to be made entirely in the dry, in the former it would merely be the removal of material by ordinary dredgers. On the other hand, the floating dock possesses many advantages in the choice of site, since it can be placed end-on with the stream, thus facilitating the entrance of vessels; and it does not require its entrance to be placed, like that of most graving-docks, more or less at right angles to the stream. Again, in rivers which are subject to a strong freshet, the floating dock is equally available either at high or low water, whereas a stone graving dock would either have to be built very much deeper than required, or else would be submerged in times of flood. In connection with this, the author discusses the point whether a vessel on a floating dock is not much better placed for purposes of repairing or painting than in the bottom of an excavated dock, and points out how open to light and air are vessels on the former. He also claims that this openness of the floating dock has other advantages in that it allows them to deal with vessels of much greater length than the dock itself, and instances of this facility are adduced; while the one-sided docks have an equal advantage as regards beam of vessels lifted. It is admitted that floating docks have their limitations, represented by the amount of their lifting power, but at the same time it is argued that though they may not be able to lift a vessel entirely, they can frequently lift it enough to enable the required repairs to be effected.

The first cost of floating docks is dealt with, and in order that an idea of their cost may be obtained, a list of the actual hull weights of several docks of different types is given.

The cost of working is also dealt with, and it is pointed out that the floating dock has a great advantage in respect of the cost of coal and oil, as the power required to lift a ship is much less than that required for a graving dock of similar capacity. Instances are given where it costs, on the average, less than 18s. to lift vessels displacing 3,000 tons.

The cost of maintenance of a floating dock is gone into in some detail, and in the appendix many instances of the actual amounts expended on repair and upkeep are given, based on the results of a number of years; from these it is found that the average cost is a little more than 1 per cent per annum of the first cost of the dock.

Some further statistics are given as to the useful life of a floating dock, and iron docks which have now been at work for over forty years are mentioned, from which the author concludes that the useful life of a floating dock may be fairly taken as at least fifty years. He points out that a life of this duration requires only a sinking fund equal to 1 per cent per annum on the first cost of the dock invested at 2½ per cent.

In conclusion, a few of the most common appliances in the machinery of a floating dock are mentioned and illustrated.

THE WATERPROOFING OF FABRICS.*

By H. HIELD.

It will be convenient to divide waterproof fabrics into two classes, viz., those which are *impervious* to water, and those which are *water-repellent*. It is important to make this distinction, for, although all waterproof material is made for the purpose of resisting water, there is a vast difference between the two classes. The physical difference between them can be briefly summed up as follows: Fabrics which are completely impervious to water comprise oil-skins, mackintoshes, and all materials having a water-resisting film on one or both sides, or in the interior of the fabric. Those coming under the second heading of water-repellent materials do not possess this film, but have their fibers so treated as to offer less attraction to the water than the water molecules have for themselves.

The principal members of the first group are the rubber-proofed goods: in these the agent employed is rubber in greater or less quantity, together with other bodies of varying properties. Before enlarging on this class, it will be necessary to give a short description of the chemical and physical properties of rubber.

Rubber, or caoutchouc, is a natural gum exuding from a large number of plants, those of the *Euphorbiaceae* being the chief source for the commercial variety. The raw material appears on the market in the shape of blocks, cakes, or bottle-shaped masses, according to the manner in which it has been collected. It possesses a dark brown—sometimes nearly black—exterior; the interior of the mass is of a lighter shade, and varies from a dingy brown to a dirty white, the color depending on the different brands and sources. In the raw state its properties are very different from what they are after going through the various manufacturing processes, and it has only a few of the characteristics which are generally associated with India rubber. Chemically it is a complex hydrocarbon with the formula $C_{15}H_{20}$, and appears to consist of a highly porous network of cells having several different resins in their interstices. It is perfectly soluble in no single solvent, but will yield some of its constituents to many different solvents. At a temperature of 10 deg. C., raw caoutchouc is a solid body and possesses very little elasticity. At 36 deg. C. it is soft and elastic to a high degree, and is capable of being stretched sixteen times its length. Further increase of temperature lessens its elastic properties, and at 120 deg. C. it melts. While in the raw condition it has several peculiar properties, one of which is: After stretching, and cooling suddenly while stretched, it retains its new form, and only regains its former shape on being warmed. Another

striking feature is its strong adhesive capacity; this property is so powerful that the rubber cannot be cut with a knife unless the blade is wet; and freshly-cut portions, if pressed together, will adhere and form a homogeneous mass. From these facts it will be seen how it differs from rubber in the shape of a cycle tire or other manufactured form.

The most valuable property possessed by raw caoutchouc is that of entering into chemical combination with sulphur, after which its elasticity is much increased; it will then bear far greater gradations of

FIG. 1.

heat and cold. This chemical treatment of caoutchouc with sulphur is known as "vulcanizing," and, if properly carried out, will yield either soft vulcanized rubber or the hard variety known as vulcanite. On the other hand, caoutchouc, after vulcanizing, has lost its plastic nature, and can no longer be molded into various shapes, so that in the production of stamped or molded objects, the customary method is to form them in unvulcanized rubber and then to vulcanize them.

Raw caoutchouc contains a number of natural impurities, such as sand, twigs, soil, etc.; these require removing before the manufacturing processes can be carried out. The first operation, after rough washing, is to shred the raw material into small strips, so as to enable the impurities to be washed out. This process is carried out by pressing the rubber against the surface of a revolving drum (A, Fig. 1), carrying a number of diagonally arranged knives, B, on its surface. A lever, C, presses the rubber against the knives; D is the fulcrum on which C works, E being a weight which throws back the lever on the pressure being removed. During this operation a jet of water is kept

FIG. 2.

playing on to the knives to cool and enable them to cut.

Following this comes the passage between a pair of corrugated steel rollers (as shown in Fig. 2). These rollers have each a different speed, so that the rubber gets stretched and squeezed at the same time. Immediately over the rollers a water pipe is fixed, so that a steady stream of water washes out all the sand and other extraneous matter. In Fig. 2, AA are the steel rollers, while B is a screw working springs which regulate the pressure between the rollers. The power is transmitted from below from the pulley, C, and thence to the gearing.

The next operation, after well drying, is to thoroughly masticate the shredded rubber between hot steel rollers, which resemble those already described, but usually have a screw-thread cut on their surfaces. Fig. 3 shows the front view of this masticating machine, A being the rollers, while the steam pipe for heating is shown at B. Fig. 3A gives a top view of the same machine, showing the two rollers.

After passing several times through these, the rubber will be in the form of homogeneous strips, and is

FIG. 3.

then ready either for molding or dissolving. As this paper is dealing solely with waterproofed textiles, the next process which concerns us is the dissolving of the rubber in a suitable solvent. Benzol, carbon-bisulphide, oil of turpentine, ether, and absolute alcohol, will each dissolve a certain amount of rubber, but no one of them used alone gives a thorough solution. The agent commonly employed is carbon-bisulphide, together with 10 per cent of absolute alcohol. Whatever solvent is used, after being steeped in it for some hours the caoutchouc swells out enormously, and then requires the addition of some other solvent to effect a complete solution. A

general method is to place the finely shredded rubber in a closed vessel, to cover it with carbon-bisulphide, and allow to stand for some hours. Toward the end of the time the vessel is warmed by means of a steam coil or jacket, and ten parts absolute alcohol are added for every 100 parts of carbon-bisulphide. The whole is then kept gently stirred for a few hours. Fig. 4 shows a common type of the vessel used for dissolving rubber. In this diagram, A is the interior of the vessel, and B a revolving mixer in the same. The whole vessel is surrounded by a steam jacket, C, with a steam inlet at D and a tap for condensed water at E. F is the cock by which the solution is drawn off.

After the rubber is dissolved, about 12 to 24 per cent of sulphur is added, and thoroughly incorporated with the solution. The sulphur may be in the form of chloride of sulphur, or as sulphur pure and simple. A very small quantity of sulphur is required to give the necessary result, 2 to 3 per cent being sufficient to effect vulcanization; but a large quantity is always added to hasten the operation.

Even after prolonged treatment with the two solvents, a solution of uniform consistency is never obtained: clots of a thicker nature will be found floating in the solution, and the next operation is to knead it up so as to obtain equal density throughout. Fig. 5 will give an idea of how this mixing is done.

FIG. 3A.

At the top of a closed wooden chamber is a covered reservoir, A, containing the solution of rubber. A long slit at the base of this reservoir allows the solution to fall between sets of metal rollers, BBB, below. Neighboring rollers are revolving in opposite directions, and at different speeds, so that, after passing all three sets of rollers, and emerging at the bottom, the solution should be of uniform consistency. CCC are the guiding funnels, and EE are scrapers to clear the solution from the rollers. D is a wedge-shaped plug worked by a rack and pinion, and regulates the flow of the solution.

It now remains to apply the rubber to the fabric and vulcanize it. Up to this stage the sulphur has only been mechanically mixed with the rubber; the aid of heat is now required to bring about chemical combination between the two. This process, which is known as "burning," consists in subjecting the rubber-covered fabric to a temperature of about 120 deg. C. Sulphur itself melts at 115 deg. C., and the temperature at which combination takes place must be above this. Fig. 6 shows one of the methods of spreading the rubber on the cloth. A is the tank containing the solution with an outlet at the bottom arranged so as to regulate the flow of solution. The fabric passes slowly underneath this, receiving as it travels a thin coating of the waterproofing. The two rollers at B press the

FIG. 4.

solution into the fabric and distribute the proofing evenly over the entire surface.

After leaving the two squeezing rollers, the cloth travels slowly through a covered chamber, C, having a series of steam pipes, EE, underneath, to evaporate the solvent; this condenses on the upper portion of the chamber, which is kept cooled, and flows down the sides into suitable receptacles. After this the proofed cloth is vulcanized by passing round metal cylinders heated to the necessary temperature, or by passing through a heated chamber. Fig. 7 shows the spreading of rubber between two fabrics. The two cloths are wound evenly on the rollers, BB; from this they are drawn conjointly through the rollers, D; the stream of proofing solution flowing down between the rollers, which then press the two fabrics together with the rubber inside. The lower rollers marked CC are heated to the necessary degree, and cause the rubber and sulphur to combine in chemical union.

So far the operation of proofing has been described as though pure rubber only was used; in practice the rubber forms only a small percentage of the proofing material, its place being taken by cheaper bodies. One of the common ingredients of proofing mixtures is boiled linseed oil, together with a small quantity of litharge; this dries very quickly, and forms a glassy, flexible film. Coal-tar, shellac, colophony, etc., are all used, together with India-rubber varnish, to make

* Technica.

different waterproof compositions. Oil of turpentine and benzol form good solvents for rubber, but it is absolutely essential that both rubber and solvent be perfectly anhydrous before mixing. Oil of turpentine, alcohol, etc., can be best deprived of water by mixing with either sulphuric acid or dehydrated copper sulphate, and allowing to stand. The acid or the copper salt will absorb the water and sink to the bottom, leaving a supernatant layer of dehydrated turpentine or whatever solvent is used. All the sulphur in a rubber-proofed cloth is not in combination with the rubber: it is frequently found that, after a lapse of time, rubber-proofed material shows an efflorescence of sulphur on the surface, due to excess of sulphur, and occasionally the fabric becomes stiff and the proofing scales off. Whenever a large proportion of sulphur is present, there is always the danger of the rubber forming slowly into the hard vulcanite state, as the substance commonly called vulcanite consists only of ordinary vulcanized rubber carried a stage further by more sulphur being used and extra heat applied. If, after vulcanizing, rubber is treated with caustic soda, all this superfluous sulphur can be extracted; if it is

FIG. 5.

then well washed, the rubber will retain its elasticity for a long period. With the old methods of proofing, a sheet of vulcanized rubber was cemented to a fabric with rubber varnish, and frequently this desulphurizing was performed before cementing together. The result was a flexible and durable cloth, but of great weight and thickness, and expensive to produce.

The chemistry of rubber is very little understood; as mentioned previously, rubber is a highly complex body, liable to go through many changes. These changes are likely to be greater in rubber varnish, consisting of half a dozen or more ingredients, than in the case of rubber alone. The action of sunlight has a powerful effect on rubber, much to its detriment, and appears to increase its tendency to oxidize. Vulcanized rubber keeps its properties better under water than when exposed to the air, and changes more slowly if kept away from the light. It appears as though a slight decomposition always takes place even with pure rubber; but the presence of so many differently constituted substances as sometimes occur in rubber solutions no doubt makes things worse. Whenever a number of different bodies with varying properties are consolidated together by heat, as in the case of rubber compositions, it is only reasonable to expect there will be some molecular re-arrangement going on in

FIG. 6.

the mass; and this can be assigned as the reason why some proofings last as long again as others. Some metallic salts have a very injurious action on rubber, one of the worst being copper sulphate. Dyers are frequently warned that goods for rubber proofing must be free from this metal, as its action on rubber is very powerful, though but little understood. As is generally known, grease in any form is exceedingly destructive to rubber, and it should never be allowed in contact in the smallest proportion. Some compositions are made up by dissolving rubber in turpentine and coal-tar; but in this case some of the rubber's most valuable properties are destroyed, and it is doubtful if it can be properly vulcanized. Owing to rubber being a bad conductor of heat, it requires considerable care to vulcanize it in any thickness. A high degree of heat applied during a short period would tend to form a layer of hard vulcanite on the surface, while that immediately below would be softer and would gradually merge into raw rubber in the center.

The different brands of rubber vary so much, especially with regard to solubility, that it is always advisable to treat each brand by itself, and not to make a solution of two or more kinds. Oilskins and tarpaulins, etc., are mostly proofed by boiled linseed oil, with or without thickening bodies added. They are not of sufficient interest to enlarge upon in this article,

so the second, or "water repellent" class, has now to be dealt with.

All the shower-proof fabrics come under this heading, as well as every cloth which is pervious to air

FIG. 7.

and repulsive to water. The most time-honored recipe for proofing woollen goods is a mixture of sugar of lead and alum, and dates back hundreds of years. The system of using this is as follows: The two ingredients are dissolved separately, and the solutions mixed together. A mutual decomposition results, the base of the lead salt uniting with the sulphuric acid out of the alum to form lead sulphate, which precipitates to the bottom. The clear solution contains alumina in the form of acetate, and this supplies the proofing quality to the fabric. It is applied in a form of machine shown in Fig. 8, which will be seen to consist of a trough containing the proofing solution, C, with a pair of squeezing rollers, AA, over the top. The fabric is drawn down through the solution and up through the squeezers in the direction of the arrows. At the back of the machine the cloth automatically winds itself onto a roll, B, and then only requires drying to develop the water-resisting power. C is a weight acting on a lever which presses the two rollers, AA, together. The water-repelling property is gained as follows:

Drying the fabric, which is impregnated with acetate of alumina, drives off some of the volatile acetic acid, leaving a film of basic acetate of alumina on each wool fiber. This basic salt is very difficult to wet, and has so little attraction for moisture that in a shower of rain the drops remain in a spheroidal state, and fall off. In a strong wind, or under pressure, water eventually

FIG. 8.

penetrates through fabrics proofed in this manner: but they will effectually resist a sharp shower. Unfortunately, shower-proofed goods, with wear, gradually lose this property of repelling water. The equation representing the change between alum and sugar of lead is given below. In the case of common alum there would, of course, be potassium acetate in solution besides the alumina.

Now that sulphate of alumina is in common use, alum need not be used, as the potash in it serves no purpose in proofing.

There are many compositions conferring water-resisting powers upon textiles, but unfortunately they either affect the general handle of the material and make it stiff, or they stain and discolor it, which is

FIG. 9.

equally bad. A large range of waterproof compositions can be got by using stearates of the metals; these, in nearly every case, are insoluble bodies, and when deposited in the interior of a fabric form a water-resisting "filling" which is very effective. As a rule these stearates are deposited on the material by means of double baths; for example, by passing the fabric through (say) a bath of aluminium acetate, and then, after squeezing out the excess of liquid, passing it through a bath of soap. The aluminium salt on the

fabric decomposes the soap, resulting in a deposit of insoluble stearate of alumina. This system of proofing in two baths is cleaner and more economical than adding all the ingredients together, as the stearate formed is just where it is required "on the fibers," and not at the bottom of the bath.

One of the most important patents now worked for waterproofing purposes is on the lines of the old alumina process. In this case the factor used is resin, dissolved in a very large bulk of petroleum spirit. The fabrics to be proofed (usually dress materials) are passed through a bath of this solution, and carefully dried to drive off the solvent. Following this, the goods are treated by pressing with hot polished metal rollers. This last process melts the small quantity of resin, which is deposited on the cloth, and leaves each single fiber with an exceedingly thin film of resin on it. It will be understood that only a very attenuated solution of resin is permissible, so that the fibers of the threads and not the threads themselves are coated with it. If the solution contains too much resin the fabric is stiffened, and the threads cemented together; whereas if used at the correct strength (or, rather, weakness) neither fabric nor dye suffers, and there is no evidence of stickiness of any description.

Fig. 9 shows a machine used for spreading a coat of either proofing or any other fluid on one side of the fabric. This is done by means of a roller, A, running in the proofing solution, the material to be coated traveling slowly over the top and just in contact with the roller, A, which transfers the proofing to it. Should the solution used be of a thick nature, then a smooth metal roller will transfer sufficient to the fabric. If the reverse is the case, and the liquid used is very thin, then the roller is covered with felt, which very materially adds to its carrying power. As shown in Fig. 9, after leaving the two squeezing rollers, BB, the fabric passes slowly round a large steam-heated cylinder, C, with the coated side uppermost. This dries the proofing and fastens it, and the cloth is taken off at D.

Besides stearates of the metals, glues and gelatines have been used for proofing purposes, but owing to their stiffening effect, they are only of use in some few isolated cases. With glue and gelatine the fixing agent is either tannic acid or some metallic salt. Tannic acid converts gelatine into an insoluble leather-like body: this can be deposited in the interstices of the fabric by passing the latter through a gelatine bath first, and then squeezing and passing through the tannic acid. Bichromate of potash also possesses the property of fixing the proteid bodies and rendering them insoluble.

HOW IMMIGRANTS ARE INSPECTED.*

By Dr. ALLAN McLAUGHLIN, U. S. Public Health and Marine Hospital Service.

INSPECTION of our immigrants may be said to begin in Europe. The immigrant usually buys his steamship ticket in his native town from an agent or subagent of the steamship company. The agents of the best steamship lines are held responsible by the company for the passengers they book for America, and if they ship one of the excluded classes they are likely to lose their agency. This makes the agent examine the applicants for tickets, and probably quite a large number of defectives are refused passage by agents of the first-class lines. These defectives then usually try some less particular and smaller lines and take chances of escaping inspection at the Canadian or Mexican borders.

The next scrutiny to which the immigrant is subjected is that of the steamship authorities at the port of embarkation. This was formerly a perfunctory examination, and is so still, as far as some lines are concerned, but first-class lines, notably the English and German, examine the immigrants carefully and with due regard for our laws. The strict enforcement of our laws, and especially the imposition of one hundred dollars' fine for bringing to our ports any case of a contagious character, have occasioned some improvement in the inspection made by ships' doctors at European ports. At the port of embarkation the immigrants' names are recorded upon lists or manifests, each list containing about thirty names. After each name the steamship officials are required by law to record answers to a certain number of queries relating to the immigrant.

Section 12 of the act of 1903 provides that the manifests shall state, in answer to the questions at the top of the manifest sheet, the full name, age, and sex; whether married or single; the calling or occupation; whether able to read or write; the nationality; the race; the last residence; the seaport of landing in the United States; the final destination, if any, beyond the port of landing; whether having a ticket through to such final destination; whether the alien has paid his own passage, or whether it has been paid by any other person or by any corporation, society, municipality, or government, and if so, by whom; whether in possession of thirty dollars, and if less, how much; whether going to join a relative or friend and if so, what relative or friend, and his name and complete address; whether ever before in the United States, and if so, when and where; whether ever in prison or almshouse or an institution or hospital for the care and treatment of the insane or supported by charity; whether a polygamist; whether an anarchist; whether coming by reason of any offer, solicitation, promise or agreement, expressed or implied, to perform labor in the United States, and what is the alien's condition of health, mental and phys-

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