A 12-FT. ALL-WOOD CANOE

NEWNES

PRACTICAL MECHANICS

9D.

EDITOR: F. J. CAMM

APRIL 1947

AT WORK ON THE NEW 40-SEATER AIR LINER "AMBASSADOR" (*See page 247*)

PRINCIPAL CONTENTS

Rocket Propulsion

The Vickers-Armstrong Project—Pilotless Aircraft for Transonic Research

By K. W. GATLAND

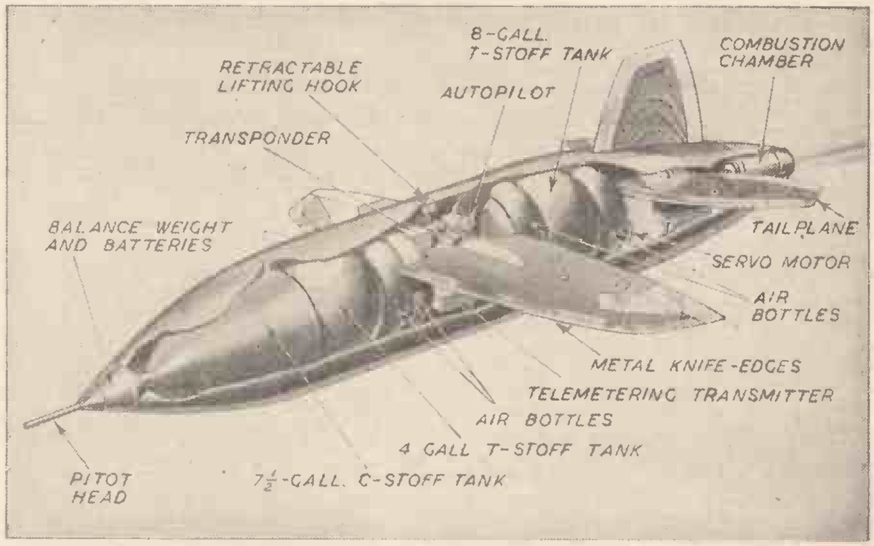
(*Continued from page 194, March issue.*)

THE first fully controlled aeroplane to achieve supersonic flight is almost certain to be American. There can be no doubting the success of the Bell XS-1 during its recent powered trials, and with at least three other machines featuring in the U.S.A.A.F.'s "S" (for sonic) programme, it would seem that some interesting times are ahead at Murac Flight Test Base, California. The Bell Aircraft Corporation is reported to have in hand a swept-back wing version of the XS-1, the XS-2, with Douglas developing an XS-3, a near "flying-wing," and Northrop a similar project known as the XS-4.

British Research Progress

It would be interesting to know exactly how all this compares with British research. On the surface, our progress seems slow. The Miles M.52 might well have been in the air *before* the XS-1 had its contract not been cancelled; and nothing further has been heard of the enterprising programme of research which features pilotless models built by Vickers-Armstrong, Ltd., first reported last July. The folly of passing judgment on the basis of public knowledge, however, is obvious.

In any event, a logical series of experiments with controlled models seems a proper *first* step. The ideal shape for transonic flight is yet a matter for experiment, and full-scale research at this critical stage seems in many ways a gamble—in life, material and man-hours. The tragedy which overtook Geoffrey de Havilland at speed in the D.H.108 is surely sufficient justification for not plunging directly into the design of piloted aircraft for even faster travel. This, however, is not to excuse the scrapping of a project so advanced as the M.52, with its detachable cabin ensuring reasonable safety for the pilot.



Sectionalised drawing of the Vickers-Armstrong rocket-propelled transonic aircraft.

The Vickers-Armstrong Project

The research programme which Sir Ben Lockspeiser, Director-General of Scientific Research (Air) at the Ministry of Supply, has before him should endanger no one, and yet provide complete data on a large variety of wing forms—and therefore virtually different aircraft—while involving minimum expenditure.

There are likely to be several models produced, each with some different arrangement of wing and tail, some tail-less, but all retaining the same bullet-like lines of fuselage.

The first model to come from Vicker's works at Weybridge was basically a 0.3 copy of the Miles M.52, and no doubt this has been produced mainly for static tests. Only when complete reliability is assured, both as regards its aerodynamic qualities and the accuracy of the air-to-ground recording system, can it be expected that models of other shapes will follow. In all essential respects, it serves the same purpose as the prototype of a full-scale aircraft, though the simile is not quite accurate. It was said at the R.A.E. when the model was first exhibited that five others would be built to this design.

The complete series will probably not be ready until sometime later this year.

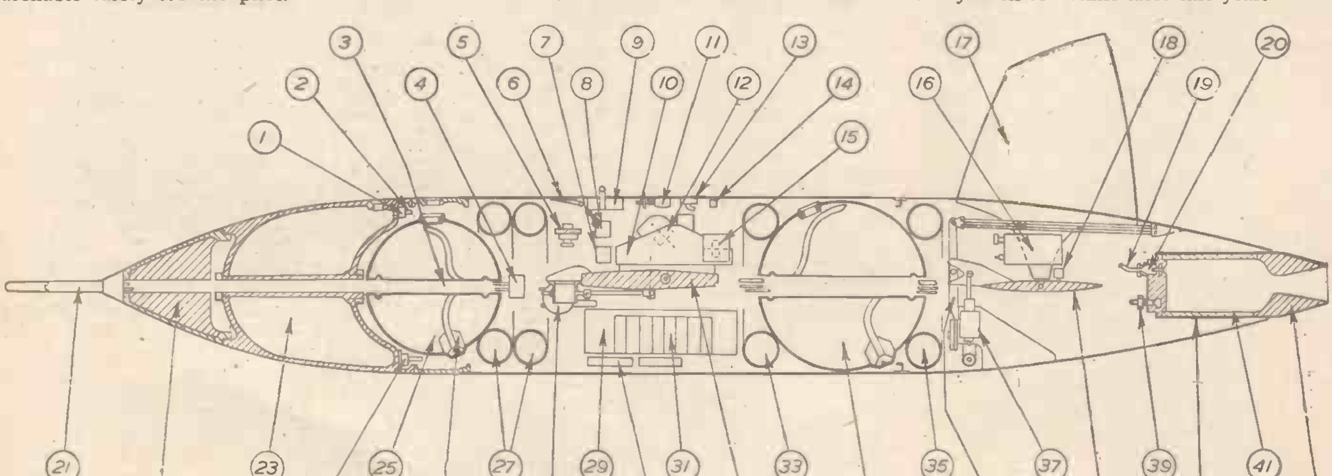


Fig. 94. Diagram of rocket-propelled aircraft giving nomenclature of component parts.

1. Non-return Valve in Air Pipe.
2. Air Pressure Pipe.
3. Pipe Conduit.
4. Air Speed Indicator.
5. Reducing Valve.
6. Hot Air—External Supply.
7. Longitudinal Accelerometer.
8. Normal Accelerometer.
9. Suspension Hook, Retracted.
10. Automatic Pilot.
11. Rocket-starting Starting Switches.
12. Position Gyroscope.
13. Electric External Services.
14. Air External Supply.
15. Rate Gyroscopes, Roll and Pitch.
16. Radar Transponder.
17. Fin.
18. Reactance.
19. Hydrogen Peroxide Inlet.
20. Mixing Valve and Burner.
21. Pitot Head.
22. Balance Weight.
23. Fuel—Alcohol Hydrazine Hydrate.
24. Safety Diaphragm.
25. Hydrogen Peroxide.
26. Anti Cavitation Vanes on Outlet Pipe.
27. Air Supply for Pressurising Tanks.
28. Servo motor for Ailerons.
29. Telemetering Six Channel Unit.
30. Oscillator.
31. Batteries.
32. Mainplane.
33. Air Supply for Pressurising Tanks.
34. Hydrogen Peroxide.
35. Air Supply for Controls.
36. Locking Device for Tailplane.
37. Twin Servo Motors.
38. Tailplane.
39. Alcohol Fuel Inlet.
40. Combustion Chamber.
41. Polygon Lining.
42. Carbon Venturi.

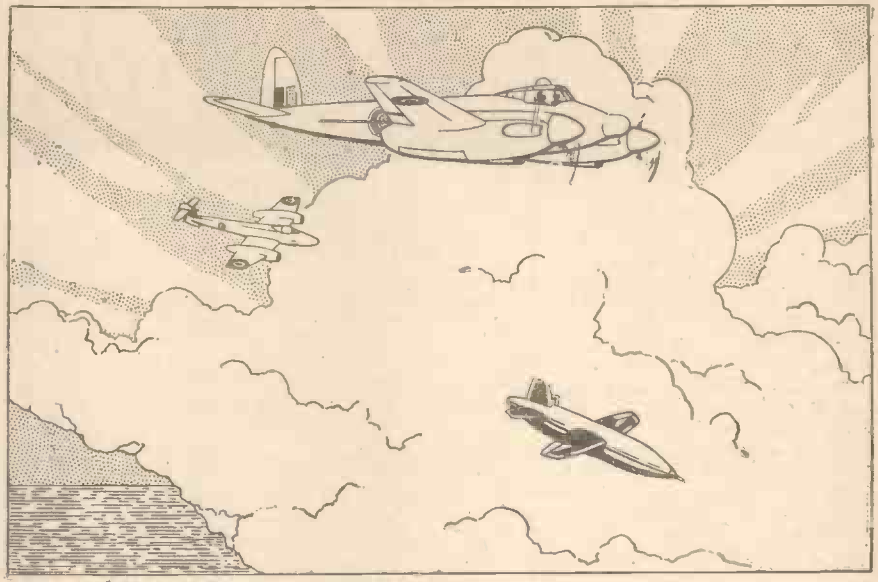
"Operation Transonic"

The scene for the actual flight experiments is set 36,000ft. above the Atlantic, a few miles west of the fringe of Cornwall, and a similar distance north of the Isle of Scilly.

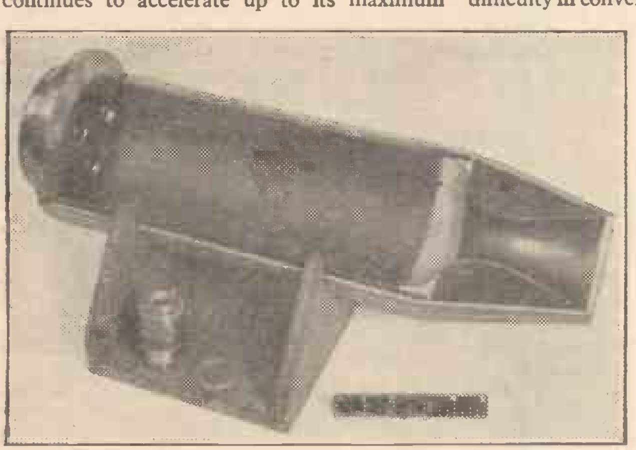
Each model will be taken up to height beneath a specially adapted "Mosquito" and released during level flight at 400 m.p.h. A single point suspension on the c.g. line of the missile is provided to secure the model beneath the 4,000lb. bomb-bay of its parent. To eliminate the drag that it would otherwise incur, this lug is spring loaded and immediately after release retracts flush with the skin surface.

The parent aircraft having dropped its load, climbs away sharply so that the slipstream of its propellers will have little chance of upsetting the model's trim. The auto-pilot in the missile comes into action immediately and a clockwork mechanism causes it to dive at an angle of 10 deg. for a period of 15 seconds before levelling out. There is a loss in altitude of about 1,000ft., which must be conceded to ensure undisturbed air and steadiness in the missile.

As soon as the missile assumes level flight, a diaphragm bursts and releases air pressure to the propellant system, feeding T-stoff and C-stoff in correctly metered proportions to the single combustion chamber. The mixture is self combusting and the resulting thrust drives the model up to sonic speed within the space of 18 seconds. It then continues to accelerate up to its maximum



A "Mosquito" releases a Vickers-Armstrong model as a "Meteor" races in to take cine-pictures.



Section of combustion chamber for Vicker's rocket unit, showing the carbon venturi.

Mach number of 1.3 (at 35,000ft.) which is reached in a total time of 70 seconds.

The propellant exhausts at this point and a horizontal glide of about 2-1/2 miles follows. Then, having decellerated to subsonic speed, the auto-pilot locks down the tailplane and the model plummets into the sea. From the time of release it will have covered over 22 miles in level flight, having attained maximum speed (880 m.p.h.) after travelling some 12 miles.

The course of each missile will be plotted by radar from a station in the Scilly Isles. This is arranged quite simply, a signal transmitted from the ground being picked up by the missile's *transponder* and retransmitted on a different frequency. At the same time, the pilot of a Gloster "Meteor" will attempt to obtain cine-photo's, and thus a complete picture of what happens during each test will be built up.

Advantages of Air Launching

The Vicker's models represent a considerable advance over those of the German "Feuerlilie" series; and not only because of their remarkably simplified power plants.

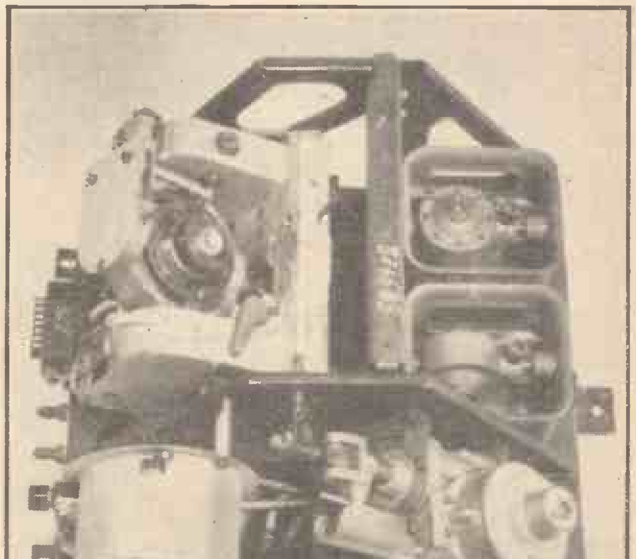
A rocket will operate with maximum efficiency only at *high speed* and in rarified atmosphere, preferably in *vacuum*. The Germans achieved the former ideal with di-lycol boosters, but by no means could they operate their missiles at effective altitude. It was not a case of no suitable aircraft being available. There would have been no difficulty in converting an Me.110, for example, to carry them up into comparatively rarified strata—the great problem was to obtain data from the models once they were released.

The German technique depended upon tracing the trajectory of models by means of cine-theodolites which, with air launching, was obviously out of the question; and having no such device as the telemeter, there was no ready solution. The use of graphical recorders within the models might have been a way out but for the fact that there was no apparent method of retrieving them in one piece. More often than not, a small crater in the ground would mark the resting place of a model and so there seemed no future in integral recording. Radio-control, with the possibility of bringing the models into a reasonable landing was likewise no salvation; the effective controlling range was not sufficiently great, and size and weight were also against it.

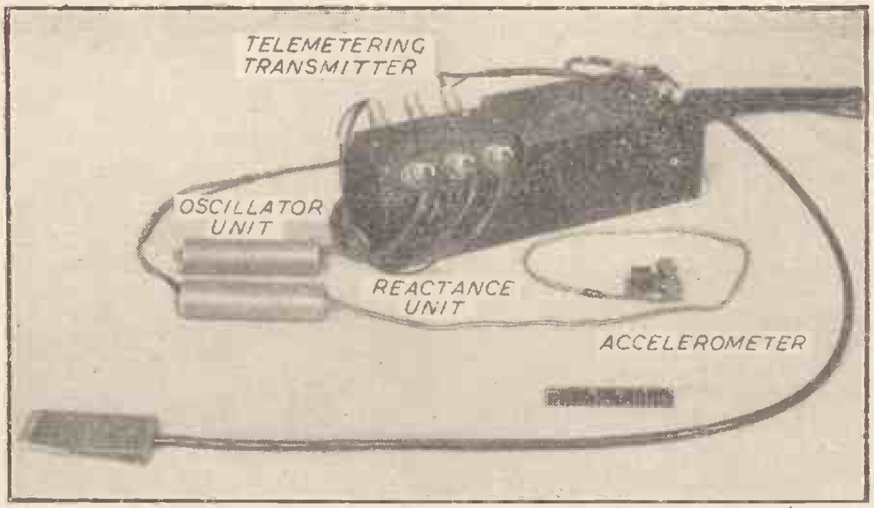
It is surprising that the only real solution, that of ejecting the instruments with their recording drums and landing them by parachute, does not appear to have been attempted. Such a device need not have been excessively complicated.

The Vicker's models operate under no such handicap. Despite their small size—the "first off" was only 11.83ft. long and 8.1ft. in span—each has its own telemeter which transmits six simultaneous readings; of dynamic pressure, static pressure, normal acceleration, longitudinal acceleration, combustion chamber pressure and tailplane angle. These signals are picked up by the ground station where the data is recorded and later tabulated to give comparative figures of performance for the entire series.

Accuracy and *simplicity of operation* are the key-notes of the telemeter which is becoming important in all flight test work. With parallel progress in radio-control, it should soon become possible to carry out the testing



The auto-pilot adapted from the V-1 unit. Components are as follow: (top left) position control gyro; (bottom left) clockwork mechanism; (top right) pitch control gyro; (centre right) roll control gyro; and (bottom right) altitude control unit.



The telemetering transmitter. The input leads for the six measurements are clearly shown. Note also how the metal insert in the wing leading edge is utilised as an aerial.

of full-size aircraft entirely by remote control. Perhaps this course will be adopted after the complete programme has been flown off, and data is available for the design of a full-scale transonic machine.

The Vicker's Project in Detail

The three main features that technicians of Vicker's and the R.A.E., Farnborough, are building into their transonic missiles are: (a) a bi-fuel rocket system based on the German "cold" units, yet of greater simplicity and improved efficiency; (b) an auto-pilot, and (c) the all-important telemeter. It is clear that German research has contributed much to the *detail* design, and yet it is the refinements made in the rocket system and the incorporation of the telemeter that, coupled with air-launching, have made these models outstanding.

The Rocket Unit

One of the most striking features of the rocket system is the simplicity of its combustion chamber. It is truly a remarkable piece of work and comprises only four main parts. The size and make up of the unit can be gauged from the accompanying photograph and it will be seen that there is a steel outer casing, swaged down at one end into which a machined carbon venturi fits. A $\frac{3}{8}$in. thick polygon insert protects the walls of the chamber and both this and the nozzle are set in position with a special ceramic paste, the joint being smoothed off to ensure good flow conditions. The injector plate, with its three stainless steel inlet nozzles, completes the assembly—the result, a perfect job without a single rivet or bolt. Approximate dimensions of the carbon nozzle are: throat diameter, 1.5in. mouth diameter, 3.5in., and the distance from the minimum throat diameter to the mouth, 4in.

The thrust developed by this motor is 209lb/lb. fluid second; the specific consumption, 17.2 lb/lb. thrust hour, and the actual temperature rise, 1,750 degrees Centigrade. As already mentioned, the unit operates on T-stoff and C-stoff, the same propellant as used in the Messerschmitt 163. These comprise hydrogen peroxide of 80 per cent. concentration (T-stoff) and a combination of 57 per cent. methyl alcohol, 30 per cent. hydrazine hydrate, 13 per cent. water. A small amount of potassium cuprocyanide is added to the C-stoff to catalyse the peroxide, thereby ensuring spontaneous combustion of the two components when they meet in the chamber. The actual fuel/peroxide ratio (by weight) is 0.300.

The swaged end of the rocket motor is exposed to the airstream at the missile's rear. There are two spherical tanks for the T-stoff, having a total capacity of 12 gallons, while $7\frac{1}{2}$ gallons of C-stoff are carried in an annular casting at the nose. Three tubular tanks in the shape of rings (in a word, "toroidal") comprise the other main items of the propellant system, supplying air to pressurise the propellant tanks. A fourth toroidal container is provided as an air drive for the gyroscopes. The location of these components will be apparent from the drawing, Fig. 94.

It will be seen also that a pitôt head projects from the nose of the missile and that the readings are conveyed to an air-speed indicator placed just aft of the small T-stoff tank, the capillaries being taken through the centre of each of the forward tanks. A similar arrangement allows for the passage of feed lines and electrical leads through the aft T-stoff tank.

The longitudinal accelerometer, normal accelerometer, and auto-pilot are all situated above the mainplane, with the six channel telemetering unit, oscillator and batteries beneath. The radar transponder is mounted above the tailplane.

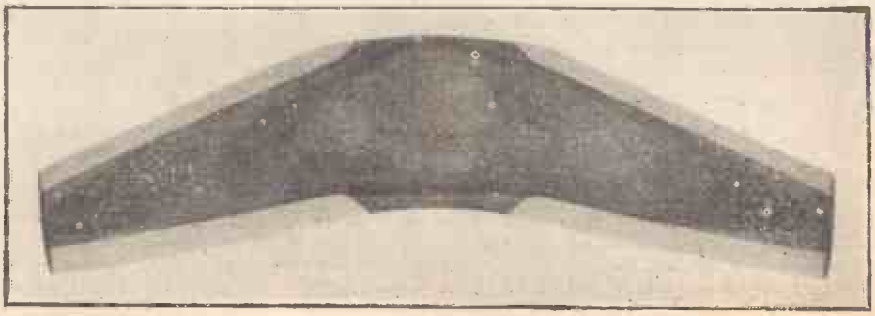
Constructional Detail

The fuselage shell is of light steel, 18in. in diameter with an ogival nosing and tapered towards the rear. The supporting and stabilising surfaces are all true bi-convex sections, the mainplane constructed in laminated mahogany, and the tailplane and fin in laminated birch.

An ingenious feature of the wing make-up is that stainless-steel "knife-edges" are bonded into the upper surface of the leading edge, serving the purpose of aerials for the telemetering transmitter, with similar profiles of light alloy let into the lower surface of the trailing edge and at the tips. There are also light alloy plates bonded into the centre of the top surface and others near the aileron cut-outs to strengthen the structure. The tailplane and fin embody similar inserts, those in the leading edge of the former being utilised for the radar transponder.

Both wing and tailplane are single-piece units passing through the fuselage. The wing is rigidly fixed at 0 degrees 33 minutes to

(Above) Mahogany wing, and (below) birch tailplane for the Vicker's transonic rocket-propelled aircraft.



Birch wing for the Vicker's transonic rocket aircraft.

the body axis, and the aileron links (from servo unit to the aileron lever arms) are taken through internal channels. Like the arrangement for the Miles M.52 (and also in the Bell XS-1), the tailplane is "all-moving." It is pivotally anchored so as to obtain elevator effect under the action of its servo motors, having a range of movement 8 degrees down and 5 degrees up. The lower part of the fin, rooted approximately a quarter the overall length of the fuselage from the rear, provides a point of pivot for the tailplane.

Conclusions

It is inevitable in a research undertaking of this nature that many alterations will be necessary before final perfection is achieved. The telemeter, for example, though a development of far reaching importance, is still virtually untried (especially in a machine of model proportions) and if, in the course of preliminary trials, its accuracy should be found anything less than 100 per cent., the missiles will not be acceptable for their exacting job. It will obvously be no use building the complete series of models if no account can be made of their performance.

New technique presented by the use of a transponder may prove equally troublesome.

No doubt there have been, or are yet to be, free-flight tests of the preliminary models to ensure good flight and control characteristics, after which it may well be that some components will require modification, perhaps complete redesign. Thus, the experimental work may be expected to continue for some time until, in the light of further flight tests, the design is found to possess no apparent fault. However, as nothing has been heard of the project for some time, it seems likely that a fair amount of the ground work is by now completed.

Those contributing to the Vickers-Armstrong project are to be congratulated on a very plausible approach to some difficult problems. The programme is admittedly less spectacular than the American, but it is nevertheless of great importance and may still pay dividends should tests prove the A.A.F.'s "XS" series premature.

(To be continued)

A 12ft. All-wood Canoe

Constructional Details of an Inexpensive Craft for the Amateur Canoeist

By R. J. CHAMBERLAIN

An easily-made craft designed for speed and buoyancy.

THIS canoe has been designed for speed, extra buoyancy and grace in shape. It is made entirely from wood, such as deal. This helps to keep the craft light in weight and, despite the softness of deal timber, it is strong—much stronger than a canvas-covered canoe.

It has a large water-tight compartment at the bow and three smaller water-tight compartments aft. Thus, in the event of a capsize, the canoe will not sink should it become flooded with water. In any case, every canoeist should be a person who can swim, particularly if fond of "coasting" around a seaside resort or crossing large inland lakes.

To fully appreciate the length of the canoe illustrated, a distance of 12ft. should be marked out on the ground. It may be considered that the craft is too long, but one feels a sense of greater security in a 12ft. canoe than, say, a 9ft. model. Indeed, some canoes are over 14ft. long.

The length of 12ft., with a beam (width) of approximately 24in. and a bow depth of 14in. and a stern depth of 8in. ensures that the canoe is suitable for carrying most individuals. It is intended for a single passenger only, but if a craft is wanted for two youths, it is a comparatively simple matter to build the craft as a double-seater type. This could be done by extending the fore end of the cockpit to the nearest forward hull-former framing, extending the length of the three footing laths and adding extra cross-pieces to make the extra seat. This alteration in plan may, be it noted, have effect on the construction of the craft, as described in this article, and the reader must make allowances, and use his own ideas.

A Suggested Design

To be quite frank, the sizes, drawings and shapes are presented more with a suggestive view in mind rather than a set principle. The construction is on the simplest lines possible with wood. Having got the general idea, the reader can no doubt plan his own particular canoe.

He should, to make his craft graceful, adopt the long, tapering bow and the "angled" deck and hulls. Wooden canoes with vertical hulls and bottoms identical in size and shape as the decks are easier to build, but lack a graceful, streamlined appearance.

The extremely high bow means that one can dash through fairly high waves in a choppy sea with a minimum of splash or spray. The cockpit coaming is an extra form of breakwater. Due to the shape of the deck (which slopes at each side from the centre) water trickles off almost immediately. And since the bottom is much narrower than the deck width, the craft, unlike the equidistant-sided type, will "settle" better in the water. These points must, therefore, be borne in mind.

The Bottom Shape

To lay the "keel," prepare the bottom piece. This consists of two 10in. wide by ½in. thick shelving boards tongued and grooved together, or alternatively, dowelled together, using ½in. dowelling and marine (waterproof) glue.

It is advisable to adhere the boards together unshaped and, when the glue dries, trim the joint with a smoothing plane and then proceed to mark the curvature shape. This is best done with a long lath of wood which bends easily. The lath is affixed with a nail at one end of the joint, kept out to width at the centre with another nail, then bent to the joint of the board at the other end and nailed. The bent lath serves as a guide for the pencil.

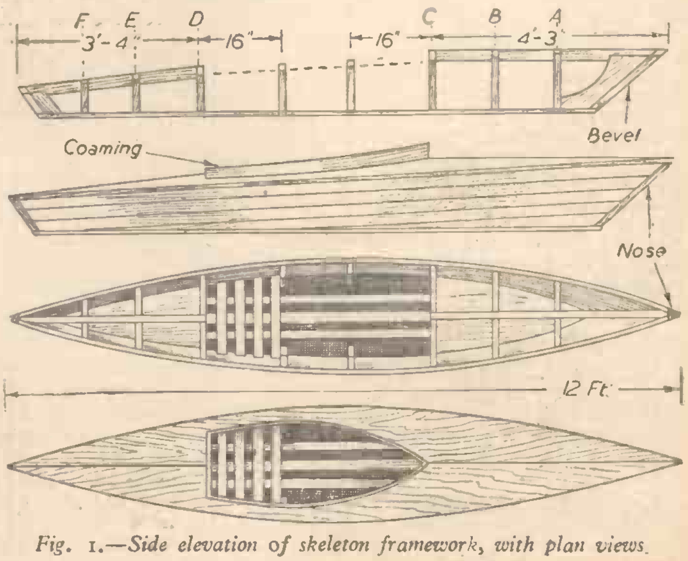


Fig. 1.—Side elevation of skeleton framework, with plan views.