in wine in proper proportion to represent the "active principles" contained in one-fourth its bulk of cod-liver oil.

Only about 10 per cent of the cod-liver oil consumed in this country is produced in the American fisheries, the great bulk of it being imported from Norway. As already shown, the product of medicinal oil in the United States fisheries is only about 25,000 gallons each year, whereas the imports usually exceed 200,000 gallons annually, and in some years exceed 500,000 gallons.

The following summary, showing the total quantity and value of cod-liver oil imported for consumption into the United States during a series of years, is compiled from the United States customs returns:

Statement of the Quantity and Value of Cod-Liver Oil Imported Into the United States During a Series of Years.

Year ending June 30.	Gallons.	Values.	Average value per gallon.
1880	315,910	$152,441	$0.483
1881	516,657	236,763	.459
1882	302,137	162,563	.538
1883	218,716	159,271	.733
1884	412,135	275,078	.667
1885	221,030	153,945	.696
1886	115,454	67,652	.586
1887	130,296	69,326	.532
1888	165,633	78,233	.472
1889	287,183	81,589	.284
1890	267,555	86,476	.323
1891	248,894	98,865	.397
1892	202,959	115,577	.569
1893	190,432	99,709	.524
1894	209,865	99,318	.473
1895	207,145	131,804	.636
1896	179,660	203,588	.133
1897	179,677	170,610	.961
1898	201,582	116,913	.582
1899	233,176	127,074	.545
1900	276,940	136,666	.494
1901	235,749	137,715	.584

PREPARATION OF COD OIL FOR TECHNICAL PURPOSES.

The methods of extracting cod oil for currying and other technical purposes does not differ essentially from the extraction of medicinal oil, the principal difference being the use of all livers secured, the absence of extreme cleanliness, and the greater putrefaction or the more extensive cooking of the material. Considerable common oil is also expressed from the livers cooked for medicinal oil after the latter has been dipped or skimmed off.

The original method of extracting cod oil, and the most common one at the present time, is by putrefaction. In the Grand and the Western Banks fisheries, during the process of dressing the fish, the livers are collected and placed in liver-butts. These butts are characteristic of vessels engaged in a salt-fish trip; in the market fishery for cod, haddock, etc., their place is taken by upright barrels or gurry kids. There are two liver-butts on each vessel; they consist of large casks, with a capacity for about 150 gallons each, mounted horizontally on skids immediately in front of the house and lashed securely to the deck. On the top, in the bilge of each cask, there is a large square opening, covered with a piece of tarpaulin securely fastened at one end, through which the livers are dropped into the cask. As the oil cells in the livers are broken by decomposition and by their constant churning with the rolling of the vessel, the oil rises to the surface, and is bailed off from time to time to make room for fresh livers. The oil dipped or bailed off, known as "sun-tried oil" or "top dippings," is placed in barrels, while the refuse blubber remains until the vessel reaches port, when it is boiled to extract the remaining oil.

The "sun-tried oil" represents probably 20 to 40 per cent of the total quantity of oil produced. It is superior to that rendered by cooking, being heavier bodied, and does not chill so quickly, the quantity of foots being much less. The oil first obtained from the butts is of a light yellow color, and formerly was used to some extent for medicinal purposes. As putrefaction advances, the color deepens to a brownish shade, and that extracted by cooking the decomposed livers ashore is very dark, with a greenish fluorescence in reflected light. In small quantities it shows a brown color, and therefore is known as brown oil. None of this oil is used for medicinal purposes, owing to its strong odor and flavor and the abundance of decomposed tissue contained in it. The market fishermen, who return to port every two or three weeks, save the livers and sell them to the oil merchants at 25 or 30 cents per bucket of 2½ gallons each.

Of the several grades of cod oil used for technical purposes, the best is that made from the livers taken in the Grand Banks fisheries; this is known as "Newfoundland cod oil" and sells for about 2 cents per gallon more than "domestic cod oil" made from livers

taken on Western and Georges Banks. "Straits oil" and "bank oil" were formerly well-known grades of cod oil, but these are now made entirely from menhaden. The low grades of cod oil are strained or filtered in the same way as the medicinal oil, 100 gallons yielding 15 or 20 pounds of foots, worth about 4 cents per pound.

Cod oil is used for currying mostly in New York, Pennsylvania, Ohio, Michigan, Illinois, and Wisconsin, only about 20 per cent being used in New England. Some of the best quality is exported. Small quantities are also used for soap-making and in various compounds.

The following table (based upon the closing quotations each week for prime domestic oil, as contained in the New York trade journals) shows the lowest and highest selling prices for cod oil for technical purposes in the New York market during each year from 1891 to 1902:

Year.	Price per gallon.
1891	$0.32 to $0.43
1892	.37 to .39
1893	.36 to .39
1894	.28 to .38
1895	.27 to .30
1896	.24 to .27
1897	.24 to .30
1898	.28 to .35
1899	.32 to .34
1900	.30 to .37
1901	.31 to .38
1902	.33 to .39

RECORDING ALTERNATING-CURRENT WAVE-FORMS BY DUDDELL OSCILLOGRAPHS.

By the English Correspondent of the SCIENTIFIC AMERICAN.

OWING to the extensive development of the utilization of the alternating current both for lighting and power

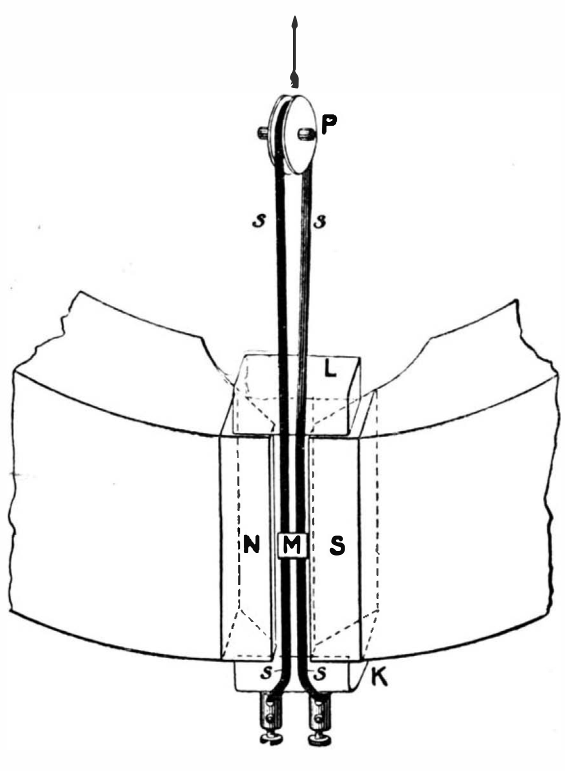


FIG. 1.

transmission purposes, it has now become essential for electrical engineers to be thoroughly conversant with the shape of alternating-current wave-forms. This knowledge is necessitated from the fact that there is a great divergence in the wave-forms of alternating electric motors, which exercises a great effect upon the efficiency of the motors. A motor that works well and with a high efficiency on one wave-form has but an indifferent efficiency upon another, and in some instances will refuse to work at all. It is thus imperative that the correct wave-form, that is, the one which is conducive to the maximum of efficiency, should be known when working with a motor of this type. Even the efficiency of transformers has been proved to be dependent to a very appreciable extent upon the suitability of the wave-form. Furthermore, the breakdown of high-tension and extra high-tension cables is often attributable to avoidable resonance conditions, the nature of which might have been clearly discovered beforehand by a study of the wave-form.

Under these circumstances it is apparent that there should be some simple method of observing and studying the wave-form of an alternating current or potential difference, and in order to accomplish this end, Mr. Duddell, the well-known English electrical engineer, of the Cambridge Scientific Instrument Company, Cambridge, England, devised his oscillograph. This instrument is a highly specialized form of moving coil galvanometer, and it fulfills the severest of practical requirements. It has an extremely small periodic time when undamped (1-8,000 to 1-10,000 of a second in the high-frequency pattern), and is perfectly dead-beat; its self-induction and capacity are practically nil; and it is absolutely free from hysteresis errors. Its deflection at any moment is thus accurately proportional to the instantaneous value of the current passing through it, even with the frequencies of 300 or more periods per second, so that it constitutes an accurate instantaneous ammeter, or instantaneous voltmeter. Its total resistance (with fuse) is only from 5 to 10 ohms.

The indices are spots of light, sufficiently small and intense, either for photography or for visual observation; while two or more wave-forms can be obtained absolutely simultaneously, such as the wave-forms for

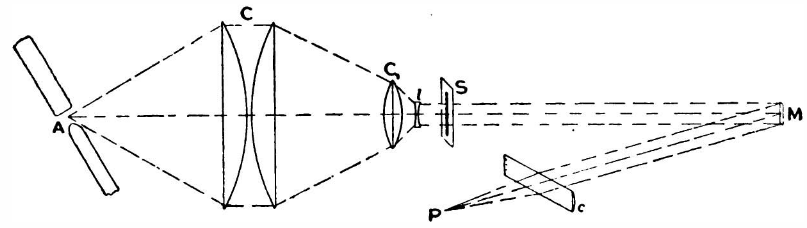


FIG. 2.

the current in a given circuit and for the potential difference between two points on the circuit. Variations of wave-forms can be observed and recorded as they occur; and irregular non-periodic changes in P. D. or current can be recorded with equal ease, whether the circuit be a direct or an alternating current one.

The practical uses of oscillographs are very numerous, for they will record with a high degree of accuracy the time changes in both potential differences and currents. For example, they will record the simultaneous changes of potential difference and current on making and breaking an inductive circuit, the charge and discharge curves of condensers, the changes in potential difference and current in the armature coils of a dynamo, and in the primary of an induction coil, etc., and they will even record the very rapid variations of potential difference and current which occur when the direct current arc hisses. In connection with alternating currents, the wave-forms and their phase difference

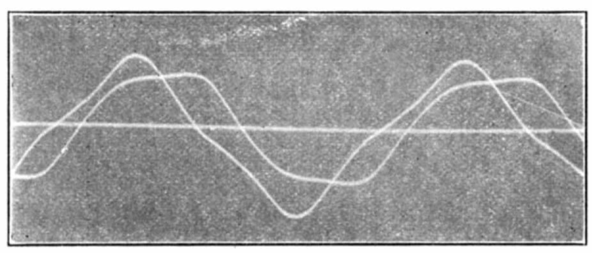


FIG. 3.—PHOTOGRAPH OF CURRENT AND P. D. CURVES.

can be obtained with ease, speed, and accuracy, so that alternators are readily brought to exact agreement of phase; while the self-induction of choking-coils, the capacity of condensers, the power factor, efficiency, etc., of transformers can be readily deduced.

The essential part of the Duddell oscillograph comprises a modified D'Arsonval galvanometer, combined with either a rotating or vibrating mirror, and a moving photographic film, or falling photographic plate. Fig. 1 represents the galvanometer part of the instrument, showing the principle on which it works. In the narrow gap between the poles *N S* of a powerful magnet are stretched two parallel conductors, *s s*, formed by bending a strip of phosphor-bronze back on itself over the pulley, *P*, which is attached to a light spring balance. At the bottom ends the strips are clamped on a block, *K*, while at the top they are held in position by the bridge piece *L*. By altering the tension on the spring stretching the phosphor-bronze loop, the periodicity of the instrument

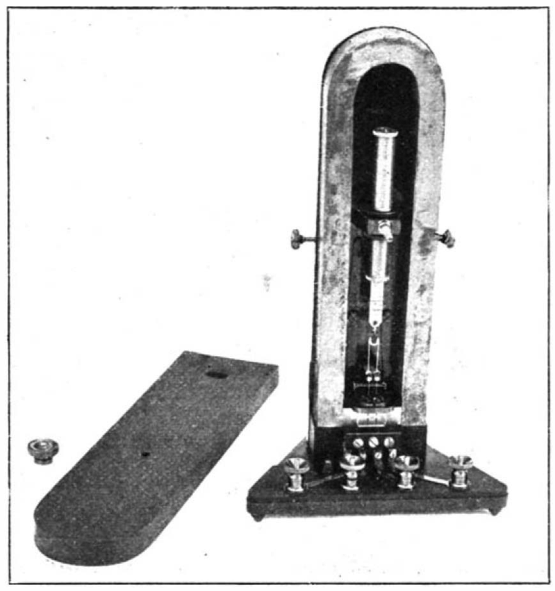


FIG. 5.—DOUBLE PERMANENT MAGNET OSCILLOGRAPH.

can be varied at will. Each strip or leg of the loop passes through a separate gap in the magnetic circuit. The clearance between the sides of the gaps and the moving strip is but 0.038 millimeter; and these gaps are filled with a viscous oil, over which is placed a small lens, which is held in position entirely by the surface tension of the oil, and serves in its turn to keep the oil in place. The object of the oil is to damp the movements of the strips. A small mirror, marked *M*, is attached to the loop, as shown in the diagram. The effect of passing a current through one of these loops is to cause one leg of it to advance while the other recedes, and the mirror is thus turned about a vertical axis. In the high-frequency instrument the natural period of vibration of the loop is 1-10,000 of a second, and the clearances being, as stated, extremely small, the damping effect of the oil is so great that the instrument can be relied upon to give accurate results, even when the periodicity of the current to be tested is over 300 periods per second. Small fuses below the loops protect these from injury in case of accidental excessive current. The fuses consist of very fine wires inclosed in glass tubes, which are held in position by spring clamps.

The beam of light reflected from the mirror, *M*, is

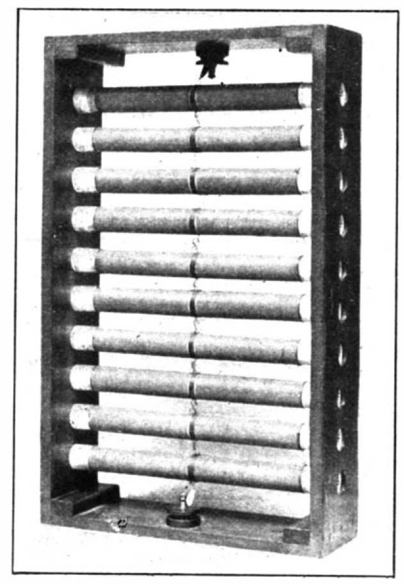


FIG. 4.—SPECIAL RESISTANCES FOR HIGH VOLTAGES, WITH A TOTAL OF 10,000 OHMS.

received on a screen or photographic plate, the instantaneous value of the current being proportional to the linear displacement of the spot of light so formed. With alternating currents the spot of light oscillates to and fro as the current varies, and would thus trace a straight line. Hence, to obtain an image of the wave-form, it is necessary for the beam to traverse the photographic plate or film in a direction at right angles to the direction of movement of the spot of light. A second mirror can be interposed in the path of the beam of light, and this mirror caused to vibrate or rotate, so as to impart to the beam of light a uniform motion proportional to time in a plane at right angles to the plane of vibration of the beam due to the current.

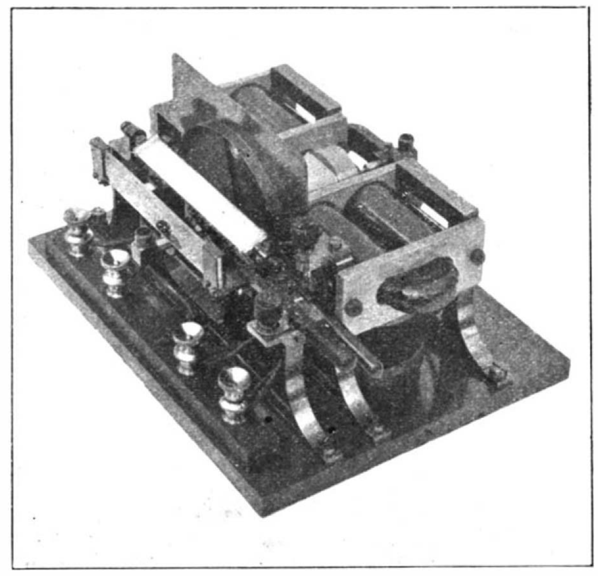


FIG. 6.—ONE-SIXTH H. P. SYNCHRONOUS ELECTRIC MOTOR FOR DRIVING CINEMATOGRAPH RECORDING APPARATUS.

A spot of light will now trace out on a stationary screen or plate the time curve of the variation of the P. D. or current, as the case may be. If the variations are periodic, as in alternating currents, then the second mirror can be synchronized, and the spot of light caused to trace out the wave-form over and over again.

For accurate research work the double high-frequency

oscillograph is utilized, as it has an extremely short periodic time (1-8,000 to 1-10,000 second) and a high sensibility. The magnetic field is produced by means of a powerful electro-magnet wound in eight sections, which are permanently series-connected in pairs, the ends of each pair of sections being brought out to a terminal, so that when they are all in series the magnet may be excited off a 100-volt direct-current circuit without using any measuring instruments or resistances. By placing the coils in two parallels of two in series, or all in parallel, the excitation can be obtained off 50 and 25-volt circuits respectively. For 200-volt circuits an 8-candle-power 110-volt lamp can be used in series with the field coils. The necessity of an exact adjustment of the exciting current is in this instrument dispensed with, as the magnetic circuit is saturated so that a change of 4 per cent, more or less, from the correct value produces only about one per cent change in the sensibility.

The normal scale distance is 50 centimeters, at which distance a convenient working deflection is 3 to 4 centimeters on each side of the zero line, and this deflection will be obtained with a R. M. S. current through the strips of from 0.05 to 0.10 ampere, according to wave-form, etc. The maximum deflection on each side of the zero line should not exceed 5 centimeters.

At the back of the vibrator is a thermometer, the bulb of which is introduced into the solid metal behind the gaps, so that the temperature of the damping oil can be ascertained.

The small lens is held in position entirely by the surface tension of the damping oil, which is adjusted so that the damping is practically correct over the range from 25 to 35 deg. C. This instrument when desired may be used either as a voltmeter or ammeter. For the former purpose resistance in strips is inserted, and to adapt it to the latter it is only necessary to shunt the strips.

In experiments on high-voltage circuits such as two and three-phase power transmission circuits, it is often impossible to arrange the connections so that the oscillograph is at earth potential. In these cases it is often necessary to experiment with 5,000, 10,000, or even higher voltages between the oscillograph and earth. For this purpose a single permanent magnet oscillograph has been designed, the feature of which is that the electro-magnet is replaced by a permanent magnet, which forms part of the case of the instrument. The advantage of this type of oscillograph is that it is always ready for use, as it does not require a direct current for magnetization. This instrument is also made in a double magnet form, so that two wave-forms can be recorded simultaneously.

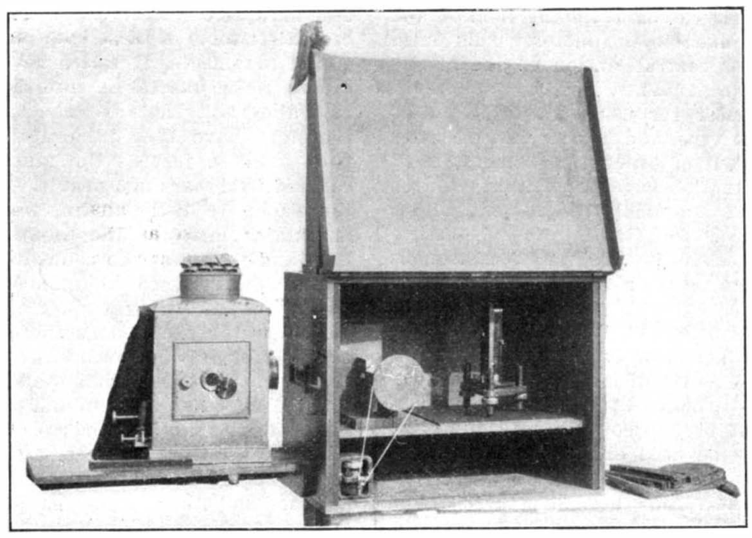


FIG. 7.—OSCILLOGRAPH WITH FALLING PLATE CAMERA.

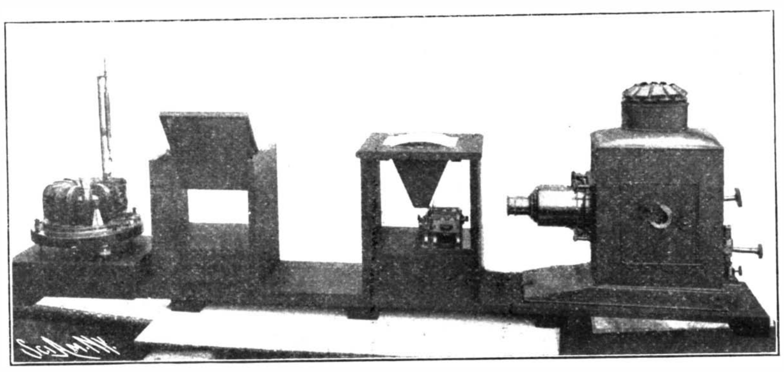


FIG. 8.—DOUBLE PROJECTION OSCILLOGRAPH ARRANGED FOR TRACING.

Owing to the small dimensions of the oscillograph mirrors, the optical system has to be one whereby small spots sufficiently intense to make the curves visible, and to obtain a photographic record, may be possible. For this purpose the arrangement illustrated in Fig. 2 has been devised.

A is the source of light, such as an electric arc light; *C* the condenser of the lantern, C_1 a second condenser, and *l* a negative lens throwing parallel rays of light. *S* is an oblong orifice about 1 millimeter wide by 15 millimeters in length; *M* the oscillograph mirror, and *c* a cylindrical lens which converges the image of the orifice into a small spot at *P*. *M* and *P* are at conjugate foci of the cylindrical lens, and the image of the source *A* is focused on the mirror *M*.

Three methods are generally employed for observing and recording the movements of the spots, and these are as follows:

1. Visual observation, for which purpose a rotating mirror is placed with its axis horizontal in such a position that the reflection in it of the moving spot on the screen can be examined, when, owing to persistence of vision, the moving spot appears drawn out into a bright time curve of the variations which it is required to observe, and this curve can be sketched if required for future reference.

2. Recording by photography, wherein the photographic plate or film is caused to move rapidly at right angles to the plane of vibration of the beam of light, so that the moving spot traces out on it the required variations. The advantage of the photographic method is that it is very expeditious, and supplies permanent records which are exempt from all errors of a personal nature. As a matter of fact, it constitutes the only reliable method of recording irregular non-periodic variations of the P. D. current.

3. Tracing, which is only applicable to periodic variations. In this case the beam of light from the oscillograph is reflected by an additional mirror, with its axis horizontal, before reaching the screen, and this latter mirror is made to move uniformly and synchronously with the period of the variations to be recorded. By this combination of the two motions at right angles—one proportional to the instantaneous value of the current through the oscillograph, and the other to the time—the spot is made to travel continuously along the time curve of variation of the current, which curve, if the frequency is sufficiently high, appears as a stationary bright line of light. This curve can be recorded by tracing or photography.

The photographic system of observing and recording can be accomplished in different ways. One is the falling photographic plate and visual method, wherein a photographic plate of the stereoscopic size falls by gravity down a slide, so that the spots of light from the oscillograph mirrors, which vibrate horizontally, trace out the required curves upon the plate. This enables any variable P. D. or current, no matter how irregular it may be, to be recorded faithfully, since the spot of light only traces the curve once, to produce the record. For alternating-current wave-forms of 50 or 60 periods per second, the height of the slide is such that the mean speed of the plate when exposure is being made is 400 centimeters per second. The plates are introduced into, and removed from, the vertical slide by means of bags and clips. After the plate is introduced into the top of the slide, it rests on a catch, ready to be released at any instant.

The oscillograph is inclosed in a case through which the vertical slide passes. The case is fitted with a rotating mirror. A small motor is also fitted for rotating this mirror, in order that visual observations can be made during the time of exposure. Directly the observer sees in the rotating mirror that the curves have special interest, he releases the catch, letting the plate fall, thus obtaining a permanent record free from personal errors. In order to obtain satisfactory records, an arc lamp must be used as the source of light.

It is often necessary, in investigations which last a considerable time, such as observations on the paralleling of alternators, the running up to speed of motors, and the surges which may occur in switching on and off cables, etc., to obtain photographic records which are considerably longer than those which can be obtained on a single plate.

For this purpose there has been designed a camera to be used in place of the vertical slide employed in the foregoing system, by means of which a roll of cinematograph film can be driven at a uniform speed, past the exposure aperture. By this means a record 64 feet long can be obtained at one time. This camera is driven by means of a small 1-6-horse-power motor, fitted with an automatic brake and starting lever, so that the film can be quickly started and stopped, thus avoiding waste. The exposure aperture is fitted with a shutter, in order that it may be closed, and the camera carried bodily into the dark room for refilling. A small adjustable wire is fitted to this camera, the shadow of which can be arranged to cut the curves at the zero point. A line drawn through these small breaks in the curves forms the zero line. The wire is only employed when the permanent magnet, single suspension, is in use, this instrument not being fitted with a zero mirror.

Another variation of the photographic process is the recording drum, the advantage of which is the obtaining not only of standard size curves up to 8 centimeters width, but also the allowing of any length of film from 10 to 40 centimeters to be exposed, and a range of perfectly uniform speed from the very slowest up to 600 centimeters per second to be obtained. In this instrument Eastman daylight loading films are used, so that the camera may be loaded or unloaded in daylight. The film is stretched tightly round the outside of the drum—actuated by a motor—face outward; and after a record has been made of the desired length, determined by the exposing shutter, the film is wound from one spool to the other, by introducing the hand into a bag, and a fresh length is unwrapped ready to use. The exposing shutter can be set to open and shut again after any desired length (from 10 to 40 centimeters) of film has been exposed. It is also fitted with a contact which can be arranged to bring about electrically the phenomena which it is desired to study. This occurs directly the shutter opens.

The tracing method is devised in order to avoid the necessity of using photography when recording alternating-current wave-forms, which remain fairly constant in shape and frequency. In this the light from the oscillograph mirrors is reflected vertically by a small mirror, which is made to vibrate synchronously by means of a specially designed alternate-current motor. The light is thrown on to a curved screen, on which tracing paper is held by means of a clip,

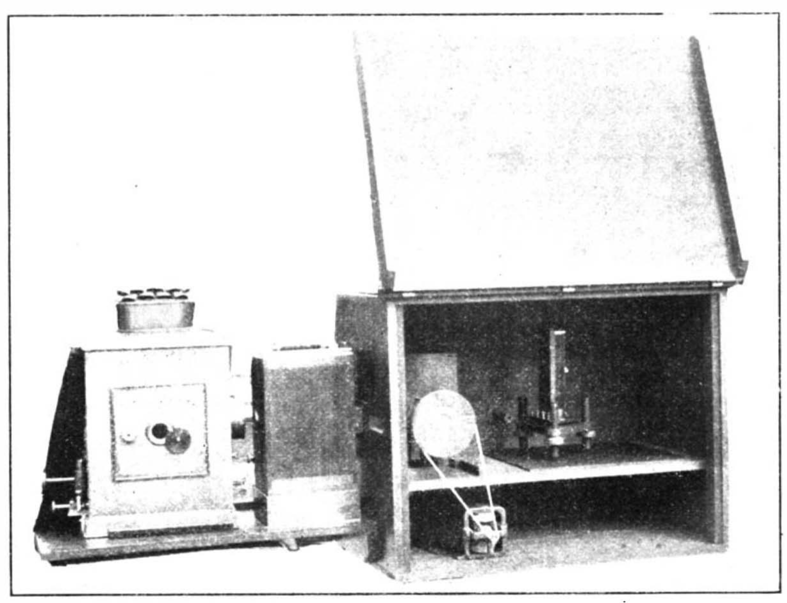


FIG. 9.—OSCILLOGRAPH FITTED WITH CINEMATOGRAPH CAMERA.

and on which the wave-forms appear as stationary curves of light, and may be traced by hand. The small mirror is vibrated by means of a cam attached to the motor shaft. This cam is so arranged that the mirror moves uniformly for about one and a half complete periods, during which the wave-form is observed. It then returns rapidly to its starting point during the remaining half-period. During the half-period of return motion, the light is cut off from the oscillograph by means of a sector fixed to the motor. This outfit is specially suitable for central station engineers and makers of alternate-current plants.

The synchronous motor for use with these outfits is of the attracted iron type, and has no moving wires or connections to get out of order. As a motor must run synchronously with the wave-forms it is required to record, it should be supplied with current, either from the same source as the circuit under investigation, or from a source which is absolutely synchronous with it. The motor can be used over a wide range of frequencies, viz., from 20 to 120 per second. When working at frequencies below 40, it is advisable to increase the moment of inertia of the armature, and for this purpose a suitable brass disk is used. The magnets of the motor are permanently connected in series, and the junction point brought out to a terminal, so that the magnets may be used either in series or in parallel to suit the voltage and frequency. When the frequency is high, or the voltage low, then the magnets should be used in parallel. On the other hand, if the frequency is low or the voltage high, they should be used in series. In either case resistances in series with the motor may be necessary. The working current for frequencies between 25 and 100 per second should be 0.75 to 1.0 ampere, the magnet coils being in series. When using the magnet coils in series, the two extreme terminals are connected to the source of power, viz., terminals 1 and 4, numbering them from the left-hand side. To run in parallel, the current leads are connected to terminals 2 and 4, terminals 1 and 3 being connected together by a wire. In order to reduce the sparking when running up to speed, a resistance fixed on the motor frame is permanently connected between terminals 3 and 4.

On a 100-volt alternating circuit at 100 frequency and with the two magnets in series, no resistance is required when running synchronously; but the starting is greatly facilitated if about 50 ohms (a 50-volt, 8-candle-power lamp or a 100-volt, 32-candle-power lamp) are put in series when running up to speed.

RECENT DISCOVERIES AT POMPEII.

THE city of Pompeii presents so vast a field for the researches of savants and artists that the whole life of a man of talent hardly suffices to penetrate the mysteries inclosed by its ruins, and long apprenticeship is necessary to study with any profit the relics of the ancient cities of the Vesuvian provinces, for they always differ notably, and sometimes radically, from those that are found at Rome and in other cities where we still see the monuments of the Classic school. The temples of Rome, the imperial forums, the palaces on the Palatine, form the most complete and most perfect group of monuments in the Classic style; they still stand, after twenty centuries, and transmit to generations a reminder of Roman grandeur, while Pompeii only recalls to our memory what there was that was brilliant, luxurious, and graceful in the Roman world, a world which was unwilling to acclimatize in the colonies founded on the smiling slopes of Vesuvius the majesty of the porticos and the solemnity of the façades which it preferred to reserve exclusively for the metropolis.

The Romans, while they were creating the most noble of architectural styles for the city to which were to lead all the threads of their world power, where the richness of far-off provinces should be discharged, where the all-powerful government of the empire must find its seat, the Romans, I say, built their country villas, as at Pompeii, Herculaneum, and Stabia, in a style expressly created to properly enframe and accommodate itself to all the little exigencies of a sojourn during which one desired to forget business affairs and enjoy life to its full. On the imperishable lines of Roman architecture, upon the impeccable trunk of Classic art, architects grafted new inspirations and opened wide the doors of their knowledge to Hellenic influences, which reached them through Magna Græcia, and, as well, to the budding suggestions of Oriental art. Dazzled by the richness of the country, possessed and ravished by the warm tones of heaven, of the ocean, and of the luxuriant foliage of the Campagna, they introduced into the ornamentation of their dwellings this Pompeiian painting whose delicate illuminations have preserved beneath the lava their ancient brilliancy, their pristine freshness.

Pompeiian science—which, in archæology, forms a separate branch—is hardly the concern of a dry-as-dust savant, a cold calculator, a patient investigator, such as those who exhumed with such brilliant success the remains of the ancient peoples of Asia Minor and Mesopotamia. To be able to study Pompeii, to have a right to call one's self "*pompéianiste*," one must be a savant, but, more than that, one must be an artist; it is well that one should excel in abstract researches, yet, more than this, it is necessary to have acquaintance with the Muses.

The part of the city which is already freed from its shroud of lava is, in all probability, the part richest in monuments and sumptuous dwellings, but there still remain to be explored vast quarters which are capable of yielding us many a surprise, and considerably enriching the artistic treasures of Pompeii.

At the present time, the exploration of the last portion of the city is going on, that part which stretches out toward Vesuvius. Discoveries that are important and wholly unhoped for have already crowned the most recent excavations. These concern the quarter that the archæologists, who have divided the entire group of Pompeiian buildings into five regions, call the Fifth Region. In large part it consists of small and cheap dwellings, where no article of great value can exist; some of these habitations even lack the utensils of first necessity which have been found in all the others. The quarter is intersected by extremely narrow alleyways that are almost impassable. It must therefore have been inhabited by the people of the poorest class, just as the faubourgs which were discovered two years ago near the shore, at the mouth of the Sarno (a little stream which descends from the mountains inclosing the Campagna), sheltered fishermen and peddlers who counted on the trade of travelers as they passed along southward. The extreme poverty of the little faubourg of the Sarno did not prevent that the excavations there should yield excellent results, for it was toward the sea and the harbor of the Sarno that the inhabitants of Pompeii took their flight. Was not there found under a portico the remains of a sumptuous cortege, in which they undertook to discover, in a certain skeleton, the last remains of the naturalist Pliny the Elder?

Upon the other hand, the Fifth Region, being the nearest to Vesuvius and most exposed to danger, inhabited by people who were not tempted to linger there in order to save their belongings, is almost completely barren. As to actualities, here are a few facts concerning the latest discoveries which have been made here, and which as yet are known to only certain archæologists. In this quarter, the frescoes, that luxury which no Pompeiian denied himself, have only a feeble interest. Often we see on the walls only a simple skimming of mortar. Sometimes the proprietor, unable to resign himself to the tediousness of seeing his flat and gray walls, undertook to decorate them, and his rude and unskilled hand has traced here foliage and other ornaments, painted in black. Elsewhere, without much success, they attempted a higher grade of work, and left on the white partitions of the triclinium or the cubicle, monstrous figures, to which only out of regard for their unfortunate authors can be accorded the name of human figures.

At the same time, this unfavorable judgment should not be extended to the entire quarter, for, amid these modest habitations, there is one which, without being very large, can pass as being very beautiful and recompenses largely all the efforts which these last excavations have entailed. This is the house of Lucretius Fronto, with which we will concern ourselves farther on.

In the extreme portion of this Region, at the very end of the city and, to be precise, in the poor house of Pagus Augustus Felix Suburbanus, they have discovered, at the depth of 30 centimeters, in a room which probably served as the workshop of a blacksmith or locksmith, a statue in bronze. The right arm was missing, as well as the left eye, and was only discovered when the trenches were carried down to the level of the house floor. The statue, which is 1.75 meters in height, represents an ephebe, a subject for which the sculptors of the time had a marked predilection, apparently always using the same model—a fact which gives their work a uniformity, or, at least, a striking similarity. In the representation of masculine beauty, especially when it was a matter of focusing in the form of a young lad the charm of youth, Roman artists never were willing to widely depart from sober lines and the calm and noble movement which assimilates their creations to the statues of the demi-gods. The statue which concerns us has the purity of lines and sobriety of gesture of the most beautiful statues of the first epoch; we see in this work that the author was much nearer to the school of archaic Greek work than to the school of Classic Roman work. The attitude is noble, the profile pure, the aspect worthy and serious, as in the statues of the purely Grecian masters.

But there is more: The ephebe of Pompeii is not a distant cousin of the Greek ephebes; he can pass for a belated reproduction of that ancient type of youthful citizen whose features have been fixed by Miron and who is now known by the name of the "Ephebe of Miron." The little idol ("Idolino") at Florence is itself a reproduction of this same theme, to whose charms the greater part of the ancient sculptors yielded. The influence of the Greek artist is manifest, for these two reproductions, this at Pompeii and that at Florence, admirably resemble one another, not only in their general lines, but in their determined sobriety of movement, in their simplicity of form, which is neither austere nor *molle*.

This discovery of the ephebe of Pompeii has, in a certain part of the artistic world, aroused a veritable enthusiasm. It is really one of the most fortunate of finds that have been made in these later years; but this is far from saying that nothing like it has ever been seen. The statue has a certain importance in so far as it reproduces a very old type. Intrinsically, it is far from perfection and its value is open to discussion. For instance, the way the shoulders are attached is hardly harmonious; in the profile there is a crudeness and imperfection which make one think that the author was vainly attempting to reproduce the features of the Greek model; the dimensions of the pelvis are not in proportion with those of the thorax; in short, it seems to be a provincial copy after a good model. The mere fact that this bronze statue was covered by a process which was not applied to art works of great value, with a plating of silver, sufficiently proves that we are not in the presence of a work of peerless worth.

But let us pass now to discoveries which are more remarkable. As we have already said, the Fifth Region was void of all the objects which have been found in the other houses of the city. By a hazard which cannot be explained, seven skeletons, forgotten in these quarters, have been found in a room opening on the gardens of the house of Lucretius Fronto, which made a portion of the Fourth Island of the Fifth Region. It is customary in the world of the Pompeiians to designate the houses excavated by the name of their proprietor. In this case, the name Lucretius Fronto has come down to us through numberless pencilings on the wall. One of these inscriptions, found on the wall of a cubicle, contains these words: "M. Lucretius Fronto, vir fortis."

The house is not large, but the arrangement of the rooms, the harmony of the ensemble, the elegance, the distinction, the good taste of the decorations, the importance of the frescoes, place it in the first rank of the private houses of Pompeii.

The vestibule, of which the pavement slopes toward the street, and whose walls are covered with a rude plastering, opens on the atrium. This atrium, of the style called *tuscanicum*, is of very regular dimensions. The soil is beaten, and sown with little stars of white marble which have geometrical designs. One would say, on beholding these beauties of art scattered on the black background, that a harvest of blossoms had been scattered with knowing irregularity over a black surface. Here is one of the secrets of Pompeiian art: To ally colors—some colors at least—in such a fashion as to produce the most unexpected, the most charming, effects.

In the middle, is dug a rectangular impluvium. The bottom and borders are of worked white marble. All about runs a band of black-and-white mosaic which sets off the whiteness of the marble and forms an agreeable transition between the brilliancy of the impluvium and the somber color of the pavement. A pretty marble table, with cannelated feet terminating in lion's claws, is placed beside the impluvium. The decoration of this room has a black background cut by broad light-colored bands, and in the panels formed by this framework animals are painted.

Two cubicles open on the atrium. The first is near the vestibule. As it is very meagerly decorated, and, moreover, as it is near the kennels, it is thought that it was used by the porter. The second is rich and elegant; the walls are decorated with black and yellow panels, enframed in slender Egyptian collonnettes. Each of the black panels bears a little composition. Apart from this, there is nothing particularly new or very interesting. The partition where the cubicle must have been has a niche which, in Pompeiian houses, takes the place of an alcove. The stucco of the rear wall is worn and discolored by the rubbing of the body and covering of the sleeper.

The tablinium is placed opposite the entrance and back of the atrium. The decoration, in the third style, is of extreme fineness. The walls are divided into great rectangular panels by broad bands and by garlands of flowers, leaves and fruits, which are superposed and ensnarled with one another so as to form an attractive composition. Above the garlands and panels are sketched conventional landscapes in which architectural composition dominates. In every case the best painting is within the panels. Those which occupy the side walls only bear little landscapes, very well handled, but which do not deserve a long analysis, while there is to be found on the central panels two compositions which can be classed among the finest of Pompeiian paintings. One represents a recognizable subject to which we shall refer later: Dionysius and Ariadne on a car. But let us turn to the panel on the northern wall. This scene represents Venus and Mars. Venus at the left, on a seat with a back, her face turned toward the spectators, wears a diadem, earrings, and bracelet (armilla) on the left wrist; her body is enveloped in a yellow chiton and is wrapped in a grand purple mantle which only allows to be seen the left shoulder and a portion of the chest; her right arm is wrapped up in the cloak. Venus is striving to restrain Mars with her left hand while he bends to kiss her. Mars wears a golden helmet, with red crest, and a blue chlamys. The right-hand portion of the painting is taken up with two female figures, the nearest one wearing a yellow and violet chiton, with green cloak. The painter has attempted a combination with which he has succeeded very fairly by drawing this figure with her shoulder turned toward the public and her hands crossed over her knee. The other female wears a light-colored chiton and gray mantle, but she is in large measure concealed behind her companion. Between the two groups, Cupid stands upon a step; he is entirely nude, save for a blue chlamys. He carries his bow in both hands and is turning toward the group formed by Venus and Mars.

In the second plane behind the five chief personages, is a bed with violet-colored mattress, with red and yellow stripes, with the head upon the right hand, occupying the full width of the fresco; behind the bed, three figures fill the background. That in the center, by its brown coloration, seems to be a masculine figure; of the two at the sides, the nearest is drawn almost in profile; its head is bound with a gray band, while the third, clad in a violet-colored chiton, is shown full-front. Finally, the scene depicts a chamber, the ceiling of which is sustained by two columns.

Notwithstanding the somewhat harsh and naïve character of the physiognomies, in spite of the awkwardness of Venus and her companions, this fresco

has real merit; the general composition is good, the grouping is agreeable and in poetic accord with the mythological legend. In certain things, as, for instance, in the pose of the little Cupid, the author gives proof of incontestable talent.

From the tablinium, we pass to the garden, which is not large and which, unfortunately, has been robbed of all the ornaments which give the characteristic charm to Pompeiian gardens. Here there are no fauns, no satyrs, no Cupids from which issued fountain-jets of which the murmur no longer enlivens these ruins. There are a few plants which have been recently set out in the garden to restore in some degree its ancient character. The wall which surrounds it is ornamented with frescoes representing hunting scenes—the pursuit of lions, tigers, etc. Before a portico—of which there remain only three columns—paved with masonry, and which formerly served as entrance to four chief rooms, rises, or, to speak more exactly, used to rise, a summer triclinium and a few other rooms which served for the functions of daily life, such as kitchens, cellars, offices, and sleeping quarters for the slaves.

In these rooms, nothing has been found except seven skeletons which the catastrophe has left in one of these entrance chambers, to prove to us that no one was spared at the time of the disaster.

At a little distance from the house of Lucretius Fronto, in the Third Island, the investigations of the archæologists have been more fruitful. In a building of shabby aspect, they have brought to light a kind of gueridon of bronze, supported by a monopode, the lower extremity of which is finished with lion's claws, while the other extremity is crowned by a calyx of acanthus leaves. From this calyx, in light and graceful pose, issues a winged Cupid. His left hand holds a shell (concha Veneris), and the right an alabastron from which he is pouring a libation; another calyx rests on his head, and in its turn supports a third, from which at length issue the three supports for the table-top. The design of this monopode is quite original, without reckoning that it constitutes one of the most beautiful expressions of Pompeiian feeling, simple, artistic, and pleasing; surely, the author certainly desired to present, by the use of the winged Cupid, the very soul of the flower, which is freeing itself from the corolla, and allowing its perfume to fall out like an essence.

Still in the Third Isle of the Fifth Region, they have just discovered a statuette which represents either a divinity or an emperor, an object of sober and serious art. It is 71 centimeters high and represents a robust young man, entirely naked, posed in such a way that the entire weight of his body falls on the right leg; the left, which was found broken half way up the thigh, is lightly extended in advance. All in the way of clothing that the statuette has is a chlamys hung over the left shoulder, falling the length of the back and reappearing where the young man's right hand rests on his hip; this slight clothing was not cast upon the statue; it is a bit of hammered work, soldered on afterward.

The countenance expresses strength; the nose is frankly aquiline; the hair hangs in conventional locks; and finally, the feet are protected only by thin sandals tied on with ribands, such as we see in the statues of Perseus and Mercury, although this detail is far from being enough in itself to cause us to recognize a divinity in this image; the features, characteristic and strongly realistic, are rather those of an imperial personage, to whom the artist, by one of those acts of adulation which were so frequent at that epoch, desired to give the attitude and attributes of a divinity. Finally, it is a good specimen of Roman art.

In the way of works of marble, there has been found in these last excavations only a fine bas-relief, 45 centimeters by 60, which presents a sacrificial scene. A feminine divinity, Venus Aphrodite apparently, sits in majesty at the right; her left hand rests on a block; the right resting lightly on her knee is playing with a long flowered scepter, which stretches from the feet to the shoulder of the goddess. Before her is a victimarius presenting a ram. Three little figures half concealed by the victim, and another group, complete the composition. Venus, wearing a diadem, covered with a Doric peplum attached at the left shoulder, is staring fixedly; calmness and divine serenity are apparent in her attitude; she is awaiting the sacrifice which is her due; her pure-cut profile is surely that of a superhuman being. These qualities of the bas-relief, joined to the graceful folds of the drapery, the beauty of the hair, and the natural drawing of the peplum, as well as the gravity of the other personages, are enough to class this bas-relief among the productions of the school of Phidias—or it may be only a copy executed with exceptional talent.

These are the last conquests of Pompeiian archæology. The excavations are going on in the Fifth Region, where it is necessary to raise one or two meters of earth before reaching the roofs of the houses. Already are showing, here and there, bits of stucco and fresco which signify the uncovering of a rich and large dwelling. Is it a sensational surprise which awaits us? Is it a deception such as has already been so often experienced in the course of the endeavors to which we owe the exhumation of these buried cities? Let us leave to the light pick of the excavators the task of answering.—Honoré Mereu in American Architect.

Will science eventually justify some of the earlier chemical beliefs in the transmutation of metals? It would almost seem as if something of the kind might be possible, though not perhaps in the sense imagined by the old searchers for "the Philosopher's Stone." Sir W. Ramsay and F. Soddy, in a recent communication to the Royal Society, tendered some evidence bearing on the suspected gradual conversion of radium or radium emanation into helium. Gas evolved from 20 milligrammes of pure radium bromide by its solution in water, and which consisted mainly of hydrogen and oxygen, was examined for helium, and after the other two gases had been removed, one of the helium lines was found in the spark spectrum. In another experiment, practically all the helium lines were obtained. A further series of experiments dealt with the radium emanation. This was condensed in a liquid air tube, and the liquid air was then removed by the pump. The tube showed no trace of helium, but showed a new spectrum, probably that of the emanation itself. After standing for four days, the helium spectrum appeared, and the characteristic lines were observed identical in position with those of a helium tube thrown into the field of vision at the same time.—Mechanical Engineer.

HOW ANIMALS DETECT POISON.

THE sense by which animals detect the presence of a poison is mainly that of smell. They seem to have very little sense of taste upon the palate. But carnivorous animals have a kind of "half-way" sense between taste and stomach ache which very soon tells them when they have taken poison or anything likely to disagree with them, and nature has kindly arranged that they can get rid of it by the throat with very great ease. An extraordinary instance of this was quoted in the Country Gentleman last August. A Scotch keeper had a retriever which he had taught to fetch any object that he had left behind him. One day on the moors in the spring he found that he had left his knife at a place where he had been sitting no great way down the hill, and sent the dog to fetch it. The dog galloped back to the place, and finding the knife, concluded that that was what he was to fetch, and picked it up. So much at least seems certain from the sequel, for when the dog arrived he had not got the knife, and also looked somewhat shamefaced. The keeper tried to send him back again, but he would not go. He went back himself, taking the dog with him. No knife was there; and it was certain that had it been dropped the dog would have picked it up. It then flashed across his mind that the dog, in running up the hill with the object in his mouth, had swallowed the knife. Unfortunately, as it apparently was not uncomfortable, the retriever showed no sign of wishing to do other than digest it, which, as it was a valuable dog, the keeper was most unwilling to risk. So he took a handful of salt, clapped it into the dog's mouth, and held it tight for a minute—and after one or two coughs, the knife made its appearance. The dog was of course trying to get rid of the salt, not of the knife.

Wolves, tigers, leopards, and other carnivora are difficult to poison because of the power which they have of rapidly getting rid of the drug. Lions, on the other hand, are very frequently poisoned, as they eat voraciously and quickly, more like a dog than the other large felidæ. It is said that a good many lion skins, especially those brought back by foreign counts and others from Somaliland before the regrettable misunderstandings between whites and blacks had begun in that region famous for large game, were obtained by the unsportsmanlike method of poisoning carcasses and leaving them for the lions to devour. Cattle, which have no less than four stomachs, are hopelessly poisoned if once they have swallowed a dose, whether in a toxic plant or otherwise. It is this curious arrangement of their interiors which makes it such a difficult matter to give cattle medicine at all.

In common with human beings, animals seem to be affected by poison in certain forms when in a particular condition of health. At other times they can eat the same plant or shrub with impunity. In certain states of health a man can eat pork, lobsters, cockles, scallops, and other somewhat risky foods without bad effects. At other times the same edibles would produce on him the effect of ptomaine poisoning. Two persons may eat of the same food at the same time, and while one is perfectly well afterward, the other may become violently ill. The curious cases of yew poisoning among cattle or horses seem to be somewhat analogous. They will sometimes browse on shoots of yew and take no harm whatever. At other times they are obviously made very ill, or die from eating the leaves. They have even been found dead with the yew fresh and undigested in their stomachs. Where poisonous plants are present in any great numbers in herbage it seems quite impossible to prevent cattle from eating them. The "poison veld" of parts of the Transvaal has a particularly bad reputation caused by plants—one of which is said to be a species of tulip—which come into leaf in the spring.

In addition to the poisons mentioned above, the deaths or illness of English cattle have been traced to eating the leaves of laurel, common crowfoot, and various other plants of the *Ranunculus* family, wild parsnips, and acorns, which are very astringent; and also, it is believed, to their eating woody nightshade. The keeping of a goat with cattle may possibly be beneficial, because goats eat by choice and with impunity plants which are injurious to cows.

Birds seem to have no discrimination whatever in regard to poisons, probably because they have almost no sense of smell, and swallow their food without masticating it. They are terrified to paralysis by the appearance of a poisonous snake (unless the terror be due to dread of the appearance of the serpent rather than to an inherited knowledge of its venomous power); but such intelligent birds as rooks will pick up and eat poisoned grain, and crows and ravens readily eat poisoned eggs or meat. Chickens will eat the poisonous seeds of the laburnum, and die from the effects; whether birds such as tits and greenfinches ever do so does not seem to be known. But wild birds are frequently found dying in gardens, though apparently they have been in good health a few hours before, and their death may probably be due to the consumption of poisonous seeds.

There is some reason to think that there are narcotic poisons which as a first symptom produce great excitement in animals, in the same way that opium or hemp first exhilarates and then stupefies. In North America there is a poisonous grass which, according to popular accounts, "sends the horses mad." They become greatly excited, and gallop at full speed till exhausted, and sometimes death follows.

In the account of Col. Mahon's successful operations against the "new Mahdi" it is noted that on the march back to the river a number of the horses died from eating "poisoned grass," on which they browsed at the halting places. A similar instance of the failure of instinct to detect danger lurking in vegetable growth, as regards which it might naturally be concluded that the animals' senses would, after long experience in the life of a species, have inherited caution, occurred quite recently in Somaliland. A train of Indian camels were brought over for use in the army transport, many of them being exceptionally good and strong animals. There were also many native Somali camels at the base. The Indian and Somali beasts were both allowed to browse freely on the wild shrubs round their quarters. The camels which had been born of native stock took no harm. But the Indian camels ate shrubs which were so poisonous that many of them died. It is not stated that they overate themselves, which rather stupid creatures like camels will often do when they get the chance, but that they were actually poisoned by the toxic qualities of the food which they selected. It is an interesting question whether the native Somali camels really avoided the dangerous plants, or whether they had become "immune" by eating them for generations, as cats and their kittens which have eaten snake poison are believed to become protected from the effects of a cobra bite. But the probability is all in favor of the theory that they purposely avoid and reject what they instinctively know to be poisonous. If the food is pleasant and plentiful, there is no reason to believe that animals ever cease eating until they think they have had enough, and by that time it would probably be too late for them to make use of experience on a later occasion.

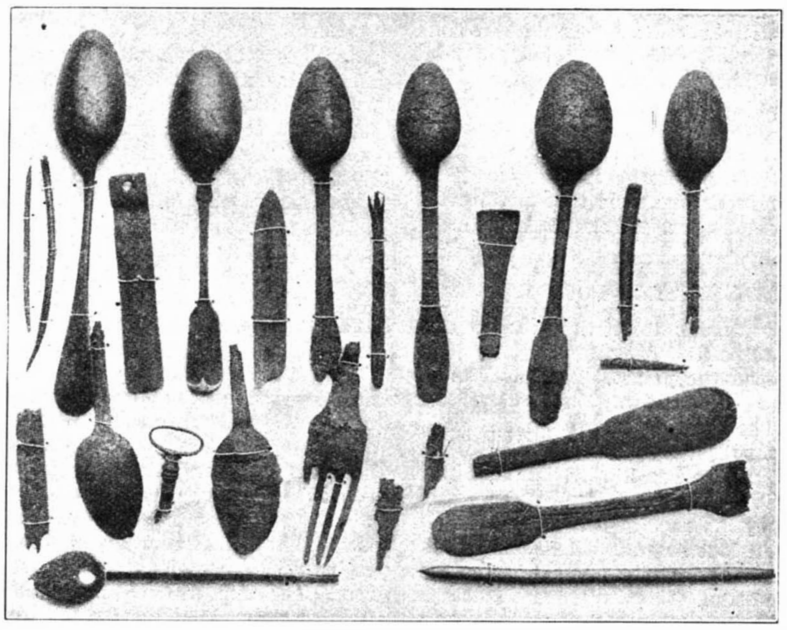
Whatever be the reason for the fact, "warning" notices of various kinds are frequently affixed by nature to poisonous plants, almost as legibly as the label which the law insists that chemists shall place upon poisonous drugs. Many of the poisonous fungi have an odious smell, so much so that no mammal or bird ever thinks of touching them. On the other hand, the scent of the mushroom is distinctly appetizing and pleasant. Henbane, an exceptionally poisonous and quite beautiful wild plant, has a most unpleasant scent which is instantly detected by cattle when the plant is green. They most carefully avoid touching it when growing. But it seems to lose its warning odor when dried in hay. Instances have been quoted in which it has been injurious to cattle when consumed in this form. The common "fool's parsley," which has poisonous seeds, is not, we believe, eaten by any bird, neither do cattle touch it when growing in meadows. But they seem to have no such suspicion about the water hemlock, which is so peculiarly deadly to both cows and horses. Mr. Rider Haggard in his "Farmer's Year" describes the sudden death of a colt, just turned out with its mother in the early spring into the wet meadows by the river Waveney, from some such plant eaten in the grass. One of our most poisonous native plants is the ordinary fox-glove, from which digitalis is made. Every part of it is toxic in a high degree—flowers, stem, leaves, and roots. It has no unpleasant odor of any kind, but for some reason cattle never touch it. The lower leaves are among the earliest to appear on the banks or on commons, though the tall spike appears much later. But however scanty the herbage, these leaves are left uneaten. In the hemlocks, several of which are poisonous to man or beast, the dangerous ingredient varies. In the spotted hemlock it is "conine" which is present in great quantities in the seeds, though there is very little in the leaves and stem. The Greek poison was probably prepared from these seeds, as is the medical extract made at the present time. On the other hand, in the water hemlock, which is not very common in England, though found abundantly by Scotch rivers, and on wet grounds in the North, the poisonous principle is contained in an essential oil. Spotted hemlock kills or injures human beings by causing paralysis, which progresses through the nervous centers till it attacks the lungs. In the water hemlock the poison acts in a different way. Like another and more deadly vegetable poison, strychnine, it causes tetanic spasms. The difference in the nature of the poison contained in plants so closely alike as these two hemlocks may perhaps account for the failure of cattle to know the danger to which they are exposed in eating them. It may well be that one variety, though injurious to man, may not affect cattle. Consequently they might naturally eat without any misgivings the other variety which is deadly to them.—London Spectator.

FOREIGN BODIES IN THE STOMACH.

THE organs of man are habitually very sensitive, and the smallest foreign body introduced into them becomes an unwelcome guest, which they endeavor to get rid of with all possible haste. If they cannot do so, they become irritated; and, as a result, profound disturbances in the functions of the organ affected, accompanied with pains of greater or less intensity, occur. Thus, for example, the least particle of a solid substance introduced into the eye causes intolerable suffering, and a simple pin introduced into the stomach often necessitates the opening of this organ in order to remove the pin, so great is the pain and formidable the disorders produced by it. On the contrary, cases of remarkable toleration occasionally occur, such as that of a child five years of age presented by us to the Academy of Medicine and from which, through an incision at the base of the neck, was removed a coin that had been encysted for eleven months in the middle of the œsophagus. The operation was suggested rather by the accident of formidable complications than by the very slight inconvenience experienced by this interesting little patient. But this example of toleration is considerably surpassed by the following case presented by us to the Academy at its session of July 15 last. It was that of a pitiful-looking youth 22 years of age, of a very low order of intelligence, and an epileptic, who came under the medical treatment of Dr. Leraux at the St. Joseph hospital, for nervous and intestinal disturbances. At the end of a few days, the presence of foreign bodies was discovered in the left hypochondrium. He then entered the surgical ward, and, on May 25, underwent the operation of gastrotomy (opening of the stomach). Great was our astonishment to feel, with the finger introduced through a one-inch incision, a large number of pieces of metal. In fact, by means of a long forceps, we removed in succession the foreign bodies represented in the accompanying figure. In the first place, two coffee-spoons; next three more coffee-spoons; and then three more again, making a total of eight, of which the first two were 5 and 5½ inches in length respectively, and the others 5½ and 6 inches. The latter were corroded by the acids of the stomach, especially hydrochloric acid. This was not all. With a still longer forceps (for the stomach was very spacious) we extracted part of a fork with three tines; the handle of the same fork, broken off; another fork-handle; the fourth tine of the first mentioned fork; one 5.5 x 0.2-inch wire nail having a very sharp point; one 2.75-inch nail; one 2.3-inch needle; one 2.3-inch knife handle; one knife blade of the same size; one fork handle; one 2-inch knife blade; one 2.3-inch nail; one 1.5-inch key; half of a sharp-pointed tortoise-shell hair-pin, 3 inches in length; and a few pieces of oxidized metal—a total of 25 pieces of a weight of over 7 ounces. All these bodies were placed quite uniformly at right angles with the long axis of the stomach, in its deepest part. Nevertheless, we were obliged, with infinite precautions, to change the position of several in order to bring them in the axis of the incision.

One of the most interesting peculiarities of this observation was the integrity of the interior of the stomach, verified by means of the finger moved about methodically in the cavity. The operation was finished by the usual sewing up of the stomach and abdominal wall.

It might be thought that after so important an operation the state of the patient would have become inquieting; but such was not the case. There was scarcely any rise of temperature for three nights in succession. On the fifteenth day the young man ate meat, and, on the twenty-fifth, he got out of bed. It was then that, having fully recovered from the effects of the operation, he confessed to us that he had begun six months previously to swallow these foreign bodies in order to put an end to his life. A desire to commit suicide, in fact, is one of the principal causes of the ingestion of such bodies, and was the motive that led a woman 32 years of age, whose history has been told by Dr. Fricker, of Odessa, to swallow 35 objects, such as a soup spoon, a tea spoon, a hair pin, etc. Sometimes the motive is bravado, as in the case of the young man operated upon by Dr. Halsted, of Baltimore. This surgeon removed from the patient's stomach, in which they had lain for four days, 208 metallic objects and 1,070 grains of broken glass. In the enumeration of all these foreign bodies, mention is made of but 7 knife blades, or, more exactly, of 7 fragments thereof. On the contrary, there was a large number of chains, such as 20 small and 2 large dog-chains and 4 watch-chains, along with 12 pins, 150 nails of varying length, etc.—Translated from the French of Dr. L. Monnier, in La Nature, for the SCIENTIFIC AMERICAN SUPPLEMENT.



TWENTY-FIVE ARTICLES SUCCESSFULLY REMOVED BY GASTROTOMY FROM THE STOMACH OF A YOUNG MAN.

STILL HUNTING.

SINCE the advent of the portable or pocket camera with its extremely sensitive and rapid dry plates, many of the mysteries of the home life and habits of the wary and timid denizens of the thicket, field, and forest have been disclosed. What was before but imagination in many instances has now become a reality; for, with this noiseless gun and a large supply of patience or mechanical ingenuity to take the place of the necessary ammunition in the more sonorous sport, we are able to obtain views of life not otherwise visible to the stranger.

With a click the unsuspecting victim is transfixed not with a deadly arrow or a missile from a murderous gun, but by a bolt of light upon a sensitized plate, which, with timely manipulation, gives back all that occurred before its piercing eye in that instant of time, rendering it permanent to be examined at the leisure and convenience of the operator.

The maternal birds upon their nests in the act of nourishing their ravenous young; the joyous warbler upon the twig proudly attuning his soul to the glories of the dawning day; the timorous rabbit in his form cautiously peering forth in search of possible danger; and the larger and more-to-be-dreaded beasts of the jungle have all fallen victims to this noiseless shot. And yet their lives have been spared to repeat indefinitely their customary habits, as well as to pursue the even tenor of their way without pain or suffering. But all the events in the lives of these apparently innocent creatures are not tinctured with friendship one for the other. Occasionally one is caught with murder in his eye, even in the act of falling upon and crushing out the vital spark preparatory to devouring the prey.

The lightning-like swoop of the rapacious hawk; the stealthy tread of the mountain lion; the vigorous spring of the king of the jungle accompanied by the agonizing efforts of the intended sacrifice to make good his escape, all form upon the sensitive plate representations of the daily occurrences in this great world's economy.

Most of these ideas have been so oft depicted that they are now familiar to the general reader, but we present herewith a picture which may not be among his collection. Apparently by accident the artist has caught in the act two sly thieves who are despoiling of its eggs the nest of a pair of low-building birds. We know with what care and ingenuity rats will carry off eggs, what pleasure some cats will take in cracking and lapping them up. In fact, there are many of the smaller animals which, much to the annoyance of our farmers' wives, show a propensity for this nourishing food; but that there should exist a species of egg-devouring snakes may be news to a great many. This serpent or snake bolts his food whole, as we here see, having no idea of crushing the shell.

The most wonderful thing in connection with this trait is that their intelligence—meager in the extreme, of course—or their instinct does not warn them of their utter helplessness for defense when in the condition exhibited by the one with the mouth full of egg. A descent into their holes would be practically impossible, and if attacked by birds or other enemies they must surely succumb.

EGG-EATING SNAKES.

THE HEREDITY FACTOR IN TECHNOLOGICAL EDUCATION.

IN a lecture recently delivered in London, Prof. Karl Pearson declared that he had set himself the problem, six or seven years ago, of determining how far mental and moral qualities and capabilities were inherited, as compared with physical characteristics. In other words, how far are health, good temper, and aptitude in science inherited by comparison with the inheritance of such readily determinable physical characteristics as stature, muscular strength, or color of hair. This problem opened up the necessity for three collateral lines of inquiry: First, a measurement of the extent to which physical characteristics are inherited in man; second, a comparison of the inheritance of physical characteristics in man, with respect to inheritance in other living things—e. g., man compared with horses; third, a measurement of the extent to which mental and moral characteristics are inherited in man.

The method of measurement as described was very interesting and depends upon hereditary conditions discovered by Galton for both human beings and sweet peas. This is the principle of fraternal regression, and may be described as follows: If one member of a family of brothers is found to deviate from the general average of the community by a given amount in a certain physical characteristic, as for example, by being two inches above the normal mean stature, the other brothers will tend to have an average deviation of half that amount, or in the case considered, by one inch in excess. If the most devious member has a certain deviation, the average other brother will be divided in his allegiance between the devious brother and the common stock and will have half the deviation, on the average. This is a property which is said to run through both plants and animals and to be a characteristic of physical heredity in general. It is closely connected with the quantitative degree of inheritance from father to son; and is a characteristic which can be applied without taking in more than a single generation, since it only needs observations on a large number of members of a community in which brothers exist. Any

physical quality or proclivity is found to be distributed in a large community according to the laws of errors in observations; i. e., equal small numbers of large and opposite deviations from the mean, and equal increasing numbers of lessening opposite deviations from the mean, with the great majority having nearly the mean value. Thus in height, or strength, or color, or any physical measurable quantity, the great mass of the people deviate but little from the mean, but deviations occur equally often above and below, and are distributed like accidental errors in the use of a measuring instrument.

Prof. Pearson measured the fraternal regression in regard to physical characteristics of young people by sending 6,000 circulars to about 200 schools, and obtaining reports upon measured physical properties of the students. In all of these the fraternal regression was found to come out close to one-half. A very large number of observations were next compiled upon 1,918 pairs of brothers as to mental and moral characteristics, and the result of this investigation showed that the fraternal regression was also very close to one-half, within the limits of observational error. Similar conclusions have been arrived at as to the fraternal regression in physical characteristics of other living things. Prof. Pearson concludes finally that mental and moral aptitudes of any kind are inherited according to the same law as applies to physical variations. The result has a very important bearing upon education, for it is useless to expect great results from education, if applied to inapt students. Great success in education can only be hoped from the application of good education to gifted or apt pupils, and the aptitude can be stimulated, but cannot be created. It must be inherited and follow the laws of heredity, which are seemingly erratic in the single individual, but which are perfectly definite and reliable in the mass of individuals. If the talented classes of a nation do not proportionately reproduce themselves in the succeeding generation, the nation will decay in talent. Prof. Pearson, speaking in England, regards it as probable that an era of great dearth of ability is approaching, because the more talented classes are found to be failing in vitality and relative reproductiveness. He considers that the progress of a nation lies largely in the hands of the most advanced citizens, those who deviate positively most from the great mediocrity of the nation in respect to mentality of various kinds. These deviations are always to be expected by the laws of error, but they can be fostered and magnified by any stimulation of the reproductiveness of the individuals possessing them. On the other hand, any systematic means for causing the more intellectual deviations to disappear has a great depressing influence on the future of a nation; as for instance, the action of the Spanish Inquisition, maintained steadily for several centuries, in eliminating and killing intelligent heretics.—Electrical World and Engineer.

AN X-RAY TUBE WITH ADJUSTABLE FOCUS.

By R. V. WAGNER, M.D.

IF one examines the outline of a shadow from a light emanating from a large area—e. g., a gaslight—it will be seen to compare favorably with the outlines on a fluoroscope or on a picture, when the X-ray is used from a tube having the anode out of focus. On the other hand, the outlines of a shadow emanating from a small area—e. g., an arc lamp—resemble the outlines on a fluoroscope or on a picture, when an X-ray tube having a sharply focused anode is used. (Figs. 1 and 2.)

The X-ray emanates from the molecular bombardment of the rarefied air in the tube on the surface of the anode. The structures of rarefied air are repelled from the concave disk or cathode, forming the cathode rays or stream. This cathode stream striking the surface of the anode or disk in the center of the tube produces the X-ray. To obtain a sharp focus, the anode must be a given distance from the cathode, just as an object must be a given distance from a lens to be in focus.

In making a Crookes tube by all methods used heretofore, it has been practically impossible to get the anode the required distance from the cathode, so as to obtain a sharp focus, as the stem supporting the anode had to be sealed in the glass by guess, and the tube exhausted before it could be tested, when if the anode was found defective in respect to its focus, it was too late to remedy the defect, without going to an expense nearly equal to that of making a new tube. A microscope cannot be focused accurately by a person who guesses at the distance the lenses should be from an object, without looking through them. This would be much easier, however, than to focus a Crookes tube by guess, as to the distance the anode should be from the cathode, because of the skill required on the part of the glass blower to seal in the stem supporting the anode, so as to hold it where he thinks it should be; his judgment of where it should be is purely guesswork because there is no way of testing, until the tube is exhausted and properly excited.

FIG. 1.

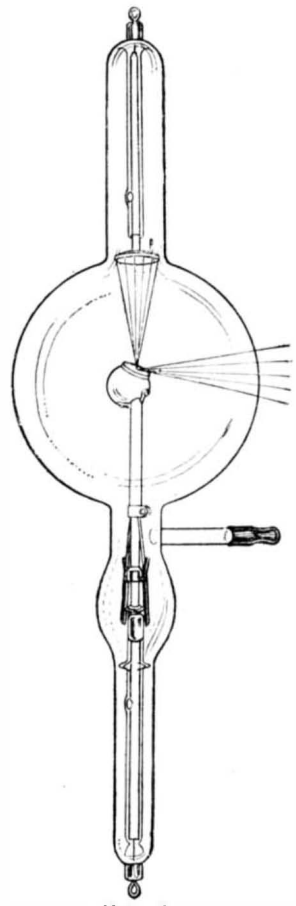


FIG. 2.

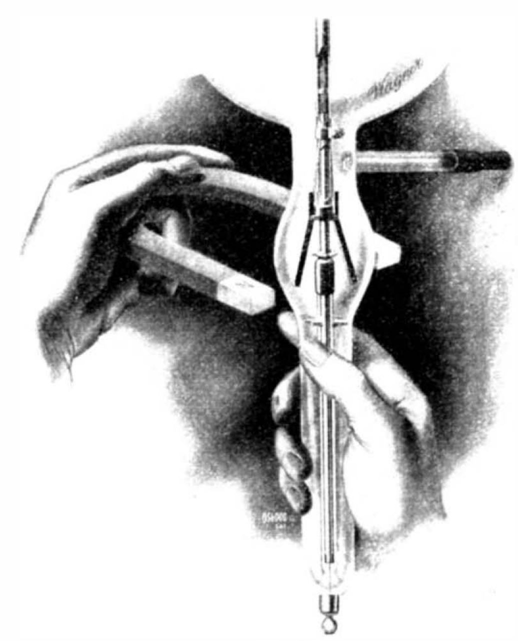


FIG. 3.

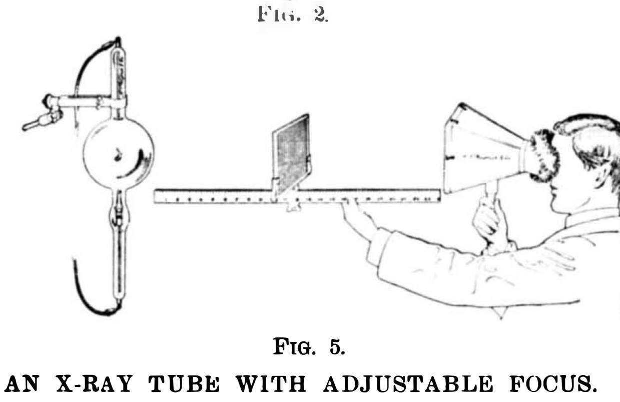


FIG. 5.

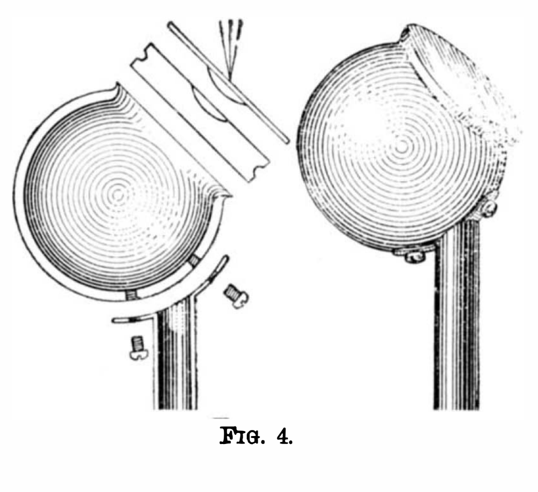


FIG. 4.

AN X-RAY TUBE WITH ADJUSTABLE FOCUS.

The new feature of my tube is in having the anode mounted on a threaded stem which can be magnetically operated through the glass, so as to move the anode up or down or circumferentially with the surface of the tube, to obtain an absolutely accurate focus (Fig. 3).

The little armature on which the magnet acts cannot possibly get out of adjustment, and will hold the anode in any required position, either in focus or out of focus, as the operator may desire for some therapeutic purposes.

When a cheap metal is used for the anode, it must of necessity be out of focus because it will not stand up under the strain of having the molecular bombardment confined to a very small area, as is the case when the anode is in focus. Platinum is the only metal that will do for a sharply focused anode, as it not only stands a very high degree of heat, but is not broken down by the molecular bombardment, like inferior metals, e. g., nickel steel.

In my tube the anode (Fig. 4) is completely covered by a plate of platinum made very thick at the focus. This plate of platinum is electrically welded to the metal forming the body of the anode, and will stand an unusual degree of heat, and unlimited usage, even with the sharpest focus.

With my method of magnetically adjusting the anode, it is possible to make every tube alike, and to accurately focus the same after the tube is finished and in operation just as you focus a microscope by looking through the lenses, instead of guessing at the adjustment by observation as to the distance of the lenses.

In order to appreciate the vast difference in X-ray work due to the proper focusing of a tube, the sharpness of definition can be carefully tested (Fig. 5) by taking an ordinary wire screen of 20 holes to the lineal inch (called a 20-mesh sieve), and holding the fluoroscope 24 inches away from a tube, when it will be found that with a poorly focused tube the screen will have to be brought very near the surface of the fluoroscope in order that the mesh be clearly distinguished. The nearer it is necessary to bring the screen to the surface of the fluoroscope, the more the tube is out of focus; but the farther away the screen may be held and the mesh clearly distinguished, the more accurate is the focus of the tube. With a perfectly focused tube the holes in a 20-mesh screen will stand out perfectly clear at least 12 inches away from the fluoroscope, with the fluoroscope 24 inches away from the tube.

A few simple tests that will enable anyone to distinguish a good tube from a bad one should be carefully considered. X-ray workers posted on the requirements of a good tube will agree that it is more difficult to obtain a good tube to-day than it was a few years ago, before low-priced competition arose, and that two tubes made in appearance exactly alike, with practically the same degree of vacuum, and the same quality of glass for the bulb, will give entirely different results, on account of the difference in the focus effecting the definition in radiographic work. Every operator will find that out of a large number of tubes, as made heretofore, but one will do good work, and that one he is willing to adopt as his "pet tube."

ON THE MEASUREMENT OF CERTAIN VERY SHORT INTERVALS OF TIME.*

ACCORDING to the discovery of Kerr, a layer of bisulphide of carbon, bounded by two parallel plates of metal and thus constituting the dielectric of a condenser or Leyden, becomes doubly refracting when the Leyden is charged. The plates, situated in vertical planes, may be of such dimensions as 18 centimeters long, 3 centimeters high, and the interval between

* Nature.

them may be 0.3 centimeter, the line of vision being along the length and horizontal. If the polarizing and analyzing Nicols be set to extinction, with their principal planes at 45 deg. to the horizontal, there is revival of light when the Leyden is charged. If the Leyden remain charged for some time and be then suddenly discharged, and if the light under observation be sensibly instantaneous, it will be visible if the moment of its occurrence be previous to the discharge; if, however, this moment be subsequent to the discharge, the light will be invisible. The question now suggests itself, what will happen if the instantaneous light be that of the spark by which the Leyden is discharged? It is evident that the conditions are of extraordinary delicacy, and involve the duration of the spark, however short this may be. The effect requires the simultaneity of light and double refraction, whereas here, until the double refraction begins to fail, there is no light to take advantage of.

The problem thus presented has been very skillfully treated by MM. Abraham and Lemoine (Ann. de Chimie, t. xx., p. 264, 1900). The sparks are those obtained by connecting the Leyden with a deflagrator and with the terminals of a large Ruhmkorff coil fed with an alternating current. It is known that if the capacity be not too small, several charges and discharges occur during the course of one alternation in the primary, and that while the charges are gradual, the discharges are sudden in the highest degree. If, as in the present case, the capacity is small, it is necessary to submit the poles of the deflagrator to a blast of air, otherwise the Leyden goes out of action and the discharge becomes continuous. Under the blast, the number of sparks may amount to several thousands per second of time. In this way the intensity of the light is much increased and the impression upon the eye becomes continuous, but in other respects the phenomenon is the same as if there were but one spark.

In order to obtain a measure of the double refraction, which is rapidly variable in time, somewhat special arrangements are necessary. At the receiving end the light, after emergence from the trough containing the bisulphide of carbon, falls first upon a double image prism, of somewhat feeble separating power, so held that one of the images is extinguished when the Leyden is out of action. The outer image would be of full brightness, but this, in its turn, is quenched by an analyzing Nicol. When there is double refraction to be observed, the Nicol is slightly rotated until the two images are of equal brightness. This equality occurs in two positions, and the angle between them may be taken as a measure of the effect. A full discussion is given in the paper referred to.

The finiteness of the angle, which in my experiments amounted to 12 deg., is a proof that the light on arrival at the CS_2 still finds it in some degree doubly refracting. To obtain the greatest effect the leads from the Leyden to the deflagrator should be as short as the case admits, and the course of the light from the sparks to the CS_2 should not be unnecessarily prolonged. The measure of the double refraction, and in an even greater degree the brightness of the light as received, are favored by connecting a very small Leyden directly with the spark terminals, but the advantage is hardly sufficient to justify the complication.

The observations of Abraham and Lemoine bring out the striking fact that if the course of the light be prolonged with the aid of reflectors so as to delay by an infinitesimal time the arrival at the CS_2, the opportunity to pass afforded by the double refraction is in great degree lost, and the angular measure of the effect is largely reduced. There is here no change in the electrical conditions under which the spark occurs, but merely a delay in the arrival of the light.

The optical arrangements which I found most convenient in repeating the above experiment differ somewhat from those of the original authors. The sparks are taken at a short distance from the polarizing Nicol and somewhat on one side, and in both cases they are focused upon the analyzing Nicol. When the course is to be a minimum, the light is reflected obliquely by a narrow strip of mirror situated in the axial line, and focused by a lens of short focus placed near the first Nicol. This lens and mirror are so mounted on stands that they can be quickly withdrawn, and by means of suitable guidance and stops as quickly restored to their positions. In this case the distance traveled by the light from its origin to the middle of the length of CS_2 is about 30 centimeters.

The arrangements for a more prolonged course are similar, and they remain undisturbed during one set of comparisons. The mirror is larger, and reflects nearly perpendicularly; it is placed upon the axial line at a sufficient distance behind the sparks. The light is rendered nearly parallel by a photographic portrait lens of about 18 centimeters focus, the aperture of which suffices to fill up the field of view, unless the distance is very long. In all cases the eye of the observer is focused upon the double image of the interval between the plates of the CS_2 Leyden.

The earlier experiments were made at home somewhat under difficulties. For the blast nothing better was available than a glass-blowing foot bellows; but nevertheless the results were fairly satisfactory. Afterward at the Royal Institution the use of a larger coil in connection with the public supply of electricity, and of an automatic blowing machine, gave steadier sparks and facilitated the readings. An increase of about one meter in the total distance traveled by the light reduced the measured angle from 12 deg. to 6 deg., so that the time occupied by light in traversing one meter was very conspicuous.

It is principally with the view of directing attention to the remarkable results of Abraham and Lemoine that I describe the above repetition of their experiment, but I have made one variation upon it which is not without interest. In this case the spark is placed directly in the axial line and at some distance behind, which involves the use of longer leads, and therefore probably of a lower degree of instantaneity. The additional retardation is now obtained by the insertion of a 60-centimeter-long tube, containing CS_2 between the sparks and the first Nicol, and the comparison relates to the readings obtained with and without this column, all else remaining untouched. The difference is very distinct, and it represents the time taken in traversing the CS_2 over and above that taken in traversing the same length of air. It should be remarked that what we are here concerned with is not the wave-velocity in the CS_2, but the *group*-velocity, which differs from the former on account of the dispersion.

In the above experiments the Leyden, where the Kerr effect is produced, is charged comparatively slowly and only suddenly discharged. For some purposes the scope of the method would be extended if the whole duration of the double refraction were made comparable with the above time of discharge. This could be effected somewhat as in Lodge's experiments, where a spark, called the B-spark, occurs between the outer coatings of two jars at the same moment as the A-spark between their inner coatings. The outer coatings remain all the while connected by a feeble conductor, which does not prevent the formation of the B-spark under the violent conditions which attend the passage of the A-spark. The plates of the Kerr Leyden would be connected with the outer coatings of the jars, or themselves constitute the "outer" plates of two Leydens replacing the jars. RAYLEIGH.

ENGINEERING NOTES.

After discussing the different conditions to be satisfied by a suitable lubricating oil, K. Wilkens (see Elektrot. Zeitschr. No. 7, 1904) exposes the physical properties of these oils to which, in the first place, the diminution of the friction is due. The most important point is the necessity of choosing in each special case an oil of a consistency such as corresponds to the pressure on the axles and the temperature of the bearings, so as to safely exclude any prejudicial contact of the sliding surfaces. Of the oils thus classified, those which, for the same consistency, show the smallest resistance with regard to the internal friction, should be preferred. In order to test the different oils from this point of view, the Berlin Allgemeine Elektricitäts Ges. has designed a special apparatus being based on a process patented by the author. The results of a large series of experiments are represented graphically.

Making machinery foundations elastic so as to minimize or even altogether prevent vibration of buildings, is a recently much-mentioned subject, special reference having been made to the uses of a particular new kind of impregnated foundation felt which is claimed to have given very satisfactory results. It has been spoken of as intended chiefly for insertion beneath rails, girders and machine beds, and as being made in sheets of varying thicknesses—from 3/8 inch to 1½ inch. The felt is impregnated with mineral fat, so as to be moisture proof. In Germany it is said to be in extensive use in connection with steam hammers, pumps, steam engines and much other machinery; under bridge girders, railway ties, rail chairs, and car bodies; and between columns and joists in buildings, and on shipboard to separate machinery from steel decks and bulkheads. The sheets are made in different sizes up to 60 inches in length by 30 inches in width. Felt mats have for many years been used as anti-vibration expedients, so that there is ample reason to expect satisfaction from the employment of the so-called "foundation felt" here noted; but it may not be amiss to observe that in many instances the apparent desirability of its use is indicative simply of something wrong in the machinery installation. Small earthquakes from the operation of a steam hammer, and trembling buildings from fast-running machinery, often are proofs that the machinery has not been properly put in. Foundations rightly proportioned and rightly laid would materially restrict the market for special foundation preparations and confine their use to the underlaying of rail chairs, bridge girders and such other more appropriate things as have already been mentioned in this paragraph. With these their services would seem to have a fitness entirely lacking where moving machinery is concerned.—From Cassier's Magazine.

At first sight there appears nothing romantic about Southwark Bridge, whose reconstruction is now being debated. But there is a wonderful little story behind it, after all. There was the inevitable fight over its construction. Street traffic and the necessities of pedestrianism might go hang, so long as the traffic of the river was not interfered with; and it was to get over the opposition of the corporation and conservators that the Rennies had to make such enormous spans—the largest ever attempted in the history of engineering up to that period. This necessitated the use of blocks of granite greater in extent than had ever been quarried since the days of the ancients. It could not be done, masons declared. Sir John Rennie on his part swore that it could and should. He went to Aberdeen, and at Peterhead found a block of granite weighing twenty-five tons. That he would have whole, he said. By excessive wages and unprecedented largesse of the native wine, men were got to cut and detach the mass from its moorings. But then it had to be taken four miles along the road to port. Such a thing had never been heard of. Sir John managed to fake up a carriage, and after a journey of a day and a half, part of which time was spent in digging the monster out of collapsed roadways, twelve or fourteen horses got it to the vessel which, after extraordinary difficulties, the engineer had succeeded in chartering. There were no cranes to lift such a weight. They had to build a scaffolding in the bed of the harbor to get the block aboard. Eventually the thing was accomplished, and although every mariner save the one who had undertaken the commission believed that the enterprise would send the vessel to the bottom, the granite was safely brought to London, and a new era in engineering inaugurated. One curious feature in the history of Southwark Bridge is that it was opened at dead of night. As the clock of St. Paul's chimed midnight it was declared free to the public.—St. James's Gazette.

ELECTRICAL NOTES.

In the case of the light given off from an arc lamp having to be utilized in a determined direction only, the lighting power may be increased in this direction by imparting to the two carbons an abnormal position, placing their axes either in parallel directions, at a certain distance apart, or at a certain angle to one another. It is shown from the experiments of E. Richter (Elekt. Zeitschr. No. 5, 1904) that for each inclination of the axes, there is a maximum of candle power corresponding to a certain displacement of the carbons, this maximum being, in the case of inclinations of 15, 20, 25, 30, 35, and 40 deg., 141, 107, 69, 47, 26, and 14 per cent respectively superior to the amount of light given off from the carbons under the same angle in the case of their position being normal. From a comparison between the different maxima, it is shown that the latter will increase to some degree as they approach the perpendicular position of the carbon axes, and with the corresponding simultaneous increase in the displacement of the carbons. These experiments were carried out in the optical workshops of Carl Zeiss, at Jena.

The vexed problem of the electric separation of oil from condensed feed water is claimed to have been solved by Messrs. Davis and Perrett, of London, who found from experiment that whereas with the untreated condensed water it was practically impossible to remove the oil by mechanical filtration, this could be done if the water was first subjected to electrolytic action. The difficulty of passing electricity through a mixture of condensed water and oil was its high resistance, the mixture being almost an insulator. They therefore added a small amount of a solution of washing soda before treatment. Their experiments were successful, and led to the laying down of a plant on a large scale for the purpose of treating condensed water commercially. It was then found that by adding a small quantity of tap water to the water to be treated, its conductivity could be made sufficient to enable the current to pass through at voltages commonly in use. In fact, the small amount of make-up which is always required was more than sufficient for the purpose. The water is passed through a wooden tank, 12 feet long, 30 inches wide, and 27 inches deep, divided into three compartments, through which the water flows in parallel streams between iron electrodes, a potential of 50 volts being maintained between the adjacent plates, and is subsequently filtered. Representatives of the Electrical Engineer (London), the source of our information, testify to the thoroughness with which the water was cleansed with 20 amperes at 150 volts, the three couples of 50 volts being connected in series, but do not say how much water was passing at the time. The public analyst of Westminster reports that the untreated water contained 1.07 grains of oil per gallon and the treated only 0.01 of a grain at a time when he was informed that the plant was dealing with between 2,000 and 3,000 gallons per hour, but does not give the current required. The cost is given in a general way as "less than one unit of electricity" (probably 1 kilowatt) per 1,000 gallons of water treated per hour.

Two things we need in electric lighting for the immediate future: One is a lamp of moderate power, moderate intrinsic brilliancy, good color, and high economy to replace or supplement the present glow lamp. The other is a very efficient lamp of almost any power and brilliancy, with plenty of red and yellow in its spectrum, and capable of operating when fully inclosed, and practically without attention. The first form of lamp has its obvious uses laid out in advance. The second would be almost equally valuable to the art, and could be utilized for indirect lighting with the greatest advantage. If the arcs with composite carbons could only be inclosed and run without attention, they would fill the bill exactly. But no form of arc yet devised can advantageously be employed as a concealed illuminant, and, however efficient, it is easily beaten out by the glow lamp for interior illumination. Almost any kind of illuminant will answer out-of-doors provided it does not require too much attention, but for the regular work of interior lighting the incandescent lamp fully holds its own, inefficient as it relatively is Which of the suggested improved lights is likely to appear first, no one can tell; perhaps both may come together. The chances seem a little better for the first named than for a light of high power; and the futile efforts which have thus far failed to obtain either are evidence enough of the difficulty of the problem. Lacking these improvements, the best hopes of electric lighting lie in the skillful use of the illuminants that

are now available, in a careful adaptation of means to ends, and in a realization that illumination is not a haphazard business where all the light that can be paid for is the proper amount to use. On the contrary, light improperly employed is not only useless but harmful, and one light well placed is better than two misplaced. If one can make ten common glow lamps do the work of fifteen as now used, he has scored as great a success as if he had installed a new form of two-watt lamp. The final test of lighting is light.—Electrical World and Engineer.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Suggestions to Exporters to South America.—Brazil.—Not long ago the German consul at Rio de Janeiro sent his government a report which contains facts of value to American exporters. German houses located at Rio de Janeiro are criticised for not confining their lines of commodities to goods of German manufacture, instead of handling English, French, American, or other goods without discrimination, if they prove profitable to the Brazilian trade. In this way American exporters have been favored with some of their marketable goods and lifted up to a position where they have been able to establish themselves on an independent footing in Rio de Janeiro.

The above contains a good suggestion for American exporters to South America, if they are not already familiar with this practice of the German houses, as there are probably numerous small articles appropriate for South American trade which could be exploited to advantage by a German house, but for which the trade would not assume sufficient proportions to warrant the dispatch of a special agent into the field to develop it. Certain German houses dealing in stationery have thus done a fine business in foreign brands of ink.

In order to establish such communication with a German house, it is necessary to know something about its trade methods, as well as to inquire into the lines of goods carried by different houses established in the country. Such information can be obtained, it is claimed, by applying to a reputable information bureau, a Rio de Janeiro house by the name of A. Confianca, Caixa 1265, which is reported to correspond in a number of modern languages, including German and English. The fees exacted by this firm are said to be 15 milreis ($8.19) for information supplied in regard to any single matter pertaining to the locality, or within the city, and 20 milreis ($10.90) for information which must be drawn from sources outside of the city in other parts of Brazil. Certain German houses in Rio de Janeiro are also reported to supply information at from 5 to 20 marks ($1.19 to $4.76) per single subject. One such firm is J. P. Roth, Rua Alfandega 38.

Great circumspection is said to be necessary in dealing with Brazilian houses (native) on a credit basis. Not only is it imposisble to avoid contact with unreliable firms and agents who indulge in sharp and questionable business practice, but the bankruptcy laws are reported to be far from perfect. As they stand at present, disreputable houses are enabled to throw up their hands in apparent bankruptcy and then escape all responsibility of settlement with the creditors through the numerous loopholes offered by the application of the law.

Colombia.—The experience of exporters dealing with Colombia also comes as additional evidence of the discouraging credit conditions existing there. Every inch of ground must be investigated. It is said to be a very general practice with some young merchants and agents to send to American and European exporters for samples of textile goods, such as hosiery, gloves, shawls, clothes, etc., under the guise of desiring to enter into trade relations, and then refuse to pay for them, or show any further signs of existence to the men whom they have swindled. Sometimes these schemers have been able to clothe their activities with such an air of plausibility and integrity that shipments of goods were even made on the strength of their representations, of course to the ultimate loss of the shipper. It is a well-known fact that the German exporters are probably more ready to grant credit, and deal on a liberal basis with comparative strangers, than any other merchants of the world. This policy frequently brings them business where others fail, as was so well shown in the case of Russia. It also exposes them to heavier losses, which, it seems, are in the long run more than compensated for by the profits received. While this practice of dealing on a liberal credit basis has brought considerable business to Germany, and seems to receive a general recognition and support, the warnings to German business men to investigate thoroughly before granting credit are being sounded more and more frequently. German consular representatives write on this subject continually, and none more than those who are located in the far-distant markets and whose unpleasant duty it is to interest themselves in the enforcement of the numerous claims presented by German exporters who have suffered at the hands of unscrupulous buyers.

On the other hand, American exporters have no cause for looking at the distant markets askance, as the opportunities there are probably greatest. It is virgin soil that yields the richest returns. Only it must ever be remembered that it is necessary to investigate just where the stumps and stones lie to preserve the machinery and prevent ruin. Having done that, it seems as though no markets are more lucrative than those which are in a state of development, as are all the distant markets.

Peru.—It may not have come to the knowledge of some of our exporters that the city of Lima has among its numerous public buildings a large structure that is the seat of a most practical organization for the promotion of foreign trade, viz., the "Permanent Exposition of Machinery and Manufactured Products" (Exposicion Permanente de Maquinarias y Manufactura). This exposition was founded in 1897 by the Peruvian government, and is at present supervised and managed by a regular government official. Within the tremendously big hall are exhibited the leading products of Peru and countless cases of Peruvian manufactures. But the exhibits are not confined to that country alone; they include the machines and manufactures of many countries. The purpose of the organization is to demonstrate the development of the Peruvian industries, as well as to give foreign manufacturers an opportunity to exhibit their commodities and bid for the patronage of the Peruvian buyers.

The exposition is open to the public and is well patronized. Among its most frequent visitors are the large planters from the plantations of the vicinity who come to the place to view the latest exhibits in agricultural machinery. The government charges nothing for floor space and admits all exhibits into the country free of all duties for the period of six months. Bonds must, however, be given for the ultimate payment of the duty in case the exhibits are finally sold. From these extremely favorable arrangements for the exhibitor it will be seen that the only charges which fall to the lot of the foreign exhibitor are transportation and the cost of erecting the machinery or placing the exhibit.

It is hardly necessary to point out to American manufacturers the wonderful opportunity offered by this government exposition to bring American machinery and American manufactured products to the attention of Peruvian buyers. It is reported by a German consular representative that probably most attention is given to agricultural machinery, which is sought on all sides by the great plantation owners. However, smaller articles of trade are also being exhibited. It will be seen that the expense of sending a small package containing late mechanical devices, dress goods, or household articles adapted to the needs of Peruvian life will be inconsiderable in the light of market opportunities which may be developed there.

The government conferred upon the management of the exposition the privilege of selling exhibits on commission. Where foreign houses which have no branches in Peru desire to introduce their commodities into the country, it is said to be wisest to engage a good agent who is familiar with the economic peculiarities of Peru, as most sales would have to be made on credit, if they are to be made at all, and the purchasing power of the buying class fluctuates considerably with the prosperity of Peru's leading industries—copper mining, sugar cultivation, and cotton growing, all of which are articles of importance in the world markets and hence subject to the frequent fluctuations in price that characterize commodities of universal demand manipulated by eccentric speculation.—J. F. Monaghan, Consul at Chemnitz, Germany.

Cardiff as a Distributing Center for American Products.—Cardiff continues to make remarkable progress. The percentage of increase in trade and population is about the largest in the kingdom. The exports during 1902 reached the enormous total of 19,970,000 tons. The registered tonnage of vessels cleared for foreign ports was nearly 8,000,000, thus placing it first in the world for exports. It is exceedingly unfortunate that there is no direct communication between the ports of the United States and that of Cardiff. American shipping was once very brisk in this port, but it practically ceased long ago.

Cardiff is a magnificent center for the distribution of food stuffs, fruit produce, and other goods of American manufacture. It possesses all the natural and acquired advantages necessary for the safe running of a trans-Atlantic service. The port has one of the most sheltered positions in the British Channel. Penarth Head, 200 feet above high-water mark, forms a natural breakwater, to which vessels frequently run for shelter during a continuance of westerly and southwesterly gales. At Barry, the entrance is well sheltered from the same winds. The port has two large breakwaters, which completely cover all points of exposure. The Barry Dock Company has also recently built specially constructed transit warehouses capable of storing any quantity of perishable goods, the building covering nearly six acres. A breakwater and pier have also been erected, where loaded vessels can run alongside and discharge and load without entering the dock. The water is so deep that vessels have no need to wait for the tide. Another important consideration is the facility for obtaining the best Welsh steam coal for bunkering purposes. Steamers can discharge their cargoes at Cardiff and land bunkers without being compelled to change ports, and thus save at least one port charge and the consequent loss of time and expense incurred at other import docks. The dues on the vessel and cargo are lower than at any other port in the kingdom.

Cardiff, from its geographical position, is the natural ocean port for the Midlands generally, embracing Birmingham and South Staffordshire. By the completion of the new Severn water way, Cardiff is enabled to place timber and grain in the Midlands at a less rate than either London or Liverpool. This will also apply to the food produce.—Daniel T. Phillips, Consul at Cardiff, Wales.

Antigua-American Trade.—As to the articles in which our trade with Antigua might be increased, especially under a lower freight rate, I might call attention to flour, butter, potatoes, general groceries, cotton and woolen cloth, hardware, jewelry, boots and shoes, drugs, soap, lumber, and shingles.

I cannot refrain from referring to the method of doing business through commission merchants in New York. It seems to me that if the merchants here could deal directly with manufacturers or jobbers in the United States they could procure their goods at much more advantageous prices. From the goods on which I have quotations I am satisfied that the Antiguan purchasers are made to pay prices to the commission merchants that are unreasonable. As an instance, a merchant thought he would introduce the American wagon to take the place of the heavy carts on the Antiguan estates. He ordered some and was charged $100 f. o. b. New York, when the same wagon should have been furnished for $50, or certainly not to exceed $60, with all expenses paid. Other instances of the same kind have come to my notice.

Canada is pushing hard for the trade of the British West Indies, and with this handicap on our trade and the subsidized line of steamers running regularly between Halifax and the islands, it has made rapid progress in the last year. Canada also takes much of the sugar of Antigua.

I refrain from suggesting methods of improvement at the United States end of the line. I only point out the defects and leave it to those who are directly interested to apply the remedies. Even under the present great difficulties we are getting a good share of the trade, but there is no reason why it should not be increased.—W. R. Estes, Consul at Antigua, British West Indies.

Effect of Russian-Japanese War on the Linen Industry.—The conflict in the Far East between Russia and Japan will soon have the effect of raising the price of linen goods manufactured in Silesia. Russia furnishes nearly all the flax and tow from which the thread used in the German linen manufactures is spun. While the cultivation of flax will probably be but little affected, the difficulty of transporting the same can be reckoned upon with certainty, as, owing to the immense distance of western Russia from the seat of war, all the rolling stock available on the railways will no doubt be pressed into service. Therefore a dearth of raw material for the linen industry will be unavoidable and the further consequences will naturally be a considerable advance in the price of linen goods. During the last calendar year the declared exports of linen goods from this consular district amounted to $337,-878.79.—Ernest A. Man, Consul at Breslau, Germany.

American Trade at Nantes and St. Nazaire.—The returns of imports issued by the Nantes and St. Nazaire customs are misleading as far as the imports consumed in this district are concerned.

Owing to the fact that there is no direct line of boats from any port in this region to the United States, nearly all American products are entered either at Havre, Marseilles, or Bordeaux or else come, in many instances, as goods of German, Belgian, or British origin, from Hamburg, Liverpool, and Antwerp. For example, the statistics would make it appear that almost none of the canned meat imported at Nantes comes from the United States, but that virtually all of it is imported from England. The fact is that nearly all this canned meat is of American origin, but it reaches France *via* Liverpool. This observation, indeed, may be generally applied to all American products sold in this region, only a very small percentage being imported directly from the United States.—Benj. H. Ridgley, Consul, Nantes, France.

American Trotting Horses Wanted in Germany.—An inquiry has been made at this consulate for the address of some reliable parties in the United States from whom thoroughbred trotting horses can be purchased for breeding purposes. I understand that animals of good pedigree and speed records—about 2:30—are desired. Two stallions and two mares at least would be required. This inquiry is made by a large manufacturer and merchant of this city for the purpose of raising stock on his estate near Breslau. Communications may be addressed to him as follows: R. Dorndorf, Breslau, XVII., Germany.—Ernest A. Man, Consul at Breslau, Germany.

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Other Reports can be obtained by applying to the Department of Commerce and Labor, Washington, D. C.

SCIENCE NOTES.

The greatest depth from which the "Albatross" has secured any life was 4,173 fathoms. This was in the South Pacific between Tonga and Ellice Islands. The dredge brought up silicious sponges, radiolarians, and brown volcanic mud. The greatest depth from which she has brought up fishes is 2,949 fathoms, or about 3 1-3 miles. This was in the edge of the Gulf Stream off the coast of Virginia. The deepest sounding ever made by the "Albatross" was at Station 4,010, near Guam, where the enormous depth of 4,813 fathoms, or nearly 5½ miles was found.—From the National Geographic Magazine.

Several English explorers have before now taken an interest in ancient Ephesus. According to the American Architect, Pococke prepared a plan of the city which proved that the walls were about four miles in circuit. They were roughly built, but cased with cut stone and defended by towers. The Dilettanti Society's work, "The Antiquities of Iona," contains views and plans of many of the buildings, including the gymnasium, the circus, temples, etc. It will be remembered that the city possessed the great temple which Herostratus set in flames in order to secure a record of his name with remote posterity. The Archæological Institute of Vienna has of late years made Ephesus the scene of operations. Its representative, Prof. Berndorff, has purchased a large tract of ground near the harbor for the purpose of excavations. By means of the last season's excavations the remains of the theater are now open to view. The unearthing of some streets which belonged to Roman Ephesus has also been accomplished, and evidence is forthcoming that in the fourth century of our era there was a systematic lighting of the thoroughfares of that part of the city. Numerous new inscriptions in Greek have been obtained. In the excavations which are about to be resumed, it is anticipated that ruins of private houses will become visible.

The Japanese Imperial Earthquake Investigation Committee has recently published a highly interesting pamphlet by one of its members, Mr. F. Omori. This pamphlet is entitled "Application of Seismographs to the Measurement of the Vibration of Railway Carriages." It is with only a moderate degree of surprise that the public will learn of the value of instruments designed to measure earthquakes, for determining the vibrations of railway cars. Most of us have held the opinion that the jolts and shakes felt in railway traveling were perhaps somewhat mental, as well as physical, and the fact that we expected to be shaken about may have produced those sensations to a certain extent. Now this Japanese scientist tells us that the sensations are very real, after all, and that the instrument that detects the tremor of earthquakes is also useful in measuring those untrammeled leaps of the dining car, which guide the fork of the unwary traveler into his eye and deposit his coffee equally over his chin and necktie. With the aid of his earthquake instruments, Mr. Omori has examined the vibrations in different classes of rolling stock on several lines of railway in different physical conditions. His results are given in great detail, with several plates and many tables, and probably form the first scientific investigation on a large scale of a subject which is of immediate importance to car builders and traffic officials the world over. The pamphlet can doubtless be obtained from the committee, which has its offices in Tokyo.—Engineering Record.

For some years past Russians have been pushing their surveys over the vast territory of Siberia, and especially through the large areas that have been almost unknown. The results of these years of labor have taken the shape of atlas sheets executed in the best cartographic style, according to the New York Sun. The new addition to the most famous of German atlases has just appeared, with a map of Siberia in two sheets on a scale that is nearly three times as large as its earlier map of the country. The larger scale is rendered necessary by the great and detailed accumulation of accurate geographic facts. The smaller maps sufficed as long as the surveys were less complete; but their day has passed in an atlas which pretends to depict what is really known of Siberia.

The future map of Siberia will be the result of still more detailed surveys; but the new map, as it is, is a revelation. For the first time we see the great swamp region of northwest Siberia which covers most of the government of Tobolsk and the northern part of Tomsk; and it is presented not only in outline but also in its interior ramifications. We see also that the whole of western Siberia, south of the swamps, is a region of many hundreds of lakes, large numbers of them so small that they can be shown only by dots of blue, while many of the larger lakes were never found before on an atlas sheet. The aspect of mountainous eastern Siberia is completely changed on the new map, for it shows the scores of mountain ranges with their valleys and spurs and transverse ranges. We see the sources of the rivers, can trace all the water divides, and observe the slope of all parts of the country. Thousands of miles of rivers are mapped for the first time. No earlier maps have been able to show any but the most prominent water partings of the drainage system of Siberia.

A competent geographer with this new map before him can write a clearer and more accurate account of the topography of Siberia than he can derive from any of the existing books. These two atlas sheets in the latest edition of the Stieler Hand-Atlas are worthy of mention as a new and valuable facility in the study of the whole of north Asia.

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