ble to the eye, but manifest themselves in the physical properties of the finished products.

This is illustrated by an imperfect piece of glass, which shows veins and striæ arising from different densities of the composition; also by mixing painter's colors of different hues and densities. Lampblack and white lead, as an exaggerated example will not form a uniform resultant gray without much stirring. It is alleged that such is the case with spiegeleisen and decarbonized iron unless it is agitated and thoroughly mixed before being poured into the ingot mould.

In support of the theory that there is a difference in the chemical composition of the ingot before rolling into the finished form, we abstract from a paper read by Mr. G. J. Snelus at the same meeting, the entire proceedings of which we find in the *Ironmonger*. Mr. Snelus says: "At the last meeting of this Institute, in the discussion of Mr. Parry's paper, Mr. Stubbs announced the remarkable fact that he had discovered that the 'cast steel ingots' could not be strictly said to be homogeneous, and that a 'redistribution of the elements took place during solidification, the carbon, sulphur and phosphorus going to the part of the ingot which remained fluid the longest, so that the center of the ingot became the most impure.' Some years ago Dr. Percy suggested to me the desirability of ascertaining whether the spiegeleisen became thoroughly diffused in an ordinary Bessemer charge, and, to test the question, I analyzed the first and last ingots from a charge, and also the top and bottom of an ingot."

At the first series of experiments, which were upon small ingots, Mr. Stubbs' theory could not be established, but on repeating them upon large ingots, different results appeared.

After the spiegeleisen had been added the blast was sent through for nearly a minute to assure a thorough admixture. Slices were taken from this ingot twenty-one inches from the top and four inches from the bottom. The samples were exhibited at the meeting, the bottom one said to be sound, while the top one was spongy, which is in accordance with every foundryman's experience. But the important feature is the difference in the chemical composition. There was more than double as much combined carbon, and more than four times as much sulphur and phosphorus, in the upper section as there was found in the lower section, while nearly the same difference existed between the center or axis of the ingot and the corners, as shown by analysis of successive drillings made on a diagonal line across the slip which had been cut horizontally from the prismatic ingot.

"These results," says the paper, "confirm the molecular interchange discovered by Mr. Stubbs in large ingots, and show that carbon, sulphur, and silicon become concentrated in those portions of the ingot that remain fluid the longest, leaving iron and manganese in excess in the portions from which they have liquidated."

The paper also says "the difference in hardness was most marked, rendering it difficult to cut the top slices near the center, while the bottom cut quite easily."

Now, it seems strange that Mr. Snelus should argue "that the singular molecular change does not afford an explanation of the peculiar behavior of the Livadia's plates." What, then, is the explanation? It is certain the plates were not homogeneous, if we are told the truth about their behavior, and the extreme care that was taken by the firm who made the boilers in annealing and reannealing them after punching the rivet holes. An engineer who has had experience with vicious workmen might fairly suspect that there is "a nigger in the fence."

It is hoped that our English neighbors will ferret him out, or else we cannot feel quite safe in the use of plates made from large ingots of soft steel. Our own steel makers have been more fortunate, but as the size of ingots increases there is danger that they also may get caught.

STEAM BOILER NOTES.

A boiler in Davis & Jones' portable steam sawmill, near Coalton, Jackson County, Ohio, exploded November 2. John Davis, one of the proprietors, was fatally injured, and David Griffiths was seriously injured.

It is a significant fact that in this country more boilers explode in establishments that use light fuel than in any other class of manufactories. In the year 1879 one-third of all the disastrous explosions that were published were in sawing and other woodworking mills that use their light refuse for fuel, and in 1880, 28 percentum of the unusually large total of explosions for that year were in this class of mills. It is probable that this results mainly from neglect of the safety valves, coupled with the great, sudden, and oft repeated changes of the temperature of the boiler shell, the result of careless, excessive, and irregular firing, and perhaps the use of ice-cold feed water. The effect is violent contractions alternating with expansions of the parts of the boiler that are exposed to cold currents of inflowing air when the fire doors are opened, which occurs in this class of boilers perhaps ten times as often as in those that burn hard anthracite. The same parts of the boiler are, when the fire doors are closed, exposed to the greatest heat of the brisk fire, and a sudden explosion follows.

The great number of thrashing engine explosions that occur every autumn tends to confirm this theory of the cause of deterioration, from which no doubt many disasters arise.

It is also a fact that portable sawmills and thrashing machines are generally in the hands of log drivers or farmers, who do not think it worth while to have their boilers inspected or to employ an engineer, even when adjustments of the engine are needed, believing that they can "fix her up," and that "she" will safely wear out as their boots or their carts and draught chains do.

Builders of portable engines sometimes, nay often, sell their machines to inexperienced persons as absolutely safe from explosion, citing some feature new to the buyer or disguised by some change of outward form of the boiler, which render it entirely unnecessary to know anything about steam or the steam engine in order to use them with perfect safety.

"Build your fire, give her plenty of water, and carry all the steam you need, she's fixed to take care of herself," is the parting instruction to the enterprising huckster as he drives away with his new purchase, the *Excelsior* or the *Gamecock*, from the works of the equally enterprising builder of non-explosive portable engines. Those who know that there are twenty ways for that machine to get out of fix, a dozen of which relate to the safety valve and the steam gauge, do not care to read the details of the inevitable sequel of such an adventure.

A RAIN OF SPIDER WEBS.

In the latter part of October the good people of Milwaukee (Wis.) and the neighboring towns were astonished by a general fall of spider webs. The webs seemed to come from "over the lake," and appeared to fall from a great height. The strands were from two feet to several rods in length. At Green Bay the fall was the same, coming from the direction of the bay, only the webs varied from sixty feet in length to mere specks, and were seen as far up in the air as the power of the eye could reach. At Vesburg and Fort Howard, Sheboygan, and Ozaukee, the fall was similarly observed, in some places being so thick as to annoy the eye. In all instances the webs were strong in texture and very white.

Curiously there is no mention, in any of the reports that we have seen, of the presence of spiders in this general shower of webs. It is to be hoped that some competent observer—that is, some one who has made a study of spiders and their habits—was at hand and will report more specifically the conditions of this interesting phenomenon.

Quite a number of notable gossamer showers have been reported in different parts of the world. White describes several in his history of Selborne. In one of them the fall continued nearly a whole day, the webs coming from such a height that from the top of the highest hill near by they were seen descending from a region still above the range of distinct vision.

Darwin describes a similar shower observed by him from the deck of the Beagle, off the mouth of La Plata River, when the vessel was sixty miles from land. He was probably the first to notice that each web of the gossamer carried a Lilliputian aeronaut. He watched the spiders on their arrival and saw many of them put forth a new web and float away.

The behavior of the spiders when setting out upon their aerial voyage has been minutely described by a recent English observer. The shower observed by him occurred in September, 1875, after a thunderstorm without rain. He says:

"About ten A.M. I noticed small spiders running over my coat-sleeves, and had to brush off several trails of gossamer web. Looking round I found that brick walls, houses, branches of trees, etc., had these webs dangling from them, and that other gossamer webs were continually falling from above and adding to the accumulation. By mid-day a long fence was festooned from point to point of its triangular rail-tops with a ribbon-like ladder of gossamer; and this was growing broader and broader as the tiny creatures kept running along this ladder, each increasing the breadth by adding its own contribution of another silken thread.

"On examining next an iron palisading near, I found it in a similar condition, with the tops of the iron spikes connected by a vibrating silken ladder of gossamer, in some places nearly an inch broad. All along this ladder the little strangers were running in an excited and hurried manner, as if they had lost their way and had got into a strange country. Some, in traveling over their improvised road, made mistakes, and got into bordering webs of the garden spider, where they were speedily devoured. About 1 P.M. the clouds cleared off, the sun shone out, and I noticed that some of the spiders had begun to reascend into the atmosphere. They might have commenced this reascension earlier; but on observing that some *were* reascending all my attention was devoted to single spiders, and this is what I saw: Fixing my eyes upon one of them, I observed that as it left the gossamer pathway it selected a clean spot on the iron railing, and gathering its limbs closely together it projected from its spinnerets several threads, which expanded outward and stretched upward from nine to twelve inches. Then this parachute seemed to show a buoyant tendency, and suddenly the tiny creature left hold of the iron rail, or was lifted off it, and quickly 'vanished into thin air.' One after another I closely watched, with the same general result; though once or twice when the spider left the rail it floated for a few seconds in an almost horizontal direction, prior to changing it for an approximately vertical one. They, however, disappeared from sight so quickly that the angle of ascent could only be guessed at. This, however, may be set down, as the rule, at from ninety to one hundred and twenty degrees."

The object of these spider migrations, if they are migrations, and the reasons for the fall of the webs at a time when the spiders are able to ascend at will, are mysteries which are as hard to explain to-day as they were in Chaucer's time, or in that mythical period from which comes the ancient nursery rhyme:

> "'Old woman, old woman, old woman,' quoth I,
> 'O whither, O whither, O whither so high?'
> 'To sweep the cobwebs out of the sky!'"

From the strength of the webs reported in the recent Western showers there would appear to be a doubt as to the spider which produced them. They seem to have been too strong for gossamers. Perhaps the shower may have been due to an unusual excursion of the more familiar geometric spider, this species having the same power of shooting out webs which float upon the air and sometimes serve as an aeraft for the producer. The natural history of spiders is comparatively an unexplored field for observation; and it is possible that many species emulate the wandering gossamer spider, and betake themselves to the air when occasion serves.

EXPERIMENTS WITH THE GOVERNMENT TESTING MACHINE.

A pamphlet lately published by Colonel T. T. S. Laidley, U. S A, contains an interesting account of experiments made with the great United States testing machine at the Arsenal, Watertown, Mass. The experiments were made upon thick, hollow, cast iron cylinders similar to cannon, some of them lined with coiled wrought iron, and some with bronze tubes, and in competition with them others lined with thin copper tubes. It was held by the author of the paper, as an officer of the Ordnance Board, that the simple hollow cylinder of American cast iron is stronger to resist internal pressure than composite cylinders made upon the plan proposed for the conversion of old 10-inch smooth borers into 8-inch rifled guns. The object of the thin copper lining used by Colonel Laidley is, in practice, to prevent the gases resulting from the burning of the charge from penetrating the incipient cracks in the bore that are developed by continued firing. These gases have thus "an enlarged surface to act upon to burst the gun."

The cylinders experimented on had a uniform diameter of 11 inches and a bore inside of the tubing of 3·3 inches. Of the cylinders made upon the composite plan, those having the iron lining had had a section of about 3 inches of cast iron and 0·9 inch of coiled wrought iron, in thickness on coil side of the bore. Those having the bronze lining had about 3·4 inches of cast iron and 0·5 inch of bronze, while those lined with thin copper had all but 0·1 inch of thin section of cast iron, and, as regards strength to resist internal pressure, they might be considered as cast iron with loose copper veneers. These cylinders, having a length of bore of 16½ to 17⅛ inches, were tested by pressure upon a filling of cold beeswax by means of a nicely fitting copper follower and a loosely fitting steel piston, which, having been put into the cylinder in the order in which they are here named, the whole was placed in the immense testing machine and the piston forced in. The wax was compressed 11·6 per cent under a pressure of 60,000 pounds per square inch, but the yielding of the cylinders before bursting allowed a shortening of the column of wax something more than that fraction of its length.

The veneered or copper lined cylinders burst at an average pressure of 93,400, the bronze lined cylinders at 84,500, and the coiled iron lined cylinders at 78,000 pounds per square inch. They burst at the above roughly stated averages with loud reports which were heard at considerable distance, and the fragments, not exceeding three or four in any one case, were thrown with such force as to crack a five-eighths inch wrought iron casing that surrounded them.

Colonel Laidley in his report says: "The strength of the different kinds of cylinders is in direct proportion to the area of cast iron in the longitudinal section through the axis of the cylinder." And his conclusion is: "That any system of gun construction based on this plan of conversion will be found to be defective in principle and in the end expensive."

It seems to be expensive in the beginning, as the report shows that about $1,700 will pay for an 8-inch rifled cast iron gun of the exterior pattern of the 10 inch Rodman smooth bore, while the weaker converted 8-inch guns recently made cost $2,050 each.

The other officers of the U. S. Ordnance Board seem to reject the conclusions based on these experiments, the board deciding "that any favorable consideration of the question of the use of cast iron (pure and simple) in gun construction would be a step backwards."

To an outsider it will not appear, from the report, that "pure and simple" cast iron is indicated by these experiments, but new cast iron guns lined with thin tubes "sufficient to act as gas checks and exclude the gas from all cracks that may be formed in the course of the firing."

Moreover, it is by no means certain that a sound cast iron surface of the bore is not penetrated by the gases, and that a proper gas check lining would not prevent the inception as well as the subsequent enlargement of cracks. The members of the board, however, having probably committed themselves, upon such information as they previously had, to the composite plan, do not approve of experiments with gunpowder upon *small* cylinders, as is now recommended by Colonel Laidley.

The pamphlet contains photographs of the broken cylinders and a reply to the remarks made by the Ordnance Board. We commend it for perusal to all who are interested in progress in gunnery.