Scientific American.

ESTABLISHED 1845.

MUNN & CO., Editors and Proprietors.

PUBLISHED WEEKLY AT
NO. 37 PARK ROW, NEW YORK.

O. D. MUNN. A. E. BEACH.

TERMS FOR THE SCIENTIFIC AMERICAN.

One copy, one year postage included........................ $3 20
One copy, six months, postage included 1 60

Clubs.—One extra copy of THE SCIENTIFIC AMERICAN will be supplied gratis for every club of five subscribers at $3.20 each: additional copies at same proportionate rate. Postage prepaid.

Remit by postal order. Address
MUNN & CO., 37 Park Row, New York.

☞ To Advertisers.—The regular circulation of the SCIENTIFIC AMERICAN is now **Fifty Thousand Copies** weekly. For 1880 the publishers anticipate a still larger circulation.

The Scientific American Supplement

Is a distinct paper from the SCIENTIFIC AMERICAN. THE SUPPLEMENT is issued weekly. Every number contains 16 octavo pages, uniform in size with SCIENTIFIC AMERICAN. Terms of subscription for SUPPLEMENT, $5.00 a year, postage paid, to subscribers. Single copies, 10 cents. Sold by all newsdealers throughout the country.

Combined Rates.—The SCIENTIFIC AMERICAN and SUPPLEMENT, will be sent for one year, postage free, on receipt of *seven dollars*. Both papers to one address or different addresses as desired.

The safest way to remit is by draft, postal order, or registered letter Address MUNN & CO., 37 Park Row, N. Y.

Scientific American Export Edition.

The SCIENTIFIC AMERICAN Export Edition is a large and splendid periodical, issued once a month. Each number contains about one hundred large quarto pages, profusely illustrated, embracing: (1.) Most of the plates and pages of the four preceding weekly issues of the SCIENTIFIC AMERICAN, with its splendid engravings and valuable information; (2.) Commercial, trade, and manufacturing announcements of leading houses. Terms for Export Edition, $5.00 a year, sent prepaid to any part of the world. Single copies 50 cents. ☞ Manufacturers and others who desire to secure foreign trade may have large, and handsomely displayed announcements published in this edition at a very moderate cost.

The SCIENTIFIC AMERICAN Export Edition has a large guaranteed circulation in all commercial places throughout the world. Address MUNN & CO., 37 Park Row, New York.

NEW YORK, SATURDAY, DECEMBER 18, 1880.

Contents.

(Illustrated articles are marked with an asterisk.)

TABLE OF CONTENTS OF

THE SCIENTIFIC AMERICAN SUPPLEMENT

No. 259.

For the Week ending December 18, 1880.

Price 10 cents. For sale by all newsdealers.

ONE MORE NUMBER.

The next issue will close another volume of this paper, and with it several thousand subscriptions will expire.

It being an inflexible rule of the publishers to stop sending the paper when the time is up for which subscriptions are prepaid, present subscribers will oblige us by remitting for a renewal without delay, and if they can induce one or more persons to join them in subscribing for the paper, they will largely increase our obligation.

By heeding the above request to renew immediately, it will save the removal of thousands of names from our subscription books, and insure a continuance of the paper without interruption.

The publishers beg to suggest to manufacturers and employers in other branches of industry that in renewing their own subscriptions they add the names of their foremen and other faithful employes. The cost is small, and they are not the only ones that will derive benefit. The benefit to the employe will surely reflect back to the advantage of the employer. The hints, receipts, and advice imparted through our correspondence column will be found of especial value to every artisan and mechanic, as well as to students and scientists.

For terms, see prospectus.

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