THE NEW SCYLLA AND CHARYBDIS.

BY H. C. HOVEY.

Two pits of extraordinary magnitude have lately been discovered in Mammoth Cave, in such perilous proximity that risk is run of falling into the one while avoiding the other. Hence they have been aptly named "Scylla and Charybdis," in memory of the verse:

'Incidis in Scyllam cupiens vitare Charybdim."

Before giving an account of these particular pits it may be well to explain the formation of such cavities in general. The accompanying diagram (Fig. 1) shows a vertical section of an excavation made by the action of water on limestone—a process requiring an indefinitely long time, and proceeding at a varying rate corresponding to the abundance of the rainfall on the surface. The water, becoming acidulated as it sinks down through the soil, attacks the limestone along its lines of weakness. It thus holds in solution a portion of the rocky strata, in the form of carbonate of lime, and carries it away as it seeks the drainage level, A B. The result at first may be nothing more than an obscure fissure, leading from the sink-holes, S and S', to the outlets, A and E, which, at a later period, become mouths of the completed cavern. As the crevice grows, the chemical action in which it began is aided mechanically by the quantities of sand and gravel swept in through the sinks, and that, being whirled about by the water, operate as a powerful cutting engine. The enlargements thus made are irregular in shape and frequently of great size.

Should the opening through the sink-hole be free from rubbish, the explorer will often find it the orifice of what he appropriately calls a *pit*. Should he gain admittance, however, by the drainage outlet, A, and follow the subterranean channel toward B, he will presently enter the chambers, C and D, and looking aloft to the vaulted roof, he will, with equal fitness, call them *domes*. But let him enter at E, the outlet of a former drainage, and come to a chasm capable perhaps of being bridged (as at F), he will say, as he alternately looks up and down, that a pit is below and a dome above. It may not occur to the explorer till long afterward that the pit, the dome, and the chasm are identical.

To this explanation it should be added, that, if the water has to make its way through a stratum of sandstone before reaching the cavernous limestone, the sink-holes and pits may not coincide; the former simply leading to crevices of no great depth, and the latter being connected with them by winding passages burrowed out between the two formations.

The thickness of what is geologically known as "the Saint Louis limestone," as it exists in Edmondson county, Ky., is between 600 and 700 feet, and it dips to the west at the rate of about ten feet to the mile. The exposed ledges everywhere show the results of erosion by acidulated water, and it is said that nearly every acre has its sink-hole, large or small. According to Prof. Shaler, there are about 500 open caverns in that single county. Many of these are capable of being entered directly from sink-holes; but it is a remarkable fact that, of all the hundreds of these depressions scattered over the area undermined by Mammoth Cave, not one is known to open directly into it! This I attribute to the overlying stratum of Chester sandstone, which resists the action of ordinary acids, although admitting the acidulated water through its seams and crevices, to do its work on the limestone below. In illustration of this, it is regarded as quite certain that the large sink-hole between the entrance to Mammoth Cave and White's Cave is drained through what has long been known as "Little Bat Avenue," in the former. Near the end of this avenue there is a small aperture into which, in 1812, a saltpeter miner dropped his lamp, and in his futile efforts to recover it found that it had gone down into a very deep pit. The incident was noted chiefly because the missing lamp could not be replaced short of Lexington. Messrs. Smith and Buford discovered "Mammoth Dome" in 1843, supposed to be the largest of all known domes. During their explorations they came across, greatly to their surprise, the miner's lamp that had been lost thirty-one years before, and that had been cemented to the floor by stalagmitic drippings!

Among the noted pits and domes in this extensive cavern may be mentioned "Napoleon's Dome," comparatively small, but remarkably symmetrical; "Lucy's Dome," estimated to be 600 feet high, though no means of taking an exact measurement have yet been found; and the "Maelstrom," the pit down whose frightful depths Prentice (son of the poet of that name) descended by a rope held by the guides. The rope was afterward measured and found to be 135 feet long. Most wonderful of all, however, is the cluster of pits and domes represented in the diagram, Fig. 2. In order to see them the visitor leaves the main cave at a point about three-quarters of a mile within, and passes around the huge block known as the "Giant's Coffin," and follows a winding way leading underneath the main cave.

The "Wooden Bowl" is a small room containing quantities of quartzose gravel, betraying the means by which these excavations were made. Next is the "Side-Saddle Pit," 65 feet deep, as measured by my guide, a colored man, William Garvin, who took along with him a ball of twine for such purposes. The opening is about 25 feet across. Over it, or nearly so, is "Minerva's Dome," 35 feet high. Descending a stairway, a short distance beyond, we enter the "Labyrinth," leading to "Gorin's Dome," formerly estimated to be 500 feet high. But the fact that recent barometrical observations fix the extreme vertical depth cut through the mass of limestone to reach the drainage level in Mammoth Cave at 328 feet, effectually disposes of all such exaggerated estimates. The aperture through which "Gorin's Dome" is seen by the visitor is a sort of window 90 feet above the floor of the dome. The latter can be gained by a side passage. In the floor is a small pit 15 feet deep, leading to a body of water 12 feet deep, making the depth from the window to the lowest point 117 feet. The height of the vault overhead seems to me to be about 100 feet; which gives 217 feet for the extreme altitude of this dome.

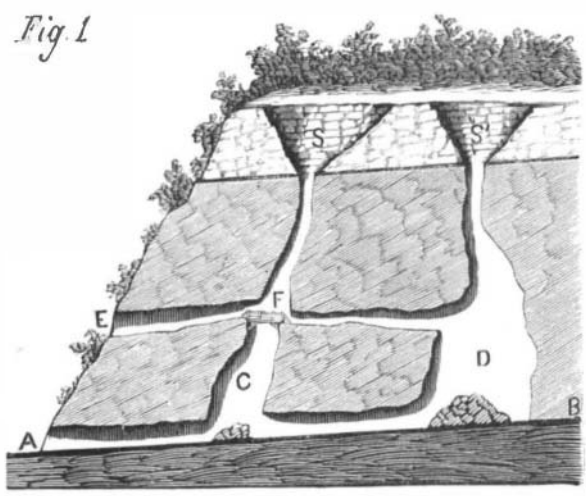
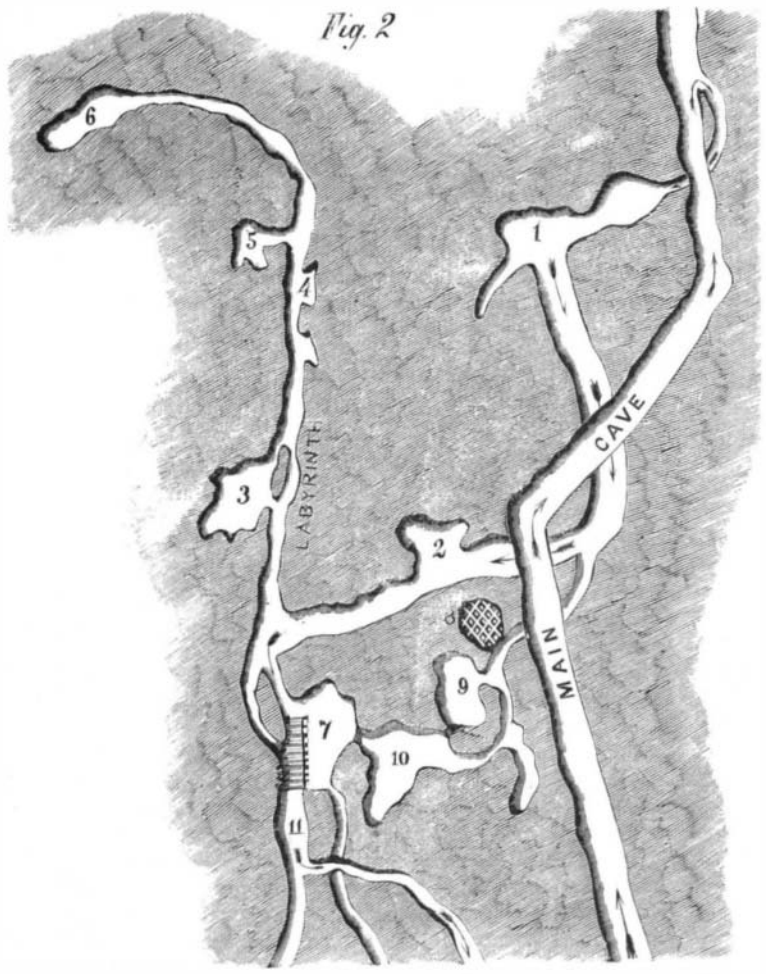


Fig. 1.—VERTICAL SECTION.

There are three or four small domes and pits beyond, indicated in the diagram merely because they belong to the group. One of these has been lately named in honor of Prof. F. W. Putnam, and the other for the writer of this communication.

Returning up the stairway leading out of the "Labyrinth," we next approach a famous chasm, known as the "Bottomless Pit," above which expands "Shelby's Dome." This was long considered an impassable barrier to further progress in the cave, but it is now crossed by a substantial bridge built to the further side from a tongue of rock that juts out into the pit for about 27 feet, seeming to divide the horse-shoe-like chasm into two pits. One of these pits is by exact measurement 95 feet deep, and the other 105 feet deep, although the guides have been accustomed to give much larger figures. "Shelby's Dome" may be about 60 feet high, the space between the pit and dome being 15 feet, thus making the greatest distance from top to bottom about 180 feet.



1. Wooden Bowl.—2. Side-Saddle Pit.—3. Gorin's Dome.—4. Putnam's Cabinet.—5. Hovey's Cabinet.—6. Ariadne's Grotto.—7. Bottomless Pit.—8. Covered Pit.—9. Scylla.—10. Charybdis.—11. Revelers' Hall.

Fig. 2.—PLAN OF A PART OF MAMMOTH CAVE.

Most of the localities thus far mentioned have long been open to visitors; but it has been necessary to show their place in the cave, and their relation to each other, in order to an understanding of "Scylla" and "Charybdis," which were found only last winter by the guide, William Garvin, accompanied by Mr. C. T. Hill, and are not yet open to any except the most resolute cave hunters. Indeed I was told by the guide that I was the first visitor who had been permitted to explore this perilous place, though I learn that several have visited it since. The approach is by a low, creeping passage, opening from the arched way, and leading to what has been known—only to be shunned—for many years, namely, the "Covered Pit," a treacherous chasm, imperfectly covered by loose slabs of limestone, between which the black depths seem to be lying in wait for the explorer. After crawling on our hands and knees for some distance, we stopped, and William told me to listen to the slow dripping of water, and throwing a pebble through a low opening on the right, I could hear it bounding from side to side, and after long intervals falling into a body of water at a prodigious distance below. The guide was delighted at my expressions of horror, and repeated the experiment several times. He then challenged me to creep up to the edge and look down. In doing so we lay on a rocky bridge, with the old "Covered Pit" on our right, and the cavity since named "Scylla" on our left. The latter is really a pit within a pit, as we found on throwing lighted rolls of oiled paper down its mouth. The upper pit seemed to be about 90 feet deep, and at its bottom we could just discern the orifice of the lower one. I was anxious to find a point from which we could examine this inner pit to better advantage. Creeping back from off the bridge, and then onward around a rocky pillar, for perhaps forty yards, we came upon the further edge of Scylla, and also found another horrible pit on the left, which, in pursuance of a suggestion from Mr. Klett, the manager of the cave, we named "Charybdis." The dividing ridge at this point was only about six feet wide, between the two chasms, and the classical names chosen seemed to us quite appropriate. Willing to run some risk in pursuit of my object, I clambered a short distance down into "Scylla," to a ledge overhanging its very deepest portion, and cleft by a serpentine crevice about five inches wide. Dropping pebbles through this crack, we could easily time them as they fell, unobstructed, to the bottom of the lowest pit. By repeated trials we determined the time to be exactly five seconds by the watch. This, by a well known formula for calculating accelerated motion, would give 402 feet as the depth *in vacuo*. Making due allowance for the resistance of the atmosphere, and also for the time necessary for the return of the sound, the space passed by the falling pebble was not less than 200 feet, nor more than 250 feet. William, not satisfied with what he may have regarded as scientific guess-work, produced his ball of cord, fastened a lamp to the end of it, and let it down into the darkness. The glimmering light served to show the irregular walls of the abyss, as it descended, until at length it caught on a projecting rock. In his efforts to shake it loose, the guide was so unfortunate as to burn the cord off. The lamp, however, remained where it had lodged, shining on as if determined to do its duty to the last! The part of the cord that was drawn up measured 135 feet, leaving us, afterall, to conjecture the remaining depth, our conclusion being that the previous calculation had been near the truth. Probably the limestone is pierced to the drainage level—a distance, according to the barometer, as inspected in the "Arched Way," of about 220 feet.

Glad to forsake the thin crust on which we stood, overhanging such depths, we climbed out of the jaws of "Scylla," and made experiments on the depth of "Charybdis." Here again the fragments of stone cast down were five seconds in reaching the pool below. Along the perilous rim William led the way to still another chasm, which he identified as the "Bottomless Pit." Regaining with some difficulty the bridge over it, we proceeded for a short distance on the path that leads to "River Hall," and then turned back by a passage leading under the rocks to an opening in the wall of the "Bottomless Pit," about forty feet below the bridge. Here we saw the famous pit in a new light, and also obtained the only good view to be had of "Shelby's Dome" overhead. While we were standing there I noticed a volume of smoke issuing from a window beyond us. On investigating this phenomenon more closely, we found ourselves looking again into "Charybdis," though not at its deepest part. The smoke came from blue lights we had ignited just before leaving it. On mentioning this fact to Mr. Klett, I was informed by him that he had, on a former occasion, been burning lights in the new pits, and workmen on the bridge had seen them.

Thus, as we have shown, there are, within an area whose diameter does not exceed 600 yards, and may be considerably less than that, six of the largest naturally-formed pits in the known world, besides several others of smaller dimensions; and the entire group is joined together by connecting passages.

On inquiring if there was any sink hole in the vicinity to correspond with such a cluster of chasms, I was directed to

a piece of unbroken forest, less than half a mile from the Mammoth Cave Hotel, where all the requirements of the case seem to be met. This vast depression embraces many acres, and is so deep that, when standing on its edge, one can overlook the tops of the trees growing in the central portion. But it remains to be proved by further exploration whether there are any hidden channels communicating, directly or otherwise, with the remarkable group of domes and pits I have attempted to describe in this article.

AMERICAN INDUSTRIES.—No. 78.

INDUSTRIAL PROGRESS AS REPRESENTED AT THE FIFTIETH EXHIBITION OF THE AMERICAN INSTITUTE.

The popularity of the now constantly recurring fairs in different sections of the country, showing the advancement we are making in the arts and sciences, in mechanics, chemistry, and our multitudinous manufactures, seems to be in no way diminished by their frequency. They are, on the contrary, at once the index and exponent of the activity, enterprise, skill, and inventive genius which are so characteristic of American progress to-day, so that the public is in entire harmony with the spirit they represent, and heartily inclined for a ready appreciation of all which contributes to their interest.

The semi-centennial exhibition of the American Institute, now being held in this city, extends and rounds out what had heretofore been a long and most valuable record of the growth of our manufactures, and the contributions of American inventors and mechanics in furtherance of the march of improvement in all the arts and sciences. It is worthy of its predecessors in all that goes to make such an exhibition not only attractive to mere sightseers, but valuable as an educator, in the means it affords of bringing the public more heartily into sympathy with the spirit of modern scientific investigation, and rendering observers more appreciative of the high degree of excellence which is being reached in all industrial pursuits.

It would be impossible, within the limits of a single article, to make even the briefest allusion to all of the exhibits here shown that are deserving of attentive examination. In the machinery department every inch of space is occupied, and some of the engines working here are models of beauty and symmetry, doing their work so smoothly and noiselessly that one would hardly know they were running were it not from the motion of the belts and shafts and the machines operated. The most interesting exhibit in this department, and one which constantly attracts crowds of visitors, is that of the Brush electric light system, the operation of which, and its thorough efficiency, with a pretty accurate idea of the consumption of power, and the inconsiderable wear and tear, can be readily understood by any visitor with the least possible idea of machinery. Of the light itself it is scarcely necessary to speak, all parts of the exhibition being made as bright as though sunlight were streaming in at every window when all of the ninety-six lamps are burning, while half of them make the gas lights look as insignificant as the old-fashioned "tallow dips."

On the first page of this paper we present illustrations of some of the prominent exhibits at the fair. The display of the New York Belting and Packing Company, shown in the large view at the bottom of the page, bears a sign in large letters, with the legend

"RUBBER VS. LEATHER."

It is on the left, as the visitor proceeds from the main aisle of the exhibition building to the machinery annex, where it cannot fail to meet the eyes of all who use belting, and under the sign is inscribed the statement that it would require "one thousand ox hides" to furnish leather sufficient to manufacture the large belts shown. One could readily figure out this for himself by taking the surface measurement and allowing for only the portions of a hide usually taken by leather belt manufacturers, but here would come in the fact that many of the leather belt manufacturers use more of the inferior parts than others, and the further fact that, no two hides being exactly alike, and no one hide being of the same strength or substance in different portions, it would probably trouble the investigator with a mathematical turn of mind as much as it does the leather belt manufacturers themselves, to tell just what selections and measurements to make to obtain even strength and substance in any large belt.

All of this difficulty is avoided in the manufacture of rubber belts, which are sure to be homogeneous throughout, and never before has there been a better display of what it is possible to accomplish in the making of rubber belting than is afforded in this exhibit.

The New York Belting and Packing Company have for many years made this manufacture a leading feature of their business and introduced improvements of the highest value. The great strength of the rubber-coated and impregnated duck used in their belts insures them against any break from a tensile pull twice or three times as great as the best leather will stand; the "stretch" is also taken out completely, the belts being subjected, while under tension, to the action of a powerful hydraulic press, one of the largest of the kind in the world, the bed and platen of which are steam heated, so that the fibers, thus compressed between the hot plates, are set almost as firmly as the particles in a bar of steel; the edges of the belts are firm and smooth, there being practically no joints, and, by a long course of improvements in the composition, they have a hard and tough, almost metallic, surface, but still one of such a nature that these belts always hug the pulley more closely than leather belts.

The contest as to the relative value and efficiency of rubber against leather belts is an old one, but it is one which mechanics and millowners are always interested in, and only those who have seen and used rubber belts of the best quality are qualified to form a correct judgment, for, although there has been a great improvement in the manufacture within a few years, there are still made large quantities of rubber belts of a cheap and inferior quality. In connection with the belting shown in this exhibit are furnished testimonials from some of the prominent users, including many of the great elevator companies, who use the largest sized belts known. These show that in some instances the belts have been used twelve and fifteen years, "without costing a dollar for repair, and still in as good condition as when first set to work." This the company think quite as good a record as can be produced in favor of any leather belting made, notwithstanding the fact that a newspaper in the interest of leather dealers a few months ago quoted as follows from the pamphlet of a leather belt manufacturer: "Buying a rubber, gutta percha, or canvas belt is very much like buying a sickly horse at 33⅓ per cent less than a good healthy one would cost. If such a horse is well groomed, used carefully, left in the stable when sick—when the weather is hot, when cold, when stormy—he may live six months; with extreme care and good luck, one may be able to say that he owns a horse for twelve or eighteen months. Pay 33⅓ per cent more and buy a good healthy one, use him well and kindly, he is always at your service, and can be depended upon. After being in use twelve or fifteen years, he is still good, and, if sold, will bring 33⅓ per cent of his cost. A word to the wise is sufficient." This seems to be a case where the saying that "one story is good until another is told," is particularly in point, and, as the exhibits of both kinds of belting are excellent, those interested will do well to examine for themselves.

Of the other productions of the company, the various kinds of packing, hose, valves, car and wagon springs, mats, gas tubing, etc., make a most interesting display to all who desire to utilize vulcanized rubber fabrics for mechanical purposes. The knot of bicycle tires shown is likewise suggestive, not only of the rapid increase of the demand for these novel steeds, but also of many other uses to which this principle might be applied in rendering cars and other vehicles noiseless and increasing their traction.

The exhibit of Vulcanite Emery Wheels covers a full line of sizes, and embraces the leading grades for fine or coarse work. Only the genuine Wellington Mills emery is used in the manufacture of these wheels, and the company believe they have now attained very near perfection in their production. Every detail as to the best possible constituents for the composition which shall closely bind the emery, the degree of heat and time required for vulcanization, and the mechanical appliances best fitted for the necessary operations, were the subject of prolonged and costly experiments, and the success they have attained is best attested by the large demand for their wheels both at home and abroad. Only just enough rubber is used in their manufacture to bind the emery closely, but they are sufficiently strong to be run at a circumferential velocity of 5,000 to 7,000 feet per minute, and wear evenly, without glazing. Many as are the uses for which emery wheels have been employed in late years, there is hardly a week but develops some new work for them in our factories and machine shops, and a uniform as well as high quality has now become quite as important in this specialty as it is in any other part of the outfit of an artisan.

THE NEW PULSOMETER STEAM PUMP.

An illustration showing this exhibit at the Fair may be seen at the top of the page, to the left. The improvements made in this pump, since which it has been designated as the "new" pulsometer, have caused a widely extended demand, and are bringing to the company encomiums of the most valuable character from all parts of the country from users in almost every department of industry. The variety of pumps now in the market is almost endless, but the new pulsometer is this year on exhibition at all the leading fairs, in competition with those of every other description. At the Fair of the Massachusetts Charitable Mechanic Association, in Boston, where a leading feature is made of the working of pumps for a variety of fountains and large reservoirs, this pump was especially designated by the management to do a portion of the daily work that could not be dispensed with, on account of the comparatively small quantity of steam it required, where other pumps made too large a drain upon the boilers. With this efficiency it combines great strength and durability, it being so simple in construction as to be almost impossible for it to get out of order.

The quickness with which this pump may be set up and put in operation in any locality is, aside from the great amount of work it will do, one of its most valuable recommendations. It is connected at the top with a steam supply pipe, and at the bottom with the suction pipe, the discharge pipe leading from the discharge chamber. It works with a vacuum and with direct steam pressure in two chambers alternately, the operation being so nicely regulated by a well-fitting ball valve that the pumping proceeds steadily and almost noiselessly, like the regular beating of a pulse, from which the pump has its name and registered trademark. In working, the steam enters the chamber directly above the water, pressing upon and forcing it out through the discharge valve with a force proportionate to the steam pressure; when the water has been displaced by the steam, which follows it to the opening of the discharge chamber, the steam suddenly condenses, leaving a vacuum, which is at once filled from the suction pipe.

Among the striking testimonials which the company have this year received as to the efficiency of their pump was one which came from the Michigan Coal Company, who had a "cave-in" at their mine at Jackson, in that State. The shaft was 85 feet deep, and the water on four to five acres at the bottom was said to average five feet in depth; they testify that the water was lowered by a No. 9 pulsometer pump at the rate of twenty-three inches per hour. Numerous other testimonials are also furnished showing their efficiency for mining, railroad, and steamboat use, for all kinds of manufactures, for draining quarries and cellars, and for irrigation, and in Europe as well as in this country.

These pumps are made of brass or other metal for pumping liquids destructive to iron, with lead for acids, bronze for sugar works, and special composition or wood valves for other purposes. They are manufactured and sold by the Pulsometer Steam Pump Company, 83 John street, New York, Wm. F. Kidder being president of the company, G. F. Badger, secretary, and Geo. W. Laird, treasurer.

ASBESTOS PRODUCTS FOR ROOFING, BOILER AND PIPE COVERINGS, PACKING, PAINTS, ETC.

One of the first exhibits to attract the eye, at the right as you enter, is that of the H. W. Johns Manufacturing Company, which we illustrate in one of the views at the top of the page. Here are arranged a selection of their varied productions, including asbestos roofing, boiler coverings, lining felt, steam rope wick, and flat packing, millboard, gaskets, sheathings, cements, etc., with their liquid paints in a great variety of packages. The display is a more tasteful one than it would be supposed could be readily made from this homely yet highly utilitarian product, and cannot fail to interest millowners and steam users generally, as well as those who study economy and good service in either interior or exterior painting.

The variety of purposes for which asbestos has been made available within the comparatively few years since its valuable properties have become known, and practicable methods of working it perfected, would be somewhat remarkable, were it not simply a repetition of our experience in the uses so rapidly found for other natural products when skill and inventive genius first adapt them to meeting acknowledged wants of the public. This silk-like and really fine-fibered mineral has, through the agency of Mr. Johns himself, who first commenced its utilization in 1858, become a most invaluable agent for many mechanical purposes, besides meeting a multitude of wants of architects and builders in a way that at once increases the durability and lessens the cost in a great variety of structures. In its use for roofing, for instance, for which it was first adapted, its great economy over the expensive materials previously thought necessary, while it at the same time made a tight roof needing but little repair after years of wear, at once gave it an extensive demand. The appearance of these goods is familiar to all, it being furnished in rolls about forty inches wide, of any desired length, so as to make a light covering, and one very quickly put on; it consists of a manila lining, upon which is a layer of waterproof composition, then a strong canvas, another layer of waterproof composition, and a surface layer of asbestos coated felt. In connection with this roofing fabric, an asbestos roof coating is also manufactured for prolonging the service and keeping the roof in good order, also a white fireproof coating, which makes the roof air and water tight, forming an effective non-conductor for protection against fire from adjoining buildings.

In the paints, which form a conspicuous portion of the exhibit, besides the asbestos fireproof paints and coatings are a full line of fine linseed oil paints, in liquid form, the company designating their productions in this line, which have now become very extensive, with the well known trademark which distinguishes all their goods. These paints are ground and mixed differently from the processes usually followed, and are not intended to compete in price with cheap goods in this line, but are claimed to have superior durability, and therefore more economical to the consumer, than white lead and other paints in common use. For roof painting the company have a special preparation, which, either alone or in combination with their asbestos cement, they recommend for rough usage and in exposed situations, and also for the preservation and repair of old leaky tin and other roofs.

The styles of coverings for hot air and steam pipes, boilers, etc., preventing the radiation of heat and economizing fuel, are shown in great variety. The company have patents on many different combinations and ways of using asbestos for this purpose, but for pipe coverings they recommend their asbestos lining felt—a pure asbestos sheathing, to one side of which is attached "flocked" asbestos. This comes in sheets and rolls, and makes an insulating cushion or non-conducting lining, over which is placed a layer of hair felt and then one of non-porous fireproof sheathing. For boiler coverings, or where large surfaces are to be protected, the company recommend a special production called asbestos cement felting, partaking of the nature of a felt and a cement. There is sufficient strength and flexibility to the asbestos fiber to prevent the cracking of such a covering from the expansion and contraction of boilers due to varia-