INSTITUTE OF MARINE ENGINEERS

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SESSION 1901-2.

President—JOHN CORRY, ESQ.

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NINETY-EIGHTH PAPER

(OF TRANSACTIONS).

THE USES OF INDIA-RUBBER ON BOARD SHIP,

BY

MR. G. W. NEWALL,

MEMBER.

READ AT

58 ROMFORD ROAD, STRATFORD,

ON

MONDAY, OCTOBER 14TH, 1901.

ADJOURNED DISCUSSION, MONDAY, OCTOBER 28TH, 1901.

PREFACE.

58 Romford Road,

Stratford,

October 14, 1901.

A meeting of the Institute of Marine Engineers was held here this evening, when a paper by Mr. G. W. Newall (Member of Council), on "The Uses of India-rubber on Board Ship," was read by the Author.

The Chair was occupied by Mr. J. R. Ruthven (Member of Council). A discussion ensued, and was adjourned to the following meeting, on Monday, October 28th.

JAS. ADAMSON,

Hon. Secretary.

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THE USES OF INDIA-RUBBER ON BOARD SHIP.

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MR. G. W. NEWALL (MEMBER).

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CHAIRMAN:

MR. J. R. RUTHVEN (MEMBER OF COUNCIL).

THE commercial article known as india-rubber must not be confused with the name of caoutchouc, the natural gum of many tropical plants, which forms the principal ingredient constituting the material known as india-rubber.

Caoutchouc of itself is of little or no use to fulfil the purposes for which india-rubber is employed. So that the term india-rubber is one of very wide meaning and application.

India-rubber is about the only material that has the property of bending, stretching, compressing, etc., and returning again to its normal state on release.

The art of india-rubber making is now so well understood that from a small percentage of the crude material, caoutchouc, a very good class of india-rubber can be produced compared with that of past years, whilst an india-rubber manufacturer to be successful at the present time, must be an excellent chemist, electrician and mechanical engineer combined.

A very brief description of the *modus operandi* of the workings of an india-rubber factory may not be out of place. Raw rubber, or gum as it is usually termed in the trade, is obtained principally from the following places, or known as :

Pará,	African,	Peruvian,
Mangabeira,	Pernambuco,	Ceará,
Manicoba,	Assaree,	Mollendo.

It is collected by the natives of these countries by tapping the trees, and formed into balls and liver-like masses, more or less accidentally or not mixed with stones, bark of trees, leaves, and other disagreeable impurities much objected to by the manufacturer. It is then packed in boxes or casks and shipped to this country, many tons at a time. The price of the raw gum delivered to the factories varies from about 1s. 6d. to 4s. 3d. per lb., impurities included.

On arrival at a rubber factory it is weighed, and the gum is then sorted over and sent into the washing shop, where the large lumps are cut open to see that no stones or pieces of wood are hidden within it; it is then roughly washed and partially softened in hot water tanks. After which it is passed several times through powerful crushing rollers with fluted surfaces, and geared in such a way as to tear the mass asunder into sheet form, where the bulk of any foreign matter is removed. From thence it is passed through massive rollers provided with sharp teeth in the washing machines, at the same time plentifully supplied with clean water, which further removes the dirt, slime, or any small pieces of remaining foreign matter. It is then dried in large rooms or chambers heated by steam, and when quite free from moisture the gum is again passed through another set of large roller mills and "batched" into blocks, and afterwards stored away in iron bins as pure gum until required.

As required, a quantity of this pure gum is weighed out, and with an exact quantity of sulphur, pigments, and colouring matter, the whole is sent into the mixing shop, and the mass is again passed through powerful rollers and thoroughly incorporated into a semi-plastic mass, termed "dough."

The dough is then given a quality number or letter and sent into a store where it is placed in iron bins until required to produce a rubber article or goods to order.

The qualities and prices of india-rubber are so manifold that factories are working with between 300 and 400 different mixtures. Almost any colour can be obtained in rubber goods, and almost at any price, varying according to purity of materials. From the "dough" stores the dough is taken into the mill, where it is calendered into sheets of any thickness, about 4 ft. wide, and any length up to 100 ft.; or it is made into tubing almost of any diameter, or solid cord, as the case may be; or it may be cut up into special shapes and placed in "moulds," when it is secured under great pressure and "vulcanised" in steam or water at about a temperature of 290° Fah.; after which it is trimmed, cleaned and weighed out to the customer at prices varying from 1s. to 18s. per lb., according to the intricacies of the mould or other requirements to meet the order.

Some of the principal pigments used in the making of india-rubber goods are :

Oxide of zinc,	Litharge,	Magnesia,
White lead,	Lithopone,	Whitening,
Red lead,	Lime,	Keisulghur,
Black lead,	Barytes,	Lamp-black,
Glycerine,	French chalks,	Creosote,
Asbestos powder,	Glass,	Antimony,
Oxide of iron,	Pumice powder,	Spanish brown.

For curing purposes :

Sulphur in various forms.

For colouring purposes :

Sulphide of antimony yields red.
,, mercury ,, crimson.
,, arsenic ,, yellow.
,, cadmium ,, yellow.
,, zinc ,, white.
Oxide of chromium ,, green.
Vermilion. Prussian blue.
Various ochres, etc.

Ordinary india-rubber goods require about from 2 to 7 per cent. of sulphur for curing purposes, and when containing caustic lime and magnesia (hydrates) the curing is somewhat accelerated, which must be allowed for, and the time required for curing purposes varies from, say, one hour to three hours.

Many colours are most difficult to produce, while absolutely white and black goods are impossible to produce.

From experience, I find engineers too readily accept what is sent them in the way of india-rubber goods for special purposes on board ship. Of all the stores sent into a ship this class of articles receives less query as to suitableness than any I know of.

When ordering india-rubber stores state carefully for what purpose the articles are for—that is, if you are ordering, say, circulating pump valves, bucket rings for hydraulic pump work, or valves for air pump requirements, state so on your order, but adding that they are subject to such and such a temperature, and name the oil or grease that is liable to come in contact with them—as all rubber manufacturers are glad to know for what purpose the goods are intended; it leads them to select a quality having the highest heat or oil-resisting ingredients in its composition; and when exposed directly to the action of steam always give the pressure.

These are guides to produce the best articles for the particular uses for which india-rubber is suitable. It will always pay engineers to be confidential with the makers and suppliers of such articles, as their knowledge of chemistry comes to their aid.

I know a member of this Institute who recently required several hundred feet of strip india-rubber for jointing water-tight doors, about 3 in. by $\frac{1}{4}$ in. thick, and, ordering the above without stating either the lengths this was wanted for use in, or the purpose for which it was required, had to wait about ten days before it could be delivered. On the other hand, had he stated his requirements he would have been supplied from stock sheet in less than the same number of hours. The strip was made unnecessarily in one length, to be cut into 6 ft. lengths by the user—a loss of nine days, which in ship work is a consideration.

The process of making such a strip, say, 250 ft. in one length, is a very tedious one, while strips of 6 ft. to 18 ft. in length are kept in stock in wide sheet form and cut into widths as required.

To illustrate the application of india-rubber for some of the various purposes employed on board ship, I have submitted a few rough sketches to show the general principle under which it may be used with advantage, the dark portion in the sketches representing the section of the india-rubber in all cases.

Fig. 1 represents the application of the old Bramah hydraulic packing ring to pack the space between the glass and the sides of the stuffing box of the boiler water gauges. By the use of this section of joint the screwing up of the gland nut does not put any undue pressure on the glass.

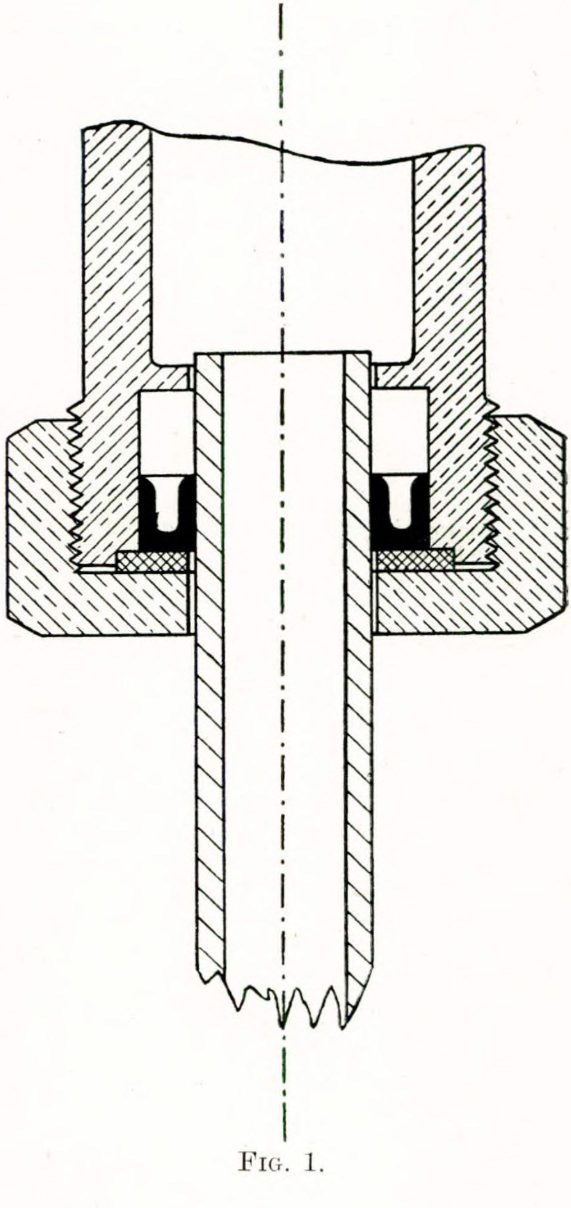


FIG. 1.

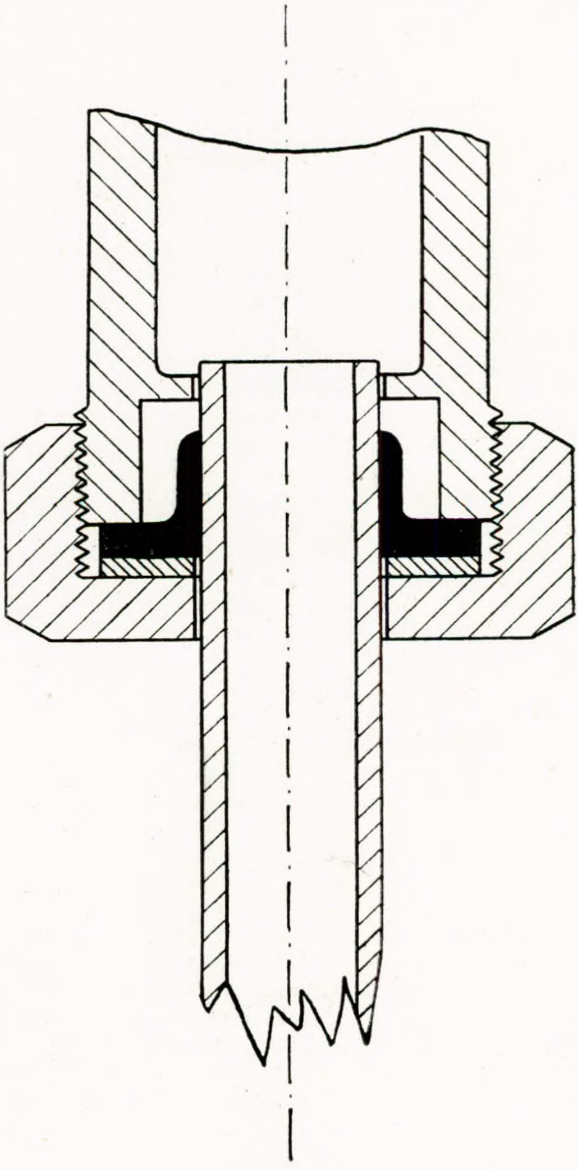


FIG. 2.

When boiler pressures were lower some years ago than is now usual, almost anything of a soft flexible nature would pack a water-gauge glass—a turn of lamp-wick, insertion washers cut from a sheet, a turn or two of cord, or even a strip torn from an old pocket-hand-kerchief, would meet the case—but when pressures rose from 60 to 100 and then on to 160 lb. per square inch, with their corresponding rise in temperature, these crude methods were no longer useful, and of late considerable invention has been brought into play regarding the best methods of packing these glands. For many years the old circular india-rubber ring was, and is yet, supplied to many ships to meet this want, but for a perfect joint, self-acting, and without throwing any stresses on the glass, this is a fair example.

In Fig. 2 we have another form of india-rubber packing for the same purpose, also dispensing with the twisting action on the glass when screwing up the gland. In this case you will notice the joint is made by end pressure, compressing the flange of the ring between the face of the stuffing box and the loose washer, the object of the latter being to get rid of any turning action on the rubber, the friction on the two metals being much less than between rubber and metal.

Fig. 3 shows the application of a compound ring of india-rubber and flax, for jointing up man-hole doors, etc., on the boilers. In using such a joint it is of paramount importance that the two faces should be inclined to each other as shown, otherwise the tightest fitting ring to door will be displaced when screwing up.

The ring itself should be made endless, and composed of woven flax, not cotton, nor asbestos, which will often be offered to engineers as a good article; the rubber should be frictioned on the flax, and composed of the best heat-resisting pigments, and in ordering such rings this is a case where the pressures carried in the boilers should be stated to the manufacturer.

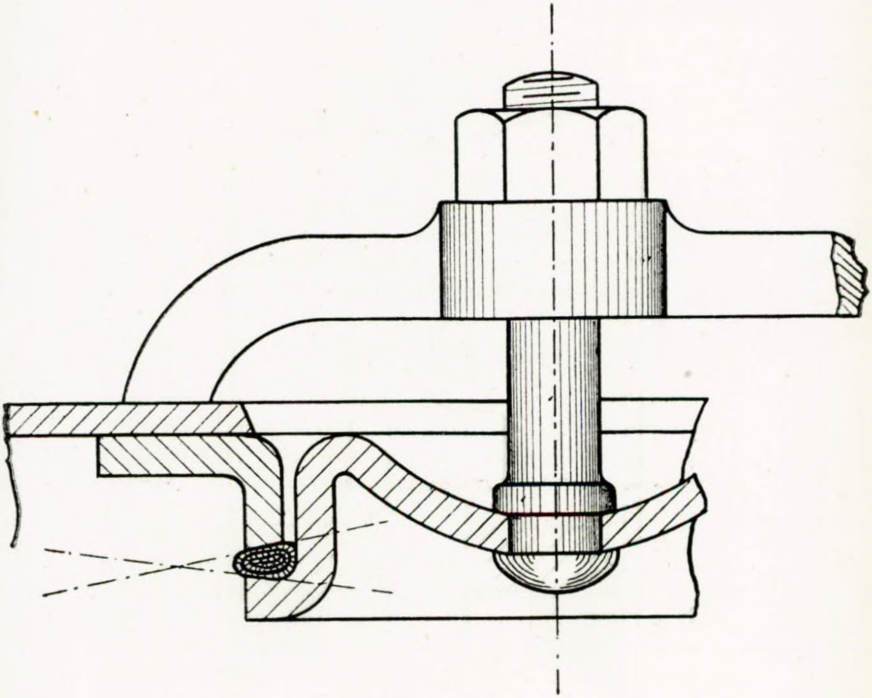


FIG. 3.

Fig. 4 represents one of the numerous forms of boiler-tube stoppers for plugging a leak in the junction between the boiler-tube plate and the tube, the object being to cover the area of the perforation by means of a wide faced ring of india-rubber, tapered in section, which is put in loosely and tightly screwed up when in place, the two bevelled washers forcing out the rubber with great pressure around the bore of the tube, thus sealing the leak.

There are many devices in the market for this purpose, but this figure represents one of the most useful. Whilst lying in the store out of use, care should be taken that the india-rubber rings are not

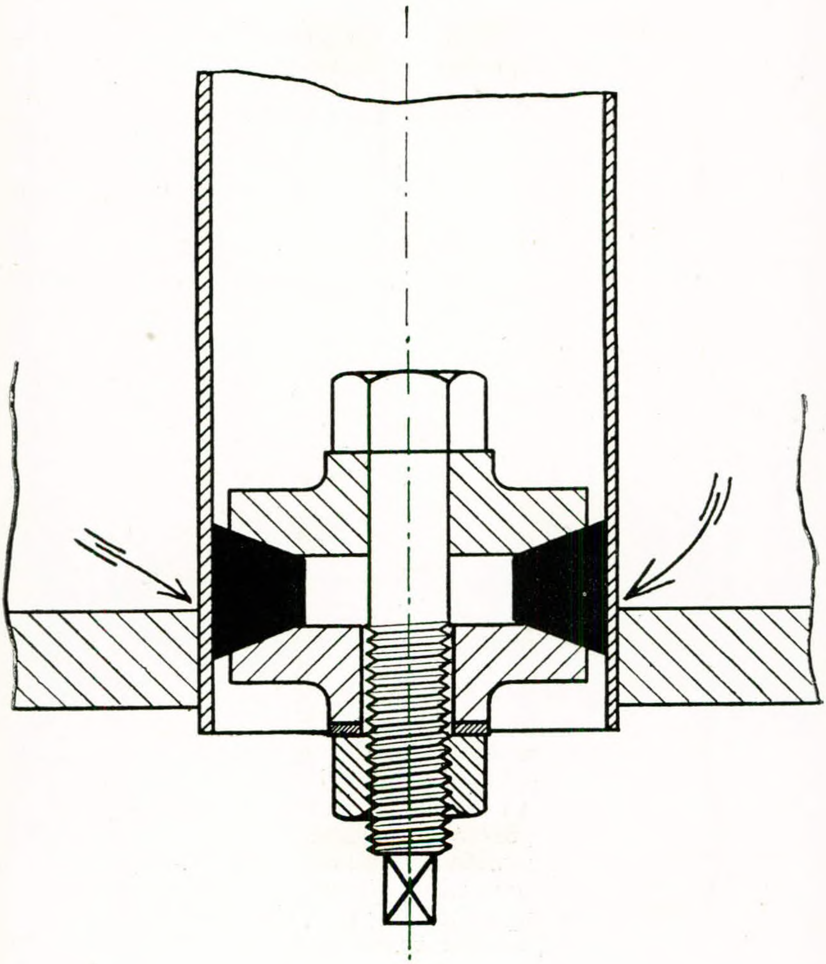
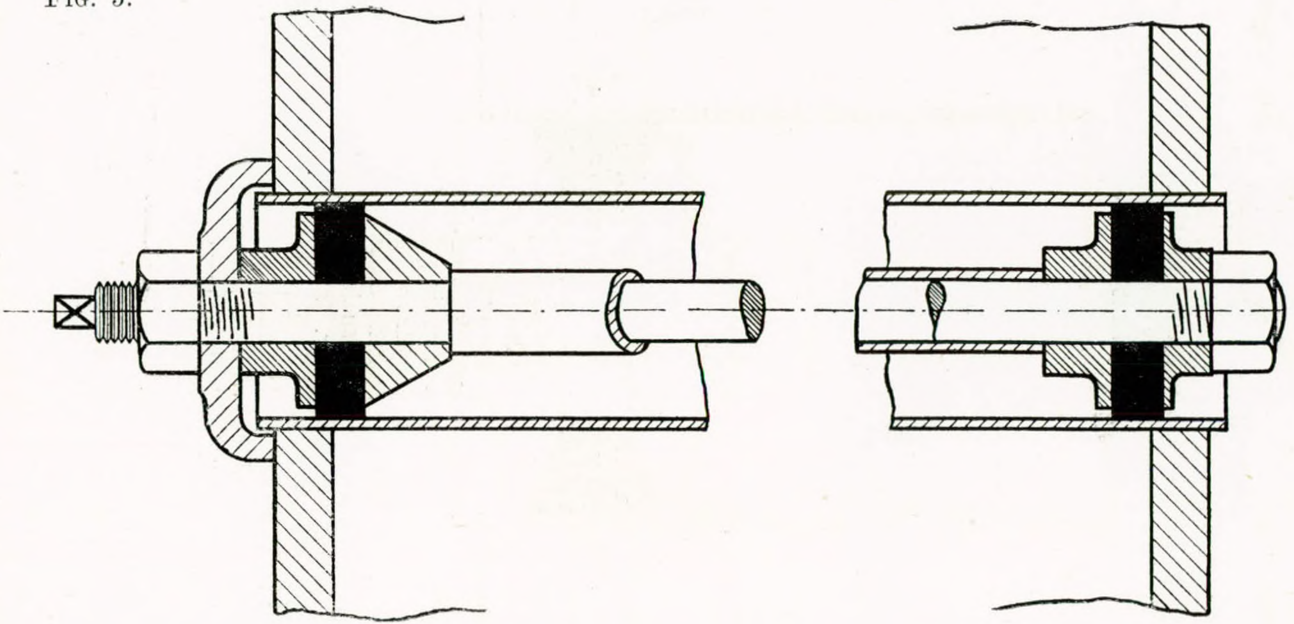


FIG. 4.

FIG. 5.



under compression, otherwise in a short time they are liable to take a permanent set and when wanted found useless; also they should be kept free from grease, and, if possible, kept in a dark, damp place. The ironwork should be stored away separately.

Fig. 5 shows the section of a double-ended tube-stopper fitted with india-rubber discs, operated through a central tube much in the same way as that already described; there are also many forms of these double-ended stoppers, whose general principle is similar to sketch. These are very necessary appliances for an engineer to have in his ship, but no doubt he would rather be without the necessity of having to use them. Whilst at sea the author always looked upon the stopping of a boiler tube as a dirty Turkish bath—thankless operation, and the less we have the better.

We now come (see Fig. 6) to one of the most troublesome and annoying classes of work—particularly when off watch—the junior engineers have to remedy at sea. In the thousands of feet of copper arteries that spread themselves over a modern steamer, many of these connections are constantly being made good, patched up where more or less inaccessible whilst at sea, they form one of the greatest worries of sea life. The author's recollections of over twenty years ago come back vividly of the hours off watch, when temperature of the sun and steam combined seemed near boiling point, space to work in not reckoned; yet these joints had to be made good. Perhaps the joint was one where the flanges were far from contact; such a joint one used often to meet, as shown in Fig. 6. But this is the fault of the engineer, as no joint should be allowed to take the form shown in the sketch. It points to the pipe being strained, the flanges almost ready to fracture where brazed; the bolts get bent, and if it was not for the good tempered material pipes and flanges are usually made of, many would part company. The causes of these joints requiring so much doctoring is owing to several things, the principal reasons being:

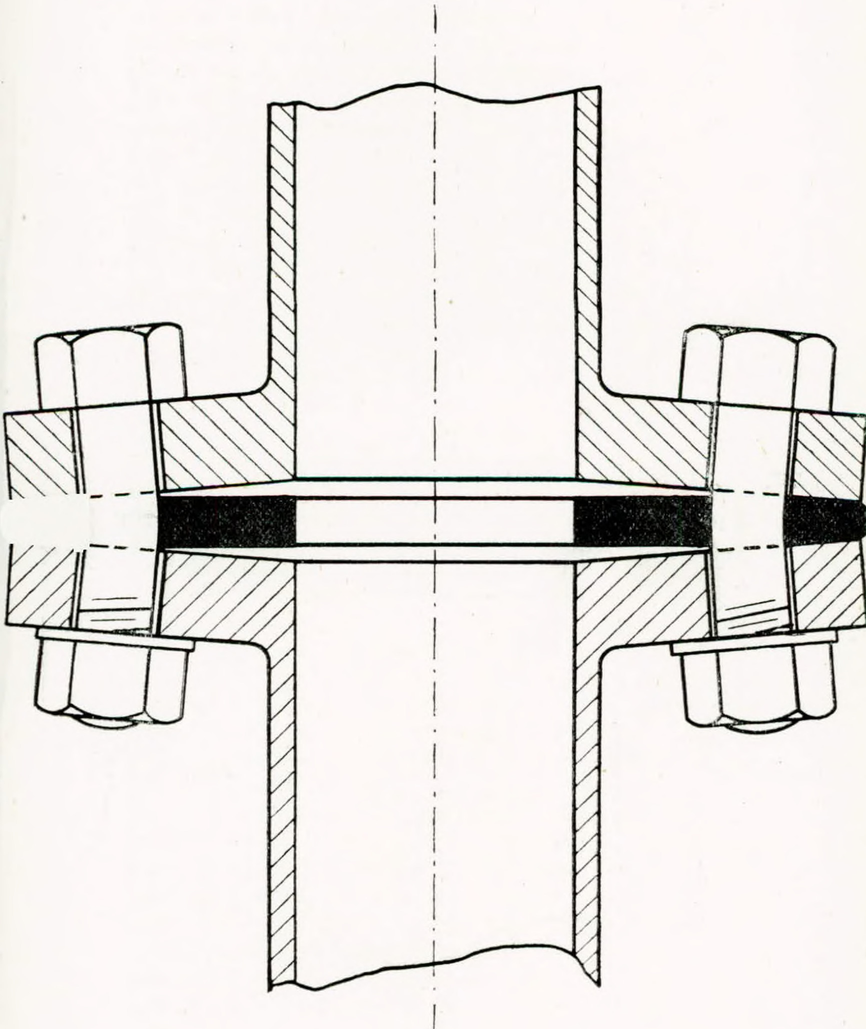


FIG. 6.

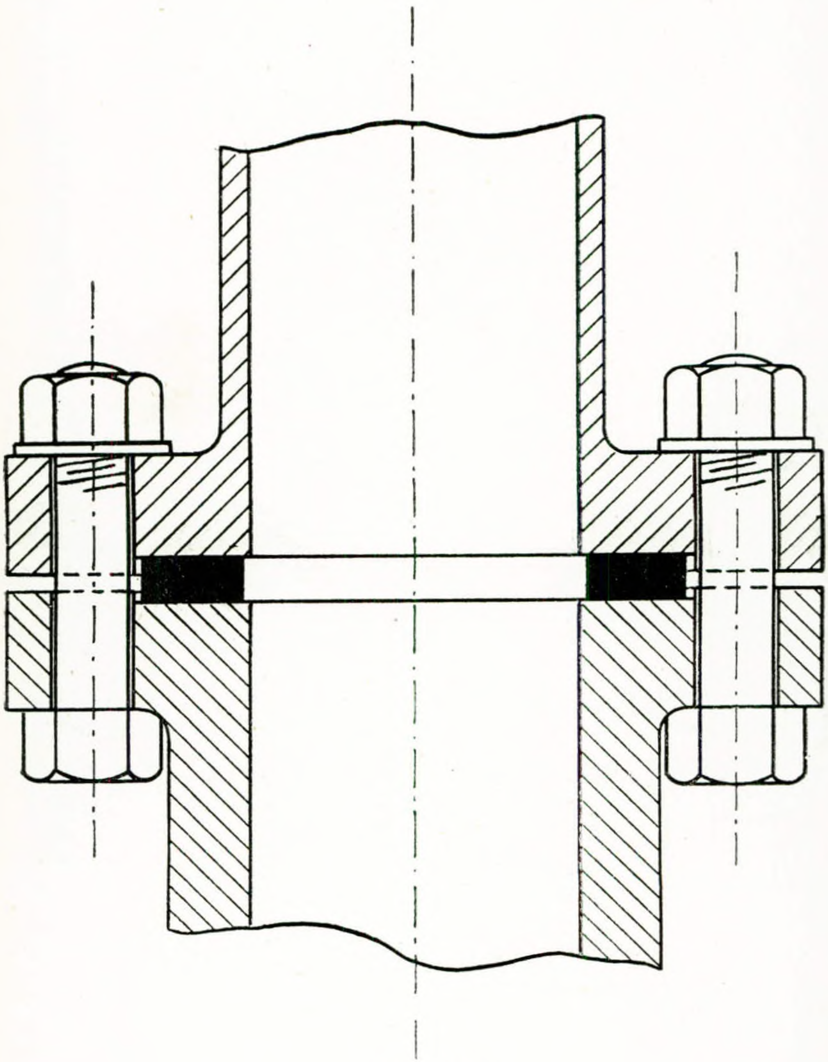


FIG. 7.

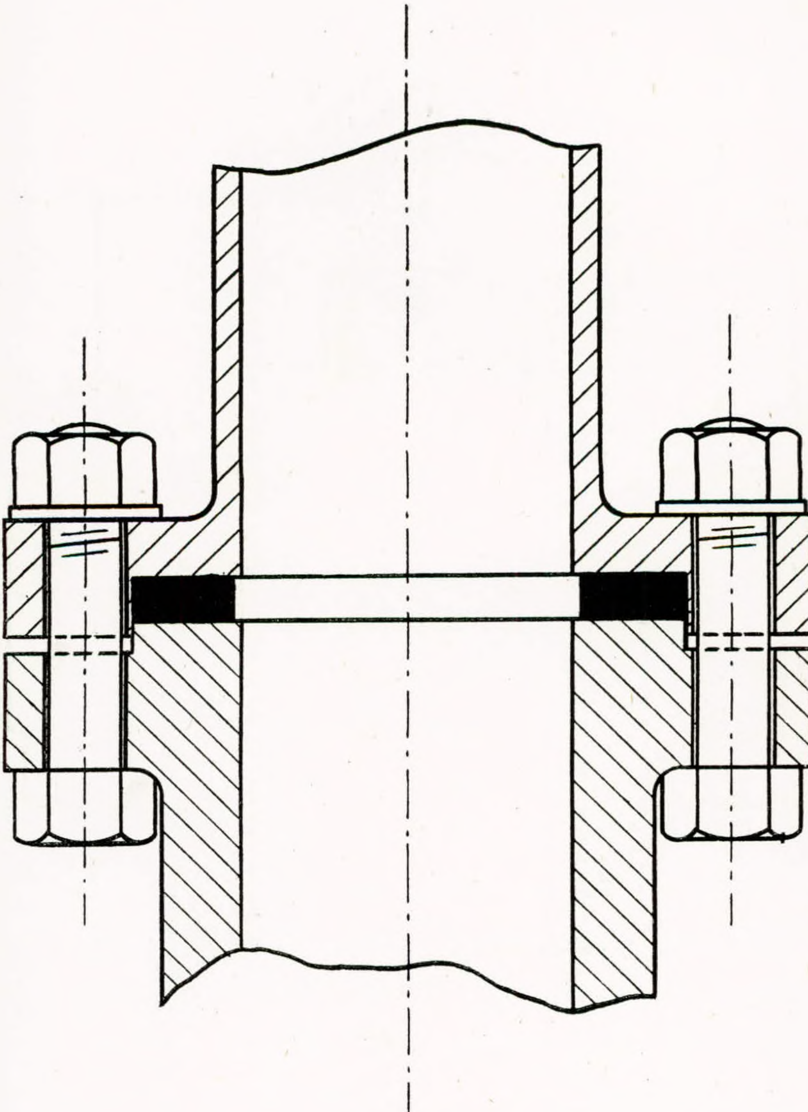


FIG. 8.

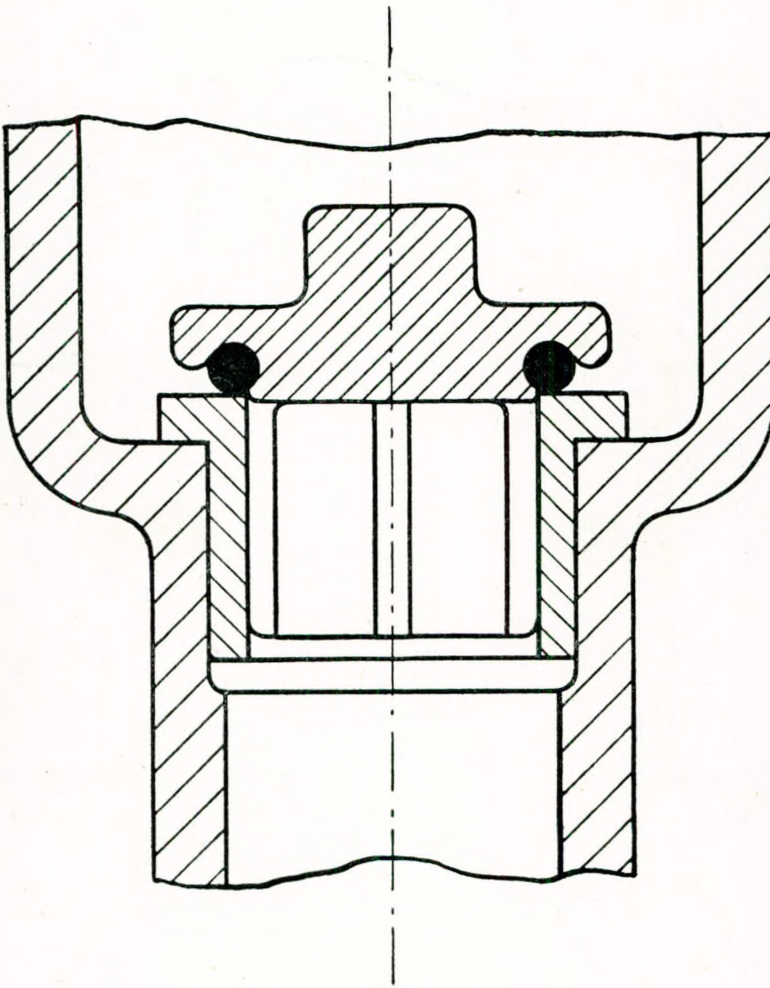


FIG. 9.

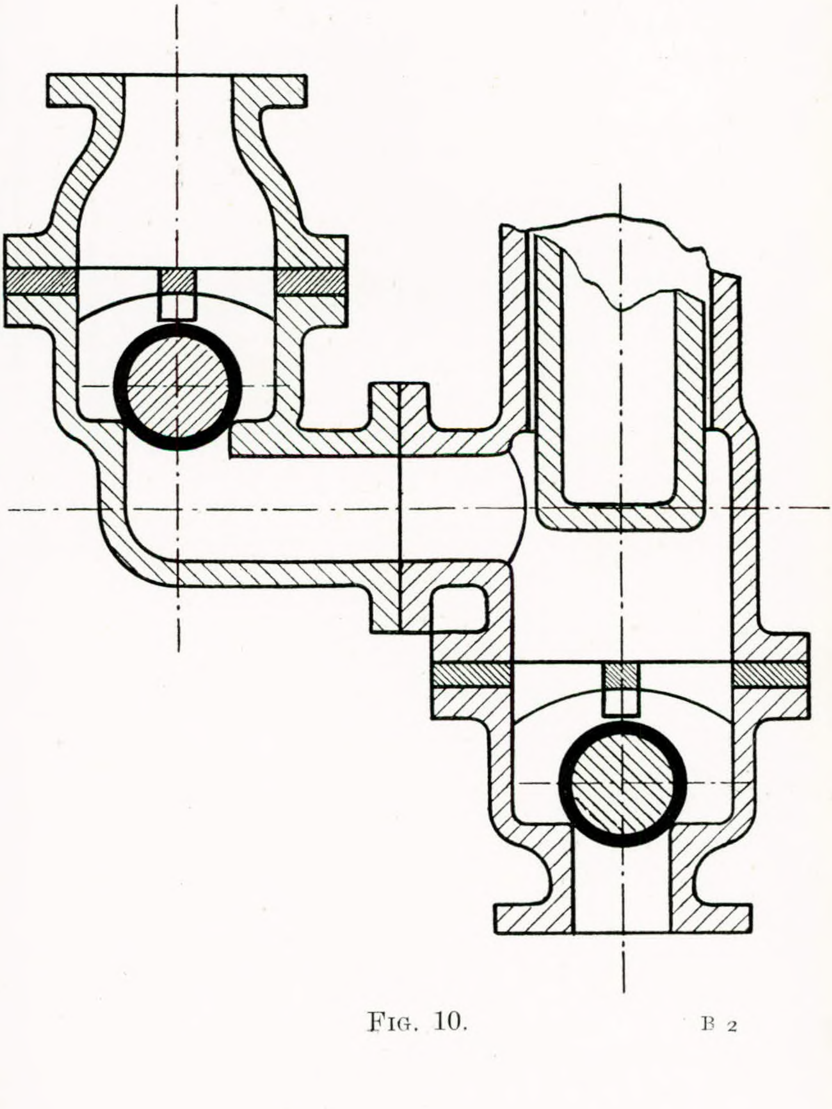


FIG. 10.

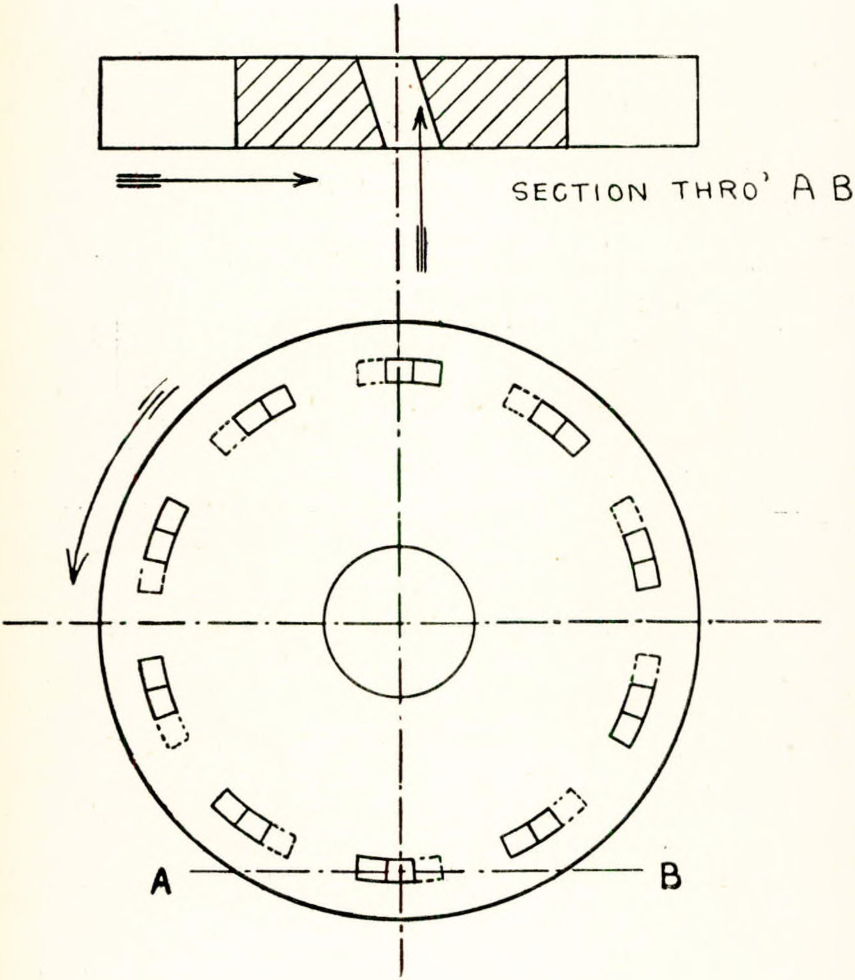


FIG. 11.

shortness of piping, flanges being too thin, india-rubber joints being too thick originally, want of expansion bends, and kicking. These can all be remedied if the joints are made as shown in Fig. 7, where stiffer flanges are brazed to pipes, and a recess formed for the joint in each flange face; but better still is Fig. 8, where the spigot of one flange fits into the recess of the opposite flange, steadying the joint and thoroughly protecting the india-rubber ring. In this case the flanges are also thickened to allow of this, and from experience the author has found this form, generally, one of the best to keep its tightness.

In Fig. 9 we have the application of an india-rubber ring to form the sealing of a pump valve on its seat, the object being that it is noiseless in action, always making a perfectly tight seal, and can be readily renewed in a few seconds whilst at sea. Such rings are moulded articles, are truly circular, both in section and diameter, and free from ridges or projections; while at the same time they do not in the least wear the valve seating, and to further reduce the clatter of these valves whilst working, the stems can be formed with an india-rubber pad to beat against the stops on the covers, or the covers themselves may be recessed and an india-rubber pad fitted, which in either case renders the working of such valves almost noiseless.

Fig. 10 represents another class of pump valve, noiseless in action; a good seal, and offers a wide unrestricted opening of suction and discharge passages, is very serviceable when fitted for bilge pump work, water tanks and similar purposes. The valves consist of a metal or wooden core, surrounded by a thick envelope of india-rubber, moulded under great pressure, and are particularly useful for ships with foul bilges, and few ships have not foul bilges.

The disc class of valve is possibly one of the earliest forms that were introduced with the marine engine; but since the plain disc valve was long since pressed into service, inventors have been busy trying to get over several old sores, the most important ones being the cracking or splitting of valves when in use a short time in the air and circulating pumps; the swelling due to oil or grease from cylinder lubrication, the permanent concave set they get into the bad habit of forming themselves, the slimy, semi-plastic condition they soon develop. Much of this can be remedied if engineers will appeal to the manufacturer when ordering such articles. If a valve lives a longer life than a predecessor, if it does its work better than one before, then this is or should be the greatest inducement for valves to be ordered from such works as can produce such conditions of longevity, and only by stating the conditions under which such valves have to work can makers produce the resisting qualities to meet this end. When we pay something between 4s. 6d. to 8s. per lb. for such valves we should certainly take some little trouble to have the best article for its work.

It has been found in practice, in the use of large disc valves, that after a time, owing to the beating or flapping in one place, the portion of the valve gratings where the bars cross, cause first small marks, then indentations in the lower face of the valve, and in time cracks appear at these places, and the valve soon goes to pieces. All such bars should be carefully rounded off to avoid this destruction, and to get over this trouble Fig. 11 was devised, the primary object being to cause the water at each stroke of the pump to impinge against the slanting recesses shown in section, through A.B. of valve, the arrows indicating the direction of the water to turn the valve and direction the valve would take, a small amount at every discharge.

Fig 12 represents another form of disc valve, designed to accomplish the same end, but the inclinations for the turning action are formed in the periphery of the valve, as shown in plan and elevation A. and B., while the arrows indicate direction of water and valve as before.

It is an old practice among many engineers who have studied the weaknesses of the disc valve, and

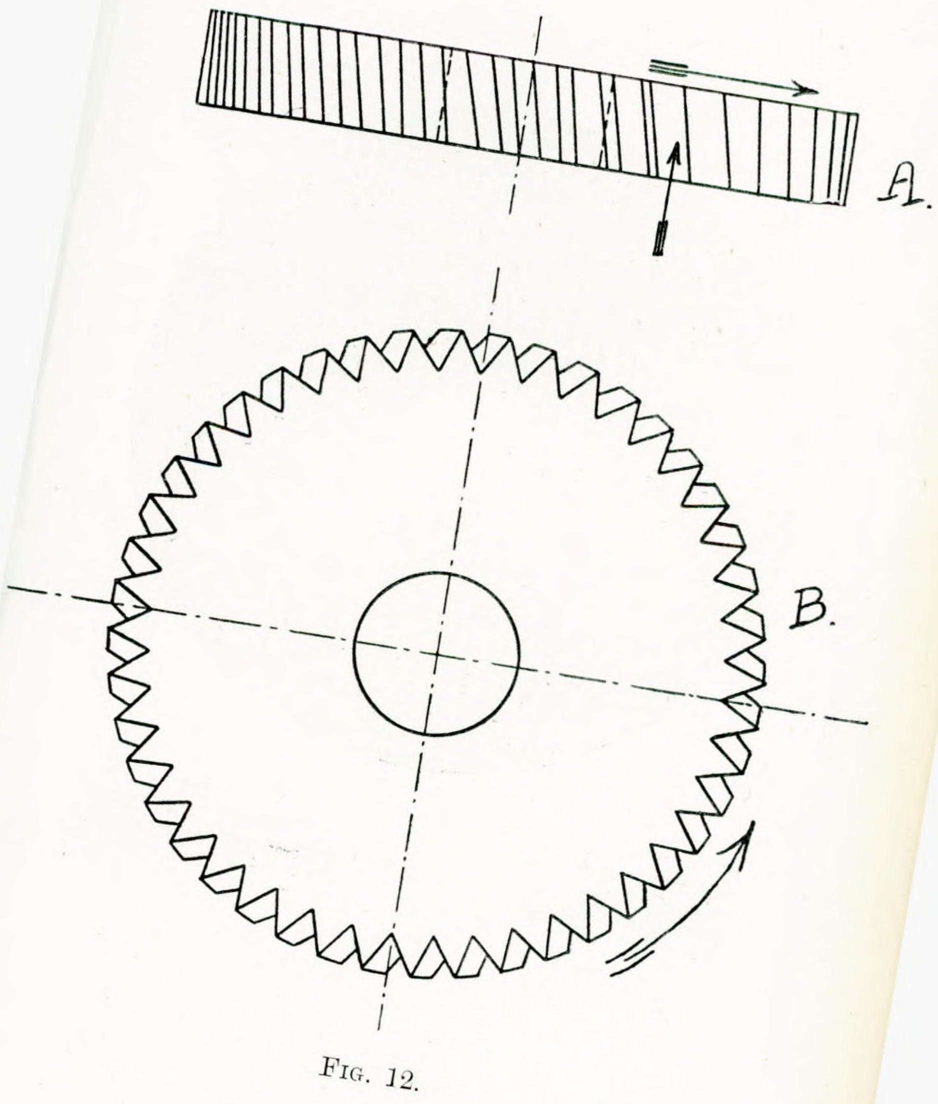


FIG. 12.

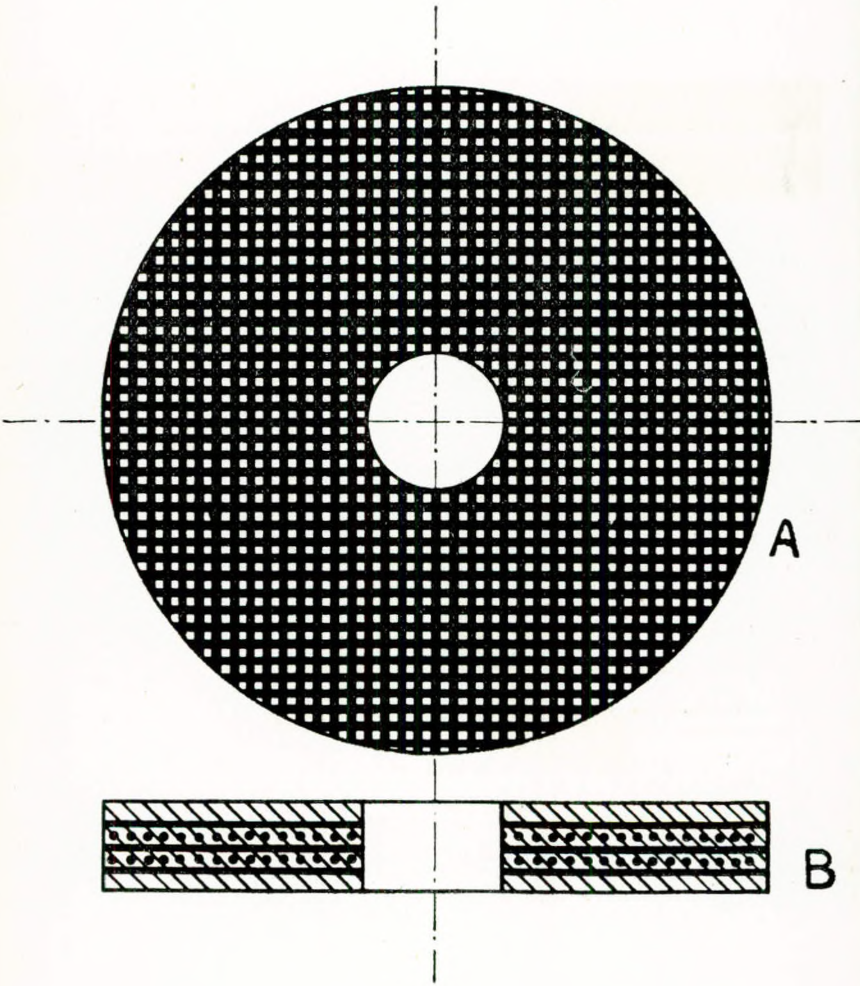


FIG. 13.

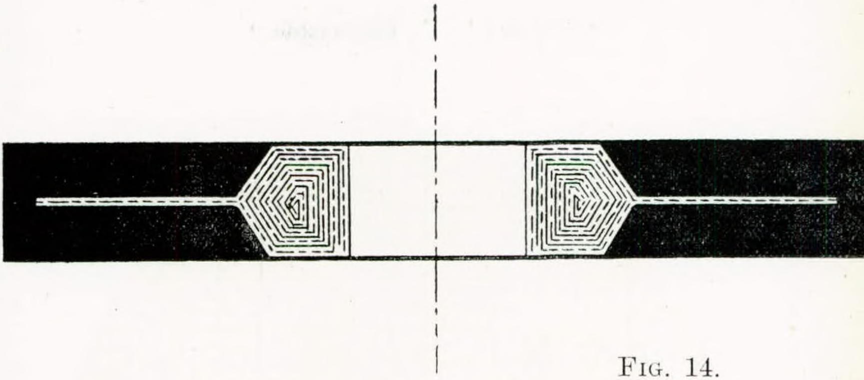


FIG. 14.

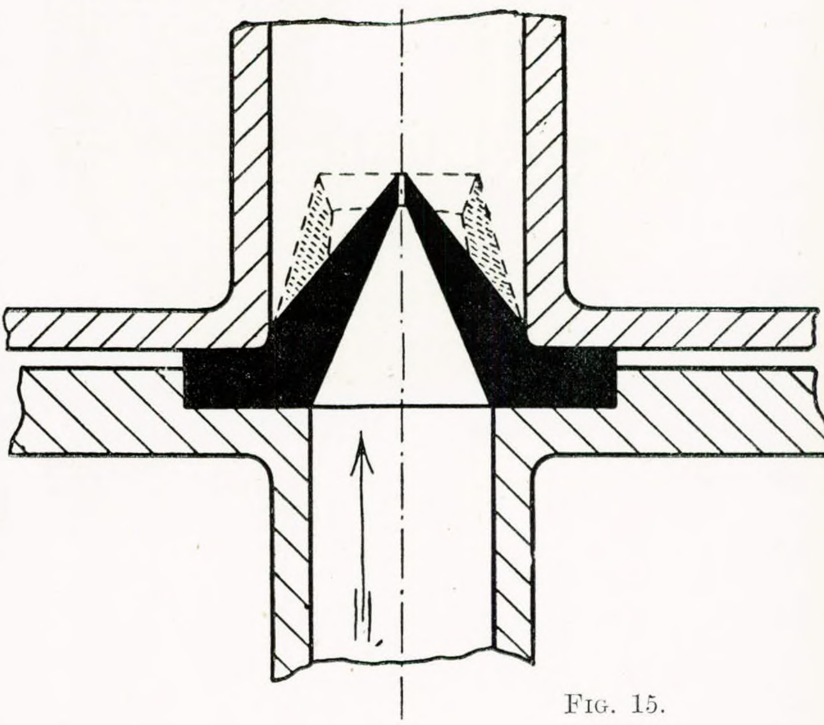


FIG. 15.

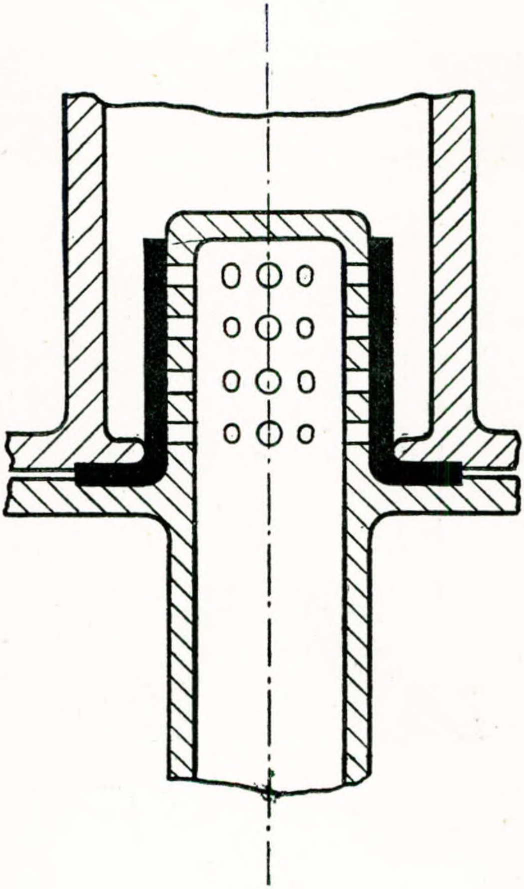


FIG. 16.

to prolong their usefulness, canvas, flax, or threads have been incorporated within them. Fig. 13 is designed to meet this object.

Owing to the action of these valves (the disc class) when at work—the surface next the grating having to be stretched, while the surface of the valve next the guard suffers a compression—any incorporation of a woven fabric within the valve would soon be destroyed owing to the sawing action of the threads over each other; to get over this the figure (No. 13) represents the plan and elevation of a valve having threads or strings laid across the valve, out of contact with each other and free to move independently, so that the sawing action above referred to is done away with. Many modifications of string, or wire embedded in this class of valve have been introduced from time to time. Some engineers have had their valves built up by spirally wound string, or loops and knots embedded in the centre of the substance of the valves in all cases, with the object of increasing the life of such when at work. Wire gauze has also been tried to form an insertion valve, but the author's opinion is generally that a composite valve goes to pieces as soon or sooner than a properly made *all* india-rubber valve. If these valves are produced from moulds, under pressure of at least one ton per square inch, free from marks, letters, etc., they are more serviceable than any special combination of two or more different materials.

Price should not govern this class of valve; while all valves should be subjected to the time test, and when found satisfactory, the quality number should always be noted in a repeat order.

Fig. 14 shows the application of a hard canvas core, formed with a central fin of canvas embedded in the centre of another form of this class of valve.

Fig. 15 represents quite a different form of a suction and discharge valve, and consists of a wedge-shaped projection, terminating in a slit at the point of the wedge, and when in operation the sides of the wedge are forced asunder to the position shown by the dotted lines, and automatically close on the fluid being checked. This form of valve is known as the Perreaux Valve, a model of which is in the museum of the Institute.

Fig. 16 shows the section of a sleeve, or hat-shaped valve, sprung over the end of a metal projection perforated all round with holes; on the passage of the fluid the sleeve of india-rubber is forced away from the perforations, exposing the holes, and on the return stroke of the pump the rubber clings to the sides of the projection and thoroughly seals the joint.

Fig. 17 represents a similar class of valve, or series of ring valves, arranged in grooves over holes in a similar valve projection, as in the former figure. These india-rubber rings are sprung over the projection, and work in much the same way as Fig. 16.

In Fig. 18 we have the application of the use of india-rubber suitable for an air or circulating pump gland; it is secured between a plate and the top of the stuffing box. The ring cone of india-rubber forming the packing is made about 5 per cent. less in diameter than rod, and sprung over the pump rod and held in the position as shown, the recess in the gland plate being formed for lubricating purposes, which in this case is blacklead and water, or even water alone.

Fig. 19 shows in section the application of india-rubber rings to the bucket or rams of hydraulic pumps, usually fitted on board ship; the ordinary packing employed for this purpose is what is known as pump leather, but those who have some knowledge and experience of india-rubber for this purpose prefer the latter to leathers.

Leathers for this important duty are very liable to break away in the neck joining the flange, as in the making of such goods to "upset" a disc of leather at right angles to its plane must unduly distress the fibres of the skin of which it is composed.

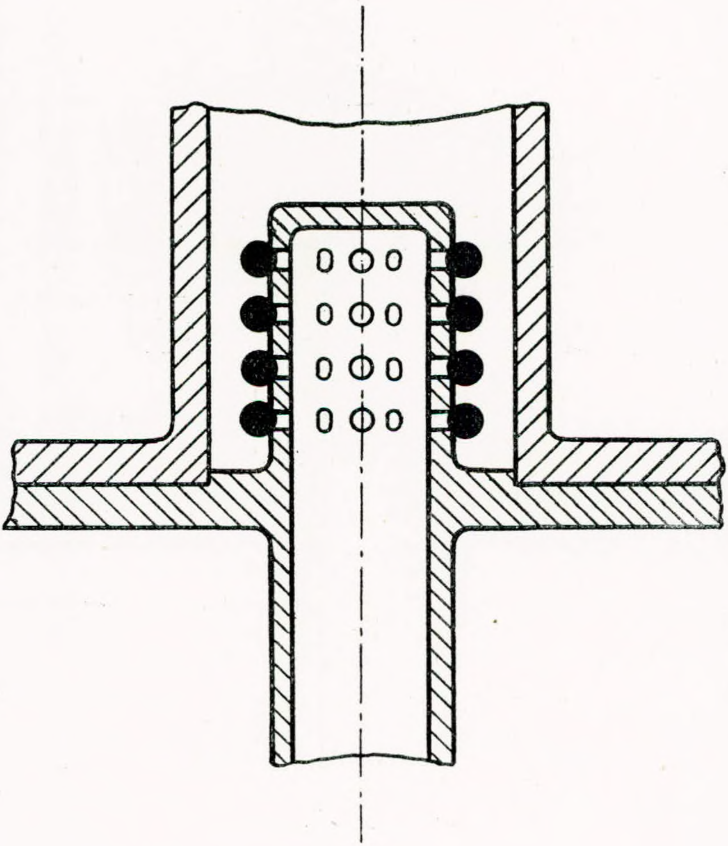


FIG. 17.

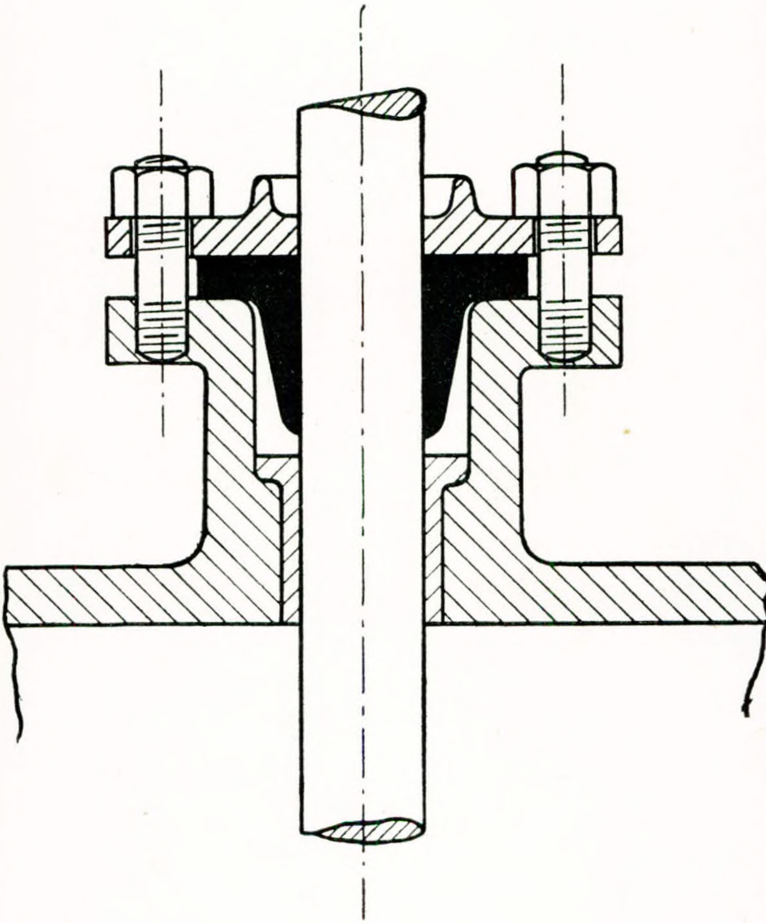


FIG. 18.

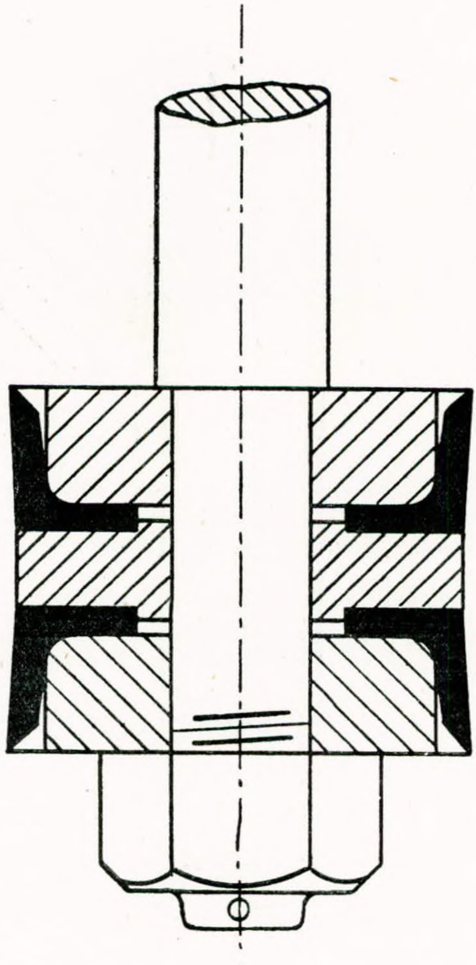


FIG. 19.

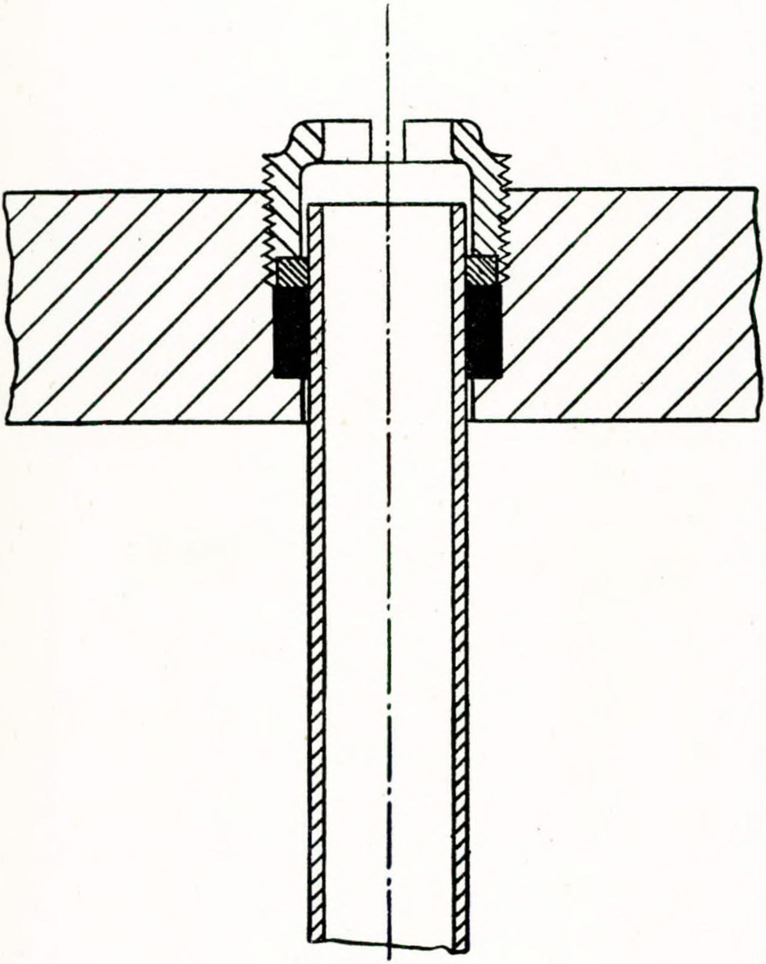


FIG. 20.

If you carefully examine such a leather under the microscope you will observe a number of small cracks at the corners where the cylinder portion has been formed out of the disc, and to hide these fractures some pump leather makers burnish the leathers at this point, which tends to close the cracks until put into use, when they often soon come to pieces.

In ordering such india-rubber packing rings always inform the manufacturer of the nature of the liquid these rings have to work with, whether in fresh water, sea water, soap water and glycerine, etc., as the case may be.

For many years wood ferrules were the only classes of packing employed to make good the junction of the condenser tube with the tube plate; then followed—by some engine-makers—a screwed gland and cotton wick as a packing; but latterly india-rubber rings, such as shown in Fig. 20, were introduced with advantage, as considerably less time was required to repack the tubes of a condenser than by either of the former methods. In the case where several tube joints have to be made good at sea, time is, of course, of paramount importance. India-rubber rings for this purpose should be composed of oil-resisting materials.

At the Annual Conversazione of this Institute, held in the Town Hall, Stratford, in December, 1892, a number of working models were shown in operation by the author, by the kind permission of Mr. C. H. Gray, manager of the India-rubber Works, Silvertown. Among others were two vessels illustrating the application of a flexible india-rubber, self-sealing joint for surface condenser doors and similar vessels, as shown in section in Fig. 21. The object being to form in a recess in the door a U shaped strip of india-rubber, similar in section and object to Bramah's hydraulic ring joint, so adapted that on closing the door, which in many cases is hinged, the water or other fluid exerting its pressure on the three sides of the recess in which it fits, automatically seals the joint between the door and the flange of the condenser.

The utility of such a quick operating joint at sea is considerable, as in a few seconds after the fluid has been withdrawn from the door, by any ordinary locking device, the door is free to open, no bolts being required to be screwed up to hold the door to the condenser, and on repair or examination of tubes, etc., the door is closed, locked, and the fluid forced in immediately, when the india-rubber joint forms a perfect seal at once.

Fig. 22 shows the section in part of an india-rubber and canvas embedded hose, suitable for the many purposes of hose work on board ships, either for deck work, engine-room, or stoke-hold, its special features being strength, and the inner lining consisting of a steam heat-resisting composition, while the outside is spirally wound with galvanised steel wire, usually known in the trade as Sphincture Grip Armoured. This spiral wire does not in any way impair its flexibility when being twisted into all sorts of corners, and greatly increases its bursting strength when used as a steam hose; it can be obtained from $\frac{3}{8}$ in. to 6 in. in diameter.

Fig. 23 represents another form of armoured hose for similar purposes, and consists of a braided or lattice worked outer sleeve or covering, made up of thin steel strips; is very flexible in use; but the strips are liable to wear through sooner, owing to the rubbing or sawing action one over the other, which is avoided by the wire, as illustrated in the former figure.

Many attempts have been made by ship-builders and engineers to deaden the vibration and rattling of machinery, particularly the many auxiliary engines, inevitable to some extent in our iron ships, whereby, owing to the continuity of metal from such machines to the skin of the ship, every metallic noise is readily conveyed all over the vessel; even into the quiet recesses of cabins, saloons, and smoking rooms, etc., the dull thud or ring of the working parts of these machines is carried.

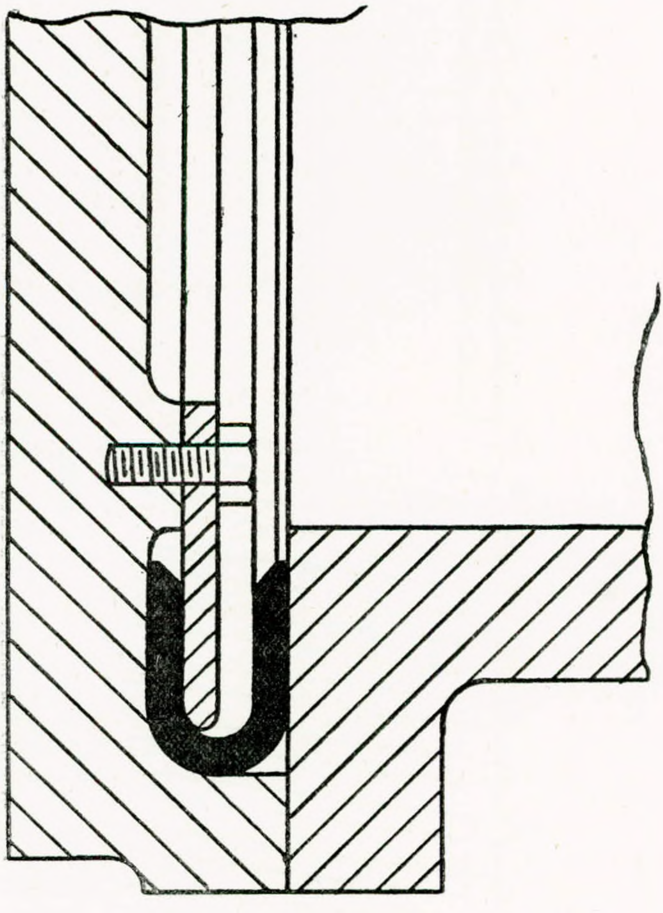


FIG. 21.

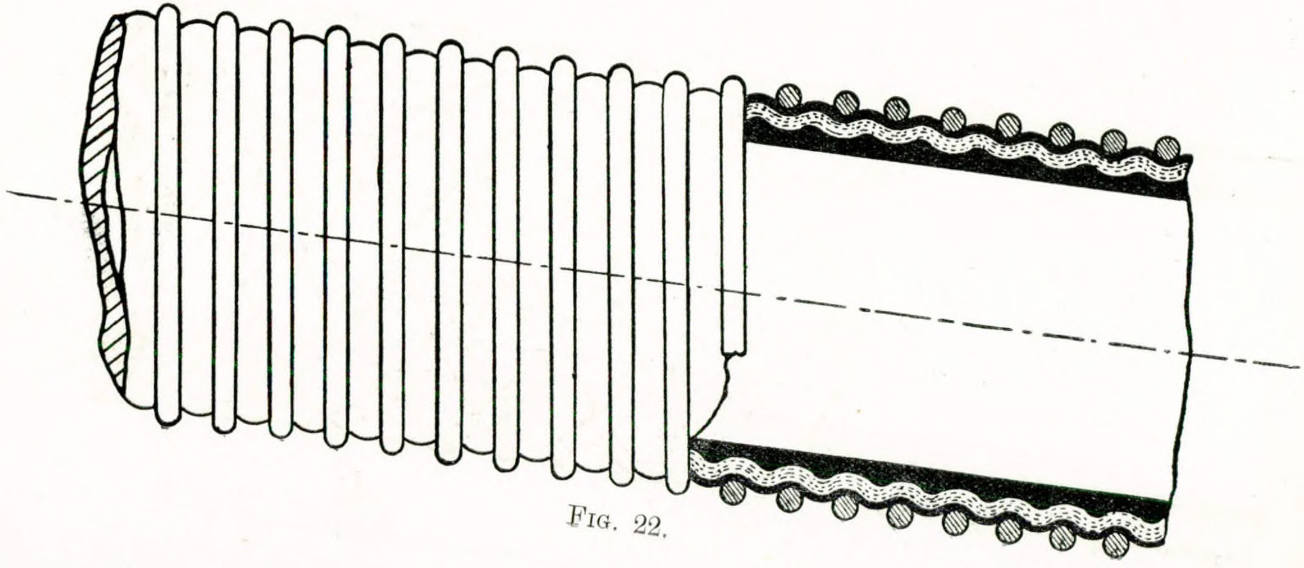


Fig. 22.

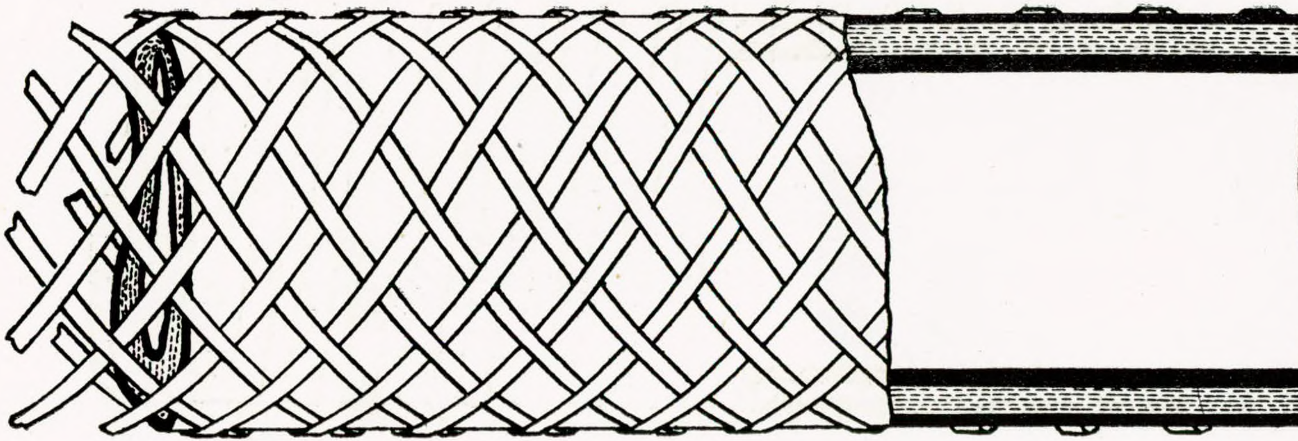


Fig. 23.

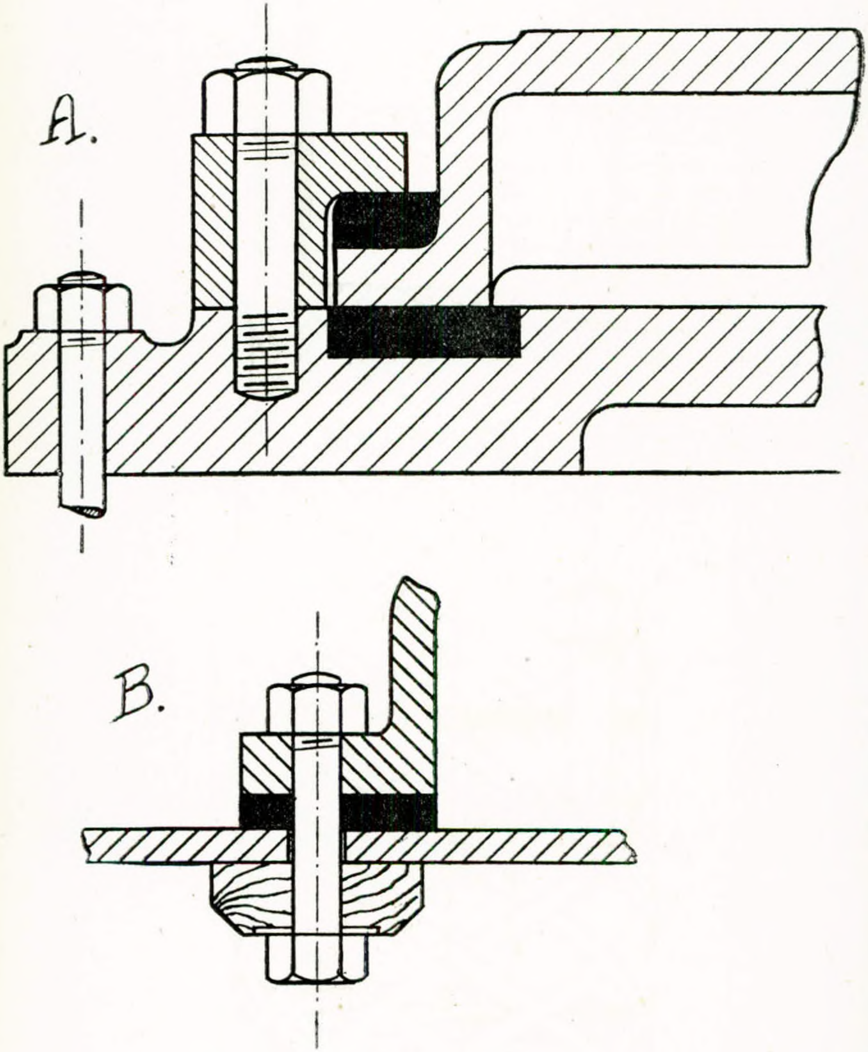


FIG. 24.

In Fig. 24 is shown in sections A and B the general principles of the application of india-rubber for considerably checking or stopping these noises being distributed through the ship. By interposing a layer of india-rubber between the iron foundation plates and between the flanges of auxiliary engines, as shown in A. Fig. 24, the vibration then set up in the machine bed-plates embraced in this manner would be at once absorbed by these strips. In B. Fig. 24, is shewn the application of a similar sheet of rubber or flexible pad placed between a sole plate or machine casting, on, say, a bulkhead, behind which is placed the usual wood packing; the bolts being out of contact with the metal of the bulkhead, so as to be insulated from the conduction of the sound or vibration of such machines when secured to iron structures.

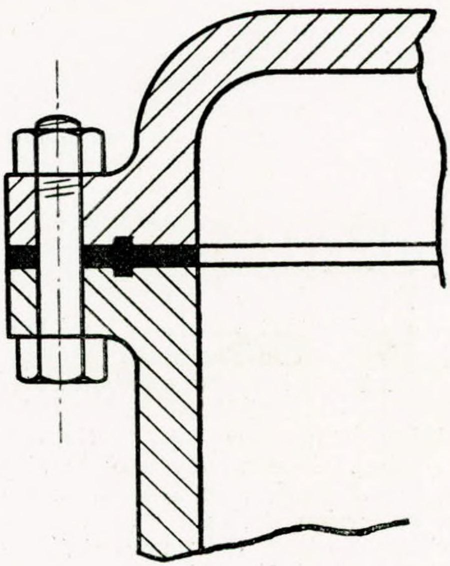


FIG. 25.

Fig. 25 represents the application of india-rubber to joint up cylinder casings, covers, and like parts of our engines of large jointing surfaces, the object being to allow of the free expansion of the rubber to check or upset the plane of the surfaces of such large areas to prevent leakage, by means of coincidental recesses formed on each face of the joint.

Fig. 26 also represents the application of india-rubber for jointing cylinder covers, where the joint is often broken for the necessary removal of such covers to overhaul the pistons, etc., the chief aim being to protect the material of the joint from destruction when working across the face of it, such flexible joints being capable of lasting a number of years if protected in this way. The recess being formed in the end of the cylinder whilst being bored.

Gland packings are so numerous that the author has purposely refrained from specialising any but one particular form. Their sections and manipulations of india-rubber and canvas; india-rubber and metals; india-rubber and gauze wire; india-rubber frictioned canvas and gauze wire; india-rubber asbestos and gauze wire, are legion. The packing that is well known to us all, and one that has had a longer life than any other, is that known as Tuck's Packing. Go where you will anywhere in the world, in any engineer's repair shop or stores, you can get Tuck's Packing. Such is not the case with many other packings that have attempted to displace it.

A new packing that promises a good long life and usefulness is the one illustrated in Fig. 27, and known as Platt and Lowther's Patent Packing.

It is composed of frictioned rubber and canvas or flax, and in principle is a copy of the old Bramah hydraulic ring. It is widely used in ships of our own merchant service, in Russia, and in many warships of foreign navies.

In Fig. 28 we have the representation of one of the many forms of india-rubber spring buffers placed in the circuit of the steering chains, the object of

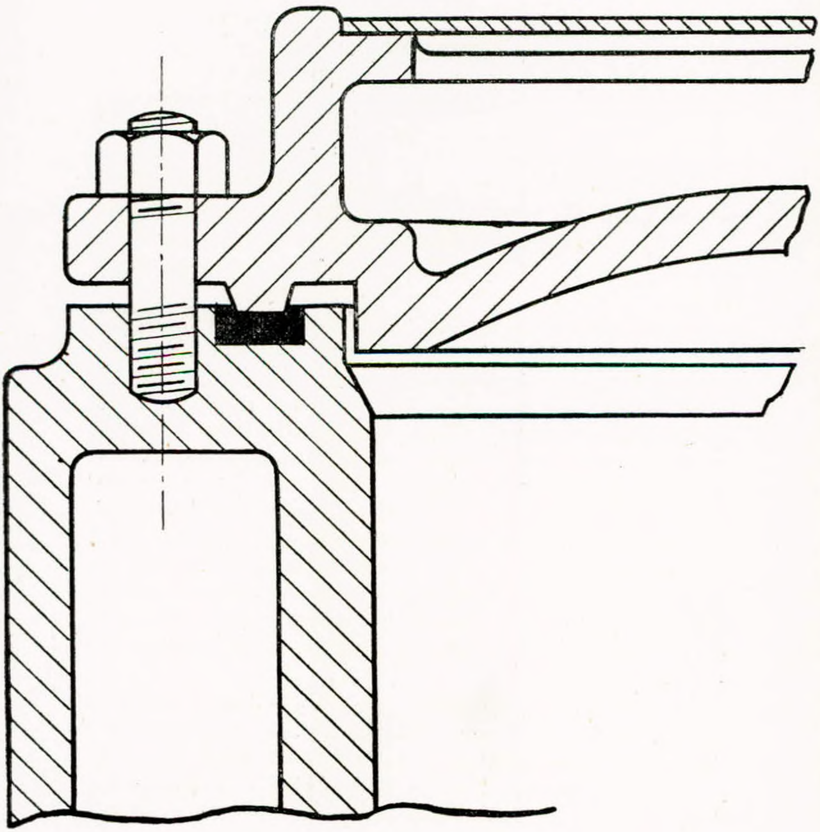


FIG. 26.

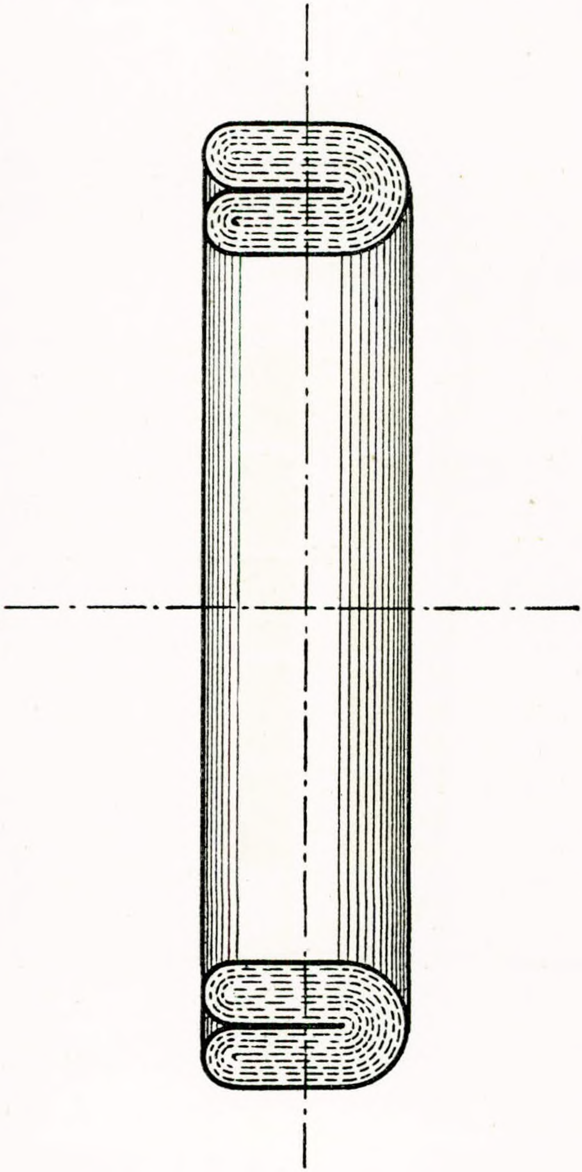


FIG. 27,

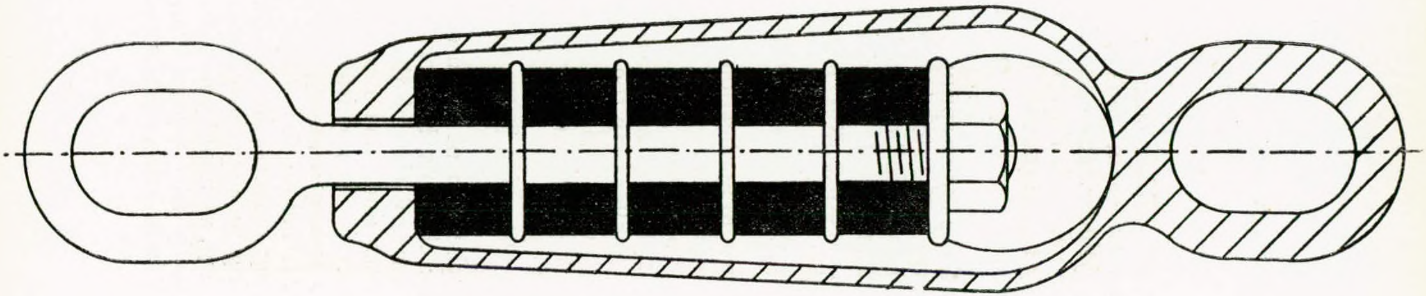


Fig. 28.

which is to deaden the shock of the water in a heavy sea on the rudder, and is often the means of saving a rudder being carried away; the main features of these appliances being to place on a loose eye-bolt a series of india-rubber circular springs fitted with a plate between each, the whole contained within a hollow cylinder, the opposite end of the cylinder being formed with an eye, while each eye is fixed respectively to the ends of the rudder chains, led along each side of the ship—one buffer on each side.

In addition to these buffer springs, on some large steamers a stationary buffer stop is fixed to the deck, determining the "hard over" of the tiller on either side of the ship. The use of these is to prevent a sudden jar on the steering gear when brought up dead should the tiller be put "right over," while the buffers ease up the gear for the return position of the tiller head.

There are two useful applications of india-rubber that must not be overlooked. The first is the covering of the exposed portion of the tail shaft between the two liners by means of an india-rubber sleeve, made considerably smaller than the diameter of the shaft, and sprung over the liners into position, thoroughly sealing the metal of the shaft from contact with the atmosphere or sea-water. A patent for this was taken out some years ago by the late Mr. Mudd.

The second application of the usefulness of this material is that for checking the corrosion often set up between the forward side of the propeller boss and end of the first liner, and many devices have come into existence in its application, the common method being to spring a strong oblong-sectioned ring over the shaft before fixing the propeller in place, or by forming a recess in the forward end of the boss and forcing in a specially formed section of india-rubber packing, secured by means of a plate.

There are broadly two separate and distinctly different classes of india-rubber goods making departments in a rubber factory. The first relates to all soft goods, that is to say, elastic goods, in sheet, tube, rod or moulded forms. The second class refers to india-rubber goods known as ebonite or vulcanite, non-elastic, brittle in fracture, and very hard in structure; the latter quality is produced by the use of a great percentage of sulphur, being as much as from 10 to 50 per cent. of the weight of the whole mixture, and a long time cure allowed for the chemical change.

The former class of india-rubber goods can be turned or bored in a lathe, or may be planed by means of revolving emery wheels and cutters at great velocities. The latter class requires only such tools and speed for machining as would be required for brass and copper work, and this material can be readily turned, bored, milled, planed or screw-cut in every way similar to that of a piece of brass or gun-metal.

To attempt to enumerate every application of india-rubber on board ship would be an almost endless task; but from the foregoing you may see that it has a wide field of usefulness.

Its uses are not as well understood as they should be. Where one particular quality of india-rubber is best suited for a particular job, the same quality may be useless for another purpose. For instance, the quality required—say, for an air pump valve—would be a waste of money if applied to the foundation of, say, any of our auxiliary engines.

In the former case a good quality of rubber is necessary, with a good stretching unit; should be soft, flexible, and moulded under great pressure (at least one ton per square inch) to make it homogeneous.

In the latter case a much harder and poorer quality is all that is necessary, having very little stretching unit; should be made from sheet laminated to the thickness required, and may be porous in section when cut.

The purer the india-rubber the more it will stretch per unit of normal length. To test this, cut a piece of rubber out of the article in question, slit it down by a wetted knife a given amount (say, 1 in. by $\frac{3}{16}$ in. thick), pull the strip so formed out until its elasticity pulls up without breaking, and measure how many times the strip will extend to.

Pure rubber will extend in this way to about seven and a half times its normal length, so that any measurement between its normal and test length will give approximately its purity. On release the strip should resume its normal length and shape.

During the last few years india-rubber has been widely used for covering the floors of smoking, reading and dining saloons, the stairs, landings, bathrooms, etc., on board ship. It is made up of various patterns and in many colours, the thickness ranging from $\frac{1}{4}$ in. to $\frac{1}{2}$ in., and produced from moulds, is known as Harland and Gray's Patent India-rubber Matting.

It is cemented to the decks by means of a rubber compound. Should any member have the opportunity of visiting any of the White Star steamships he will be interested to see to what extent this matting is used. The tread is soft and silent, the material is particularly healthy and does not store up dust and dirt like that of a woven fabric.

The principal colours of the matting as fitted on these ships are red, vermilion, brown, drab, black, white, blue, green, and yellow. Some of the designs are really works of art.

Among the greatest trials to the nerves of a sensitive person sleeping on board ship for the first time are the many strange noises such as cannot be found elsewhere, the vibrations of the main engines, the distinct throbbing of some of the auxiliary engines, the rumbling noise of the propeller shafting, and if the ship has the least rolling motion on, the rattling of cabin and pantry fittings, and when cabin doors are "on the hook," the music set up by these useful but noisy appliances is very trying to the novice.

All cabin fittings, hooks and eyes, pantry and saloon fittings, should be shod with india-rubber tubing, or receptacles containing articles free to move in, should be fitted with india-rubber rings or soft pads to deaden these thousand and one noises so common to a ship.

In all our floating palaces thousands of pounds have been spent on the decorations of saloons, dining-rooms, cabins, companion-ways and landings, to make the inside of a vessel as unlike a vessel as possible; large domes have been fitted to many ships—great aids of the builders to disabuse our senses of the fact of ship surroundings—while statuary abounds in all sorts of nooks and corners to please the eye and suggest ease and comfort. Yet, often through the quiet of an evening, or whilst in port in the dead of night, somewhere down in the bowels of the ship is heard the measured throb of a pump, or the clicking, hurried beating of a refrigerator at work, or one or more of the many auxiliary engines common to our modern steamers will be started; then all the beauty of such palatial grandeur is swept away, and one is reminded that for the time being at least he lives in a floating factory. As engineers snatch every opportunity of doing as much repair work whilst the ship is in port as is possible, there come the sounds from filing or chipping at a vice or elsewhere in the engine-room; the vice being steel is fixed usually to an iron-top table, the iron table is fixed to an iron bulkhead, the iron bulkhead is secured to the frames of the ship, and the skin of the ship, like a huge sounding box, distributes every metallic noise from the engine-room for the benefit of the passengers, who don't want them. Now, as iron is a better conductor of sound than air in the proportion of one to sixteen, the sounds are conveyed through the metal of the ship sixteen times better than through the air, say, of an open skylight. To check this, right at the source of annoyance, india-rubber clamps can be made for the jaws of the vice; these will be useful for many jobs for which the vice is required; india-rubber pads can be fitted under the vice, or the iron bench can be isolated from the bulkhead by india-rubber strips as already described. In like manner all deck winches, steering gear engines, etc., should be bedded on slabs of india-rubber.

When so many thousands of pounds have been spent on board ship to please the eye, surely it would be worth while to lay out a few pounds on noise-stopping or noise-checking appliances, and india-rubber is one of the best, if not *the* best, for such purposes.

These suggestions should appeal to those whose business it is to study the comfort of passengers on board their vessels. Shipowners, builders, superintendents and engineers do not give this material the place it demands in their ships, if they will only consider where it can be applied with advantage. All things that produce noises, broadly speaking, on board a ship should be shod in india-rubber.

I now wish to draw your attention to a small model mechanical hammer I have here, designed as an experiment to illustrate the deadening effect of the application of india-rubber when fitted under the sole plate, etc., of any machine or appliance producing noise or vibrations whilst working or free to move. Being a mechanical device the blows of the hammer are uniform and I shall now work the machine alternately on the bare top of this table and then on the india-rubber, that you may judge from this crude experiment at once the great quieting effect of the use of this material when employed for one of the purposes I have brought to your notice, and if all noises common to the most of our ships can be reduced even by the amount as demonstrated here by this simple means, the value of the outlay is amply returned by the uses of india-rubber.

DISCUSSION.

58 ROMFORD ROAD, STRATFORD,

MONDAY, OCTOBER 14th, 1901.

CHAIRMAN:

MR. J. R. RUTHVEN (MEMBER OF COUNCIL).

THE CHAIRMAN: You have now heard the paper read, and you see it is illustrated by a number of drawings which I consider of great value; they are so very clear and distinct. As Mr. Newall says, these are examples of the uses of india-rubber on board ship, and each of you in your own department, I have no doubt, can supply others. The paper is now open for discussion. I have made notes of a few points on which I shall be glad of further information, and if Mr. Newall can give us this information he will add considerably to the value of the paper. The author refers to the properties of india-rubber in bending, stretching, and compressing, but further on that statement appears to be qualified in regard to limits of time. I have several pieces of india-rubber that were stowed away many years for use at a future date, but they have apparently become so hardened with age as to be of no use at all. Can Mr. Newall tell us the limits of time within which india-rubber, if left to itself, becomes useless—loses its elasticity? It would certainly appear that india-rubber hardens with age, and I would like to know the cause of the change and if there is any method by which its elasticity and usefulness may be retained. After the rubber has become hardened what, if anything, will make it elastic again? I have heard it said that use is the only thing to keep india-rubber in order. Is that so? What are the limits of time within which india-rubber remains useful? And does it vary with the quality? For instance, suppose sample A, when new, will stretch 50 per cent., and after ten years' rest will stretch only 25 per cent., and suppose sample B will stretch 20 per cent. when new and 10 per cent. after ten years, is that what would be expected in the circumstances? In asking for this information I do not ask for any trade secrets, but for data to enable an engineer to test the goods with a view to placing his orders only with honest manufacturers, and this is one of the cases where honesty should be the best policy. In one of the pocket books generally used—Molesworth's—in the course of a reference to this subject mention is made of "adulterated grey rubber." Will Mr. Newall say what the word "adulterated" means in this connection? Is it something that is detrimental either to the quality of the rubber or its price to the buyer? If the rubber fulfils its object it would seem that it cannot in a sense be called adulterated. Then will Mr. Newall compare india-rubber with asbestos, and say which he prefers, and why? Can a cock which is made for asbestos be used with india-rubber with advantage? It will also be interesting to know the weights of the different qualities of rubber for different purposes. Has any test been made as to the number of percussions that rubber will stand without detriment? With regard to the splitting of valves, what is the cause of the cracks, and will valves long out of use crack more easily than those in constant use? How long will the flexibility of rubber used as a foundation retain its quality? And if Mr. Newall will add a little table showing the specific gravity or weight per foot of different kinds of rubber, it will be very useful and assist us greatly. Can Mr. Newall give us some data that would enable us to test readily the qualities of some of the rubber with which we have to deal?

Mr. Peter Smith (Member): The subject of this paper is a very important one to marine engineers and all those interested in the use of steam, and ought to provoke a very extensive discussion. The author has handled the subject in a most practical and able manner, giving valuable information to novices like myself. I had no idea that there were so many different mixtures in india-rubber—the author states 300 to 400, and at prices varying from 1s. to 18s. per lb., according to the intricacies of the mould, and, I presume, the quality of the material used. Judging from the long list of ingredients given there is a great temptation to adulterate; and, as there are tricks in every trade but our own, I am inclined to think that the manufacturer of india-rubber, or the middle man, comes in for a large share of it. At all events, from my own personal experience there is, or used to be, vile rubbish sold for high-pressure work, often causing heart-burnings to an engineer in charge of machinery, necessitating a stoppage at sea, which so often causes consternation amongst the nervous section of the passengers, besides loss of valuable time. All that, of course, can be easily obviated by dealing with first-class manufacturers of undoubted reputation, who will supply the very best article at a remunerative price. Unfortunately, in these days of keen competition, shipowners are driven to the cheapest market, and hence the marine engineer has to go to sea sometimes with stores not up to date in quality for present day pressures and high temperatures. The uses of india-rubber on board ship are so varied as to make it almost indispensable. These uses are very intelligently illustrated in the various figures in the paper. Rings for packing water gauge glasses form a very important item often overlooked. Some agents supply utter rubbish for that purpose, which often fails and blows out after being in use only a few hours in the top end of the glass where the higher temperature is, thus causing severe work to the engineer on watch, especially so in a tropical climate. A number of the uses referred to I do not agree with. Some, indeed, have become obsolete, such as for pumps, circulating, air, sanitary, bilge, etc. I am glad to learn it can be used for hydraulic pump rams, as usually fitted on board ship, as leather is liable to break away, as stated in the paper. Although there is nothing like leather, it comes in the same category as india-rubber, offering the same temptation to be tampered with. I have known a supply of cups for pump rams made of very inferior material that only stood the pressure for a few hours, causing a vexatious delay at one of the intermediate ports *en route*—where the time of a mail steamer is so important—owing to the working of cargo having to be stopped for hours. Yet good leather can be supplied to last for voyages. Hydraulic pressure pipe joints are also troublesome to keep tight on board a vessel unless made of the best leather. For main pressure pipes in the proximity of the main steam pipes, where the temperature is 160° or more, the best of leather is useless for jointing. While the water keeps circulating the joints stand all right, but between ports the water gets hot and so affects the leather that, when the pressure is put on at the next port, the joints leak, causing another melting job for some junior engineer. Even the best makers of hydraulic gear are often unaware that leather is unsuitable for joints exposed to a high temperature, so the marine engineer is left to make the best of it. India-rubber is an excellent thing for such joints if the rings are specially made and interwoven with gauze wire.

Mr. D. Hulme (Member) said he hoped the author would have a chance of answering the questions asked by the chairman, as if answered they would possess a great deal more knowledge of the subject. As to the covering of certain parts of machinery, his experience of rubber was that it became sticky, due perhaps to the composition of the rubber not being correct. It had been tried, for instance, for the hand wheels of steam stop valves, where it became very sticky indeed. The author did not tell them in the paper the lowest temperature at which rubber hose could be used with safety. Could he give them any information on this point? He (Mr. Hulme) had heard of an experience with some rubber hose that was taken out to Klondyke, and when used in the low temperatures of that district the hose broke.

Mr. W. M'Laren (Member of Council) spoke of the extent to which india-rubber had been displaced by asbestos on board ship, and said he thought the manufacturers themselves were largely to blame for this because they had not combined to supply a good class of rubber. An engineer on board a steamer could not always say what kind of india-rubber he would have, and had to make the best of what was supplied, and even if he was confidential with the manufacturer, as Mr. Newall recommended, that confidence was often taken advantage of by the agent. The author had told them that the rubber was brought out of the rubber works to go through certain processes, and that it was then put away in bins. Were those bins made air-tight? Because it had been stated that on steamers bringing rubber or rubber goods from Para there was a considerable amount of evaporation. He would very much like to know up to what temperature pump valves of the description in Figs. 9 and 10 would be able to work. He should hesitate to start with them unless for a fairly low temperature, and it would be preferable, he thought, if the balls in Fig. 10 had a cup-shaped stop; as shown in the diagram he feared they would be inclined to cut. Figs. 22 and 23 showed forms of india-rubber hose, but with the other flexible tubing now in the market he did not think that rubber had much chance for this purpose, especially with the present day high pressures. In Fig. 28 they had a representation of one of the many forms of india-rubber spring buffers for steering chains, but on the occasion of their recent visit to the President's ship, the *Star of Australia*, they saw that Mr. Corry used felt in preference to rubber; a number of sheets or discs of felt were put together in the form of a buffer, and Mr. Corry seemed quite satisfied with the results obtained from this arrangement.

Mr. G. SHEARER (Member) called special attention to the sketch submitted by the author in Fig. 21, illustrating the application of a flexible india-rubber self-sealing joint for surface condenser doors. He said it was stated in the paper that bolts were not necessary for this particular form of door, and he asked how the pressure on the inside of the door was taken up.

Mr. JAMES ADAMSON said that when Mr. Newall was considering the weight of rubber goods it would be an advantage to include the cost per pound. He had found, when examining and considering samples of valves, that the weight by the price per pound of such gave nearly the same result, the higher priced valve being lighter and in many cases approximately in direct ratio to the price, so that the actual cost of a low priced valve might be superficially cheap yet doubly dear, first on account of the weight, second on account of the shorter life and more frequent renewals. This was a case illustrative of the difference between parsimony and economy, and more obviously so than many other cases, as it admitted of demonstration. It would be interesting to have a comparison of the lasting power of the various kinds of valves in use for pumps, india-rubber compositions of different kinds, fibre and metal of many patent designs. With regard to force pump cups, leather is not reliable ; a set might last twelve months, another, apparently as good, might give way after a few hours' work. He tried a change of material some fifteen months ago against leather, one bucket in the same set of pumps being packed with leather, the other with composition. Both had stood equally well up to date, which was rather curious—as if the threatened leather had pulled itself together for a new lease of life ; the pressure on the pumps was about 1,000 lb. per square inch. Leather was discarded some years ago in favour of rings and springs, by reason of leather cups proving uncertain and troublesome. The change still left something to be desired, and a return to the cup was made in the case cited with very satisfactory results so far. The fatigue on the leather in cressing it to the shape of a cup for a force pump bucket must be severe, while on india-rubber or gutta-percha the shape is formed naturally in the mould.

Mr. J. MORTON having asked for fuller information on certain points, the discussion was adjourned till next meeting, when Mr. NEWALL agreed to be prepared with answers to the questions which had arisen.

Votes of thanks were then heartily accorded to the author of the paper and the chairman, when the proceedings closed.

DISCUSSION CONTINUED

AT

58 ROMFORD ROAD, STRATFORD,

ON

MONDAY, OCTOBER 28th, 1901.

CHAIRMAN:

MR. W. LAWRIE (MEMBER OF COUNCIL).

THE CHAIRMAN: This paper was read, and partly discussed, at our meeting a fortnight ago; to-night we continue the discussion. To begin the business this evening Mr. Newall will reply to some of the questions that were put to him on the last occasion, and after that we shall be very pleased to hear any further remarks by any of the gentlemen present.

Mr. NEWALL: In reply to Mr. Ruthven's many questions I may say that all india-rubber goods deteriorate in time varying from a few weeks to years, according to various circumstances. I have tabulated a list of causes here, and the first is *a*, "Sulphuring up." All india-rubber goods, when they are manufactured, are mixed with a certain proportion of sulphur, and according to the hardness of the goods and the time of cure, so the quantity of sulphur used in the mixture is regulated. Now if you let the articles lay by, say for a few months, or years, you will find that the sulphur which has been put in the rubber originally has found its way to the surface, and under the microscope you can distinctly see the crystals that are formed on the face of the rubber by the sulphur that has issued from the pores of the rubber. That is one of the things—the loss of sulphur—that tends to make india-rubber deteriorate. Then *b* is "decomposition of ingredients." The ingredients that are put into india-rubber are very numerous and some of them are liable to change—chemical changes, for instance, due to the action of heat—and in time the article becomes rotten. Then *c* is "exposure to light." India-rubber deteriorates when exposed to light. In fact, all india-rubber goods should be kept in a dark, damp place, and quite free from grease or similar foreign matter. Then *d* is "exposed to dryness." India-rubber should not be kept too dry; it is better to keep it somewhat moist. Then *e* is "contamination with grease or oils." Most india-rubber goods are very soon caused to become rotten and useless by contamination with fat or oils, and on board ship it is very difficult to find a place within the bounds of the engine room which is entirely free from grease or oil. But if you wish to keep india-rubber for any length of time you must make that the first point, and keep it free from those two things. Then *f* is "distorted by pressure when not in use and taking permanent set." Now, india-rubber goods for many purposes are made of a definite and particular shape, and if they are subjected to weight or pressure in a short time they take a permanent set so that when they are wanted they are not of much use. Then *g* is "contact with heat." What I mean by that is, that it is a very bad plan to have india-rubber goods next to a boiler, bulkhead for example, or where there is a temperature of over 100°. The best preservative for india-rubber is use. Then Mr. Ruthven asked further: Can rubber be made to be elastic for ever? "For ever" is too long a time to guarantee, but I suppose what was really meant was, could rubber be made to be elastic if used within a reasonable time, say two or three years? Yes. Then he asked further: Can goods becoming non-elastic be made elastic? Well, if the rubber has once deteriorated to the extent that it has lost its elasticity and become rotten, then I say, No. Rubber, having once lost its elasticity, cannot be made elastic until it has been re-ground and gone through a very tedious process, when it may form the basis of lower qualities. The limit of time within which india-rubber goods must be used depends on their care in the stores, but disc valves, for instance, if properly cared for, will last for from five to seven years. The usefulness of india-rubber depends entirely on the quality and conditions already mentioned. The poorer the quality the sooner it will crack by hardness. "The poorer the quality" is perhaps rather vague, but what I mean by that is, when india-rubber goods are ordered by an engineer, he sometimes tells the manufacturer: "We require so and so, and at so much per pound." That ties the manufacturer down at once to give you an article that may or may not be the proper quality for the job the engineer desires it for, but that is not the manufacturer's fault. I know of several cases where that has been done, and I could cite one case where a quantity of india-rubber was ordered for ship's use to cost 2s. per pound. The india-rubber that was taken out of this particular ship originally would have cost about 3s. 9d. to 4s. per pound—about double—

so what are the chances when the manufacturer is tied down to a price per pound in that way? Where the price is stated, irrespective of the use to which the goods are to be put, we must be content to have something that we should not have had we given the manufacturer a free hand. The stretching point of india-rubber varies with age until it gets short. That is to say india-rubber, when it is new, will stretch so many times its normal length. A piece of what you would call pure rubber, containing little pigments and a little sulphur just enough to cure it well, will stretch about seven times its length. If you get a piece that stretches only three-and-a-half times its length you say that it is about 50 per cent. "pure," and the poorer the quality the less it will stretch. With regard to the period of time required to take the stretch out of india-rubber, that depends on its uses and on its care when not in use. A knowledge of the specific gravity of india-rubber is of no use to engineers apart from samples. Mr. Ruthven asked if I could supply a table of specific gravities giving qualities and prices and various things, but I may say broadly that even in an india-rubber factory, when they are getting out the prices of goods, it is almost impossible, without the samples in your hands, to know the proper quality of the rubber that is suitable for the customer's order. In practice these samples are always kept handy, so that they may be taken out when required with their quality numbers attached, and by practice the best quality can then be selected for the customer's purposes. The specific gravity of india-rubber is of no use to engineers. Personally I do not see where it comes in. You can take twenty pieces of india-rubber, each different from the others, and yet all of one specific gravity—every piece may be different from the others—there are so many things to be considered. First we have colour. Then there is elasticity. Some jobs do not require rubber with any elasticity, and on the other hand some require the most elastic qualities. Then there are heat resisting qualities which have to be considered, and again, oil resisting qualities, and lastly, price. Engineers are entirely in the hands of the rubber manufacturers, who make it a point never to divulge their mixtures. The mixtures of an india-rubber factory are the stock in trade of that factory, and in my own personal experience I have seen as much as £250 spent in producing a particular rubber article for a special purpose. When manufacturers have been working, perhaps years, to produce a special article, you can understand that its composition is well guarded. The only tests that engineers can make are time tests—nothing else—and if you order india-rubber goods you should know the manufacturer's name and the quality. Never take india-rubber goods from an agent unless he can tell you who made them and the quality number or letter. Every manufacturer sends a quality number with all his goods so that if you subsequently want a similar article he knows what to give you. India-rubber agents will often sell you anything, and they frequently make a point of not disclosing the name of the manufacturer or the quality of the material. Then Mr. Ruthven asks: What is adulteration of rubber goods? I do not understand that question. I do not mean to say that rubber goods are not adulterated, but it is a kind of question that I cannot answer. (A MEMBER: What are the adulterants?) The adulterants are chiefly old india-rubber ground down into small particles, and put into so-called new goods. Mr. Ruthven also goes into the question of how makers can be just to themselves or their customers. If customers will tell the uses they require the goods for, a manufacturer will give any amount of advice as to the most suitable goods for the purpose, mainly for the purpose of securing orders, and the manufacturer will give such an article as he hopes will ensure him a repeat order, and that is where the justice comes in. Mr. Ruthven asked a question in reference to asbestos. Asbestos is useful for only a few purposes compared with india-rubber. The principal use of asbestos is for jointing purposes. India-rubber is best suited for all the other purposes mentioned in my paper. Of course, it is possible in some cases to combine india-rubber and asbestos in the mixture. In that case, however, it would not be known as an asbestos article but as a rubber article. A question was asked whether a cock could be packed with india-rubber similar to an asbestos packed cock. Well, india-rubber would be entirely useless for this purpose. Mr. Ruthven means, I take it, packing the cone part of the cock, as you would with asbestos. Then with regard to tests, he asks a question as to how many percussions india-rubber will stand. Tests are constantly being made by rubber manufacturers who have special appliances for testing the material by the number of percussions it will stand. For instance, india-rubber buffer cushions that are put on railway carriages and for the doors to swing against, are tested in the rubber works until they are destroyed. As many as 20,000 or 30,000 blows are put on rubber goods at over a ton per square inch, and I have made special machines myself for testing goods in this way at the rate of sixty blows per minute. Mr. Peter Smith said that he had seen india-rubber rings fitted to water gauge glasses, and that they had melted in a few hours. Well, if those rings melted they were not made of india-rubber. They may have been made in a rubber factory, but it would be as well to get hold of the maker's name. India-rubber will not melt. That is a peculiarity of it. It is like coal, and passes from the solid to the gaseous condition without melting. The only way in which engineers are to know what is sent them in the way of india-rubber stores is by the time test, and then, if satisfactory, to repeat the orders to the same makers. Never accept india-rubber goods without knowing the makers and the makers' quality numbers or letters. Disc valves made of metals have come largely into use, and their value as against india-rubber disc valves is more or less a matter of opinion, but in all cases where india-rubber is used it is of the utmost importance to state the object of the article, the temperature to which it will be subjected, and whether it will come in contact with oil or grease or anything of that sort. If india-rubber valves are properly made with ingredients to suit their work they are, in my opinion, better than metal ones. Mr. Hulme stated that parts of machinery—some wheels—had been covered with india-rubber which had become sticky. India-rubber is very unsuitable for covering parts of machinery and wheels and handles, because owing to the free use of grease on board ship you cannot touch anything without leaving an impression of grease behind, and a very little grease will soon make a lump of rubber rotten. So it will be waste of money to cover wheels and parts of machinery with rubber, except in the ebonite form which is sometimes used for electrical purposes. Mr. Hulme also asked the lowest temperature that india-rubber can be used at. India-rubber is of no use as a flexible agent below 40° Fahr. It then gets brittle, and if used for hose work would soon split up into short lengths. India-rubber has a very short range of temperature during its usefulness, and is not useful when it gets anywhere near freezing point. Then Mr. McLaren asked, in reference to the bins used for storing rubber, whether they are airtight. They are not airtight, and there is no pretence of making them airtight. They are simply large shelves or open recesses, and the india-rubber is kept in them until it is wanted. With reference to the ball valve shown in Fig. 10 Mr. McLaren made some remarks about the sharp edges. All these sketches are rough sketches, and there is no pretence at all at accuracy or scale. They are merely blackboard drawings on paper to show the idea. In practice those sharp edges in Fig. 10 would be very much rounded, say to the extent of half an inch radius. In reference to Mr. McLaren's question as to the temperature that pump valves will work to, I have a note here that they will work up to 230°, but all india-rubber goods, such as pump valves that are required to be distorted out of their plane, should not suffer a greater temperature than about 200°. In the case of gauge glasses and places where the india-rubber can be used undisturbed, the temperature may go up to about 400°. The only change that takes place then is that it hardens. Mr. McLaren also mentioned that when we paid a visit to the *Star of Australia* in the Victoria Docks, our attention was called to the use of felt, instead of india-rubber in the buffer fitted in the steering gear. I think we asked Mr. Corry the reason for that, and he said he got sufficient elasticity out of circular discs of felt, instead of having to use india-rubber. That is to say, for the little elasticity required to take off the strain of the sea on the rudder, he found that the felt answered as well or better than india-rubber. That was rather new to me, and I never saw it before, but we saw many things on board that are not common to most ships. Mr. Shearer asked a question in reference to the condenser door joint shown in Fig. 21 in the paper. Mr. Shearer asked how does the door joint to the condenser, as there are no bolts shown. I think he was under the impression that when the water came on to the rubber ring shown here the pressure of the water held the door to the condenser. Is that so ?

Mr. SHEARER : No, but according to the paper and diagram that is so.

Mr. NEWALL : That is not what is meant. The rubber does nothing more than seal up the crack.

Mr. SHEARER : The words of the paper are " no bolts being required to be screwed up to hold the door to the condenser."

Mr. NEWALL further explained the matter by means of a sketch on the blackboard, and at the conclusion of his explanation,

Mr. SHEARER said he now understood the author perfectly. This condenser door closed in exactly the same way as the door of a Milner's safe. But no bolts or locking device was shown on the diagram.

Mr. NEWALL (continuing): Mr. Morton asked the age of india-rubber trees, and the time of withdrawing the sap or gum. The rubber trees of Costa Rica, known as the *Castilloa Elastica*, possess the greatest tenacity of life and quantity of its yield for gum, and has no equal among rubber plants. They require a temperature never less than 60° and an elevation not over 1,200 ft. above sea level. Native trees are abundant and in the best state of development at between 500 to 1,000 ft. apart. Rubber yielding trees do not thrive near the sea, where the air is filled with salt. The annual rainfall should not be less than 80 in. It takes from seven to eight years for rubber trees to yield gum, and to avoid injury to the trees the 8th year yields 1 lb. only, the 10th year $1\frac{1}{4}$ lb., the 12th year $1\frac{1}{2}$ lb., and after 15 years about 2 lb. per year. The yield of gum from the Para rubber trees under cultivation in the Ceylon Botanical Gardens is shown by the fact that the late Dr. Henry Trumen tapped one tree with these results:

At the age of 11 years	1 lb.	$11\frac{3}{4}$ oz.
,, ,, 13 ,,	2 ,,	10 ,,
,, ,, 15 ,,	2 ,,	13 ,,
,, ,, 17 ,,	3 ,,	3 ,,
,, ,, 19 ,,	3 ,,	$0\frac{1}{4}$,,

Para trees twelve years old yield about 3 lb. per annum. With regard to the sketch Fig. 18, which Mr. Morton referred to, for air pump-rod packing purposes, this coned ring might be reversed, and in respect to the friction of such a packing ring, so long as the gland is supplied with water the friction is very small. Mr. Bartle asked: Will india-rubber stand a pressure of 1,000 lb. per square inch of CO_2? Yes, if the temperature be between the range of 40 and 100° Fahr. Mr. Adamson made some remarks to the effect that by multiplying the weight of india-rubber goods by the price we got an equation which should be of some use in determining the value of such goods, but if Mr. Adamson will be good enough to show us how that can be carried out a little further I shall be glad to hear him. I think I have now endeavoured to answer all the questions that have been put to me so far.

Mr. JAS. ADAMSON: The samples and makers' names being before one when considering prices and weights, a very good idea can be formed as to which will prove the most economical value for good service. Experience is, no doubt, the best guide, but apart from this—such is the view I wished to express—I have found as a rule a good article, though higher in initial cost than an inferior one, is the more economical, just as it is more economical to make a good job than a half one for cheapness. It reduces the insurance risk.

The CHAIRMAN: Members seem to have been very industrious with their questions, and we shall now be glad to hear any members express their opinions on the paper. The rapid advance of steam pressures in recent years has more or less dislodged india-rubber from the position that it once held, but still there are plenty of uses for it at the present time, and I do not think you could have a better opportunity of increasing your knowledge on the subject.

Mr. J. B. JOHNSTON (Member), after speaking of the adulteration of rubber by "pure earth," said that in his answer to a previous question about Fig. 18, the author suggested that the conical washer should be turned upside down for an air pump, but he questioned the necessity for reversing the cone in this way. With regard to the temperature for which india-rubber could be used he thought the author had put the figure too low. He had known india-rubber to be used for very high pressures of steam, and he cited one case in which a hose had been used for scalding out a hold or cleaning down machinery when using steam of from 250 to 300 lb.

per square inch. He also expressed doubts as to the working of the condenser door shown in Mr. Newall's sketch on the blackboard.

Mr. SHEARER said there was one point on which he should like to ask the opinion of the author, especially after the statement of that gentleman that 240° was about the limit of temperature for india-rubber. The packing for gauge glasses used in connection with Belleville boilers was now always made with hexagonal plugs of asbestos, and with this asbestos packing he had always found the greatest difficulty in keeping gauge glasses. It was as solid as a piece of wood or woodite. It had occurred to him however that if it was possible to put a core of india-rubber inside this packing they would get a combination that would give greater elasticity and ensure a longer life for the gauge glasses. But with Belleville boilers the steam pressures ran up to 300 lb. per square inch, and if the rubber became vulcanite or lost its elasticity at that temperature it would be useless putting it in. Would Mr. Newall give them his views on this point?

Mr. SILLEY (Member) said that with regard to india-rubber rings in gauge glasses he had had the same experience as Mr. Smith, and the rings which melted in this way were supplied by different makers. The only way in which they could obviate the trouble was by putting a core of asbestos in with the rubber. He had also had a great deal of trouble through circulating pump valves made of india-rubber giving out, and he had seen a bill for £30 for rubber valves for a round voyage. He had had some experience of the use of felt for the buffers of steering gear, instead of india-rubber, and when a heavy sea struck the rudder a compression of as much as an inch and three quarters could be observed. Fig. 18 showed the use of a rubber ring for a circulating pump-rod. How was that ring put on, in case, say, of a renewal being required at sea? Was the ring cut in two, or would they have to disconnect the end of the pump-rod in order to slip the ring over it?

Mr. W. E. FARENDEN (Member): India-rubber has been found to be a very good material to use where oil, grease, or fatty matter does not come in touch with it, otherwise it is soon destroyed. This is the reason why metallic valves have taken the place of india-rubber in the air, feed, and bilge pumps; and the same with regard to india-rubber rings for condenser packing, as it was found that they would not stand for any length of time, and soon became rotten.

I do not think the author should introduce in his paper who he considers to be the best maker of rod and gland packing, as it is rather like an advertisement, and one finds that all makers claim their particular packings as the best. This should be left to the discretion and experience of superintendent engineers.

No doubt it was a very good practice to cover the exposed portion of tail shafts between the two liners with an india-rubber sleeve as mentioned, but the general practice now is to cover the whole length of the shaft inside the stern tube with a gunmetal liner, which makes a more satisfactory and permanent job.

Mr. Newall's suggestion to bed machinery down on india-rubber for preventing the noises being distributed throughout the ship might answer in the case of light engines such as ash hoisting engines, but for heavy machinery I do not think it would do, as rubber perishes very quickly, and the machinery would soon require to be re-bedded. At present nothing can beat good hard wood for this purpose.

I should like to ask Mr. Newall the highest steam temperature rubber will stand, as I am doubtful whether it is much good for high pressures such as 180 to 250 lb. per square inch.

Mr. J. PRICE (Visitor) said he was very pleased to have had the privilege of attending this meeting, because the paper under discussion contained a very great deal of useful information, particularly as affecting his practice, which was not that of a marine engineer. In the purchase of rubber, oil and steel, he never could trust his own judgment, and always preferred to trust himself in the hands of a manufacturer of sufficient standing to make him feel that he had a character to maintain. Unfortunately a great many of them, whose requirements in the way of india-rubber were not large, had to buy from factors or merchants, and he was not at all surprised that there had been questions asked about adulteration. A remark had been made about multiplying the weight by the price of india-rubber goods as a test of the quality, and many years ago he had almost come to the same conclusion, but he never worked it out. Reference had been made to the effect of CO_2 on india-rubber, and perhaps Mr. Newall could tell them something of the effect of ammonia on rubber. He (Mr. Price) believed he had heard that liquid ammonia had a sort of preservative effect on india-rubber, rather than otherwise, by preventing ageing and cracking, but he could say nothing at all positive on the point. With regard to the use of rubber for buffers it occurred to him that rubber showed the effect of the absorption of force very speedily. If they struck rubber repeatedly it soon heated, and to give sixty blows per minute was, he thought, putting it to a test which it was never likely to have to stand in practice. On the other hand it had been mentioned that rubber at 40° Fahr. became brittle. He once saw a piece of very elastic rubber that had been treated with frozen air, which of course represented a temperature very much lower than 40°, and the rubber was powdered up into dust. In the course of the paper ball valves covered with rubber were shown, and he should like to ask whether there was any tendency on the part of this rubber to split off. If the rubber was put together in two hemispheres it seemed to him that there would be a zone of weakness, and that the joint of the two pieces might give way. This was really an important point in connection with the use that he had in view for valves of this description, and that was as pump valves for cold water. He would also like, if possible, to obtain some information about some of those variations of india-rubber that were called dermatine and woodite. He had lately come across some attempts at substitutes for india-rubber. Whether these had been evolved in consequence of the increase in price because of the greatly increased demand for rubber for bicycles and motor cars he did not know, but possibly Mr. Newall could tell them something on this point. His own experience in using them for his own purposes was that they seemed to do very well. In conclusion he could only again express his pleasure at being present at this meeting, and he could assure them that since he came into the room he had learnt a great deal about india-rubber.

Mr. A. H. MATHER (Member of Council) said that mention had been made of the substitution of metallic valves for india-rubber in air pumps, and he believed there were very few air pumps made now with the old single india-rubber valve. He had a very lively recollection of the trouble that was formerly experienced every voyage with these rubber valves. If Mr. Newall could give them, say a guarantee, that rubber could be used for air pump purposes, and last anything like a proportion of the time that metallic valves lasted, that would be a great point, because in some cases it might be preferable to use rubber in place of metallic valves. Then, with regard to the use of rubber packing for water gauge glasses, could Mr. Newall say if the rubber had any effect upon the glass itself?

The CHAIRMAN observed that one trouble very frequently experienced with air pump valves made of rubber was the opening out of the holes in the centre. Indeed, this was one of the worst troubles that he had met with.

Mr. JAS. ADAMSON (Hon. Secretary) : On page 29 there is a sketch showing a pipe perforated with holes, and over these are rubber rings. Would Mr. Newall kindly explain what provision is made for keeping these rings in place? It would rather seem that the action of the water would tend to cause the rings to drop out of position.

The CHAIRMAN observed that notwithstanding what had been said as to the price multiplied by the weight, he thought that after all there was no test like the time test.

After some remarks from Mr. McLAREN, who asked for explanations of one or two details in the drawings given with the paper,

Mr. J. B. JOHNSTON (Member) proposed that the discussion be adjourned until the next meeting, on November 11th, and the motion, having been seconded by Mr. PETER SMITH, was put and carried, the CHAIRMAN intimating that Mr. Newall would defer his reply to the remarks of the various speakers at the present meeting.

Mr. NEWALL reminded members that on Monday, November 4th, they had arranged to carry out a series of most interesting and useful experiments in the testing of coal and the fumes therefrom, the object, of course, being to obtain information to assist them in burning coal to the greatest advantage. He hoped there would be a large attendance on the occasion, and he appealed to members to make a point of being present.

A vote of thanks to the Chairman concluded the meeting.

DISCUSSION CONTINUED

AT

58 ROMFORD ROAD, STRATFORD,

ON

MONDAY, NOVEMBER 11th, 1901.

CHAIRMAN:

MR. S. C. SAGE (MEMBER OF COUNCIL).

THE CHAIRMAN: This evening we continue the discussion on "The uses of india-rubber on board ship." I will ask Mr. Newall to reply to the discussion that took place at the last meeting.

MR. NEWALL: With reference to some remarks by Mr. Johnston regarding the adulteration of rubber by earth matter, no doubt that is often done if engineers make their own prices. For this reason we should not cut prices with rubber manufacturers, because if manufacturers want, say, from 10 to 15 per cent. profit on goods at 3s. per pound they will still get the same profit if you only pay them 1s. 6d. per pound, but are the goods got for 1s. 6d. per pound suitable for their purposes? Articles made with this so-called adulterated rubber would be more or less useless for the purposes for which you require them. I wish to make that plain, that it never pays an engineer to dictate prices to a rubber manufacturer, because he will let you have goods at any price you like, but he will take no responsibility. If you tell him you want goods for a certain purpose he will bring in all his chemical knowledge as well as his mechanical knowledge to give you a good article. That is his business, because you know that if you buy articles which soon go wrong you will not go there again, and the manufacturer wants repeat orders. Mr. Johnston also remarked that india-rubber had been used for very high pressures of steam, instancing the case of a hose used for scalding out a hole or cleaning down machinery when using steam from 250 to 300 lb. per square inch. I think that Mr. Johnston overlooks the fact that in a hose with a free end or opening the pressure within it is nothing like that in the boiler, so that the temperature of course is greatly reduced. Even if you close the cock on the end of such a hose you would have a pressure of steam in the hose, but you would not have a temperature equal to the temperature of the steam in the boiler, and as soon as you open the cock for the hose to do its work the pressure is reduced, and consequently the temperature also. Then regarding Mr. Johnston's objection to overhanging a condenser door weighing, say, one and a half tons, as shown on my blackboard sketch, one and a half tons hanging on strong hinge pins can be made very strong. The greatest objection would be the swinging of such a door when the ship is rolling, but that could be easily remedied by many suitable means. Quadrant, rack and worm, or quadrant and lever secured by a fly nut, etc., would answer the purpose, but in the case of a condenser door such as I drew on the blackboard the readiest thing to do would be to have a block and tackle, one to open the door and one to serve as a guy, to prevent the door swinging about while you are making a repair or stopping leaking tubes at sea. With reference to Mr. Shearer's remarks regarding the combination of asbestos and india-rubber for gauge glass work, this, I may say, is a very common practice with rubber manufacturers. It works well with temperatures up to between 300° and 400°, but there is one thing you must bear in mind, and that is if rubber goods are subjected to very high temperatures you must never disturb them. Rubber does not bear being disturbed after being submitted to very high temperatures. Mr. Silley remarked that he knew of cases where circulating pump valves made of india-rubber had given out and the necessity for sending for experts to explain the reason. This all turns on the point as to whether the manufacturer had notice for what purpose these valves were required, and further, care must be taken that the holes in the centre of them are not too large originally, and also the amount of free lift these valves are subjected to. If they are caused to "cup" considerably they soon go to pieces. This is more a question of the mechanical design of the pump than the mixture in making up the valves. The statement of Mr. Silley that £30 for valves for a voyage seems high, but that of course is dependent upon the length of the voyage. Regarding Mr. Silley's experience of felt for the buffers of steering chains in lieu of india-rubber, I am rather surprised that a compression of an inch and three-quarters can be observed as set up by the rudder in a heavy sea. I should have been inclined to think that felt was too sluggish a material for such uses. The first occasion on which I saw felt used for this purpose was on board our President's ship, the *Star of Australia*. I asked him what he considered was the advantage of felt over rubber, and I think he said it was cheapness. It was much cheaper to get fifteen or twenty inches of discs of felt, which are easily renewed, than to buy india-rubber at 2s. or 3s. a pound, and he said that the felt answered just as well or better than the india-rubber, which rather surprised me. In reference to Mr. Silley's remarks regarding Fig. 18, say for a circulating pump rod on the requirement of the renewal of such packing at sea, he asked whether this ring was split, or whether it was necessary to disconnect the top end of the rod to get the packing over. Well, it is necessary to disconnect the end of the circulating pump rod and slip the packing over, and for this reason it may be open to some objection. Mr. Farenden asked a question as to the extent to which metallic valves have been used to displace india-rubber valves for air and circulating pump valves?

Personally, I cannot say to what extent this has been done. My experience of metallic valves is that unless the guard bears diametrically across the valve they soon split from the hole, and object strongly to being "cupped." Of course this is not the case with india-rubber valves. Regarding Mr. Farenden's objection to my specifying one particular class of gland packing (Fig. 27), and his remark that he views it as a free advertisement, I must say that until he mentioned the fact it had never struck me that such was the case. It was put in the paper simply because of its mechanical structure which appeared to me to fulfil admirably the object for which gland packings are employed. Its principle is that of the Bramah ring, and is as old as the steam engine itself. The application of the old Bramah ring is included in two other illustrations given with the paper, viz., Fig. 1 and Fig. 21. On the completion of this paper I shall take the trouble of informing Messrs. Platt & Lowther of the fact of their free advertisement being brought, as it will be, before a community of men who are large users of steam packings, and as convener of the Experimental Department of the Institute for this session, I will endeavour to obtain from them some useful plant now required here—I have in my mind the want of a 2-ft. grindstone or small rivet forge—so that Mr. Farenden's objections may be removed. Regarding his remarks about covering the tail end of propeller shafts with india-rubber sleeves between the two brass liners, until recently this was a common practice. At present many ships are fitted with liners without a gap exposing the iron of the shaft. His remarks also regarding the bedding down of machinery on slabs of india-rubber, he excludes entirely except for the base plates of ash hoists, and for all other auxiliary engines he prefers hard wood. I do not agree with him, as this application could be usefully extended to much other noisy machinery on board ship. Mr. Price asked several questions, especially in connection with the fact that in many cases we have to rely upon the manufacturer. He stated that the three classes of goods which must be left with the manufacturers were steel, oil and india-rubber, and I think he is about right. In all these cases the requirements for such goods should be fully stated when ordering. We know that in ordering steel we must be very precise in telling the manufacturer what we want it for, and you do not say that you want to give only so much per pound for it. That applies equally to oil, and that is why I advocate having in this Institute a small oil testing plant so that we can do justice to the oil that engineers use as we are trying to do with the coal they use. Further, Mr. Price agrees that with regard to india-rubber goods we must rely upon the manufacturer. We may ask them what they can do certain articles at, but be confidential with them in every case and say what the goods are for. If they are to be used under exceptional conditions—in contact with oil, heat or acids—then say so in your order, and I feel sure that if you deal with respectable manufacturers they will give you fair value for your money. Regarding Mr. Price's statement about weight multiplied by price as a test of the purity of india-rubber goods, it is a practice which I believe is employed by all makers of such goods, although such knowledge does not aid one to determine the quality best suited for particular uses. I wish to make it quite plain that you cannot tell the best goods for the purposes you have in view unless you have got samples to deal with. In reply to his query, whether india-rubber is affected by ammonia, I should say to no appreciable extent, as it is a common practice with manufacturers to use ammonia for distending all hollow goods when moulded, and on cutting these open years afterwards the rubber appears to have been unaffected by its use. With regard to Mr. Price's remarks about the heavy pounding of india-rubber goods, the heat set up, and the number of percussions that can be given to same, that depends on the quality of the mixture. Some goods are destroyed under such conditions as those already stated within a few minutes, while others require many days to complete destruction, the test being the poundage multiplied by the number of blows. In reference to his remarks regarding Professor Dewar's experiment of powdering india-rubber by subjecting it to excessive cold, I believe that this has been done with very successful results. India-rubber manufacturers often require to reduce vulcanised rubber to the smallest possible size, and it is found that by simply cooling the rubber in liquid air and then dropping it from a height into a chamber the mass becomes disintegrated at once. That is a very peculiar thing, and it was brought forward in a lecture by Professor Dewar at the British Association. He showed that various articles when immersed in liquid air became of quite different material from what they were in a normal temperature. In the case of cast iron I believe that after being immersed in liquid and then allowed to fall some eight or ten feet it simply powdered up into a dust. I believe that that can also be done with india-rubber. Regarding the production of ball valves, such as is shown in Fig. 10, the layer of india-rubber has no zone of tension set up during manufacture as suggested, as in moulding the "dough" softens to such an extent and so spreads itself throughout the cavity of the mould that no portion is in more tension than another, and is quite dissimilar to that of making a metal ball in halves where zones of great stresses are set up, owing to the resistance of the latter material. An india-rubber moulded ball has no joint properly speaking. Regarding dermatine or woodite I have no experience of either, and I know nothing of their composition or virtues. In reference to whether india-rubber substitutes have replaced pure rubber owing to the demand of the bicycle trade, I cannot say, but I am inclined to think that there is as much india-rubber substitute used for tyre making as in any other class of goods. Mr. Mather said that in his experience air pump valves gave trouble every voyage due to swelling, taking permanent set, cupping, etc., and that he had to reverse the valves to get them to work. Possibly that was principally due to the fact that the manufacturer had no knowledge of what the valves were to be used for, the heat to which they were to be subjected or the nature of the grease they would come in contact with. Possibly also the shape of the guards had much to do with their destruction. It is very necessary to take all these conditions into consideration before condemning such articles. As regards manufacturers guaranteeing their goods in such uses I never heard of the application, but it might be worth trying. Regarding the eating away of gauge glasses in contact with india-rubber packing rings when subjected to pressures of over 100 lb. per square inch, I have had no personal experience of such being the case. With reference to Mr. Lawrie's question regarding the canvas core around the hole in the disc valve shown in Fig. 14 for ensuring the hole retaining its size in use, I may say that this is one of the objects of the insertion of the canvas, and, further, the canvas fin extending out into the body of the valve is for binding the valve as a whole to stop splitting when in use. With regard to the various colours in which such valves are made, that is often done simply to distinguish each for its own particular uses, but colour goes for nothing. Mr. Adamson asked what provision is made to keep the rings in place in Fig. 17, page 29. These rings are simply sprung into grooves. Mr. Adamson also told me in conversation that his attention had been called to the use of india-rubber on board ship whilst in port in a way which was very detrimental to the engineers and officers of the vessels, that is, by the use of india-rubber shoes by ship thieves. That is a point which never struck me when I was getting my paper together—that india-rubber could be used for this bad purpose—but Mr. Adamson has enlightened me to this extent, that india-rubber shoes are often used by thieves who prowl about on board ship at night time and simply steal all they can lay their hands upon. Mr. McLaren said he considered that the boiler door packing rings as shown in Fig. 3, page 11, should have the angles of the metal faces reversed, but if this were done the ring would be screwed off into the boiler in screwing up the dogs. The angles as shown are to compress the rings hard against the body of the manhole door, and yet retain it between the faces of door and ring on boiler. Mr. McLaren also asked a question as to how bicycle tyres can be kept in condition when not in use. The only way is to keep them free from grease and oils. Wrap them in several thicknesses of brown paper when partially inflated, and keep them at a temperature of never less than 60°. The wrapping up is to keep them from the light. I think now I have answered all the questions that were put to me.

The CHAIRMAN: Most members present have had practical experience of the use of india-rubber on board ship, but some of us remember when there were no india-rubber valves used. They were all metallic, and I think it is only a question of time when we shall have no more vegetable valves. For air pumps rubber has now been largely rejected and it is now an exception on a modern steamer to find an air pump working with rubber valves. I have seen vessels with the bilge pump valve working with india-rubber, but I never saw one like that illustrated in Fig. 10. The stop has always been in the shape of the sphere, and I should think that a stop like that shown would soon destroy the ball. I think that there is no allusion in the paper to what is evidently a sister gum, "gutta percha."

Mr. NEWALL: Gutta percha is not elastic. It is quite the reverse of india-rubber.

Mr. W. LAWRIE (Member of Council): After the questions and the very full and lucid explanations given by Mr. Newall, I think we know about as much as is necessary for any engineer to know about india-rubber. The paper has been very instructive to me, and also I believe to others, because sometimes we blame, not only india-rubber but also other materials, when perhaps the fault lies with ourselves for not applying the material in the proper way. Now that we have had all this information I have no doubt that we shall use india-rubber in future with a greater amount of intelligence. A remark was made about the mention of a packing being an advertisement. That is a matter in which it is very difficult to draw the line. In drawing up a paper if you see something very good which you would include in it but for the fear that it might be regarded in the nature of an advertisement, the paper will be bare of useful details. Every paper with illustrations is more or less subject to the remark that the matters illustrated are in the nature of advertisements, but I am quite sure that Mr. Newall when he introduced this particular sketch had no idea of anything of that sort.

The CHAIRMAN: There is one very good principle laid down in this paper when Mr. Newall remarks that it is hopeless to expect to get a material, be it india-rubber or anything else, of the best class, at a fourth or fifth class price. If you desire a good article the manufacturer of that article should have a chance of giving you what you require by receiving full particulars of the work it is required to do and of the treatment to which it will be subjected. These points are very important factors, and if they were fully carried out there would be much more satisfactory work done by material such as that which forms the subject of this paper; you can get it at almost any price you like, and you may rely upon it that a respectable firm will give you full value if you pay the maximum price.

Mr. NEWALL said that before the discussion closed he would like to mention one use of india-rubber that had not been referred to. Some years ago india-rubber was tried experimentally by several firms for sheathing torpedo boats. It was thought that when the rubber was perforated by shots the material round the holes would expand and close the holes, and so keep out the water, but apparently the experiment was not very successful.

Votes of thanks to the author and the chairman were accorded and the discussion closed.

PREFACE.

3 Park Place,

Cardiff,

April 9th, 1902.

A General Meeting of the Bristol Channel Centre of the Institute of Marine Engineers was held here this evening, Sir Thomas Morel, President, in the chair.

The Chairman expressed his thanks for, and appreciation of, the honour of being re-elected for a second year to the position of President of the Centre. He hoped that his health would be stronger than it was last year and enable him to do more justice to the duties devolving upon him. He was of opinion that the Institute performed useful public work, and that it could be made still more useful in connection with the great profession to which they belonged.

It was announced that the Committee had almost completed arrangements for a visit of inspection to the Barry Docks and Works on Saturday, the 26th inst. Mr. Archibald Hood, Deputy-Chairman of the Barry Company, who had always kindly interested himself in the Bristol Channel Centre, had written to say the directors of the Barry Railway Company offered the members every facility and convenience on the occasion, and Mr. Hood had also undertaken to himself contribute a short paper on that great dock and railway enterprise.

George Sloggett,

Hon. Local Secretary.

DISCUSSION

ON

THE USES OF INDIA-RUBBER ON BOARD SHIP.

3 PARK PLACE, CARDIFF.

WEDNESDAY, APRIL 9th, 1902.

CHAIRMAN:

SIR THOMAS MOREL (LOCAL PRESIDENT).

MR. A. SCOTT YOUNGER, B.Sc., observed that the author had indicated a couple of dozen uses to which rubber could be put on board ship, and certainly some of these were very ingenious suggestions. One suggestion of special interest seemed to be the use of a rubber sleeve over a bilge discharge valve—a principle that had been adopted in a well-known bicycle valve. In respect of the action of grease or oil upon rubber, however, the paper conveyed very little information. It was well known that grease or oil had a very destructive effect upon rubber, and he had recently been making experiments, particularly with the view of discovering the action of the heavier oils upon different qualities of rubber. He cut up an old rubber valve into sections exactly the same size, and each piece he immersed in different qualities of paraffin and engine oils. The result was certainly startling. In about a week the rubber in the paraffin had swollen to about twice its bulk and was quite soft and pulpy, having absolutely lost the characteristics of india-rubber, whereas the rubber immersed in the heavier oil—the engine oil—was hardly affected at all in the course of a fortnight. Perhaps it had swollen slightly, but its properties remained almost the same.

Mr. C. W. W. HANSEN agreed with the author that engineers in ordering india-rubber were not sufficiently careful to specify what they wanted it for. Turning to the author's figures illustrating defects, and with reference to Fig. 9, in which they had the application of an india-rubber ring to form the sealing of a pump-valve on its seat, the objects being noiseless action, a tight seal, and easily renewable at sea, he thought it would be well if engineers could be sufficiently persuasive to induce owners to go to a little more expense in first cost, thereby obviating endless expense and trouble in renewing valves and valve seats. With regard to the splitting of disc valves, he thought much benefit and convenience would arise from a standardisation both in quality and sizes. If, say, three types were agreed upon, the engineer would state the number or size of circulating valve he needed, and he would be able to get a guaranteed article. The author had thrown some light upon the causes of failure in the highly-polished pump leather packing which they might well bear in mind. With regard to the suggested india-rubber packing between the sole plate and foundations, the author gave no indication of the cost—whether it involved more expense than the usual wooden bed—but in respect of the deadening of sound and minimising the effect of vibration caused by metallic substances coming into continual contact, the idea seemed a good one. It appeared more probable that with india-rubber the unevenness of an unmachined cast-iron sole plate would be obviated, and the machine kept on a solid bed throughout its surface. But all this cost money, which engineers would do well to induce their owners to incur. As to the author's suggested application of india-rubber for jointing cylinder covers, there ought to be a ring outside as well, because with a pressure on the inside and nothing to support the outside great risk was run of breaking off the flange of the cover, due to no support outside against the flange. As to the various uses to which rubbers were put, they ought certainly to be as much used as possible to deaden sounds on board first-class liners, where expense was not considered. Foreign competitors were alive to this mode of promoting the comfort of passengers.

Mr. J. T. SHELTON believed that while india rubber was used some years ago in the earlier low pressures, it had been very much superseded in the engine-room in modern times. It was not an uncommon circumstance years ago, when a ship had completed a foreign voyage, to find pump valves missing—no doubt due to the disintegrating effect, referred to by Mr. Younger, wrought in india-rubber by the oils and also probably to the feed water being so hot, condensers in those days being much smaller than now. With regard to the suggestion to insulate the connections on the hull and bulkheads, it seemed to him that if pumps were screwed up to a firm hold in their places there would not be the deadening effect that was looked for. Rubber could be screwed up so hard as to assume the rigidity of a board. He had known rubber useful when small pump springs had carried away and no spare spring at hand. He also knew it was the practice many years ago of some engineers to pack the piston springs to keep them from moving, but this had been superseded by improved pistons. With reference to the author's proposal (Fig. 26) to apply india-rubber for jointing cylinder covers, a rubber being used between a stud and the inside of the cylinder, he recalled a case in which a very large cylinder cover was broken by not having an outside joint.

Mr. T. ALLAN JOHNSON thought that india-rubber should be kept entirely out of the engine-room and metallic substances adhered to. The mere fact of its liability to deteriorate if not kept in store under certain suitable conditions was enough to condemn india-rubber for use in the engine-room of a tramp cargo steamer. There were other substances for packing which commended themselves to the practical engineer much more than india-rubber, which was a very difficult material to deal with. No doubt on board passenger ships there were many ways in which rubber could be used to advantage, but not in the engine-room of a merchant tramp. Do not let them attempt to deaden the sound of machinery and destroy its efficiency. To deaden sound by insulating bulkheads and providing for the heavy-footed passenger was all right, and much more could be done in this way than by putting an india-rubber mat underneath the donkey-engine.

Mr. M. W. AISBITT thought the paper a very acceptable contribution, even if it only induced them to turn their attention to the all-important matter of detail—a matter which had enabled the Americans to come ahead in industrial competition throughout the world. The author had furnished them with very useful information in the direction of selecting rubbers suitable to the purposes for which they were intended. At the same time, the use of india-rubber in high temperatures was undesirable, while it might be good in low pressures. India-rubber sleeves on anything he did not consider practicable. As to Mr. Younger's experiments, they ought to ascertain why paraffin had the increased effects upon rubber compared with the heavier oils.

Mr. H. BRANDON said the effects spoken of were not upon the india-rubber itself, but upon substances mixed with it for its market condition. The chemist knew of no solvent of pure rubber. One of the best tests of rubber was the floating test—the more ingredients are mixed with it the heavier it is. As to the effect of oils upon india-rubber compound, if an oil was not free from the acids used in its abstraction, those acids would disintegrate the so-called rubber. Rubber should not be used in any internal part of the engine. Metallic and fibre valves could be made to resist any acid which might get into the water, and a perfect action obtained from them independent of all rubber.

Mr. J. E. MORGAN believed they could get a rubber valve to stand any degree of heat required. A good solid mineral oil was the best working oil for a marine engine. A vegetable oil formed too heavy a lather for uniform lubricating purposes. He did not agree with Mr. Johnson as to the uses of india-rubber on a steamer, believing that it could be advantageously adopted for the cushioning of machinery. He did not think it would ever be done away with.

Mr. R. SCOTT, on the other hand, thoroughly supported Mr. Johnson's views. Rubber, he said, had no business on board a modern steamer in connection with engines.

The CHAIRMAN, at the close of the discussion, said he had been instructed by what he had heard, and as a shipowner he thought much might be learnt by shipowners of the port attending these meetings of the Bristol Channel Centre. They would hear many things which would be useful to them in the conduct of their business.

Mr. YOUNGER proposed a vote of thanks to the author, a resolution which Mr. ALLAN JOHNSON wished to second most cordially.

The motion was carried by acclamation.

At the suggestion of Mr. AISBITT, endorsed by the CHAIRMAN, it was agreed to ask the Committee to appoint an honorary chemist of the Centre.

The proceedings closed with a hearty vote of thanks to Sir Thomas Morel for presiding.

Mr. G. W. NEWALL : In reply to the discussion held in Cardiff the following comments are offered :

Regarding the remarks made by Mr. A. Scott Younger that the paper conveyed very little information of the action of grease or oil upon rubber. As there are so many different oils and fats used by engineers and so many different qualities of india-rubber that one could ring the changes with, any exact statement from experience or practice would be of little use. There are qualities of india-rubber that are not affected practically by most oils, Russian tallow or petroleum jellies ; on the other hand there are qualities of rubber goods that are affected almost at once by all greases and oils.

There are qualities of india-rubber that will resist to a great extent the searching action of spirits, and on the other hand there are qualities that are convertible into soft, slimy masses directly they are immersed in some spirit liquid or low flashing point oils.

India-rubber goods can be made both oil and heat resisting for practical purposes. Very few india-rubber goods, such as are supplied to ships, are affected at all by castor oil or crude petroleum; slightly by Russian tallow, and glycerine has no effect on it from a practical standpoint. Turps have very little effect on it, while paraffin attacks most rubbers unless specially prepared. The napthas of course will attack any class of soft rubber goods. The heavier the oil the less rubber is affected by it. When india-rubber has been swollen by contact or immersion in oil, it is no longer of use as an elastic agent; it has become "rotten"; even after having reached its normal size again, it will be found almost useless for the purpose it was designed.

In reference to Mr. C. W. W. Hansen's remarks, I am pleased to note that he considers we should be careful to specify what rubber goods are required to do. I have referred to this many times in my paper and during our discussions at the Institute, and the impressions I gathered from our members were that they considered I made too much of this statement, but forgive me once again clenching the matter up, that it is of vital importance for the manufacturer to know what the goods are for. Among, say, 400 qualities of a rubber factory consider from how many secret store places these goods can be produced, and among such there is always a "best."

Regarding the proposed standardisation of pump valves, until engine makers standardise their pumps makers cannot standardise valves. To do so would produce a solid valve, moulded under great pressure and produced cheaper than the present indifferent practice. The common method being, say, for valves 16 in. diameter, $\frac{3}{4}$ in. thick, 4 in. hole in centre, or similar sizes, a sheet of the required thickness, but perhaps 3 ft. wide and many feet in length, is placed under a valve-cutting machine carrying two knives, one cutting the outer and one the inner circle. In a few revolutions your valve is produced ready for your pump. First, what has it cost? As to this, do not forget you pay for corners and the centre-piece.

That brings the price per pound up at least 15 per cent. Second, what class of material have you paid for? A good-looking rubber, say red or any colour you like, feels all right, smells all right (most persons smell rubber goods when they buy them). Now get a microscope and look well all round the valve where it was cut from the sheet. As the sheet has been made up by six laminations of about $\frac{1}{8}$ of an inch each and put under a press where the pressure at most is only a few pounds per square inch, it is probable you will observe a number of small slits, where the laminations, due to dust, chalk and other impurities, do not allow the sheet to become homogeneous around your valve, and after a little time in use the oil works into these small cavities, the cupping of the valve stretches the slits and it soon goes to pieces. Thirdly, never buy pump valves unless they are "moulded." As this means a compression of many tons to make a solid article, you pay for what it weighs, as there is no waste to produce such as in the first case, and you pay the same or sometimes less for the better valve. Regarding the cost of india-rubber packings under the sole-plates of some of our noisy machinery, it depends on extent; and where the question of how to lessen the noise so common to some of our floating factories arises, it is worth a trial, but for what purpose it is required when ordering, coupled with the fact that it must be "oil-resisting," should always be stated.

As regards the remarks made that for jointing cylinder covers there ought to be a ring outside the line of bolts as well as inside, this requirement entirely depends on the diameter of the cylinder.

The remarks made by Mr. J. T. Shelton that the existing pressures of to-day have displaced much of the uses of india-rubber is owing, I am inclined to think, to the fact that manufacturers have not been kept posted as to the increased requirements of this useful article, and engineers too often think it is india-rubber, and india-rubber is india-rubber, but sometimes india-rubber is not india-rubber except on the invoice. However, the rubber manufacturers are quite competent to meet all the requirements of our modern steamers up to 200 lb. pressure per square inch, if we only seek the information.

In reference to Mr. Shelton's remarks that rubber could be screwed up so hard that the deadening effects would be annulled is not correct, as however hard it may be screwed up it still has properties no other material has, and more than that it is not necessary to screw up anything like that required when no rubber is used between the flanges of a foundation plate. To prove this, place a piece of metal between two slabs of india-rubber and note the immense effort to move the plate ever so little, compared with the ease with which the metal will be moved between two slabs of metal representing the ordinary attachment. Mr. T. Allan Johnson said he thought india-rubber should be kept out of the engine-room entirely for metallic appliances, as being more suitable, as the storing requisite for india-rubber condemned its usefulness. Such should not be the case in a well kept ship. All india-rubber goods, when not in use, should be kept in a tank filled with sea-water, and having a jointed lid. Under such conditions rubber would last ten years.

Regarding the india-rubber mat beneath the donkey-engine, it is worth the trial if the donkey is a noisy one, and most donkeys have that failing.

As convener of our Experimental Department, it may be interesting and probably useful knowledge to ascertain what effect various oils and greases have on the various india-rubber articles as supplied to our ships, and keep in bottles from time to time samples of rubber goods in the various oils likely to come in contact with same, which perhaps, at some future date, may form at least the subject of an evening's discussion at the Institute.

This paper and its discussions seem to be like the subject, very elastic ; but I thank all members who have taken part in it. It was written solely to promote a discussion on a subject apparently little known by us, and should the least gain in knowledge accrue the aim of the author is attained.