

steering gear; the engines are triple expansion, the cylinders having a diameter of 19, 30, 46, by 36 stroke, pressure 170 lb., driving the ship at a speed of 13 knots on an easy consumption of coal.

The cable gear is the design of Messrs. Latimer Clark, Muirhead & Co. (limited) on the tandem principle, driven by two separate engines, which can be united together and exert either their full power, if found necessary, on either of the drums, or can be separately used on one or the other drum independently.

The electric lighting and search lamp is by Messrs. Johnson & Phillips, of Charlton, Kent.

The saloon is amidships and is very tastefully finished, being enameled white and gold.

The illustration will give a general idea of this ship, which is beautifully lined. It is the third ship of its kind which has been built. One was the Magneta, the other was the Electra, the cable gearing of both of which vessels was manufactured by Messrs. Johnson & Phillips.

The dimensions of the Amber are rather less than those of the two vessels just named, each of which was 230 ft. in length and 32 ft. in beam, their (builder's) tonnage being 1,096 tons. The Amber's depth, however, is the same as her predecessors.

It will be remembered that the Magneta was lost, with all hands, about three years ago; and the new steamship Amber has been designed to take her place. The Amber is fitted with all the latest and most approved appliances for cable laying and cable repairing, and is, it may be said, the outcome of the varied and wide experience which the owners of these vessels have

may be found for it (as I am sure they can be) in our laboratories.

Upon thoroughly settling down to work upon the subject, I was astonished at the mass of evidence already borne to its usefulness, especially so as about forty or fifty years ago practically little was known about asbestos, or where it could be found; and may I not say that even now comparatively limited is our conception of what it may still prove capable.

I purpose treating the subject in two sections:

1. Descriptive of where and how it is obtained, and general appearance.

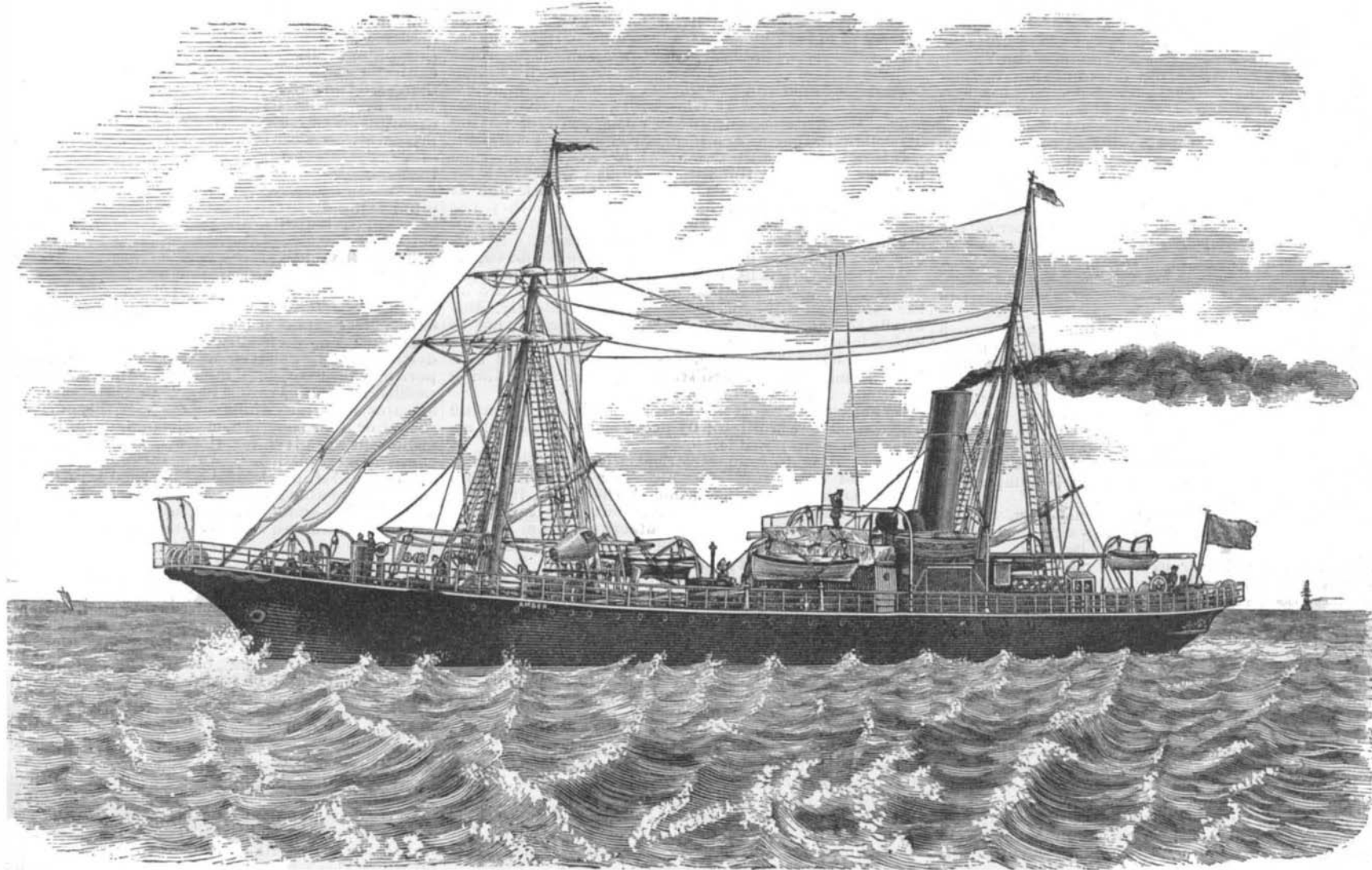
2. Descriptive of its numerous applications.

Asbestos takes its name from the Greek word "asbestos," meaning "inconsumable," and is a variety of the amphibole or hornblende family of minerals, and akin to tremolite and common hornblende. According to mineralogists it is a fibrous silicate of calcium and magnesium. The composition of the whole family is chiefly silica, magnesium, aluminum, and ferrous oxide, but varies considerably, those containing most iron being most easily fusible. Its most familiar allies with which we have practically much to do are *soapstone* (magnesium-aluminum silicate), and asbestos is supposed by some chemists to be soapstone in a different form, *pumice stone* (a porous silicate of aluminum and of alkali metals), and *hornblende* (magnesium and calcium silicate with a little iron). It is found in the older crystalline, but more generally in the serpentine, rocks, and is distributed almost over the entire earth, having been found in Italy, Spain, France, North and South America, Sweden, Ural Mountains, Silesia, New South

found in the Valtellina and valley of Aosta. It was first discovered in the valley of the Valtellina, about 5,500 feet above sea level, where, surrounded by loose bowlders and stunted pines, stands a serpentine rock, near the top of which it was found, in a nearly horizontal course through it, changing, however, to a vertical direction and going down into the rock almost like a corkscrew. Descending further into this valley we find a large excavation in the side of the rock, traversed in every direction by thin seams of asbestos, which seem to start as from a center and spread out in every direction, and these again are crossed by thin seams both horizontally and diagonally.

These seams generally converge to a center, where the various thin seams unite themselves, and there a quantity of asbestos may be found, then all appearance of it ceases, only to reappear in the same form when further worked into. On account of the irregular way in which it is mixed up with the rock, the only method of working it is by blasting with dynamite. Further down this valley other seams of fine fiber were found, which on being worked followed a semicircular direction, entering a good way into the mountain side, and finally changing course came again to the outside, leaving a large isolated rock in the center. The finest piece of asbestos, I believe, yet found was discovered in this working. Asbestos is found all over the rocks on the north side of the valley, and is worked in a similar way to the above.

In the table land of Acqua Nera, 6,500 feet above sea level, the whole western rock is rich in asbestos, but here the seams follow a nearly vertical direction. Go-



'THE NEW CABLE STEAMSHIP AMBER.

gained in their important operations.—*The Electrician*.

#### ASBESTOS.\*

By FRANK ALFRED ROGERS.

ASBESTOS is a substance so far outside the range of practical pharmacy that an apology would almost be necessary for making it the subject of a paper, were it not for the fact that the practical uses of asbestos are to many little imagined, and in bringing it for discussion before a meeting of practical pharmacists, I do so with the hope that many more applications and uses than are mentioned in this paper may be found for it. I would remind you that in many instances it has been proved that it is not only its suitability for resisting fire on a large scale to which it owes some of its, may I say, grandest successes, but also in its application to what may, perhaps, seem almost trivial matters, were it not for the fact that we are not judges of what is or is not trivial.

As I take it, the general impression regarding asbestos from a chemist and druggist's point of view is something of this sort—that it is a substance we are never really sure we keep in stock until looked for; a substance generally kept in a locker along with other things required very seldom; occasionally useful for straining purposes, on account of its being almost entirely unaffected by acids, oils, etc., and there the matter ends. I purpose to-night, as far as I am able by the aid of the specimens on the table and the facts I have accumulated, to present this substance to you under a slightly different coloring, and to show you what has already been done with this remarkable *natural* product, and to hope that many more useful capabilities

Wales, Corsica, Japan, Switzerland, South Africa, and in Scotland, Anglesea, and Cornwall. But the two countries from which it is almost exclusively obtained at present are Italy and Canada, and as the quality of that derived from the former is far superior to that from the latter country, I purpose dealing with that first.

But before proceeding to do so, let us get a general idea of what asbestos is. We have seen what it is chemically, and I wish to say here that I make no mention of *how* asbestos is formed in the earth, for the reason that, as far as I am aware, nothing is really known on this head. Several theories have been put forward, but as they are all mere conjecture, I have thought it best to leave them unstated.

On referring to the "Encyclopædia Britannica," we find the following:

"Asbestos consists of fine crystalline elastic fibers with a silky luster, varying in color from white to gray and green, and derives its name from being specially indestructible by fire. A single fiber of it fuses to a white enamel, but in the mass it is capable of resisting ordinary flame, and has on that account been regarded from ancient times as a most interesting substance. Woven into cloth it forms a fireproof texture, which to be purified requires only to be thrown into the fire; gloves, napery, towels, handkerchiefs, and even dresses have been woven of it, and it is said that the ancients used to wrap the bodies of their dead in asbestos cloth to keep their ashes separate from those of the surrounding funeral pile."

The three samples (fibrous, floss, and powder) you have now before you are varieties of *Italian* asbestos. The *fibrous* is lengthy and tough, and feels somewhat like soapstone, and varies in color from white to gray and brown. The *floss* is like silk, but dry, and of a beautifully white color. The *powder* varies in smoothness and color, like the fibrous.

*Fibrous Italian Asbestos*.—This variety is principally

ing further north, the chief source is in a deep narrow valley, the rocks on either side presenting the appearance of having been ground smooth by a glacier; and here asbestos is found almost everywhere. The seams here followed a circular direction. In the center the rock was quite friable and soft, and the asbestos of poor quality, while at the circumference the rock was very hard and the asbestos of fine quality. In this district it is found up to 10,000 feet above sea level, and it is sometimes worked at this height, but in some years the seams remain buried in snow. Very different surroundings from those at the valley of Aosta mines, where the workings are either in pine or chestnut woods or among meadows, seldom exceeding 6,000 feet. There are numerous workings all along these mountains.

The next principal Italian mines, as previously stated, are those of the valley of Aosta, a place greatly resorted to in summer for its mineral waters. The workings are exposed to the south or southwest, and the formation is similar to that in the Valtellina. When asbestos is first found in any new place, the general appearance of the rock is that the cracks are filled up with a white powdery substance; this, on being removed, presents a leathery-looking substance, under which the true asbestos may be, but is not always, found. We saw just now that the face of the workings was toward the south or southwest; the importance of this will be gathered from the following practical conclusion of the Italian employes: "If asbestos be found on the face of a rock, exposed to either the south or southwest, the product is generally fairly abundant and of good quality. If exposed to the east, there is a fine quality, but very small quantity, while if exposed to the north the quantity is plentiful, but dry and hard, and on entering into the rock all traces of it are lost."

It will thus be seen that very great care and discrimination have to be exercised before a new vein is worked,

\* Read at a meeting of the Chemists' Assistants' Association.—*Pharm. Jour.*

as it may, while appearing valuable, prove worthless. Asbestos of good quality is only found in the serpentine formation. The following analysis of *Italian* asbestos is by the late Professor Barff:

Lime and magnesia.....	37.84
Silica.....	41.69
Oxide of iron.....	3.01
Potash.....	0.85
Soda.....	1.41
Alumina.....	2.57
Moisture evap. at 100° C.....	3.04
Loss on heating to white heat, water of hydration, and organic matter.....	9.56
Loss.....	0.03
	100.00

Years ago, when asbestos was little more than a mineral curiosity in geological collections, there used generally to be specimens obtained from the eastern part of the Alps, partly from Switzerland, but chiefly from certain localities in the Tyrol. The impression was that that found in connection with hornblende or amphibole was the best. This contained a larger proportion of alumina, whereas from the analysis the most valuable kinds contained a larger proportion of lime and magnesia and were found in the serpentine formation. The serpentines in various parts of Europe could hardly be examined without finding them intersected with fissures, which, generally speaking, ran from  $\frac{1}{4}$  of an inch to 2 or 3 inches in breadth, and contained asbestos of more or less suitable quality, but the fiber was so short as compared with those before you as to exclude them altogether from practical use.

**Floss Fiber.**—Varieties in which the fibers are very delicately and regularly arranged are called "flexible asbestos" or "amianth" (a Greek term signifying "unpolluted"). Traces of this are found in the Valtellina and the valley of Aosta, but it is found and worked in part of the chain of mountains between Susa and Turin, about 8,000 feet above sea level. It is usually found in thicker seams than the fibrous quality, and is generally horizontal and dips rapidly as you enter into the rock. There is always a very large quantity of short powdery matter found along with it. There are many varieties, as:

**Mountain Cork and Mountain Leather**, in which the fibers are less flexible and regular than in either of the above, and instead of being parallel, are interwoven, the color being brown or dirty white. **Mountain cork** is so named from being not unlike common cork, and so light as to swim in water. **Mountain leather** is in thin, flexible sheets.

**Mountain Wood** is a soft, tough, opaque, brownish colored variety, and much heavier than the two previous kinds. These three varieties of floss fiber are not, however, at present used commercially, and are merely objects of curiosity.

**Asbestos Powder** is found in the same range of mountains as the floss, but at a much lower elevation, about 5,000 feet. It was noticed after a large landslide, and when first seen was of a pasty consistence, but on exposure to the air crumbled into powder, the important use of which will be referred to later.

Having thus considered the Italian asbestos, we now pass on to glance at the Canadian variety. I would draw your attention to the difference between the two, the Italian being superior in every respect, especially in its capabilities of being woven into cloth. Many instances have occurred in which cotton has been mixed with asbestos by American manufacturers, but the samples of finished material before you are all made of pure fiber.

**Canadian Asbestos.**—You will notice at once the chief characteristics of this variety. It is short and brittle and much inferior to Italian, being only about 1 to  $1\frac{1}{2}$  inches long, and so weak that for a long time it was considered impossible to weave it. This difficulty, however, was overcome, and there are samples on the table of the cloth. It is mined only in the province of Quebec. In the township of Broughton there is a small deposit of asbestos of very long and fine fibers, but the seams are few and uncertain, while to the southwest they are found so much mixed with foreign substances, such as chrome iron, that they cannot be worked. The whole district in which asbestos is mined has a radius of about ten miles. The mining is wholly conducted by opencast or quarrying. One peculiarity about Canadian asbestos is that although fire-resisting and proof against acids, etc., yet it is very easily damaged if exposed to rain or water in its crude state, becoming hard almost like wood.

The following is an analysis of *Canadian* asbestos:

Lime and magnesia.....	33.20
Silica.....	40.90
Oxide of iron.....	5.75
Potash.....	traces.
Soda.....	0.68
Alumina.....	6.60
Loss on heating to white heat, water of hydration, and organic matter.....	12.50
Chlorine.....	0.25
Loss.....	0.12
	100.00

Since writing this I have had placed in my hands a sample of asbestos from the *Cape*, with the analyst's report upon the same, from which I have extracted the following:

"The sample contains a considerable quantity of iron; ordinary commercial asbestos contains only 2 to 4 per cent. of oxide of iron, while this specimen has as much as 39 per cent. The fiber is fairly strong, and provided the material does not alter by exposure to air, it would be suitable for weaving into cloth. It will not, however, stand any degree of heat without disintegrating and becoming quite rotten. This effect is probably due to the fact that a portion of the iron is in the form of a ferrous salt; by exposure to air and heat this salt oxidizes and alters the composition of the asbestos to such an extent that it is easily converted into a powder. This powder would answer the purpose of a fire-proof paint."

We have now become acquainted with where and how asbestos is obtained, and come to the second section of this paper, viz.:

**The Applications of Asbestos.**—Its valuable fire-resisting properties have been known for upward of two thousand years, and advantage has been taken of its

qualities for the performance of clever trials of fire-handling, etc. It has been used by the peasantry in the regions where it is found as an indestructible lampwick, its power of capillary attraction rendering it specially adaptable to this purpose. In the early time the art of weaving the cloth was its chief application, and was much valued. There is in the museum at Naples a piece of cloth of ancient Roman or Grecian manufacture, which is so similar to that now made that very few persons would be able to detect the difference. There is also in the Vatican a piece of asbestos cloth which is supposed to be one of the napkins which are said to have been used by popes and emperors. It is stated that Charlemagne had a table cloth made of this material, which he used to have thrown into the fire after dinner for the astonishment of his guests. As I stated in a previous part, the Greeks are said to have used asbestos cloth ages ago for wrapping up the bodies of their dead, to keep their ashes separate from those of others in the funeral pile, and as many of us are glad to see that the practice of cremation is gaining ground again, I submit that this use for asbestos may be again a practical and useful one. The asbestos from which these cloths were made is supposed to have been found at Paphos in the island of Cyprus, and recently asbestos has been found in this island.

From the year 1850 various attempts were made by Italians to utilize asbestos, especially as regards its manufacture into cloth, and chief among those who did this was the Chevalier Aldini, of Milan, who is said to have had a complete dress made of the cloth, and to have made very successful experiments with it by way of testing its protective power for firemen. Among those to whom we are indebted for the first mechanical applications was the Italian priest Guiseppe della Corona, of Florence. After many experiments he succeeded in making asbestos into millboard and paper of a very good quality. About the same time some Americans had succeeded in manufacturing the Italian asbestos into packings for piston glands, and in 1872 a company was formed at Glasgow to make these packings. To this company belongs the merit of having first offered asbestos in a form suitable to the engineer.

It is not my intention, to-night, to take up your time by describing fully the various kinds of packings for piston glands, etc., into which it is made, although at present, on account of its remarkable durability, the most numerous and important applications of asbestos are in connection with engineering, specially in the case of marine engines under high pressure and superheated steam, that have to be at work night and day on long voyages. Samples of the chief kinds are on the table, and will explain themselves sufficiently. But briefly to refer to the other and more general use to which it has been put:

**In the Form of Millboard.**—It is largely used as a jointing material between steam pipes and as a lining for fireproof cases and deed boxes.

A common source of fire is from gas shades becoming overheated and igniting; by using shades made of asbestos this is impossible.

As a tubing to hold electrical wires, which is fire-proof and waterproof and also non-conducting, and preserves the perfect insulation of the wires; it is also used to form a non-conducting envelope for steam pipes. Paper has been manufactured from it, and would prove invaluable in case of fire for public documents, etc., were it not that the paper is rather tender to use and that the writing disappears after a red heat. It is made into a wall paper, and at the present time is being used in this form in Belgium, under an order from the government, for papering stage scenery, with very good results.

**In the Form of Cloth.**—One of the most valuable uses to which asbestos has been put is as fireproof curtains for theaters. You will remember after the burning of the Ring Strasse theater in Vienna great attention was called to the necessity for providing some form of curtain for perfectly isolating the stage from the other parts of the house. And since the frightful disaster that occurred at Exeter some few months ago, several theaters in town and country (Terry's in London, Queen's and others in Manchester, and in Hull, Sheffield, and Birmingham) have been supplied with asbestos curtains. Both iron and other curtains have been tried, but found to be ineffective.

It has been largely used by beet root sugar refiners in Germany for filtering purposes, filter bags of asbestos being found very much better fitted for this purpose than those of canvas, as they are not affected by the acids generated in the manufacture of the sugar, and are easily cleaned.

It is also extensively used for the filtration of both acids and water.

A strong, coarse make of this cloth is often used for protecting the clothes of men employed in the manufacture of strong acids and for fireproof clothes for firemen, and might advantageously be used for making bags for the transportation of gunpowder.

**In the Form of Floss Asbestos.**—It is principally used in the manufacture of gas stoves in the shape of single fibers or balls, which not only present all the warm and comforting appearance of a coal fire, without its accompanying dirt and trouble, but are sustained when once fairly heated by a comparatively small supply of gas, the balls also being used to save the consumption of coal by being placed in among ordinary fires. In speaking of the mining of this variety of asbestos, we saw that there was always a large quantity of short powdery matter found with it; we will now see to what uses this is put.

One of its most important applications is for covering steam boilers and pipes to prevent the radiation of heat, and also to *economize the fuel*. To apply this it is made about the consistency of mortar, and is mixed with certain chemical ingredients which, although not injurious to the metal, cause the asbestos to adhere to the plates, and when dry it sets quite hard. With a boiler carrying say 80 lb. pressure the application of from  $1\frac{1}{2}$  to 2 inches of this composition so well retains the heat in the boiler that a thermometer with its bulb held close to the surface of the covering will not indicate more than 80° to 85° F. It has also been used in excessively hot climates as an external covering for houses, in which under ordinary circumstances the heat was almost unbearable, with the result that whereas the temperature outside was about 100° F., inside it did not exceed 70°.

On considering this variety of asbestos and its applications, we thus see that it is equally valuable either

for excluding or retaining heat; and when we recollect that we live not so much for our own generation as for the future ones, and that all the learning of one age is merely the stepping stone for the further advancement of the next, we can think of nothing that will be of more importance than our coal supply (the failure of which I take from a trustworthy authority is not so far off as is imagined). We in our time have no cause for uneasiness on this head, but when we think of the enormous amount that is annually consumed, we cannot help but feel almost alarmed for the time when it will have to be dispensed with. Granted, you will say, that our successors will have so far eclipsed us as to have found a means by then of utilizing the enormous force at present lying dormant in the tides. Still I venture to submit that it is our duty to see that we make no abuse of our at present abundance, but that we endeavor, if possible, to utilize it more and more thoughtfully; and not only does it present itself to us in this light, but in that of *economy*, which is the one aim of both the natural and inventive world. This economizing can be performed by the means of asbestos in many other ways than the two mentioned, and I venture to say that, in the future of electricity, we have little idea of the important part asbestos will play.

There remains but one other variety of asbestos to consider, viz.:

**In the Form of Powder.**—In which its chief and most important application is in the form of a *paint*. You are probably aware of the numerous experiments which were performed some four or five years ago, to prove the perfect fire-resisting properties of wood covered with this paint, as compared with others not similarly protected. This was established without a doubt, and no better demonstration could possibly have occurred of its value than took place at the South Kensington exhibition in May, 1884, when the stall of an exhibitor caught fire and would have spread and endangered the entire building, but for the fact that the walls were painted with asbestos paint. The various experiments have clearly shown that this paint will preserve woodwork from being consumed by the action of fire for a considerable time, and although by continued subjection to a fierce heat the wood underneath may become charred, yet it cannot be a means of communicating the fire to surrounding objects. Samples of wood coated with this paint, which resists both the action of fire and water, are upon the table, and you will see that in all respects it presents as good an appearance as any ordinary paint.

The last and certainly one of the most important applications is as a *medium for filtering water*. To effect this purpose it is essential that there should be a sufficiently energetic chemical action for the removal or destruction of deleterious matter in solution and a perfectly mechanical straining for the removal of suspended matter. Porous blocks or slabs of carbon or silicates of various kinds are used for this purpose; but sooner or later they become clogged, and although instructions are given for the brushing and scraping of these, it is impossible to do it thoroughly. If instead of this a carefully cleaned and carded layer of asbestos be used, the above essentials are perfectly carried out, and it can be changed and cleansed easily.

You will thus see that the chief value of asbestos lies in its *fire-resisting*, *acid-resisting*, and *fibrous* qualities, and in all its different applications these qualities have been kept in view. When we consider the number of firms engaged in it, and that its manufacture has gradually grown during the last few years from almost a private speculation to become one of the staple industries of the country, it would be impossible to say now to what an extent it may be further carried, and what better augur could be wished for its future usefulness than this. I have endeavored to give you its most interesting and practical applications, and although I have been able to name but a few of the many ways in which it may be used, I leave the subject to your more scientific and practical experiences for that development which it is capable of, feeling it cannot be left in better hands.

In conclusion I have to thank the United Asbestos Company, of Queen Victoria Street, for their kindness in providing me with the chief part of the information on which this paper is based, and for the complete set of samples on the table, which give you an idea of the importance of the industry.

## CEMENT FROM WASTE PRODUCT LIME.\*

By J. S. RIGBY.

THE question of waste products in the manufacture of alkali has long been a source of trouble to the manufacturer, and any feasible method of disposing of the same must be hailed with satisfaction, especially where such method is at once a means of disposal and at the same time a source of profit.

In bringing this matter before the public, I have been encouraged by some of the largest alkali makers in the trade, who have unhesitatingly adopted my process for the manufacture of Portland cement from lime mud.

Portland cement, as most of you are aware, takes its name from its resemblance to Portland stone. The seat of the manufacture is on the Thames and Medway, where it is made from chalk and mud, both existing in almost unlimited quantities in the same neighborhood. A comparatively small quantity is produced in North Wales from the carboniferous limestone, and in the Midlands from the lias limestone, which contains from 10 to 20 per cent. of silica and alumina, with a small percentage of oxide of iron. It is ground by the aid of suitable machinery as finely as possible and mixed with shale (in the same fine state of division) containing silica and alumina in such proportions that will produce approximately a cement corresponding to the following analysis:

Lime.....	62
Alumina and iron.....	10
Silica.....	22

It is of the highest importance that the lime should exist in as near the quantity named as possible. A very slight divergence would alter the quality of the cement very materially; an excessive quantity of clay would give a cement of a brown color, having a low tensile

\* Read before the Society of Chemical Industry at Liverpool University, by Mr. J. S. Rigby, on April 4, 1888.