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FIRES—CAUSES AND PREVENTION.

It is estimated that the total annual losses of insured property by fire, throughout the world, average nearly two hundred million dollars. Add to this the annual destruction of uninsured property, and we should probably have a total amounting to quite double these figures. How great the loss, how severe the tax upon the productive industry of mankind, this enormous yearly destruction amounts to, will come home to the minds of most readers more directly if we call attention to the fact that it just about equals the value of our total wheat crop during a year of good yield. And it is a direct tax upon productive industry everywhere, because, although here and there a nominal loser, fully insured, has only made what is sometimes called "a good sale" to the companies holding his risk, this is only a way of apportioning the loss whereby the community at large become the sufferers. Thus it is that we find all ably-managed insurance companies earnestly endeavoring to make it plain to the public how fires should be guarded against, or most effectually localized and controlled when once started.

During the fall, or from "lighting up" time till about New Year's day, more fires occur ordinarily than in any other portion of the year. This fact points to some of the most general causes of conflagrations—as in the lighting and heating of houses, factories, etc., where this had not been necessary during the summer months. It is also found that after the first of the year the number of fires is greatly diminished, the lighting and heating arrangements having been subjected to a period of trial during which their most obvious defects would be remedied. While it may readily be conceded that the utmost care of the owner of property could not totally prevent great average losses from fire—for the greater the holdings the more must the proprietor trust to the oversight of others—it is evident that the above facts indicate the necessity of more strenuous precautions at this season. Gas pipes and fittings should then be tested; furnace flues and settings looked to; stove, heater, and grate fixtures and connections examined—and in all these particulars the scrutiny should be most closely directed to parts ordinarily covered up or out of sight, so that any defect or weakness from long disuse may be exposed. When to the above causes of fires we have added the extremely fruitful one found in the extensive use of coal oil within a few years past, we have indicated the most common sources of conflagrations of known origin. An English authority gives the percentages of different causes of 30,000 fires in London, from 1833 to 1865, as follows: Candles, 11·07; curtains, 9·71; flues, 7·80; gas, 7·65; sparks, 4·47; stoves, 1·67; children playing, 1·59; matches, 1·41; smoking tobacco, 1·40; other known causes, 19·40; unknown causes, 32·88. The foregoing figures do not give the percentage of incendiary fires, and later statistics would, no doubt, show vastly more fires from the use of kerosene than are here attributed to candles.

The prevention of fires, and the best means of minimizing the loss when they do occur, are topics which cover a wide field, and a collection of the literature on the subject would make a very respectable library. As the question presents itself to-day, it may well be doubted whether the general practice of large property holders of insuring all their possessions does not tend to lessen the constant vigilance which is the most essential requisite in preventing fires. Thousands of merchants never mean to keep a dollar's worth of goods in store or warehouse that is not fully covered by insurance, and they make this cost a regular charge upon their business as peremptorily as they do the wages paid the hands in their employ. But few manufacturers can so completely cover their risks by insurance, yet a large portion of them do so as far as they are able. It does not follow but that the larger portion of both merchants and manufacturers exercise what the law will fully decide is "due vigilance" in the care of the property so insured, but it is evident that in most cases the thoughtfulness is much less complete—the care wonderfully lacking in personal supervision—as compared with what would be the case were each one his own insurer. Of course, this in no way casts a doubt upon the general policy of business men being amply insured, but in fact shows the greater necessity why they should be so, that they may not suffer from the carelessness of a neighbor; it also points to the necessity of continually increasing care and thoroughness of inspection on the part of the insurance companies. These agencies, in fact, must compel the insured to keep up to the mark in the introduction of every improvement to ward off fires or diminish their destructiveness.

The progress made in this department during recent years has been great. The almost universal use of steam has been attended by the fitting up of factories with force pumps, hose, and all the appliances of a modern fire brigade; dangerous rooms are metal sheathed, and machinery likely to cause fire is surrounded by stationary pipes from which jets of water may be turned on instantaneously from the outside; stores and warehouses have standing pipes from which every floor may be flooded with water under pressure, and the elevators, those most dangerous flues for rapidly spreading a fire, are either bricked in entirely or supposed to be closed at every floor. The latter point, however, is sometimes forgotten, as sea captains forget to keep the divisions of their vessels having watertight compartments separate from one another; the open elevator enlarges a small fire as rapidly as the open compartment allows the vessel to sink.

With the best of appliances, however, discipline and drill on the part of the hands, in all factories, is of prime importance. It is always in the first stages of a fire that thoroughly efficient action is necessary, and here it is worth a thousand-fold more than can be any efforts after a fire is once thoroughly started. Long immunity is apt to beget a feeling of security, and the carelessness resulting from overconfidence has been the means of destroying many valuable factories which were amply provided with every facility for their own preservation. The teachers in some of the public schools of New York and Brooklyn, during the past year, set an example which some of our millowners might profitably follow. There have been cases when, from a sudden alarm of fire, children have been crushed in their crowding to get out of the building. The teachers, in the instances referred to, marched their children out, under discipline, as if there had been a fire. Let owners of factories try some such plan as this, by which workmen may be called upon to cope with an imaginary fire, and many of them will, we venture to say, find means of improving their present system or appliances for protection, elaborate as they may at present think them to be.

WHAT IS LIGHT?

If on opening a text book on geology one should find stated the view concerning the creation and age of the earth that was held a hundred years ago, and this view gravely put forward as a possible or alternative hypothesis with the current one deducible from the nebula theory, one would be excused for smiling while he turned to the title page to see who in the name of geology should write such stuff. Nevertheless this is precisely similar to what one will find in most treatises on physics for schools and colleges if he turns to the subject of light. For instance, I quote from a book edited by an eminent man of science in England, the book bearing the date 1873.

"There are two theories of light; one the *emissive* theory; . . . the other, the *vibratory* theory;" just as if the emissive or corpuscular theory was not mathematically untenable sixty years ago, and experimentally demonstrated to be false more than forty years ago. Unless one were treating of the history of the science of optics there is no reason why the latter theory should be mentioned any more than the old theory of the formation of the earth. It is not to be presumed that any one whose opinion is worth the asking still thinks it possible that the old view may be the true one because the evidence is demonstrable against it, yet while the undulatory theory prevails there are not a few persons well instructed otherwise who still write and speak as though light has some sort of independent existence as distinguished from so-called radiant heat; in other words, that the heat and light we receive from the sun are specifically different.

A brief survey of our present knowledge of this form of energy will help to show how far wrong the common conception of light is. For fifteen years it has been common to hear heat spoken of as a mode of molecular motion, and sometimes it has been characterized as *vibratory*, and most persons have received the impression that the vibratory motion was an actual change of position of the molecular in space instead of a *change of form*. Make a ring of wire five or six inches in diameter, and, holding it between the thumb and finger at the twisted ends, pluck it with a finger of the other hand; the ring will vibrate, have three nodes, and will give a good idea of the character of the vibration that constitutes what we call heat. This vibratory motion may have a greater or less amplitude, and the energy of the vibration will be as the square of that amplitude. But the vibrating molecule gives up its energy of vibration to the surrounding ether; that is to say, it loses amplitude precisely as a vibrating tuning fork will lose it. The ether transmits the energy it has received in every direction with the velocity of 186,000 miles per second, whether the amplitude be great or small, and whether the number of vibrations be many or few. It is quite immaterial. The *form* of this energy which the ether transmits is *undulatory;* that is to say, not unlike that of the wave upon a loose rope when one end of it is shaken by the hand. As every shake of the hand starts a wave in the rope, so will every vibration of a part of the molecule start a wave in the ether. Now we have several methods for measuring the wave lengths in ether, and we also know the velocity of movement. Let v = velocity, l = wave length, and n = number of vibrations per second, then $n = \frac{v}{l}$, and by calculation the value of n varies within wide limits, say from 1×10^{14} to 20×10^{14}. But all vibrating bodies are capable of vibrating in several periods, the longest period being called the *fundamental*, and the remainder, which stand in some simple ratios to the fundamental, are called *harmonics*. Each of these will give to the ether its own particular vibratory movement, so that a single molecule may be constantly giving out rays of many wave lengths precisely as a sounding bell gives out sounds of various pitches at one and the same time.

Again, when these undulations in the ether fall upon other molecules the latter may reflect them away or they may absorb them, in which case the absorbing molecules are themselves made to vibrate with increased amplitude, and we say they have been heated. Some molecules, such as carbon, appear to be capable of stopping undulations of all wave lengths and to be heated by them; others are only affected by undulations of particular wave lengths, or of wave lengths between special limits. In this case it is a species of sympathetic vibration. The distinction between the molecular vibrations, and the undulations in ether that result from them, must be kept in mind, as must also the effect of the undulations that fall upon other molecules. To one the name *heat* is applied, to the other the name of *radiant energy* is given; and it matters not whether the undulations be long or short, the same molecule may give out both.

Now let a prism be placed in the path of such rays of different wave length from a single molecule, and what is called the dispersive action of the prism will separate the rays in the order of their wave lengths, the longer waves being less refracted than the shorter ones; but the energy of any one of these will depend upon the *amplitude of undulation*, which in turn will depend upon the amplitude of vibration of the part of the molecule that originated it, but in general the longer waves have greater amplitude, though not necessarily so. Consequently, if a thermopile be so placed as to receive these various rays, and their energy be measured by its absorption on the face of the pile, each one would be found to heat it, the longer waves more than the shorter ones, simply because the amplitude is greater, but for no other reason, for it is possible, and in certain cases is the fact, that a short wave has as much or more energy than a longer one. If the eye should take the place of the thermopile it would be found that some of these rays did not affect it at all, while some would produce the sensation of light. This would be the case with any waves having a wave length between the limits of, say, 1-37,000 of an inch and 1-60,000 of an inch; any shorter waves will not produce the sensation of light. If instead of the eye a piece of paper washed in a solution of the chloride of silver should be placed where the dispersed rays should fall upon it, it would be found that only the shorter waves would affect it at all, and among these shorter ones would be some of those rays which the eye could not perceive at all.

It was formerly inferred from these facts that the heat rays, the light rays, and the chemical rays were different in quality; and some of the late books treating upon this very subject represent a solar spectrum as being made up of a heat spectrum, a light spectrum, and an actinic or chemical spectrum, and the idea has often been made to do duty as an analogy in trinitarian theology; nevertheless it is utterly wrong and misleading. There is no such thing as an actinic spectrum; that is, there are no such rays as special chemical rays; any given ray will do chemical work if it falls upon the proper kind of matter. For instance, while it is true that for such salts of silver as the chloride, the bromide, etc., the shorter waves are most efficient; by employing salts of iron one may get photographic effects with wave lengths much too long for any eye to perceive. Capt. Abney has photographed the whole solar spectrum from one end to the other, which is sufficient evidence that there are no special chemical rays. As to the eye itself, certain of the wave lengths are competent to produce the sensation we call light, but the same ray will heat the face of a thermopile or produce photographic effects if permitted to act upon the proper material, so there is no more propriety in calling it a light ray than in calling it a heat ray or an actinic ray. What the ray will do depends solely upon what kind of matter it falls upon, and all three of these names, *light, heat*, and *actinism*, are names of *effects of radiant energy*. The retina of the eye is itself demonstrably a photographic plate having a substance called purpurine secreted by appropriate glands spread over it in place of the silver salts of common photography. This substance purpurine is rapidly decomposed by radiant energy of certain wave lengths, becoming bleached, but the decomposition is attended by certain molecular movements; the ends of the optic nerves, which are also spread over the retina, are shaken by the disrupting molecules, and the disturbance is the origin of what we call the sensation of light. But the sensation is generally a compound one, and when all wave lengths which are competent to affect the retina are present, the compound effect we call white or whiteness. When some of the rays are absent, as, for instance, the longer ones, the optical effect is one we call green or greenness; and the special physiological mechanism for producing the sensation may be either three special sets of nerves, capable of sympathetic vibration to waves of about 1-39,000, 1-45,000, and 1-55,000 of an inch in length, as Helmholtz has suggested, or, as seems to the writer more probable, the substance purpurine is a highly complex organic substance made up of molecules of different sizes and requiring wave lengths of different orders to decompose them, so that a part of the substance may be quite disintegrated, while other molecules may be quite entire throughout the visual space. This will account for most of the chromatic effects of vision, for complementary colors, and for color blindness, by supposing that the purpurine is not normally constituted. This is in accordance with experimental photography, for it has been found that the long waves will act only upon heavier molecules. It is true vision may be good when there is no purpurine, but there is no doubt but that this substance is secreted in the eye, and that it is photographic in its properties, and so far must be taken as an element in any theory of vision; but the chief point here considered is that objectively light does not exist independent of the eye, that light is a physiological phenomenon, and to speak of it otherwise is to confound a cause with an effect. It is, hence, incorrect to speak of the velocity of light; it has no velocity. It is *radiant energy* that has the velocity of 186,000 miles a second. It is incorrect to say we receive heat from the sun. What we do receive is *radiant energy*, which is here transformed into heat. This is not hypercritical, but is in accordance with the knowledge we have to-day. The old nomenclature we use, but without definite meaning; the latter is left to be inferred from the connection or context. If a man should attach to the water main in a city a properly constructed waterwheel, the latter will rotate; but it would not be proper to say that he received rotation from the reservoir. What he received was water with a certain pressure; in other words, a certain form of energy, which he transforms into rotation by the appropriate means; but by substituting other means he can make the same water pressure maintain a vibratory motion, as with the hydraulic ram valve, or let it waste itself by open flow, in which case it becomes ultimately molecular vibration that is heat. The analogy holds strictly. The trouble all comes from neglecting to distinguish between different forms of energy—energy in matter and energy in the ether.

GLASS SPINNING AND WEAVING.

Quite recently a Pittsburg glass firm has succeeded, to a notable degree, in producing glass threads of sufficient fineness and elasticity to permit of their being woven into fabrics of novel character and quality. Their success is such as to warrant the assumption that garments of pure glass, glistening and imperishable, are among the possibilities of the near future. The spinning of glass threads of extreme fineness is not a new process, but, as carried on at present by the firm in question—Messrs. Atterbury & Co.—possesses considerable interest. From a quality of glass similar to that from which table ware is made, rods of glass averaging half an inch in diameter are drawn to any desired length and of various colors. These rods are then so placed that the flame of two gas burners is blown against that end of the rod pointed toward the large "spinning" wheel. The latter is 8½ feet in diameter, and turns at the rate of 300 revolutions per minute. The flames, having played upon the end of the glass cylinder until a melting heat is attained, a thread of glass is drawn from the rod and affixed to the periphery of the wheel, whose face is about 12 inches wide. Motion is then communicated, and the crystal thread is drawn from between the gas jets and wrapped upon the wheel at the rate of about 7,500 feet per minute. A higher speed results in a finer filament of glass, and *vice versa*. During its passage from the flame to the wheel, a distance of five or six feet, the thread has become cooled, and yet its elasticity is preserved to a notable degree. The next step in the process consists in the removal of the layers of threads from the wheel. This is easily accomplished, and after being cut to the desired lengths, the filaments are woven in a loom somewhat similar to that used in weaving silken goods. Until within the past few weeks only the woof of the fabric was of glass, but at present both warp and woof are in crystal. Samples of this cloth have been forwarded to New York and to Chicago, and the manufacturers claim to be able to duplicate in colors, texture, etc., any garments sent them. A tablecloth of glass recently completed shines with a satiny, opalescent luster by day, and under gaslight shows remarkable beauty. Imitation plumes, in opal, ruby, pale green, and other hues, are also constructed of these threads, and are wonderfully pretty. The chief obstacle yet to surmount seems to lie in the manipulation of these threads, which are so fine that a bunch containing 250 is not so thick as an average sized knitting needle, and which do not possess the tractability of threads of silk or cotton.

[The foregoing information is furnished by a correspondent in Pittsburg. A sample of the goods mentioned, a tablecloth of glass, is now on exhibition in this city.

The weaving of such heavy fabrics of glass for ornamental purposes and for curiosities is no new thing; nor, in our estimation, does comparative success in such experiments warrant the enthusiastic claims of the Pittsburg manufacturers touching the adaptability of glass for wearing apparel. Unless it is in their power to change the nature of glass absolutely and radically, it does not seem possible for them so to overcome the ultimate brittleness of the separate fibers as to make the fabric fit to be brought in contact with the skin. The woven stuff may be relatively tough and flexible; but unless the entire fabric can be made of one unbreakable fiber the touch of the free ends, be they never so fine, must be anything but pleasant or beneficial, if one can judge by the finest filaments of glass spun hitherto. Besides, in weaving and wearing the goods, a certain amount of fiber dust must be produced as in the case of all other textile material. When the softest of vegetable fibers are employed the air charged with their fragments is hurtful to the lungs; still more injurious must be the spiculæ of spun glass.

However, although the manufacturers are likely to be disappointed in their expectation of finding in glass a cheap and available substitute for linen, cotton, and silk in dress goods, it is quite possible that a wide range of useful application may be found for their new fabric.]

REMARKABLE ERUPTION OF MAUNA LOA.

Late advices from the Sandwich Islands describe the eruption of Mauna Loa, which began Nov. 5, as one of the grandest ever witnessed. The opening was about six miles from the summit of the mountain, and already two great streams of lava had been poured out; one of them, from one to two yards wide and twenty feet deep, had reached a distance of thirty miles. Terrible explosions accompany the flow of the lava stream, which for a time threatened the town of Hilo; at last reports the flow seemed to be turning in another direction.

Mauna Loa, "long or high mountain," occupies a large portion of the central and southern part of the island of Hawaii, and reaches an elevation of 13,760 feet. It has been built up by lavas thrown out in a highly fluid state, and flowing long distances before cooling; as a consequence the slopes of the mountain are very gentle, averaging, according to Prof. Dana, not more than six and a half degrees. Its craters are numerous, and usually occur near the summit and on the sides, new ones opening frequently, and furnishing, as in the latest instance, magnificent lava streams. The terminal crater is circular, 8,000 feet in diameter, and in 1864 was about 1,000 feet deep. In 1859 an enormous lava fountain spouted from this crater for four or five days, throwing a column of white hot fluid lava about 200 feet in diameter to the height of two or three hundred feet. The lava stream ran 50 miles to the sea in eight days. Other great eruptions have occurred in 1832, 1840, 1843, 1852, 1855, 1868 and 1873. The lava streams poured out in 1840, 1859, and 1868, flowed to the sea, adding considerably to the area of the island. Those of 1843 and 1855 are estimated to have poured out respectively 17,000,000,000 and 38,000,000,000 cubic feet of lava. In 1868 the lava stream forced its way under ground a distance of twenty miles, and burst forth from a fissure two miles long, throwing up enormous columns of crimson lava and red hot rock to the height of five or six hundred feet.

On the eastern part of Mauna Loa, 16 miles from the summit crater, is Kilauea, the largest continuously active crater in the world. It is eight miles in circumference, and 1,000 feet deep. Its eruptions are generally independent of those of Mauna Loa.

NEW AIR ENGINE.

A valuable improvement in compressed air engines has recently been patented in this country and in Europe by Col. F. E. B. Beaumont, of the Royal Engineers, and we learn from accounts given in the London and provincial papers that it has proved highly efficient and satisfactory.

The engine possesses some peculiar features which render it very economical in the use of compressed air. It has two cylinders, one being much larger than the other. Into the smaller of these cylinders the compressed air is taken directly from the reservoir, and after doing its work there it is discharged into the larger cylinder, where it is further expanded, being finally discharged into the open air.

The admission of air to the smaller cylinder is regulated by an adjustable cut-off apparatus, which admits of maintaining a uniform power under a variable pressure. When the reservoir at first starting contains air at a very high pressure, the cut-off is adjusted so that the small cylinder receives a very small charge of air at each stroke; when the pressure in the reservoir diminishes the cut-off is delayed so that a larger quantity of air is admitted to the small cylinder; and when the pressure in the reservoir is so far reduced that the pressure on the smaller piston gives very little power, the supply passages are kept open so that the air acts directly on the piston of the larger cylinder. This arrangement is also available when the air pressure is high and great power is required for a short time, as, for example, in starting a locomotive.

It is, perhaps, needless to mention the advantages a motor of this kind possesses over the steam locomotive. The absence of smoke and noise renders it particularly desirable for tunnels, elevated roads, and, in fact, for any city railroad.

Further information in regard to this important invention may be obtained by addressing Mr. R. Ten Broeck, at the Windsor Hotel, New York.

Telegraph Wires Underground.

Philadelphia newspapers report that the American Union Telegraph Company are about to try in that city the experiment of putting their wires underground. The plan works well enough in European cities, and there would seem to be no reason why it should not succeed here, save the indisposition of the companies to bear the first cost of making the change. For some months the Western Union Telegraph Company has had the matter under consideration, but will probably wait until pressed by a rival company before it undertakes the more serious task of taking down its forest of poles and sinking the wires which contribute so much to the prevailing ugliness of our streets. Sooner or later the poles and wires must come down; and it is altogether probable that the change will be beneficial to the companies in the long run, owing to the smaller cost of maintaining a subterranean system. It will certainly be an advantage to the community.