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.

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 This is for our information and not for publication.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 40 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.