THE SAFE LOAD AND STRENGTH OF IRON.

A very able and suggestive paper has lately been read before the Society of Engineers, London, by Mr. Zerah Colburn, on "the relations between the safe load and ultimate strength of iron." When it is taken into consideration how extensively iron is now employed for engineering purposes, such as in bridges, boilers, buildings, &c., positive knowledge respecting the safe load which it can bear for a long period of time is of the first importance. Mr. Colburn forcibly points out the deficiency of knowledge on this subject, and suggests that protracted, accurate and repeated experiments be made to ascertain the safe load which iron will sustain permanently He states that much difference of opinion prevails among engineers respecting the safe working strength of iron, and that its permanent supporting power is variously estimated at from four-tenths to one-tenth of its breaking strength. In the application of this metal to railway structures, the late Mr. Glynn recommended that a cast-iron bridge should never be loaded beyond one-tenth of its ultimate strength Mr. R. Stephenson and several other engineers considered that a ratio of one-sixth of the breaking load was safe; while Brunel held that from two-fifths to one-third was allowable. Thus one of these engineers would allow 33 tuns as the safe load upon a girder that would just bear 100 tuns, while the second would allow 17 tuns as the load, and the third —Mr. Glynn—only 10 tuns. The British Board of Trade limits engineers to a maximum tensile strain of 5 tuns per square inch in designs for wrought-iron railway bridges. The breaking and crushing strength of iron is well known, but its capacity to bear loads for long periods of time in permanent structures is *not* well known; hence the different opinions and practice prevailing among engineers.

Mr. Colburn says:—"In employing iron in any structure where it is subjected to strain, we seek to keep within its limit of elasticity; yet, not only have we but a comparatively small number of recorded experiments to show us what this limit is, even under a single and temporary strain, but we have the result of M. Vicat's experiments to show us that we cannot depend upon anything like this limit under a long-continued strain. What experimental knowledge we have goes to show that the original elastic limit of iron is greater when hammered than when rolled; but we are unable to count with any degree of certainty upon the ultimate superiority of hammered iron in this respect after long-continued strain."

An iron bar or girder, which supports a certain load for a week or a month, will become gradually weaker if that load exceeds its limit of elasticity; hence the necessity for knowing the exact load which it will bear a great length of time. Mr. W. Fairbairn made an extensive series of experiments between the years 1837 and 1842 to ascertain how long bars of cast iron would support loads equal to about nineteen-twentieths of their breaking weight. By taking care to prevent any vibration about these bars several of them continued for five years to support this load. Their deflection steadily increased, however, during the whole time, and some of them broke with one-twentieth of their original breaking weight. It is also known that iron which has withstood a great proof strain oftentimes breaks down afterwards under a much less strain.

Mr. Colburn raises a warning voice with respect to increasing dangers from the explosions of locomotive boilers by carrying high pressures of steam. He says:—"Iron is perhaps more severely strained in steam boilers than in any other structures. In the case of locomotive engines there is a disposition to employ still larger boilers and to carry still greater pressures. With 50-inch boilers, formed of $\frac{7}{16}$th-inch plates, double riveted and carrying (as is not now unusual) from 130 pounds to 150 pounds pressure, there is at the higher limit a circumferential strain of 5½ tuns per square inch at the joints and a longitudinal strain of nearly 2 tuns per square inch along the whole length of the boiler; the resulting strain at the joints being nearly 6 tuns per square inch. This strain is constantly maintained with plates ranging from 21 tuns to 24 tuns in strength and under all the contingencies of corrosion, incessant vibration and occasional sudden exaltations of pressure due to the instantaneous production of steam upon overheated tubes or plates. In many cases we have 4-feet boilers with ⅜-inch plates, single riveted and worked at 120 pounds—corresponding to a strain of at least 6½ tuns per square inch at the joints of the boiler when new; the circumferential and longitudinal strains being both taken here into account. Put under this strain when new, many locomotive boilers are worked in all for from ten to twenty years, and often from three to seven years without any internal examination of the plates. It is not remarkable, therefore, that explosions are becoming so frequent."

LIGHT AND HEAT FROM ELECTRICITY AND THE STARS.

A very remarkable scientific lecture was lately delivered before the Royal Society in London, by Prof. Miller, its treasurer. He related the results of a large number of experiments which he had made to test the chemical effects of different rays of light upon photographic paper, when transmitted through various transparent substances. There is a wonderful difference of chemical effect produced by different lights; and as great a variety of effect obtained from transparent substances in transmitting and absorbing both light and heat. Some of the results obtained from Prof. Miller's experiments and related in his lecture we give in a condensed form.

Some bodies which are transparent to light are not equally so to radiant heat. Glass for example, arrests a large portion of the rays of heat emitted by bodies which are not sufficiently hot to become luminous; but pure rock salt, freely transmits rays of both light and heat from all sources. In light there are also chemical rays, and while common glass absorbs many of these, quartz transmits them freely. The chemical rays of various luminous objects vary greatly in quantity and quality. Some sources of light emit rays of much higher refrangibility than others. Thus the flame of ordinary coal gas, when burned in an admixture of air so as to produce a blue light and a smokeless flame, gives out scarcely any rays capable of affecting an ordinary photographic plate; whilst the same gas, burned in the ordinary manner for illumination, emits decided rays capable of producing chemical action. It is also remarkable that the rays emanating from the intensely hot jet of the oxyhydrogen flame exert scarcely any chemical action upon sensitive collodion; but when this flame is thrown upon a ball of lime, the light then emitted contains as large a proportion of chemical rays as the light of the sun, and they are of nearly the same refrangibility. The most wonderful source of chemical rays, however, is afforded by the electric light, the chemical spectrum of which is three times as long as that obtained from the sun itself. Out of fourteen transparent solid substances through which light from the electric spark was sent and permitted to fall upon collodion coated with the iodide of silver, rock crystal, ice, and fluor spar transmitted the greatest number of chemical rays; the diamond was much inferior to any of these. Out of nine transparent liquids tested in the same manner, pure water was found to be the best; out of thirteen gases, oxygen, nitrogen, hydrogen, and carbonic acid were superior to all the others. Photographs were taken by the transmission of the light through these substances, and the time required in making the pictures was carefully noted.

In the case of reflection from polished surfaces, metals were found to vary greatly in the quantity of the rays which were reflected. Gold and lead, although not the most brilliant, reflected the rays more uniformly than the bright white surfaces of silver and speculum metal. The temperature of the hottest blast furnace does not exceed 4,500° Fah; and the oxyhydrogen flame has been estimated at a temperature of 14,600°. The spectrum obtained from this light was the same as that obtained from the solar spectrum; hence Prof. Miller considers that the temperature of the sun is not higher than that of the oxyhydrogen flame, which is far below that of the electric spark. The temperature of the sun's atmosphere is therefore considered to be less than the heat of the electric spark.

With respect to the influence of light from the distant stars, Prof. Miller said: "Conjointly with Mr. Huggins, I have been pursuing investigations with an 8-inch equatorial refractor, and we have obtained some interesting results, having measured the principal lines in the stars *Sirius*, *Betelgeus* and *Aldebaran*. The light of *Sirius*, from the measurements of Sir J. Herschel and Mr. Bond, is little more than one-sixth-thousandth-millionth part of that of the sun, and although probably not less in size than sixty of our suns, is estimated at more than one hundred and thirty millions of miles distant. And yet it is influencing in a measure the chemical changes which are perpetually occurring upon the earth's surface, and by suitable means the changes may be recorded, estimated, and measured; we have registered these by the photograph from rays which emanated from *Sirius* twenty-one years ago." A photograph has also been taken by the rays of the star *Capella*, which is more than three times the distance of *Sirius* from the earth.

Revenue Tax upon the Products of Iron Foundries.

The Commissioner of Internal Revenue has made the following decisions with reference to taxes imposed upon various products of iron foundries:—

1st. All steam engines, whether marine, locomotive or stationary, are subject to a duty of three per cent *ad valorem*.

2d. Cast-iron shafting is liable, in all cases, to a specific duty of one dollar and fifty cents per tun, under the act of March 3, 1863. Wrought-iron shafting, if held to be manufactured within the meaning of Division No. 71, is liable to a tax of three per cent *ad valorem*.

3d. Railroad-car wheels are taxable, in all cases, one dollar and fifty cents per tun. All other castings of iron exceeding ten pounds in weight, not otherwise provided for, are taxable one dollar and fifty cents per tun, by act of March 31, 1863.

4th. Castings of all descriptions made exclusively for instruments, articles of machinery upon which duties are assessed and paid, are exempt from duty under Section II., act of March 3, 1863.

5th. Castings not exceeding ten pounds in weight, which are so well known and so generally used as to have a commercial value in themselves, are taxable three per cent *ad valorem*, when not otherwise provided for.

6th. Castings used for bridges, buildings or other permanent structures are taxable one dollar per tun. Permanent structures are interpreted to mean bridges, buildings, monuments and edifices of all descriptions. Lamp-posts, water and gas pipes are not held to be permanent structures; but all such castings are taxed at the rate of one dollar and fifty cents per tun.

7th. Stoves and hollow-ware are taxed at the rate of one dollar and fifty cents per tun of two thousand pounds.

8th. Casual and ordinary repairs are not taxable, but renewals of any part of an engine, as, for instance, a boiler, cylinder, piston-rod, valve motion or governor—such parts being considered manufactures in themselves—are taxable, when made to replace corresponding parts of an engine, broken or worn out, and thrown aside. The same is true of cars, and all machinery, when new parts are supplied.

An Awful Shell.

An "occasional correspondent" of the *N. Y. Tribune*, writing from Washington on the 18th of April, states that a newly-invented explosive shell that has been recently tried at Woolwich, England, can "burst a plate however thick, produce a tremendous explosion, and set the vessel on fire." He states that one weighing 286 pounds, made of iron, and loaded with 11 pounds of explosive powder, was thrown from a 300-pounder (Armstrong), with a charge of 45 pounds of powder, and with a velocity of 1,330 feet per second. This is the shell recently described in our columns (page 257), as having been fired at the target in the experiments at Shoeburyness, England. The velocity of this shell is due to the charge of powder, not to the construction and nature of the shell. Such shells can be manufactured here as well as in England, but we cannot give them a high velocity with the small charges of powder which are used in our large cast-iron guns.

THE word "rhodomontade" has passed into most modern languages; it signifies a boastful way of talking, and is taken from Rodomonte, a boisterous character in "Orlando Furioso."