ALUMINIUM-BASE BEARING ALLOYS

LIGHT METALS

DECEMBER 1945

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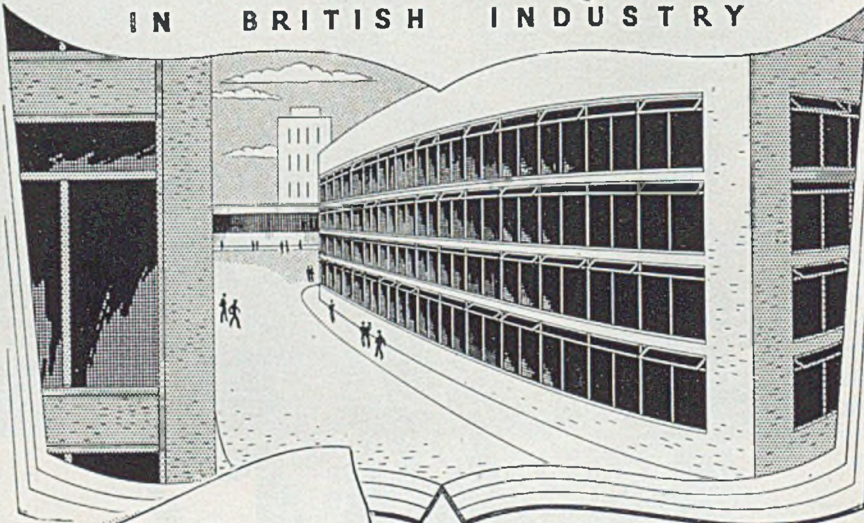
A New Chapter

IN BRITISH INDUSTRY



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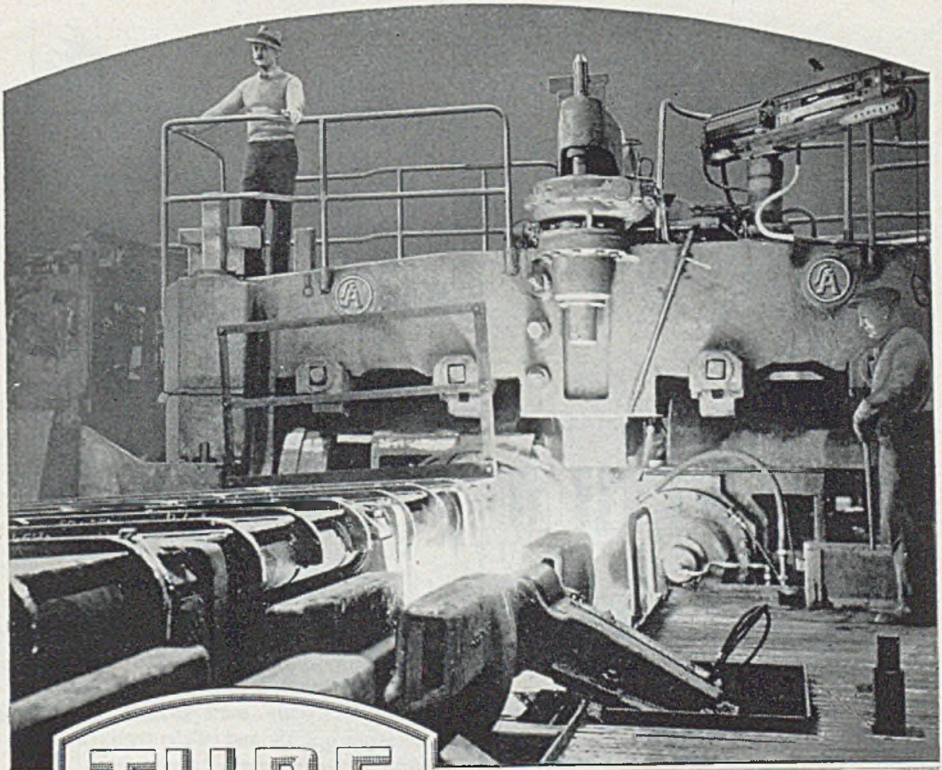

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VOL. VIII. No. 95 DECEMBER, 1945

LIGHT METALS

Proprietors:
TEMPLE PRESS LTD.

Managing Director:
ROLAND E. DANGERFIELD

Dealing Authoritatively with the Production, Uses and Potentialities of Light Metals and their Alloys

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EDITORIAL OPINION

What! No Aluminium?

HAPPY days they were! Machine shops loaded to capacity and working day and night, contract departments volubly protesting their absolute inability to cope with fresh work, rough stores bulging with bar and sheet stock of all kinds, a constant stream of lorries shipping goods away from the finished stores to every battle front in the world. They were good times. If a machine broke down or if the work's manager wanted a new handle for the mangle, there was always the odd length of material lying around—special brasses, stainless steel, aluminium alloys galore: now it is all changed.

Getting back into peace-time production has brought with it many unexpected problems. Harassed foremen and machine-shop superintendents are beginning to realize that some of the pleasant habits cultivated during the war years are no longer admissible. Those pieces of sheet, tubes, and off-cuts from bars can no longer be found, ready, like ripe fruit, to be plucked when the occasion demands. The luxury of selecting one's pet material from an almost limitless variety has now to be foregone.

We are frequently told that, between the years 1939 and 1944 we enjoyed undreamt of opportunities for becoming acquainted with light metals, their peculiarities, their virtues, and methods of working. How true this is! How our appreciations grew day by day! With what pleasure did we conjure up visions of the peace-time jobs we were going to execute in aluminium! Well, peace is here and, unfortunately, many of us have discovered snags in our day dreaming.

When large orders come along, or should we be associated with a big organization carrying ample stocks, few difficulties are likely to arise when we require that small but vital piece of light metal, maybe for an unusual maintenance job, or, possibly, for some prototype, the responsibility for the manufacture of which has suddenly been thrust upon us by an important client. But the smaller manufacturer, not organized, perhaps, for large-scale buying, often exists (and, in most cases, quite satisfactorily), on a hand-to-mouth basis.

Go to any fair-sized industrial town, Luton or Watford, for example; there are hundreds of small factories in and around these areas, some with machine shops, some without, and it is quite customary, when sheet or rod or tube is required, to send the boy out to buy it from the engineer's sundriesman around the corner. Admittedly, choice is somewhat restricted: brass, one or two grades of carbon steel and copper sheet can be acquired in this way; but what if during the war years a taste has been acquired for aluminium? That taste is likely to go unsatisfied, for, in general, it is, at present, not possible to purchase light alloys in this way.

We are not stating here a hypothetical case, but one which has occurred very frequently during the past three or four months and shows every sign of increasing as existing stocks of light alloy which may remain on manufacturer's premises become exhausted. We hear of small factories reluctantly turning over to cadmium-plated steel for minor lots of wireless chassis. They would rather use aluminium, and have said so quite definitely, but cannot obtain it through their accustomed channels. Brass rod is frequently found once again coming back into favour, solely because the aluminium rod which had displaced it during the war years is no longer on tap. Aluminium alloys have become popular in the machine shop, there is no doubt about that, and, in a host of instances, their passing (temporary, we hope) is viewed with the deepest regret.

The storage and sale of aluminium may, we admit, entail careful consideration of some special problems, but it is questionable whether or not in the past these have been viewed in too serious a light. The engineer, in critical jobs requiring the special brasses, or bronze to tight specification, buys these through specific channels. Ordinary yellow metal, however, was purchased in immense quantities from the small stockist (even from the ironmonger), as also was mild steel or black plate. For holding special grades of aluminium and certain alloys, it is realized that authorized warehouses will still be required, and, from these, a customer, particularly a smaller manufacturer, should be able to requisition his material, cut, maybe, very close to size in order to ease machining problems and diminish waste. One such warehouse at least should be located in every industrial centre of note, where circumstances permit.

It would seem desirable, however, in addition, that the better-equipped engineers' stockist should also be given an opportunity of handling this business, for, in all probability, he has, ready created, a wide market for its disposal. In addition, much good might be done by ensuring that the smaller dealer also held his quota of ordinary grades in the usual forms, together with, say, an assortment of chill cast rod, tube and section in some of the cheaper and more popular secondary alloys. Experience has taught us that problems of corrosion in storage rarely arise. We have, for example, 16 specimens of 18-gauge aluminium sheet, which, between the years 1925 and 1935, were kept, together with brass castings, higgledy-piggledy, in a bin in the rough stores of a London engineering works. From 1935 to the present time, they have been living very comfortably with an odd assortment of copper rivets, wire nails and brass washers in an attic next to the water tank. Test pieces of light-alloy rod have been stored in contact with steel since 1930 in a chicken run. No corrosion of any importance has occurred in either instance, but the steel has rusted away. Finally, customers can, as a rule, be relied upon to use their material in a sane manner.

Contents

"LIGHT METALS" is published in London, England, on the fourth Thursday of the preceding month.

SAVE PAPER.—Waste paper is still required to manufacture into a thousand forms for our Navy, Army and Air Force overseas.

ALUMINIUM-ALLOY BEARINGS

Account after Deck, Neuhausen, on the Development, Properties, Uses and Advantages of Aluminium-base Alloy Bearing Materials. Translated from "Technische Rundschau," October 6, 1944, No. 41, and October 13, 1944, No. 42

EVEN prior to 1939, Switzerland, in common with some other countries, had begun the development of bearing alloys based on aluminium. Three compositions were introduced—La 11, La 21 and La 31. These three grades differ in working qualities and in mechanical and physical properties, and one or other is selected according to service requirements.

Alloy La 11 consists of aluminium with small quantities of magnesium and zinc; it contains no additions which are not readily obtainable in Switzerland.

Alloy La 21 is the eutectic aluminium-silicon alloy with additions of copper, nickel, manganese and magnesium; the copper and nickel contents being about 6 per cent.

Alloy La 31 again consists of aluminium with about 8 per cent. of tin, plus copper, plus nickel, together with some magnesium. The medium-hard alloys, La 11 and La 31, are similar to each other in possessing good running qualities and good resistance to edge pressure.

Alloy La 31 is preferred to La 11 when it is impossible to give the bearing surface a high finish and when it is not expedient to run the bearing in gradually under load.

If required, the mechanical properties of these alloys may be considerably increased by suitable heat treatment, the results of which may be deduced from Table I. Thus it may be seen that the greatest strength can be obtained with the hard bearing alloy La 21; the rubbing or running qualities of this alloy are also excellent, but its resistance to edge pressure is lower than that of the other two alloys on account of its greater hardness. The thermal expansivity of La 21 is comparatively low, and this is very advantageous.

In Fig. 1 are presented coefficients of thermal expansion for various materials, including cast iron and steel. Alloy La 21 has approximately the same coefficient of expansion as bronze and is used mainly for bearings subjected to shock and high load. It is also employed for metalling cast-iron bearing housings operating at high temperature. None of these three alloys is markedly affected by heating such as is likely to occur in normal operating ranges.

Fig. 2 shows hardness of bearing materials of various types up to 200 degrees C. It will be observed that hardness decreases to any notable extent only above 150 degrees C. However, in the case of aluminium-base bearing metals, the deterioration which occurs is by no means so pronounced as that which takes place with a tin-base bearing metal (WM80). The three alloys differ considerably in their structure. La 21 follows the classical form, showing hard "bearing" particles (mainly Si) in a moderately hard matrix. La 31, however, exhibits a soft, tin disperse phase in a moderately hard matrix, whilst La 11 shows the homogeneous structure of a solid solution. These physical differences influence "bearing" qualities and, according to the running conditions obtaining, account for occasional trouble due to over-heating.

La 11 has little effect on a steel journal, whether this latter be of the alloy or plain carbon type. If by any chance seizing should occur, a thin layer of aluminium will be found adhering to the journal and can be easily removed. The hard, crystalline particles in La 21, however,

Table 1.—Mechanical Properties of Aluminium Bearing Alloys.

	S.G.	0.2% P.S., tons/sq. in.	Tensile strength, tons/sq. in.	Elongation, %	Brinell hardness
1. Cast material :					
La 11 NHT	2.7	9.5-17.4	22 -28.4	4 -12	35- 45
La 11 HT*		23.6-31.6	28.4-38	1 - 4	60- 85
La 21 NHT*	2.8	28.4-40	30 -44.5	1 - 3	100-120
La 21 HT		40 -49	43 -49	0.5- 3	120-150
La 31 NHT*	2.85	11 -15.8	22 -30	3 - 8	40- 55
La 31 HT		23.6-35	30 -38	0.5- 3	65- 80
2. Wrought material :					
La 11 NHT	2.7	9.5-14	22 -30	14 -22	35- 50
La 11 HT*		27 -31.5	35 -40	10 -15	65- 85
La 21 NHT	2.8	22 -30	31.5-38	2 - 4	80-100
La 21 HT*		46 -58.5	54 -60	0.2- 1.5	130-150
La 31 NHT	2.85	14 -20.5	25 -31.5	6 -12	45- 60

* Qualities recommended. NHT = not heat treated. HT = heat treated.

may in unfavourable conditions, score the journal. The tin inclusions in La 31 do, to a great extent, prevent seizing-up occurring with this alloy, particularly on machines of high capacity. Here, if overloading should occur, the bearing surface will remain usable for some time, the only alteration which occurs being an increase in clearance—a feature which may in certain cases, be of great value.

Aluminium bearings are mainly employed in the form of solid or split bushes. The materials are supplied in the form of wrought rod and tube and as sand and chill castings. La 11 and La 31 can also be produced in the form of cold-drawn tubes in the usual manner. For example, a tube with an outer diameter of 2 ins. and about ⅛ in. thick can be made to an accuracy of ± 0.007 in. on inside and outside diameters; hence, in the case of bearings with large clearances, assembly can be carried out without previous machining. For special purposes, for instance, as a lining in a supporting bearing, La 11 can be supplied in the form of sheet or strip; the cold-worked surface, which possesses good "running" properties is, obviously, ideally suited for a bearing.

Results of Laboratory Tests

The aluminium-based bearing alloys which have been described, together with a number of bearing bronzes, tin-base white metals and special cast irons, have been examined with respect to their bearing qualities on a special testing machine, using forced oil lubrication and a shaft rotating against the specimen to be examined. Test pieces were in the form of solid bushes 2 ins. internal diameter and 4 mm. wall thickness. The maximum permissible loading of a testing machine, 2.6 tons, was not sufficient to cause breakdown of bearings of the usual length, namely, 1¼-2½ ins. For this reason, specimens were chosen of about 6.5 mm. long in order to permit loading up to 800 kg/cm². Even under this high loading it was possible to run some journals at 2,000 r.p.m. (corresponding to a surface speed of 1,520 ft./min.) without trouble; an accompanying illustration shows two bearing rings and the shaft after the test (Fig. 6).

For the comparative test bearings were fine turned with a diamond and clearances were maintained at a uniform value throughout. Temperature on the bearing surface varied between 100-140 degrees C., according to the load, which was increased in stages of 50-100 kg./cm.², starting from 100 kg./cm.² and raised until either the bearing broke down or the maximum permissible loading of the testing machine was reached. The results of the test are listed in Fig. 7. The height of the columns in this diagram corre-

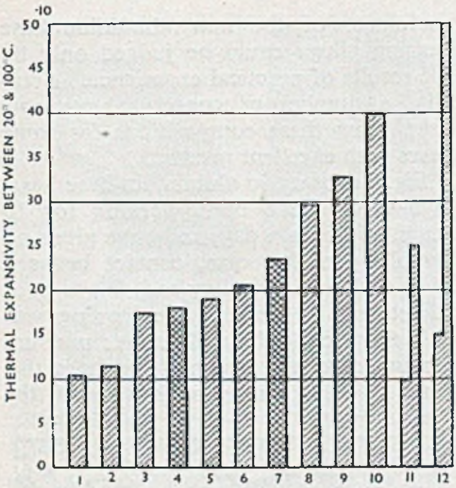


Fig. 1.—Linear coefficient of expansion for various bearing materials between 20° and 100°C. : 1, cast iron ; 2, steel ; 3, bronze (GBz 12) ; 4, La 21 ; 5, brass ; 6, tin-base white metal (WM 80) ; 7, La 11 and La 31 ; 8, zinc ; 9, lead-base bearing metal (Bn) ; 10, zinc-base bearing metal ; 11, laminated plastics ; 12, other plastics (thermal expansivity of 11 and 12 depends on the composition and treatment of the material).

spond to the average maximum load during the test.

It will be seen that the aluminium-base alloys can withstand very high loads, equal, in fact, to those sustained by the two best lead-tin bronzes L and MN. All other bearing materials, including GBz12 and the tin-base bearing metal WM80, broke down under loadings of a very much lower order. Despite the fine machining which was given to it, special cast iron KA 12 proved inferior to the rest of the materials, which demonstrates that the inherent bearing qualities of the material are of importance even if the running surface be scrupulously lubricated and finished to the highest degree of perfection. The tests demonstrate, furthermore, that the aluminium-base alloys possess better running-in qualities than any of the bronzes or cast irons examined. In this regard, however, tin-base bearing metals remained unsurpassed.

Rapid increase in load and careless running-in are sustained better by the aluminium-base alloys than by any of the bronzes examined, this being due, probably, to the better cold working properties of the light-metal compositions, their high capacity for oil adsorption and their good heat conductivity. Without minute examination of emergency running-in qualities, it must be admitted that, in this regard, the tin-base bearing alloys and most of the bronzes are superior to the aluminium-base alloys under conditions of optimum lubrication. However, La 21 in this respect has proved superior to La 11 and La 31. Experience in practice however, has shown that the properties of aluminium-base bearing alloys are, in general, sufficiently good for emergency running-in under conditions of poor

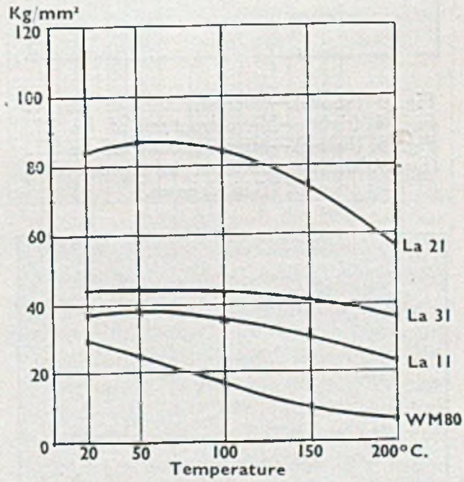
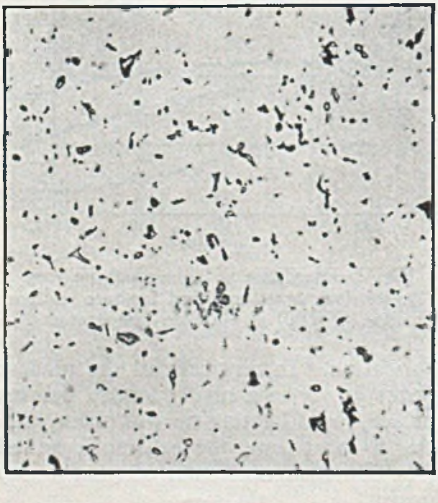


Fig. 2.—Hardness of aluminium bearing alloys (wrought form) and tin-base white metal (WM80) at elevated temperatures.

lubrication. In any case, if the oil film breaks down on a highly loaded bearing surface, rapid heating-up will occur, and, after a short time, the bearing is bound to be damaged, no matter of what it may consist.

Subjected to wear against the rough, hardened surface of a steel shaft under conditions of dry friction in a special testing machine, wear values obtained for the aluminium-base alloys were at least as good as those for the best bronzes (L and S), and La 21 exhibits even greater wear resistance than those bronzes. Bronzes containing higher lead contents (W, W15

Fig. 3 (above).—Microstructure of La 11.
Fig. 4 (right).—Microstructure of La 21.
Fig. 5 (below).—Microstructure of La 31.
(Equivalent magnification in reproduction = × 70 in all cases.)



and MN) wear out more rapidly than any aluminium-base bearing alloy.

Results of Field Tests

However favourable may be the results of laboratory tests, it was realized that the usefulness of the new aluminium-base bearing alloys could be judged only by the results of practical experience. Actually, a number of concerns have now been using these compositions for some years with excellent results.

Fig. 8 shows two aluminium-base bearings which have been working for 10 years, 16 hours a day, and have given no trouble. In this case, contact between shaft and bearing is very bad, due to poor adjustment. Although the loading was only 6 kg./cm.^{2}, the real surface pressure amounted to more than three times this figure. Furthermore, at low speed, the

bearings received little lubrication. In spite of these unfavourable conditions, high pressure at the edges and lack of lubrication, the assembly has been free running and has caused no stoppages in a period of 58,000 hours.

Three bushes from Swiss State Railway goods wagons supplied by Adolf Saurer A.G. are illustrated in Fig. 9. The S.B.B. comments upon its experience of these bushes as follows:—Maximum surface load amounts to approximately 64 kg./cm.^{2} with a surface speed of 600 ft./min. The shafts are of mild steel 55 kg./mm.^{2} U.T.S. For the space of a year now, more than 300 aluminium bushes have been in use, and, more recently, a further 700 have been or are being installed

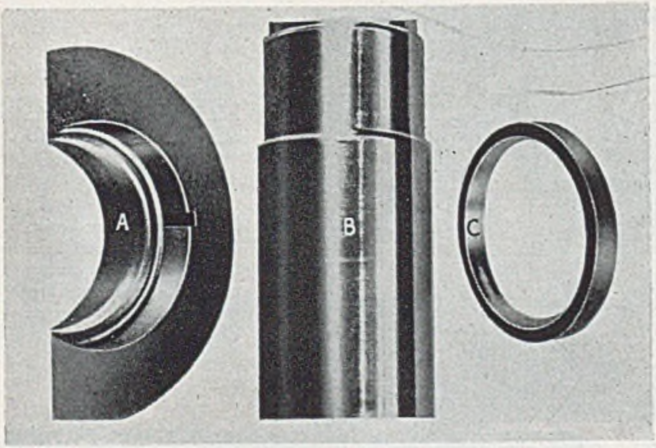


Fig. 6 (above).—Test bearings of La 11 after 20 hours running under load of 800 kg./sq. cm. at 2,000 r.p.m. (1,520 ft. per minute):

A, bearing pressed into housing; B, bearing surface of test shaft; C, rubbing surface of a bearing bush. With the exception of the centre portion, the rubbing surfaces of the bearings have acquired a high polish. Traces of seizing on the shaft are negligible.

Fig. 7 (right).—Limits for specific pressure of various bearing materials.

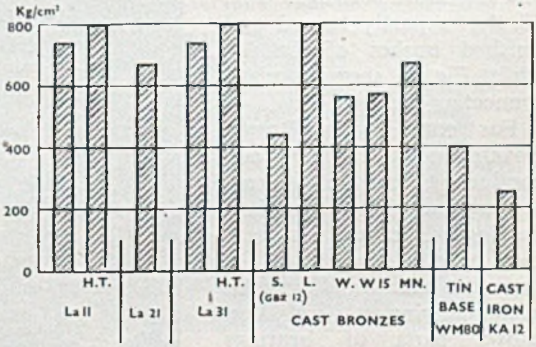
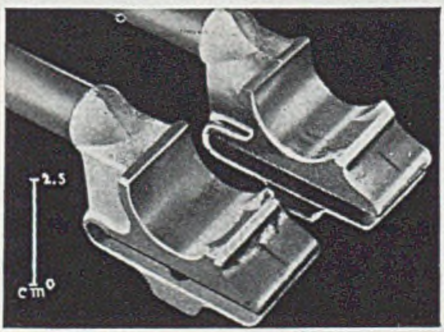


Fig. 8 (below).—Aluminium-alloy bearings after 10 years' use still in good serviceable condition in spite of poor lubrication and high edge pressure.



The aluminium-base compositions have proved superior to bushes with tin-base bearing metal linings, and, so far, no trouble has arisen with undue heating up. Tests in which the oil supply was cut off during the run demonstrated the superiority of aluminium-base bushes as compared to those of bronze with tin-base linings. The aluminium-base alloy did not melt and run as did the white metal. A further test with synthetic-resin bearing compositions showed that these were not suitable for the load and speed in question.

Considerable experience has been gained with aluminium-base bearing metals in automobile engines, and Adolf Saurer A.G. have for the past three years, employed an alloy corresponding to La 31 for main bearings and con.-rod bearings in compression-ignition engines. This concern observes that experience in practice is very good and that aluminium-base alloys will undoubtedly continue to be employed now that the war is finished. On account of the high heat conductivity of aluminium-alloy bearings, these have proved suitable for sustaining the very high loads met with in the modern high-speed high-output engine, where the consequences of seizure in bearings might be very serious.

Junker and Ferber, in Zürich, have also developed aluminium-base bearings independently of Saurer, and have used them in automobile engines of all types. Besides La 31 for main bearings and con.-rod bearings, an aluminium piston alloy, similar to La 31—Novasil—has been used with great success for gudgeon pin

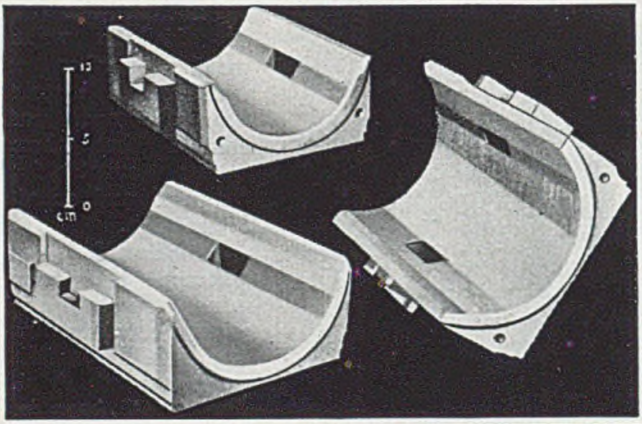
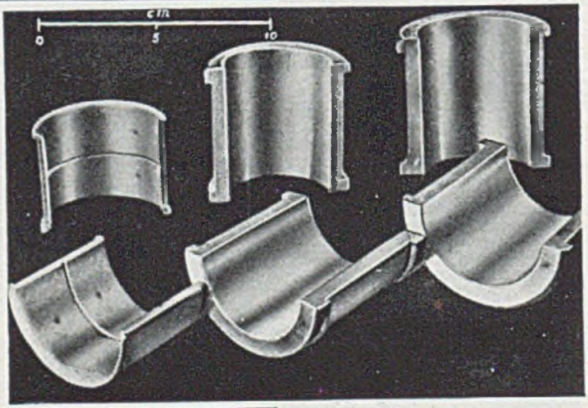


Fig. 9 (left).—Aluminium alloy bushes from SBB goods wagons.

Fig. 10 (below).—Group of rough turned and finished aluminium alloy (La 31) bearings for automobile engine.

and camshaft bearings. Fig. 10 shows partly turned and finished bushes of La 31, whilst Fig. 11 shows Novasil connecting-rod bearings.



For some years Brown Boveri and Co. have been conducting tests on different bearing materials for Michell bearings in steam turbines; they have selected La 31 as the most suitable alloy. An accompanying illustration shows parts of bearings patented by this company. Suitably machined, these bearing segments and cams can withstand loads up to 900 kg./cm.^{2} at surface speeds of 6,000 ft./min., and can, without difficulty, sustain the starting loads occurring with steam turbines. Unlike other bearing materials, La 31, when breaking

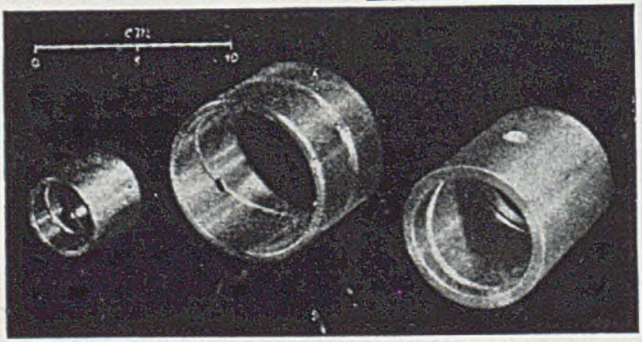
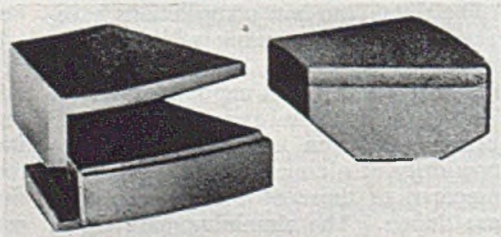
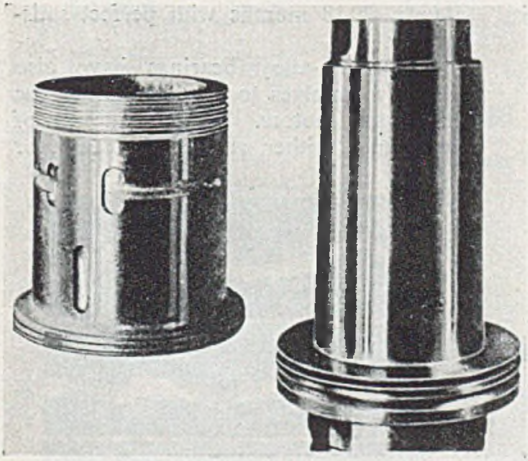


Fig. 11 (left).—Connecting-rod bearings in Novasil for various automobile engines.

Fig. 12 (below).—Michell bearings with La 31 plates.



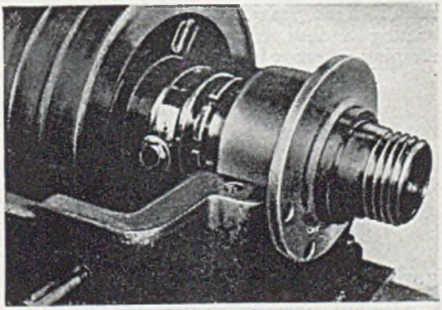


experienced with them. The load in this case amounts to 4.3 kg./cm² at a surface speed of 80 ft./min. Lubrication is by means of oil applied to simple drilled holes which are not particularly dirtproof, or reliable in delivery.

The fact that aluminium-base bearing alloys are also suitable for bearings with very little clearance has been proved by their tentative use for main spindle in lathes.

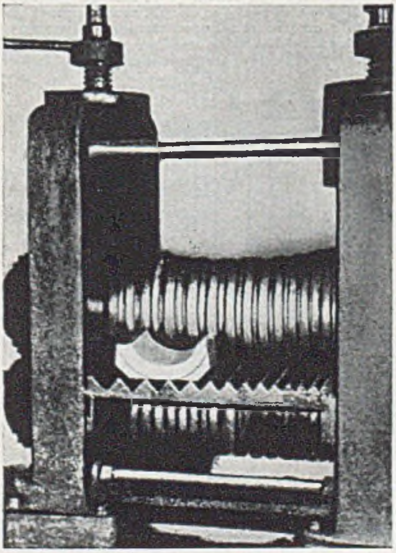
Fig. 13 (left).—La 21 main spindle bearing and tapered shaft of a lathe.

Fig. 14 (below).—La 21 bearing for main spindle fitted to an old lathe.



down, will not affect the comparatively soft and polished steel journal even when very heavily loaded; as observed previously, an aluminium film is formed and may easily be removed. The use of La 31 instead of bronze may represent, in this case, a technical advance.

A manufacturer of textile machinery has had 250 La 31 bushes in use since March, 1943; no difficulties have been



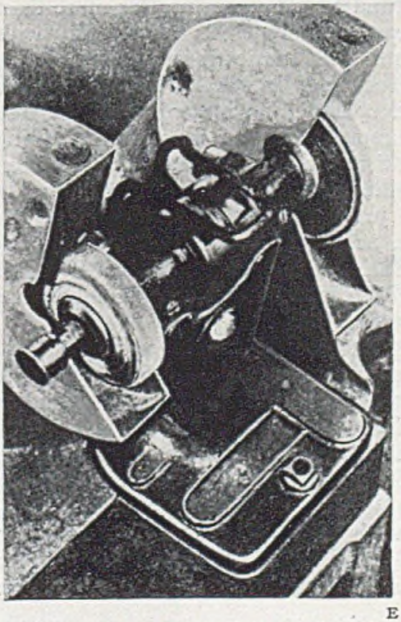


Fig. 15 (above).—Aluminium bearing for rolling mill. Fig. 16 (right).—Grinding machine with three aluminium bearings.

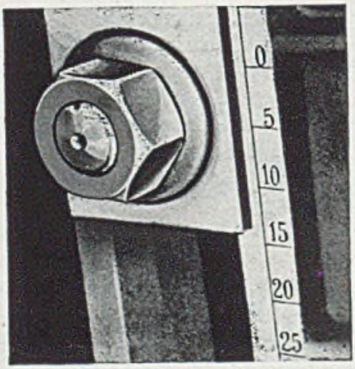


Fig. 17 (above).—Planing machine with aluminium sliding block.

Fig. 18 (below).—Cylindrically bored bearings used in conjunction with a shaft located in an inclined position result in diminished bearing surface (diagram at right); by scraping, effective increase in bearing area is obtained (diagram at left).

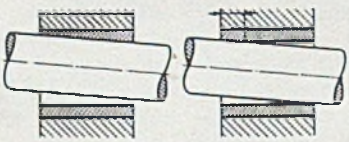


Fig. 12 shows a bearing in La 21 with its conical shaft. Two bearings of this kind have been in use for more than a year, running eight hours daily with pressure oil lubrication; no breakdown has occurred. In one workshop the worn main spindle bearings of an old lathe was replaced by an aluminium bearing with drip lubrication (Fig. 13), since then this lathe has been working one and a half years without trouble. It may be seen, according to this experience, that La 21 is well suited to replace the usual bearing bronzes even for main bearings on lathes.

A number of further uses are illustrated in Figs. 15-17, these show a rolling-mill bearing, and a grinding machine with three aluminium bearings (in this case, lubricated with grease and exposed to highly abrasive swarf). Finally there is shown the sliding block of a high-speed planing machine also made of La 21. In every one of these cases the plant has been in operation for a year or 18 months with perfect satisfaction.

Aluminium-alloy bearings have also shown themselves to be suitable for use on electric motors. Quite a number of these units, either run continuously, or

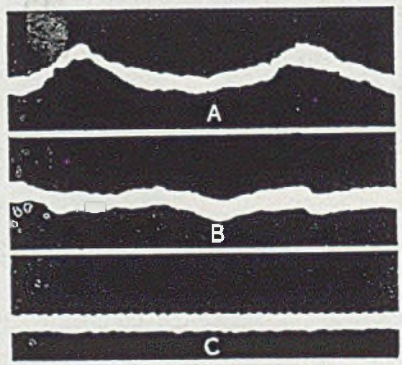
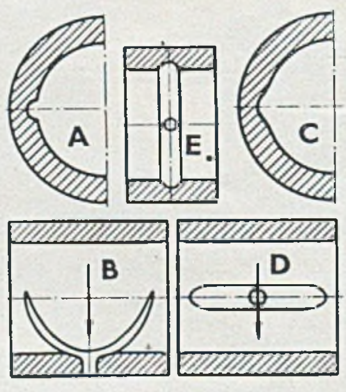


Fig. 19 (above). — Light slot sections through various surfaces by method of Schmaltz (× 70):

A, rough turned; B, finish turned; C, fine turned with diamond.

Fig. 20 (below).—Oil groove design and location:

A, sharp edges unfavourable; B, grooves in areas o load reduce load capacity; C, modern prac.ice with groove well rounded off; D, modern practice with oil groove in non-loaded portion of bearing; E, centre zone ring to be used when all available bearing area is loaded.



frequently switched on and off and reversed, have now been operating with aluminium bearings for well over 12 months and no abnormalities have been observed.

In the case of one workshop, many

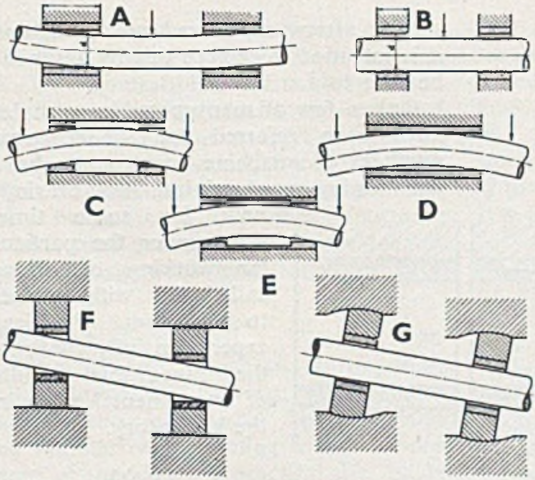
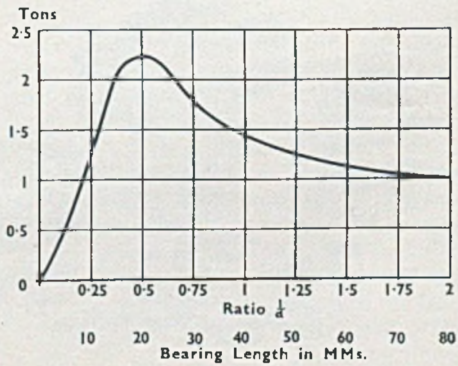


Fig. 21 (left).—Bearing design :

A, D, long bearings, large interval between bearings, flexible shaft; these are factors causing edge pressure; B, modern bearing is short, bearings are placed at closer intervals, shaft is stiffer and edges of bearing are reduced; these factors make for high loading capacity; C, long bearings are preferably divided into two as shown here; E, alternatively the centre of a long bearing may be relieved as here to increase load capacity; F, rigidly built-in bearings result in edge pressure if shaft is inclined; G, modern design of adjustable bearings increases load capacity.

Fig. 22 (below).—Influence of length of bearing on loading capacity (after Falz). Rubbing speed 200 ft. per minute.



machine tools, whilst under repair or modification, have during the past year been fitted with aluminium bearings. The three alloys La 11, La 21 and La 31 have been employed, lubricated with grease or oil and working against shafts in carbon and alloy steels (some merely in the hardened state, others case-hardened). In this instance, the bearings are all working at temperatures below 60 degrees C., and, accordingly, were machined to the same pattern as bronze bearings. In most cases they were fine turned or scraped in the usual manner. To date, their service has been in every way satisfactory.

A flywheel bearing 80 mm. in diameter and 160 mm. long is worthy of special mention. When made of bronze and with

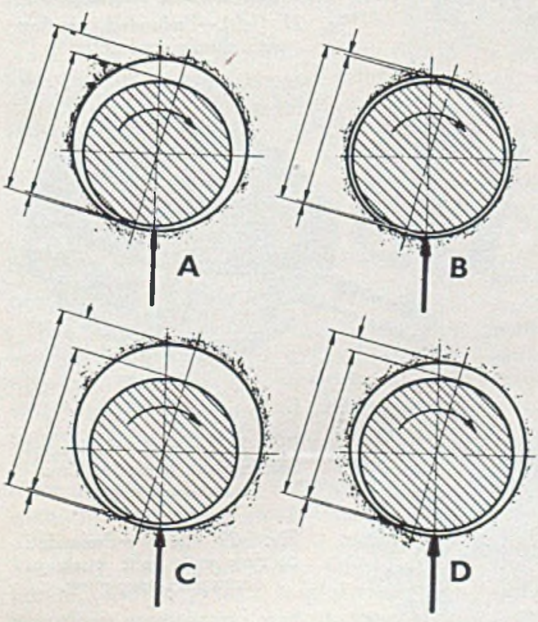


Fig. 23.—Aluminium-alloy bearing bushes for cast-iron houses :

A, room temperature, clearance too small, hence, B, bearing siezes; C, bearing at room temperature with good clearance, hence D, clearance still ample when bearing heats up.

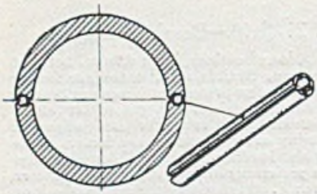


Fig. 24 (above).—Aluminium-alloy bushes fitted in iron housing with tubular spring retainers.

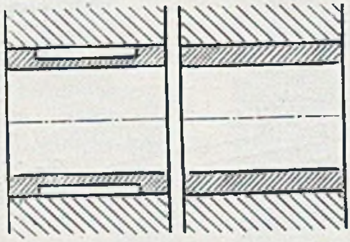
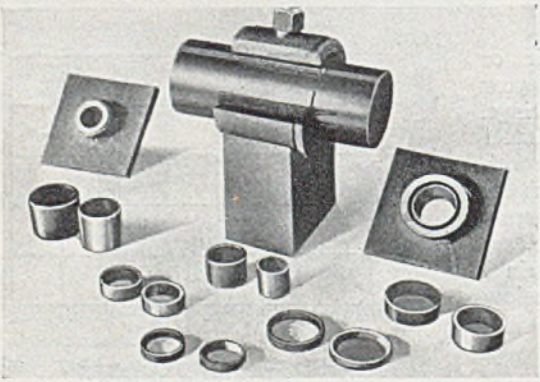


Fig. 25 (right).—Adjacent sketch shows design unfavourable to heat transfer, whilst sketch at extreme right shows design favourable to heat transfer.



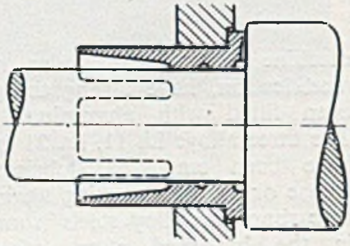


Fig. 26 (above).—Aluminium-alloy bearing for heavy duty with minimum oil supply; the bush expansion keeps the bearing surface well cooled.

Fig. 27 (left).—Preloaded bearing with aluminium liner.

a ring lubrication system frequent interruptions of service were caused by corrosion. Without any alteration in design, therefore, the same bearing was worked up in La 31 and fitted in as an experiment; it was run 16 to 24 hours a day for over a year without causing trouble. Another bronze bearing fitted later to replace an experimental La 31 bearing shortly afterwards seized up again, and it is intended to replace this by a similar bearing to La 31.

Only a few of many possible examples have been referred to, for a great number of machine constructors have been testing out aluminium-alloy bearings now for some time, each under the particular working conditions called for with respect to this plant. Practical experience fully confirms the favourable results of experimental trials in the laboratory.

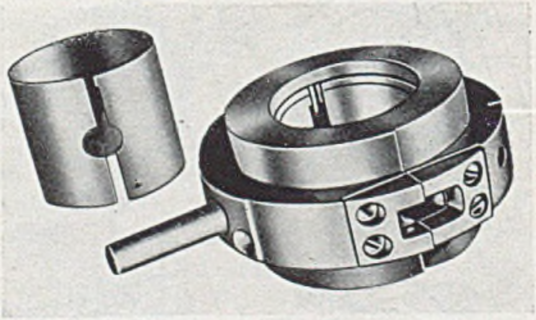


Fig. 28 (above).—Preloaded bearing with bush of aluminium-base alloy.

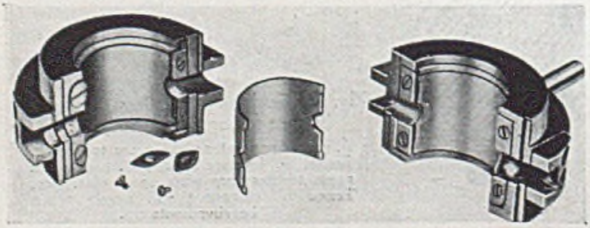


Fig. 29 (left). — Preloaded bearing with split bush of aluminium-base alloy.

Design Recommendations

In any change-over to a new material, it is recommended that design and operating conditions be suitably modified to suit the different properties likely to be encountered with the new material. This is especially necessary in the case of a bearing, and of double importance where such a bearing is heavily loaded. A few suggestions have therefore been developed.

Selection of Material

The varying properties of the three aluminium-base bearing alloys have already been referred to. These will now be summarized according to the importance of the alloys in practical use: La 11 contains no metals such as tin, copper or nickel, which at the moment are difficult to obtain in Switzerland; it is high corrosion resistant, exhibits good adsorbing properties for an oil film, and is relatively low in first cost.

La 21 is suitable for vibratory loads, has a thermal expansivity similar to that of bronze; runs well with minimum lubrication, may in emergency continue in operation even when strongly heated up (although in this case the shaft may be damaged).

La 31 is readily movable, easily run in and resistant to edge pressure, and shows no undue tendency to seize, even with minimum lubrication.

Shaft materials to run against aluminium-base-alloy bearings are mild steel of the usual tensile strength, cast iron, or (for heavy loads) hardened and tempered steel or casehardened steel.

Machining Aluminium-alloy Bearings

The best results are achieved with bearings and shafts of highest surface quality. The bearings are fine-turned with diamond or sintered-carbide tools, employing very small feeds; the journals are fine-ground or lapped. Fig. 19 shows three different surfaces, the sections being each of the same magnification and obtained by the light-slot method of Schmaltz ("Technische Oberflächenkunde," Berlin, 1936). It is obvious that a surface fine-turned with diamond can bear heavier loads than honed or rough-turned surfaces, where comparatively few raised points have to bear the whole load. By careful and extended running in, such imperfect surfaces can be smoothed and loadability increased. However, this procedure is in only very few instances economical.

It often happens that bearings cannot be precisely located; hence the load may be borne by only a small part of the surface as shown in Fig. 18. In this case it is advantageous to scrape the surface, thereby considerably increasing the bearing area. As, however, the degree of smoothness obtained is inferior to that resulting from diamond turning, maximum permissible loading cannot be applied.

Tests with La 11 on the apparatus referred to in the opening paragraphs of this paper showed that scraped bearing bushes broke down under approximately 170 kg./sq. cm., whereas bushes of the same material fine-turned with a diamond tool withstood loads up to 150 kg./sq. cm.

The machining of aluminium-bearing alloys causes no difficulty, provided that the correct cutting angles (clearance and rake angle) and the correct speed (at least 1,250-1,550 ft. per min.) be selected. The wedge or cutting angle should be about 45 degrees for high-speed steel, and 75 degrees for sintered-carbide tools. La 11 and La 31 are readily machined, but La 21 requires some care; the tool material must be of good quality, as La 21 contains hard particles. Both La 21 and La 31 are free cutting.

Lubrication

Any lubricating system is permissible with aluminium-alloy bearings, but oil is preferable to grease. Pressure feed in conjunction with a reliable filter is to be recommended; however, ring or drip lubrication are quite suitable. In the last case, it is suggested that the oil cup be provided with a felt wick. It is sometimes not appreciated that, by leading the oil ducts into grooves which expand in the direction of rotation, it is possible to obtain what might be described as automatic pressure lubrication; even if the oil supply be situated below the bearing level the lubrication will be sucked up. According to Buske and Klemencic (" V.D.I. Zeit.," 1934/87/409), a vacuum of 0.2 to 0.3 atmospheres may be recorded under these conditions, corresponding to an oil column 3 metres high; consequently, the bearing concerned will never lack sufficient oil. Unfortunately, for some reason or other, this method is not often applied.

Lubrication with grease is suitable only for smaller loads, especially if the shaft be oscillating. In this case, contrary to oil lubrication, the load must not exceed 280 lb./sq. in. It is recommended that, for this type of lubrication, a device be designed which permits grease to be forced continuously on to the bearing surface.

The loadability of bearings is greatly influenced by the arrangements of the oil grooves. In Fig. 20, current practice and earlier designs are compared. The occurrence of sharp edges where oil grooves intersect the bearing surface hinders the generation of a coherent oil film; such edges should therefore be well rounded off. An oil groove in the loaded part of a bearing disturbs the development of an oil film, hence load-bearing capacity is reduced and chances of seizing increased. The loaded part of the bearing should not be provided with oil grooves. Bearings that are loaded throughout the periphery should be fitted with a central ring groove for lubrication.

General Recommendations

In most cases, bearings of minor importance subjected to no very great loading can be replaced by aluminium-base alloys without alteration of design, that is, provided that the operating temperature does not exceed about 60 degrees, and, of course, that lubrication is always sufficient and that no chance of serious corrosion attack is likely to occur. Should these antagonistic factors arise or be suspected to exist, then the change over to aluminium-alloy bearings must be considered carefully and, if necessary, investigated by special tests.

The loading capacity of bearings operating under heavy load or at high temperature must, so far as possible, be increased by avoiding edge pressure and by providing for expansion under heat. Thus, Fig. 21 shows a number of possibilities, each of which, by itself or in combination with others, results in a safe bearing even under difficult conditions. It may not always be possible to follow all these recommendations; in any case, however, modern practice recommends that the length of the bearings should not be excessive, a desirable ratio of length to diameter being 0.5 : 1, reducing the length of a bearing to the equivalent of half its diameter will considerably increase loading capacity.

Falz (" Petroleum," 1931/27/16) published an interesting report of his investigations in this connection (Fig. 22). The loading capacity of long bearings decreases as a result of edge pressure caused, first, by bending of the shaft, and, secondly, by normal inaccuracies in the machine base. Narrow bearings, on the other hand, may waste oil at both ends. Falz succeeded in calculating optimum ratios which were in agreement with the results of his tests. If a long bearing surface must be retained it is suggested that two separate short units be employed instead of one long one; alternatively, the bearing surface may be recessed in the centre (Fig. 21). By either method, edge pressure will be greatly reduced. The recess may be used as a reservoir for lubricant.

When a bearing material is fitted into a housing exhibiting small expansion with heat, correct radial clearance must be applied. Fig. 23 demonstrates how clearance changes when operating temperature is reached. If clearance be initially too small, then, sooner or later, the bearing will seize. As clearance is measured at room temperature, a certain factor must be added to account for the different expansivity of housing and bearing. If the bush has a thrust collar, then clearance must also be provided for this.

Numerous suggestions have been made for the elimination of seizing at the joint in split bearings. The easiest way out of the difficulty would seem to be to place an oil groove at the joint and to round the edges. Flexible packing has proved successful in overcoming difficulties in thermal expansion.

To prevent permanent deformation of tight-fitting aluminium bushes in heavy metal housings, the following points must be borne in mind: the aluminium-base alloys La 11 and La 31 can be used in the un-heat-treated condition and without any special precautions for operating temperatures up to 100 degrees C. If heat treated, they may be used up to 180 degrees C. The limits for La 21 are higher than these, viz., 170 degrees C. in the un-heat-treated condition and 250 degrees C. in the heat-treated condition. Difficulties of this sort, however, may be avoided by fitting aluminium-alloy bearings into light-metal housings.

Advantages of High Heat Conductivity

The heat conductivity of aluminium bearing alloys is approximately 0.4 cal./cm./°C., as compared to a figure of 0.13 for bronze, 0.1 for tin-base bearing metal and 0.07 to 0.11 for cast iron. Thus frictional heat is conducted much more readily from the rubbing surface of aluminium-alloy bearings than from those of other bearing materials. Such bearings, therefore, are safer, a point of some importance where heavy loads are concerned. However, gaps, insulating shims or openings which interfere with heat flow or transference must be avoided; for example, heat flow may be hindered by an oil film between the two parts of a split bearing. Again, to avoid any difficulty with heat transfer, the outer faces of the bushes should be in close contact with the matching faces of the bearing housing. Fig. 25 compares a good and a bad design.

Fig. 26 shows a suggestion by Muller, of Schaffhausen, for an efficient bearing operating with the small quantities of oil likely to be provided by a suction system, drip, or wick lubrication, etc. The expansion of the bush beyond the bearing surface by internally milled slots has the effect of fins radiator cooling, especially if air circulation be provided for. By this arrangement the best possible use is made of the high heat conductivity of aluminium-base bearing alloys to cool the bearing surface.

Putting Aluminium Bearings Into Operation

It is recommended that oil grooves and holes be washed or blown out to remove chips, swarf and other foreign bodies. Bearing surface and journal should then be slightly oiled. If the finish of the bearing and its fitting are in order, no running-in should be necessary and the bearings will be able to work under full load immediately. If, however, the bearing surface is poorly finished, or if there be any risk of undue edge pressure, then careful running-in must be adopted; in this way bearings may be obtained which can carry high loads with perfect safety.

Multi-purpose preloadability bearings by Schmuziger (Rüschlikon), for which patents have been applied, may be fitted with little difficulty. As can be seen from Fig. 27, the finished bearing consists of a split and flexible steel ring into which are fitted La 11 bushes with quite thin walls. The tolerance on internal diameter for diameters of 45 to 60 mm. is 0.046 mm., that is, 1 per cent. or less of the diameter concerned. Figs. 28 and 29 show two supporting bearings patented by Brown Boveri. They can be used with a solid or a split bush.

Conclusions

Aluminium bearing alloys may be considered as high-grade replacement materials for metals which are difficult to obtain in Switzerland at the present moment. They are not to be considered as "substitutes" in the commonly accepted sense of the word, for, as has been shown, they have permitted the development of new and improved designs. They have high loading capacity, are relatively insensitive to load variation, and are readily run in (if necessary), have high heat conductivity, are light in weight, are readily machined, show good wear-resistant properties, and are not affected by heat developed in running.

DESIGN FOR THE INDUSTRY

"The spirit of self-reliance is continually discouraged; no wonder it grows faint. Young men returning from the Forces are told that they are to have special training to fit them for 'positions' in the industrial world and arrangements are proposed for lectures, 'courses' and what not. Very few 'positions' are waiting for them, but there are any number of 'jobs' for those who seek them diligently and are prepared to take off their coats and work their own way to such 'positions' as they prove themselves capable of holding. And, be it remembered, the best industrial training colleges in the world are the workshops and the business offices of our industrial enterprises—where the hard and inescapable facts of life take the place of more or less nebulous theories."—ALFRED HERBERT.

AT Claridges, on Thursday, October 25, on the occasion of a reunion luncheon to members of the committee responsible for the first exhibition "Aluminium—War to Peace," at Selfridges, G. H. Friese-Greene read a paper on industrial design and designers in relationship to craftsmanship in light alloys and to the aluminium industry in general.

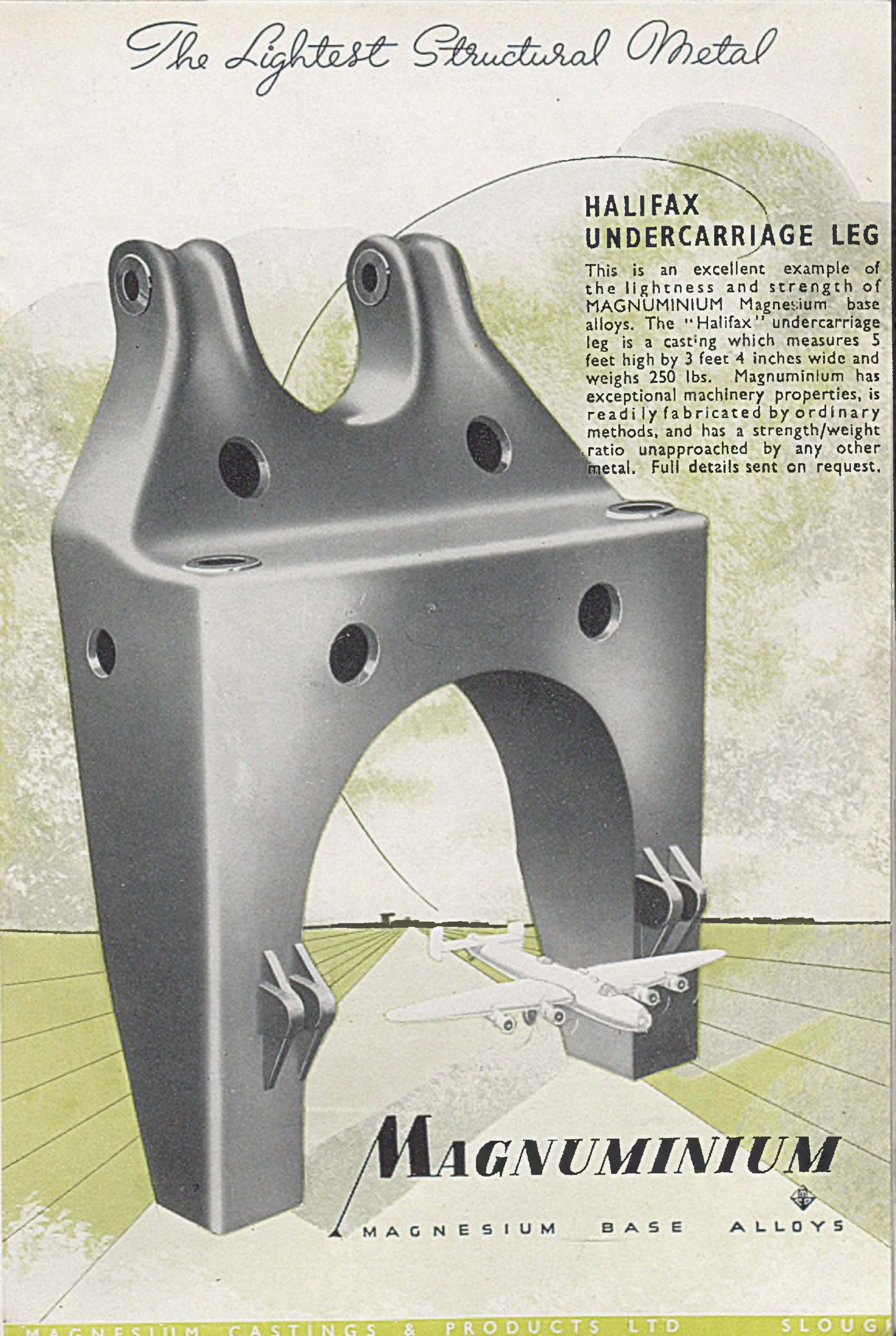
Friese-Greene opened his talk by expressing his pleasure at seeing the committee once again gathered together in the old friendly and fighting spirit. Especially he welcomed Air Commodore Helmore, the principal guest, and said that it was the realistic attitude that the Air Commodore had taken towards the aluminium industry in his preliminary address as chairman at a recent meeting in Burlington House that prompted him to speak hard facts to the industry.

He explained that he had attended many meetings and special gatherings within the industry since the aluminium exhibition was held in London in June last; in nearly all instances he had come away with the impression that the industry was enveloped in a damping fog and the dampness and fogginess could be quite depressing. He went on to say that in fogs, bogeys of all kinds may materialize; these bogeys of doubt, lack of confidence, or of forces that mitigate against progress, could be dispelled only by clearing away, first of all, the fog.

Friese-Greene then went on to speak as follows: "Gentlemen, I will now deal with some plain facts known to most of you, but which for reasons of etiquette and modesty have not been spread abroad. The aluminium industry is young, and, to expand rapidly in the consumer fields of civil and marine architecture, housing, domestic furniture and household ware, it must be prepared to face hard truths and to hit hard if it wishes to capture the home and export markets.

"Publicly to demonstrate the limitless possibilities of aluminium was, as we all know, first and foremost, the purpose of the exhibition at Selfridges, but there were many other aims behind this venture which, already, is beginning to bear fruit, but which undoubtedly would yield a more prolific crop if it were not for influences, which consciously or unconsciously tend, it seems to me, to break down confidence in the team spirit.

"Individual zeal in the form of healthy criticism is to be welcomed, but that zeal must carry with it reality, broad knowledge and hard experience. We are all tempted to talk rashly when we are riled, but some of us resist the urge and bottle up our feelings until one day out pops the cork. My mind, and some of my bottled feelings, carry me back to the bad days of uncertainty and extreme exploitation between the two wars: design and craftsmanship suffered very much during that period. I am vividly conscious of the external causes and there is, I suspect,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a danger of their re-occurrence, but, Gentlemen, our task on behalf of progress alone is quite sufficient for us to cope with, and we do not want to fight bogeys as well; they distort vision and undermine confidence, and, at this moment, the aluminium industry is, or should be, very concerned with the maintenance of confidence, both within and without its own organization.

"You know, some people criticize so much and for so long that, in the end, they really believe their own criticisms. This is amusing enough as between individuals, but once let the habit get out of control, then it is likely to affect industry itself, and its sting must be extracted. We have growing up in our midst to-day, persons, groups of persons, societies and even councils to guide and educate industry to a higher standard of design. The movement is, I believe, designated 'Art Applied to Industry.' Enlightened industry welcomes every assistance it may obtain from this gathering of artistic talent and, for the common good, will open its doors to new processes and working techniques, developed during and since the war period, but again in the common good, industry must protect itself, its skill, its dignity, its honour and finance.

"Such new organizations must demonstrate their confidence in themselves and their good faith to others by tackling those external factors which tend to lower the standard of design, then industry will be free to grow in grandeur from within and will willingly enlist from outside the guidance of specialists who can bring in that element of freshness always so welcome. For it is fully realized that in the competitive world-markets of to-day, this quality of freshness in design is essential to the well being of us all.

"Skilled artists, and good designers in their specialized groups should, if they are out to assist industry, have a professional standing and official training, preferably architectural, and should be assisted, encouraged, and inspired by every branch of industry and commerce. But, Gentlemen, in pursuing these worthy ends and in their fight for professional recognition, such groups must be wary of those amongst their number who would make of their calling an esoteric cult.

"Gentlemen, there is not, and indeed should not be, any more mystery in industrial design than in any other form of skill, except that there must be artistic appreciation of form and colour, knowledge of tradition and fashion, and the realization that there is not a sharp division between industrial art for quantity production and artistic handicrafts for single specimens. It is important, therefore, irrespective of any alliances which we in industry may form outside, that this appreciation be developed within industry itself. It must flourish in the shops, amongst the staff and throughout our sales organization.

"To design in metals as with all other materials, you must learn to construct. A nation of craftsmen, and such we are, must be wary of those who would cover up their craftsmanship and divert attention from their honesty of purpose by artificial streamlining and such-like devices. Any so-called streamlining, decoration, or casing should be always an integral part of the design. Design, in other words, must face up to reality, with the artist just as potent a factor in the general make-up as the technical designer, technician and craftsman. There is no short cut for the industrial designer; if an artist is to claim justly as his right the qualification 'industrial,' then he must either come *from* or pass *through* industry. Artists outside industry must choose for their calling some other title, otherwise they stand to be accused of being mere opportunists.

"Industry, when put to the test, knows exactly what it wants, just as the good architect of a building knows what he wants. Try and influence an architect on taste and you will soon feel the results! Rightly he stamps his personality and his taste into an harmonious home. I know you will forgive me if I refer here to my own company, which, dealing with architects in this generation and traditionally since 1752, has learnt that its designers must always be sensitive to the widest variety of styles and tastes. Thus they have become versed in detecting immediately the requirements of the individual, and of the period or environment.

"This attitude is easily understood, but less readily explainable, for the interpretation is so largely *unwritten*. We, in fact, as industrial designers and interpreters of taste —and artists—are, when our own tastes are sought, very much in the position of an architect in a public competition: between two stools, knowing what he likes personally and what he knows the assessor likes, or, more important still, knowing that it would be advisable to refrain from doing what the assessor does not like.

"There are standards of good taste, but, in this regard, our likes and dislikes differ, so do not let this problem of design become a bogy. After all, artists have their bad as well as their good days, and know only too well how easy it is to allow a slightly discordant note to creep into a design. Artists and designers in industry have, over the war period, been harnessed to the detailing of weapons of destruction in all their forms. It is to be expected that, for some little time yet, their style may be cramped, for their inspiration has suffered. For goodness' sake —encourage them!

" It is axiomatic that, no matter what may be the structure in which you are interested, or upon which you are engaged, every effort should be made for the realization of serviceability, simplicity and truth. In many instances, decoration will be called for, may be to please the client or to blend to a period in design, to harmonize with an environment or to tell a story. But, in decoration or enrichment, every effort should be made to avoid discord, and often this is not quite so simple as it may appear. As far as possible, given good functional form and pleasing proportions in a structure, reliance should be placed on the inherent beauty and natural finish of the material employed.

" For good designs these are simple laws and must be obeyed, although, paradoxically enough, the simpler forms, to be really good, are generally more difficult and more expensive to make. It is cheaper to hide a joint by a rosette than by precision craftsmanship, but if this practice be adopted, at least let the rosette be designed for the article and not just a stock pattern. Sometimes it is easier to make a joint a feature than to hide it altogether. So you see, by example, how essential it is that industrial design and those who practise it must face up truthfully to reality. It is the designer's duty to satisfy his customer at the right price. If he does so and, at the same time, raises the standard of taste, he will at least have achieved something.

" To assist design on articles for quantity production models and prototypes should be made. Such a course will entail the expenditure of time and money, heavy expenditure maybe, but it will be well worth while. In my own company we specialize in a great variety of prototypes covering many industries, *and the form values have to be adapted for the industrial machine.* In my own experience, clients have hardly ever regretted the initial expenditure, although a momentary groan may escape them when they receive the bill.

" Industrial designers know their materials so well by association that when they design on paper they see at once a three-dimensional presentation of their work. By eye, and without models, they can estimate very accurately the weight of sections, extrusions or castings required. Again, within my own organization, mistakes are seldom made for neither we, nor anybody else, can afford errors. You can tear up a drawing, gentlemen, but you cannot tear down a six-story building.

" Most people of culture are, in one form or another, artists, and the masses in general will be found to possess submerged artistic feelings merely waiting for stimulus to provoke them to activity. That is why the standard of design can be raised immediately and exploited for its selling value in mass production, particularly for export.

" Good taste in design is acquired through education, amongst the most important aspects of which, for our purpose, may be considered culture, tradition, and association. Fundamental improvement in standards of design amongst the masses of our people must rest with the Board of Education, for the surest foundations are to be laid when the subject is very young. These are points, however, that we may well leave here to our educational experts and to the sociologist.

" The aluminium industry is interested in the realm of art and must continue so to be, for *there* lies real progress and the true path of commercial development. Deville recognized this nearly a hundred years ago. It is only through the arts that aluminium can be established in tradition. In applying the correct scientific method and technique for the solution of its problems, the aircraft industry, in the use of high-strength alloys of aluminium, has approached the fine arts. What can be more beautiful to the eye than some of our latest fighters? But it is in performance that we see them in their fullest glory. Here we have form and purpose, the keynote in all industrial design, however large, however small, however complicated, however simple the unit.

" Scientists and technicians are generally modest about the beauty of their achievements, but they know—for the search for truth in design brings beauty. If only the scientists' societies would occasionally open up their meetings for discussions on the philosophy of art and science as applied to new materials (maybe for talks on the philosophy of those new materials themselves), there would be a more general and scientific appreciation from all raw-material producers in the design and destination of those of their wares destined for the consumer markets. Internally one big chemical company has already taken the lead: it was delightful to listen to the chairman of I.C.I., Ltd. (Plastics Division), speaking at a recent meeting with quiet confidence on the future of 'Perspex' in science and art.

"Possibly the nearest approach to good decorative art that the aluminium industry has achieved over here are the murals 'telling the story of aluminium' and first shown during the exhibition at Selfridges (see 'Light Metals,' July, pp. 336-337). For these, the industry is indebted to the brilliance of the architect and mural artist, Ralph Lavers. He would not wish it to be forgotten that the final result was achieved by a team of industrial designers, technicians, detailers and craftsmen working as an harmonious whole. There was full sympathy and purpose throughout, just as there must always be when interpreting architects' designs.

"Ralph Lavers's mural designs were carried out meticulously, line for line, with character and precision, although it should be recorded that the form of display, construction, and the working technique were conceived within industry itself—with the industrial designers and the craftsmen actually doing the job. This example of inspiration and team work was made possible by mutual understanding and respect. Sometimes it is not sufficiently appreciated how important it is to inspire, maintain and protect confidence in every member of a team if really good work is to be produced; the slightest destructive criticism while the job is in progress will assuredly affect the final result. Craftsmen know that, to achieve their best, they must put their very soul into their work. They do not just exist because of it.

"I well remember visiting the blacksmith's shop whilst they were forging the decorative window grille exhibited at Selfridges, and hurriedly mentioning that it would be good to introduce a snail to fit a small space in the design. Next morning, sure enough, there, crawling along the anvil, was a live snail, and, beside it, a forged reproduction in aluminium, formalized to blend to the pattern. This decorative grille was reproduced in aluminium to indicate the extreme malleability of the metal in the hands of the blacksmith employing his traditional technique, but the smith soon learned to enjoy the forging of a delicate tracery in aluminium for other exhibits, exemplifying more natural applications of the material in every possible sphere of decorative work.

"It does not take long for good craftsmen, fitters, welders, machinists and polishers to learn to manipulate aluminium without scratching or denting the surface. Its lightness and ease in handling are distinct advantages in construction compared with the much heavier group of metals, so fabricators new to light alloys need not fight shy of introducing them into their shops; they will soon revel in them as we do!

"I look forward to the time when creative artists can feel and live aluminium as we do, although creativeness is not exclusive to the skilled artist on paper or canvas. Be true to yourself, true to your material and use your imagination as it was meant to be used, then, having done these things, respect simplicity, and any one of you can produce a work of art in light metal. Only when the creative artist or sculptor *thinks* aluminium, only when he is thoroughly steeped in the knowledge and experience of its properties and has himself transcended artisanship to transmute abstract beauty into a dimensional form will you get creations in light metal which justify a niche in the realm of pure art. I wonder if this will be possible by June next year, in time for the national exhibition? I hope the Aluminium Development Association will not be found wanting either in the searching or in the inspiration.

"Of the Selfridge exhibition, in connection with which most of us on the committee worked and fought, I really have quite a lot to say without even mentioning the words—rhythm, subtlety, form, or the bill at the end of it all. The exhibition was a success far beyond the dreams of those not in close touch with the deliberations of the committee. After all, the interests and the pockets of trade and commerce were well represented, with industrialists, scientists, technicians, super salesmen, organizers, display artists, journalists and others, all out to one end, to sell the aluminium idea.

"As was intended, the architect and constructional engineer visiting the exhibition soon absorbed the potentialities of the metal for progressive design, for they saw details with an observant eye, a trained mind and practised hands. Judging by personal inquiries, the exhibition in all its reality and versatility has more than impressed fabricators. It has certainly stirred the public.

"If I may presume for a moment: I believe that the time is now opportune for the personality of a good architect to be felt at the exhibition on tour, in planning display and adding new exhibits. Industry has told its first story and the architect's presence at this stage would prepare the aluminium industry for the national effort next year. For the office in question, however, an authority of the highest standing must be selected. It is now the concern of architects and designers all over the country to begin to tell *their* story in aluminium and a mighty story it will be, if the Association enlist 'super-salesmen' of the right order and give them the right job to do.

"May I please add a little advice: If fabricators be approached for the execution of special exhibits, competition should be cut out, for your architect will see that you get value for the amount you spend. Times are difficult for production, and fabricators are important to the industry; they must be encouraged to use aluminium now—not to-morrow or the day after. Here I am not referring merely to my own company, for we are but one of a world-wide guild of craftsmen of incredibly ancient lineage. We all began with bronze and wrought iron, and in this generation we shall probably finish with magnesium. Anyhow, the traditional metals will not envy you nor us: it is a delight to work in them all. However, it is important that your pioneer work in aluminium be carried out by the very best of craftsmen, and cut prices do not ease the situation. Finally, competition in art is always false economy. You will probably recall the story of Cellini, who, finding himself short of metal when casting a statue, tipped in the petty cash. You want the craftsman's very best work for your exhibits next year? Then give him time to do it. The hours are slipping by.

"Now, how and why was the Selfridge exhibition a success? It was so because the committee responsible to so large an extent for its organization was composed of realists, and, as such, they wanted action. They knew that with aluminium 'seeing is believing.' In their realism they wanted the best they could get in the shortest time, although, with the war in Europe still in progress, production conditions were far from favourable. How could it be done? If, in spite of prevailing conditions there were to be an exhibition worthy of the industry, the public had to see the real material—not just stick, plaster and photographs. And why was the whole matter of such vital urgency just then? Because it was a moral and a national issue. At that time it was known that there would soon be a need to re-absorb from the aircraft industries a million skilled operatives used to working and handling aluminium. It was, therefore, realized that a healthy and versatile demand for light metals would have to be created right speedily.

"My own company was approached to form a team to conceive, design, and produce exhibits worthy of aluminium and of the occasion. Very few knew the real difficulties. Government inspectors had to be induced to cultivate the "Nelson" eye, and, with the men, all the prickly problems of post-war production loomed up at one fell swoop. Finally, the works themselves were clogged with war material.

"Anyway, the situation was understood, and, eventually, the wholehearted co-operation of the entire organization was enlisted in the effort. I just do not want you to forget what those men did, nor what was done by those of the Northern Aluminium Co., Ltd., British Aluminium and other companies which supplied the material to time. The rest most of you know. It was team work everywhere with splendid leadership by our chairman, Mr. Jones. Special praise must be given to Selfridges for producing the masterly plan of the exhibition itself, and for their untiring enthusiasm. Nor should we forget the trials of Alumilite and Alzak, Ltd., which concern, within a matter of weeks, days, sometimes hours, executed vast amounts of polishing, anodizing and dyeing for the numerous special exhibits.

"Gentlemen, in the exhibition, 'Aluminium—War to Peace,' at Selfridges, you succeeded in your aims. In the domestic field you stimulated not only interest but constructive thought: results of the kitchen ware quiz give good indication of this. From the public itself came fresh ideas from which, in a matter of hours, new designs were produced. In the field of general engineering you did, in the 'Story of Fabrication,' successfully encourage the structural engineer, the consultant, and the experts dealing with other materials to think in terms of aluminium. In the field of industrial art and architecture you made the task of the craftsman easier in the promoting of materials which all of us know to be good. This is not wishful thinking. There is a glorious history ahead for light metals here, and everywhere: make no mistake about that!

"The aluminium industry has sown the seeds for a great national effort next year. I wish you well. Vigour of purpose and alertness of mind—the material will do the rest."

Two-Seater

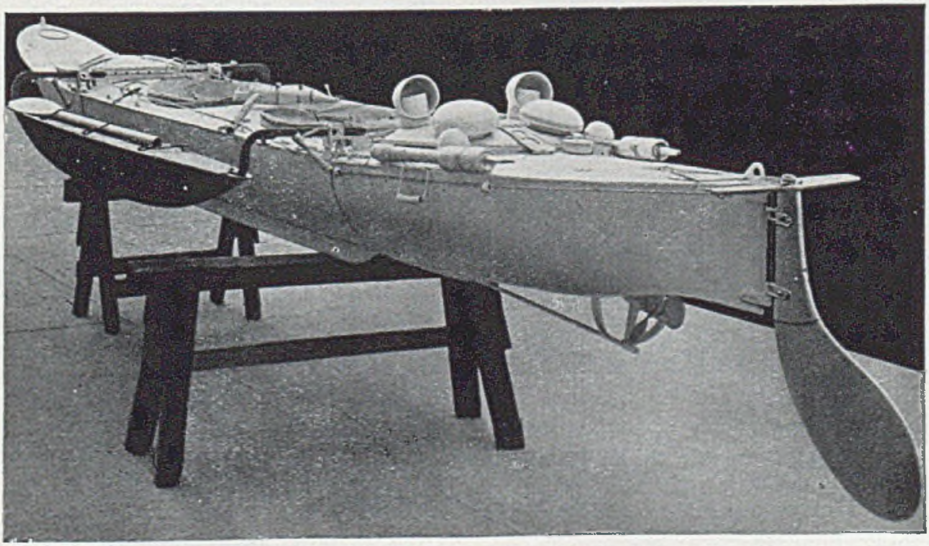
Power Canoe in Light Alloy

Presenting a Brief Note on the History and Development of a Special Light-metal Boat Incorporating Many Novel Features. A Complete Specification is Included in the Account

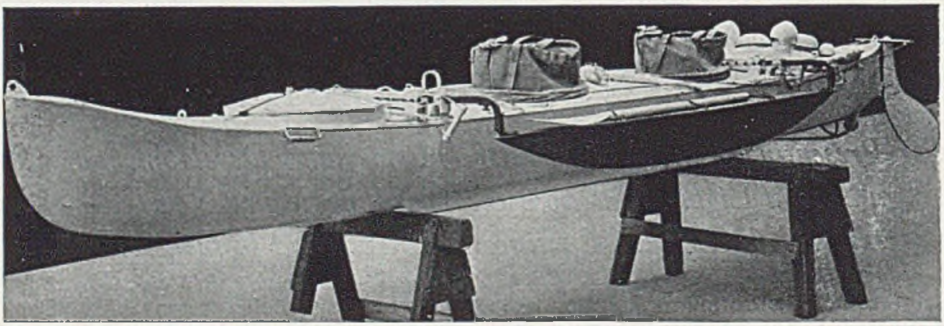
At some time during the course of the war it appears that the Services called for the construction of a special boat for a purpose which, on grounds of security, was not made public. It was required that this boat should be easily transported by hand and should be capable of standing up to very heavy weather.

The request having gone forth, an assortment of brains, technical skill, and craftsmanship was mustered, and eventually a hard-chine wood prototype canoe on the Catamaran principle was evolved. It was soon discovered, however, that this design was too large to be handled conveniently; a further model, therefore, was designed, with a round bilge, bow and stern sections being removable. Construction was in $\frac{3}{16}$-in. plywood with a mahogany keel. Unfortunately, for tropical conditions, the use of wood in this way proved unsuitable, and the Warwick Aviation Co., Ltd., was now approached and asked to design a model in Birmabright. In the execution of the metal boat, other concerns, including Aldous Successors, Ltd., participated.

This particular alloy was selected principally on account of its very high resistance to corrosion, even under marine conditions, and because, in addition, it exhibits the necessary high mechanical strength. On the Birmabright assembly a special bow was designed with a particularly high sheer and wide flare, features



SHOWN here, and at the head of the following page, are two views of the boat described in this account. Note particularly the stern and rudder design. (Courtesy Warwick Aviation Co., Ltd.)



which played a very large part in giving the boat such sea-going qualities.

1. Dimensions.

Length (overall), 18 ft. 0 in.
Length (bow section), 5 ft. 0 in.
Length (centre section), 8 ft. 0 in.
Length (stern section), 5 ft. 0 in.
Beam, 2 ft. 1½ ins.
Width over catamarans, 4 ft. 7 ins.
Depth (from gunwale to underside keel), 1 ft. 1¼ ins.
Depth (from C/L deck to underside keel), 1 ft. 3¼ ins.
Draught, 6 ins.

2. Weights.

Complete with all gear, oil and petrol, 270 lb.
Complete without oil and petrol, 229½ lb.
Bow section, 26½ lb.
Centre section, 63½ lb.
Stern section, with rudder (less oil and petrol), 105½ lb.
Catamarans (2), 34 lb.

3. Power Unit.

Manufacturers, Norman Engineering Co., Ltd., Warwick.
Type, horizontally opposed, twin cylinder, four-stroke T.300.
Capacity, 296.56 c.c.
Cooling, air.
R.p.m. at full throttle, 2,000.
B.h.p. (at 2,000 r.p.m.), 3.
Petrol consumption (at 2,000 r.p.m.), 1 pt. per b.h.p.-hr.
Oil consumption, 1 pt. per 20 hrs.
Lubrication, gear pump.
Oil pressure, 30 lb./sq. in.
Ignition, B.T.H. magneto.
Starting, by handle from aft cockpit.
Petrol tank capacity, 1½ gallons.
Oil sump capacity, 1 pt.
Carburetter, Solex.

4. Propeller.

Number of blades, 3.
Diameter, 8 ins.
Pitch, 7 ins.

5. Performance (at full throttle).

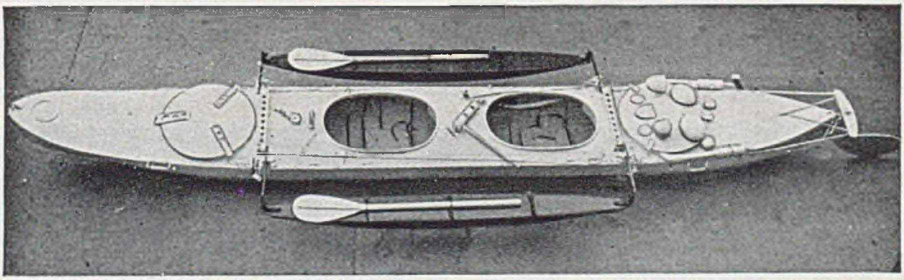
Speed, 7.75 knots, 8.9 m.p.h.
Petrol consumption, 3 pts. per hr.
Range on 1½-gallon tank, 35.6 miles, 4 hrs.
Range per gallon, 23.7 miles, 2 hrs. 39 mins.
Propeller efficiency, 67.25 per cent.
Propeller slip, 32.75 per cent.

6. Gear.

Double-bladed paddles, 2.
Waterproof seat cushions, 2.
Waterproof cockpit canopies, 2.
Waterproof cockpit covers, 2.
Mast apron, 1.
Mast, sail and yard, with halyard and tack down, 1 set.
Slings, 2.
Painters, 2.
C.Q.R. anchor and line, 1.
Fire extinguisher, 1.
Bilge pump, 1.
Engine tools and spares, 1 set.

7. General Specification.—(a) Material.

The material used is mainly Birmabright, an aluminium-magnesium alloy which combines high mechanical strength with a weight one-third that of steel and



FURTHER view of the power canoe which, at the foot of page 604, is seen in its dismantled form. (Courtesy Warwick Aviation Co., Ltd.)

an exceptionally high resistance to sea-water corrosion. M.G.5 rivets have been used throughout, together with Duralac for all joints. For fittings which have called for additional strength, stainless steel, together with bolts of the same material, have been used, and where it has been necessary to use bronze fittings these have been insulated from the Birmabright with thin fibre sheet to reduce the risk of electrolytic action.

All sheet Birmabright is to specification B.B.3, excepting the centre section skin; this is to specification B.B.5, the higher magnesium content giving greater toughness and strength.

Both bow and stern section skins, together with the Catamaran skins, are of 20.G., each being fabricated in two halves with a central welded seam. The centre section skin is of 22.G. in one piece.

(b) Construction.

All frames are of a strong section and, together with bulkheads, deck beams, stringers, deck stiffeners, decking, bilge keels and seats, are of 20.G.

The main keels are of 16.G., those for bow, stern and centre sections being of channel section, and for the catamarans of a swaged section.

The yoke and rudder are mainly of 18.G. and of welded and riveted construction.

The outrigger slides are of 16.G. and 12.G., the outriggers themselves being of 1-in. by $\frac{1}{2}$-in. flat stock, while the body of the outrigger locks is a Birmabright casting.

All cleats are cast Birmabright, the painter eyes and mast stop being die-stampings in the same material.

All bow and stern attachment fittings are of high-grade stainless steel, together with the brackets mounting the outrigger locks; all bolts, screws and nuts securing these items are of the same material.

8. Noteworthy Features.—(a) Patent Quick Release Attachment for Bow and Stern.

The advantages of the above will be appreciated readily, since it makes the detachment of the bow and stern from the centre section a matter of seconds, simply by removing two pins in each case, thus dividing the canoe into three sections, convenient for handling, transit or stowage.

The pins are permanently made fast to the bow and stern sections, to obviate loss when unassembled, and upon assembly are positively locked in position as a precaution against working out under buffeting.

Every care has been taken, both in design and fitting, to ensure that the fittings are not only adequate but more than strong enough to cope with all normal conditions.

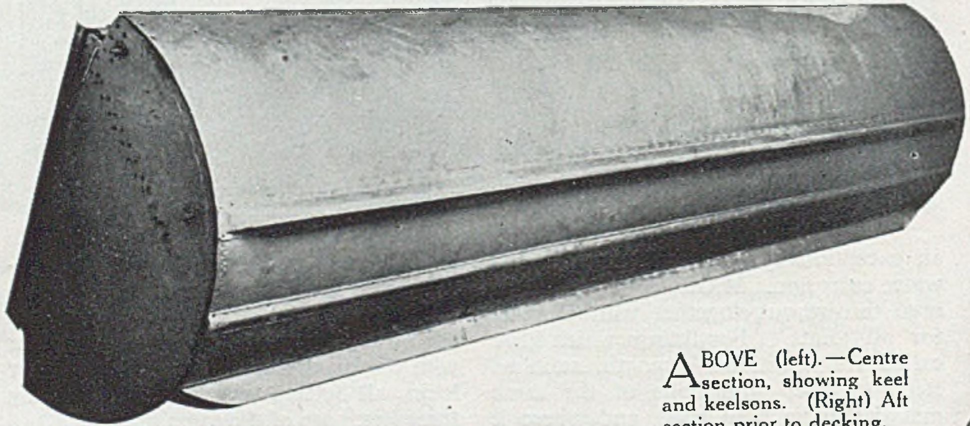
(b) Patent Watertight Hatches on Bow and Stern.

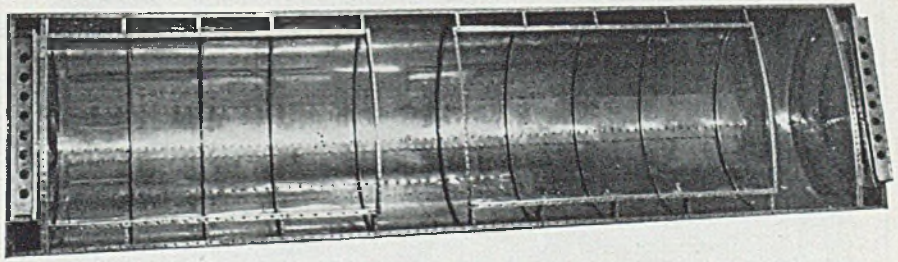
The hatch design, forming an efficient breakwater, has the advantages of simplicity, watertightness and a pleasing appearance.

The universal hinge permits the cover to be raised in the normal way or to be swung back horizontally to clear the

(Continued on p. 604.)

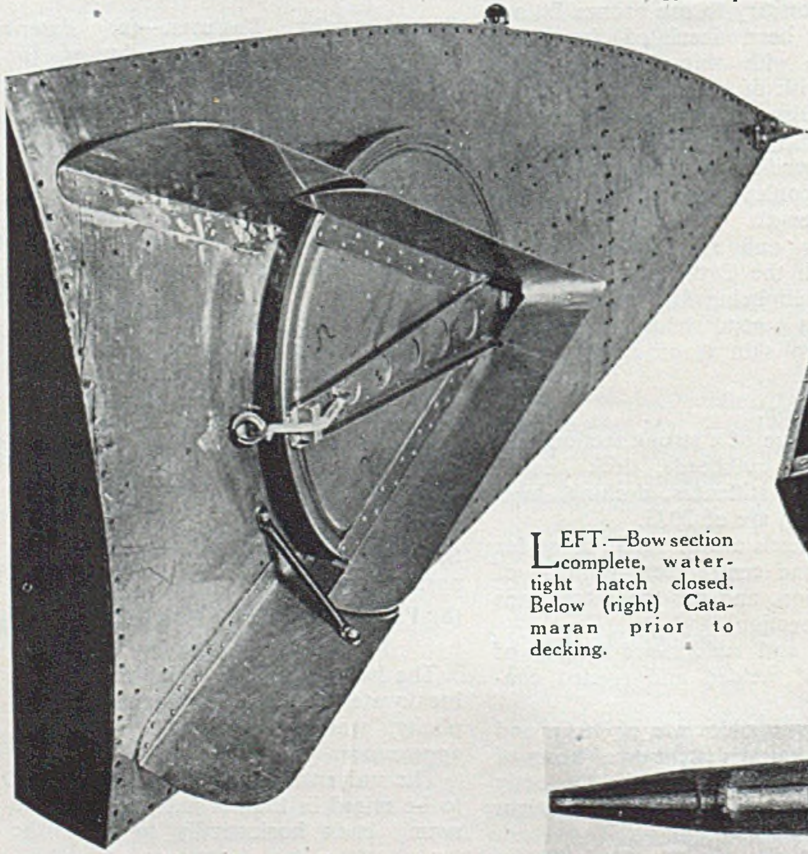
LIGHT-ALLOY POWER CANOE

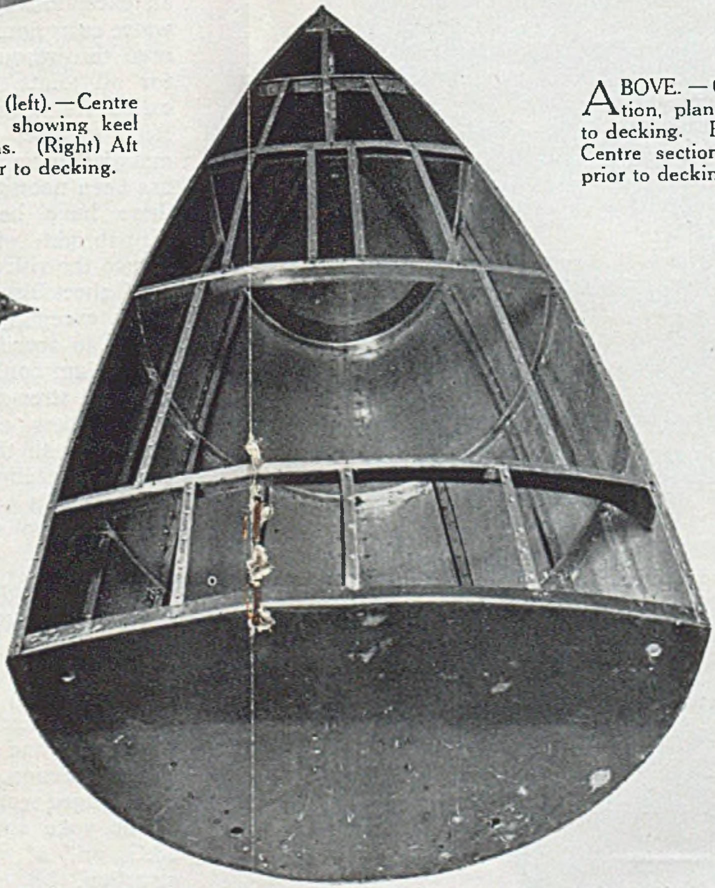


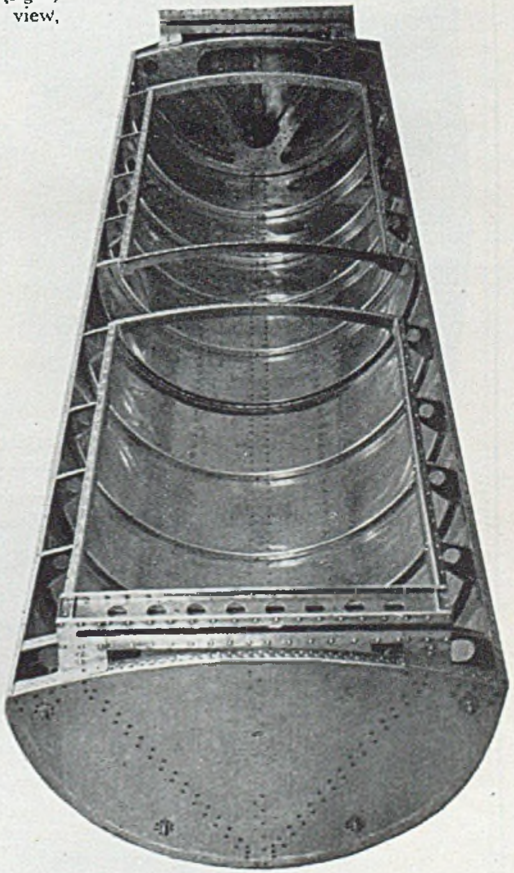


ABOVE (left).—Centre section, showing keel and keelsons. (Right) Aft section prior to decking.

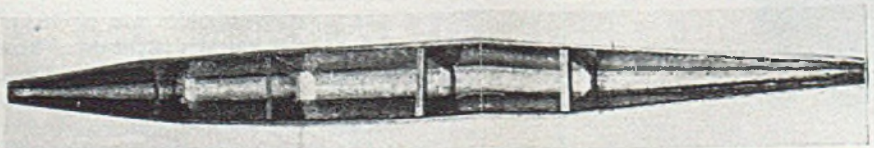
ABOVE.—Centre section, plan view, prior to decking. Below (right) Centre section, aft view, prior to decking.

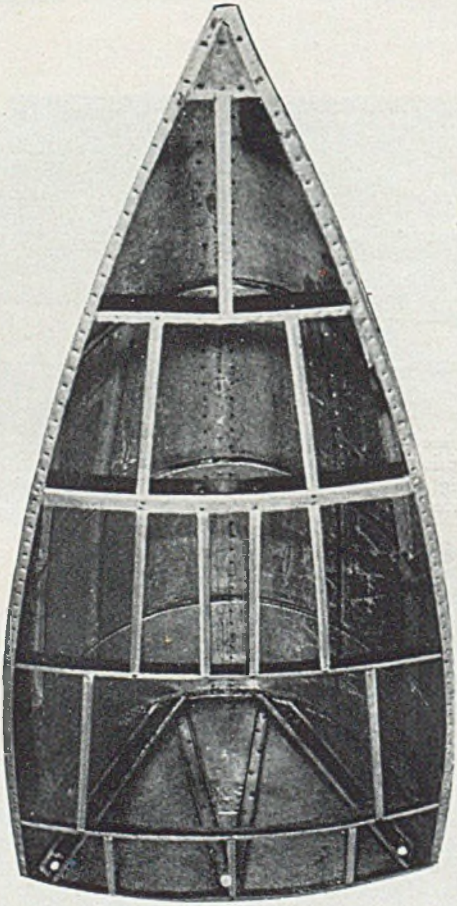


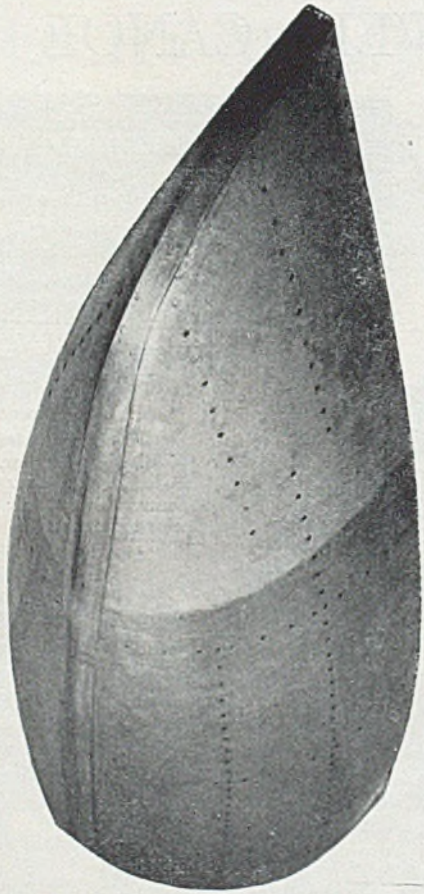




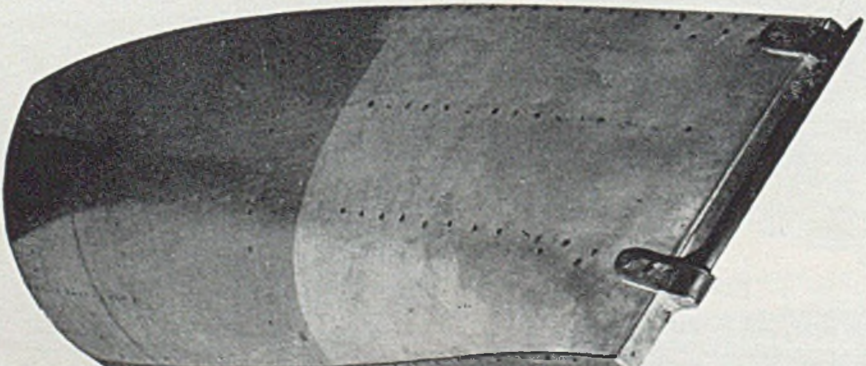
LEFT.—Bow section complete, watertight hatch closed. Below (right) Catamaran prior to decking.

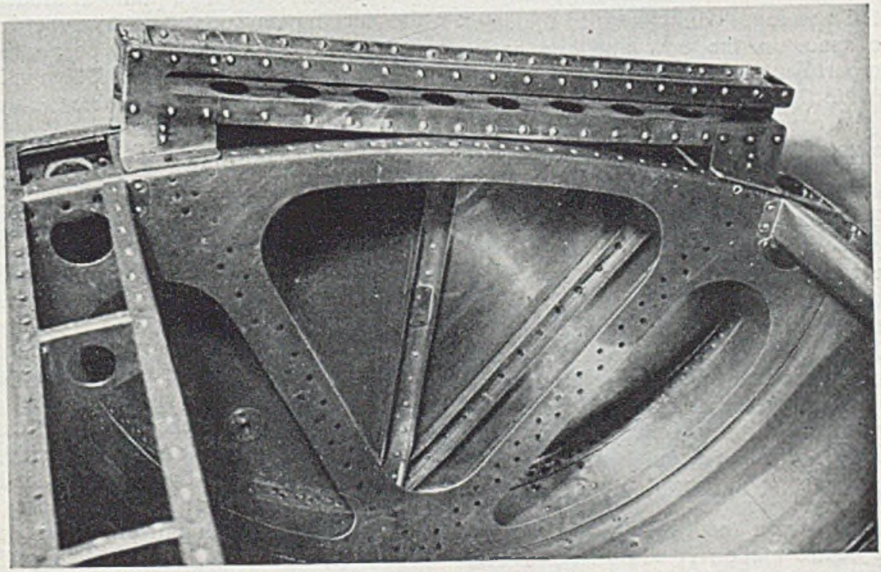


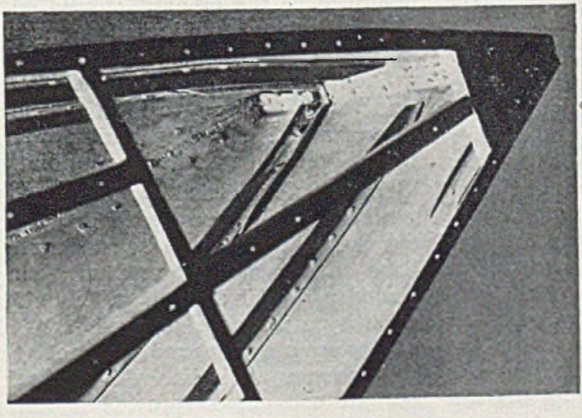




ABOVE, left: Bow section prior to decking. Above, right: Bow section showing keel. Below: Aft section showing keel and rudder post.

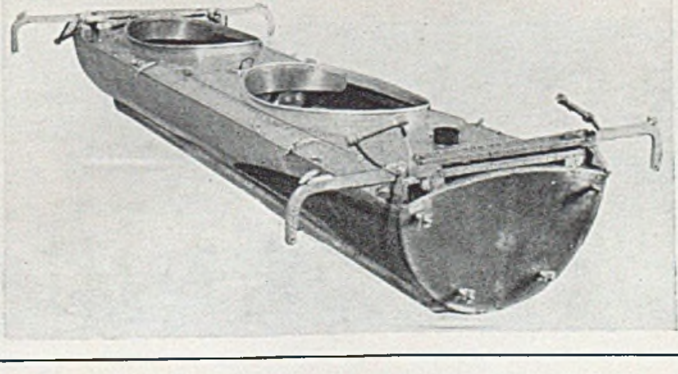






ABOVE: centre section. Detail of bulkhead, main frame, and outrigger beam.

LEFT Aft section, showing attachment of rudder post.



RIGHT: Centre section complete, three-quarter forward view.

(Text continued from p. 599.)

hatch opening, giving access to the stowage space in the bow and the engine compartment in the stern section.

Watertightness is effected by the closure of the cover on to a rubber seating by means of two quickly operated catches.

(c) Bow Section.

The deck lines of the flared bow are noticeable, the combination of flare and sheer tending to keep down spray, at the same time preventing burrowing when running with a following sea.

For ease of access to the stem to carry out any necessary repairs, a handhole and cover are provided on the decking, the remainder of the bow section being readily accessible through the hatch.

(d) Centre Section and Catamarans.

Apart from the two cockpit openings the centre section is completely decked, and two seats, fitted with waterproof cushions, are provided. The accommodation is such that there is ample leg-room for the two occupants, each being provided with a waterproof canopy, the bottom of which is secured by a rubber cord around the cockpit edge and the top tied snugly under the armpits of the user, with light braces over the shoulders. Thus, while providing protection against spray and excluding water from the centre section interior, the canopy permits the occupant to leave the cockpit at will, since the upward thrust of the body pulls the rubber cord from the cockpit edge.

A drain plug is fitted behind the aft seat, and a fire extinguisher on the aft bulkhead.

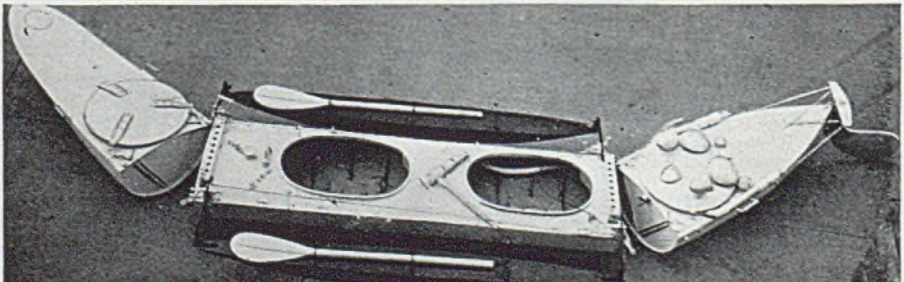
A suction-type bilge pump is fitted on the decking, in such a position between the two cockpits that it may be conveniently operated from either. The suction hose is sufficiently long to enable the stern section to be pumped out.

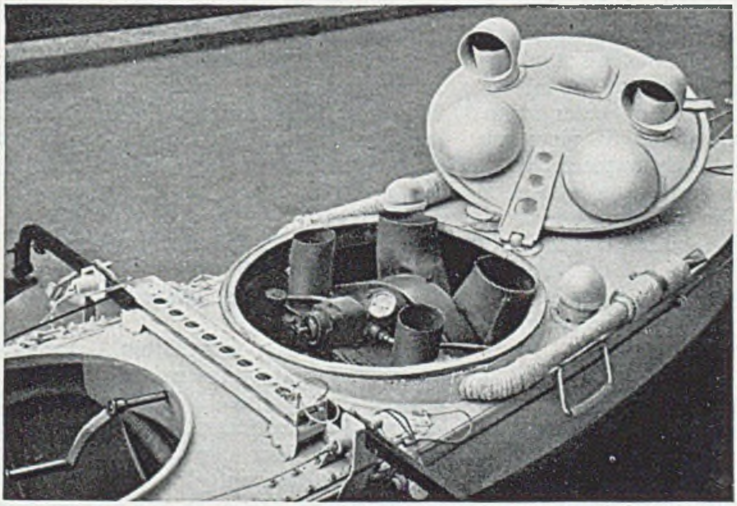
The mast yard and sail are stowed on either side of the decking and secured by rubber straps, the C.Q.R. anchor being similarly secured immediately forward of the mast deck ring. The latter is rendered watertight by a rubber cap when the mast is not stepped.

The catamarans are mounted on outriggers, which run in slides mounted athwart each end of the centre section. The outriggers are locked when the catamarans are in their outboard positions, of which there are two; fully extended when under power or sail, and closer in when paddling. Each pair of locks is controlled by one wire, which when pulled unlocks the outriggers; each catamaran may then be slid inboard, stowed on top of the decking and locked in position, thus facilitating handling and transport.

Each catamaran is filled with table-tennis balls to preserve the buoyancy in case of a leak or holing, and is provided with a drain plug at the lowest point.

One double-bladed paddle, in two sections, is stowed on the decking of each catamaran, and secured by rubber straps. Each section may be used as a single-bladed paddle if desired, and should the necessity arise, as a jury rudder. For this latter purpose a rope grummet is fitted on each gunwale in line with the back of the aft cockpit, to provide a fulcrum point for the paddle shaft.





PART view of the two-seater power canoe with engine in position. This unit, of three horse-power, manufactured by the Norman Engineering Co., Ltd., embodies light-alloy components to the extent of 50 per cent. of its total weight.

The yoke lines from the rudder are carried along the centre section gunwale and provided with wooden toggles at each cockpit position. They are kept permanently in tension by rubber cords, the ends of which are made fast to the forward outrigger slide.

A waterproof cover is provided for each cockpit, for use when the canoe is carrying one person only or lying at moorings.

To facilitate carrying and lifting, two handles are provided on the gunwales, at each end of the centre section.

(e) Stern Section and Rudder

Those points already noted on the bow in regard to the watertight hatch, handhole and cover, apply equally to the stern section, but the most notable feature is the propeller tunnel. This, coupled with the fact that the rudder blade is hinged to the stock, enables the canoe to traverse shallow water and to be beached without difficulty or risk of damage to the propeller, which has an additional protection in the form of a stainless-steel skeg and guard ring.

By means of a pulley at each end of the yoke, the load on each yoke line is halved in relation to the reaction on the rubber blade, the minimum turning circle diameter being equal roughly to twice the length of the canoe.

For stowage and in order to detach the stern from the centre section, the yoke and rudder may be readily unshipped.

(f) Watertightness of Individual Sections

When considering the descriptions of the three sections in the foregoing subparagraphs (c), (d) and (e), it should be noted that each is an independent watertight section, so that if desired the bow and stern may be detached from the centre section while afloat.

(g) Power Unit and Installation

The main specification details of the engine installed in the stern section have already been referred to in paragraph 3, but a general survey will further emphasize its advantages.

Weighing only 65 lb. dry, it has already proven its reliability in a number of fields over a considerable period.

Due to the horizontally opposed twin-cylinder four-stroke design, excellent balance and mechanical silence are achieved, together with smooth running.

The fan air cooling is efficient, maintaining the engine compartment temperature at approximately 100 degrees F. within, of course, close limits dependent upon climatic conditions. This efficiency is obtained by means of a casing which directs the air flow from the fan around the engine, the air intake being through two mushroom ventilators and the outlet through the two cowl ventilators, all located on the hatch cover. The advantages, due to the fact that no water pump, filter, water intake, outlet or pipes are necessary, will be readily appreciated.

A full pressure lubrication system is maintained at 30 lb. per square inch by a duplex-type gear pump, which both feeds and scavenges, through drillings and ducts. No piping is used, thus obviating the risk of fracture and the resultant failure of the system.

An adjustable relief valve is included, and the filler pipe is brought to a convenient position on top of the casing.

Although the engine and all working parts are totally enclosed, any minor adjustments may be made through the hatch opening.

The throttle and slow-running adjustment screws on the carburetter are accessible, and for cleaning the float chamber may be removed together with the jets.

Since the magneto is mounted on top of the engine, the contact-breaker points can be cleaned and adjusted easily.

Tappet clearances may be adjusted after removing the casing top and valve gear covers.

The throttle lever is mounted in a convenient position on the starboard side of the aft cockpit, and may be quickly unclamped from its mounting when detaching the stern from the centre section.

The engine switch and choke control rod are located on the stern decking.

Engine starting is easy under all conditions by means of the detachable starting handle operated from the aft cockpit.

The engine is mounted on 16.G. bearers and a 12.G. bedplate by means of four $\frac{3}{8}$-in. dia. bolts.

The $\frac{7}{16}$-in. dia. stainless steel propeller shaft, keyed and grub screwed into the engine coupling, enters the tunnel through a watertight gland and runs in a water-cooled bearing of synthetic material in the outboard bracket.

Removal of the engine from the stern section is a simple and speedy operation. It may be lifted through the hatch, after removing the four holding-down nuts and contact-breaker cover, and uncoupling the propeller shaft, throttle and petrol connection.

Upon removal of the engine casing, decarbonizing is simplified by the detachable cylinder heads; the cylinders need not be disturbed.

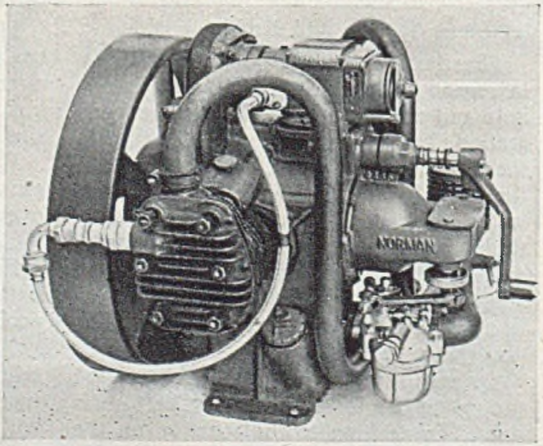
The $1\frac{1}{2}$-gallon petrol tank is slung under the decking, immediately aft of the engine, an additional rubber cap, to ensure watertightness, being fitted over the existing filler cap where it passes through the decking.

The engine idles at so low a speed that no clutch has been deemed necessary, the forward motion and thrust with the throttle closed being negligible.

(h) Sailing

The canoe is equipped with a simplified lateen rig, and under sail handles well, with good performance.

In conclusion, it should be pointed out that there has recently come to light a middle-18th-century print of a wooden boat capable of being dismantled into three sections for ease of transport.



Close-up view of the power unit. Pistons, timing-case cover, valve-gear covers, crankcase and flywheel all consist of aluminium alloy.

For New Homes:
WHY NOT ALUMINIUM?

E. Carrington, M.Sc., presents an elementary summary of light alloys from the standpoint of the builder interested in the advantages offered by these modern structural materials and in expediting the realization of post-war planning.

EVERYONE will agree that one of the most important jobs to be done in the change over from war to peace conditions is the provision of homes for our people. It is of the utmost importance that happy family life should be resumed as quickly as possible, because on happy families is based a happy nation. To this end, it is essential that a really large number of homes should be provided, and those who are responsible for their provision will doubtless look in all possible directions for materials which can be used for house building. There are, of course, well-tried materials with known properties, and these are sure to be used on a very large scale, although war experience may have given new ideas even in the use of these materials. There are also materials available which were not used for this purpose. Amongst these are aluminium and its alloys—the so-called light alloys.

Not very many years ago, aluminium was practically unknown to the man in the street, and in pre-war days it was only generally known as the material from which pans and kettles could be made. During the war the position completely altered, and aluminium is now known to a very large proportion of our people as an important metal for the building of aircraft and aircraft engines. When used for these purposes, it has been an unqualified success, and the urgent necessity of making the utmost use of its properties and improving those properties in every possible way has provided us with a series of alloys which lend themselves to general use in very many industrial spheres. Amongst the possible uses for aluminium alloy is the building of houses, and when various alternative materials are being considered for any part of a house, those responsible are strongly advised to ask themselves: "Why not aluminium? Is it not possible to make use of the large amount of aluminium which is available instead of, or in addition to, the materials hitherto used?" Let it be said at once that this does not mean the indiscriminate substitution of aluminium for other constructional or decorative materials. Aluminium, like other materials, has its limitations, and every effort should be made to find out whether or not the aluminium alloy will give the service expected before deciding to apply it for any new purpose. Most of the producers of aluminium alloys have research departments, and have also a fund of knowledge obtained from intensive experience during the war. In addition, there has recently been formed the Aluminium Development Association. Its purpose is to advise and assist those who wish to use aluminium alloys and to take every advantage of their properties. The Aluminium Development Association is a very young baby, but is going to be a very virile one, and anyone who requires advice or assistance is strongly advised to consult it. The address is: Union Chambers, 63, Temple Row, Birmingham, 2. Phone, Midland 0847.

Having seen that aluminium is not a panacea for all ills, or a perfect substitute for all and every other building material, let us try to see what it actually is.

Aluminium is a metal with a pleasing white appearance. It is very light compared with other metals, its specific gravity being 2.7 compared with 7.5 for iron, 8.9 for copper and 7.2 for zinc. Consequently, a ton of aluminium will make three times as many components as a ton of copper. Against this must be placed the higher price of aluminium. This has recently been stabilized in this country at £85 per ton. How this will compare with that of other metals remains to be seen, but it compares very favourably with the pre-war price of £100 per ton. Most aluminium alloys contain at least 85 per cent. of aluminium and are therefore classed as light alloys. An important exception is aluminium bronze, which contains about 10 per cent. aluminium and 90 per cent. copper.

Many aluminium alloys can be rolled, forged or extruded. Others have quite good foundry properties. It is therefore readily seen that, whether a wrought or a cast alloy is required, a suitable one can probably be supplied.

Another method of shaping metals is by machining. Aluminium alloys lend themselves quite well to all kinds of machining. Some are not so good as others. Those containing a high proportion of silicon drag somewhat, and the particles of hard silicon shorten the life of the tool. In general, however, very high speeds may be used when machining aluminium alloys, and sometimes the ease and speed of machining enables an aluminium alloy casting to be produced at a lower overall cost than a similar iron casting, although the "as cast" cost is higher. All tools should be given well-polished cutting edges, and the teeth should be well spaced and the angles so arranged that the turnings or millings are speedily removed and do not clog the tool. The following guides to the machining of aluminium alloys will help those who may use them in our future homes:—

(1) "Machining of Aluminium Alloys, Research and Development Bulletin," published by the Northern Aluminium Co., Ltd.

(2) "Machining of Wrought Aluminium Alloys," Bulletin No. 7, published by the Wrought Light Alloys Development Association.*

(3) "Recommendations for Machining Light Alloy Castings," published by Messrs. Birmingham Aluminium Castings (1903), Ltd.

The weldability of aluminium alloys varies somewhat, but pure aluminium and most of the alloys may be welded by either the gas or arc process. An excellent booklet entitled "Fusion Welding of Wrought Aluminium Alloys" may be obtained from the Wrought Light Alloys Development Association,* the address of which is Union Chambers, 63, Temple Row, Birmingham, 2.

Aluminium and aluminium alloy sheet may be shaped by beating or spinning, and guidance on these processes may be obtained from the Wrought Light Alloys Development Association* in the form of an information bulletin (No. 9) entitled "Spinning and Panel Beating of Aluminium Alloys."

An important point to consider when contemplating the use of metals for any purpose is corrosion resistance. In general, the alloys of aluminium are reasonably corrosion resistant. Pure aluminium is quite good, and the best alloys are the magnesium alloys, followed by the magnesium-silicon alloys, and the silicon alloys. Irmann says that while aluminium alloys are quite suitable for use in a system using circulating water, they do not stand up to fresh running water as well as copper alloys. When aluminium is exposed to the air it quickly becomes coated with a very thin layer of aluminium oxide, which prevents the further attack of oxygen. Unlike the oxide of iron (rust), this layer resembles the surface of the metal and does not become detached.

The heat conductivity of aluminium is much better than that of iron, but not so good as that of copper. The relative figures, taking silver as 100, are: copper

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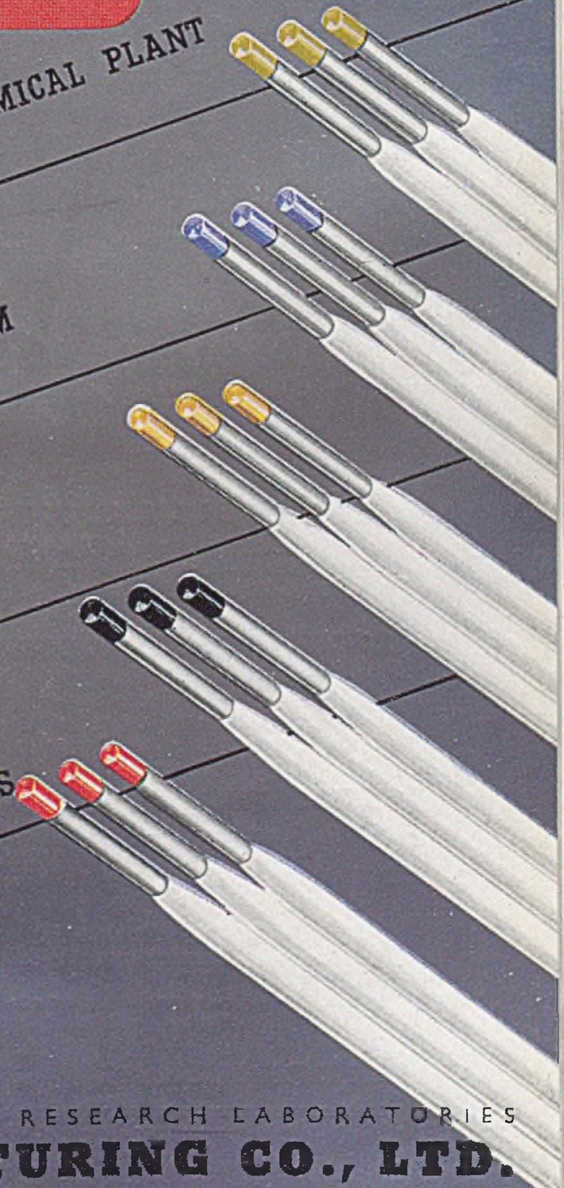
*The Wrought Light Alloys Development Association has now been incorporated in the Aluminium Development Association at the same address.



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92, aluminium 35 and iron 16. The electrical conductivity figures are: silver 100, copper 94, aluminium 57, iron 17. The specific heat is 0.23 and is double that of copper (0.11) or iron (0.11). In spite of its comparatively good thermal conductivity, aluminium can be an excellent heat insulator. Foil is fixed on a wooden or similar support and used as part of the walls of a room. The surface of the foil reflects the heat rays and thus prevents the transfer of heat through the wall.

There are several ways of treating the surface of aluminium for decorative purposes, or to improve corrosion resistance. A process known as the M.B.V. process consists in dipping the part in a hot solution of sodium carbonate and sodium chromate for four to five minutes. A film is produced which varies in colour from light to dark grey, with the alloy used. In the case of wrought alloys, the grain shows through the film, giving a decorative effect. The film improves corrosion resistance but is not very resistant to abrasion. It is very adherent and forms an excellent base for paint, the adhesion of which it promotes.

Paint may be applied either on the M.B.V. coating or on the metal surface itself. If a little paint is removed from the surface of iron or steel, the rusting process spreads under the paint and eventually quite a large area of paint may be dislodged. This does not occur with aluminium alloys.

Another surface treatment which may be applied to aluminium and its alloys is known as the anodic treatment. It is an electrical treatment carried out in either chromic, sulphuric or oxalic acid. A strongly adherent and wear-resisting coating of aluminium oxide is formed on the aluminium. This may be almost transparent, or may vary in colour from dark grey to bronze, according to the alloy and the process used. The coating is corrosion resistant, and the corrosion resistance may be increased by simple chemical methods. The film may also be dyed, very pleasing effects being obtained. It is thus possible to produce aluminium parts which match the furnishings of the home. Under special conditions, the anodized surface gives excellent reflectivity.

Aluminium alloys may also be electroplated. This is by no means an easy process and whatever coating is required it will be necessary to first deposit nickel, using one of several special methods, after which any other metal which is normally used for electro-deposition may be deposited on the nickel.

Aluminium alloys take a good polish. It requires some experience to obtain identical colour on a batch of parts, but, when properly done, the effect is very pleasing. It is necessary to lacquer a polished surface in order to avoid the effects of finger marks.

Aluminium itself is rather weak, its tensile strength being 4 to 9 ton/in.^{2} according to its purity and its mechanical and thermal treatment. On the other hand, it has excellent ductility and can therefore be shaped easily by mechanical means. It presents difficulties in the foundry, and hence is only used for holloware and similar castings. In the form of sheet, however, or as tubes, wire, or wrought sections, it is widely used. The wrought sections are made by extrusion, i.e., pushing the aluminium through a die, and a very wide range of sections is available. Messrs. British Aluminium Co., in their "Aluminium Facts and Figures," 1938, show a good selection of these, including rod, angles, channels, glazing beads, cover mouldings, handrails, gutterings, etc. The sections regularly supplied by this company number nearly 4,000. They say ("Aluminium Facts and Figures," 1938, p. 79): "The facility with which aluminium can be extruded is one of its major properties. Because of this, the use of extruded aluminium sections instead of machined or cast components will often show astonishing economy. Should any particular purpose not be met by one of the existing dies, the production of a new die is by no means an expensive matter, and would be justified when the total requirements were very small." Owing to the high ductility of aluminium, extruded sections can easily be bent.

Sheet is supplied in several forms. As

a result of mechanical or thermal treatment, it may be "hard," with a tensile strength of more than 9 tons/in.^{2}, "half hard," with a tensile strength between 7 and 8½ tons/in.^{2}, or "soft," with a tensile strength between 5 and 6½ tons/in.^{2}. The surface may have a bright finish, a frosted or satin finish, or a specially polished mirror finish. If it is to be anodized, it should be ordered as "anodizing quality."

Flat sheet is supplied down to 30 S.W.G., but for gauges thinner than 16 S.W.G. it is more economical to order the sheet in coil form.

There are several grades of "pure" aluminium, distinguished by their degree of purity: 99.99 per cent. aluminium sheet is used almost exclusively for reflectors. When treated by a special anodic process, it gives really high reflectivity.

99.8 per cent. aluminium is made into sheet and foil and is used where the highest corrosion resistance, electrical conductivity or ductility is required.

99.6 per cent. metal is similar to 99.8 per cent. quality, and may be used where its somewhat inferior properties are acceptable.

99 per cent. aluminium is available in a variety of forms, such as sheets, tubes, holloware, panelling, food containers, mouldings, etc. Its strength increases with cold work, but this increase is accompanied by a drop in ductility. It can be cold worked and welded.

Before the war, there were a large number of aluminium alloys available, and these were being added to at quite a rapid rate. Frankly, many of these were no better than those already in use, and there was no sound reason for their introduction. When the war came, both in this country and in America, the number of alloys to be used was reduced to a minimum. This simplified the supply problem and enabled scrap to be segregated and remelted to produce useful alloys. It is hoped that the number of alloys will remain small and that those who require aluminium alloys for use in our homes will order one of the well-tried alloys. They will help the producers and will help themselves by using an alloy the properties of which are well known because of wide and intensive application during the war.

A committee was formed during the war in order to guide and advise all the Government departments in the use of metals. A schedule was issued, known as the S.T.A. 7 schedule, and all Government departments order metals by reference to this schedule. It is hoped that, eventually, most private firms will also do so. Group No. 6—aluminium alloys—has recently been issued, and it will be found to contain a wide range of wrought and cast alloys from which material could be selected to fulfil any purpose for which an aluminium alloy can be used. The S.T.A. 7 schedule is available from the British Standards Institution, 28, Victoria Street, London, S.W. The grades of pure aluminium mentioned above are included in Group No. 6.

If greater strength is required than is obtained with pure aluminium, aluminium alloys are used. These may be divided into two classes—wrought alloys and cast alloys. Wrought alloys are so called because they can be formed into shape by rolling, forging or extruding. Cast alloys are, of course, those which can be used in the foundry for the production of castings. As before mentioned, the addition of alloying metals gives greater strength. The working of these alloys by one of the above methods gives still greater strength, and this can be further improved in some cases by heat treatment. Only those alloys which contain copper and/or magnesium can be heat treated. The following may be considered to be a good all-round selection of wrought aluminium alloys: AW 2 in the S.T.A. 7 schedule, 9-14 per cent. silicon. This is suitable for low- to medium-strength applications. The softer tempers have good ductility. It may be obtained in the form of bars and sections, sheet strip, tubes and wire. It is also available in the form of soft rivets and as welding rod. It is an excellent alloy for welding, and the rod is useful for welding castings in 11 per cent. silicon alloy: 5 per cent. silicon (AW 1) is another good welding alloy.

An alloy with a small amount of manganese (AW 3) may be used for similar applications to 99 per cent. aluminium. In view of its greater strength (11 to 15 tons/ins.^{2}), lighter gauges may be used than are called for in the case of pure aluminium. It may be spot or fusion welded.

Several alloys are available containing magnesium as their chief addition, generally with a little manganese also. The first of these, AW 4, is used for low- or medium-strength applications. It may be used for skins, pressings, floors, pipes, handrails, etc. The soft temper has good ductility (18 per cent. elongation). It may be spot or fusion welded.

AW 5 has a somewhat higher strength than AW 4, and may be used for similar purposes. It can be spot welded and, with care, may be fusion welded.

AW 6 has somewhat similar properties to AW 4, but is used for moderately strong parts in the half-hard temper or after-cold working soft material. It may be spot welded and is fusion welded with difficulty. Medium-strength rivets are obtainable in this alloy, which are driven cold as received.

AW 7 is used for high-strength applications. It is a similar alloy to AW 6.

AW 8 is a free-cutting alloy suitable for use in automatic machines. It is suitable for medium-strength applications.

We now come to a series of heat-treatable alloys. The full heat treatment of aluminium alloys consists of two processes. In the first one the alloy is heated at an accurately controlled temperature a little above 500 degrees C. and water-quenched. This is known as the solution heat treatment. In the second one it is heated at a lower temperature—about 150 degrees C.—with similar accurate control and either water-quenched or air-cooled. This is known as the precipitation treatment. Sometimes only the solution treatment is given. If maximum strength is required, with a somewhat lower ductility, both treatments are given and the alloy is said to have been fully heat treated.

AW 9 has quite a small addition of magnesium, and when solution heat-treated is used for low-strength applications. It has excellent ductility (20 per cent. elongation). When fully heat treated it may be used for moderate strength applications. It is specially useful for thin sections, such as glazing bars, and has good weldability.

AW 10 has medium to high strength according to the heat treatment given. It has good weldability. If annealed or given solution heat treatment it has very good forming properties and is used for structural parts and mouldings.

AW 11, medium to high strength according to heat treatment. It is used for structural members, as AW 10, and for mechanical parts.

AW 12, medium-strength wire and rivets. Rivets are supplied solution heat treated and are driven cold as received.

AW 13, wire and rivets for high-strength application. Rivets are headed from soft wire and must be given the solution treatment and driven within 2 hrs. or else stored in a refrigerator. The precipitation changes take place in this alloy at ordinary temperatures.

AW 14, fully heat treated forgings, suitable for use at elevated temperatures; good machinability. AW 15, suitable for highly stressed structures, but if corrosion resistance is required, only the solution heat treatment should be given.

AW 16 is normally used where highest strength is required. It is supplied fully heat treated, and has good machinability.

AW 17 and AW 18 are suitable for applications requiring high strength at elevated temperatures.

If corrosion resistance is important, the alloys which are least corrosion resistant may be "clad"; that is, covered with a thin coating of pure aluminium of the 99.5 per cent. grade. In this way a material with high strength may be given a surface which is corrosion resistant.

In general, wrought alloys possess better physical properties than cast alloys, but they are more expensive because of the way in which they are prepared. If cheaper parts are required, especially if the numbers required are small, or are likely to vary, castings would be preferable. Three kinds of castings may be obtained in aluminium alloys, namely, sand, gravity die, and pressure die castings. If only a limited number of castings are required they should be made by means of sand moulds, because the cost of the gravity or pressure die would be prohibitive. Again, if the casting is of complicated shape, or is very long, it will be made in sand. If large quantities are required, or if dimensional accuracy is necessary, die castings are called for. The decision as to which kind of die should be used would depend upon several factors.

If there is undercut on the casting the pressure process cannot be used, but a gravity die with either a steel core made in several parts, or a sand core, can be employed. If some sections are rather thick the casting would not be produced satisfactorily in a pressure die. Again, if heat treatment is required, to give maximum strength, pressure die castings would not be chosen as they do not lend themselves to heat treatment. Neither are they easy to anodize. The size of the casting also controls the choice of process, as the pressure process is only suitable for small castings. On the other hand, if absolute accuracy of shape is required, with such dimensional limits as $\pm$ .002 in., or if it is desired to produce small castings which require no machining, except perhaps the reaming of a few holes, the pressure process is indicated. The process is very suitable for the production of castings with wording or diagrams cast on. Really sharp impressions are obtained. It should be pointed out that if the letters are raised on the casting the cost of making the die is much less than if they are sunk. If castings are required very quickly to enable work to be started on a few houses. wooden patterns could first be made, perhaps of a fairly rough type, and a fair amount of machining may be necessary to obtain the component in its final shape. Meanwhile, the die is being made, and when it is ready castings will be produced which will require very little machining, in the same alloy as was used for the sand castings. This adaptability of aluminium alloys could be made great use of when large numbers of parts are required, first very quickly in small numbers, and later in gradually increasing numbers. A new process has recently been introduced whereby castings are made in aluminium dies instead of iron dies. This process is likely to enlarge the scope of die casting, and it appears probable that such things as window frames will be cast by this method instead of being built up from wrought sections, or cast in sand, a method which would necessitate a fair amount of after treatment in order to obtain a good-looking surface.

In both the pressure and the gravity-die casting process inserts of heavy metal such as brass or steel are " cast in " to the casting, by placing them on a secure seating in the die and running the metal in in the usual way.

The alloys which may be used for all three casting processes are those to Air Ministry specification D.T.D. 428 and D.T.D. 424, and to British Standard Specification 2L33. These are Nos. AC 1, AC 4 and AC 6, respectively, in the S.T.A. 7 schedule. They are not heat treated. The first two are prepared in the aluminium refinery from scrap returned from aluminium foundries and machine shops, and are therefore comparatively cheap. 2L33 must be pure, and as the molten metal requires a special treatment known as modification it is a little more expensive. This alloy is one of the best in existence for casting really thin sections. It has good ductility; the specified figure is 5 per cent. elongation, but 10 per cent. is generally obtained.

Another alloy produced from scrap and given a specification during the war by Light Alloy Control is L.A.C. 112. This is a somewhat similar alloy to 2L33, and is very useful for pressure die castings. It is AC 2 on the S.T.A. 7 schedule. Light Alloy Control developed another alloy known as L.A.C. 113A from scrap which contained zinc. It is quite a good alloy, and its comparatively high specific gravity, due to its high zinc content, would not be detrimental to its use in houses. It is AC 3 on the S.T.A. 7 schedule.

AC 5 is an excellent corrosion-resisting alloy, and might be found very useful for special applications. where corrosive conditions may be met with. None of the above castings are heat treated, and if cheapness were the primary consideration when choosing an alloy, one of them would no doubt be chosen.

We now come to heat-treatable alloys. For general use, there are two alloys, numbered AC 7A and AC 7B. These are grouped together because they have somewhat similar compositions, different additions being made to refine the grain. They can both be used for sand or gravity die casting.

If high strength is required, especially if some ductility is also needed, high-purity alloys are used which require close technical control and great care in casting and heat treatment. Two alloys of this type are the magnesium, corrosion-resisting alloy AC 9, and the copper-containing alloy which is numbered AC 10A, if given a single heat treatment, and AC 10B, if given a double heat treatment. These alloys are by no means easy to use in the sand foundry, and in the gravity die shop are only used for castings of small size or simple shape. Nevertheless, a very large tonnage of both sand and die castings has been cast during the war for aircraft parts. If somewhat lower tensile and elongation figures are acceptable, and especially if the casting is difficult to cast, AC 8 could be used. This is similar to AC 6 and has excellent casting properties for either sand or die castings.

There is a type of alloy which, after being heat treated, may be used at fairly high temperatures (say, 300 degrees C.), without losing the benefit of heat treatment. These are classed as the piston alloys, but they may, of course, be used for other purposes. One of these alloys was developed by Light Alloy Control and was labelled L.A.C. 10 (AC 11). Like the other L.A.C. alloys, it was developed in order to use up scrap, and is therefore a comparatively cheap alloy. It is only used for light-duty pistons. Another piston alloy (AC 13) was developed by the National Physical Laboratory during the 1914-1918 war for high-temperature use, and called Y alloy. It is often looked upon as the cast equivalent of the wrought alloy Duralumin. There are two high-strength piston alloys which are improvements on Y alloy. These are AC 14A and AC 14B. They have a higher tensile strength and are rather more castable.

If an alloy is required which withstands high temperatures reasonably well, and, in addition, has a comparatively low coefficient of expansion, AC 12 may be found suitable. It should be noted, however, that this alloy has the worst machining properties of all the aluminium alloys, and requires considerable care and experience if a first-class surface finish is to be obtained.

No doubt many of those who contemplate using aluminium or its alloys in the construction or decoration of our homes would like further details of the alloys given above, and might also like to know if there are alloys which would be specially suitable for some new or unusual application. Full details as to specified composition and physical properties, and the heat treatment required, if any, are given in the relevant Air Ministry (D.T.D.) or British Standard (B.S.S.) Specification. The available equivalents to S.T.A. 7 alloys are as follow:—

	Aluminium	Equivalent
A 4	99 per cent. aluminium ingot	B.S.S. 2L31
	99 per cent. wrought bars and sections, as extruded	B.S.S. L34
	99 per cent. tubes, ½ hard	B.S.S. 4T9
	99 per cent. sheet and strip, soft	B.S.S. 2L17
	99 per cent. sheet and strip, ½ hard ..	B.S.S. 2L16
	99 per cent. sheet and strip, hard	B.S.S. 2L4
	99 per cent. wire and rivets	B.S.S. L36

Wrought Alloys		Equivalent
AW 3	Sheet and strip, ¼ hard	D.T.D. 653
	Sheet and strip, ¾ hard	D.T.D. 213A
AW 4	Bars and sections, as extruded	B.S.S. L44
	Tubes, soft	D.T.D. 310B
	Tubes, ½ hard ..	D.T.D. 440
	Sheet and strip, soft..	D.T.D. 634
	Sheet and strip, ½ hard	D.T.D. 606
AW 5	Sheet and strip, soft..	D.T.D. 180B
AW 6	Wire, welding rod and rivets, soft	D.T.D. 303
AW 7	Bars and sections, soft	D.T.D. 297
	Tubes, soft	D.T.D. 190
	Sheet and strip, soft..	D.T.D. 182A
AW 8	Bars for machining (free cutting) ..	B.S.S. 1080
AW 11	Bars and sections, solution H.T. ..	D.T.D. 443
	Bars and sections, fully H.T.	D.T.D. 423A
AW 12	Wire and rivets, solution H.T.	D.T.D. 327
AW 13	Wire and rivets, solution H.T.	B.S.S. 2L37
AW 14	Forgings, fully H.T...	D.T.D. 130A D.T.D. 410
AW 15	Bars, sections and forgings; solution H.T.	B.S.S. 6L1 B.S.S. 2L39
	Fully H.T.	D.T.D. 364A
	Tubes, solution H.T...	B.S.S. 5T4
	Fully H.T.	D.T.D. 464
	Sheet and strip, solution H.T.	D.T.D. 603 B.S.S. 5L3
	Sheet and strip, fully H.T.	D.T.D. 646
	Aluminium - coated sheet and strip, solution H.T.	D.T.D. 390 D.T.D. 610
	Aluminium - coated sheet, fully H.T. ..	D.T.D. 546
AW 16	Bars and sections, fully H.T.	D.T.D. 363A
AW 17	Forgings and stampings, fully H.T. ..	B.S.S. 4L25
AW 18	Forgings and stampings, fully H.T. ..	B.S.S. 2L42

Casting Alloys		Equivalent
AC 1	Sand and gravity die ..	D.T.D. 428
AC 2	Pressure die	L.A.C. 112
AC 3	Sand	L.A.C. 113A
AC 4	Sand, gravity and pressure	D.T.D. 165
AC 5	Sand and gravity die ..	D.T.D. 424
AC 6	Sand, gravity and pressure	B.S.S. 2L33
AC 7	Sand and gravity die, A	D.T.D. 133C
	Sand and gravity die, B	D.T.D. 287
AC 8	Sand and gravity die, artificially aged, A..	D.T.D. 240
	Sand and gravity die, fully H.T., B ..	D.T.D. 245
AC 9	Sand and gravity die, solution H.T. ..	D.T.D. 300
AC 10	Sand and gravity die, A, solution H.T. ..	D.T.D. 298
	Sand and gravity die, B, fully H.T. ..	D.T.D. 304
AC 11	Sand and gravity die, fully H.T.	L.A.C. 10
AC 13	Sand and gravity die, fully H.T.	B.S.S. L35
AC 14	Sand and gravity die, A, fully H.T. ..	D.T.D. 131B
	Sand and gravity die, B, fully H.T. ..	D.T.D. 255

D.T.D. specifications may be obtained from H.M. Stationery Office, York House, Kingsway, London, W.C.2.

B.S.S. specifications may be obtained from the British Standards Institute, 28, Victoria Street, London, S.W.1.

Any further inquiries regarding either wrought or cast alloys should be sent to the Aluminium Development Association at the address already given.

In addition to joining aluminium alloy parts together by welding or riveting, it may be found desirable to fix aluminium parts to wood or similar material. If steel screws are used, there is always a danger of electrolytic corrosion, due to the setting up of a galvanic cell when two unlike metals are in contact, especially if they become wet. In order to avoid this trouble, aluminium screws may be used. They are available with raised, round or countersunk heads, and the sizes are given in the British Aluminium Co.'s "Aluminium Facts and Figures," 1938, pp. 74-75.

It is hoped that the above account has shown that aluminium and aluminium alloys are exceedingly useful from both the constructional and decorative points of view, for the construction and improvement of our homes. When considering, then, the various alternatives which can be used for the rapid construction of a large number of houses—why not aluminium?

New Low-priced Car in Aluminium

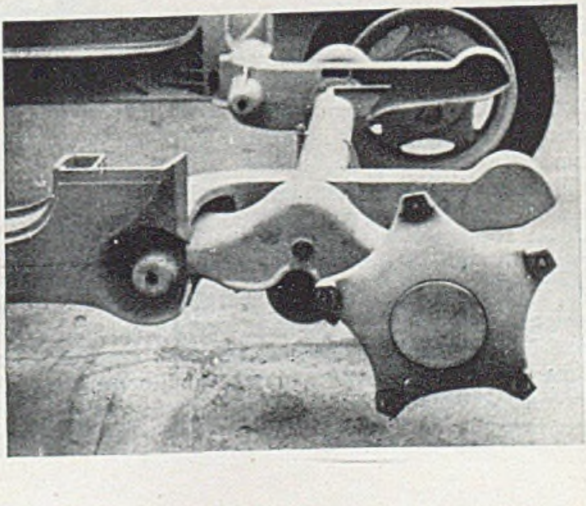
The People's Car of France, Designed by J. A. Grégoire and Referred to and Described on Many Previous Occasions in "Light Metals," will Soon be Seen on Roads in Great Britain. Manufacturing Rights for the British Empire for this Model Have Been Acquired by a British Group

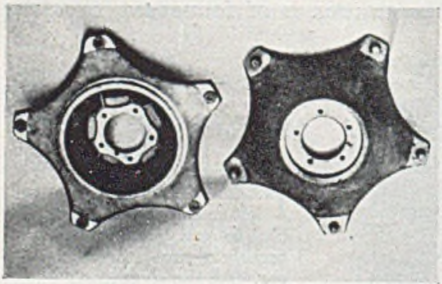
IT is known that Col. Devereux recently made a flying visit to Paris to secure the manufacturing rights of the car designed by J. A. Grégoire which the French Government has chosen to manufacture as the " National Car."

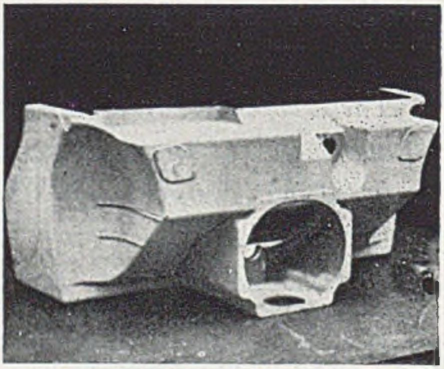
This car embraces many novel features, the chief of which is that the main structural members are made up of aluminium castings, a feature which offers great economies in production costs.

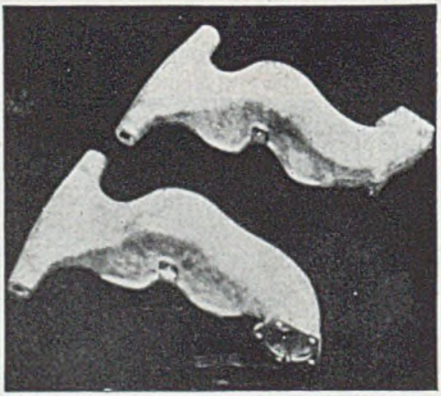
This four-seater, front-wheel-drive car weighing only 800 lb., is powered by an air-cooled 549 c.c. engine which gives the remarkably low petrol consumption of 71 miles per gallon at 30 miles per hour, and 58 miles per gallon at 60 miles per hour. The gearbox is of four-speed, overdrive

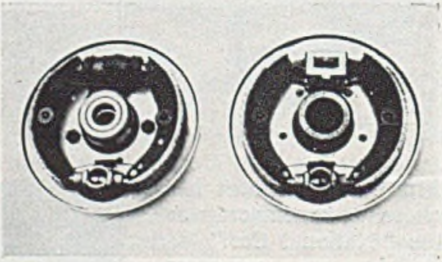
ILLUSTRATED at the left is a view of the chassis and scuttle assembly of the Grégoire car. All the significant elements here are in light alloy. Reproduced below is an illustration showing further structural details.











GROUP of components all in aluminium alloys which are amongst those which go to make up the Grégoire car. Aluminium-alloy castings form the bulk of the assembly.

type. There is independent suspension on all wheels.

It is anticipated that this car will be sold at a price considerably below any so far available in Great Britain.

Manufacture in this country, in conjunction with tractors and other cars, will be undertaken by W. D. Kendall, M.P., of Grantham Productions Ltd., who hopes to maintain an output of 500 cars per week.

This new car has been so designed as to take full advantage of the remarkable combination of lightness and strength offered by modern aluminium alloys, and of the highly developed production techniques which have been evolved during the war.

It is anticipated that the advantages derived from the extensive use of light alloys in this car will create a wide interest in the form of construction employed and that it will be incorporated in other manufacturers' designs.

For the manufacture of the aluminium-alloy castings, which fulfil the most important functions in this car, the great resources of Renfrew Foundries Ltd., owned jointly by Almin Ltd., and Rolls-Royce Ltd., will be available.

NEWS—General, Technical and Commercial

A Novel Refrigerator Car

ANOTHER instructive application of aluminium alloys to transportation is noted in the Aluminum News Letter—October, 1945. Illinois Central Rail Road have, in the design stage, a novel refrigerator car to be constructed from aluminium alloys, and which, by the use of collapsible bulkheads, can be transformed to a box car in a few minutes. The van will weigh about 14,000 lb. less than the refrigerator car in use at present.

Co-operating to perfect the design were the United States Fruit and Vegetable Association, Car Construction Committees of the Association of American Railroads, and the Aluminum Company of America.

Aluminium—"Now It Can Be Told"

CONTAINED in Alcoa's News-Letter for October, 1945, are stories of the part aluminium played in the atom bomb, in body armour for warplane crews, and in D.D.T. mosquito fighting equipment.

Uranium slugs were "canned" in aluminium sheaths to protect them from corrosion and to transmit the heat evolved to water. Originally, armour vests during the war were made from manganese steel, but it was found that aluminium alloys were resistant to small shell fragments. These protective vests, made of aluminium, nylon and canvas, weighed only 44 oz. per sq. ft. of protection, 38 per cent. less than the earlier airman's ferrous armour. The insecticide D.D.T. and pyrethrum were used in a solution of Freon contained under pressure in a container consisting of an aluminium tip and syphon assembly.

Air Pressure Tight Castings

ILLUSTRATED in the latest Alcoa News-Letter is another novel use of gravity die castings. Wagner Electric Corporation, St. Louis, Mo., are producing a transportable high-pressure air container for the servicing of motorcar hydraulic brake systems.

The container assembly is approximately spherical in shape, but the interesting feature is that two hemispheres are produced by permanent mould methods and then welded together.

Announcing Formation of Almin, Ltd.

IN conjunction with Lazard Brothers and Co., Ltd., and Erlangers, Ltd., Col. W. C. Devereux, F.R.Ae.S., has incorporated Almin, Ltd. (i.e., Associated Light Metal Industries), in order to implement his plans for the scientific development and extended application of light metals and their alloys.

The new company, of which Col. Devereux is managing director, has a capital of £2,000,000, and the other directors are Mr. P. Horsfall as chairman, Mr. Leo d'Erlanger and Mr. Spence Sanders. Through subsidiary or associated companies it will co-ordinate the financial and commercial policy of a group of undertakings, extending from scientific research and engineering development and design through all stages from the refining of the metals and alloys to the production of finished light-metal goods. These undertakings include International Alloys, Ltd., which with its subsidiary, Light Alloys Products Co. (Birmingham), Ltd., is the largest British producer of high quality light-alloy ingot; Renfrew Foundries, Ltd., which has been established, and is owned jointly by Rolls-Royce, Ltd., and Almin, Ltd., in order to acquire and operate commercially the largest and best equipped light-alloy foundry in Europe at Hillington, near Glasgow; Warwick Aviation, Ltd., which will continue to be managed by its founder, Mr. L. E. Metcalfe, as a fabricating unit and manufacturer of finished articles; a forging and extrusion unit, now being formed; and as the life centre of the group, a research institute devoted to the metallurgy of the light alloys and kindred studies for the service not only of the Almin group but of anyone who wishes to avail himself of its resources.

The operating companies, associates with Almin, Ltd., already employ more than 5,000 people and there is every reason to believe that the group will before long provide employment, directly or indirectly, for many more in a branch of industry in which this country possesses knowledge and skill unsurpassed anywhere in the world.

It is not the intention for the time being to make an offer to the public of shares in Almin, Ltd., or its associated companies, or to seek a Stock Exchange quotation.

Aluminium-magnesium System

THE latest addition to the Institute of Metals Annotated Equilibrium Diagram Series is that of the aluminium-magnesium system. By G. V. Raynor, M.A., D.Phil. (Institute of Metals Annotated Equilibrium Diagram Series No. 5. 11¼ ins. by 8¾ ins. Pp. 6 with 1 fig. 1945, London: The Institute of Metals, 4, Grosvenor Gardens, S.W.1. 6d. post free.) It contains (a) the diagram reproduced on a generous scale and based on what is regarded as the most reliable work in each phase field; (b) a table giving all important data connected with the diagram; (c) a number of critical notes; and (d) a list of reference.

Nos. 1 to 4 of the series are still available, price 6d. each post free. They deal respectively with the aluminium-zinc, copper-tin, copper-zinc and copper-aluminium systems.

Death of G. J. Edwards

WE regret to announce the death, on November 3, of Mr. G. J. Edwards, Chairman and Managing Director of Edgar Vaughan and Co., Ltd., Legge Street, Birmingham, in his 64th year.

Mr. Edwards was well known and highly respected in the oil industry and engineering trade, with which he had been associated for the past 36 years.

Institution of Metallurgists

AT a widely representative meeting in London on November 28, it was announced that a professional institution for metallurgists had been formed. Dr. Harold Moore, C.B.E., the President, who for many years was director of metallurgical research at the Armament Research Department, Woolwich, and later director of research for the British Non-ferrous Metals Research Association, said that while metallurgy was one of the oldest of the arts, it was one of the youngest of the sciences. Metallurgists were well served with learned and technical societies, but there was no organization that could represent their common interests, express their corporate views, or give the hallmark of a recognized professional qualification in metallurgy. For a long time there had been a widespread desire for a new organization admitting only qualified metallurgists and having functions supplementary to, but independent of, those of the existing metallurgical institutes and societies.

The Institution of Metallurgists had, therefore, been incorporated with the active help of the Iron and Steel Institute and the Institute of Metals. The provisional council had already drafted regulations for admission by examination and otherwise to three grades, Fellows, Associates and Licentiates. "It is the intention," said Dr. Moore, "that the Institution, by setting high standards of competence, shall serve the public interest and make an important contribution to industrial efficiency. Possession of the Institution's qualifications will be evidence of capacity to undertake responsible work as a metallurgist." At the meeting, high officers of kindred institutions voiced a warm welcome to the new organization.

R.-R. Foundry, Hillington

THE Rolls-Royce aluminium foundry at their Hillington, Glasgow, factory is to be continued into peace-time production under a new arrangement between Colonel W. C. Devereux, F.R.Ae.S., and Rolls-Royce, Ltd., and the Ministry of Aircraft Production.

The range of projected mass-produced goods includes office and domestic furniture, cooking and kitchen equipment and utensils, domestic equipment of every type, and an equally wide range of products in the industrial sphere, for the shipbuilding, aircraft, vehicle and transport industries as well as for industry in general. The greater part of the output will be aimed at the export market.

Planned in 1938 and brought into production in June, 1940, the foundries reached their maximum output of aircraft engine castings in 1943, when an aggregate output of 7,800 tons was achieved.

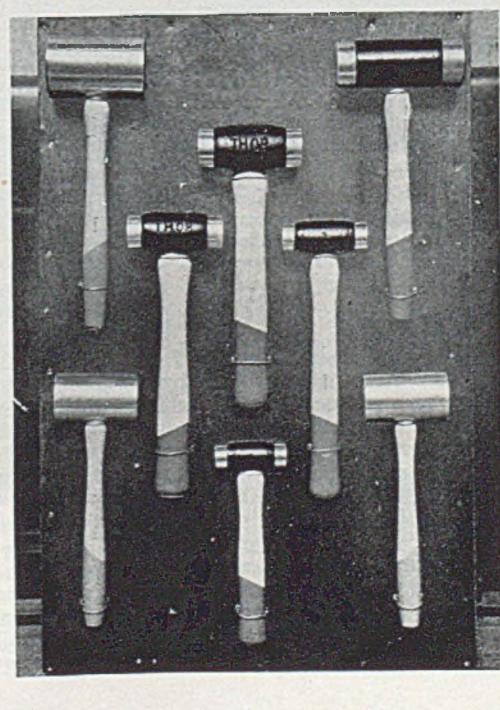
Aluminium Houses by Blackburn

THE first aluminium houses at Dumbarton have now been erected by Blackburn Aircraft, Ltd., Dumbarton, whose yard, throughout the war, turned out Sunderland flying-boats and other types of aircraft. This change-over was achieved only six days after the last of the 250 flying-boats made by the factory had been launched. C. A. Oakley, regional controller Ministry of Aircraft Production, stressed, however, that the yard was essentially one for the production of aircraft and that it was essential that that should not be ignored. When flying-boats were again in demand, he hoped to see the Blackburn yard producing them.

Major F. A. Bumpus, managing director of Blackburn Aircraft, Ltd., also pointed out that the factory was a peace-time planned unit and not a war-time development. He would be glad, he said, to see a return to the production of aircraft as soon as possible.

"Aluminium—War to Peace"

LEFT:—Milking pail and container for liquid chemicals by F. Braby and Co., Ltd., Bristol. Both items are of large capacity and their construction in light-metal results in a welcome reduction in deadweight.



BELOW: — Panel of special hammers by "Thor," Birmingham. These tools have light-alloy heads on wooden shafts and are more comfortable to use than copper hammers and, for some purposes, may even replace the rawhide type.

THE centenary year of aluminium is drawing to a close. It has been a period not without its progressive changes. Long experience and intensive scientific research within many factories, finds the light-metal industry again ready to play an essential part in the national peace-time campaign for export and overseas markets.

Within a few weeks of the German capitulation, the aluminium industry opened in the heart of London a show which, throughout the month of June, attracted some 8,000 visitors a day. That first demonstration aroused not only the interest of metallurgists from all parts of the world, but evoked the praise and admiration of artists, designers and craftsmen alike with a display of industrial skill which has set new standards in exhibition technique. Even Selfridge's, that house in Oxford Street famous for its triumphs of presentation, declared the aluminium exhibition to be one of the most successful they had ever staged for the benefit of a critical British public.

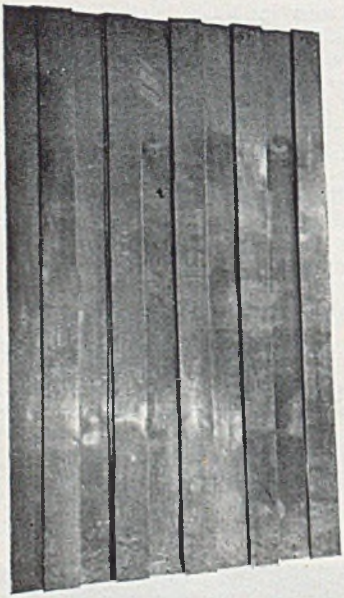
Thousands of sight-seers at that first showing in London saw the true significance of it all, and realized that a milestone in progress had indeed been reached—the Aluminium Age, a promise of events which bid fair to lighten and brighten a war-weary world.

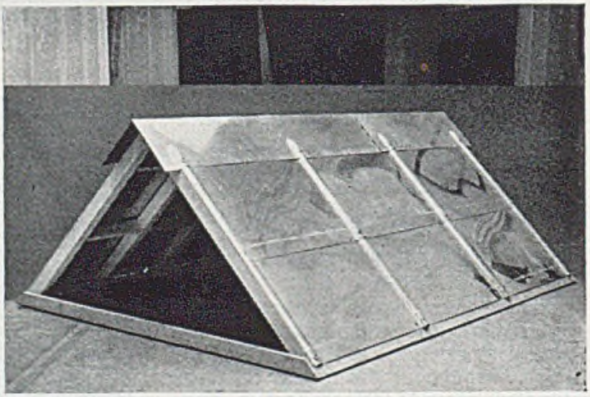
Inspiration was evident at the very entrance to the exhibition, in that array of murals brilliantly conceived by Ralph Lavers to show the various processes by which aluminium is produced and fabricated. Those who saw the screen representing the "Foreword" to the story of aluminium—a mural with metallic lettering which stood out like polished silver on a black-dye anodized ground surrounded with motifs to indicate "Genesis," "Stone Age," "Bronze Age," and "Iron Age"—understood how cleverly the artist had depicted the steps by which the present Age of Aluminium has evolved. This hall of murals has accompanied the aluminium exhibition on its tour of the provincial cities, and, infallibly, the same deep impression has been created.

In Birmingham, where the attendance was even greater than London, was found an insatiable demand for booklets, pamphlets—any kind of literature which provided details of the exhibits. On show there were two new exhibits worthy of mention—a greenhouse with detachable glazing bars in aluminium alloy by the Patent Glazing Co., Ltd., of Birmingham, and a sailing canoe by Warwick Aircraft. Co., Warwick, together with a 3 h.p. outboard motor by the Norman Engineering Co.

The new greenhouse demonstrated admirably the advantages of aluminium-alloy glazing bars, showing not only a saving of weight and a greater lighting area, but also a detachability which most gardeners greatly desire. Aluminium glazing bars have been in use for more than 14 years, and in this country have competed very successfully with those of other metals. The effect of weathering on many installations has been recently investigated, and in all cases the findings were satisfactory. At Hammersmith Hospital, London, for example, the glazing bars—although they have been in position for nine years with no protective coating—are still in excellent condition.

From Birmingham, the exhibition was transferred to Bristol, where, at the Bristol Museum, on November 5, it was officially opened by Professor Andrew Robertson, President of the Institution of Mechanical Engineers. Professor Robertson drew attention to the great quantities of light metal which were now available and emphasized the need for engineers and constructors to examine the possibilities offered by light metals. He briefly outlined the history of aluminium and referred in particular to the resistance it offers to those corrosive influences responsible for the annual losses of such great quantities of structural steel work.





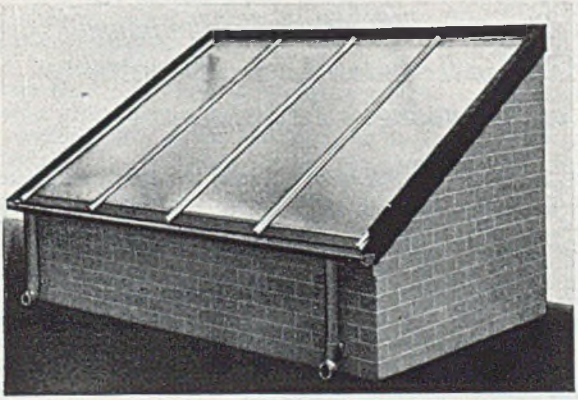
ABOVE:—Section of "square" corrugated heavy-gauge aluminium sheet by Steel Fabricators Ltd., Birmingham.

RIGHT:—Roof section exhibit by Austin Aero Co., show design and method of fixing the special light-metal-sheet tiles manufactured by this company.

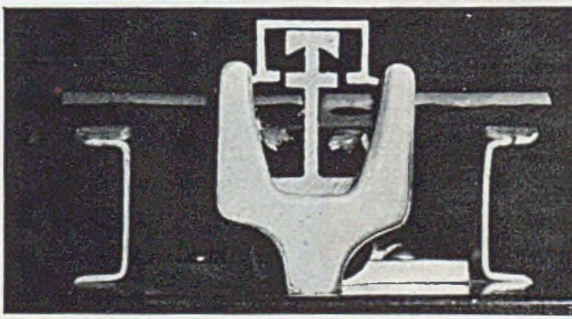
To the already growing list of items shown in Birmingham, three new exhibits were to be seen in Bristol; the most attractive of these were, undoubtedly, examples of colour printing by the "Decoral" process of E. S. and A. Robinson. This system involves the use of an anodized aluminium sheet into the treated surface of which colours are absorbed to produce, fundamentally, the same ultimate effect as in three-colour process work, with these differences, however, that the texture of the metal exerts a profound effect on the final result obtained and adds to the colours a "life and warmth" which cannot be obtained with paper. Particularly striking, for example, is the fact that, viewed from a very oblique angle, the subject and colours can still be seen.

From the design point of view it might be interesting, too, to comment on the system of framing adopted for the Robinson panels. The pictures were mounted on the front of wooden blocks, the moulded edges of which retreated from the picture. This is possible with aluminium, as the surface needs no protective glass covering and, furthermore, is, in itself, sufficiently bold to endure the prominence into which it is thrown.

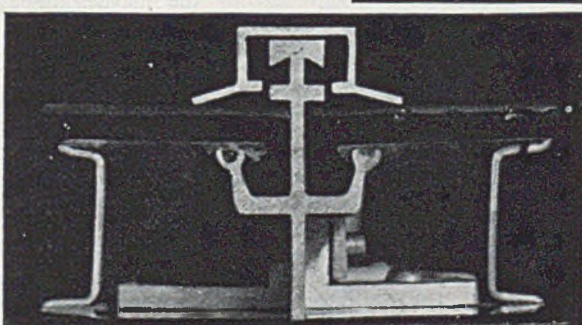
Attention was drawn in a past issue of "Light Metals" to special hammers with light-alloy heads; those illustrated at the time were of German origin. Similar items made in France were shown at the recent Paris Fair, and, at Bristol, was exhibited a panel of such hammers by "Thor" of Birmingham. Steel Fabricators, Ltd., of Birmingham, showed a series of massive corrugated aluminium panels, whilst the Austin Aero Co. provided a roofing assembly cover with specially designed aluminium tiles. F. Braby and Co., Ltd., of Bristol, placed on view a new milking pail, together with a light-metal receptacle for chemicals. Amongst the smaller exhibits was a model demonstrating a new draught excluder designed to fit any door and fabricated from light-metal section.



COLD frame fitted with special light-alloy detachable glazing bars as illustrated at the right and below.



RIGHT: — End view of patent glazing bar, showing stop. Below: — Patent glazing bar, showing open end.



Light Metals in the
FOOD AND ALLIED INDUSTRIES

Presenting the First Part of an Exhaustive Survey of the Theory and Practice of the Use of Aluminium and Aluminium Alloys in the Industrial and Domestic Processing and Handling of Foodstuffs

ALUMINIUM is no newcomer to those industries specializing in the preparation of goods intended for human consumption or which, because they come into contact with the human skin or with the inside of the human mouth, require especial care in all stages of processing and dispensing to guarantee their purity and to ensure that their nutritional or therapeutic value is maintained. Even more widespread is the use of aluminium, mainly as plain or decorated foil, in the packaging and display of these goods. Light metal also figures in the transport of the finished goods and, sometimes, of the raw materials, too, so that it can be said without exaggeration that aluminium has rather a universal appeal in all branches of such industries as the dairy, beer, wine, tobacco, confectionery, cosmetics, pharmaceutical and similar industries.

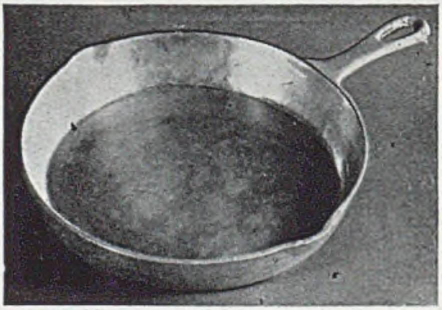


Fig. 1.—Frying pan for contact heating cast in pure magnesium. This has been in continual use since July, 1945, over an open gas flame; no distortion of the bottom has occurred. After use it has been regularly cleaned with steel wool and soap flakes together with washing soda; it still remains bright and shows no sign of corrosion although, after standing idle for a few days, it does acquire an easily removable not-unpleasant-looking whitish film (Courtesy Dominion Magnesium Co. Ltd.)

In many of these applications, aluminium has become the recognized material to use; in other applications, and even in cases where the advantages of aluminium are quite indisputable, progress has been slow. Often this has been due simply to lack of knowledge concerning the light metal and, as its characteristics become better known, a great advance is being made in this direction and more and more light metal is coming into service in the food and related industries. The main apprehensions of the would-be user of aluminium appear to be connected with questions of the durability and efficiency of aluminium plant, the possibility of the light metal exerting any detrimental effect on the foodstuffs and other products with which it comes into contact, and the question of cost. There are, therefore, two factors to be considered, namely, the reasons why light metals come into the picture at all and to what extent they can satisfy these three crucial points.

Dealing first with the ultra-light alloys because there is less to say about them, the magnesium-base alloys have only a very limited application at the present time in the fields under consideration. Whilst their resistance to attack by certain media is highly specific, their reactivity generally is too great to allow of their use in contact with more than a very small proportion of the raw materials and finished products and their use is confined rather to applications in which the utmost reduction in weight is required in parts not exposed to any considerable corrosion hazard. At the moment it is probably unwise to formulate any hard and fast statements in this regard, however.

With aluminium, however, the position is very different. Not only is it numbered among the few materials which can be employed safely in contact with foodstuffs, but it also combines valuable structural characteristics with simple methods of fabrication at a cost which is seldom excessive. For packaging and display purposes, the availability of aluminium in the form of foil is very advantageous.

As stated above, inadequate appreciation of these factors and lack of knowledge of the properties of aluminium and its light alloys have contributed largely to the slow rate at which aluminization is being adopted in certain branches of industry, and it is largely in an endeavour to alter this state of affairs that the present article is written. The plan of this contribution is, first, to examine briefly the general characteristics of the light alloys with emphasis on those properties which make these metals of interest to the food industry and, secondly, to deal in greater detail with realized, and a few potential, applications in specific fields.

Corrosion Resistance

One of the greatest difficulties which beset the chemical engineer and food packer alike is the selection of material which is least affected by, and which itself has the least effect on, the materials and atmospheres with which it comes into contact. Under normal conditions, the stability of aluminium is high and it shows very good corrosion resistance in comparison with most other common metals. Thus, on normal outdoor exposure, aluminium surfaces seldom suffer greater damage than the formation of a thin film of tarnish provided they are washed down once or twice a year to remove corrosion nuclei which, if undisturbed, are liable to develop into pits.

It is resistant to sulphur and many sulphur compounds in marked contrast to the yellow metals and, indeed, to most ferrous metals, and it can be relied upon to give good service in sulphurous atmospheres or in contact with sulphur-containing materials where the ferrous and yellow metals would be liable to attack leading to rapid breakdown of the metal component and to contamination of the product. Sulphur dioxide rarely has more than an insignificant action on aluminium whilst, even with sulphuric acid, the rate of attack is sufficiently low to enable the metal to give good service in many applications in industry where metal pans, etc., come into intermittent contact with this acid. This is important since many foodstuffs contain traces of acids or sulphur compounds which give rise to blackening or rancidity when they are packed in foils of other metals.

Aluminium is resistant to many oxidizing agents; in fact, the presence of oxidizing agents frequently lessens the attack by corrosive materials. Thus, increased resistance to chloride impurities in tap water is obtained in the presence of a little soluble chromate or dichromate.

Ammonia gas and ammonia solutions have very little effect on aluminium, but strong alkilis, and particularly the caustic alkalis, dissolve the metal and must not be allowed to come into contact with it. A number of milder alkalis such as sodium metasilicate, sodium carbonate (soda ash), sodium bicarbonate, trisodium phosphate and soft soap also tend to attack aluminium slowly and their use in cleaning solutions is best avoided except in the presence of a suitable inhibitor. Useful inhibitors, are, fortunately, quite commonplace materials and sodium silicate in amount about 10 per cent. of the alkali metal salt or about 1 per cent. of a soluble chromate or dichromate are generally employed. For application in the food industry, chromates and dichromates are best avoided because of the possible harmful effects of any retained chromium compound on the human system and the choice falls naturally on to sodium silicate. Thus, solutions containing 0.5-5 per cent. soda ash and 0.05-1 per cent. sodium silicate are efficient cleansing materials, for example, in the dairy industry, and yet, at the same time, cause no appreciable attack on the aluminium. Some proprietary cleansers for aluminium incorporate inhibited sodium metasilicate. It must never be forgotten, however, that the addition of silicate does not prevent corrosion by caustic alkalis, and under no circumstances can these materials be used for cleaning aluminium. It is believed that silicate functions as an inhibitor by virtue of the deposition of colloidal silica gel, and it is a fact that corrosion in the food industry is often reduced or even prevented altogether by the fortunate presence of sugars and various colloidal materials essential to the various food preparation processes.

Hypochlorite sterilizing solutions can be used on aluminium, although there is a slight attack. A solution of 1 oz. of chloramine T per 10 gallons of water is also used because its rate of attack is very much lower.

As far as brines are concerned, aluminium is seriously attacked by alkaline brines, but much less so by neutral solutions; in the latter case, attack may be almost entirely inhibited by the addition of a small amount (0.17 per cent.) of sodium chromate. Some of the special refrigerants such as freon (dichloro-difluoro-methane) have no action upon aluminium and aluminium-magnesium alloys.

The behaviour of aluminium in contact with solutions of the salts of the heavy metals depends on the difference of potential between it and the metal ion in question. Frequently this difference is considerable and the aluminium is attacked. Thus, in the case of copper salts, copper is deposited from the aqueous solutions on to the aluminium and a corrosive couple is formed which results in rapid and severe pitting of the aluminium. It is, therefore, important to guard against the formation of electrolytic couples in aluminium plant since it is nearly always the aluminium that suffers; zinc is an exception and has been made use of in a few instances in the chemical engineering field to provide protection to the aluminium at the expense of zinc sheets located nearby. Aluminium in juxtaposition to brass, for example, should be insulated from it in some way or another; for instance, by the use of a gasket or by means of shellac paint. Similarly, cooling brines should not be allowed to come into contact with copper, brass and other heavy metals during their circulation through the plant. Otherwise traces of yellow metal are dissolved and, later on, are thrown out of solution on to the aluminium, where they give rise to local galvanic attack on the light metal. This question of bimetallic corrosion need not deter would-be users of aluminium equipment, however. The phenomenon is well understood and its solution seldom involves more than the insertion of a few gaskets and the elimination of yellow metal from liquid circulation systems. Attention to these details is, however, vitally necessary to the successful working of aluminium plant and equipment.

Aluminium is scarcely attacked by dry steam and only slightly by wet steam, but high pressure steam is likely to erode the metal, particularly when the jet is perpendicular to the metal surface. The severity of erosion depends upon the velocity and temperature of the steam and on the hardness of the alloy. Attack by water depends upon the impurities it contains, but is usually very small.

Even more marked is the resistance of aluminium towards organic materials. Thus, saturated and unsaturated hydrocarbons have no action on aluminium and the metal possesses satisfactory resistance towards other substances which are found in small amounts as impurities in hydrocarbons and hydrocarbon products (sulphurous materials, for instance), or which are used in admixture with them to secure certain desirable properties.

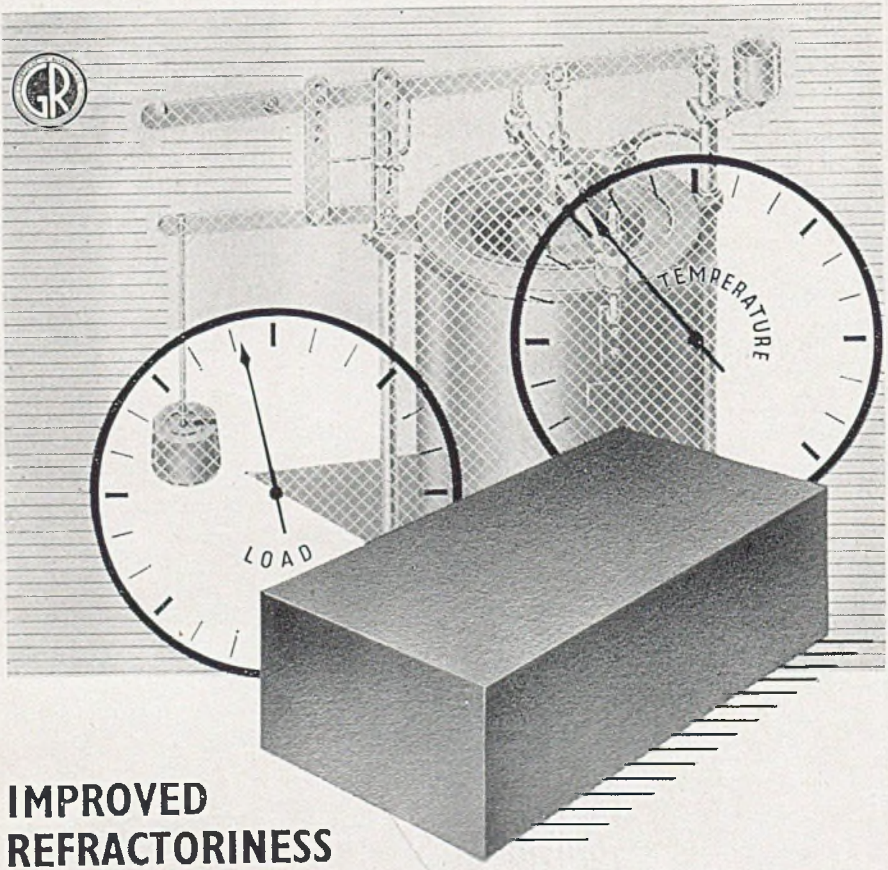
Generally speaking, alcohols are without effect on aluminium, but the influence of small amounts of impurities may, on rare occasions, be very marked.

Ethers uncontaminated by acids are without action on aluminium, whilst amines, like ammonia solutions, may give rise to a slight initial attack as a result of which an adhesive and rather impermeable layer of corrosion product is soon formed on the metal surface and which prevents further attack unless it is destroyed by, for example, an inorganic base or a halogen salt.

The fatty acids vary quite widely in their effect on aluminium, but, in general, attack is negligible at normal temperatures. Gross quantities of impurities may accelerate attack and not infrequently corrosion by dilute solutions is greater than with concentrated solutions. Nevertheless, aluminium must be classed as one of the most satisfactory metals to use in contact with fatty acids and, in point of fact, it is already used extensively in industries treating fatty acids at normal temperatures in the construction of storage tanks and so on. The use of aluminium equipment prevents that darkening and discoloration of the product so inseparable from the use of other metals such as iron and copper.

Considerable aluminium equipment is in use in the handling and transport of acetic anhydride, glacial acetic acid and acetic acid solutions, as well as for the higher homologues of acetic acid. The higher fatty acids (oleic, margaric, palmitic, stearic, etc.) are generally quite inert to aluminium even after prolonged contact at the boiling point provided they are not completely water-free. Formic acid is the only real exception. This material attacks aluminium fairly readily and no adequate protection is available.

Ethyl, butyl and amyl acetate and other esters of the fatty acids which are employed in industry as fruit essences, perfumes, solvents and intermediate products have no effect on aluminium. Since, moreover, the metal is not attacked by small amounts of retained acetic and sulphuric acids which are employed in the esterification process, aluminium is revealed as a most suitable metal to employ in the handling, processing



IMPROVED REFRACTORINESS UNDER LOAD *AT HIGH TEMPERATURES*

THE load-bearing properties of refractory products assume ever greater importance in the design of furnace structures. This arises from the insistent demand for more efficient furnace operation and increased outputs, which entails the use of higher temperatures and heavier loads. General Refractories' products keep abreast of all requirements by the operation of a system of strictly controlled processing in which importance is placed upon raw material selection, grading and high temperature firing. Widely used throughout the country and overseas, G.R. products provide a complete answer to the vital need for strong, stable, and lasting furnace linings.

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and transport of these materials since it introduces no contamination to impair the odour, taste or colour of the product.

Aluminium equipment has given considerable satisfaction in contact with formaldehyde. Not only is it practically unaffected by the aldehyde, but, in addition, it does not accelerate decomposition of this rather unstable substance, a behaviour which is in marked contrast to almost every other metal. Care should be taken, however, to ensure that the aldehyde is free from formic acid.

The halogen compounds of the hydrocarbons (ethyl chloride, ethylene chloride, dichlorethylene, trichlorethylene, perchlorethylene, chloroform, carbon tetrachloride, ethylene bromide, etc.), and such materials as iodoform, have no action on aluminium at normal temperatures when dry. Should any decomposition occur, however, the corresponding halogen acid is formed and the metal is liable to severe corrosion.

The halogen acids, and the halogens, too, for that matter, all attack aluminium strongly, although the high purity metal does exhibit some resistance to dilute solutions, even of hydrochloric acid. In some cases, however, the effect of these acids can be largely inhibited, certain resins and aryl sulphides being effective in this respect. Thus, the effect of hydrochloric acid on aluminium is largely inhibited by the addition of quinoline or benzyl sulphide and such inhibited acid has been recommended for cleaning equipment free from beer scale, milk stone and boiler scale. The advantage of this material over the nitric acid which is more commonly employed appears to lie in its more rapid action, together with its freedom from the evolution of noxious brown nitric fumes. In addition to such isolated and specialized applications as this, information on the effect of such potent reagents as the halogens and halogen acids is relevant since these materials, in small amount, may come into contact with the light metal through slight decomposition of other products or through the retention of these substances from earlier processing.

Whilst the vulnerability of aluminium to such corrosive substances as the halogen acids and caustic alkalis is admittedly a great drawback, it must not be forgotten that aluminium does not stand alone in this respect. Brass suffers badly from the effects of caustic, while even stainless steel is not immune to hydrochloric acid.

Of direct interest to the food industry is the effect of the dibasic and hydroxy acids such as oxalic, maleic, succinic, lactic, tartaric, citric and malic acids, since these are present in many food products, fruit juices, sour milk, and so on. These acids and their solutions have only a slight attack on aluminium at normal temperatures. This attack, which is largely independent of concentration, increases with rise in temperature and becomes much more pronounced at 60 to 70 degrees C. It can, however, nearly always be reduced to negligible proportions by the presence of colloids or fats which act as inhibitors; milk, for instance, has less effect on aluminium than an aqueous solution containing only lactic acid in the same concentration as it was contained in the milk. In consequence, in applying data relating to the effect on aluminium of pure aqueous solutions, it must be remembered that the action of the fruit juice or other product of complex constitution may be very different from that of the dibasic or hydroxy acids it contains. Aluminium equipment has given satisfaction in the processing of fruits and fruit juices and is being used to an increasing extent for their packaging.

Similarly, albumen and gelatine are without action on aluminium and equipment in this metal has given every satisfaction in the production of gelatine for human consumption. Whilst glucose (grape sugar) and pure lactose (milk sugar) are without action on aluminium, light metal is unsuited to the production of the latter since the crude milk sugar contains acids which attack the metal.

The action of glues on aluminium depends on their pH and their composition. Usually, neutral glues are without action on aluminium, although alkaline or acid glues may cause some pitting. In view of the large demand for such products as paper-backed aluminium foil, special adhesives have been developed and these have given every satisfaction. There is, in fact, no special difficulty in the adhesion of aluminium beyond that of narrowing down the field of available adhesives and selecting one with sufficient adhesive power in view of the smooth nature of aluminium foil surface and one which does not contain a corrosive constituent. The fact that this creates no special difficulty is exemplified by the quantity of backed foil which has been used satisfactorily to date for the wrapping of a multitude of different food products. Tests for the action of a glue on aluminium should be thorough and exhaustive since corrosion may not commence for some time. This fact is of special importance with glues for attaching aluminium foil to papers.

(To be continued.)

Light-alloy Chassis-cum-body

A Brief Account of a New Commercial Vehicle of 6-tons Capacity and Platform Area 161 sq. ft.

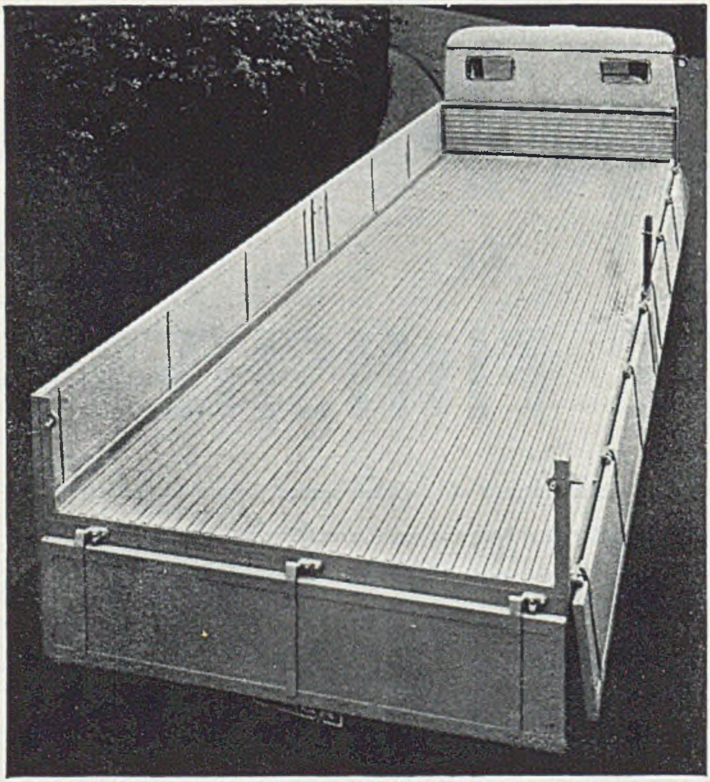
IN "Light Metals," 1939/2/11 was noted a remarkable vehicle of light-alloy construction built by Jensen Motors, Ltd., of West Bromwich. About that time, four of these vehicles were completed: they differed in various respects but all embodied the same principles. Throughout the war they have been in constant use and have covered many thousands of miles apiece, without suffering any troubles due to the materials used or the methods of construction.

One was involved in a serious accident, being hit broadside on with such force that it was turned on its side, and its load was thrown over a hedge. This caused damage which with many conventional designs would probably have necessitated a new chassis frame, amongst other things. In this case, however, the side members were straightened and the diagonals re-riveted, since which repair the vehicle has been in regular use with entire satisfaction.

Apart from such a special case as that, it is instructive to learn that every rivet in those four vehicles has held tight, and there has been no sign of corrosion.

Using the experience gained with the early models, together with the lessons learnt in war-time fabrication of a variety of products, this same company has now designed and built the JNSN lightweight commercial vehicle which combines the same basic light-alloy construction with carefully selected mechanical com-

THIS three-quarter front view of the new JNSN gives a good idea of the size of the cab in which, incidentally, some cadmium-plated steel tubing is employed.



MEASURING 23 ft. by 7 ft., the loading area of the new JNSN is believed to be the largest available on any make of 4-wheeler. The two-part drop sides close on to a detachable centre post. Renewable timber inserts give long life to the corrugated aluminium-alloy floor.

ponents by specialist manufacturers. The vehicle is well able to take advantage of its legal maximum speed of 30 m.p.h., due to an unladen weight of less than 3 tons, although it can carry loads up to 6 tons.

While on the subject of carrying capacity, it may be noted that the loading area of the body is no less than 161 sq. ft.; the length and width are 23 ft. and 7 ft. respectively. With little doubt, this must make it the largest platform on four wheels under the regulations in this country. The corresponding overall dimensions of the complete vehicle are 27 ft. 6 ins. and 7 ft. 6 ins.

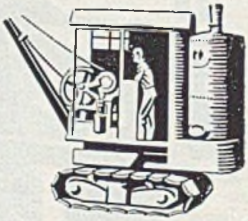
The body and the chassis together form, in effect, a unit. Two straight and deep I-section light-alloy beams extend from end to end of the vehicle, being joined by cross-members of similar section placed at suitable points, which include the spring anchorages. Diagonal braces, also of light alloy, are disposed along the length of the frame to increase lateral rigidity and to prevent any "lozenging." All the joints in this main structure are riveted.

Carried directly on the main beams, the floor consists of light-alloy sheet formed into rectangular corrugations. The spaces on the upper side of the floor are filled with timber strips which stand proud of the metal and take all the wear. In this way strength and lightness are combined with long life. Even when the wood has worn down, it can easily be replaced without great expense.

Drop-sides and end are fitted, the side panels being in two lengths for ease of operation, and the centre posts are quickly removable, so that they need not

The better use of

POWER



Where to look for further economies

YOU MAY HAVE DECIDED that you have reached the limit of improvement in efficiency of power usage. But are you sure? Why not make doubly sure by going through these Bulletins *point by point?* If your search reveals only a single possibility it will have been well worth while. The probability is that you will find many.

Turn up these Bulletins:

FUEL ECONOMY BY SAVING ELECTRICITY (*Bulletin No.* 13)

A rapid survey of the possibilities. Brief, practical pointers that take you straight to sources of substantial economy in electricity consumption.

THE INDUSTRIAL USE OF COMPRESSED AIR (*Bulletin No.* 29)

Compressed air is a very convenient medium of power transmission. But it can also be a great waster of power unless carefully supervised and maintained. This Bulletin tells you what to look for and how to put it right.

FUEL ECONOMY AT COLLIERIES (*Bulletin No.* 32)

The colliery official will find this Bulletin a real boon. It is a guide to the economical operation of colliery compressed air plant, but it also contains a brief summary of hints on steam boilers, prime movers, fans, pumps and so on.

SMALL VERTICAL BOILERS, STEAM CRANES AND SHUNTING ENGINES (*Bulletin No.* 37)

These power units are often neglected. How fuel losses can be reduced and operation improved is explained in a very practical way.

UNTIL YOU HAVE looked into the possibilities of every recommendation in these Bulletins you ought not to decide that your power is being used efficiently. If you haven't all the Bulletins ready at hand, please ask for the copies you need from the Regional Office of the Ministry of Fuel and Power.

ISSUED BY THE MINISTRY OF FUEL AND POWER

BESIDES the unusual radiator grille forming the name JNSN, the standard equipment of the new vehicle includes two driving mirrors, a fog and pass lamp, and a near-side lamp projecting a long, flat top beam in lieu of dipping. The width of the cab is especially to be noted.

interfere with the loading of lengthy articles. The hinges for the sides and end have integral hooks for roping on a load or attaching a tarpaulin.

By removal of the ends and sides, this body is converted, at once, into a flat platform, and later there will be other body types, including a van.

In the cab there is some steel framing, square tubes being used for certain parts to give the desired rigidity. The doors, for instance, have frames of this kind. These, and all other steel parts of the frame and body, are cadmium plated to prevent rust or corrosion. Although it occupies only 4 ft. of the vehicle length (there being the usual small gap at the front of the body) the cab is not at all cramped. Inside each front door pillar there is a hand-rail which makes entry very easy. The driver's seat is adjustable vertically as well as horizontally. There is exceptionally good visibility and all the controls are quite handy.

Just behind the driver on each side of his seat are the clearly marked containers for the brake fluid, the Kigass paraffin (for cold starting), and the chassis lubricating oil, which is distributed by a Tecalemit unit operated by the clutch pedal and embodying a separate small pump for each point requiring lubrication. In this way every such point is served without interference by what may be taken or refused by other parts.

Returning to the cab, the fuse box is accessibly placed and the battery is mounted behind the mate's seat, which, by the release of a large knurled-headed setscrew, can be tilted forward so as to facilitate inspection or topping-up.

Ventilation of the cab has not been overlooked. Apart from the fact that the driver's side of the windscreen can be opened, there are two adjustable ventilators in the front of the cab. In cold weather, these can be closed and warm air admitted through two ventilators in the bonnet. There is also a ventilator in the roof.

Cerium in Light-alloy Technology

Marked Improvements in Mechanical Properties may be Obtained by Regulated Additions of this Metal

INVESTIGATION into German war-time metallurgical practices, with special reference to ordnance, aircraft, and the like, has revealed the extensive use of cerium as an alloying element or as an additional agent in light alloys.

Cerium is always associated with its sister elements, but, fortunately, these exhibit closely similar properties, and it is not usually necessary, therefore, to isolate pure cerium metal. "Misch metal" is the name given to the metal mixture, the composition of which varies somewhat according to the origin of the raw material from which produced. The American cerium standard alloy falls approximately in the following range:—

Cerium	45 to 50 per cent.
Lanthanum ...	22 to 25 per cent.
Neodymium ...	15 to 17 per cent.
Praseodymium	8 to 10 per cent.
Terbium... ...	0 to 5 per cent.
Yttrium... ...	
Illium	
Samarium ...	
Iron	0.1 per cent.
Silicon	0.3 per cent.

This is the type of material generally used, and research indicates that the results, using technically pure cerium, are the same with respect to micro-structure, physical, and chemical properties.

The first reference to cerium in metal alloying was in 1904[37], when it was added to aluminium under a protective flux of chlorides of sodium and potassium, and, fundamentally, this procedure is probably still the same to-day. G. Ahrens, of the Cerium Metals Corporation, New York, under the heading of "New Uses for Cerium," gives the following information upon important alloys of cerium with both aluminium and magnesium in "Metals and Alloys," September, 1945, from which the bibliography included herein is also taken.

Generally, tests indicate an improvement in the micro-structure of castings from secondary aluminium when cerium is added. Heat treatment of cerium-containing aluminium alloys is stated to give improved tensile strength, elongation, and hardness. Cerium-aluminium alloys are recommended for pistons when creep and fatigue at elevated service temperatures are important considerations[34]. Support to this is given by the Battelle Institute's investigations on enemy ordnance[7], by Sutton's findings on "Non-ferrous Metals in Enemy Aircraft,"[8] and by Goddard's "Outlook for Magnesium."[9] Sutton's findings coincide with the report by Murphy[34] on light-metal alloys containing cerium. Latest British alloy specifications[35] mention five cerium alloys. Carrington[36] names cerium-aluminium alloys as the most useful and preferable in his light-metal alloy classification for foundries.

The Battelle report on enemy ordnance mentions an alloy of 93.0 per cent. magnesium, 5.5 per cent. cerium, and 1.5 per cent. manganese, which is used in a front cam follower guide in a BMWD-2 engine of a Focke-Wulf 190 German aircraft. The prime reason for the use of this alloy was high-temperature stability.

Another alloy comprised 93.7 per cent. magnesium, 1.45 per cent. manganese, 0.03 per cent. silicon, and 4.55 per cent. cerium, and this was used in a supercharger impeller on a German aircraft engine BMW 801A; ease of forging is given as the reason for this choice.

The 5.5 per cent. cerium alloy had a hardness value of 80 Brinell at room temperature and 45 at 400 degrees F.

Beck[10] states that the German alloy AM537 contains 0.5 per cent. cerium, has a density of 1.769 and the highest thermal conductivity of all magnesium alloys, and that it is markedly superior to the same alloy without the cerium addition. Greater fluidity of the alloyed magnesium in foundry practice is one of its reported attributes.

Beck gives micrographs which indicate marked grain refinement in magnesium-manganese alloys by the addition of cerium. Improvements are also noted in the following properties:—Modulus of elasticity, notch-impact, shear, deep drawing properties, wearing qualities, fatigue, and creep.

The Battelle Institute report adds confirmation to Beck's deductions, and commends the sound and perfect German castings as representing the highest state of the aluminium founders' art. Freedom from cracking in a very complicated casting, evident easy castability, good properties in the actual casting, freedom from porosity, shrinks, and other foundry troubles; these are quoted as a tribute to the alloy and technique acquired.

Although cerium is not always found in analysis, its presence is inferred. Borcher's[12] patent refers to the properties obtainable from the use of cerium in aluminium refining before casting, although analysis of the completed alloy showed no trace of cerium. The effect of cerium was well defined, and Schulte[13] confirms Borcher's work. Again, Smirnow-Verin[1] found 16.6 per cent. rejections in aluminium-alloy piston castings, 67 per cent. for cracking, 33 per cent. for porosity. By the addition of 0.35 per cent. cerium to the alloy, rejections for these faults were completely eliminated.

Houghton and Schofield[14] also report upon the beneficial effects from cerium additions to light alloys, and advocate a special melting technique to achieve the best results. Biltz and Pieper[20], in their paper on alloying practice, give further evidence that cerium in aluminium-magnesium alloys is beneficial for grain refining and scavenging effects, and add support to the belief that the excellence of the German castings depends in part upon cerium additions to the melt.

The National Smelting Co.[23] employs cerium as an optional addition to heat-resisting, low expandable aluminium alloys. Rolls-Royce[21] similarly regards it favourably in high heat applications for internal-combustion engines.

Wellinger and Keil[25] compare the German alloy "Mahle 549," which is a magnesium-cerium-manganese alloy, with 14 other high-strength aluminium alloys. This cerium alloy possesses better creep resistance. Desch[26] also shows that cerium-magnesium alloys have strength characteristics akin to those of the Y alloys.

Kratky[27] shows improved corrosion resistance in magnesium-cerium-aluminium alloys. The Magnesium Development Corporation[15] and the Société Le Magnesium Industriel de Paris[28] show improvement in the forging properties of light alloys from the addition of cerium, I.G.Farbenindustrie use cerium in piston alloys, and Specialloid, Ltd.[37], find cerium additions improve heat resistance and diminish thermal expansivity.

From these references, the evidence indicates that additions of cerium from 0.2 per cent. to 0.5 per cent. to aluminium and to magnesium alloys result in specific benefits, viz., improved grain structure, higher tensile strength, greater elongation, augmented hardness, improved creep resistance, better fatigue and thermal resistance, facilitated castability, less liability to cracking, and superior thermal properties.

REFERENCES

(1) *"Metal Industry," March* 30, 1945 ; *"Modern Metals," May*, 1945 ; *by S. Smirnow-Verin, Novosti Tekhnikie.* (2) *Borchers and Stokem, German Patent No.* 172,529; *Muthmann, "Annales,"* 1902, 231,320; 1904, 1,331; 1907, 116,355. (3) *Jukkola, Audrieth ; B. S. Hopkins, "J. Am. Chem. Soc.," Vol.* 56, 1934, *p.* 303. (4) *Thrombe, "Trans. Electrochem. Soc.," Vol.* 66, 1934, *p.* 231. (5) *Hirsch, "Chem. Met. Engineering," Vol.* 9, 1911, *p.* 940. (6) *"Z. f. angew, Chemie," Vol.* 28, *Part I, pp.* 319-328. (7) *"Metal Progress," Battelle Institute, February,* 1945. (8) *H. Sutton, "Metal Industry," April* 28, 1944, *and May* 12, 1944. (9) *G. Goddard, "Metal Industry," September,* 1944. (10) *Beck, "Technology of Magnesium,"* 1940 *translation from Beck,* 1939, *Germany.* (11) *Grain structures, Microphotographs from Beck's book.* (12) *Borchers, German Patent No.* 246,484. (13) *Schulte, "Metall und Erz," XVIII (N.F. IX), Vol.* 10, 1921. (14) *J. H. Houghton, T. H. Schofield, "J. Inst. Metals," Vol.* 60, 1937. (15) *U.S. Patent No.* 1,915,932, *Magn. Development Corp.* (16) *Barth, "Metallurgie," Vol.* 9, *p.* 261. (17) *Th. Goldschmidt, Essen, British Patent No.* 266,696. (18) *"Brass World," March,* 1920. (19) *Rolla, Jandellie, Caneri, Vogel, "Z. f. Metallkunde," February,* 1943. (20) *Biltz and Pieper, "Z. f. anorg. Chemie,"* 1924, *p.* 234. (21) *Heraeus Vacuum Schmelze, German Patents Nos.* 631,985, 740,480, *and U.S. Patent No.* 2,144,200. (22) *I. G. Farbenindustrie, U.S. Patent No.* 1,818,556; *"Amer. Foundryman's Assn.,"* 1921, *p.* 626. (23) *National Smelting Co., Canadian Patents Nos.* 424,133, 424,415. (24) *Rolls-Royce, French Patents Nos.* 797,714, 819,263. (25) *Wellinger and Keil, "Z. f. Metallkunde," Vol.* 35, *September,* 1943. (26) *C. H. Desch, Nat. Phys. Lab., Royal Aeron. Soc.,* 614*th Lecture,* 1937. (27) *Anton Kratkey, Australian Patent No.* 123,225, *Swiss Patent No.* 136,096. (28) *Le Magnesium Industriel de Paris, U.S. Patent No.* 1,816,983. (29) *I. G. Farbenindustrie, French Patent No.* 624,449 ; *British Patent No.* 263,755. (30) *Ullmann, "Encyclopædia," Vol.* 2, *Part III,* 1939, *p.* 181. (31) *"Metals and Alloys," February,* 1945. (32) *Catalogue of Cerium Metals Corp.* (33) *Muthmann, "Annales," Vol.* 46, 1904, *p.* 331. (34) *"Metallurgia," January,* 1945, *A. J. Murphy ; "Modern Metals," June,* 1945. (35) *Brit. Light Alloys Spec., "Light Metals," December,* 1944. (36) *"Light Metals," March,* 1945, *Carrington, S foundry alloy classifications.* (37) *"Automobile Eng.," October,* 1944, *December,* 1944 ; *"Light Metal Age," March,* 1945 ; *"Modern Metals," May,* 1945 ; *British Patents Nos.* 556,224, 557,070, 558,562.

LIGHT-ALLOY AUTOMOBILES

Comments by M. Boghossian, of L'Aluminium Francais, on an Account Which Appeared in "Light Metals," 1945/8/417

THE article given in "Light Metals," September 1945, aroused considerable interest in France, but due, possibly, to difficulties of communication, certain corrections are necessary regarding the specification and performance of the Mathis car. In the first place, the capacity of the engine is not 530 c.c. as stated, but 700 c.c., the stroke and bore figures being 75 by 80 mm., and although the power output of 15 b.h.p. is correct, it is achieved at 2,500 r.p.m. and a piston speed of 2,670 ft. per minute and not 3,000 r.p.m. with a piston speed of 2,370 ft. per minute as stated in "Light Metals." Moreover, side valves are used, not inclined overhead valves, and the transmission is through conventional Spicer joints and not tractor joints.

The maximum speed of this car is 63 m.p.h., and the fuel consumption realized is the remarkable figure of 95 m.p.g., and on the Grégoire-Panhard the corrected figures are 55 m.p.h. and 68 m.p.g.

On the subject of how far reduction in weight is affected by the mass of light alloys introduced, it is our experience that one should not seek to deduce any general law in this matter. However, we believe that it is possible to take a vehicle with an initial weight of 3,300 lb. and to reduce the weight by over 1,500 lb. by introducing only 550 lb. of light alloys.

The important relationship between weight reduction and drag reduction was particularly realized by Andreau when he decided to adopt three-wheeler layout for the Mathis. Although it may be true, as Pomeroy remarks, that the aerodynamic factor can be reduced by about 40 or 50 per cent. without going to the extreme of using three wheels, in the case of the Mathis a very much greater reduction has been achieved. It is, in fact, calculated that the drag coefficient of the Mathis is only 27½ per cent. as great as for the more conventionally designed Panhard of Grégoire. This reduction of nearly 75 per cent. has enabled Andreau to achieve a speed increase of some 10 m.p.h. with a very low output.

As mentioned before, the consumption figures for this car are almost unbelievably low—95 m.p.g. at 41 m.p.h. average point-to-point speed and 114 m.p.g. at a steady sustained speed of 44 m.p.h. These figures alone are ample justification for the recourse by M. Andreau to a three-wheeler layout, and to obtain stability with this arrangement a special study had to be made of springing and weight distribution. It would certainly be difficult to reduce consumption to the above figures with the conventional four-wheel type, and it is certain that it would be impossible to do so without going to the very maximum of weight reduction and drag reduction. The results given by this small car are, however, such that it becomes easily possible to imagine four-wheeled cars of greater capacity, larger overall size, more comfortable and with better performance than those now produced. We consider that it will be possible to produce a comfortable five-seater weighing less than 12 cwt. empty, having a drag coefficient about 60 per cent. lower than conventional practice and a fuel consumption of 44½ m.p.g. at 50 m.p.h.

OBJECT LESSON!

WE recently received the following letter from the Technical Editor of "The Motor":—

"For the past ten days I have been staying in one of the few undamaged buildings in Wiesbaden and have looked out over a square containing on one side the remains of the Rathaus and the windowless but relatively undamaged cathedral. On a broad piece of pavement on the other side of the square was the remains of a Wanderer car, a product of the Auto Union Co. Of this particular specimen nothing much was left; the wheels and tyres had been taken, the engine lifted out, the front seats had gone, the bonnet was a twisted piece of metal some yards away.

"Once upon a time, however, it had been rather above the ordinary run and had had a cabriolet type body with light alloy framework for the folding top. The body panels themselves were of steel and where the cellulose had been torn away they were rapidly rusting. The chromium plate on the lamps and windscreen was peeling off, leaving horrible orange scabs, but, shining like a light in darkness, were the still highly polished light-metal sections of the body; they appeared literally as new and provided a remarkable, because entirely accidental, proof of the corrosion-resisting properties of correctly selected light alloys."—L.P.

EDITORIAL & BUSINESS ANNOUNCEMENTS

ALL instructions, matter and passed proofs for all kinds of advertisements must reach the Head Office of "LIGHT METALS" by the 10th of each month to ensure insertion in the following month's issue.

"LIGHT METALS" is published in London, England, on the fourth Wednesday of the preceding month.

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None of the vacancies under this heading relate to a man between the ages of 18 and 50 inclusive or a woman between 18 and 40 inclusive unless he or she is excepted from the provisions of the Control of Engagement Order, 1945, or the vacancy is for employment excepted from the provisions of that Order.

Aluminium-alloy Die Foundry Manager. Vacancy exists for a young man, with initiative, and capable of taking responsibility, suitably qualified as assistant manager for gravity die-casting foundry, age 30-35, salary £500-£600. Replies will be treated in confidence. Box 8493, care of "Light Metals." 97-5175

Managing Director of light alloy foundry in Midlands wishes to get in touch with man about 30 to learn the business, and for immediate service in sales administration. For a suitable man there might be good prospects of qualifying in due course for a senior administrative position. Desirable qualifications are:—Good education, agreeable personality and good mixer, capable of taking responsibility, some engineering training, some knowledge of commercial procedure; salary £650-£700. Replies should give full particulars of education and previous experience, and will be treated in strict confidence. Box 8494, care of "Light Metals." 97-5174

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Vol. VIII. No. 95 LIGHT METALS