Stressed Rubber*

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INTRODUCTION

This paper is primarily concerned with the use of rubber as a stress-carrying material. There are many other features of rubber, in particular its resistance to corrosion, which interest marine engineers, and these will be mentioned. Engineers, however, must judge rubber as an engineering material and that leads us to consider first its mechanical properties, which are unlike those of other engineering materials. The engineering uses of those properties will then be considered.

Raw rubber as it exists in the natural state is useless as an engineering material. It must be subjected to many processes before it exhibits the elasticity and resilience which are its chief characteristics. These processes are chiefly the concern of the rubber technologist but two of them are of interest to the engineer; they are compounding and vulcanization. Compounding is the process by which certain chemical substances in selected proportions are incorporated into the mix. Chunks of raw rubber in the form received from the plantation are fed into mixing mills together with the chemicals and the whole is worked or "masticated" into a plastic mass. The chemical substances are sulphur, which is the main vulcanizing agent, the reinforcing materials, chiefly carbon black in high-grade rubbers, and others which accelerate the subsequent process of vulcanization, improve the "ageing" characteristics, and effect other improvements. The mechanical properties of the compound depend to a considerable degree on the proportions of the chemical substances.

The final process in manufacture is vulcanization, or cure, and its function is to restore and improve the elastic properties. It consists of subjecting the mixture to an appropriate period of heating. In the case of moulded articles, this is done by placing the mould between the steam-heated platens of a press. The time and temperature of vulcanization also govern the elastic properties of the product and must be carefully controlled.

By variations of compounding and vulcanization, rubber can be produced in an infinite number of forms, from a soft brown material called a pure gum stock, to a hard black material called vulcanite or ebonite which the layman does not consider to be a rubber. This wide variety is one of the main difficulties in rubber design and because of it the engineer must always seek the advice of the rubber technologist before selecting the compound for a particular job. Rubber specifications have not been rationalized in the same way as alloy steels although some progress in this matter is being made. Often the engineer is faced with meaningless trade names instead of precise specifications and he naturally dislikes being too much in the hands of a specialist. However, undue concern on this score is not necessary because the assistance of reputable rubber companies in any engineering venture is readily forthcoming.

Despite this wide variety of compounds, it is possible to describe the mechanical properties of rubber in general terms. No attempt will be made to describe in detail the behaviour of synthetic rubbers. The term is something of a misnomer. In synthetic rubbers, scientists have produced artificially materials which have a similar chain-like molecular structure to natural rubber and which respond to similar manufacturing processes. They were developed in Germany as a direct substitute for natural rubber and by other countries to overcome certain of the disadvantages, such as poor oil-resistance, of natural rubbers. During the war, however, when supplies of natural rubber were cut off, the U.S.A. expanded its production of synthetic rubber enormously, and this production capacity is maintained against a similar possibility in the future. The use of a certain percentage of synthetic in rubber products is mandatory in America. The technical improvement of synthetic rubbers and their decreasing cost make them serious rivals to natural rubber compounds. Broadly speaking, both natural and synthetic compounds show the same general features as regards elastic properties.

MECHANICAL PROPERTIES

The essential characteristic of all rubber-like materials is their ability to withstand severe elastic deformations without serious damage. They have a low shear modulus and a relatively high bulk modulus. In this respect, a comparison with steel is interesting, as shown in Table I.

TABLE I

	Bulk modulus K	Shear modulus C	Ratio $\frac{K}{C}$
Steel	25×10^6 lb. per in.^{2}	12×10^6 lb. per in.^{2}	2·1
Rubber of 50 Shore hardness	$0{\cdot}35\times10^6$ lb. per in.^{2}	95 lb. per in.^{2}	3,600

The low shear modulus of rubber means that small forces will produce large changes of shape. The bulk modulus of rubber approaches the same order as that of steel, so that it has a high resistance to change of volume. It may be said that rubber is virtually incompressible, and it follows that, in design, provision must be made for the rubber to expand to maintain the necessary constancy of volume. A familiar example is the sealing ring of a wet liner in an oil engine. The rectangular groove must have approximately the same cross-sectional area as the rubber ring so that there is room for the rubber to flow into the corners.

Owing to its large elastic deformations, rubber is an excel-

* Read before the Institute of Marine Engineers' Local Section, Sydney, on 5th October 1951.

lent material for isolating vibration. It can store large amounts of energy; whilst a steel spring can store up to 100ft. per lb. of energy per lb. of material a medium-hard rubber may store several thousand ft. per lb. of energy per lb. Rubber also shows high hysteresis so that in a vibrating system mounted on rubber there is considerable inherent damping of the vibrations. Another attractive feature lies in the fact that rubber springs can be stressed in several directions. The familiar rubber bush illustrates this (Fig. 1). It is capable of sustaining

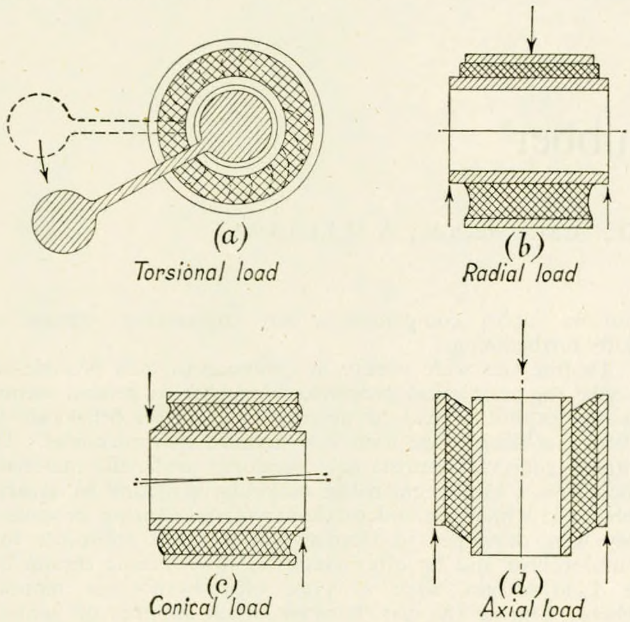

FIG. 1—*Rubber bush under various types of loading*

(a) torsional loads; (b) radial loads; (c) longitudinal couples or "conical" loads and (d) axial loads; and the various loads and couples may exist in combination. By contrast, metallic springs can usually be stressed in one direction only.

RUBBER IN COMPRESSION

In engineering applications, rubber is usually stressed in compression and shear. In a compression test, a cylindrical specimen takes up a barrel shape. This is due to the friction at the ends which restrains sideways expansion. In all practical applications, restraint of some kind must exist and it is necessary to appreciate its effect on the apparent stiffness of the rubber; Fig. 2 is an illustration of this. It shows the stress-

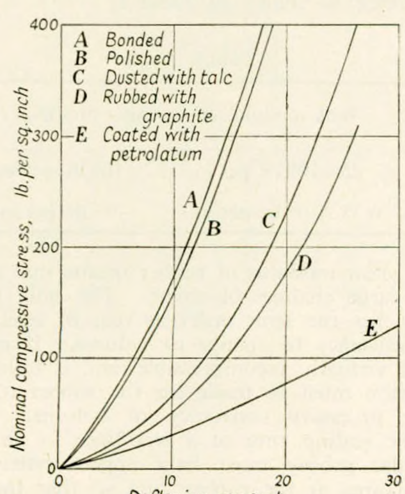

FIG. 2—*Effect of restraint at ends*

deflexion curves for five similar specimens when the frictional restraint at the end faces is varied by means of lubrication. Curve E has the smallest slope; in this case the use of petrolatum allows the ends to expand laterally so that the cylindrical shape is maintained. When the ends are bonded, curve A, there is perfect restraint at the ends and the stiffness of the rubber is greatly increased. Curve B lies very close to curve A and illustrates the high coefficient of friction between dry rubber and steel. (In one well-known make of rubber bush, the frictional effect is relied upon entirely to resist torsional loads.) Curves C and D lie between the extreme curves, the lubrication in these cases effecting only partial end restraint.

Considering this effect further, it will be clear that the relative dimensions of the specimens will change the amount of barrelling; a short specimen will not expand laterally so easily as a longer one, with a consequent effect upon the apparent stiffness of the rubber. As an example, we may compare the apparent compressive moduli of two cylindrical specimens of the same height but of diameters in the ratio of 6:1. It will be found that the modulus of the shorter specimen is about four times that of the longer one for a given deflexion. Unfortunately, the moduli are not in simple proportion to dimensional ratios. This difficulty in design is overcome by the use of empirical shape factors, the most rational of which is that suggested by Kimmich,* namely,

$$\text{Shape factor} = \frac{\text{area of one loaded face}}{\text{total free area}}$$

The author has published charts showing the chord modulus values for 10 and 20 per cent axial deflexion for rubbers of different Shore hardness. Fig. 3 is this type of chart. These

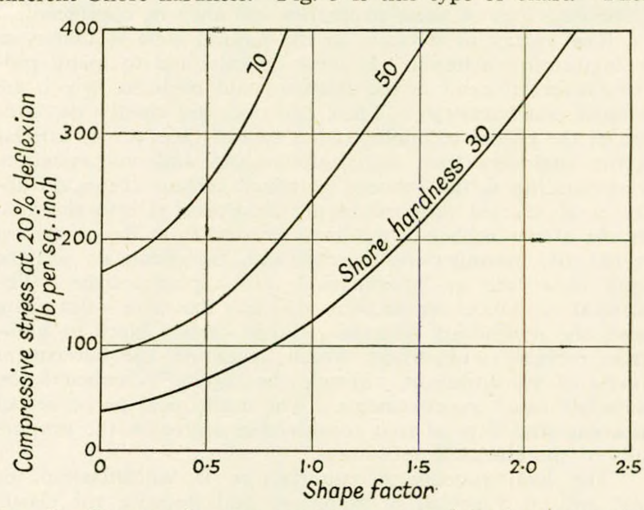

FIG. 3—*Compressive stress at 20 per cent deflexion for various hardness values*

charts are by no means universally used, most rubber manufacturers having their own empirical formulæ or nomographic charts. There is a sad lack of uniformity in the various design methods.

RUBBER IN SHEAR

Since deformations are almost wholly changes of shape, it follows that the most logical way to employ rubber is in shear. Shape factor effects are negligible and the stress-strain relationship is linear. Fig. 4 shows the results† of tests on shear mountings for rubbers of different hardnesses. The hardest rubber shows a linear relationship up to 0·1 strain, corresponding to an angular deflexion of 12 degrees, and the softest for a range up to 0·4 strain. These values exceed the allowable practical values. We conclude that Hooke's Law applies for moderate shear strains and that conventional methods of design may be safely used.

* Kimmich, E. G. 1940. "India Rubber World", Vol. 103, p. 85.
† Haushalter, F. L. "The Rubber Age", Sept. 1939, p. 219.

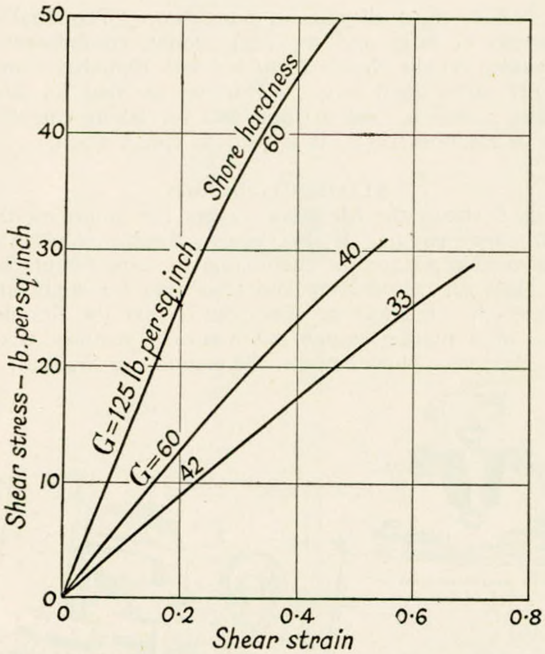

FIG. 4—*Stress-strain curve for rubber in shear*

The practical use of rubber in shear involves the adhesion of the rubber to rigid metal parts. This adhesion is called "bonding" and the development of the process in recent years has revolutionized rubber design. There are two main methods of bonding; in one method the rubber adheres directly to a layer of electro-deposited brass and in the other cements are used between the rubber and the metal. Sometimes a thin layer of harder rubber is used adjacent to the bond to improve adhesion. In all methods, the adhesion is effected during vulcanization, and bonding should not be confused with "sticking" by means of adhesives applied after vulcanization, which is unsuitable for highly stressed parts. Bond strengths of as high as 1,000lb. per sq. in. are possible but designers rarely exceed 50lb. per sq. in. in components under pure shear subjected to alternating stresses. As bonding technique improves, rubber can be more effectively used in vibrating systems.

A combination of compressive and shear deformation is frequently used in practice and unusual but desirable characteristics can be achieved in this way.

TEMPERATURE AND TIME EFFECTS

By comparison with metals, the useful temperature range of rubber is small and, within the useful range, temperature may have some effect upon mechanical properties.

As the temperature of natural rubber decreases from about 0 deg. C., it is found that resilience falls rapidly, and at the same time the modulus increases steeply. The material is changing in character and behaves more like an ordinary solid, becoming less flexible, harder and ultimately brittle. There is a minimum value of resilience which may be less than 10 per cent and the temperature at which this occurs is called the lower critical point. In natural rubber compounds, this temperature is around −40 deg. C., so that a complete transformation is effected over a narrow range of temperature.

There are also changes in resilience and modulus over the temperature range 20-100 deg. C., although these are relatively small. It is generally known that temperatures above 100 deg. C. soon lead to breakdown of the rubber.

With oil-resistant synthetics, these effects are generally more pronounced. The useful temperature range is decreased, particularly at the low temperature end, where the stiffening and loss of resilience may begin at about 20 deg. C. and the lower critical point may be above 0 deg. C.

Due account of these changes must be made in design and careful thought must be given to components that operate in sub-zero temperatures.

Time effects reveal themselves in a variety of ways. Under a constant dead load a rubber component will continue to deform after the load is initially applied, thus exhibiting "creep". The rate of creep diminishes with time and for all practical purposes becomes zero after a time, although this may take some hours or days. The converse condition is called "delayed elastic recovery", which means that the initial set at the moment of unloading will decrease as time goes on. With some soft compounds, the permanent set is often negligible after the lapse of a few hours. Yet another kind of time effect is that of "stress relaxation", which means that when a component is kept in a state of constant strain, the stress in it will diminish with the lapse of time. These effects are important in design; for example, when rubber is used in a transmission system, creep effects may cause misalignment.

Perhaps the most important revelation of time effect is in the relationship of dynamic properties to static properties. One may not use without modification data obtained from static tests at slow rates of loading, as in an ordinary testing machine, and apply them to vibrating systems. For example, the stiffness of a particular mounting may be 20 per cent greater than the static value when stressed at, say, 20 cycles per second. Some synthetics show a dynamic to static modulus of as much as 3 to 1. It is commonly accepted that the ratio for any particular compound is constant and unaffected by frequency. The author has questioned this conclusion and has suggested that a careful investigation of the low frequency range would show that stiffness is a function of frequency.

SOME PRACTICAL EXAMPLES

We know from simple vibration theory that in order to reduce the vibration transmitted to a supporting structure, it is necessary to have a natural frequency much lower than the disturbing frequency. This low natural frequency is achieved by mounting the engine or machine on springs of low stiffness. For such springs rubber is an excellent material. The supporting structure may be a factory floor, an automobile chassis or a ship's hull; the principles of design which must be observed are the same.

Most rubber suspensions are rubber-to-metal bonded units in which, under normal running conditions, the rubber is loaded substantially in shear. As we have seen, rubber has a low modulus in shear. There is always the need to provide for overload and this is done by introducing compressive loading. Overloading frequently occurs at right angles to the axis of the suspension, as, for example, when a ship strikes a jetty. There are many types of patented vibration mountings and one of them is shown in Fig. 5. It consists of concentric conical shells between which is bonded a layer of rubber. As

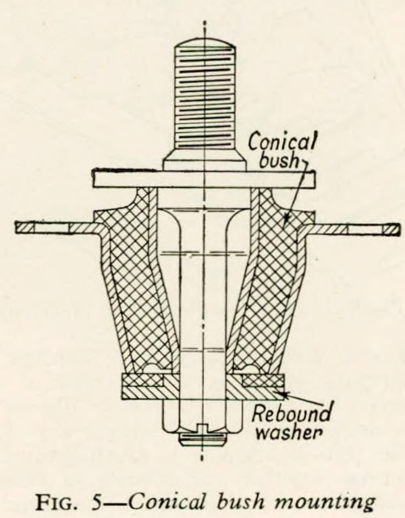

FIG. 5—*Conical bush mounting*

shown, the unit is unloaded. The central member carries the live load, and thus the rubber is under both shear and compression, the compression component becoming relatively greater as deflexion increases. The increasing stiffness as deflexion increases or, as it may be termed, the "rising rate" of the spring, is often a desirable feature. Excessive deflexions in the vertical direction are prevented by the "flange" of rubber at the upper end and by the rebound washer at the lower end. Horizontal forces place the rubber in compression radially, in which respect it is immensely strong.

The engine suspension of the Austin A.40 motor car is an example of good design. Fig. 6 shows the front-end

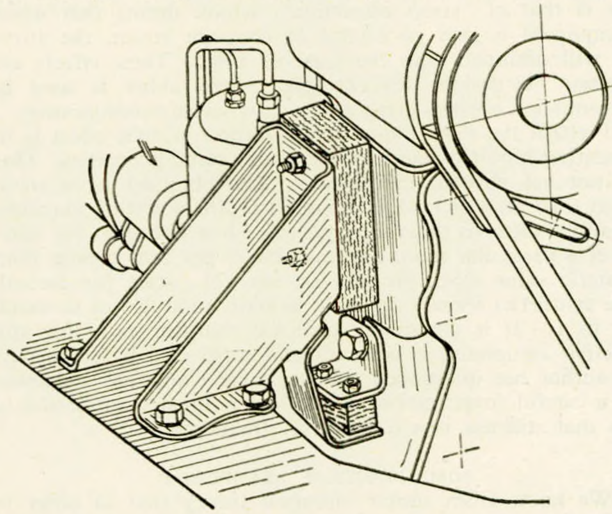

FIG. 6—*Front suspension—Austin A.40 engine*

mountings and it will be observed that the weight of the engine stresses the rubber mostly in shear. The inclination of the mountings is about 70 degrees to the horizontal and so there is some compressive component which reduces the tearing effect at the bond. Excessive forces may arise owing to torque reaction and road shocks. They are allowed for by providing compression pads as shown. These pads are normally set at a clearance of $\frac{1}{32}$ to $\frac{1}{16}$-inch and come into play only when overloading occurs.

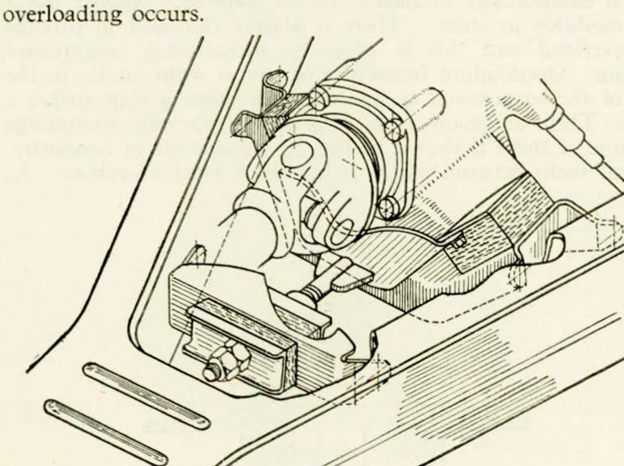

FIG. 7—*Rear suspension—Austin A.40 engine*

The rear end suspension, Fig. 7, consists of bonded rubber-to-metal pads placed at the rear end of the gearbox. The inclination of these pads is about 45 degrees and so the compressive component is relatively greater than for the front suspension; the vertical stiffness is much greater. The fore and aft mountings together approximate to three-point suspension. It should be noted that acceleration and retardation of the vehicle place all pads in pure shear. The axial forces set up may be large and so simple double compression pads are provided on the chassis in such a way that they come into play only under axial forces. Thus we see that for isolating vibration, rubber is used in shear and for taking care of high inertia or reaction forces, it is used in compression.

FLEXIBLE COUPLINGS

Fig. 8 shows the Metacone system for mounting flexibly a small marine engine. It also shows a flexible coupling which has the double purpose of cushioning to some extent the torsional loads on the shafting and providing for slight angular misalignment. It must be remembered that the flexible suspension of a marine engine automatically requires flexibility in all other connexions between the engine and the hull; more-

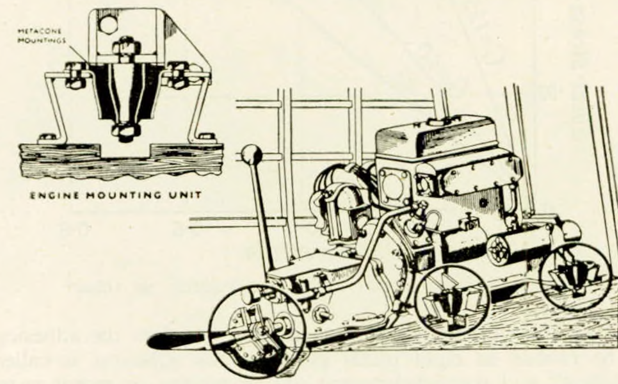

FIG. 8—*The Metacone system for flexibly mounting a small marine engine; also rubber type couplings*

over, the problems of misalignment arising from flexibility of the engine unit and from possible creep must be solved. Misalignment of the main shafting is not a new problem to the marine engineer.

Connexions to the engine must not, of course, be rigid. Fuel feed pipes, cooling water pipes and exhaust systems must be examined from the standpoint of flexibility. None of the problems is difficult to solve even in big craft.

In the smaller sizes of internal combustion marine engines the thrust block is accommodated within the engine. A flexible coupling between engine and shaft must then be able to withstand the axial forces in both ahead and astern running. The coupling illustrated in Fig. 7 has proved reliable in service. Astern running places the rubber bond almost wholly in tension and a tribute must be paid to the rubber companies who have developed reliable bonding techniques which can meet such exacting conditions.

The Metalastik double cone flexible coupling, illustrated in Fig. 9, is a heavy-duty design which is suitable for a 130-h.p.

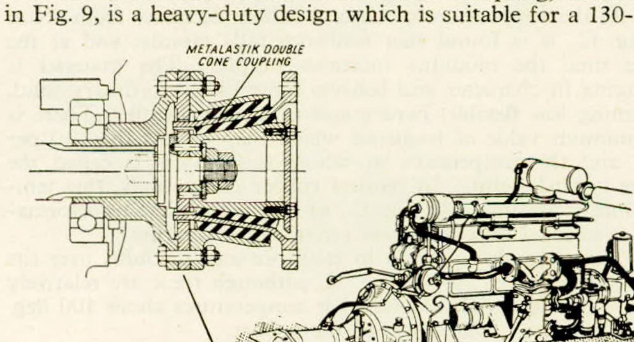

FIG. 9—*The Metalastik double cone flexible coupling, which carries thrust load*

Diesel marine engine. The metallic parts are conical in shape with the rubber bonded between them. This is another example of the wise use of combined stresses to produce maximum flexibility combined with high strength.

The Silentbloc thrust type coupling, Fig. 10, employs

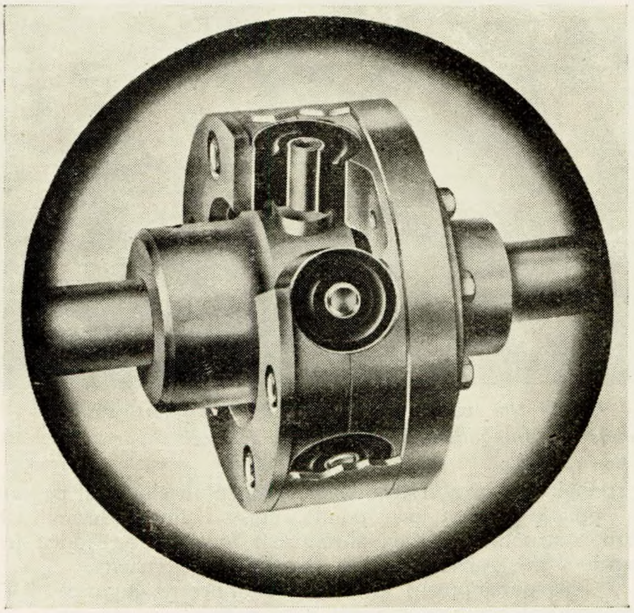

FIG. 10—*The Silentbloc thrust type coupling, showing the radially placed rubber trunnions, which absorb torsional vibration and compensate for a limited amount of misalignment*

rubber trunnions disposed radially around the shaft. In transmitting torque and in resisting end thrust the rubber sleeves are subjected to radial forces. They are very strong in this respect. This coupling, as well as the others, allows for a limited degree of misalignment. Rubber can be weakened by fatigue and misalignment will naturally set up cyclic stresses. It must therefore be kept to a minimum and the flexibility of the transmission must not be made an excuse for carelessness in lining up.

Plummer blocks can be mounted on rubber compression pads where necessary, such pads being cheap and reliable.

TORSIONAL VIBRATION

Torsional vibration is a serious problem in propelling machinery, especially with internal combustion engines. Flexible couplings automatically provide some benefit but designers tend to provide some direct means of damping vibrations to some degree. Vibration dampers using bonded rubber are marketed. The principle of operation is to allow a heavy disc of comparatively high inertia to vibrate freely and this involves attaching it to the crankshaft by a suitable springing medium. Steel springs are commonly used but soft rubber is equally suitable and the design is simple. An oil resistant synthetic rubber must be used. Fig. 11 shows one design used in automotive work in which the backplate is fitted to the crankshaft at the free end. It is arranged to carry the fan driving pulley. The position of vibration dampers along the crankshaft has an important bearing on their effectiveness although it is convenient to place them only at the front end. The subject is complex and is beyond the scope of this paper but it seems possible that a vibration damper incorporated in the transmission shafting itself in the correct position for a given layout could cause a considerable reduction in the amplitude of torsional vibration.

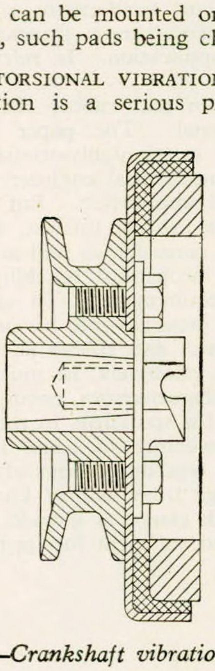

FIG. 11—*Crankshaft vibration damper*

INSTRUMENT MOUNTING

It has always seemed to the author that vibration in the engine rooms of larger vessels is given insufficient attention. Pressure gauges, revolution indicators and other instruments vibrate about a mean reading and sometimes lengths of piping resonate with the frequency of some piece of machinery. In motoring, the comfort of the passenger is a foremost consideration and designers are forever finding new ways of eliminating discomfort arising from engine and vehicle vibration. Simple rubber components can often bring about improvement. It seems that discomfort in the engine and boiler rooms of a ship is accepted as inevitable but one sometimes wonders whether any serious attempt is made to reduce it to a minimum. Vibration can assume many forms, and can do many kinds of damage. Mechanical damage is well known and every designer is alert to such a possibility but human damage is treated casually. Research has shown that vibration is fatiguing to the human frame, impairs concentration and efficiency and may be physically harmful. Continuous noise, especially if it is high-pitched, is a type of vibration which can be very objectionable. In passenger ships, vibrations of many kinds must be considered and one may ask whether the usefulness of rubber in vibration absorption is fully appreciated by ship designers.

Instrument mounting by means of bonded rubber components is highly developed in the aeronautical field and could be extended with advantage to marine engineering. Rubber sheeting and various rubber composition materials might be applied to bulkheads, decks and machinery casings to lessen noise and other vibration, and the cost of such improvements would be very small.

CORROSION RESISTANCE

Rubber has been considered chiefly as a stress-carrying material but there are other uses which solve engineering problems. Three developments will be described by way of example.

The corroding and eroding action of sea water on metallic surfaces is a problem which continually faces the marine engineer, and rubber can be used with advantage in preventing damage from these causes. A technique has been evolved by which rubber sheeting of ⅛-in. thickness can be bonded to large areas and a few companies specialize in this work. The work is best done in the factory where there are adequate facilities for cleaning the surfaces and applying the heat and pressure necessary for "curing" the rubber. However, the condenser doors of H.M.S. *Vanguard* were treated without removing them from the engine room and this work was done by a mobile team of the Andre Rubber Company. The steel surface has first to be made thoroughly smooth and clean; this may entail welding up corrosion pits or other imperfections

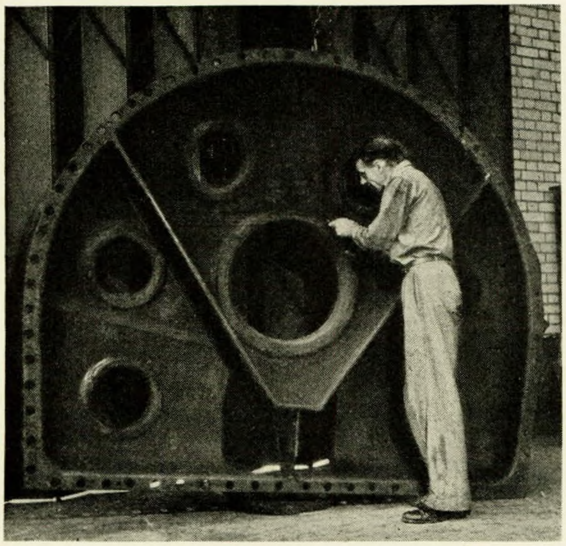

FIG. 12—*Lining a cast steel condenser door with rubber*

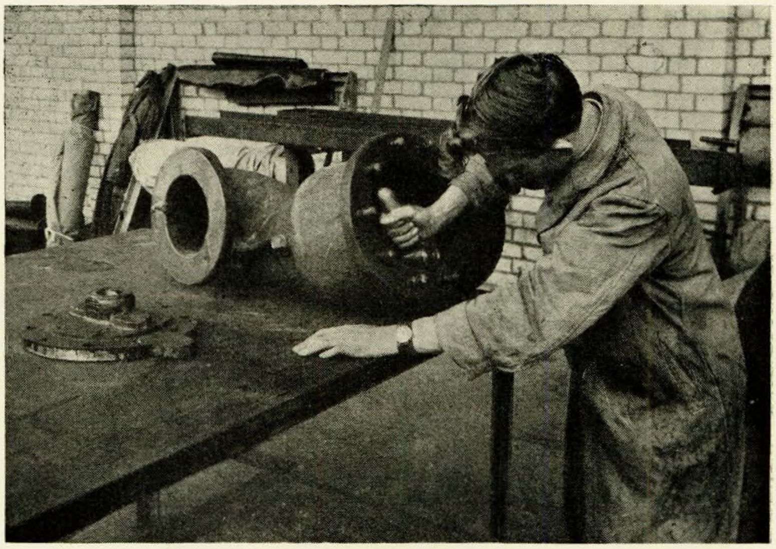

FIG. 13—*Lining the interior of a seacock casing with rubber*
With acknowledgements to "Shipbuilding and Shipping Record"

and grinding the surface smooth, since quite small air bubbles will expand and prevent adhesion when heat is applied. Both the metal and the rubber sheets are coated with a special cement and a degree of adhesion takes place. Special care is taken with overlaps and around protrusions. Hand rolling is used to effect good contact and Fig. 12 shows an operator doing this type of work. The rubber at this stage is not fully vulcanized and is thus sufficiently plastic to follow the contours of the surface.

In the case of the *Vanguard*, the doors were bolted in position on the condenser, the various openings were sealed and the ship's own steam supply was used to effect the vulcanization of the rubber. A careful inspection of the work was carried out to make certain that there were no imperfections in the surface through which sea water could penetrate, and an electric spark method was used to locate the imperfections. They may be easily repaired.

Seacocks, expansion pieces and many other components can be treated in this way (Fig. 13).

THE CUTLESS BEARING

In the stern tube bearing of the Cutless type, rubber is used as the wearing surface. Here the good resistance to abrasion and low coefficient of friction of wetted rubber are the properties which recommend its use. The B. F. Goodrich Company in the United States of America and the British Tyre and Rubber Company in Britain are specialists in this application of rubber.

The rubber is inserted in segments with bronze backing which are dovetailed into the main housing. The segments are easily renewable. It is said that the frictional resistance of this type of bearing is comparable with that of roller bearings. There is no shortage of the necessary lubricant, water, and the presence of sand and grit is not so detrimental as in hard-surfaced bearings. Up to fifteen times the life of an orthodox bearing has been recorded and the cushioning effect of the rubber cuts down vibration and noise even when the bearing is worn.

CONDUCTIVE RUBBER

We think of rubber as an almost ideal insulator but a recent development is electrically conductive rubber. The property of conductivity is obtained by incorporating in the rubber a special type of acetylene black. When an electrical potential is applied between two points, current flows through this carbon structure. Often aluminium foils are embedded in a panel of this rubber to assist the flow of electricity.

This development interests a number of engineers. The aeronautical engineer can use it to prevent ice formation and the build-up of static charges. In printing machinery, static electricity makes the paper hard to handle and this problem can be eliminated by the use of conductive rubber. In explosive atmospheres, static charges set up on rubber belting can be dangerous and can now be avoided. Conductive rubber can be used to lag pipes when the temperature needs to be closely controlled.

In heating and refrigeration engineering, the development is specially welcome. In space heating, large low-temperature panels are preferable to small high-temperature elements, and in the U.S.A. this application is well established. Large panels of pleasantly decorated effect are attached to the walls and operate between 100 and 150 deg. F.

Conductive rubber is being applied to marine work. It can maintain a constant temperature in a ship's hold when used in conjunction with simple thermostatic controls; cabin heating is a similar application. In refrigeration work it can prevent condensation.

It has been shown that rubber can fairly be classed as an engineering material. The paper has emphasized the importance of rubber in its highly-stressed form only because the author, being a mechanical engineer, is particularly interested in that type of application. But the problems of the engineer, whatever his field of interest, are many and varied. He is concerned with corrosion as well as fatigue; with human comfort as well as mechanical reliability; with æsthetic as well as functional requirements. To solve his problems he must gather as many materials into his net as he can—plastics, timber, leather, ceramics and rubber as well as metals. And to use these materials effectively, he must know something of their properties and characteristics, enough to guide him when occasion demands to the specialists in those materials.

Rubber is a newcomer to some fields of engineering. Prejudice lingers on regarding some of its applications and prejudice often springs from lack of knowledge. This paper has attempted a quick glance at a wide field and it is hoped that the view has been sufficient for its purpose.

INSTITUTE ACTIVITIES

Minutes of Proceedings of the Ordinary Meeting held at the Institute on Tuesday, 22nd September 1953

An Ordinary Meeting was held at the Institute on Tuesday, 22nd September 1953, at 5.30 p.m. Mr. Stewart Hogg (Chairman of Council) was in the Chair, supported by Mr. A. Robertson, C.C. (Vice-Chairman of Council); sixty-three members and visitors were present.

The CHAIRMAN opened the meeting as follows:—

We are here tonight for the opening meeting of the 1953-54 session which I am sure is going to rank with any in the past for quality and interest.

This year the Institute has gone outside the usual field of eminent marine engineers, shipbuilders and shipowners when looking for a President and is to be congratulated on its choice of such a distinguished Civil Servant as Sir Gilmour Jenkins and fortunate indeed that he was able to accept the duties of the Presidential Chair.

Although the President does not belong to the group I have just mentioned, as a professional administrator and head of the Ministry which handles the State's interest in shipping, he has a very close connexion with all our activities. On that account I am sure you are all anticipating a most informative Address and, indeed, one which only he could deliver.

I am not going to say much about the President's career, as a short note on that subject will be found in the printed copy of his Address which will be available at the end of this meeting. I will merely draw attention to the fact that he first gained distinction in the service of his country as an officer in the 1914-18 war, since then his career has been marked by many distinctions. Amongst them he is European Chairman of the Planning Board for Ocean Shipping under the North Atlantic Treaty Organisation, and I would also point out that since his Address went to the printers it has been announced that he will be the Permanent Secretary of the combined Ministries of Transport and Civil Aviation as from the 1st October next.

As your Chairman of Council, I would like to add that I have found the President keenly interested in our affairs since his first day in office and I am sure his year in the Chair will be a fruitful one for the Institute.

I have much pleasure now, Sir, in asking you to read your Address.

SIR GILMOUR JENKINS, K.C.B., K.B.E., M.C.: Before reading my Presidential Address, may I say how grateful I am to you for the kind things that you said about me. I would also say once more, as I said when I first appeared on this platform, how honoured I have been to be chosen by the Marine Engineers to be their President this year and to follow the very distinguished line of Presidents whom you have had in the past.

The President then delivered his Address (see p. 249).

The CHAIRMAN: It is a very great personal honour to have the opportunity to voice the thanks of the members and visitors present to you, Sir, for your most informative and scholarly Address. In my introductory remarks I said we would be expecting an informative Address and I am sure now everyone present will agree with me that our expectations have been fulfilled. We have had much more meat than it is possible to digest with one bite. Most of us will require to meditate later on the printed copy of the Address.

The President is to be congratulated on his choice of the subject of his Address, as in his unrivalled position he gets a view point of our industry with all its ramifications which few of us can hope to get. In sharing his viewpoint with us, he has given us a brief historical picture of the growth of the State's interest in shipping, first, in the physical requirements of ships in their advancement towards the ideal of the safest ship, and second, in the many diverse human interests in the shipping industry. He has shown us how the State and industry are now almost one family, particularly at International Conferences, with the result that a strong united voice from this country leads the maritime nations of the world in all shipping matters. He has paid generous tribute to all in the industry from shipowners to the officers and men of the Merchant Navy and their representatives, for their co-operation in making possible the united voice of Britain, and he rightly pointed out that no other industry in recent years could show such a record of goodwill and agreement.

These achievements, I am sure you will agree, are in no small measure due to the work of the members of his profession, who are always at the disposal of the shipping industry to assist in the solution of the various shipping problems, national and international. I submit, therefore, that the President has without doubt established the close relationship that exists between our profession and his. In fact, he has shown us that we are now one indivisible whole in national and international matters. In case anyone should misunderstand me, I would add we are not a nationalized industry.

I am, as many of you know, a member of the President's staff, and as such can appreciate to a greater or lesser extent both sides of the picture he has shown us. My professional duties as an engineer are, however, generally concerned with settled policy, somewhat removed from the activities of the administrators, and like most of you, therefore, I look with admiration and respect on the results achieved by the President and his administrative colleagues. My thanks and the thanks of the members and visitors present are, therefore, due in full measure to you, Sir, for your most excellent Address. I have pleasure on their behalf in proposing this vote of thanks to you, which I would now like Mr. Robertson, Vice-Chairman of Council, to second.

MR. A. ROBERTSON (Vice-Chairman of Council): It is a very great pleasure and honour to be called upon to second the vote of thanks which has been so ably proposed by our Chairman. As usual, the Chairman, in his opening remarks and in proposing the vote of thanks, has said practically all there is to say on the subject and leaves me very few remarks to make. But there are one or two observations I should like to make, Mr. Chairman.

The President's opening remarks referred to the practice of the Institute in choosing Presidents from outside their own ranks. This is a practice instituted by our forebears when they started the Institute in 1889, and I think it has proved undoubtedly to have been a very correct and wise policy.

Carry your mind back over the years and you will remember the names of some of the Presidents we have had—men like the Right Honourable Lord Kelvin, Lord Inchcape, the Right Honourable Charles A. Parsons, Viscount Weir of Eastwood, John H. Silley, Engineer Vice-Admiral Sir George Preece, and many others, a very distinguished line of Presidents. We have benefited enormously from their connexion with the Institute and, indeed, every President has played his part in helping to build up the prestige of the Institute and in promoting the interests of marine engineers in general. We feel sure, Sir, that in you we have a worthy successor to so many men who have filled this great office of President.

Our President's career has already been referred to by our Chairman, and as you will have noted it is a very distinguished one and one that has led him to gain the experience and knowledge which have enabled him to give you such an interesting paper this evening. One could make references to distinguished characters during the history of British shipping during the last three or four hundred years. Our President has not particularized or brought before us the names of any of the great personalities of the past who have built up and made British shipping what it is today. But he has referred to officers and men of the British navies who face the deprivation of home life and the daily perils of their calling. Then he goes on to observe that harmony within the industry has hardly been even mildly fluttered in recent years.

This brings to my mind a character who was undoubtedly, in his time, very greatly instrumental in bringing about that harmony, particularly in the early part of this century. I refer to the late James Havelock Wilson, who was for many years the secretary of the National Sailors' and Firemen's Union. We had the pleasure, Mr. President, of his company at many of our annual dinners. He was a charming personality, one who was admired and loved by all those with whom he came into contact. There are many other personalities one could refer to, but time forbids.

Mr. President, the position of President of this Institute does not demand a very great deal of the President's time. But I can assure you the office does demand somewhat more time these days than it has done in the past due to a large extent to the fact that we have now outside centres. We have seven centres established throughout the United Kingdom; and if our President can find time to visit those outer spheres of influence, we shall be very greatly pleased and gratified. I am quite sure the members in Southampton, Cardiff, Birmingham, Hull, Glasgow, Liverpool and the North East Coast will be only too delighted to give you a hearty welcome.

I do not think I can say more than to express to you, Sir, that we are all very greatly privileged to have heard the Address you have given this evening. Our members all feel pleased at having been able to be present and wish you a very happy year of office as President of the Institute.

With those few remarks, I have very great pleasure in seconding the motion.

The vote of thanks was passed by acclamation.

The PRESIDENT: I think you have probably heard enough of me for one evening, but I must say thank you for the very kind terms in which this vote of thanks has been proposed and seconded. It has been a very great pleasure to me to be here and to set forth the thoughts I have inflicted on you. I can only say this, I think, in amplification: that I do very earnestly believe in the importance of that close relationship between Government and industry which we have established in the shipping industry. We have established it not, I think, by any particular virtue in ourselves (I am not convinced of that but at any rate for the benefit of outsiders we must say so) but perhaps because of the greater difficulties which have faced the shipping industry, certainly over the last century, than those that have faced other industries—particular difficulties which have called forth the efforts, and the co-operative efforts, of everybody concerned with the industry's affairs.

I have touched mainly in my Address on the matters concerning ships themselves and the crews who sail in the ships rather than on the wider and more nebulous policy questions of flag discrimination and matters of that kind. But it is that sphere, the sphere of the relationship between owners and their officers and crews, and then the relationship between the whole industry—shipowners and their officers and crews together—and the Government, that I have particularly wanted to deal with. It is in that sphere that I feel that the closest touch, the closest day-to-day co-operation in all matters, is of vital importance to all of us. I would add to this—and it is not a small thing—that it makes life more pleasant as well as more efficient. All of us, perhaps, do not give quite enough attention to that: to how much effect on efficiency and on the happiness of our lives (and they are short enough, as I begin to realise) helpfulness and pleasant relations in our work can have, and to the importance of these things in getting the work done.

I have gone on too long, I am sure, Mr. Chairman, but to come to more practical matters I think the Vice-Chairman cannot have known that the Chairman and I take sleepers for Glasgow tonight to do the very thing he has been suggesting we should do. We are visiting the furthest away of our centres outside London. I know I shall be welcomed in Glasgow with the same cheerfulness and friendliness as I have always received whenever I have been among marine engineers.

Thank you, Mr. Chairman and Mr. Vice-Chairman, and thank you, Gentlemen, very much.

The proceedings then terminated.

Local Sections

North East Coast

The North East Coast Section held their first meeting of the 1953-54 session on Thursday, 1st October 1953, at the Neville Hall, Newcastle-upon-Tyne, when Mr. George Laing, who is a well-known marine insulation specialist, gave a paper on "Thermal Insulation for Marine Requirements".

There was a general introduction on the scope of marine insulation, followed by an analysis of the physics of heat transfer and the relevant terms used, particularly in insulation problems, together with details of the thermal conductivity of the more common materials used on ships. The application of insulation to refrigerated cargo holds and chambers was then considered, together with heat leakage factors and quantities involved in a typical fully-refrigerated ship. Survey of the moisture and condensation problem followed, with details as to how this affected insulation thickness on steel work and low temperature pipe lines.

The insulation of high temperature surfaces, i.e. boilers and steam pipework, was then discussed, with some remarks and diagrams on the theory of economic thickness, particularly as it applies to superheated steam lines and pipes exposed to abnormal conditions.

Some remarks on subsidiary insulation, i.e. engine and boiler room casings, ventilation ducting, etc., were made, together with recommendations.

Finally, an indication of the problems of insulation at ultra-low and ultra-high temperatures was made, together with some details of the most recent developments to meet these extreme conditions.

Much of Mr. Laing's information was being published for the first time and his lecture gave the Section a good send-off into its first full session. A frank and lively discussion was followed by a vote of thanks. The attendance was sixty-eight.

Scottish Section

An Ordinary Meeting of the Scottish Section was held in the premises of the Institution of Engineers and Shipbuilders in Scotland on Wednesday, 23rd September 1953. Mr. T. A. Crowe, M.Sc. (Chairman of the Section) was in the Chair and sixty-eight members attended.

The President, Sir Gilmour Jenkins, K.C.B., K.B.E., M.C., was present to read his Presidential Address and was accompanied by Mr. Stewart Hogg (Chairman of Council) and Mr. J. Stuart Robinson, M.A. (Secretary). Warm appreciation was expressed of the President's gesture in travelling north to the opening meeting of the first full session of the Section.

Autumn Golf Meeting

One of the most successful golf meetings was held at Hadley Wood Golf Club on Thursday, 1st October 1953. Twenty-eight players participated, and brilliant weather prevailed throughout the day.

The morning Medal Competition was won by Com'r(E) J White, D.S.C., R.N.(ret.), with a net score of 70, and he received a clock. Messrs. H. E. Upton, O.B.E., and J. A. Rhynas tied for second place with 75, but Mr. Upton won on the best score for the last nine holes.

In the Bogey Greensome Competition in the afternoon, Com'r J. S. Osborn, R.C.N., and Mr. H. E. Upton came in first with 2 down; Mr. J. A. Rhynas and Com'r J. White came in second with 3 down. As no member could take more than one prize, Mr. Upton elected to forego the second prize in the morning, and to accept the first prize in the afternoon with his partner, and they received whiskey flasks; this gained Mr. Rhynas the second prize in the morning, which was a vacuum jug. Similarly, Mr. Rhynas and Com'r White could not take the second prizes in the afternoon, and this brought in Messrs. R. K. Craig and H. R. Humphreys, who were third with a score of 5 down, into second place; they received sets of heat-resisting trays.

Mr. Robertson, the Convener of Social Events, called upon Mr. Stewart Hogg, the Chairman of Council, to present the prizes during the tea interval. Subsequently, Mr. Robertson proposed that a very hearty vote of thanks be accorded to the Committee of Hadley Wood Golf Club for the arrangements which had been made for the meeting, and particularly to the Steward and the catering staff who had prepared such an excellent lunch and tea. This was carried unanimously. Grateful thanks were also accorded to the donors of the prizes, Messrs. F. P. Bell, R. K. Craig, C. P. Harrison, G. T. McIntyre, P. R. Masson, J. M. Mees, J. A. Rhynas, A. Robertson, W. Sampson, C. C. and P. C. Speechly, W. Tennant, H. E. Upton and R. M. Wallace.

Mr. Robertson observed that from several remarks which had been made to him, the Hadley Wood Golf Course appeared to be the most popular selection for meetings of the society.

A suggestion was made, and would be submitted to the Social Events Committee in due course, that members should be allowed to bring visitors to the meetings. This idea was very strongly opposed by one member. It was also suggested that the local sections should be informed of the golf fixtures in the hope that parties from the provinces might attend, and it was decided in future to send notices of golf meetings to the local honorary secretaries.

The meeting terminated with a vote of thanks to the Convener and Committee and particular reference was made to the care and attention which Miss Wood had devoted to these meetings since their inception.

Membership Elections

Elected 21st September 1953

MEMBERS

William Allin, Lieut.(E), R.N.
Hedley Albert Amos
P. B. L. J. Beertsen
Aaron Sassoon Benjamin
Charles Bie
Barin Chuckerbutty
Norman Fox Coleman
Digby Leonard Hearn Collinson
Jack Critchley
Charles Augustus Davies
Leslie Frost
Albert Alexander Hay-Mackenzie
Edgar James Jones
Harold Stanley Keay
Hector McWaters
Robert Miller
Alexander Ernest Munro
Herbert Murnaghan
Walter Smith
Knowles Stannard
John Walton Stephenson
Richard Young

ASSOCIATE MEMBERS

John McIver Livingstone
Stanley Harold Moore
Ronald Stewart Punt
Dennis Henry West, Lieut.(E), R.N.

COMPANIONS

Frederick William Newbatt
Sir George Leighton Seager, Bart., C.B.E., D.L., J.P.

ASSOCIATES

Ambrose William Abbott
Sudhindra Kumar Basu
Alexander Robert Gower Borrill
John Alexander Carson
Thomas Cornock
Thomas Curphey Corteen
Stanley William Dickenson
Bachaspati Goswami
Norman Clive Green
William Gardiner Hair
James Harold Hall
Keith Lefevre
Hughie Austin Lohrmann
Victor John MacLeod
Gerard A. McGuire
Tahil Teckhand Mansukhani
William Arthur Oxford
Kenneth James O'Neill
Edward Arthur Pickering
Charles Pinto
Konda Trivikrama Raju, Sub. Lieut.(E), I.N.
Andrew Beattie Scrimgeour
James Paul Sewell
Syed Ghulam Qadir Shah
Ian Sherriff
John Albert Smith
Norman Stewart
Peter Haswell Tyler
Orestis Valassakis
Neville C. Williams
Robert William Wood
Malcolm Joseph Wylie

GRADUATES

Peter James Ogden
Joseph George Scott

STUDENT

Jamshid Munchershaw Jall

PROBATIONER STUDENT

Gerald David Ashley

TRANSFER FROM ASSOCIATE MEMBER TO MEMBER

Harold Yeoman Mosey

TRANSFER FROM ASSOCIATE TO MEMBER

John Robert Armstrong
John Bremner Bremner
Howard Rivers Deeks
Albert Henry Eddy
William Francis John Dunlop Ewart
Joseph Bray Gilbertson
Norman Walter John Henney
Nathaniel Afolabi Pearse

TRANSFER FROM STUDENT TO ASSOCIATE MEMBER
Paul Eric Bass, Lieut.(E), R.N.
Harry Graham Julian, Lieut.(E), R.N.

TRANSFER FROM STUDENT TO GRADUATE
Tirloki Nath Bhargava, B.Sc.(Durham)

Elected 12th October 1953

MEMBERS
John Henry Birtwhistle
Kang Yue Chang
Brijendra Nath Chaturvedi
James Gemmell
Charles Newbold Graham
Samuel Henry Henshall, B.Sc.
Robert George Hogg
William Gilbert Liley
William McConkey
Charles Harry Taylor-Cook, B.Sc.
Kiyoji Tanaka
Ernest Edward Thaxter, Lt. Com'r(E), R.N.

ASSOCIATE MEMBERS
Rowland Cyril Judah Seider-Benson, B.Sc.
Maurice Frank Hughes
William Richardson

COMPANION
Edmund Hannay Watts

ASSOCIATES
Iain Macpherson Anderson
Geoffrey Harry Banks
Edward Henry Barth
John Frederick Birch
Michael Joseph Ogugua Bosah
Chitta Ranjan Chowdhury, Lieut.(E), I N.
Laurence Olaf Christensen
Benjamin Stewart Clark
George Henry Crooks
Hugh Francis Evans
Jack Davidson Garrett
William McNish Inglis
James Lindsay
William Archibald McLure
Douglas Saunders Marsh-Jones
John Anthony Merry
John Reginald Mitchell
John Spence Oswald
John Alfred Powell
William Robert Vickery
Chia Sung Yang
Colin Frank Young

STUDENTS
Martin Victor Elliston
James Philip Jones

PROBATIONER STUDENTS
Peter Arthur Adler
Eric Cyril Avery
James Anthony Beaumont
John Charles Beland
Brian Boughtflower
Alan Arthur Charles Brewster
Brian Sidney Brown
Bryan Leslie Cackett
Thomas William Cripps
Alan James Cruickshank
Alan George Dean
Peter Brian Deane
Edward Alan Dinsdale
William John Duce
Kenneth Douglas Dunn
Ian Walter Edmondson
David John Fenwick
Spencer John Flynn
Michael John Gibbons
Malcolm Kenneth Gilbert
Brian Richard Goodchild
Derek Gurr
John James Hole
Colin Howard
Bernard Leslie Howe
David Leslie Edward Johnson
Nicholas Bill Knowlton
John Mason
Neil Lucas Mattin
Anthony Francis Mears
Alan Walter Nash
James Wilson Pond
John Lauder Powell
Anthony Humphreys Roberts
Alfred Edward Rowell
Brian Roland Sangster
Roy Slee
Peter McIver Baldwin Stone
Ronald Cyril Frederick Thomas
Gerald Peter Warn
John Graham Watson
Peter John Webb
John Frederick Wolfe

TRANSFER FROM ASSOCIATE TO MEMBER
David Calvert Ellis

TRANSFER FROM GRADUATE TO ASSOCIATE MEMBER
George Ronald Baldock

OBITUARY

HIRAM ROOKE HOULDIN (Member 3077) was born in 1873. He served an apprenticeship with J. H. Wilson and Company of Liverpool and in 1897 joined the Leyland Line; he obtained a First Class Board of Trade Certificate in 1900 and from 1908-16 he sailed as chief engineer in the company's ships. Before leaving the Leyland Line in 1916, he had superintended

the building and installation in Glasgow of the first marine Diesel engine; he served as chief engineer in this ship during her first two voyages to the West Indies.

In 1916 Mr. Houldin was appointed superintendent engineer of the Glen Line, a position he held until 1936, when the company was taken over by Lamport and Holt, Ltd., and he retired. He died in August 1953. He had been a Member of the Institute since 1916 and served on the Council for three years, from 1918-20.

MATTHEW FLANAGAN (Member 1908) was born in 1871. He served an apprenticeship with the Maryport and Carlisle Railway Company and first went to sea in 1892. In 1894 he began his long service with Alfred Holt and Company by joining the *Ixion* as fourth engineer, and was promoted third engineer of the same ship in 1895. In 1898 he was appointed second engineer of the *Tantalus*. He remained in that ship until 1905, when he was transferred to the *Oopack,* one of the old China Mutual Steam Navigation Company's ships, as chief engineer. In 1913, he became chief engineer of the new ship, the *Lycaon,* and remained with her until his retirement in 1931.

Mr. Flanagan was a well known character and very popular; he was thought by many people to be the original of the chief engineer in the novel by J. J. Abraham, "The Surgeon's Log". He died on 1st November 1949, having been a Member of the Institute since 1906.

WALTER GARRIOCK (Member 9481) was born in 1911. He was apprenticed with R. and H. Green and Silley Weir, Ltd., at the Royal Albert Dock from 1927-31, and attended the Poplar Technical College during these years. He joined the Commonwealth and Dominion Line as a junior engineer in 1931 and served that company until 1936 when he resigned his appointment as third engineer to come ashore. He obtained a First Class Board of Trade Certificate, with a First Class Motor Endorsement. He volunteered for sea service at the outbreak of war, however, and served with the Royal Fleet Auxiliary from 1939 until the end of 1943, when he was appointed second engineer with the Anglo-Saxon Petroleum Co., Ltd. He was later promoted chief engineer and remained with the company until he was invalided out in 1952; from then until his early death on 6th February 1953, he was site engineer with the Rimer Manufacturing Co., Ltd., at Louth. He leaves a widow and four young children.

Mr. Garriock was elected an Associate of the Institute in 1942 and transferred to full membership in 1949.

DAVID HAIR (Member 5964) was born in Glasgow in 1893. He was educated there at Allan Glen's School and the Royal Technical College. He served an apprenticeship with D. and W. Henderson, Ltd., of Glasgow, and after five years during the first world war as an artificer in the Royal Navy, he joined Alfred Holt and Company as an assistant engineer in 1919. He was promoted chief engineer in September 1942 and completed his last voyage in the m.v. *Automedon* in March 1953; he was at home on leave prior to his retirement at the end of April, when he died on 26th April.

While serving in the *Memnon* during the second world war, the ship was torpedoed but Mr. Hair reached the African coast safely in one of the two boats which survived. Later, he served for a time in the Mediterranean and was in many convoys to Malta; for his services during these years he was awarded the M.B.E. in the 1943 New Year's Honours.

Mr. Hair was elected to membership of the Institute in 1928.

GEORGE EDWARD HARWOOD (Member 7829) was an apprentice with the Central Marine Engine Works, West Hartlepool, from 1918-25. He started his sea career by joining the Prince Line, Ltd., as a junior engineer in 1925; he served in the company's ships until 1946 and as chief engineer from 1937. He obtained a First Class Board of Trade Certificate in 1931. In 1945 Mr. Harwood was chief engineer of the s.s. *Samtucky* when she was torpedoed in the Atlantic; the ship was not a total loss and as a result of the initiative shown by the officers and men she was sailed to Halifax, Nova Scotia, where she was made seaworthy again. For his part in this venture, Mr. Harwood received the Brave Conduct Medal and Oakleaves.

He left the Prince Line in 1946 to take up a shore appointment with the Nitrogen Fertilizer Company, Flixboro, which he held until his death on 28th May 1952. He had been a Member of the Institute since 1935.

FRANCIS HENRY PECK (Member 5611), born in 1886, died suddenly on 18th March 1953 in the garden of his home at Hessle, East Yorkshire. He served an apprenticeship with J. H. Fenner and Company and Earles Shipbuilding and Engineering Company, both of Hull, and this was followed by five years as engineer-in-charge of a saw mill. In 1913, he joined the engineering department of Reckitt and Sons of Hull, but enlisted on the outbreak of war in 1914 in the Royal Engineers, and was gazetted inspector of ordnance machinery at Woolwich, with the rank of lieutenant, in 1917. Returning to Reckitt and Sons in 1919, he supervized the construction of the company's works and dwellings at Choisy-le-Roi, France, in 1921. There followed in 1923 the supervision of the construction of the first factory to be built for the company in South America, at Santo André, Brazil, where Mr. Peck remained as works manager. After six years he was compelled to resign owing to ill health and he returned to Hull but was able to visit Brazil again in 1933 to supervise the construction of the first altramarine works to be built abroad by his company. From 1934-39 he was once again in Hull, after which he sailed for Argentina to supervize the construction of a factory at Buenos Aires; he returned to Hull in 1945 and, except for one six-months period as manager of the Montevideo factory in Uruguay, he remained there in the employment of Reckitt and Sons until his death.

Mr. Peck was elected a Member of the Institute in 1926.

JAMES ANDREW RUSSELL (Student 12693), born in 1926, was accidentally drowned while canoeing in the Solent on 25th July 1953. From 1942-47 he was a dockyard apprentice at Portsmouth and attended Portsmouth Municipal Technical College, where he obtained an Ordinary and a Higher National Certificate in mechanical engineering and an Ordinary National Certificate in electrical engineering. During 1947 and 1948 he was an engine fitter and turner in Portsmouth Dockyard and, on passing the necessary examination, he was established as a draughtsman. In November 1950, however, he joined the British Electricity Authority as a junior engineer in the construction department and was promoted two years later to general assistant engineer at the Southern Division Headquarters at Portsmouth.

Mr. Russell was an Associate Member of the Institution of Naval Architects, a Graduate of the Institution of Mechanical Engineers, and had been a Student of the Institute since 1949.

JOHN MCPHERSON RUSSELL (Member 11682) was born in 1892. He served an apprenticeship with Fullerton, Hodgart and Barclay, Ltd., Paisley, from 1909-14, and then joined the Commonwealth Government Line, sailing as fourth to second engineer between 1915-20. From 1920-30 he was second engineer in ships owned by Elder, Dempster and Co., Ltd., and then came ashore to an appointment as resident engineer at Standon Hall Hospital, Stafford, where he remained until 1937. Then Mr. Russell joined Andrew Weir and Co., Ltd., as senior second engineer and obtained a combined First Class Ministry of Transport steam and motor certificate in 1939. He was a prisoner-of-war from January 1941 until May 1945 and then returned to Andrew Weir and Co., Ltd., for about two years but was forced to leave the sea owing to ill health. He obtained employment as a shift engineer with J. Lyons and Co., Ltd., in 1947 and continued in their employment until his death on 14th September 1953. He had been a Member of the Institute since 1948.

JOHN MINSHULL VEAL (Member 7269) was born in London in 1889. He was educated at Berkhamsted and then for three years he was a student in mechanical engineering at the Northampton Polytechnic. He was apprenticed with John I. Thornycroft and Co., Ltd., leaving their employment to gain sea experience; he obtained a First Class Board of Trade Certificate in 1916. In 1919 he rejoined John I. Thornycroft and Company, where he served in various capacities, again leaving in 1922 to rejoin the White Star Line, with whom he had already served at sea, when he was sent to Germany on trial trips of the s.s. *Majestic*, with which ship he stayed till 1923 when he emigrated to Canada. He joined the Canadian National Steamships, Ltd., as chief engineer and was for eleven years, from 1927-39, chief of the *Canadian Cruiser*. In 1939 he left the sea to join the firm of German and Milne, naval architects of Montreal, as their chief engineer, and remained with them until his retirement in March 1953; his death followed shortly afterwards.

Mr. Veal had been elected a Member of the Institute in 1932.

WALTER STEPHENSON (Member 8969) was born in 1895. He served an apprenticeship with the Mersey Docks and Harbour Board from 1911-15 and this was followed by four years in the Royal Navy during the first world war. He was first employed in June 1919 as an assistant engineer by Alfred Holt and Company, in whose service he continued throughout his career, and was promoted chief engineer in June 1940. His last foreign voyage in the *Glenearn* was completed in April 1949 and was followed by a long and painful illness which ended in his death on 24th June 1953. Mr. Stephenson was elected a Member of the Institute in 1939.