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(9292) S. N. S. asks: Suppose one is using 1 kilowatt of electricity to heat a room; about how many pounds of anthracite coal per hour, burned in an ordinary stove, would it take to produce the same amount of heat? A. The perfect combustion of 0.235 pound carbon will produce 1 kilowatt hour of electrical energy. This is theoretical. No figure of value can be given for "anthracite burned in an ordinary stove" since there are all sorts of coal and all sorts of stoves. Authorities differ, but 16 per cent is a liberal allowance for the heating value of coal burned in an ordinary stove, and this would make the quantity of coal required about $1\frac{1}{2}$ pounds per kilowatt hour.

(9293) E. P. asks: Can you through the columns of your valuable journal give an idea of how to sharpen the points of diamond drills, that is to say, very small drills of about 1-16-inch diameter, and how they are turned up true? We have a great many drills in operation and often one or more get dull and the delay of sending them away will pay the firm to put in apparatus for doing the work, and if I had only an idea of how done would soon experiment. A. For putting a cutting edge on small diamond drills, you will need a small soft steel lap, about five inches diameter, run at about 200 revolutions per minute. The face of the lap to be fed occasionally with a small portion of diamond dust in oil. Use but little oil to prevent waste, hold the drill to the lap lightly, as in grinding on an emery wheel.

(9294) J. S. C. asks: 1. How many pounds of compressed air could be put in a small brass tank 1-16 inch thick, 6 inches long, 3 inches wide, 3 inches high, soldered with silver solder? A. If the tank is strong enough to bear 75 pounds pressure per square inch, you can put in six volumes of air weighing 23-100 of an ounce. 2. What is the formula for determining the amount of pounds? A. Thirteen cubic feet of air weighs 1 pound. The capacity of the box is 54 cubic inches or 1-32 of a cubic foot × 6 volumes = 6-32 cubic foot ÷ 13 = 6-416 × 16 ounces = 6-26 ounce or 0.23 of an ounce. 3. If I should put a safety valve on the above tank what would have to be the length of the lever, how far from the end would fulcrum have to be placed, how far from the fulcrum would weight have to be placed, and what should be the weight? Give formula. A. The size of safety valve need be no more than ⅜ inch diameter made by the formula:

$$P = \frac{Wl + wg + Vl}{Al} \text{ in which}$$

P = air pressure per square inch.
W = weight of ball.
w = weight of lever.
g = distance between fulcrum and ball.
V = weight of valve and spindle.
l = distance between valve center and fulcrum.
A = area of valve.
All in inches.

(9295) M. N. H. asks: Would thank you to let me know if there is any substance ⅛ inch thick or thinner that will insulate the power of a magnet: in other words, is there anything against which magnets can be placed that will prevent the magnets from being attracted toward each other if you would place a magnet on each side of a thin sheet of same? Any information you can give me on the subject will be very thankfully received. A. There is no substance which can prevent two magnets from attracting each other when placed between the two magnets. Iron is the only screen for magnetism and that because it offers an easier path for magnetism than air offers. If two magnets were placed on opposite sides of a plate of iron each would convert the iron into a magnet and both would adhere firmly to it. This is not what we understand you to be in search of.

(9296) J. W. K. asks: 1. What causes the phenomena known as Fata Morgana? A. The Fata Morgana is the name by which the mirage was known. It is an optical illusion produced by unequal heating of the air near the surface of the earth and above it. The rays of light are bent by refraction, so that the angle of refraction finally becomes larger than the critical angle and the light is totally reflected, changing its direction so as to make it enter the eye as if coming from a very different direction from the real direction of the object. Many textbooks of physics give illustrations of this. You can find it in Ganot, which we can send you for $5. 2. What causes the Aurora Borealis? A. It is generally accepted by scientific men that the aurora is due to the passage of electric currents through the upper air, where the density of the air is about the same as in a Geissler tube. 3. What caused the dark day on May 19, 1780 A. We do not know what caused the dark day, but believe that it was no different from the days now when it is necessary to light lamps at midday. The cause of the dark days at present is dust in the upper air. The use of soft coal produces this in some places, forest fires in others, and volcanoes in others.

(9297) J. S. P. says: A glue factory and brewery are located within one hundred yards of each other. The glue factory manufactures a first-class, almost odorless, glue from beef hide stock carefully prepared and purified in quicklime water. The vapor generated during the boiling process passes out through openings in the roof of the glue factory as high as the brewery. Is it probable that the odor from the manufacture of glue would in any way affect the quality of the beer made in the said brewery? Would the odor above referred to have a tendency to cause the beer made in the above-mentioned brewery to become what is known as "ropy beer"? A. At the distance of one hundred yards and height of the ventilators of the glue-boiling vats, in a calm, or the wind blowing the vapors away from the brewery, there should be no odor from the glue factory, and no harm done to the beer in any condition of its manufacture. The only possible harm may come with a strong wind blowing from the glue factory directly across the brewery, bringing a strong odor to the mash or mixing tubs, in which case there is probably an absorption of the odor by the cold liquids, but not by hot liquids, as the vapor discharged while the liquids are warm or boiling repels the odor. In the fermenting cellars, the carbonic acid gas being heavy and lying on the top of the beer, should repel any odor that might reach the cellars, and prevent its absorption by the beer. In drawing off the cold beer, there is a possibility of its absorbing the glue odor when very strong to a slight extent, but we think not enough to affect the taste or natural odor of the beer. Still, we think for sanitary reasons that glue factories and breweries should not be near neighbors, for odors are odious.

(9298) W. S. G. asks: 1. Is there any difference between a square foot and a foot square? A. There is no difference between a square foot and a foot square, if the square foot is a foot square; nor is there any difference in the measure of surface, if the square foot is of any other shape than a foot square. So that the term *foot square* is not proper for any surface of a square foot that is not a rectangle of 12 inches on each of its four sides. 2. Is a square foot and a cubic foot the same? A. A cubic foot may be a foot square on each of its six rectangular faces, or it may mean the volume of any form equal to a cubic foot of 1,728 cubic inches.

(9299) G. A. B. asks: Exactly how is the temperature of liquid air measured? How is the displacement of vessels calculated? A. The temperature of liquid air and other low temperature is measured by either a hydrogen thermometer or by a platinum resistance thermometer. The hydrogen thermometer employs the expansion and contraction of that gas as a measure of temperature. The platinum resistance thermometer employs a coil of platinum and a Wheatstone's bridge. The resistance of the platinum coil is determined with accuracy at many points along the scale of temperature, and by means of a curve its resistance can be plotted so as to be an indicator of the temperature corresponding to any resistance. This is explained in Sloane's "Liquid Air," which we can s nd you for $2.50 postpaid.

(9300) A. J. P. asks: 1. Miller's "American Telephone Practice," page 299, says: "The high retardation of the ringer magnets is obtained by winding them to a high resistance with a *comparatively coarse wire*; so as to obtain a large number of turns in the winding." Is not "comparatively coarse wire" meant for fine wire? High resistance would be obtained with fine wire, and not with a coarse one. If he uses a coarse wire, he will not be able to obtain a large number of turns without increasing excessively the size of the coils, and therefore not obtain the result looked for. A. There seems to be no reason to suppose that Miller, in the paragraph referred to, failed to say what he meant. The "comparatively coarse wire" is really a fine wire after all. In the example given, the coarse wire is No. 33 single magnet wire, as against No. 38 used by other makers. The use of the coarser No. 33 allows many more turns with the same resistance, and so a much greater retardation by self-induction, not by ohmic resistance, as you seem to suppose. In the same paragraph, Miller says, "Resistance in itself is not the thing desired, but a great number of turns in the winding." Resistance is the incidental result, but the effect desired is not produced by the resistance. 2. I understand that the ocean cables are operated with a very small current compared to the current used on the telegraph lines. Is this due to the induction, static or magnetic? And what law applies to it? Please give the formula to determine it, if it is, as I understand, due to the induction, the waves getting bigger as the distance increases. Is it right that if a strong current was used on a cable, the distance being great, say from Europe to America, the induction produced in the conductors of the cable would be so great as to destroy the current before it had reached the end of the cable, and would cause a retrograde current to flow back to the starting point. A. An ocean cable is a Leyden jar. Its static capacity is great. No signal can be received at its remote end till the charge sent in has risen sufficiently to work the instruments. This requires an appreciable time. A second signal cannot be sent till the cable has discharged and been recharged as before. This demands that very sensitive apparatus be used. A very good presentation of this may be found in Thompson's "Elementary Lessons," which we can send you for $1.50.

(9301) G. H. G. asks: 1. Is the typhoid germ an animal or vegetable organism? A. The germ of typhoid fever is a vegetable, as are the germs of all such diseases. All bacteria or bacilli are plants, and not animals. 2. In their course around the sun, the planets Venus and Mercury keep the same side to the sun all the time. Is this because they are so near to the sun that its attraction is so great as to prevent a daily axial revolution? And would our moon, if it were far enough away from the earth, have a similar axial revolution as our earth has? A. If the planets Mercury and Venus keep the same face toward the sun, it is because the strong attractive force of the sun in early times, when planets were soft and plastic, raised tides upon them of such size that these tides reduced the velocity of rotation of the planets, and brought them to rest with reference to the central body. This is George Darwin's theory of tidal evolutions, as it is called, which may be found in all modern textbooks of astronomy. It is used to account for the similar motion of our moon. 3. Is the planet Neptune visible to the naked eye at any time? A. The planet Neptune is not visible to the naked eye.

(9302) J. M. D. asks: 1. When two persons are conversing over the line, and a third party takes down his receiver to listen, is there any instrument or some other way of finding out at what instrument the receiver was taken down? If so, what arrangements would have to be made to do so? A. We do not know of any way of telling when a person has "sneaked in" on a telephone circuit already in use for the purpose of listening to what is being said. One of the systems of "selective signaling" would enable one to call a particular telephone on a line having only a limited number of instruments. You can obtain information regarding these by writing to the dealers who supply you with the outfits for your lines. 2. What kind of an instrument is best to use to find out a fault on a line, for instance a broken wire, or where it might be grounded or the line wires tangled, to designate the place where the trouble is without going over the whole line? A. Faults and grounds are located by capacity and other tests, which require galvanometers, condensers, and testing instruments. You will find the processes described with the necessary formulas in Miller's "Telephone Practice," which we can send you for $3. 3. For crossing or bridging the line wires so as to stop the noise on a line, as the line may be quiet on one place, and a few poles further off it may be very noisy, should the wires be bridged where the line is quiet, or on the poles where there is most noise? We have two wires, on cross-arms 30 inches long, and about 10 miles long. How often should the wires be bridged? A. The prevention of inductive disturbances upon a telephone line is secured by crossing the wires over and under at regular intervals, so that the wires in effect are twisted slowly around each other throughout the whole length of the line. The long-distance lines are thus transported at intervals of a quarter mile, in a systematic manner which is shown by a diagram in the book referred to above. 4. How can you find out when the dry batteries need repairing? A. A dry cell needs renewing when its voltage falls below one volt. The only way in which this can be measured is by some one of the battery tested, unless you have a good voltmeter, which is the best instrument to use for such purpose.

(9303) F. F. H. asks. Would you kindly inform me on the following questions: In what position must the carbons of an arc lamp be so as to give the greatest amount of light? How much light will be emitted when the carbons are at an angle of 90 deg., and in which direction will the light be thrown? A. If an arc lamp is to be used in lighting the space below and all around the lamp, as in the street, it is best to place the positive carbon directly above the negative, the centers of the carbons in the same vertical line. If, however, the light is to be projected in some particular direction, it is better to point the positive carbon in the desired direction while the negative carbon stands at an angle with the positive carbon, so as not to cut off any of the light from the positive carbon. They may stand at an angle of even 90 deg. The light will then be projected nearly in the direction of the positive carbon, and nearly all the light will be available. This arrangement is frequently adopted in the stereopticon, where the light is only wanted in the direction of the screen.

Science Notes.

Benzine is often adulterated with petroleum oil, in which case it gives off a disagreeable and persistent odor. A method of recognizing the fraud consists in placing a small piece of pitch in the suspected benzine, which, when the benzine is adulterated, will soon be dissolved, but will color the liquid less on account of the presence of the petroleum oil. To judge with certainty, it is well to examine the benzine by comparison with a type of standard purity (benzol). Benzine can be distinguished from benzol in the following way: Benzine is colored violet by a crystal of potassium iodide, while benzol is colored carmine. If to two cubic centimeters of benzine three or four drops of a clear ether solution of sandarac (1 to 10) are added, a persistent cloudiness is produced in the benzine, while with benzol, treated in the same way, the cloudiness will soon pass away. Finally, if the benzol is shaken with a drop of alcohol, it will become clouded, while the benzine will remain clear. To deprive the benzine of its characteristic odor, it is sufficient to let it fall drop by drop into a vessel containing sulphuric acid, which is fitted with an abducent tube carrying the benzine in the form of vapor to a receiver, in which it is condensed as a liquid having the odor of honey. The temperature of the mixture of sulphuric acid and benzine ought to be carried to about 150 deg.

Prof. Henri Dufour has drawn up a comparison between the reports of four European meteorological stations—Lausanne, in Switzerland; Heidelberg and Freiburg; and Valencia, in Spain—upon the summer weather of 1903. Their data, taken independently, agree at all points. The sun's warmth from December, 1902, to July and the first half of August, 1903, has undoubtedly been terribly below the average; but some consolation is supplied by the forecasts of Prof. Dufour, with which the Lausanne meteorologist, E. Bahrer, also agrees, that signs are exhibited of a return of normal weather. The cold and the rains of the last summer were not the product of any decline in the power of the sun, as some have fearfully conjectured. "There is no symptom whatever," says the professor, "of any universal cosmic change; the increase of cold or wet is a temporary accident. We have been affected by a phenomenon which is demonstrably partial and limited in time and space."

The principal results of a discussion in the Annals of Harvard College Observatory (vol. xviii., No. 5) are summarized below. The logarithm of the number of stars brighter than a given magnitude is equal to a constant multiplied by the magnitude plus a second constant. On theoretical grounds we should expect that on any reasonable hypothesis the value of the first constant would be 0.60. Its actual value for bright stars is about 0.52, gradually diminishing to 0.46 for stars of the eighth magnitude, and to 0.35 for stars of the twelfth magnitude. An absorbing medium in space, although probable on other grounds, still requires a coefficient of 0.60 for bright stars, and does not account for the observed values. The coefficient is the same in and out of the Milky Way. Accordingly, the distribution of stars in both these regions is identical, or the proportion of stars of any given magnitude is the same. The number of stars for a given area in the Milky Way is about twice as great as in other regions, and this ratio does not increase for faint stars down to the twelfth magnitude. The Milky Way covers about a third of the sky and contains about half of the stars. There is no evidence of a limit to the faintness of stars, although the proportionate increase in number becomes less for each successive magnitude.

A solid fat has been obtained from cocoanut for some years, which has been used in the most varied manner in the preparation of foods. This fat is being expressed in large amounts, especially in Marseilles, where it is placed on the market under the name of "Vegetaline," while in Germany it has become known for kitchen use under the name of "Palmin." Recently a French firm has undertaken to produce this fat at the place where the nuts are grown, in India, and has placed its product on the market under the name of "Cocotine." This is a pale-yellow, fluid fat that assumes the consistency of butter when put into cold water, and is both tasteless and odorless. Cocotine has the advantage of not becoming rancid and of not losing its fresh and mild taste for months even if exposed to the air. The production of this fat in Marseilles amounts to six hundred barrels monthly. It could be employed as substitute for lard and for petrolatum in pharmaceutical practice. A vegetable fat called "nucoline" is very similar to cocotine.—Pharmaceutische Centralhalle.

Dr. Ramsden, of the Royal Society of Great Britain, has been carrying out a series of experiments in connection with the surface tension of liquids. If a vessel containing water be closely examined, a thin skin or membrane will be observed floating upon the surface. Although apparently substantial, the skin cannot be detached from the water. In the case of sticky liquids, however, by skillful manipulation this membrane can be detached, which action demonstrates the fact that the skin has a separate existence, and is not, as it were, an inherent part of the liquid. In the course of his experiments, Dr. Ramsden placed a number of candle ends in a vessel of water. They were observed to assume a position of symmetry without any extraneous assistance. When, however, the candles were inserted in a liquid which was slightly sticky, they remained in exactly the same positions in which they were placed, proving the existence of some opposing force which prevented the candle ends from adjusting themselves. This force was clearly the surface membrane on the liquid. Dr. Ramsden's next experiment was still further interesting. He blew a number of bubbles in the liquid, and then deflated them by suction. The bubbles, however, did not entirely disappear, but left behind them secondary bubbles, the extraordinary point of which was that they were not spherical or oviform in shape, but assumed the form of inverted cones. Such formation is impossible without the assistance of a solid. Dr. Ramsden pointed out the fact that on the surfaces of all limpid solutions, which can produce bubbles, there is this thin albeit solid skin, and he demonstrated by mechanical effort that it is possible to heap these membranes together in such a manner as to cause them to form opaque solid masses. These masses can be separated from solutions of one in one million parts.

Radium has still another curiosity to number among its remarkable phenomena. In the Electrician it is chronicled that Mr. E. Dorn inclosed 30 milligrammes of Buchler's strongest radium bromide in a tube of Jena glass free from alkali and 6 centimeters long. This was done last December. At the end of May he wanted to open the tube. Just as he was applying a three-cornered file, and had only slightly scratched the surface, the glass was pierced by an electric spark with an audible noise. The phenomenon may be explained by supposing that the negative electrons had escaped through the walls of the tube, which were 0.3 millimeter thick, and a positive charge remained. Negative ions would then accumulate on the outer surface of the tube, and this accumulation would be facilitated by the ionization of the air around. Since the author held the tube in his left hand and the file in his right, the discharge was rendered possible. But it is remarkable that a difference of potential capable of puncturing at least 0.2 millimeter of glass should have been produced.

ROTARY ENGINES.—ARTICLES ON this type of engine, giving many details and illustrations, are contained in SUPPLEMENT Nos. 1158, 1186, 1193 and 1309. Price 10 cents each. For sale by Munn & Co. and all newsdealers.

SHOE BLACKING.—FORMULAS FOR liquid and solid blacking are given in SUPPLEMENT Nos. 1213 and 1239. Price 10 cents each. For sale by Munn & Co. and all newsdealers

Engineering Notes.

After certain tests of abrasive wheels made at Sibley College, the metal removed was micro-photographed. The photographs, it is said, show that the metal removed by emery wheels is in the form of minute globules; that from carborundum wheels is in the shape of chips or shavings. This seems to show that an emery wheel "grinds" or wears the metal off, while the carborundum wheel cuts it off in a manner much the same as a milling cutter. This is an important distinction. It not only indicates that the carborundum wheel should be the most efficient in metal removed for the same power, but that heating should be much less, since it is cut off instead of being abraded by friction. The wheel that heats the least, other things being equal, should give the most accurate work.

According to careful experiments made by Prof. S. P. Thompson, a square foot of uncovered steam-pipe filled with the vapor of 100-pound pressure will radiate and dissipate in a year the heat put into 3,716 pounds of steam by the economic combustion of 398 pounds of average coal. Thus, 10 square feet of bare pipe corresponds approximately to the waste of two tons of coal per annum. Another experimenter, testing the various materials employed for wrapping, concludes that the saving in condensation effected with the best form of mica covering is nearly 88 per cent—that is, calling the loss of heat with bare pipes 100, the loss when wrapped with mica-packing would be 12. Asbestos covering seems to be considerably inferior to mica, and cements less desirable than either.

Some twelve months ago a motor schooner, the "Sirra," was constructed at Rotterdam, with the propelling engine consisting of a 50-horsepower gasoline motor. The vessel was constructed as an experiment to ascertain the feasibility of adapting this class of engine to small vessels. The craft has only been employed during this period for coasting purposes, but it recently completed with conspicuous success its first sea voyage from St. Petersburg to Dundee, Scotland, with a freight of oilcake. The "Sirra" is the first gasoline-motor-propelled vessel to undertake a sea voyage. The most prominent features of this type of craft are the small space occupied by the machinery, the absence of coal bunkers, which consequently renders greater space available for freight, and a clearer atmosphere on board. During the twelve months no mishap or breakdown, except of a temporary minor character, has been encountered, so that new possibilities appear to be available for the gasoline engine.

The engineers of both the elevated and subway lines in operation or in the course of construction are very much concerned about the matter of the noise made by the moving trains. No end of experiments have been made with a view of suppressing the din, but with very little success. The latest suggestion to be tried with this object in view has been that of ballasting an elevated structure with broken stone, much the same as the more important surface lines have been treated, in the effort to secure a perfect roadbed. For a stretch of about three train lengths on the circuit between Rowe's Wharf and Congress Street, Boston, the sleepers have been boarded up from the under side, and the rails raised about four inches, and the spaces filled to the level of the tracks with rock ballast. It is the first time in the history of railroading that the well-known principle of rock-ballasting has been applied to an elevated structure. The stone has not been in place long enough to warrant any decision, but on account of the great expense which would be entailed by its general adoption, the whole line will not be so treated unless its advantages are shown to be very great.

The economy in floor space possible with steam turbines is illustrated by the fact that turbo-generators of the Parsons type, rated at 5,500 to 8,280 kilowatts, occupy a space measuring only 51¾ feet by 14 feet by 12 feet. A 6,500-kilowatt turbo-generating set is being built by Brown, Boveri & Co., which measures 59 feet by 10 feet by 10 feet. A Curtis turbine of 5,000 kilowatts is running in Chicago; this is a combination of the Parsons and De Laval systems, and is arranged with a vertical shaft. In shape it is cylindrical, and, including turbine and generator, stands 25 feet high with a diameter of 14 feet. It may be interesting to note that there are over 500,000 horse power of turbines in use or on order, and twenty-four stations in this country use the turbine more or less.

It is known that when a cylindrical rod is struck by an approximately axial blow, the particles of the rod perform in general elliptic vibrations, the axes of which vary in direction at different points, and it was one of the objects of a study reported in the Abhandlungen of the Bavarian Academy to find how far a gun-barrel behaved in the same manner. A number of military Mauser rifles were furnished with projecting wires, and the motions of their shadows, thrown on a screen by a lens, were photographically recorded side by side with a tuning-fork trace. It was thus found that the vibrations are in general of an elliptic character, and consist of a fundamental and overtones. The periods of vibration of the prime and first two overtones are of the order 0.04, 0.008, and 0.002 of a second. It was arranged that the instant of the bullet leaving the muzzle should be shown by a white dot on the photograph. The diagrams given show that in one case (that for a 6-millimeter Mauser rifle) the bullet is clear of the barrel before any deflection due to vibration has occurred. This is obviously an important practical result.

The Paris Municipal Committee, appointed to investigate the recent tunnel disaster on the Metropolitan Railroad, has made its report, indicating the reforms which should be immediately made in the underground railroad system of Paris. The principal proposals are that the present system of a motor car at each end of the train should be suppressed; the motor cars must be capable of isolation from the train; in case of the slightest fire, the train must be stopped and the motor cars isolated; telephones and speaking tubes must be provided at reasonable intervals along the line; the number of employes at the stations must be increased; the platforms must be cleared of every obstruction and lighted by an electric current, independent of the currents supplying the traction or the lighting of the tunnels; and numerous lamps must be placed to indicate the direction of the exit. The report states that it is proposed to insist that later on incombustible rolling stock be used and that refuges be constructed in the tunnel walls.

With the bad waters in the Southwest and under the necessity of providing engines enough for the trains, an effort is being made to extend the life of firebox sheets by removing in every possible way all unnecessary thicknesses of metal between the fire and the water. In this connection crown bolts with large heads are giving place to crown stays resembling stay bolts having taper threads in the crown sheet and riveted over like stay bolts. On a number of roads opinion favors wider mud rings with 5-inch water spaces at the bottom of the water leg. There is also a tendency toward widening the spaces between tubes, making 1-inch bridges instead of the narrower spaces now prevalent. Several roads are now experimenting in this direction. They are prepared to sacrifice some tube heating surface for the sake of securing more water space around each tube in the hope of reducing the amount of tube leakage.