ing the crucible with a pair of tongs and plunging it into cold water, a process not without danger to the operator.

The effect of this sudden change in temperature was to cause the iron, which was heated to incandescence, to instantly contract and with such force that the particles of carbon held in suspension in the liquid mass were greatly increased in density, and having the brilliancy and other attributes of real diamonds.

Mr. Henry W. Fisher, chief engineer of the Standard Underground Cable Company, of New York city, has improved upon Moissan's method in many respects but especially in the manner in which the contents of the crucible are immersed in the cooling bath. Other improvements relate to the construction of the furnace and the means employed for obtaining a more intense and uniform heat, the details of which will be made clear by referring to the diagrams.

The furnace was made by attaching sheets of asbestos, 1, 1, above and below the table, 2; on top of the asbestos, fire brick, 3, 3, 3, 3, were placed and a lining of magnesite, 4, 4, formed the inner surface of the furnace. The crucible, 5, was made of Acheson graphite and so designed that a portion of it extended through the hood of the furnace and on through the table; 6 is a valve stem arranged so that it can be lifted and the incandescent mass in the crucible permitted to fall into a cooling bath immediately below. Graphite electrodes, 7, 7, are capped with brass conductors over the ends to facilitate the flow of the current; crushed coke is packed around the crucible and electrodes, this serving to retain a large percentage of heat that would otherwise be wasted.

In the diagram showing a top elevation of the furnace, where like figures are used to designate similar points, extending to either side of the powdered coke, 8, is the lining of finely-divided magnesite, 9, 9, which in this form does not conduct and dissipate much of the current when the furnace becomes excessively heated. This furnace is the outcome of several prior ones that Mr. Fisher had designed and built. The first one was of lime and similar to the one used by Moissan, and then furnaces of asbestos board were constructed and these were lined with blocks of magnesia, but not until he set up the one described above was a really satisfactory furnace obtained.

Since there were large heat losses due to the reduction of temperature from the instant the crucible was removed from the furnace until the contents were thrown into the cooling bath, the experimentalist devised several methods in which the matrix could be instantly dropped from the furnace into the cooling vessel below.

His first plan was to employ a cylinder of hollow graphite for a crucible and have the lower end of this rest on a graphite slab large enough to project beyond the furnace; when it was desired to discharge the mass in the crucible into the cooling bath the flat slab was pulled away and gravity did the rest.

The danger due to explosion by the sudden change of temperature when the matrix was cooled in water led the investigator to test the efficiency of other mediums as cooling agencies; in one a large lead casting having a hole of appropriate size drilled in the center formed the receptacle for the fluid mass; then a bath of solder was tried, but finally it was found that water gave the best results.

In one of the early trials at making diamonds when the pivoted drop door of asbestos was used to plunge the molten mass into the bath, the crucible holding it did not fall in a straight line, as had been intended, but precipitated the seething matrix into the bath in such a manner that it came in contact with the iron vessel containing it; instantly a bluish-white flame shot up like a heavy disruptive discharge, due, it is thought, to the rapid decomposition of the water, and the matrix then passed through the bottom of the iron pot, melting a large hole in it.

This accident led to further improvements so that the crucible could not depart from its predetermined course. It was subsequently found that the more rapidly the contents of the crucible were cooled, the greater the diamond-making qualities of the matrix, and when the cooling process took place very quickly little pieces that were broken off in the water from the principal mass contained diamonds, which was not the case with the large lump remaining in the crucible and which was partly insulated by it.

In one of the accompanying photographs is shown a reproduction of a microphotograph of the first diamonds produced by Mr. Fisher; as the illustrations indicate, the photograph was taken by reflected light from the top and shows well the transparency of the miniature crystals. Our cut shows a specimen containing several perfectly transparent crystals which were evidently chips split from a larger crystal and the largest of these measured one-half millimeter in diameter; this was burned on platinum foil and when consumed left only a trace of ash. The long, sharp crystal was exceedingly brilliant and its sharp edges showed very clearly that it was fractured. This photograph was likewise made by a direct light from the top.

Attempts were made to obtain photographs by transmitted light, but where this was tried the reflected light thrown off by the diamonds cast a kind of a halo and this fogged the plate.

To create these beautiful little gems Mr. Fisher employed a current that reached as high as 1,200 amperes and the maximum power required was about 50 kilowatts. The arc produced by this great expenditure of energy caused the temperature of the furnace to speedily reach the limits of the pyrometer used to determine its value, which was 1,950 deg. C. The work of the arc had, however, only begun, and before the matrix was ready for the water bath it was estimated that its temperature had risen to a point near 2,500 deg. C., and it is quite probable that in some places within the crucible this reached as high a value as 3,500 to 4,000 deg. C.

While the stones thus formed are not large enough to be of commercial importance, it is of more than passing interest, for it points out a way for the manufacture of diamond powder for polishing and grinding purposes, and Mr. Fisher is confident that his future investigations will result in a process by which he will be enabled to produce diamonds of fairly good proportions.

It is stated that the Austrian administration put in service not long ago in the central telephone office of Vienna an automatic section constructed according to the American Strowger system. This section supplies 200 subscribers at present, but it can be extended to take in as many as 10,000 subscribers. The expense of the outfit, as regards the special devices for automatic connection, reach $6,000 for the 200 subscribers above mentioned, not counting the mounting of the apparatus, the wires, etc. This apparatus has been purchased from the German concessionaires of the Strowger patents. Should the trial prove satisfactory, there is no doubt that arrangements will be made to manufacture the apparatus in Austria in order to apply it in Vienna on a large scale.

RECENTLY PATENTED INVENTIONS.

Of Interest to Farmers.

CULTIVATOR.—C. E. A. STICKEL and H. C. ROGERS, Battlecreek, Iowa. The invention relates particularly to the construction of disk-cultivator. One purpose is to provide a cultivator constructed in two sections, so connected that they have independent action and when in action a rocking movement, so that when one section moves upward the other generally moves downward, whereby the cultivator is not liable to clog or choke in damp and trashy soil. The implement will leave the soil in an even condition, well turned over, and with the grain or trash thoroughly covered.

COTTON CHOPPER AND CULTIVATOR.—W. G. SUGG and J. V. SUGG, Searcy, Ark. While this machine is designated as a "cotton chopper" it may be used for chopping out corn or similar crops. The object of the invention is to provide a machine by means of which scraping, dirting, and chopping may be done practically in one operation, thus causing a great saving of time and labor in the cultivation of cotton.

Of General Interest.

PAVEMENT.—G. W. CRICHFIELD, Jersey City, N. J., and W. T. S. CRICHFIELD, New York, N. Y. The object in this case is to provide an improved sheet or so-called "monolithic" pavement; and the invention relates to that general class in which the pavement is formed of bituminous or asphaltic mixtures. Such pavements as usually constructed are formed of a base or binder laid in a continuous sheet and having above it a wearing-surface formed of a mixture having greater elasticity than the base or binder. These pavements have disadvantages and difficulties which are overcome by the provision of an improved pavement formed of a number of separate blocks of convenient size and peculiar composition. The blocks form a continuous, unbroken, and practically monolithic or sheet pavement.

COUPLING FOR DRILL-TOOLS.—F. EDER, Thayer, Mo. This coupling is capable of use in any construction requiring a rigid connection unaffected by rotation. One of the principal advantages of the improved coupling is the absolute security against detachment by reverse rotation. To disengage the parts, access must be had to the chamber. This is an important feature in well-drilling as it is frequently necessary or desirable to reversely rotate the drill.

CONFECTIONER'S CANDY-STIRRER.—M. RAUBOLD, Hopkinsville, Ky. It is customary in making candy to make frequent tests of the liquid candy by means of cold water. These are necessarily inaccurate, because the water is often of different temperatures, and the making of each test ordinarily occasions a stoppage of the stirring operations. The invention prevents the necessity for taking these frequent tests. Mr. Raubold's object is to facilitate observations of temperature of the liquid candy as it cooks.

RECLINING-CHAIR.—C. CONN, Bremerton, Wash. This is a form of chair usable as an ordinary chair or instantly and conveniently converted into a reclining-chair simply by the movement of the body of the occupant. The occupant may assume a full or partially reclining position at will and the parts will remain in their adjusted position as long as desired and will so remain when the chair is vacated until the adjusted parts are purposely disturbed. It is flatly foldable without disconnecting any of the parts.

AIR-SHIP.—W. C. BRANCH, Minneapolis, Minn. This invention relates particularly to improvements in the balloon or body portion of air-ships, the object being to provide an air-ship body portion so constructed that it will move through the air on a practically even keel or without undue rocking or tipping sidewise and that should a leak of gas occur will descend slowly, thus making the ship practically safe for passengers.

CREASING AND FOLDING DEVICE.—E. C. NAYLOR, Gloversville, N. Y. The intention of the inventor is to provide a new and improved creasing and folding device more especially designed for conveniently and quickly creasing and folding fabrics—such, for instance, as shade-cloth—with a view to form a pocket for the reception of a stick, but the device may be used for other purposes, such as folding fabrics for the formation of neckties and the like.

ICE-CREAM CUTTER.—C. A. KULENKAMPFF, New York, N. Y. The purpose of the improvement is to provide a device for cutting at one operation a block or brick of cream in slabs or cakes of equal or varying thickness and to so construct the device that the knives can be quickly and conveniently placed and adjusted in the body-section and secured in adjusted position and wherein the knives may be as expeditiously and readily removed and each part of the device rendered accessible for cleaning.

WATCH-GUARD.—A. FISHMANN, New York, N. Y. The objects in this improvement are to provide means for preventing the removal of a watch or similar object from the wearer's pocket, at the same time permitting the watch to be removed sufficiently for the use of the wearer without the necessity of manipulating any fastening devices or disengaging any hooks or the like.

SOLAR APPARATUS FOR PRODUCING HIGH TEMPERATURES.—M. A. G. HIMALAYA, 13 Rue de Buzenval, Boulogne-sur-Seine, Seine, France. This invention refers to an apparatus for producing high temperatures, particularly in the metallurgical and chemical researches which necessitate the use of temperatures higher than those of ordinary furnaces, including the electrical furnace. It converges solar rays upon a confined focus placed in the center of a furnace, crucible, or other receiver, this furnace, etc., being, if desired, placed completely outside the reflecting system. Means adjust or set the apparatus so as to maintain convergence of rays upon the focus selected whatever the height of the sun above the horizon.

APPARATUS FOR SHARPENING MOWERS.—E. C. SPRINGER, Mason City, Iowa. In the use of this apparatus, the mower to be sharpened having been secured in place and the crank member clamped upon one of its driving-wheels, some fine abrasive material such as flour of emery, is mixed with oil and applied to the ledger-blade, whereupon by rotating the working blades in the opposite direction to that in which they rotate in use, by means of the crank member, their edges will be sharpened. It is particularly applicable to "lawn-mowers."

FIRE-ESCAPE.—E. A. MEADERS, JR., Grenada, Miss. The device may be secured to a window-sill or any convenient object within the room from which the person desires to escape. The operator carried by the sling from the casing may exert any desired tension upon the line in the reel in order to assist in controlling the descent. It is intended to be made of such size that it can be easily carried in a satchel or trunk and can be immediately brought into use when needed in a hotel or elsewhere. Ordinarily the main section of the casing will be about five or six inches in diameter and about two and a half inches thick or in the direction from end to end along its axis.

Hardware.

WRENCH.—E. F. ATKINSON, Battlecreek, Mich. This wrench belongs to that class having a fixed jaw and a movable jaw. The inventor's object is to provide novel details of construction for a wrench which adapt it for convenient adjustment to engage cylindrical or angular objects between its jaws and afford means for reliably holding the movable jaw at a desired distance from the fixed jaw.

SAW.—C. DILKS, Alloway, N. J. In this instance the invention is an improvement in saws, capable of application to band or circular saws, as desired. In practice the application of the bits and keys, will not interfere in any appreciable degree with the tension of the saw at the rim thereof; nor will it detract to any material extent from the ring of the saw-blade in operation.

PIPE-WRENCH.—W. H. BROCK, Seaford, N. Y. This improvement relates to the manner of mounting the lugs. Means are provided to replace the plates when broken or worn out and to greatly cheapen the construction of the wrench. The plates may be made of fine and hard metal, whereas the handle may be constructed of comparatively cheap material. Means enable the pivot-point and channels to be formed by drop-forging. By forming the channels this way the surface is made of comparatively hard metal, whereas if channels were made by milling or by filing the metal left and constituting the bottom and sides of the channel would be comparatively soft.

Household Utilities.

THREAD-CUTTING THIMBLE.—W. H. GAY, Richmond, Va. This form of thread-cutter is a very convenient means for severing the thread from the work without use of scissors and without biting off the thread and is always on the hand when sewing and is conveniently available. It is cheaply made and is not liable to cut the work nor the fingers and presents no unsightly projection from the thimble.

Machines and Mechanical Devices.

TABLET-MOLDING PRESS.—J. F. BUCKLEY, 26 Meath road, Ilford, Essex, England. Mr. Buckley's invention relates to molding-presses, preferably of the hand-operated type, and has for its object the production of a press whereby tablets varying in thickness from the thinnest wafer to a comparatively thick lozenge may be compressed into any given uniform thickness and density at the will of the operator in a very efficient manner.

Prime Movers and Their Accessories.

ROTARY ENGINE.—W. SCOTT, Sheridan, Wyo. The invention relates to improvements in double-cylinder rotary engines using steam, air, or gas as the motive agent, the object being to provide an engine of novel and simple construction in which there will be an economical use of steam or other motive agent. Another object is to provide an engine with speed-reducing mechanism thus adapting it for use in drilling or boring.

Railways and Their Accessories.

CAR-PLATFORM.—A. MELGAREJO, Harrison, N. Y. The general purposes of this invention is to avoid accidents to passengers in getting on or off at stations and to expedite traffic. In railway operation gaps sometimes occur between the car and station-platform at the

doorways through which passengers must pass. This defect becomes exaggerated on curves. Such circumstances as those suggested have caused many accidents to occur by persons falling into the space, and the object is to produce a platform adapted to overcome these defects.

SWITCHING DEVICE.—C. J. Carlson, Spokane, Wash. The purpose here is to provide a switch mechanism whereby the engineer, motorman, driver, or operator of a car or train of cars without leaving his station can direct the rolling-stock from the main line to a siding or from the siding to the main line, the movement of the switch being automatically accomplished through the medium of a device carried by the car and which is under complete control of the operator and may be brought instantly into operation.

DUST-PROOF JOINT.—G. W. Tidrick, Dillonvale, Ohio. In the present patent, the inventor's object is to provide a new and improved dust-proof joint more especially designed for use in mine-cars and similar cars and arranged to protect the bearing of the axles from injury by the coal-dust or other fine particles of the load passing to the bearing-surfaces.

Note.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

Business and Personal Wants.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. **In every case it is necessary to give the number of the inquiry.**
MUNN & CO.

Marine Iron Works. Chicago. Catalogue free.

Inquiry No. 7219.—For manufacturers of milk bottles made of paper.

"U. S." Metal Polish. Indianapolis. Samples free.

Inquiry No. 7220.—For manufacturers of stamping machinery.

Drying Machinery and Presses. Biles, Louisville, Ky.

Inquiry No. 7221.—Wanted, address of manufacturers of Columbian printing job presses.

2d-hand machinery. Walsh's Sons & Co., Newark, N.J.

Inquiry No. 7222.—For manufacturers of milk sterilizers.

Perforated Metals, Harrington & King Perforating Co., Chicago.

Inquiry No. 7223.—For manufacturers of filtering presses for syrups and other liquids; also pails and other wooden containers for stock feed.

Adding, multiplying and dividing machine, all in one. Felt & Tarrant Mfg. Co., Chicago.

Inquiry No. 7224.—For manufacturers of cellulose or corn pith, compressed.

Sawmill machinery and outfits manufactured by the Lane Mfg. Co.. Box 13, Montpelier, Vt.

Inquiry No. 7225.—For manufacturers of Ajax battery motor.

WANTED.—Patented specialties of merit, to manufacture and market. Power Specialty Co., Detroit, Mich.

Inquiry No. 7226.—For manufacturers of sheet lead, lead pipes, lead drawn traps, and soft and chilled shot.

I sell patents. To buy them on anything, or having one to sell, write Chas. A. Scott, 719 Mutual Life Building, Buffalo, N. Y.

Inquiry No. 7227.—Wanted, address of manufacturers of Clemons single and double belt sanders.

The celebrated "Hornsby-Akroyd" Patent Safety Oil Engine is built by the De La Vergne Machine Company, Foot of East 138th Street, New York.

Inquiry No. 7228.—For manufacturers of small pasteboard boxes for medicinal tablets.

Gut strings for Lawn Tennis, Musical Instruments, and other purposes made by P. F. Turner, 46th Street and Packers Avenue, Chicago, Ill.

Inquiry No. 7229.—For manufacturers of collapsible lead sheet tubes, suitable for pastes.

FOR SALE.—One Hoppes Live Steam Feed Water Purifier; capacity 1,000 h. p.; in good repair, cheap. Studebaker Bros. Mfg. Co., South Bend, Ind.

Inquiry No. 7230.—For manufacturers of an apparatus to produce sulphur dioxide, either as gas or liquid.

Manufacturers of patent articles, dies, metal stamping, screw machine work, hardware specialties, wood fiber machinery and tools. Quadriga Manufacturing Company, 18 South Canal Street, Chicago.

Inquiry No. 7231.—Wanted, address of company who manufactures the prismatic binoculers for the United States government.

Absolute privacy for inventors and experimenting. A well-equipped private laboratory can be rented on moderate terms from the Electrical Testing Laboratories, 548 East 80th St., New York. Write to-day.

Inquiry No. 7232.—For manufacturers of small hand tally registers.

Manufacturers of all kinds sheet metal goods. Vending, gum and chocolate, matches, cigars and cigarettes, amusement machines, made of pressed steel. Send samples. N. Y. Die and Model Works, 508 Pearl St., N.Y.

Inquiry No. 7233.—For manufacturers of elastic webbing, buckles and trimmings for suspenders.

Inquiry No. 7234.—For manufacturers of miniature engines, such as used in automobiles.

Inquiry No. 7235.—For manufacturers of glass tubes having 1-16 inside diameter.

Inquiry No. 7236.—For manufacturers of appliances for protecting buildings and property from lightning.

Inquiry No. 7237.—For address of manufacturers of Dry powder-mixing machines.

Inquiry No. 7238.—For manufacturers of air pumps or those run by electricity.

Inquiry No. 7239.—For manufacturers of spring motors wound by a key and run for 5 or 10 minutes.

Inquiry No. 7240.—For manufacturers of moving stairways.

Inquiry No. 7241.—For manufacturers of turbine engines.

Inquiry No. 7242.—Wanted, address of parties selling human skeletons, or portions thereof.

HINTS TO CORRESPONDENTS.

Names and Address must accompany all letters or no attention will be paid thereto. This is for our information and not for publication.
References to former articles or answers should give date of paper and page or number of question.
Inquiries not answered in reasonable time should be repeated; correspondents will bear in mind that some answers require not a little research, and, though we endeavor to reply to all either by letter or in this department, each must take his turn.
Buyers wishing to purchase any article not advertised in our columns will be furnished with addresses of houses manufacturing or carrying the same.
Special Written Information on matters of personal rather than general interest cannot be expected without remuneration.
Scientific American Supplements referred to may be had at the office. Price 10 cents each.
Books referred to promptly supplied on receipt of price.
Minerals sent for examination should be distinctly marked or labeled.

(9754) C. H. C. writes: I would like to ask the following questions relative to cement walks: How thick should they be? How much top and how much bottom? What proportion sand, gravel, and cement in bottom? What of the same for top? What thickness of cinders for foundation? The above walk to be in residence district. A. The usual specification for a cement walk is as follows: First, lay 4 or 5 inches of clean, sharp cinders. On top of this ram thoroughly in place from 4 to 6 inches of good concrete, and continue the ramming until the water appears at every point on the surface of the concrete. As soon as the concrete is set, spread very evenly a finishing coat about one inch thick of either neat cement or cement mortar made of equal parts of cement and sharp sand. This foundation coat should be thoroughly troweled to a polished surface. The best proportions for the concrete are as follows: Five parts of sharp broken stone, three parts of clean, sharp sand, one part of best Portland cement.

(9755) W. L. Du B. asks: How long a spark ought an induction coil to give which has a 7-inch core 1 inch in diameter, primary five layers No. 16 insulated copper wire, secondary 5 ounces of No. 36 double cotton-covered wire? Does too much insulation between the core and primary and also between primary and secondary affect the length of the spark to any marked extent? Does the secondary need any more insulation between layers of double cotton-covered wire? A. Your coil may give a spark something less than a quarter of an inch long. The primary wire has too many layers. No. 12 or 14 wire wound in two layers is better. Then you will get a strong current from your battery. Much insulation is not required between the primary and the core, but the secondary must be well insulated from the primary coil. It is not well to use double cotton-covered wire in the secondary. It takes up too much room. Single silk is the proper thing. Get the turns as near the primary as possible. Insulate with shellac or paraffine the layers of the secondary coil. All such details can be learned from Norrie's "Induction Coils," which we send for $1.

(9756) M. B. writes: 1. In answer to question 9697, you say that a ball of lead will fall faster to the ground than one of cork of the same size. Now this answer, which seems according to reason, is in direct contradiction to the article on gravitation in the Britannica, Vol. 11, page 66, in the latter part of the second column, on that page. As you are not likely to give a wrong answer, will you explain the contradiction? A. The usual statement that all bodies fall under gravity with an equal velocity, since each body is acted upon by gravity in proportion to the quantity of matter in it, is true when all resistance to motion is removed, outside of the matter of the body itself. In a vacuum this is literally true, a mote and a cannon ball would fall equally fast; but not so in the air, which resists the fall of small motes so that they are hours in falling a few feet, as any one can see by watching them float in a sunbeam. The actual velocity of fall is dependent upon the ratio of the weight of the body to that of the air it displaces. When a body displaces a weight of air less than its own weight it falls toward the earth; if its weight is the same as that of the air it displaces, it floats in the air, and would never fall; when its weight is less than that of the displaced air, it rises in the air as does a balloon. We do not understand that this is in contradiction to any known law of motion. 2. I was much interested in reading of a rainbow by moonlight, and also the article on the apparent reason of animals, such as cats. An action which seems almost reason, came under my notice. A cat was constantly in a cellar, which was kept closed; on complaining to the servant about it, she told me that the cat opened the door herself; this I did not believe, thinking it an excuse for carelessness; but being in the kitchen one day I saw the cat jump up, put one paw through the handle of the old-fashioned latch, the other on the latch, while with one of her hind legs she pushed against the door frame, thus opening the door. Of course this was only imitation, but it looked very like reason. A. If a cat or other animal performs an act which we should say involved reason when performed by a man, why not say that it is reason in the cat? We see no reason why we should not do so. We have known several cats which could open doors in the manner you describe, and have seen dogs and other animals act in a reasonable manner, under circumstances in which some men would not have done any better.

(9757) C. E. T. asks: I should like to find out which leg is the longer, or if both legs of an ordinary person differ in length. The reason I ask is this: While skating and moving in a circle with the right leg on the outside of the circle, the balance is easily obtained; but on moving in the opposite direction with the left leg on the outside, balance is harder to obtain. As the ears differ from each other, the idea struck me that probably the legs were affected in the same way. A. The two legs of nearly every one differ in strength; thus people are right-legged or left-legged, just as they are right-handed or left-handed. This is taken as the explanation of the fact that people tend to walk in a circle when they are not guided by eye sight. Persons lost in forests usually come around to the place from which they started in their wanderings. There is no difference in the length of legs in a person of normal condition. If there is any difference a person limps.

(9758) E. P. inquires: How many square feet of heating surface of a hot-water radiator is required to heat a room measuring 16½x14 feet with a 10-foot ceiling? A. A common rule for calculating the heating surface of a radiator is as follows: Add together the square feet of glass in the windows, the number of cubic feet of air required to be changed per minute and 1-20 of the surface of the external wall and roof; then multiply this sum by the difference between the required temperature of the room and that of the external air in the coldest weather; and lastly, divide this product by the difference in temperature between the hot water in the radiator and the required temperature of the room. The result equals the required radiating surface in square feet. The cubic feet of space in a room has little to do with the amount of radiating surface required, but is often convenient for rough calculations. Under average conditions, one square foot of radiating surface at 212 deg. will heat from 100 to 150 cubic feet in brick dwellings exposed on all sides, and from 70 to 100 cubic feet in modern dwellings exposed on all sides. From the above information you can readily calculate the heating surface you will require.

(9759) J. H. R. writes: Some laymen in our town have been discussing whether hot water would burst from a frozen water-pipe, while cold water would thaw it without any fracture. I take it that such a conclusion is based upon insufficient evidence and reasons, and hold that, if the pipe should begin to leak upon the application of hot water, the crack had been previously formed. Kindly give me your opinion upon this subject. You will pardon a few words stating my position. Suppose we start with a pipe filled with water at any temperature, say 20 deg. C. As the temperature lowers, both pipe and water contract until 4 deg. is reached, when the water begins to expand. Suppose freezing takes place without bursting the pipe, and a temperature of —20 deg. is reached. Now, as the temperature rises both pipe and water expand, repeating every stage or condition passed through as the temperature lowered, and if a point is reached where the strain is sufficient to burst the pipe, that point would have also been reached as the temperature lowered, and the fracture would have taken place previously. There is another consideration which favors the fracture on cooling rather than heating. Inasmuch as the conductivity of the metal pipe is far superior to that of the water, the pipe would "lead" in the contraction on cooling, and also, in expansion on heating, and so there would be an additional strain on the pipe as the temperature lowers, due to difference of temperature of pipe and water, and as the temperature rises, this strain would be diminished. This difference, while usually negligible, becomes very appreciable when hot water is used in thawing. I am very sure that this opinion about hot water bursting pipes is due to insufficient investigation. No one is able to say that there was not an incipient crack before the water was applied, and the hotter the water the more promptly the vent will be opened. The fracture cannot be due to unequal expansion of the outer and inner surfaces of the pipe, else a smith would shiver a piece of steel when he goes to temper it. It cannot be due to the formation of steam within the pipe, for the temperature of the water in the pipe will always be a mean between its original temperature and the temperature of your hot water, say 100 deg. I can only think of one theory which will explain the phenomenon in question, viz., viscosity of ice. That is, to suppose that more ice has accumulated in the pipe per cubic centimeter than was present before freezing. Suffice it to say I do not think this theory applicable. Please state your opinion definitely, for I wish to show your leter to the disputants. A. It is not an uncommon phenomenon for pipes which have been frozen to burst in the process of thawing. Your reasoning regarding the contraction of water is correct up to a certain point, but you forget one point: Water contracts as the temperature is lowered until 4 deg. C. is reached. From 4 deg. to 0 deg. it expands. In the process of freezing water at 0 deg. to ice at the same temperature there is another expansion much greater than the expansion of the water between 4 deg. and 0 deg. After the ice is formed, however, it contracts as the temperature is lowered below 0 deg. centigrade, just as any other solid contracts. This is the fact that you overlooked. As the temperature rises from any point below the freezing point the exact reverse of the above occurs. Therefore, if a pipe is filled with ice at a temperature of —20 deg. C. and the temperature is gradually increased uniformly along the entire length of the frozen section, there will be the instant before the ice melts the same strain on the pipe that there was the instant that the water froze. The pipe may be able to stand this strain once, and yet not be able to stand it the second time. It therefore may burst on thawing, even though it did not burst when the water froze. The above reasoning is based on the supposition that the frozen section is increased in temperature uniformly. If, however, the heat is applied only at the center of the frozen section, I think you can readily see that the strain on the pipe will be greater than it was when the pipe was frozen, provided the temperature then was lowered uniformly along the entire length of the frozen section, as it usually would be.

(9760) M. F. Co. asks: In running a short telephone line connecting several houses together, will you please advise us if you think there is great danger of lightning striking the wire and damaging the houses? Can this danger be entirely removed by running ground wires down the corners of the houses so the lightning can take a short path to the ground? A. There is always danger that a wire in the air will be struck by lightning. The proper mode of protecting buildings into which such wires enter is by the use of lightning arresters properly installed. Ground wires will not answer the purpose, since they will injure the service of the telephones on the line.

(9761) G. E. M. asks: What are the principles of a steam turbine? What are the principal defects in the Parsons type? Does the steam enter through nozzles or does it enter in bulk? Why does the efficiency of the steam decrease when the steam is throttled? Is there much difference between a Parsons and a Curtis? Please inform me where I can obtain books on the above subject. What is the power (about) in foot-pounds of an ordinary 8-day clock spring? A. The principle of a steam turbine is exactly the same as the principle of an impulse water wheel, like the Pelton wheel, the only difference being that there are very many more buckets for the steam to strike against. The work done by a steam turbine depends on the velocity of the steam as it issues from the steam nozzle. Throttling the steam decreases the velocity and therefore decreases the efficiency of the turbine. There is very little difference in principle between the Parsons and the Curtis turbines. For more detailed information we would refer you to "Descriptions of Turbines and Their Efficiencies," published by the General Electric Company, of Schenectady, and to the Westinghouse Manufacturing Company, of Pittsburg, and to the De Laval Steam Turbine Company, of Trenton, N. J. We cannot tell the power in the spring of an ordinary eight-day clock. It varies with the size and character of the clock, but in most cases would probably not be much over two or three foot-pounds.

(9762) E. G. asks: Kindly give me a clear definition of adiabatic heating, explaining fully the difference between a gas adiabatically heated and one heated by mechanical compression. A. The word "adiabatic" is derived from the Greek and has three parts. *A* means without; *dia* means through; *batic* means going. This word as a whole means "without going through." Applied to heat, the sense is that no heat passes through to affect the temperature of the gas under test, be it steam in a boiler or any other gas in any receptacle or in the air in the atmosphere. A gas which is compressed without any heat leaving it becomes hotter, and a gas which is expanded without any heat coming into it grows colder. Both of these are adiabatic changes. The gas which is heated by mechanical compression is heated adiabatically. Adiabatic changes are of great importance in the atmosphere. 2. In reducing a barometer reading of a given altitude to sea level, the average temperature of the air must be known. Is this average obtained by taking the average of the dry thermometer readings at the A. M. and P. M. observations, or by taking the average of the maximum and minimum temperatures for the day? A. The average temperature of the air in the problem of the reduction to the sea level is the average of the temperature of the air at the various altitudes from the sea level to the altitude of the observation. This can be found only with considerable probable error, since the change of air temperature with altitude varies greatly in different regions, and any error in this causes an error in the weight of the air column to be calculated. The actual temperature at the place at the time of observation is the only temperature to be employed in the reduction of that observation. 3. Is water vapor properly classed as one of the constituents of the atmosphere? A. Water vapor is one of the constituents of the atmosphere. No percentage value can be given for it, since it varies very much, from a mere trace to as much as five per cent of the amount of dry air The chemical composition of air as ordinarily given is usually that of dry air,