Innes George Lumsden, c/o U.S.H.D. Insurance Company, Lossiemouth, Scotland.
George Semark Miskin, c/o Thos. Cook and Co., Ludgate Circus, London.
Wm. Allan Peel, 51, Wargrave Avenue, Stamford Hill, N.15.
Claude, Plowman, Dorrigo, N.S.W.
George Fenwick Robson, 45, Beacontree Road, Leytonstone, E.
George Shields, 142, Sheringham Avenue, Manor Park, E.12.
Leslie Stanley Sims, 37, Salisbury Mansions, Harringay, N.15.
Edwin Chas. Talbot, c/o Port Talbot Graving Co., Ltd., Port Talbot.
Thomas Venables, 46, Park Road, Barry, Glam.
Edmund Williamson Woodward, 161, Hatherley Gardens, East Ham, E.6.

*Associate-Members.*

Norman Allison, 11, Kensington Terrace, Sunderland.
Wilfred Hall, 26, Ellison Place, Newcastle-on-Tyne.
Norman H. R. Lester, Manor House, Kettering, Northampton.
Joseph M. Micallef, 33, Caulfield Road, East Ham, E.6.
Christopher Leonard Story, 39, Torquay Drive, Leigh-on-Sea.

*Graduates.*

Harry Frederick Adie, 39, Belmont Gardens, West Hartlepool.
John Ritchie Spiers, 19, St. Margaret's Road, Manor Park, E.12.

*Transfer from Associate to Member.*

G. E. Walker, 63, Dover Street, Crumpsall, Manchester.

---

## SPECIAL NOTICE.

An Extraordinary General Meeting of members will be held on Thursday, May 12th, at 6 p.m., in the Lecture Hall, when a Resolution will be submitted in accordance with the regulations to increase our membership to 3,000.

A meeting will be held on Thursday, May 26th at 6 p.m., to confirm the Resolution.

# THE MANUFACTURE OF HIGH-CLASS MARINE PROPELLERS.

*The following concluding remarks of Mr. G. J. Wells (the Chairman) should have followed Mr. Lambert's lecture on page 470 :—*

The CHAIRMAN : It seems strange that so few of you are ready to speak on this subject, because if there is one subject more than another that leads to controversy, not to say trouble, it is the propeller problem. The shapes of the blades are many and various, and I believe I have heard it said more than once by competent authorities that the best is not much better than the worst, if the worst is not better than the best. That is probably one way of calling attention to the wide variation of shapes of blade. I recall on one occasion that a party went to Oxford in a small torpedo boat which did not draw much water, but it cut up the river bottom and crumpled up the blades badly. The engines at the start of the trip made the required speed at about 200 revs. per minute, but when we came home we were doing about quarter speed, and the engines were running much faster than usual. When we examined the propeller we found that the steer blades had curled up round the boss of the propeller, so it looked like a possible design for patenting for use in mud and water. The mystery was that the propeller ever sent the ship ahead at all. The most interesting thing to me was the success Messrs. Stone's have achieved in the foundry. There are no more conservative people than founders. You may try and persuade them that you know something but you will never convince them that you do. Stone's seem to have achieved the impossible, because, as I understand it, they send out a specification to the foundry to show the exact mixtures to employ and the temperatures that must be employed in order to meet the ship owners needs in the most efficient manner possible. All this is rank heresy, and if you acted in the ordinary foundry once, and in this manner, it required a brave man to repeat the process. But at Stone's they watch the foundry and see that they get their directions carried out. There is another point—heat treatment. It is one thing to specify the exact quantities of each metal required to form the alloy required in the finished propeller, but to obtain this result it is necessary to allow for wastes due to the more volatile ingredients being boiled away in the cupola. The regulation of the temperatures attained, the temperature of pouring, the rate of cooling are vital points that must be attended to that the required structure be attained. All this Messrs. Stone's appreciate, and have achieved the impossible in teaching their foundry employees its importance

also. This point to me seems to be a step in the right direction. If you take an interest in the foundry and in the pattern shop you may achieve more there than is usually possible in the modern machine shop. Another point that will, I think, be of interest to some of the members and others is the microscopic side of the question. There is no question that in the case of nine men out of ten, when you speak of the microscopic structure of metals, you are talking Dutch or Hebrew to them; they do not understand. Probably they would understand Dutch better. Perhaps Mr. Lambert would not mind if I tried to crystalise that part of the subject. One knows that if one has a solution of a salt and you cool it slowly, certain crystals will fall out. If you could freeze it solid at that instant you would have a structure such as frozen water or ice with crystals embedded, etc. In the case of the metal, as the liquid mass cools, different crystals are formed as the temperature falls, so that by cooling slowly or cooling suddenly, different arrangements of crystalline structure from the same charge can be obtained, and each of these structures corresponds to a definite set of mechanical properties. As an illustration, take the operation of hardening and tempering of tools. A chisel is required, the smith, after shaping it from a pat of steel, heats it to a bright red, and then dips the business end for about $\frac{1}{2}$ in. into water, cooling it; after this operation it will be found to be very hard and brittle. Next the end is brightened by rubbing it with a stone, and as the temperature rises the bright surface will become coloured, first yellow, followed by deepening shades, until finally it becomes a deep blue. Each succeeding tint indicates an increased temperature, and increased softness. If it is plunged into water and completely cooled at one of these tints it will have been slightly softened or its hardness will have been "tempered" or lowered so that the tool will stand up to its work. All this is perfectly familiar to every engineer, as a description of a very usual shop process; also equally familiar is the vexatious results that often follow. One chisel will last for hours, whereas a second brakes after a few blows, although the chisels were made from the same bar of steel by the same smith, and hardened and tempered at the same time. Why is this result attained so frequently? The study of the crystalline structure of metals with the aid of the microscope has practically answered this conundrum as well as many others. The steel is a solid solution of iron, carbon, and certain other substances, and the hardening and tempering process just detailed is a very

crude and rough process of obtaining the crystalline structure corresponding to the degree of hardness required. This structure is obtained by raising the temperature to that at which the particular state of crystallisation necessary is possible, and then by suddenly cooling it before any further modification can occur. Then by means of a pyrometer and properly constructed muffle furnace, the hardening and tempering of tools has been reduced to a precise science.

It has been claimed by some workers that it is quite possible to predict the qualities of the metal if the area occupied by the several constituent crystals be estimated, allowance being made naturally for their condition, when examined by means of a suitable microscope.

This matter was referred to in a paper read before the Institution of Naval Architects some three or four years ago by Prof. W. E. Dalby, in which some particulars of this method of dealing with the matter were mentioned. It was blessed by Dr. Carpenter, and so I suppose there is something in it. One feels the want of confirmation of these things. We could get a certain distance by examining small specimens, but we want to know what will happen on the large masses handled in the shop. The author mentioned also the subject of aluminium propellers. I was hoping he would have said more about that, because I have had worries in regard to aluminium castings. We came to the conclusion that there was in our foundry only one man who could successfully cast aluminium. He was a provoking man. The foreman took him out one Saturday night and treated him very liberally, hoping that eventually he would learn something about casting aluminium, but he was one of those men who became sentimental and could not talk shop at all under that treatment. It was very annoying, because whenever this man was away, if any aluminium casting had to be made the proportion of wasters was high. The moulder who deputised was a skillful man with both brass and iron but he could not get sound aluminium castings, and I was wondering if Mr. Lambert was going to take the lid off the secret of this part of the process and say something good for aluminium propellers. Mention has been made of the machinery of these propellers. I have forgotten the details of the machine at Messrs. Stone's: but there is no question that the problem of machining a propeller is a very difficult proposition. For propellers may have variable pitches, and frequently curved blades, then the

thickness of the blades must vary from almost a knife edge at the edges to quite considerable amounts where it meets the boss, and taking these factors, as well as others not mentioned into consideration, one can easily understand why it is that most makers are quite content to rest satisfied with hand finishing by means of the chisel and file.

Altogether, Mr. Lambert has placed on record in our "Transactions" a very valuable account of propeller manufacture as carried out by Messrs. Stone, a firm who evidently intend to continue to deserve the very high reputation they now enjoy for placing the best possible propeller at the disposal of the Marine Engineer. We thank Mr. Lambert for his paper and time; also Messrs. Stone's for according him the opportunity of dealing with their methods.