series of small pipes into the current of water that is circulated through the tanks, particularly if at some point the current be sent through a single pipe of quite small diameter, so that the current will have a considerable velocity. By curving the ends or nozzles of the small air pipes so that they will lie in the direction of flow of the current, air would be drawn in, and would of course mingle with the water flowing through the tank. We make this as a suggestion simply.

(12042) H. A. E. asks: Will you please tell me the meaning of gage in wire and sheet metal, as 14 gage, 22 gage, etc.? Also the meaning of 10 ounces, 14 ounces, 20 ounces, etc., in regard to sheet copper? A. There is in this country no uniform or standard gage, the same numbers representing different thicknesses of wire or plate in different gages, of which the commonest are the American or Brown & Sharpe (B. & S.), the Roebling or Washburn & Moen, the Birmingham (B.W.G.), and the British Imperial Standard. In 1893 a United States standard gage for iron and steel was established by act of Congress, based on the fact that a cubic foot of iron weighs 480 pounds, a sheet 1 foot square and an inch thick weighing 40 pounds, or 640 ounces, so that a sheet of that size weighing one ounce should be 1/640 of an inch thick, the distinguishing numbers representing a certain number of ounces in weight per square foot and the same number of 640ths of an inch in thickness. Unfortunately, however, there is only an arbitrary relation between the gage numbers and the thicknesses; thus, No. 16 gage sheet weighs 40 ounces to the foot and is 40/640 thick, which happens to be 1/16, but No. 5 gage weighs 140 ounces to the square foot and is 140/640 or 7/32 inch thick, which has no relation to 5, and No. 31 gage, 7 ounces to the foot and 7/640 thick, has no relation to 31. This well-intended measure only added to the existing confusion, although it differs but little from previously existing gages, as shown by the following figures, the thickness of a sheet or wire corresponding to the same number by the different gages being shown in decimals of an inch.

Gage.	B.W.G.	B. & S.	Roebling.	British.	U. S. Standard.
1	0.3	0.289	0.283	0.3	0.281
3	0.259	0.229	0.244	0.252	0.25
9	0.148	0.114	0.148	0.144	0.156
20	0.035	0.031	0.035	0.036	0.037

A joint committee of the American Society of Mechanical Engineers and the Railway Master Mechanics' Association recommends, as a remedy to the existing confusion, the adoption of a decimal gage in which "0.25 gage" can mean nothing but a thickness of 25/1,00 or 1/4 of an inch, and "0.06 gage" nothing but 6/1,00. of an inch, or 1/16 nearly. This has already been adopted by many manufacturers.

(12043) J. S. asks: Is it possible for the temperature to be twice, or any number of times, as warm or cold as any specified degree of temperature? Can this be measured or computed? For instance, how cold is twice as cold as 0 deg. F.? A. In terms of degrees of the Fahrenheit or any other scale, reckoning from the zero point, the question has no answer and no meaning whatever. Degrees of the scale of any thermometer are not to be compared by multiplication or division, excepting those of the absolute scale. This is reckoned from the absolute zero, which is 459 deg. below the Fahrenheit zero. Half as hot as 0 deg. is then — 229.5 deg. absolute F.

(12044) A. T. G. A. writes: In your issue of October 3rd, 1908, T. B., No. 10867, asks why the days and nights are not equal on the days the sun crosses the celestial equator. I have for many years been impressed with the care, patience, and directness of your answers to the many inquiries. It has been the most interesting column of the paper to me. In this one particular case, however, may I suggest you do not include the main reason for the discrepancy? In some almanacs the time of sunrise and sunset is computed for the instant the first glimpse (or the last) of the sun's disk would be seen on the true horizon. Allowance is made for the semi-diameter of the sun and for the refraction of the atmosphere. This would cause the sun to appear a few minutes earlier in the morning and to be seen a few minutes longer in the evening, making the day (sometimes) 8 or 9 minutes longer than it would otherwise be. When this happens during the time of lengthening days (as in March) it would cause the equal days and nights to come earlier, and to come later in September. The matter of semi-diameter and refraction is not taken into account by all almanac computers, some giving the moment when the center of the sun would be on the horizon if there were no atmosphere. In such almanacs the equal days and nights come exactly on the days of spring and autumnal equinox, but only theoretically so. The equation of time would have the effect only of transferring the time of both sunrise and sunset earlier or later, as the case might be, and so would have no effect upon the length of the time of daylight. There would, of course, be a slight effect due to the change in the equation of time between sunrise and sunset, but that would scarcely amount to as much as one minute. Pardon my "butting in" in this matter. My appreciation of the uniform accuracy of your answers in all other cases causes me to feel you will understand the spirit in which this correction is sent. A. We appreciate the substance as well as the spirit of the correction. Our readers will find this matter fully discussed in Todd's New Astronomy, under the topic "Sunrise and Sunset." We send the book for $1.50 postpaid. An almanac should give the moment when the last ray of the sun is seen on the horizon as the time of sunset, and the first ray as the time of sunrise. What all almanacs do give we are not able to say.

(12045) S. B. asks: Will you kindly inform me through the columns of the SCIENTIFIC AMERICAN what the corrosive and electrical resistance of aluminium is, as compared to brass, copper, and tin? A. The specific electrical resistance of the metals you name is as follows: Aluminium 2.98, copper 1.59, tin 13.1, and brass, containing 66 parts copper and 34 parts tin, is 6.3. If you wish to have the data more exactly, we would refer you to Foster's "Electrical Engineer's Pocket Book," pages 134 to 140. We send the book for $5. If by "corrosive resistance" you mean the resistance to the action of acids, etc., we would say that aluminium is acted upon more slowly than any of the others by most chemicals, and tin would be placed next to aluminium, while copper would probably be acted upon more than brass for the above reason by most corrosive chemicals. No figures can be given for any general statement of this sort. Figures would differ for each chemical tested.

(12046) Dr. V. D. B. asks: Will you kindly let me know who was the first engineer that introduced structural steel in the construction of buildings? A. We should say that it would be most difficult, if possible, to answer your question positively. If you refer strictly to steel in the technical sense, its use must be comparatively modern, but the transition from iron to steel in buildings must have been as gradual as it is vaguely defined in manufacture of the metal. There are many iron bridges in Europe more than a century old, one of the oldest being that over the Severn, built in 1776. Possibly you do not use the term "buildings" in a sense to include bridges, but iron could hardly have been used for such a purpose long before its introduction in roof trusses for large spans. That use was commonplace before the introduction of railways, the earliest termini in Europe being so roofed, and we should say that the use of iron imbedded in or in conjunction with masonry would date back a century or more. An article in one of our early SUPPLEMENTS, May 12th, 1877, abstracted from a paper read before one of the engineering societies, refers to the imbedding of iron in masonry as "too old to be patented," even then, which means that it must be more than a century old.

(12047) L. E. B. says: There seems to be a common belief among barbers that a razor after much usage becomes tired. That is, the razor will not keep in condition with the care usually given it. After it is laid away to rest it seems to become all right again. If this is true, what are the causes, and is there any remedy besides the rest cure? A. The only scientific explanation of the benefit of "rest cure" for razors is that honing, and more particularly constant stropping, tend to increase the smoothness of the edge; and whereas this is an advantage within certain limits, the best cutting edge of a razor looks under a microscope like a saw, the better the steel and the edge the more regular the "teeth," and in correct shaving the operation is that of sawing and not slicing off the hairs. However carefully a razor may be dried before putting it away, a certain amount of oxidation takes place, and this in the case of a good razor of homogeneous steel should tend to deepen the "teeth," just as a barrel hoop with an edge one-eighth of an inch thick may by exposure to the weather become so sharpened as to saw wood. This natural process could probably be imitated more rapidly by the action of acids.

(12048) E. K. asks: Would you please inform me which wheels have the tendency to rise off the ground when an automobile is rounding a curve at high speed? The principle is the same on trains, carriages, and trolley cars, is it not? A. When an automobile or any other vehicle is turned sharply in one direction, its momentum tends to carry it straight on. If its speed is sufficient and its front wheels are turned sufficiently sharply, it will turn over on its right side in rounding a curve to the left, the left or inside wheels therefore leaving the ground first. This is readily demonstrated by the fact that the tendency to go straight on or turn over in railroad trains is corrected by the super-elevation of the *outer rail*, throwing the center of gravity nearer to the inner wheels, to keep them down and counteract their tendency to rise.

(12049) R. A. asks: Will you be so kind as to furnish the information as to what number of degrees Fahrenheit is required in the surrounding temperature to cause ice to melt? A. Ice begins to melt the moment the temperature of the surrounding atmosphere rises above 32 deg. F. The reason ice melts so slowly is that it requires more heat units (transferred from the surrounding atmosphere or somehow) to melt ice at 32 deg. to water at 32 deg. than it does to raise the same quantity of water through 1 deg. of temperature, on account of what is called the latent heat of fusion, but that does not affect the temperature at which fusion commences.

(12050) F. A. J. asks: In a SUPPLEMENT for May, 1908, you had a design for small alternating current motor, and I have found it very simple in all but one thing, which is the inductors for the rotor core plate. I do not quite understand if the No. 4 wire which you give for the inductors should be peeled of the entire insulation and laid in without insulation or with the insulation left on the wire. Kindly let me know which is the correct way. A. The inductors in the rotor of the motor of SUPPLEMENT No. 1688 are not made of insulated wire. The holes into which they are put are drilled with a drill 0.213 inch in diameter, and the No. 4 wire is 0.204 inch in diameter. There is no room for insulation unless, as the article says, thin paper is used and glued upon the wire. The wire is bare copper wire. If you refer us to a phrase in a long article like this, you should do so by page and column and part of column, so as to save our time in reading the entire article till we come to the part in question. It is a mistake to suppose that the editor knows all the articles which have been in the paper in all the past. He must find the matter of the inquiry and consider it before he can answer the inquiry. This often takes much time; and if correspondents can save us time they ought surely to do so, since our work is entirely in their interest and is not directly a source of profit to the editor or the paper.

(12051) B. B. M. asks: Will you please inform me what purpose the brushes serve in the Wimshurst electrical machine? That is, whether the brushes cause friction or act as inductors to carry the electricity. A. The rods with brushes at their ends upon the Wimshurst machine act by induction. Suppose a charge upon one of the tinfoil sectors acts inductively upon the sector of the other plate, which happens to be opposite it at the moment and in contact with one of the brushes. That sector and the brush in contact with it will become charged oppositely to the sector, which acts inductively upon it, and the other end of the rod, its brush, and the sector in contact with it will become charged similarly to the sector on the other plate. This action takes place upon each pair of opposite sectors of both plates as they rapidly pass each other. Thus the charge upon the sectors is rapidly built up. You will find a good description of the action of the influence machines in Carhart's "University Physics," vol. 2, which we can send you for $1.50.

(12052) R. H. T. asks: Can you tell me to what extent common water has ever been compressed? A. Pure water is compressed by a pressure of 15 pounds per square inch at the temperature of its freezing point 0.0000503 of its volume. The amount of its compression at various temperatures is given in a table in the book called "Smithsonian Physical Tables," page 83, to which we would refer you. It can doubtless be found in the library of the Polytechnic in your city.

(12053) M. M. asks: 1. Do you know of a London firm which offers a large sum to any one who will invent a method of dispelling fogs? A. We do not know any offer of a prize for a fog-dispelling device. The electrical apparatus of Sir Oliver Lodge has been entirely successful in dispelling fog over small areas, but the large first cost of equipment has prevented its general adoption for larger areas hitherto. 2. I have an idea on which I should like to have your opinion. If the X-ray will show objects through opaque flesh, why cannot it be made powerful enough to show objects through opaque fog? A. The statement that X-rays show opaque objects through the flesh is not quite correct. X-rays cast the shadows of bones, etc., upon a substance which the rays also cause to glow with light. These shadows are thus made visible by the light around them. The eyes are in the dark box of the fluoroscope, and do not see any object but the luminous fluorescent surface of the screen. People commonly say they see the bones, but they do not see anything but a shadow of a bone cast upon the screen. Our eyes cannot see X-rays. They do not affect the optice nerve, and do not excite the sense of vision in any manner whatever.

(12054) J. C. asks: I. If a disk of iron or steel be magnetized, how will the poles be located? The disk is 1/8 of an inch thick and 4 inches in diameter. A. If a steel disk is magnetized, drawing it over a magnet, its poles will be at the opposite ends of a diameter of the disk, near the edges of the disk. If it is magnetized by placing it flatwise between the opposite poles of a pair of magnets, it may be magnetized so that one face of the disk shall be north and the other will be south. 2. Also which will make the most powerful magnet—an iron or a steel disk? A. An iron disk cannot be made into a permanent magnet of any degree of strength. Only steel can be strongly magnetized permanently. 3. I suppose that in an ordinary compass the end of the needle which points north is the south pole of the magnetic needle of the compass. Is this correct? A. Do not confuse yourself about the names of the poles of magnets. In America it is well-nigh universal to call the end of a compass needle which points north, the north pole, and the end which points south, the south pole. This has nothing to do with the kind of magnetism which is resident in the poles; it simply tells the direction the ends of the needle assume when it comes to rest. We also name the ends of all the magnets in the same manner. A pole like the north end of a compass we call the north pole. 4. There is a power located in the north direction which attracts one end of the needle of the compass. Is there any such power located in the south direction which attracts the other end? A. The earth acts as if it were a huge magnet, with a pole in the northern hemisphere, and one of opposite nature in the southern hemisphere, as a general statement. It is impossible form a single magnet pole. The having of a positive pole involves the necessity of having an equal negative pole. One pole cannot exist alone, so far as we are able to control the matter on the earth. The nature of the magnetism in the north magnetic pole of the earth is the opposite of that of a compass needle which is directed toward the north on the earth. That is all it is necessary to say. If we call the north pole of a bar magnet or a compass needle plus, as we do call it, we must say that the magnetism of the earth is negative at its north pole, and positive at its south magnetic pole.

NEW BOOKS, ETC.

ACCURATE TOOL WORK. By C. L. Goodrich and F. A. Stanley. New York: Hill Publishing Company, 1908. Pp. 200; fully illustrated with photographs.

This work produced in the excellent style of the Hill Publishing Company, is conformable with the Hill Kink Books except in the matter of size and arranging the same sort of useful information more in the form of a continued treatise. The developments referred to in a preceding review have increased the importance of the tool-maker's art and also caused the application to many industrial machine shops in order to obtain interchangeability of parts the extreme accuracy, delicacy of finish, and the processes for obtaining them which were formerly used only in watchmaking. Jigs, master plates, and refined test indicators are more and more commonly used, and even the compound microscope with the adjustable cross-hairs arranged as a profile gage for screw threads. The uses of all of these are carefully described and the book, which is admirably illustrated with clear photographs and diagrams, should be as valuable to the practical man as it is interesting to the amateur, the development of these particular refinements having been so rapid that there is practically no literature on the subject. A chapter on trigonometry in the tool room assuages the fears of the non-mathematical workman by the claim that it contains neither equation nor Greek letter, and the practical nature of the work is assured by the fact that the first-named of the authors is a department foreman for the Pratt & Whitney Company.

MODERN POWER GAS PRODUCER PRACTICE AND APPLICATION. By Horace Allen. New York: D. Van Nostrand Company, 1908. Pp. 326; 136 illustrations. Price, $2.50.

The author's aim has been to describe the practical commercial types of products and their application so far as they have been developed while defining briefly the ruling principles of the gasification of fuel which govern design. The result is a compact and complete work of reference for the investigator and the practical operator of gas producer plants, if, perhaps, a little condensed at the expense of clearness in places for the interested amateur. Many of the economies shown by the substitutions of producer gas for steam plants in industrial works are very remarkable. The figures given for corresponding economies in weight and space occupied per horse-power for marine engines are not so large as some recent claims have contended, but in fuel economy alone, i. e., in the greater distance run for a given quantity of fuel, the results more than warrant the growing attention to this method of ship propulsion. The author gives a brief chemical analysis of fuel and gas necessary for intelligent study of the operation of gas plants and of the direct determination of the heating value of fuels by calorimeter tests. A useful chapter is also added describing briefly all the patents issued on producer gas accessories from which investigators can see in how far their work is overlapping that of others.

FREEHAND AND PERSPECTIVE DRAWING. By H. E. Everett and W. H. Lawrence. Chicago: American School of Correspondence, 1909. 8vo.; pp. 125; ill. Price, $1.

This volume, like the rest of the series of the Correspondence School, is intended especially for self-instruction and home study, and it appears on the whole to fulfill this requirement although its "foreword" applies rather obviously to the series in general rather than to this work in particular. The opening paragraphs on drawing, while beautifully put and in no way too technical, are probably a little beyond the depth of the class of students for which the correspondence school is primarily intended, but the instruction itself is perfectly clear and sound, and also has the merit of being original. The author of the first part has wisely adopted the freehand perspective exercises of A. R. Cross, which could hardly be improved upon. The explanations of perspective are as clear as possible to anyone who is familiar with descriptive geometry, but might perhaps have been expressed in terms a little simpler for the benefit of those who are not. To the careful student there is, however, in

this volume all the material necessary for the obtaining of a working knowledge of freehand and perspective drawing.

The Commercial Handbook of Canada. Heaton's Annual. Heaton's Agency, 1909. 12mo.; pp. 400. Price, $1.

Without an inch of wasted space and with no pretensions to being literary or entertaining, this volume makes its fifth annual appearance more complete than ever, packed with useful information from cover to cover and in the most condensed form consistent with clearness. It gives particulars of all branches of the public service, government officials, members of the Senate, House of Commons, and local legislatures, lists of banks and branches, insurance and trust companies, railway and steamship lines, patent and trade-mark regulations, regulations affecting foreign corporations, weights, measures, and money values and their corresponding values in the systems of all foreign countries. Nothing could be more complete than the information as to customs regulations and tariffs, and the proportionate imports and exports of all commodities, which should be invaluable to export merchants in the United States having dealings with Canada. The handbook also gives full but concise information compiled from official reports on agriculture, commerce, finance, fisheries, forests, manufactures, and mines, and a gazetteer of all towns of over 1,500 population, their existing industries, shipping facilities, power rates, and inducements offered to or especial opportunities for new industries.

The Flute and Flute-Playing in Acoustical, Technical, and Artistic Aspects. By Theobald Boehm. Translated and annotated by Dayton C. Miller, D.Sc. Cleveland: Published by Dayton C. Miller, 1908. Pp. 100. Price, $1.50.

While much has been written about the flute, the writings of Boehm, the inventor of the modern flute, are not well known; this is especially true of his second book, which is here presented. There is need, therefore, of this work, in which is given as complete a description as is possible of his flutes and instructions for handling them, and instructions upon the art of playing the flute with a pure tone and a good style. Boehm urged that an English translation be made, for "then all that I have done in sixty years will be known." For the present publication the translator has received the permission and hearty approval of Theobald Boehm and his sisters, of Munich, grandchildren of the inventor of the flute.

Mars as the Abode of Life. By Percival Lowell, New York: The Macmillan Company, 1908. 8vo.; pp. 288. Price, $2.50.

The Mars of Prof. Lowell is not as yet the Mars of most astronomers, partly because Prof. Lowell, unlike other astronomers, has devoted the better part of his life to a careful study of the ruddy planet, and is therefore a partisan specialist, and partly because his antagonists are not willing to accept his ingenious deductions. Prof. Lowell's argument is briefly this: Mars is a planet which is fast drying up. The only water there to be found is gathered at the poles in the form of ice and snow. If the planet be inhabited, the chief concern of the inhabitants must necessarily be to conduct this polar water to those arid regions which could be made to blossom if they were irrigated. Hence the "canals" which Prof. Schiaparelli originally discovered, and the number of which has grown astonishingly under Prof. Lowell's eye. Lowell's arguments in favor of the artificial origin of the canals are their remarkable straightness and the fact that they converge apparently with intention in well-defined spots. His theory stands or falls with the artificiality of the canals, and it is just here where most astronomers differ with him. His reasoning is reasoning by analogy, because he constantly compares the conditions on Mars with conditions on the earth. Whether or not Prof. Lowell's views be accepted, it must at least be said that they explain more simply than any other theory the phenomena of our nearest planetary neighbor. In spite of much adverse criticism, he has adhered unswervingly to his views. Prof. Lowell has a happy gift of presenting his discoveries in such an interesting way that even the skeptical critic must admire the skill with which he has prepared this book. The astronomical reader will find some sixty pages of notes of a mathematical nature, which will enlighten him on those phases of the subject that could not be discussed in the body of the work because of its popular character.

Handbuch für Heer und Flotte. Enzyklopädie der Kriegswissenschaften u. verwandter Gebiete. Unter Mitwirkung von zahlreichen Offizieren, Sanitätsoffizieren, Beamten, Gelehrten, Technikern herausgegeben von Georg von Alten, Generalleutenant z. D. Berlin und Leipzig: Deutsches Verlagshaus Bong & Co., 1909.

This is the first installment of what promises to be an excellent military and naval encyclopedia. Many of the standard works on military science are antiquated, for which reason an attempt to publish a book abreast of the times should meet with a favorable reception. From this first installment we judge that the complete work will discuss in alphabetical order subjects relating to the training and use of troops according to modern tactics, transportation and commissary facilities, military hygiene, military medicine, naval affairs, co-operation of army and navy, and the latest advances in military science in general. An admirable feature of the articles is the brief bibliographies by which they are concluded, and which render it possible for one to refer to original sources for more complete knowledge. Naturally, a very large portion of the work will be devoted to the technical advances that have been made in recent years. The history of the art of war will be discussed in illuminating articles. The "Hand Book" is to appear in nine volumes, of 900 pages all told, and is issued periodically.

Legal Notices

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