though the aberration of figure was much reduced,) had a shorter focus than the central rays. This combination might probably be improved, when its aperture is large, by adding a plano-concave lens of the same kind of which the other two lenses are made, having its concave side towards the parallel rays, and by changing the curves of the meniscus so as to destroy the aberration of figure.

A very simple microscope, mentioned in the *American Journal of Science and Arts*, Vol. 17, p. 362, was proposed by Dr. Wollaston, consisting of two plano-convex lenses with their plane sides next the object, and placed at such a distance from each other as would best correct the colour. (See p. 56, of this volume.) Though this microscope has advantages, I am satisfied from experiments that the sextuple object-glass is decidedly superior.

Purple light may be obtained by causing the sun's rays to be refracted through the prism, which will sufficiently separate the colours when it is placed ten or twelve feet from the microscope. It is probable that purple light would be preferable to any other, if it could be obtained sufficiently strong; but from experiment it appears that blue light answers the purpose as well, on account of its greater intensity.

In viewing most objects with blue or purple light, it is necessary to cause the light to pass through a surface of ground glass, which should be placed one or two tenths of an inch further from the object-glass of the microscope than the object viewed.

[*Silliman's Journal.*]

On the Safety of Steam Boats. By Professor SILLIMAN.

THE painful interest connected with this subject continues to receive occasional augmentation from the recurrence of fatal accidents. We refer our readers to some remarks in the beginning of the first article of the present number, and although they were written several months since, they are (if correct and judicious) more seasonable now than ever. The late fatal catastrophe on board the *United States*, steam boat of New Haven, is in some respects more interesting to the community than any one that has preceded it. This increased importance grows out of the fact that we are here deprived of the usual extenuations by which we hope to persuade ourselves that the accidents are fortuitous, and that they may not occur again. On board the *United States* there was a full supply of water, and the flue was not unduly heated; there was no improper pressure, and less than had been usually employed; the part of the boiler that failed was new; the commander was a veteran, distinguished for his experience, skill and vigilance, and his people were sober and faithful; still an explosion occurred which destroyed one-sixth of all the persons on board; we cannot, therefore, enjoy the consolation of imputing blame, and must charge the catastrophe to causes that may and will produce the same effect again.

In other cases we hear, indeed, that in one instance, the water was

deficient, and the flue became red hot; in a second, that the safety valve was obstructed or overloaded; in a third, that the supply tube was choked; in a fourth, that the boiler was old, and had become weak; in a fifth, that the metal, although new, was flawy; in a sixth, that they were in a strife for speed, and carried too much steam; and in a seventh, that the engineer was ignorant or intemperate, and the commander unqualified or remiss.

All these causes and others, have, doubtless, in different cases, contributed to produce explosions; but still the painful conclusion is forced upon us, that *explosions of steam boilers are produced by the energy of the power and by the weakness of the materials.* Our efforts must, therefore, be directed to the controlling and regulating of the power, and to the best use of the copper and iron, of one or the other of which the boilers are always made, and to their most judicious size, form, construction and position. This subject has recently attracted the attention of the Franklin Institute in Philadelphia, and that very useful and patriotic body has published a judicious circular, calling for exact information as to the facts that may tend to illustrate the causes and to indicate the remedies for explosions by steam. They direct their inquiries particularly to

The Boiler.—Its size, form, and relative thickness, the material from which it is made, (of copper or iron, &c.) if of iron, whether of foreign or American iron, especially in the boiler that exploded.

Safety Valve.—Its form, size, load in proportion to the thickness of the boiler, liability to get out of order, facility of repair, number used, location of the valve.

Supply of Water.—Mode of insuring a sufficiency, how gauged?

Arrangement of the Boilers in the Boat; which is less liable to accident?

Construction of the Boat—to avoid accidents in the boilers.

The very respectable names attached to the circular give us the best pledge, that a valuable report will, hereafter, be given to the public.

In the mean time, however, other explosions will occur, and other victims will be added to the great number already immolated by these thunder strokes of a power which so often proves more than a match for human skill. There is every possible motive for increased effort in improving the means of producing, managing and controlling steam; and with no view to diminish, but rather to quicken those efforts, we urge, that certainly for the present, and perhaps for ever, the safety of the community must depend upon one of two arrangements.

1. Having two boilers placed on the guards of the vessel over the water, and separated from the passengers, not only on the side,* *but every where*, excepting at the mouth of the furnace, by a bulwark made of timber, and sufficiently strong to resist, not only water and steam, but also the fragments that may be projected, or even the entire boiler should it be thrown from its bed.

* Open of course towards the water.

2. By taking a passage vessel in tow, the power being generated in one vessel, and the passengers being in another.

The first arrangement would be particularly important in such waters as are occasionally rough, where towing might be inconvenient, and at times impracticable, as on Long Island Sound, and the Chesapeake and the great lakes. To the second there seems no objection of any weight, upon waters protected from storms, and which are generally smooth; such as all our rivers and many of our bays, and arms of the sea. The excessive speed which is now aimed at, is of no importance; no reasonable man will be dissatisfied if, (sleeping and waking) he can go ten miles in an hour, which exceeds the rate of the swiftest mails in Europe, and is hardly surpassed by the fastest sailing ships of war. This degree of speed, and probably more, is attainable in tow boats, and we have thought the important suggestions of Mr. Richard Sullivan, an experienced scientific, as well as practical engineer, contained in the subjoined paper, which originally appeared in the Daily Advertiser of New York, worthy of being preserved, as containing an excellent summary view of safety barges, towed by steam boats. With him, we greatly fear that explosions will never be entirely prevented; and while several of them occur every year; while many valuable people are thus torn from life and from their friends, in a manner even more agonizing than by the casualties of war; while general anxiety pervades the community, and we know that (like the Parisians of late) *we are reposing over a volcano*; no time should be lost in adopting such means of prevention or of safety, as cannot fail to be in a good degree successful, at least in preserving the lives, now so often sacrificed; and the number of which will be greatly augmented whenever an explosion shall happen among the congregated hundreds, who now, *tempted by a mischievous nominal fare*, crowd the decks of many of our steam boats, so that they resemble transport ships, in a time of war, more than vessels for safety and pleasure, in a period of peace. The double remedy now pointed out is worthy of the more consideration from the proprietors of steam boats, because all those now in use, (with a great addition to their accommodations as well as safety,) can be furnished with the double boilers and the protecting bulwarks, which, to afford every possible security to their people, should be adopted, even where the safety barges are added. Then all the protection will be afforded, which the present state of our experience admits, and it will probably be sufficient, even should science and art do no more for mankind on the subject of steam; explosions will be diminished in number, because the boilers will be smaller, and more anxiously watched, and the victims, few in number, will be those who, like soldiers and sailors in time of war, encounter a known danger, and have a right to, and will obtain, a reward in some measure proportionate to the risk incurred. *The proprietors of steam boats must answer it to their country and to God, if they neglect any practicable means of defending their fellow creatures from the most awful and afflictive casualty to which the confiding traveller is exposed.* No scheme will answer which does not either remove the passengers

from the danger, or remove the dreaded boiler from the crowd which surrounds it, and from the possibility of deluging men, women and children, in boiling water—in boiling brine—in an atmosphere of over heated steam, or of destroying them by the fragments, or by the entire boiler, projected among their crowded ranks. *The boat which is first ascertained to afford absolute security will be a fortune to its proprietors.*

On the Safety of Steam Boats. By JOHN L. SULLIVAN, Civil Engineer.

Theodore Dwight, Esq.—SIR,—Your paper, and others, having given expression to the public solicitude on occasion of the late accident on board the *Marshall*, in reference to the future safety of passengers, it may be presumed that any suggestions to that end will be acceptable to a community with whom the inquiry may well arise, whether there can be any sure remedy for this danger?

To mention only some of its sources will enable all to answer the question for themselves.

The engineer (commonly so called) is not perhaps the person to whose negligence these calamities are chargeable, but rather to the fireman; who, besides throwing in the fuel, has to see, by the gauge cocks, that the water is kept adequately supplied. This station is extremely arduous, and he is to an unusual degree exposed to the temptation of drinking inordinately. The boiler is usually made of large diameter, and with an inside flue, which is intended to be always covered by the water. This is not the strongest form in which a boiler can be made, but is that which takes up the least room. This flue may, not only from the inattention of the fireman, but from any accidental obstruction or disorder of the supply pump, get uncovered, or the water low, when it will become red hot, soft, flexible, thin, and weak; and as this part of the boiler is out of sight, this may happen (to a degree short of giving way) frequently in the course of a season: and although the proper quantity of water may be presently regained, still the hidden weakness thus caused remains, and may show itself fatally at some subsequent period. If it were asked, how is the thickness of a boiler in all its parts, after being some length of time in use, ascertained to be sufficient? The usual method is to strike it with a hammer, wherever accessible, trusting to the indications given by the sound of the blow. In the making of boilers, it is possible that the plates may have flaws not quite obvious enough for their rejection, and it is not uncommon for rivets to break by the expansion of the metal, if not made of very good iron. Boilers may be kept in use too long, when the business is not very profitable. It is an expensive job to displace them for repairs, and it is natural to defer it as long as may be safe. Steam boats are sometimes sold at auction, to close a concern, when although the age of the boiler may be told, its condition cannot be so easily known.

It is commonly supposed that the safety valve is an effectual safe-