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.