NEWNES

PRACTICAL MECHANICS

AUGUST

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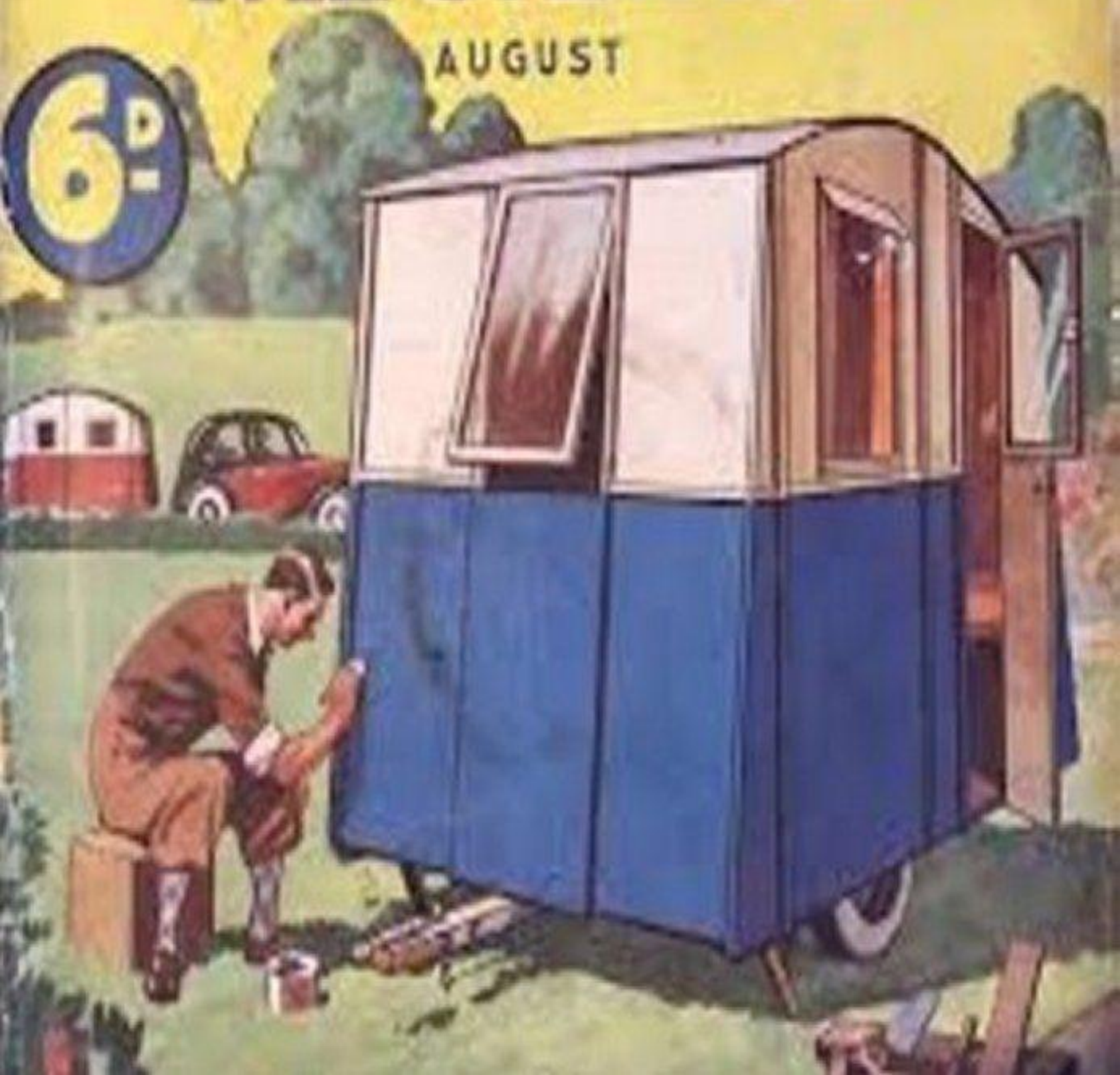

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PRACTICAL MECHANICS

VOL. IV. AUGUST, 1937 No. 47.

The £50 "Petrel" Contest

INTENDING competitors have already been advised that the Contest for our £50 cash prize for building and flying the "Petrel" described in recent issues will take place at Brooklands Aerodrome, Weybridge, on Saturday, August 14th, at 3 p.m. A large number of competitors have signified their intention of competing, and the contest promises to be one of great interest. The first prize is the largest ever offered in a model aircraft contest, and this will be run under S.M.A.E. rules, and will be judged by myself and judges appointed by the S.M.A.E.

Our Changing Times

SO many of the old scientific notions have been proved false that nothing to-day seems certain and absolute. Not so many years ago we were taught that light travels in a straight line, but Einstein has proved beyond all doubt that light rays bend. Perhaps this scientific doubt accounts for some of the questions I receive. We are still taught that a meteor falling through space has incredible velocity, glows and burns by virtue of its friction with the air. Yet, if you wish to cool a cup of tea you blow on it; a motor-cycle cylinder is cooled by its passage through the air and the faster you travel the cooler it becomes. Air in motion cools you, it does not make you warmer! A piece of red hot steel rapidly becomes cool if you swish it, and the temperature of a cane does not rise when you swish it through the air. These are some of the points raised by correspondents, many of whom seem unaware of the properties of heat and that heat can travel by conduction, convection, and radiation. Regarding the meteors, I am not going to dogmatise, for I have never been certain in my own mind that the large mass constituting a meteor can become red hot by rapid passage through the air. But stay! When you blow a blacksmith's fire it glows brighter! Here are some pretty problems, for those arguments which many of my readers so delight in if I can judge by the number of letters I receive which commence "to settle an argument. . . ."

Fair Comment

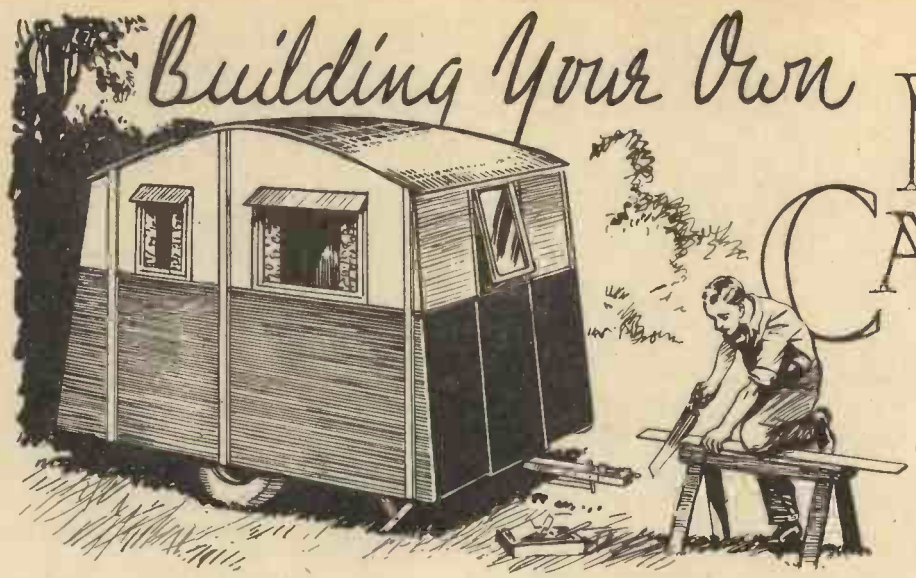
By The Editor

But the fact is that it is impossible to say with certainty that anything is certain. The factors of 4 or any other number are not absolute; the factors of 4, for example, can be plus 2 times plus 2; or minus 2 times minus 2; or minus 1 times minus 4. Not so many hundreds of years ago men believed that the earth was flat, in spite of all the evidence of the seasons that it must be somewhat round in shape. In fact, there are many learned people to-day who still believe that the earth *is flat*, and a society—the Zetetic Society—exists in the hope that it will some day convince the world that this is so. We must not laugh because others believe what we do not believe. Not so many years ago it would have been considered fantastic to suggest that we should be able to sit in our own homes and by means of a simple piece of apparatus to listen to a voice hundreds of miles away. Yet the telephone and wireless are part of our civilisation. Less than fifteen years ago to suggest that we should be able to *see* what was happening many miles away would merely have raised a smile. It is an accomplished fact to-day. A couple of centuries or so ago visionaries who were ahead of their time suggested that men would fly in the air, and towards the latter part of the last century Old Mother Shipton forecast that carriages would go without horses, at a time when the motor car had not been dreamed of. The whole world scientifically is in a state of flux. The fantasy of to-day is the practicability of to-morrow. The practicability of to-day is merely the basis of to-morrow's miracle. A miracle is merely something which has not been done before. Once it is repeated it shakes down amongst the accomplished things and becomes the commonplace. Nothing seems impossible, for it is only nothing which is impossible. We have to readjust our ideas from time to time to meet changing conditions. This present generation has seen the birth of the motor car, the aeroplane, wireless, television, the telephone, and in this respect it is the most fortunate generation in the whole history of the world. The future will surely see the development of the rocket ship and stratospheric travel. It seems absurd to-day just as all things have come to pass that at one time have seemed absurd. The inventor, however, of 1937 may find it just as difficult to convince a sceptical world of the value of his ideas, but at least he is free to dream and invent. He should take heart from the fact that Bacon and others were imprisoned because they dared to give voice to their scientific notions—all of which have come to pass.

Colonisation

THE denser the population of a country, and I am referring to density in its geographical sense, the more important it is for that population to be kept fully occupied, otherwise the country must face national bankruptcy. There is enough land in this world for every individual to own a goodly chunk of it and for him to be kept fully occupied and to earn a just reward for his labours. But fate has accorded to certain countries a division of land which each seeks to develop for the advancement of its own people. The parent country encourages colonisation, so that the raw and undeveloped country can yield its natural resources to supply world markets and thus provide an outlet for the labours of those who cannot find work in the parent country. The population of the world could be entirely accommodated in a box having one-mile sides, yet you find large chunks of the population of the world confined to small areas.

Building Your Own MOTOR CARAVAN



Constructional Details of an Attractive and Roadworthy Three-Berth Caravan. It can Be Built for £20, and May Be Towed by a 9-12 Horse-Power Car

By "Handyman"

HAVING enjoyed several very happy holidays in caravans which had been hired on each occasion, it occurred to me early last year that the building of a caravan of my own design would not be too difficult a job, and would, in fact, be a somewhat intriguing way of spending leisure moments and week-ends.

There were many points to be considered before making a start, and the question of tools was first carefully reviewed, and it was decided that my ordinary set—very ordinary—should meet the case, this consisting of one household saw, one hacksaw, various chisels, spanners and screw drivers, one small vice, one 4-in. cramp, and all the usual odds and ends that are accumulated by the average handyman.

Cost was naturally of considerable importance and on rough figures it was estimated that the total should not amount to more than about £20. Eventually it worked out a little less. Unfortunately there was no garage or storage place available, but the use of a large tarpaulin seemed the only means of keeping the job clean and dry.

The Axle

The idea, after thinking over all the likely difficulties, grew into realisation and forthwith a suitable axle unit was selected from a local car dismantler. There were so many different types and sizes of axles to choose from that the first visit to the dismantler's was somewhat bewildering. The points to consider were: (1) Extreme solidity; (2) Efficient braking and easy brake operation; (3) Wheel base; (4) Spring base, that is, distance between each spring; (5) Wheel and tyre sizes.

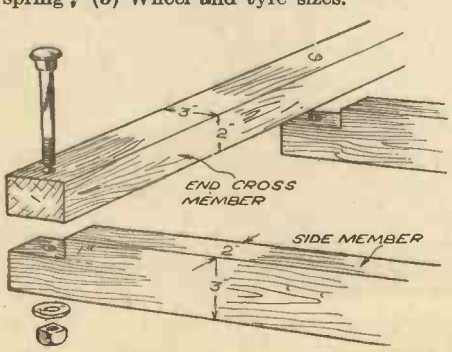


Fig. 2.—Method of jointing used between the ends of the chassis side members and cross members.

Perhaps the spring base is of major importance, as in view of the very considerable overall width of the caravan, the springs should be mounted as wide apart as possible.

The average car front axle has a very narrow spring base, apart from which there is always some difficulty in locking the swivels, and as a scrap unit is probably in a worn condition the swivels would perhaps be very slack. This latter condition would naturally be very undesirable, and for these last two reasons it was eventually decided to make use of a rear axle assembly and one preferably with underslung springs.

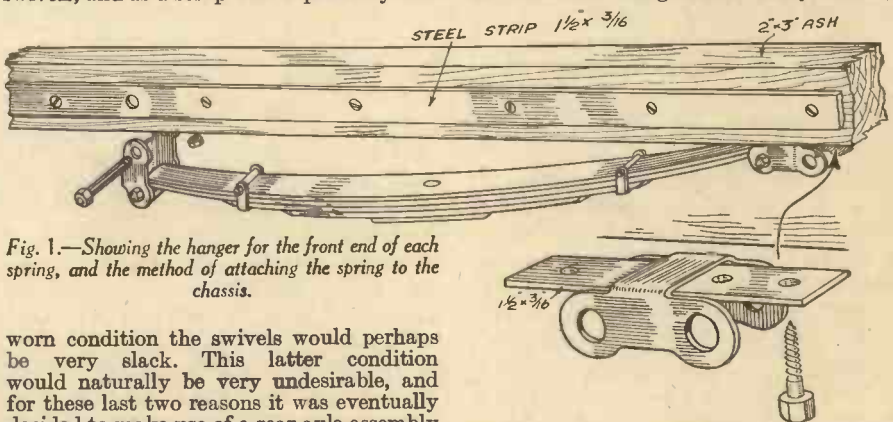


Fig. 1.—Showing the hanger for the front end of each spring, and the method of attaching the spring to the chassis.

The efficiency of the brakes on the average car rear axle may, up to a point, be taken for granted, but large-diameter brake drums are useful as the amount of effort at the brake lever is not very great. With regard to wheel size, there is never very much choice, but an average may be regarded as 19 in. with a low pressure tyre size 27 × 440 (or 450 × 19).

Axle Details

After a great deal of searching, I was fortunate in finding an old Riley (which had been very badly damaged at the front of the chassis, the rear axle, rear wheels and springs being apparently in quite sound condition. The rear axle and springs seemed adequately to fulfill the requirements under consideration, as the spring base was 37 in. centre to centre, wheel track 4 ft. and spring camber 7 in. approximately. A few days later, when the car was dismantled, I purchased the complete rear axle assembly, rear wheels and springs, and then proceeded to make due alterations to adapt the unit for use in the caravan chassis.

In doing this, the chief trouble lay in the fact of the propeller shaft being enclosed by a long torque tube, but as the tube at the forward end was already damaged, and in any case the propeller shaft, bevel pinion and other parts were not required, I decided to cut the crown gear housing short. On dismantling the differential and axle, it was found that the brakes were in quite good condition, apart from the camshafts being rather badly rusted, but it was not a difficult matter to put the brakes in really very good order by cleaning and greasing the camshafts and roughing-up the brake linings.

The next step was the stripping of the differential assembly, which was rebuilt with the crown wheel left out, only the differential box and pinions remaining so as to provide a centre bearing for both axle shafts. The nose of the crown gear housing where it had been cut short was blocked up with a plug of hard wood, and in finally fitting up the cover plate a quantity of grease was put in the axle casing. The results of this work were very gratifying, as the differential had an extremely smooth movement, the braking seemed efficient, and the unit was undoubtedly very solid.

Road Springs

For the time being I had to return to the work on the axle unit, and took off

the road springs for examination. Apart from being somewhat rusty, they were quite sound and their camber seemed to be just suitable to give clearance to a straight chassis side member. Some provision had to be made for the axle unit to take the torque resistance when braking, and as separate torque rod or member would only have involved extra weight and unnecessary work, I decided to dowel the springs to the axle case, using the existing spring dowel pins and letting down the spring platform to grip the machined surface of the axle case. Apart from drilling the axle case, which gave tremendous resistance to my comparatively crude tools, there was no difficulty in doing this, although naturally great care had to be taken in drilling the dowel positions at the exactly correct point on the circumference of the axle case.

Fig. 4.—This illustration gives a good impression of the appearance of the home-made caravan described.

Making the Chassis

The undercarriage assembly having been completed, the chassis members were prepared for fitting. The longitudinal members were 12 ft. 3 in. by 2 in. by 3 in. ash, cut to length and planed on each face, and the cross members were also of 2 in. by 3 in. ash, 6 ft. long. Two centre longitudinal members were selected and were strengthened by bolting to the 3 in. face, a strip of mild steel 1½ in. by ⅜ in. for practically the whole of their length. It was decided to mount the axle a little behind centre of the chassis in order to make the caravan slightly nose heavy, and so add to its road-holding qualities. Accordingly a point 9 in. behind dead-centre of the centre longitudinal members was duly marked, and the axle offered up, thereby giving the location of the front shackle. This was made by welding a strip of 1½ in. by ⅜ in. mild steel to the inside of an inverted spring shackle. (See Fig. 1.)

The steel plate was drilled in three places and bolted up to the underside of the chassis member. The rear end spring mounting naturally had to be flexible and the spring suspended from a shackle in a similar way to a motor-car front spring, and although the original design incorporated the use of a car chassis shackle bracket, it was eventually decided to bolt a 6 in. length of the strip steel previously used to the opposite side of the chassis side member, drilling through the plating on both sides, also the wood, to take a shackle pin carrying the top end of the spring shackle. In determining the position of the top rear shackle bolt the spring shackle was set vertically so that when the chassis was under load there would be enough movement in a rearwards direction to provide spring flexibility. A sketch of the spring suspension is shown in Fig. 1, both sides being identical.

To make up the total 6 ft. width of the chassis, two extreme cross members were fitted back and front across the two already assembled centre members. The material used for these cross members was, as before, 2 in. by 3 in. each, and the extremities of the centre chassis members were recessed 1 in., the cross members being carried on top of the others and secured by 4½ in. coach bolts (see Figs. 2 and 3). It will be noted that the 3-in. face of the side member is vertical, whereas the same face of the cross member is horizontal. The extreme chassis side members 12 ft. 3 in. and 2 in. by 3 in. each were then suspended from the extremities of the cross members, being recessed in a similar manner to the previous fitting. This arrangement gave all four chassis side members an equal height, the fact being utilised when making and fitting the floor boards, which was the next step. It would be as well to mention that before covering the chassis, all the side members were heavily creosoted and the undercarriage, springs and shackles well coated with a good-quality paint.

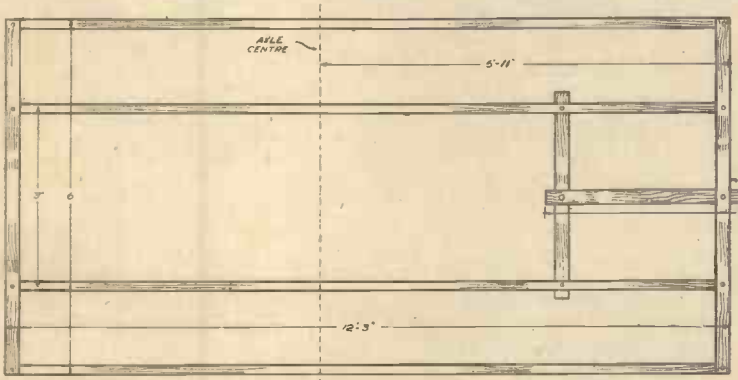


Fig. 3.—This is a plan of the chassis frame showing the principal dimensions.

Fig. 5.—A view of the inside of the rear compartment, showing cupboard and stove compartment.

Fitting the Floor

The flooring was made of ⅞ in. tongued and grooved weather boarding in 6 ft. lengths, each length being screwed down across the top of each chassis side member. Special care was taken in fitting the floor boards to strengthen the framework against twist or distortion such as would be involved under normal road conditions. In the centre of the flooring the boards were reduced to 4 ft. width to clear the road wheels which protruded above the height of the chassis members, leaving an aperture 30 in. by 24 in. on both sides to form a raised wheel arch which was built later. Each length of boarding, before being finally laid down, was well soaked in creosote, the top surface being left white so that the inside colour scheme could be decided upon later.

At a distance of 36 in. behind the extreme front cross member and slung underneath the side members was bolted-up another cross member to carry the back end of the trailer bar. For both trailer bar and extra cross member, similar-sized timber was employed 2 in. by 3 in., and the trailer bar before fitting was strengthened with a strip of 1½ in. wide steel bolted to its side. The trailer bar was attached to the front of the chassis cross member by means of a ½ in. steel bolt with large steel washers and a split-pinned nut, the rear end of the bar being similarly treated.

Bodywork

In view of the necessity for minimising the total cost of the caravan it was decided to make use of ordinary commercial ¼ in. plywood which is obtainable in a stock size of 5 ft. square sheets. The timber for the body pillars was next ordered in 7 ft.

engths of 1½ in. square, rebated ¼ in. on one face, ⅛ in. deep (see Fig. 6) for taking the end surface of each sheet of plywood. The two front side pillars were, however, of

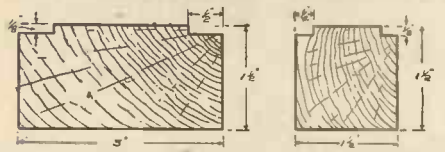


Fig. 6.—Section of front pillars (left) and of other body pillars (right).

a stronger material, 3 in. by 1½ in., and similarly rebated, the extra strength being considered necessary to take wind resistance and other similar forces normally met under travelling conditions.

The front end was first assembled, and a triangular template with an angle of 80 degrees was made so that the front corner pillars could be set at the correct angle. The corner pillars (*A*) of 1½ in. square ash were cut to length, 5 ft. 2 in., and the front cross member recessed so that when the pillar was screwed in position its angle conformed to the template previously made. The front side pillars (*B*), of 3 in. by 1½ in., were then fitted and bolted to the outside of the chassis side members. The space formed between the two pillars was filled up with a sheet of plywood cut to shape, the bottom edge of the ply being flush with the lower edge of the side member, and each contacting face of the plywood glued, tacked and screwed. A cross rail (*C*) of 1½ in. square ash was then fitted on top of the extremities of the front corner pillars, steel angle brackets being the method of attachment in addition to the pillars and rail being screwed together. (Fig. 7.) The centre front pillars were recessed into the front cross member similarly to the corner pillars and were again joined to the roof cross rail by screwing and the fitting of corner brackets. At a distance of 27 in. below the roof cross rail another cross rail (*D*) was fitted between the two centre pillars to form the aperture for the front window and a plywood panel was cut and fitted between this cross rail and the front cross member (on the outside face of the pillars) and more plywood panels were cut and fitted to fill in the apertures between the corner and centre pillars, the plywood in this case being glued and screwed to the inside face, thereby making a small bay of the centre section. (Fig. 8.)

Starting on the offside, the centre pillar *E*, 6 ft. 8 in. in overall length, was bolted to the side member, and a complete sheet, 5 ft. square, of plywood fitted between its one edge and the front pillar *B*.

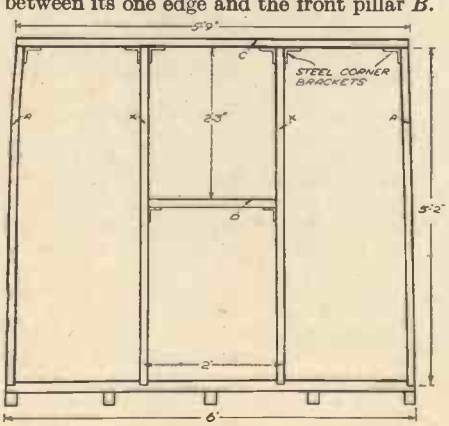


Fig. 7.—Elevation showing the members constituting the front of the body frame.

The rear pillar *F* was similarly fitted, but its height was not determined until the roof side rail had been sprung in position, which necessarily had to be done very much later. The rear corner pillars *G*, and centre pillar *H*, were fitted on similar lines to the front pillars, and the rear door post was fitted and left an indefinite length. The front door post and nearside centre pillar were erected and the spaces between each pillar, excepting, of course, between the door posts, were filled with sheets of plywood. At this stage, the whole of the woodwork now assembled was thoroughly primed with a red lead primer, particular care being taken in sealing the edges of the plywood, the top edges having no support or fixing as yet.

It was next necessary to secure the top extremities of the front *B* and front corner pillars *A* by means of a specially-made corner bracket (Fig. 10) and on the offside a rail (see Fig. 8) of 1-in. square ash was fitted along the top edge of each plywood

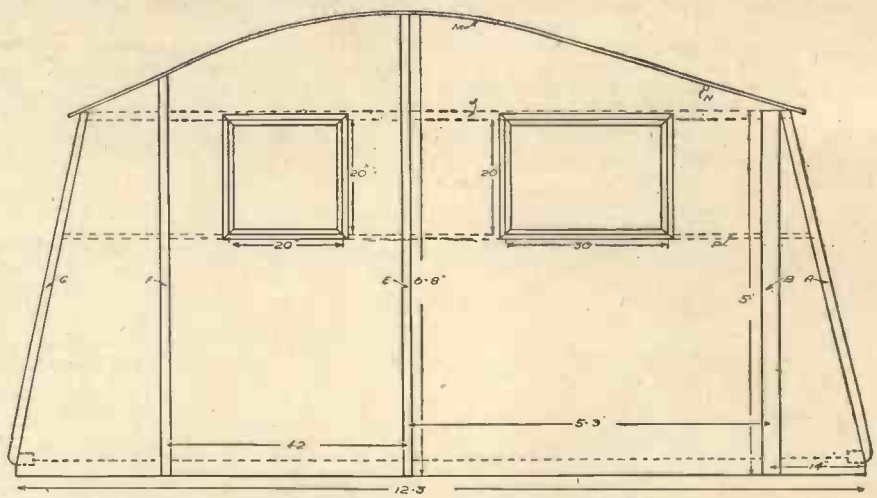


Fig. 8.—Nearside of the body framework.

panel, extending from the front corner pillar *A* to the rear corner pillar *G*, the rail being screwed to the inside of each pillar and the plywood being glued, tacked and screwed to the rail. On the nearside a similar rail was fitted, but terminating at the front corner post, a short rail being used between the rear door post *A* and the corner pillar *G*.

Curved Side Rail

The next step was to provide a pair of curved roof side rails, and for this purpose two 12 ft. 6 in. lengths of 1-in. square straight-grained ash were obtained and, using the floor of the caravan, were bent on an improvised jig and left for several days, occasionally being soaked with hot water. After each day of this treatment the bend was gradually increased, so that when the timber was eventually released its curvature corresponded very closely to that required between the corner pillars *A* and *G* and centre pillars *E*. At the top of each centre pillar a 3 in. by 3 in. reinforced angle bracket was fitted as shown in Fig. 12. It was then a comparatively simple matter to attach the one end of the curved roof rail to the top of the rear corner pillar (Fig. 13) and then, after straining the side rail over the centre pillar brackets, screwing it directly to the top inside face of the main front side pillars (Fig. 10).

This operation was repeated for the opposite side and the centre roof cross rail *L* was screwed on to the same brackets as the side rails, after having been cut to such a length as to give a total width of 5 ft. 9 in. between the two outside faces of the side rails.

Panelling

It was now possible to complete the panelling of the caravan sides and accordingly the space between the curved roof rail *M* and the lower side rail *J* was filled in with plywood sheets, the top edges of which were cut to fit flush with the top of the curved rail *M* and, incidentally, the centre panel top bracket was removed and refitted to clamp the sheeting between itself and the pillars. Although it would have been possible to have covered the roof framework with the waterproof material already obtained, it was thought that the inside finish would not be very satisfactory, apart from the obvious difficulty of fitting the material smoothly, and so it was decided first of all to cover the roof with plywood sheets similarly to the body sides. As the overall width of the roof was 5 ft. 9 in., a centre rail had to be fitted through the length of the roof so that the roofing could be made in separate panels. This rail was obtained as a 12 ft. 6 in. length of ash 2 in. by ½ in. and was quite easily fitted, its curvature being almost identical with that of the side rails. The extremities were screwed directly to the roof end cross rails, and the centre roof cross rail was recessed ¼ in. as an added steady, the joint of this being glued and screwed. The roof behind the centre pillars was covered in by two separate

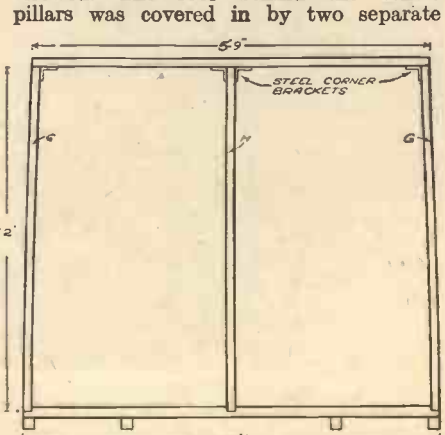


Fig. 9.—Rear body framework.

sheets 5 ft. in length and approximately 2 ft. 10 in., and as two more sheets of plywood cut similarly did not entirely cover in the front end of the roof, an extra roof cross rail was made and fitted at the point marked *N* in Figs. 8 and 11. The roof covering was then completed by filling in the two comparatively small spaces at the front.

Waterproofing the Roof

After the outside roof panelling had been thoroughly dressed with primer, it was covered with a single piece of waterproofed hood material, similar to that used on cars, obtainable in 6 ft. widths and in several different colours and shades. The colour scheme decided upon was two shades of green with cream uppers, and we were fortunate in obtaining a material of a suitable shade of green. The material was merely stretched from end to end of the roof and then drawn from side to side, and when finally it was perfectly smooth all over the roof it was tacked down. The lower edges were left for the moment, as it was thought better to allow the weather to take effect on the material before finally cutting off and fitting the roof guttering. In order to protect the lower

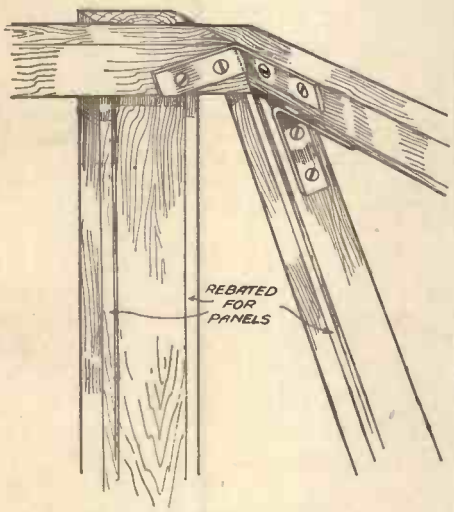


Fig. 10.—Method of joining the front corner pillars.

edge of each body panel, angle strips of aluminium beading were fitted between the pillars and bedded snugly against the plywood and the underside of the chassis side members, a little putty being spread along the inside of the aluminium beading before finally tapping down and pinning in position (see Fig. 15). This angle beading was also used to protect the edges of the front window bay and the edge of the plywood up each corner pillar.

The body shell being completed, the positioning of the windows was decided upon and a window frame made for the front. For all the windows planed deal 1 in. square rebated ¼ in. by ⅜ in. (Fig. 16) was used, the window frame corners being jointed in the orthodox manner. The glass, after being cut to size, was bedded down into the window frame with putty and secured by strip ¼ in. round beading (Fig. 17). Similar beading was also used as weather strip for the inside of the window aperture.

Windows

Working from the inside of the caravan, the side windows were marked out on the panelling, making a window aperture of 30 in. by 20 in. After cutting out this

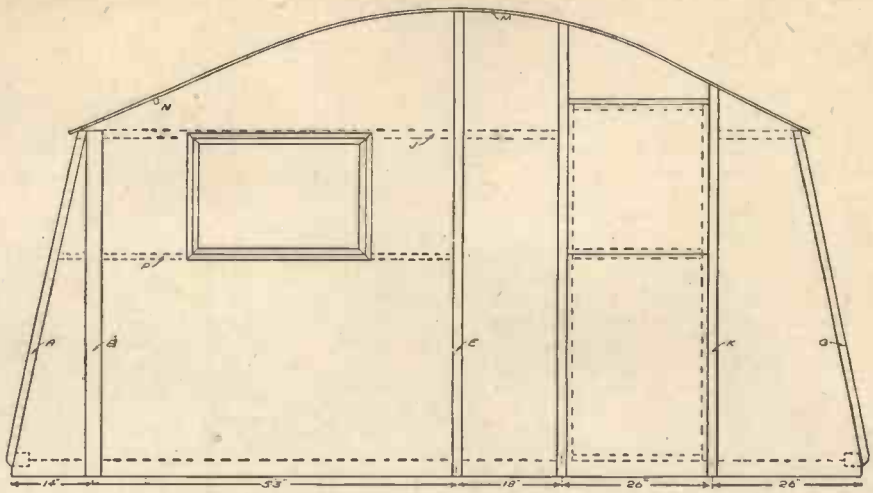


Fig. 11.—The offside of the body frame.

space with a hacksaw blade on an improvised handle, a frame was built up around the inside, 1 in. square deal being used and the window side pillars being jointed into the side rail. The lower rail of the window frame was extended to the inside of the front and centre body pillars, making a waist rail above the seating position. This rail *P* was screwed on to the pillars mentioned and was also pinned and glued to the outside plywood. A corresponding window was made to suit a similar operation carried out on the opposite side. The offside rear window was made up on identical lines, the aperture size being 20 in. by 20 in. On the outside of each window aperture strips of lathwood were fitted to form a window frame, and these strips were glued to the plywood and screwed through the plywood into the

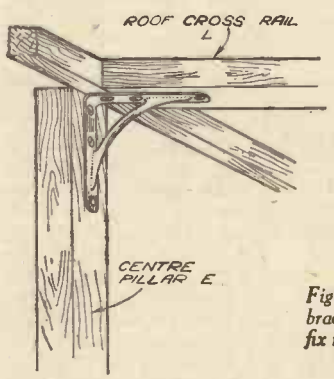


Fig. 12.—Angle bracket used to fix the roof cross rail.

window main framework, thus giving added strength and also protecting the raw edges of the plywood where cut. In fitting these outside strips, similar strips were used to finish the joints between the lower sheets of body panelling and the top ones, and as a special precautionary measure any slight space between the two sheets of plywood was filled in with either red lead or putty before fixing, gluing and screwing the strips.

To improve the outside appearance and also help to keep the window hinges watertight, louvres of sheet aluminium were made and fitted over each side window.

Outside Painting

All the outside panelling and pillars next received their first coat of paint, and a line was drawn on each panel approximately 38 in. from the lower edge of the chassis side members in order to divide the cream uppers from the green lowers. The door was made in two sections, the top of the lower half coinciding with the colour-dividing line. Each door section was built up of a separate frame covered on the outside with a sheet of ⅜ in. thick plywood, a Yale-type lock being fitted to the top door, along the bottom inside edge of which was fitted an overlapping strip to hold the lower door closed. Bolts were also fitted to the lower door.

The wheel arches were made up of boarding 10 ft. in width and cut as shown in Fig. 16. These pieces were then screwed directly on to the chassis side members in pairs, and a strip of sheet metal covered the top of the wheel arch boards, being pinned into position and bedded down into putty. The extremity of each strip of sheet metal terminated underneath the floor boards, to which it was pinned and made watertight.

Constructing the Beds

The framework of the beds was next built, using 1 in. square deal and making as much use as possible of the already-assembled body pillars. The width of the beds was decided at 24 in., and the height from the floor 16 in. It was thought that a concave base for the mattress would improve the comfort and, accordingly, each bed top rail was planed off on one edge to which the plywood was fitted as shown in Fig. 18. In the 6 ft. length of the top bed rail three supports of 1-in. square were screwed to the underside and three similar struts were placed crosswise between the two top bed rails.

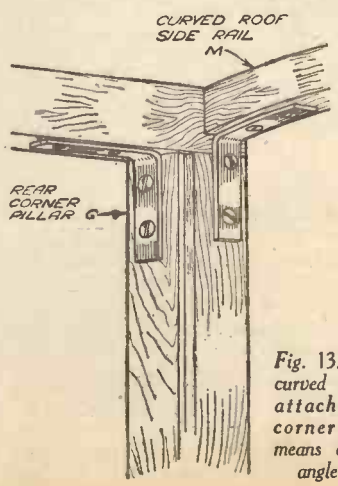


Fig. 13.—How the curved roof rail is attached to the corner pillar by means of an iron angle bracket.

Plywood panels were then cut to fill in the 6 ft. length, the edges of the plywood being glued and screwed as previously. One half of the bed side had a fixed plywood panel, the front half being covered in with a sliding portion, the slide rails consisting of a length of ¼-in. round beading screwed to the caravan floor, and a length of aluminium angle bead screwed to the top rail. The rear bunk was built up on similar lines, with the sliding panel on the nearside.

In making the centre body partition the front bed corner pillars were extended to the roof, meeting the centre roof cross rail to which they were joined and recessed. A dummy pillar ½ in. square was screwed to the inside of the centre body pillar and another cross rail fitted between the partition pillars and the body side rail. The spaces were then covered in with plywood panels extending right down to the wheel arches. A cupboard 34 in. high and 18 in. by 18 in. was built in against the offside wall almost underneath the window, and within a few inches of the rear bunk. It had three shelves and the door was covered with perforated zinc. A hole was cut in the top of the cupboard to accommodate a wash bowl approximately 15 in. in diameter.

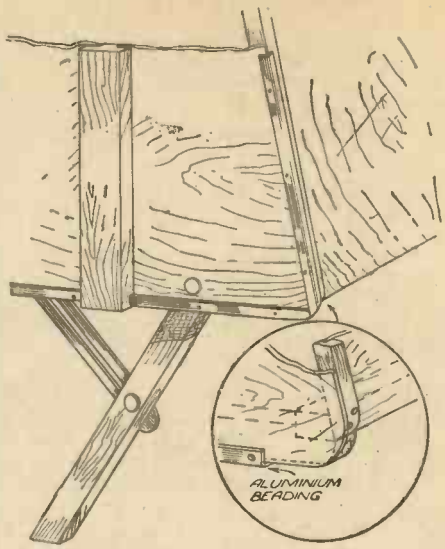


Fig. 15.—Fitting of the aluminium angle beading and the rear body stay.

Fig. 14.—The "Kitchen" showing the arrangement of stoves and cup hangers.

The stove platform was made the same width as the cupboard and fitted 24 in. above the floor boards, thus forming a recess between the partition and the cupboard, the sides of which were lined with tinplate, as also were the platform and caravan side panel. The object in doing this was to prevent damage in case of a Primus stove catching fire. There was ample room for two stoves, which, when travelling, were held down to the platform by spring curtain wire with hooks and eyes. Below the stove platform was room for carrying the paraffin tin and water container, which also were secured with spring curtain wire hooked on to the side of the cupboard and body.

A built-in wardrobe was fitted across the nearside partition pillar and the front door post, in triangular form, the door swinging towards the caravan centre and a mirror being fitted to the inside of the door.

Internal Painting

The whole of the inside next received its first and second coats of cream paint and all the body side rails, roof cross rails, roof centre rail and window frames were picked out in green. It was decided to have a folding table with the fixed portion 12 in. long screwed to the underside of the front window cross rail, and strengthened by separate angle pieces attached to the centre front pillars. The folding portion 28 in. long and 20 in. wide, the same as the fixed portion, rested against the same pillars when not in use and was held in position by a clip. When the table is raised a folding leg is dropped on to a catch fitted to the caravan floor. The floors and bunks were varnished stained and the table taken down for french polishing.

In the back compartment green linoleum was laid down, and a strip of green-edged carpet was laid along the floor of the front compartment.

Fig. 16.—Section of timbers for window frame (left), and shape of wheel-arch panel (right).

A double flock mattress of 4 ft. width was obtained and cut down the centre, thus forming two separate mattresses 6 ft. long and 2 ft. wide, which just fitted the front bunks. As we were not carrying a passenger, cushions only were used in the back bunk for the time being.

Soft Furnishings

The curtains and bed coverings were made of green folkweave material, the mattresses having loose covers made with a small valance hanging down in front. Spring-steel curtain wires were used for the curtains, and owing to the angle of the front, it was necessary to use two such curtain wires for top and bottom respectively. A hanging curtain of similar material was hung across the partition, thus separating the two compartments. This was kept folded back during the daytime. Several bright orange-covered cushions decorated the caravan, the covers being taken off at night and the cushions used as pillows. There was, of course, ample storage space underneath the bunks for keeping the bed linen during the day.

Along the body side rail in the rear compartment, ordinary clothes pegs, painted green, were fitted about 2 in. apart for holding the cups, and this method was found entirely satisfactory while travelling. A frying pan and saucepan were hooked on to the kitchen side of the partition, and on the front compartment side of the partition two 1 in. square rails rebated ½ in. by ½ in. were fixed and painted green to carry a set of gaily-

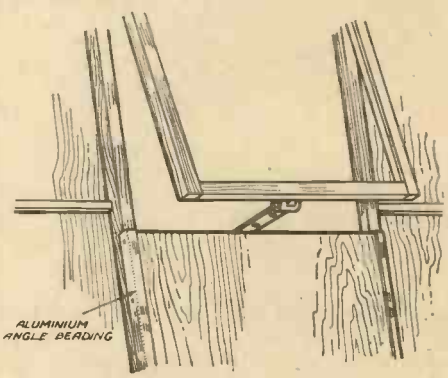


Fig. 17.—Hinged window at the rear of the body

decorated plates, which, in addition, were secured by spring curtain wire. (Fig. 20.) Spring curtain wire was also fitted inside the bottom half of the cupboard to hold tinned goods in position when travelling.

Electric Light

An electric light for use from the car batteries was rigged up with a lead through to the towing bar, and the light itself, with a decorated shade, was hung from the middle of the centre roof cross rail. A small tumbler switch with green cover was fitted to the centre partition in a handy position just above the offside bunk. A small paraffin lamp was also carried for use in an emergency and fitted in a clip underneath the stove compartment.

A towel rail, obtained from a sixpenny stores, was fitted to the lower door on the inside. The tail lamp and rear number plate were carried on angle brackets immediately beneath the rear cross member and suitably wired through to the tow bar.

Having thus completed the inside

fittings and furnishings, the outside of the coachwork received its second coat of paint, after which aluminium water gutterings were fitted round the sides and end of the roof and the raw fabric edges cut off with a razor blade.

The parking jacks were then made, the design being quite orthodox, consisting of a folding leg and adjustable stay as shown in Fig. 15. To finish off the dividing line between the green lowers and cream uppers, strips of wood 1 in. by $\frac{3}{16}$ in. were painted green and nailed along the outside surface of the plywood panels.

Towing Bar

One of the last jobs was the fitting of a towing coupling to the trailer bar. A very suitable connection was obtained from Messrs. H. D. Trailers, Fieldgate Works, Kenilworth, for 17*s.* 6*d.*, the coupling consisting of a cylinder enclosing compression springs and a coupling rod with a hook end for the actual connection to the car bracket. The cylinder was secured to the tow bar by a pair of *U* bolts, holes for which were drilled in the draw bar, and steel plates made and fixed underneath, thus clamping the coupling and bar together (Fig. 19). The brake lever was

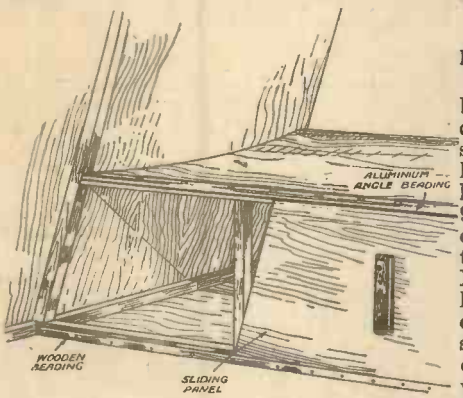


Fig. 18.—*Details of one of the beds.*

fitted immediately behind the coupling cylinder, a slot being cut in the trailer bar and a mild steel lever 8 in. long pivoted to its centre point on a bolt fitted horizontally through the bar. The lower end of the brake lever was then connected by cable to the brake camshaft levers in the axle unit, and cable adjusters of the aeroplane type were fitted in tandem.

For manœuvring purposes, grip handles were screwed to each corner pillar and these were found particularly useful when moving the caravan from "dock."

All is now ready for the first road test, and it may be mentioned here that the caravan is so well balanced that in its unloaded condition it can be balanced from the trailer bar on a finger-tip, although when travelling it is always advisable to load up the front compartment to make it slightly nose heavy.

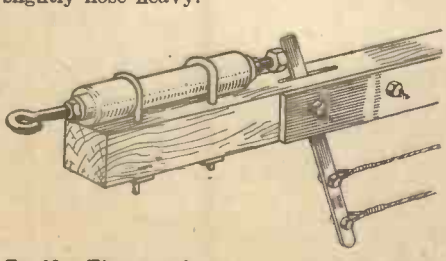


Fig. 19.—*The towing bar and automatic brake, which is simple and effective.*

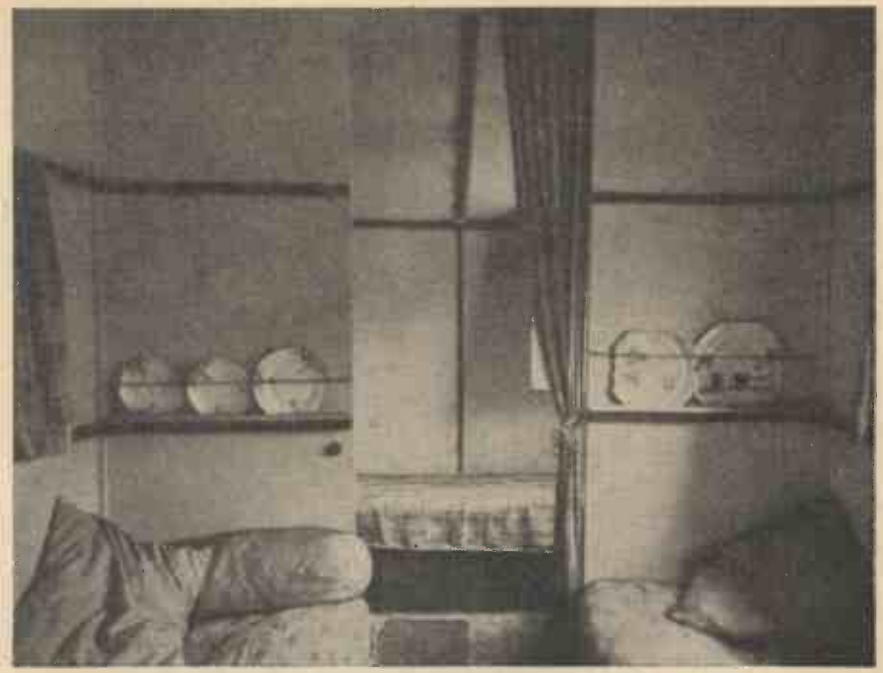


Fig. 20.—*The inside of the "home on wheels," looking through the front window*

Final Tests

The first road test was gratifying, the braking and road-holding qualities being quite exceptional and certainly up to the standard of various other caravans which I have previously handled. It seemed very light and was very easily drawn by my 9-h.p. car. For anyone who knows the district, it may be of interest to mention that the car and caravan were taken up Peak Hill, Sidmouth, fully laden. This hill, I understand, has in parts a gradient of 1 in 3½. Immediately following the short road test of about nine miles, the caravan was taken on a tour round Devon, where it was eventually parked for a few days at Sidmouth. Throughout the tour the caravan gave no trouble whatever, and although a full kit of tools and spares were carried there was no necessity whatever to make use of them.

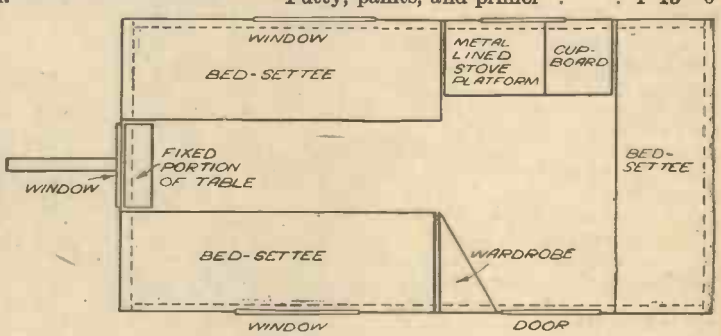


Fig. 21.—*This plan shows the disposition of the various fittings built into the caravan.*

Those who are sceptical about the use of plywood will be interested to know that between September and the end of December the caravan has been standing in an orchard exposed to all weathers and there is no sign whatever of "lifting" or deterioration of the plywood, neither have there been any leakages into the inside.

A few words about the total cost may be of interest. First, it should not be necessary to pay more than 30*s.* for an axle assembly with springs, as most car dismantlers pay not more than £2 10*s.* for a complete car. The supply of timber is best arranged from one source, and a contract made as favourably as possible, This in particular applies to the plywood, as it is very expensive unless purchased in bulk. Most of the inside fittings can be obtained from sixpenny stores, who can supply all the window catches, cupboard hinges and locks and innumerable other small parts of this kind.

The total expenditure is shown below as accurately as possible:—

	£	*s.*	*d.*
Axle unit, including wheels and tyres	1	10	0
Chassis and body timber	2	12	0
Flooring		11	9
Towing bracket		17	6
Plywood	2	10	0
Bolts, screws, and nuts, etc.		10	0
Furnishing materials	1	5	6
Carpet and linoleum		8	6
Mattresses	1	0	0
Putty, paints, and primer	1	15	6
Window and door fittings, locks, etc.		12	6
Roof material, approx. 7*s.* 6*d.* per yard	1	5	0
Steel strip and shackles		7	6
Wire, bulbs, tail lamp and number plate, roof light and shade		9	6
Aluminium beading and water guttering		16	0
Glasses		8	0
Timber for windows, body rails, roof, etc., and beadings, approx.		18	0
Door lock		4	6
Brake cable		3	6
	£18	3	9

A "Safety-seat" for Air Liners

Details of a New "Seat-cum-life-belt" Device

Part of the promenade saloon of a flying-boat showing the new seats.

RELIABILITY of aircraft and safety of passengers are two matters to which, it can be fairly claimed, no air company in the world has given more attention than Imperial Airways.

Imperial Airways have been pioneers in many advances which have proved to the betterment of air transport. A striking example of this was that they were the first to introduce air-liners equipped with four engines—a design which gave ample reserve of power with corresponding increase of reliability.

Air-liners of this type have been operated by Imperial Airways for the past six years, although America is only now following suit and building its first four-engined passenger aircraft.

The same unremitting research has been put into smaller innovations, and a recent example was the patenting of a passenger chair for the Empire flying-boats. This provided not only a high degree of comfort but weighed only 18 lb. As far as is known, the lightest chair giving anything approaching comparable comfort in passenger aircraft before was one weighing 35 lb.

The New Seat

Now Imperial Airways experts, after nearly 18 months' research, have designed a new pattern "safety-seat" which for simplicity, lightness, and efficiency has, it is claimed, no equal in the world.

This new apparatus is one in which the seat cushion and back cushion of the passenger chair already mentioned will serve the dual purpose of providing extremely comfortable upholstery and also a concealed but really accessible life-belt.

This new invention has been patented on behalf of Imperial Airways and is now being manufactured for the company by David Moseley & Sons, Limited, whose research experts, working on the production of ultra-light-weight rubber, have contributed a great deal to the success of this new British invention. It has already been installed, in conjunction with the new light-weight seats, on all the Empire flying-boats in service, and will be a feature of the equipment on later boats.

Its Advantages

Three revolutionary advantages are:

The total weight of a set of cushions (seat cushion and back cushion) is under five pounds, including the linen chair covers and straps.

The two cushions can be converted into a life-belt in under ten seconds.

As a life-belt they can support indefinitely in the water the weight of two men aggregating no less than 20 stone.

The two cushions for this new "seat-cum-life-belt" are of rubber and have been manufactured on the float-on-air principle to a secret specification.

Despite their lightness, these cushions afford a high degree of comfort during travel by air, and "roll" or undue sag has been eliminated by a process of manufacture which has enabled each seat cushion to be built up of four separate compartments.

Such an invention as this became desirable for Imperial Airways when they decided on the construction of the fleet of 28 Empire flying-boats.

Every steamship, in accordance with Board of Trade regulations, has to carry complete life-saving equipment. A flying-boat on the water is open to the same mishaps as a steamship, and efficient life-saving equipment is consequently required against the possibility of future need.

Air companies, however, are in a more difficult position than steamship companies as ordinary pattern life-belts, although efficient, are too bulky and too weighty to be carried with convenience in passenger-carrying flying-boats.

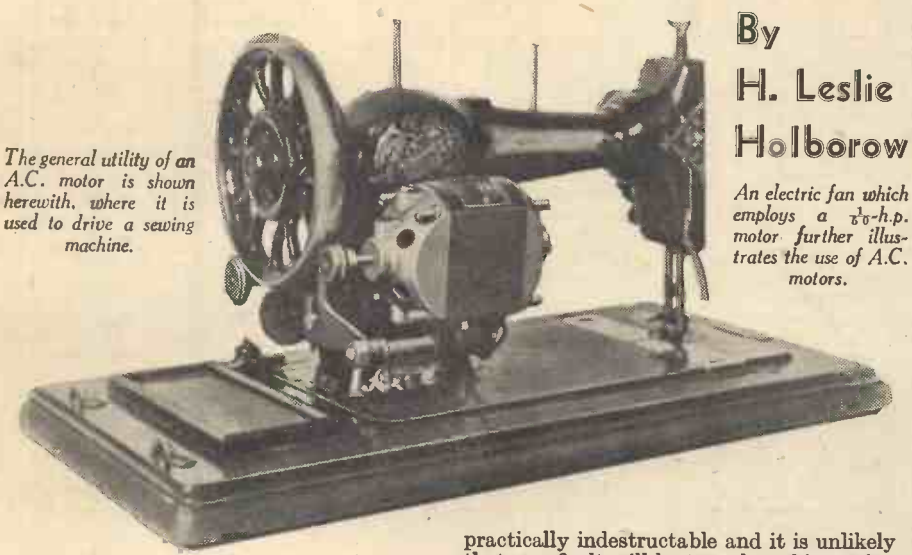
This was the problem Imperial Airways had to face, and the new invention provides a real solution. Each of the Empire flying-boats carry up to 24 passengers and a crew of five. More than adequate protection can now be afforded this full complement by the use of a total of only 145 lb. of this new equipment.

Eleven Empire flying-boats out of the full fleet of 28 are now in service, and all carry this apparatus. It will be made standard on all remaining craft, and in addition is expected to be employed on all Imperial Airways passenger-carrying speed-boat tenders operating in marine bases in this country and the Empire.

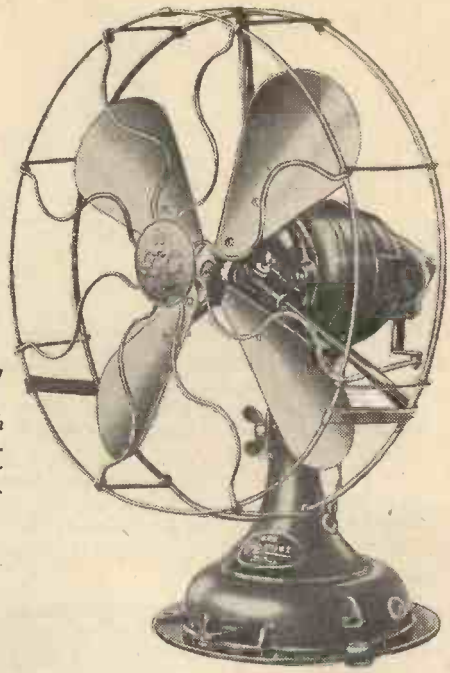
The seat removed showing the life-belt.

FRACTIONAL HORSE POWER A.C. MOTORS

By H. Leslie Holborow



The general utility of an A.C. motor is shown herewith, where it is used to drive a sewing machine.



An electric fan which employs a $\frac{1}{10}$-h.p. motor further illustrates the use of A.C. motors.

A Description of the Main Types of A.C. Motors with Notes on the Repair and Rewinding

WHILE there is abundant literature available concerning the design and repair of direct current motors, there appears to be a scarcity of easily assimilable literature dealing with motors of the A.C. class.

It is the purpose of this article to show the method of locating faults and the correct way of carrying out the necessary repairs. Such calculations as may be necessary are kept as simple as possible, and although the liberties taken with orthodox formulae may offend the mathematician, it must be borne in mind that it is the writer's aim to keep the subject matter well within the scope of the average reader

Before dealing with the question of rewinding a broken-down motor, it would be as well to give a brief description of each of the more commonly encountered types of A.C. motor, so that the reader will have no difficulty in recognising the class to which his motor belongs and can accordingly understand the correct method of arranging and connecting the wiring.

A.C. motors are usually classed according to their methods of starting, variations of which in recent years have been rapidly developed so that these motors compare very favourably as regards ease of starting with the older and more familiar direct current motor.

The table in Fig. 1 conveniently summarises the main types of A.C. motor and their variations.

The Induction Motor

The characteristics and general construction of all induction motors, irrespective of their methods of starting, are fundamentally the same. The rotor, or as its name implies, the revolving part of the motor, consists simply of a number of laminated iron stampings separated by insulating material and threaded round the periphery by a number of copper or aluminium bars, the latter being short-circuited at each end by heavy metal end rings. This part is practically indestructable and it is unlikely that any fault will be traced to this section of the motor. The stator or external member is of similar construction to the rotor, except that in the place of the copper bars and their short-circuiting end rings, coils are grouped round the inner periphery, being arranged in slots cut in the iron stampings. There is a variation of this motor known as the " inverted rotor " type which is sometimes met with ; in this design the coils are carried on the rotor while the stator bears the copper rods and end rings, the principle is exactly the same except that the positions of the rotor and stator are reversed.

Induction motors are constant speed motors, the speed in all cases being a definite function of the frequency of the supply, for instance, if the supply alternates fifty times a second or 3,000 times a minute, the speed of a two-pole motor would be 3,000 r.p.m. while a four-pole motor would revolve at half this speed and a six-pole motor would have one third or 1,000 r.p.m. Intermediate speeds are unobtainable, as the speeds must always bear a whole number ratio to the frequency of the supply. These speeds are, of course, theoretical, as there is a slight drop in speed on load which, however, never amounts to more than about 5 per cent. of the free running speed.

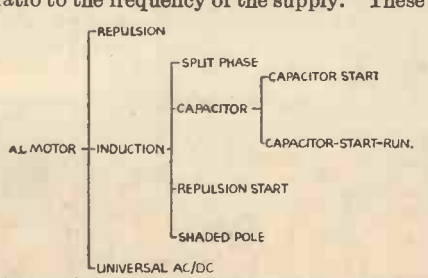


Fig. 1.—This table summarises the main types of A.C. motors and their variations.

The Split-phase-start Motor

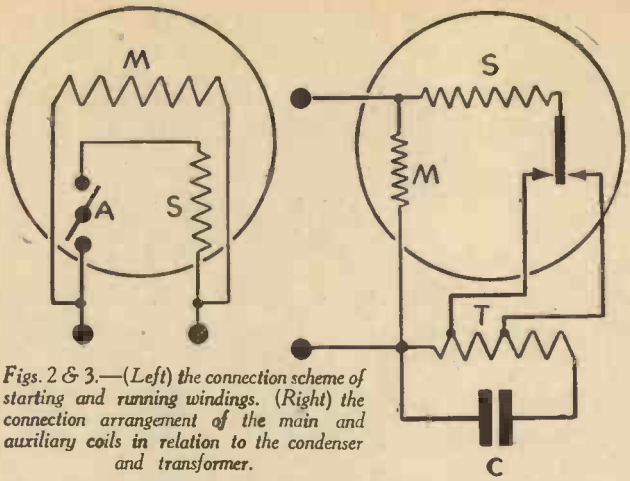
This type is the earliest and simplest of all induction motors; its freedom from mechanical breakdowns and robust construction generally makes this an ideal type for household and similar purposes. Its only drawbacks are a low starting torque which, on modern designs, amounts to about twice full load torque, and an excessive starting current which amounts to nearly four times that required when running.

The connection scheme of the starting and running windings is shown in Fig. 2. The starting windings are usually wound on top of the main windings; the coils, however, are displaced one half pole pitch to the main coils. This gives rise to secondary poles which, coming into operation either earlier or later than the main poles, create a phase lag which drags the rotor round in a definite direction.

When the motor has accelerated the starting windings are cut out of the circuit by means of either an external manually operated switch or, in the case of more modern designs, by an automatic centrifugal switch which is attached to the spindle of the motor itself and comes into operation at a predetermined speed.

The Capacitor Motor

This type is yet another variation of the split-phase-start type of motor and differs only in its method of starting. There are two types of capacitor motors in use : the " capacitor-start " motor and the " capacitor-start-run." The former has a condenser introduced into the circuit in series with the starting winding, and which is cut out together with the starting winding when the motor has run up to speed. The latter has a small transformer in addition to the condenser, both in this type being left permanently in the circuit, an automatic centrifugal switch changing to transformer tappings when the motor has accelerated. The connection arrangement of the main and auxiliary coils in relation to the condenser and transformer is shown in Fig. 3.



Figs. 2 & 3.—(Left) the connection scheme of starting and running windings. (Right) the connection arrangement of the main and auxiliary coils in relation to the condenser and transformer.

This type of motor is virtually a two-phase motor and has all the starting advantages of such a motor, and is undoubtedly a great improvement on the simple split-phase type.

The Repulsion-start Motor

This type of motor is a combination of the repulsion motor and the ordinary squirrel-cage induction motor. The principle of the repulsion motor is employed at starting, but at a predetermined speed the commutator bars are short-circuited and the motor runs as an ordinary squirrel-cage motor.

The Shade-pole Motor

A brief description of this type of motor will complete the four variations of induction motor set out in the table in Fig. 1. Although very little used except in the very small sizes, this type is of a very reliable and simple design, but unfortunately the very low starting torque exerted by this motor makes it unsuitable for any purpose except perhaps for driving small fans, and similar apparatus, where no starting effort is required beyond that needed to overcome the friction of the bearings.

The design of the stator is of the usual type except that no starting coils are used, each pole being unequally divided by a copper strip which causes a time-lag between the magnetisation of the two unequal surfaces, thereby setting up a sliding flux across the surface of the poles which drags the rotor round in a definite direction.

The Universal A.C./D.C. Motor

No useful purpose will be served by giving here a full description of this type of motor as it is simply a series wound D.C. motor, and any text book on the subject will give a full description of its design and chracteristics. Reference to Fig. 5 should fully explain the connection scheme, which is extremely simple.

The repulsion type of motor, the connection scheme of which is shown in Fig. 6, is similar to the universal type except that instead of having the coils groups on projecting poles, they are distributed in slots all round the periphery. The connection arrangement is also different in that the brushes are short-circuited together and the current supplied to the field winding only.

There is a further class of motor known as the "synchronous" motor, but reference to this type is omitted as they are rarely met with in such small sizes.

Rewinding

Let it be assumed for the purpose of explanation that the motor to be rewound is rated at ¼ H.P., and is intended for use on a 200-volt 50-cycle supply at a speed of approximately 1,500 r.p.m. If the follow-calculations are carefully worked out no difficulty should be experienced in applying the same method in carrying out the same calculations for any other size of A.C. motor under 1 H.P.

The first step before proceeding with rewinding is to find by calculation the correct size of wire necessary to carry the current absorbed by the motor. In order to do this the current consumption must first be found. Bearing in mind that 1 H.P. = 746 watts, and referring to the table of efficiencies given in Fig. 4, the input in watts is arrived at by multiplying the output watts, which for the motor in question would be 746 divided by 4, by 100, and dividing the product by the

1/16 to 1/10 h.p. . . .	45 per cent.
1/8 to 1/4 h.p. . . .	50 per cent.
1/4 to 1/2 h.p. . . .	60 per cent.
3/4 to 1 h.p. . . .	70 per cent.

Fig. 4.—A table of efficiencies.

efficiency. The table gives the efficiency as 60 per cent., thus the input watts would be :

$$\frac{746 \times 100}{4 \times 60} = 310 \text{ watts.}$$

To find the current consumption from the above figure it is now necessary to divide by the voltage and correct for power factor, which for small motors may be taken as ·6 thus :

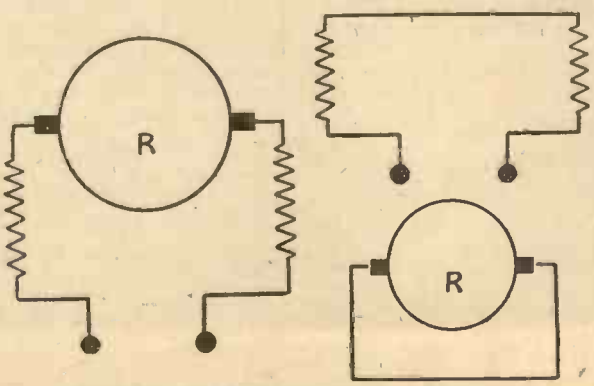
$$\frac{310}{200 \times \cdot 6} = 2.6 \text{ amperes.}$$

Reference to the wire table will now give

TABLE OF WIRE GAUGES

S.W.G.	CURRENT.
25	0·942
24	1·140
23	1·356
22	1·848
21	2·412
20	3·064
19	3·771
18	5·430

the nearest size of wire suitable for carrying a current of 2·6 ampres as being No. 21 S.W.G.



Figs. 5 & 6.—(Left) the connection scheme of a universal motor and (Right a repulsion type of motor.

Estimation of Number of Turns

The first step in arriving at the number of turns necessary for the main windings consists in calculating the flux per pole. In order to do this it is necessary to find the area of the inner surface of the stator in square inches by multiplying the circumference of the stator by the depth. Let it be assumed for the purpose of explaining the following calculations that the stator has a circumference of 9 in. and a depth of 2 in. The product of these two figures gives the total area in square inches. As this area must be shared by outgoing and incoming magnetic flux lines the magnetic pole section must be taken at a half this figure, which is still reduced by multiplying by the factor ·5 to allow for loss of iron through the slot spaces. The working area would thus be :

$$\frac{9 \times 2}{2 \times 2} = 4{\cdot}5 \text{ sq. in.}$$

The area thus obtained must now be divided by the number of poles and multiplied by a figure denoting the flux density, this latter value may be taken as an all-round figure of 35,000 for any size of motor under 1 H.P. As previously stated, a motor running at 1,500 r.p.m. must have four poles on the stator, thus the flux per pole of the motor under consideration would be :

$$\frac{35{,}000 \times 4{\cdot}5}{4} = 39{,}375 \text{ lines per pole.}$$

The total number of turns can now be ascertained from the following formula :

$$\text{Turns} = \frac{\text{E} \times 10}{\phi \times \text{F} \times 4}$$

where E stands for the voltage of the supply, ϕ the flux per pole and F the frequency.

Substituting the calculated flux per pole and the other known data in the above formula, we get :

$$\text{Turns} = \frac{200 \times 100{,}000{,}000}{39{,}375 \times 50 \times 4} = 2{,}539$$

This figure must be further divided by the number of poles which brings the number of turns per pole to 635.

Arrangement of Coils

Assuming the stator of the motor under consideration to have twenty-four slots, which is the usual number for a motor of this size, it is obvious that, as each coil occupies two slots, twelve coils will be required. Thus the turns per coil will be :

$$\frac{635}{12} = 53 \text{ turns}$$

Having arrived at this figure and knowing the gauge of wire to be used, the actual winding can now be undertaken. No particular difficulty attaches to this part of the work, but care must be taken that the windings are kept as compact as possible, otherwise there will not be sufficient room left for the starting windings which follow the main windings. These latter are wound over the main windings, but are displaced one half pole pitch so that starting will be possible in either direction. No calculations of a complicated nature are necessary in estimating the turns and gauge of wire for the starting coils. A perfectly safe plan to follow is to use wire of five gauges smaller than that used for the main winding, and to wind each of the twelve coils with from one half to two-thirds of the number of turns used on the main coils. All coils are connected in series.

CAN WE MAKE LIFE?

A PROBLEM FOR THE COMING GENERATION OF SCIENTISTS.

A drop of human blood, highly magnified. Note the individual blood corpuscles, each of which is endowed with lifelike properties.

SCIENTIFIC romancers have long visualised the making by man of a sort of mechanical replica of himself endowed with something closely akin to life and in actual fact there have been in the history of mechanics instances of clever inventors who have succeeded in constructing human models which were capable of performing limited movements in lifelike fashion.

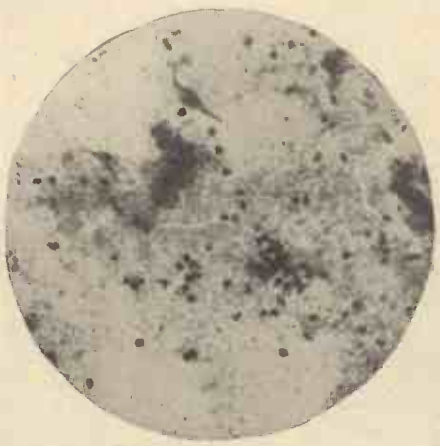
There is, however, when it comes to the question of life-endowed organisms, an infinitude of difference between a working model and the real thing. Scientists of the present day can and, indeed, actually have constructed artificial hearts, working models of kidneys and other animal organs which function in almost precisely the same manner as do the natural articles. It is quite possible, also, that, working along these lines, a realistic automaton representing a man or an animal more closely than has ever previously been conceived might be built up at the hands of clever and ingenius laboratory workers.

Remarkable Functions

Not even, however, the cleverest and most successful automaton designer would ever, in virtue of his creation, claim that he had actually made Life, for Life is a principle which transcends inanimate matter. It is rather, a mysterious force or entity which, springing from some secret recesses of the world of creation, activates inert matter and enables it to perform many remarkable and truly astonishing functions.

No serious scientific thinker dreams of ever being able to create a man or even a warm-blooded animal. Yet there have been and, indeed, there are scientists who see little reason why, in the time to come, we should not be able to create life in its very simplest forms or, at least, to construct organisms which closely imitate the functions of a living entity.

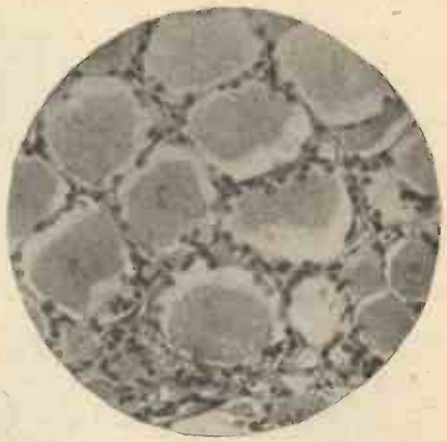
What is Life? The definition is an exceedingly difficult one to form. It has its physical, chemical, biological and theological aspects and with such we cannot deal here. There is, however, one attribute of life which is universally shared by all living forms, lowly or otherwise. Living organisms are, at some stage of their development, able to reproduce themselves.



The centre of human ingenuity. Single cells in the brain of a man, very highly magnified. Note the "grey-masses" content of each brain cell.

So universally is this function of reproduction attached to all forms of life that it has come to be regarded as one of the main properties of a life-endowed organism. An object which, under favourable circumstances, cannot reproduce itself is not alive. That is a very important point to bear in mind, for if, in the future, scientists ever succeed in fashioning out of complex chemical substances a cell or an organism which appears to have lifelike properties it will have to multiply itself entirely of its own accord before it can be said to possess life.

Here is a "pure" strain of mould being grown experimentally under laboratory conditions. Much of our knowledge of lowly life-forms has been garnered from the study of moulds.



A "deadly" form of life, the notorious "T.B." germ. Here magnified more than 1,000 times, we see the minute living germs of tuberculosis in the saliva of a patient suffering from the disease.

A Significant Fact

Another significant fact connected with the life principle is that it is always associated with chemical substances containing carbon. We term such substances "organic" ones, since from a certain number of them organised life appears to spring. Little more than a century ago, it was considered impossible to make such organic substances artificially in the laboratory. They were supposed to be endowed with a *vis vitalis*, a "vital-force" which operated to prevent their being created by chemical means. Such a theory has long been exploded. Chemists are now able to manufacture a large number of different materials which are formed by plants and animals and not only to imitate them exactly but actually to improve upon them.

There is, however, one category of organic chemical substances containing carbon which have not yet yielded up the secrets of their composition to the probings of the chemist. And significantly enough it is just these substances which are most intimately concerned with the phenomenon of life.

"Protoplasm" is the name of the chemical material with which all life is bound up. Protoplasm, in some strange way, appears to hold the secrets of all life as we know it. Its very name signifies "first form" and from this material, all life, human and animal, has, according to the strict evolutionists, originally sprung.

Protoplasm

What is protoplasm? To the eye, it is a jelly-like substance, almost transparent in nature. Chemical analysis shows that it is composed of carbon, oxygen, hydrogen and nitrogen, together with small amounts of sulphur and phosphorous, all of which ingredients are compounded together by Nature in an exceedingly complicated manner.

Protoplasm, of course, despite its complexity, is only an organic compound or, at any rate, a mixture of such compounds.

Chemists, biologists and other scientists, therefore, have seen no reason why, ultimately, protoplasm should not be made artificially in the laboratory just as other simpler organic compounds, as, for instance, uric acid, sugar, indigo and tannin, have been built up from common materials.

If, therefore, as many scientists confidently predict, protoplasm will one day be created synthetically by artificial means, will it exhibit all the phenomena of life which the natural product does ?

Ah ! there's the question, and, to be perfectly frank, the answer is that we simply do not know. Chemists must try to make protoplasm and then if they succeed and the material which they produce is capable, under suitable conditions, of multiplying itself, the problem of creating life in its most fundamental form will certainly have been solved.

Enormous Complexities

The great difficulty concerning the synthesis of protoplasm is its enormous complexity. Common salt (sodium chloride), as most amateur chemists know, contains in its molecule but two atoms, one of sodium and one of chlorine, and the arrangement of the atoms is a very simple one. If, again, we take another well-known substance, say washing soda (sodium carbonate), we find that this, although a little more complex in constitution than common salt, contains but six atoms in its molecule, its chemical formula being Na_2CO_3. That familiar liquid which we call benzene contains a dozen atoms (six of carbon and six of hydrogen) in its molecule and at one time it was regarded as having a complex composition.

It has been estimated, however, that the number of atoms contained in a single molecule of protoplasm amounts to more than one hundred thousand, a truly prodigious number. Furthermore the protoplasm atoms are all arranged to form a very definite (but unknown) pattern and it would seem that the life-force associated with protoplasm is as much the result of the arrangement of its atoms as of the actual number of atoms present in it.

Chemists have been able to make substances distantly resembling protoplasm and containing upwards of 30,000 atoms per molecule. Such materials, however, show no forms of life. They are merely "albumenoid" substances like the white of an egg.

The problem of creating protoplasm artificially is analagous to being given an enormous number of six different kinds of balls and of being told that when approximately a hundred thousand of them are assembled together in the right proportion and so as to form one definite pattern, the result will show signs of life.

A highly magnified photograph of an amœba, life's simplest form. It consists merely of a mass of living protoplasm.

The problem is a truly enormous one, so formidable, indeed that it seems likely that it will baffle the ingenuities of chemists and other scientists for many years to come. Yet, indeed, if it were solved and if protoplasm were created artificially, who knows whether the first elements of life would not have been created by man ?

Simplest Form of Life

The simplest form of life which we know of is to be seen in a microscopic organism known as the *amœba*. The amœba is simply a mass of living protoplasm which exists at the bottoms of pools and ponds. It is devoid of all sensory organs and contains merely a central "life-spot" or nucleus. The amœba, however, is capable of changing its form. This it does by thrusting out masses of transparent jelly which give it the appearance of having short tentacles. The organism feeds upon tiny vegetable cells which it literally envelopes by spreading itself around them.

The amœba, too, possesses a sort of immortality in that (unless it is purposely or accidentally destroyed) it never dies. At a certain stage in its development, the amœba merely splits across and becomes two amœba. These two, likewise, in due course, divide up into further amœba, but in no sense does a single amœba cease living.

Next to the amœba we have those tiny, yet infinitely useful and, at times, alas, mightily destructive forms of life which we term the *bacteria*. Bacteria are really miniature plants. They are more complex in make-up than the amœba, despite the fact that they are hundreds of times smaller. In them living protoplasm is always to be found.

Can we make artificial bacteria ? The question is a moot one. Provided that we can arrive at a clear understanding of the inner nature and composition of elementary protoplasm, it seems very likely that we might be able to make such lowly life-forms. Whether, of course, such scientific power would be for our weal or for our woe is quite another point, for synthetically manufactured bacteria would be a very potent weapon in the hands of a nation or of a cowardly dictator.

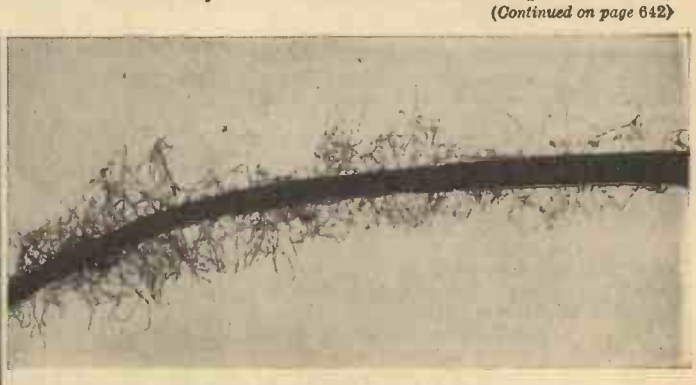
Moulds

Higher up in the scale of life than the bacteria are the moulds. Could we ever hope to make an artificial mould, one which would grow on cheese and bread and upon other organic materials like the familiar moulds of our present-day existence do ? Some scientists appear to think not. They contend that any life-creation other than the mere synthesis of elementary protoplasm is for ever beyond the power of humanity. Others take a more forward view and suggest that the artificial production of some growing entity similar in nature to an ordinary mould might ultimately result from a thorough knowledge of the technique of artificial protoplasm building.

Moulds, of course, lowly as they may seem to the average individual, are, in reality, fairly highly-organised life-forms. They grow in much the same way as a plant, have their maturing periods and produce their seeds. It is quite obvious, therefore, that if mankind were ever able to create such organisms, it would be well on the way to making higher entities still.

At one period it was universally held that life could originate out of nothing. This theory of "spontaneous generation" held for centuries. You took a piece of meat,

(*Continued on page 642*)



(*Left*) *This is a highly magnified photograph of the mould which grows upon cheese, bread and other eatables. It has formed "seed-heads" which will eventually burst and scatter the minute seeds.*

(*Above*) *Living filaments of mould growing on a tiny twig. Many scientists hope to be able to imitate such growths at a future time.*

LAND SURVEYING

II—Traverse and Plane-table Surveying

LAND which is to be the subject of a survey may be of widely different types. The method of surveying by means of chain, and offset staff and ranging rods, described in the previous article in this series, is only applicable to one of these types, viz.—comparatively small areas of open country, free from obstructions in the form of hills, woods, etc., and of regular shape.

Where the shape is irregular, for instance a winding valley or a river, or where the land contains obstructions, it may be impossible to obtain a straight base line of any length.

In such cases the method of traverse surveying must be adopted.

Traverse Surveying

This consists of dividing the base line into a number of lines, changing direction at each obstruction or "station" (Fig. 1). Not only must the length of the lines be measured, but also their direction. The latter may be done by two methods:

(1) Measuring the included angle (see Fig. 4) by means of a theodolite.

(2) Measuring the bearing of each line with a compass.

Under heading (1) comes the theodolite, which is the instrument par excellence for this class of work. If great accuracy is not required, and the land is fairly level, a box sextant may be used. This is a cylindrical box with a swivelling telescope and two mirrors so arranged that the images of two poles, one on each line, may be superimposed, and the angle subtended by the poles read off on a scale.

For very rough work, the angles between

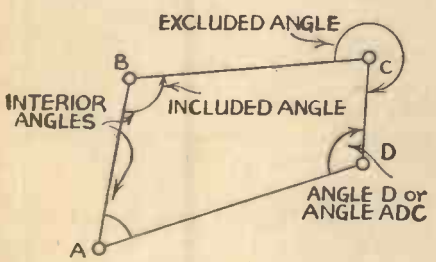


Fig. 2.—How the positions of points on the plan are built up from the intersection on lines of sight drawn from the base line.

the traverse lines may be chained, i.e., the two lines are produced and a "tie" is measured across them.

The Compass

Under heading (2) comes the compass, which may be of the prismatic type, i.e. fitted with a sight and a reflecting prism, so that the line and the compass reading may be seen at the same time.

Traverse surveys taken with the theodolite are invariably worked out trigonometrically (the position of each station of the traverse is fixed, when plotting, with reference to horizontal and vertical co-ordinates drawn on the plan). It is only in rough, or "non-rigorous," traverses that plotting with a protractor would be permissible; but as it is not possible to describe the trigonometrical reduction of traverses here, it is proposed to deal with those surveys capable of being plotted by protractor, i.e. compass traverses.

In Fig. 1 the base line *AD* has been split into *AB*, *BC*, and *CD*, and the lengths and bearings of each section, or "leg," have been measured.

Topographical Surveying

The reader will probably be interested in topographical surveying—the representation of features of the countryside over which he rambles frequently. It is, of course, possible to buy a map of the district for a few shillings per sheet: but it is much more interesting to make one's own large-scale plan of a particular stretch of moorland or woodland, with all features, paths, etc., shown. Moreover, such a map will be much more up-to-date than the official maps; and all actual rights of way

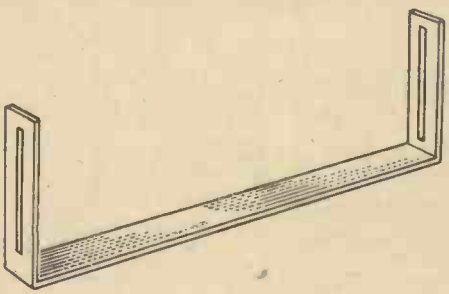


Fig. 3.—A simple Alidade or Sight Rule for use with a Plane-table.

can be shown, whereas on the Ordnance Survey maps the "footpath" sign does not necessarily denote a right of way.

In Fig. 1, the traverse follows the line of a particular ridge around a valley. Starting at *A*, which we mark as our first station (with a peg in case we wish to identify it again), we sight on to station *B* (the assistant is holding a pole or ranging rod there) and measure the bearing of the line *AB*. Then we move to *B*, chaining the distance as we go, and measure the bearing *BC*, and so on.

Having arrived at *D*, the line *AD* cannot perhaps be chained, owing to the fact that it crosses the valley which the ridge encircles. If the surveyor does not proceed further, *ABCD* is called an "unclosed traverse," and there is no real check on the work. If, on the other hand, *DA* can be chained, then the actual length of the "closing line" (*DA*) can be compared with that obtained by calculation or drawing when plotting.

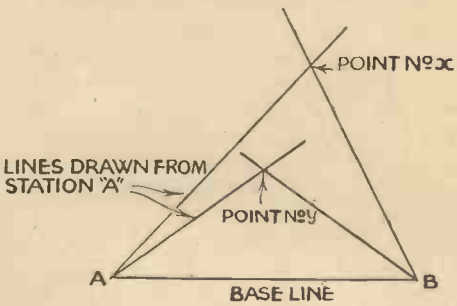


Fig. 4.—Working out the included angles.

Checking the Bearings

In this particular case, although we cannot measure the length of *DA*, we can take its bearing. We book the bearings of the lines thus:

Line	*Length*	*Bearing*
AB	3600 links	N.42° E.
BC	3065 ,,	N.88° E.
CD	1820 ,,	N.135° E.
DA	— ,,	N.257° E.

Having obtained the bearings of all the lines, we can check them by working out the included angles (see Fig. 4), as follows:

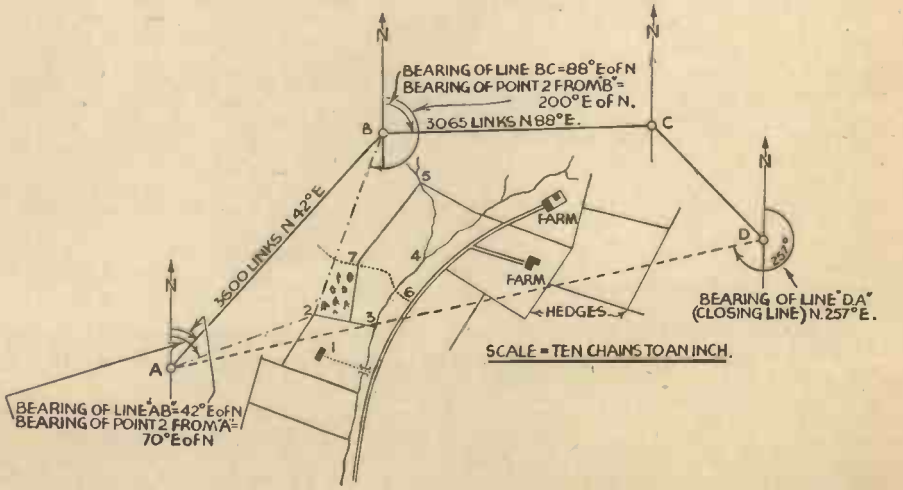


Fig. 1.—Sketch of traverse ABCD taken along a ridge, with conspicuous points in the valley numbered. Sight lines are shown from A and B to point No. 2. [The diagram is fully explained in the text.]

To find the included angle at any station (say C), take the bearing of the previous line (BC), add 180°, and subtract the bearing of the following line (CD). If the result is more than 360°, subtract 360°. This makes angle C (or stated more precisely, angle BCD) $88° + 180° - 135° = 133°$. By similar working, we find the other angles as follows: $< A = 35°$, $< B = 134°$, $< C = 133°$ and $< D = 58°$.

The sum of the included angles should equal $(2n - 4)$ right-angles, where n = the number of sides or "legs" in the traverse. Now here $n = 4$, and $2n = 8$. 8 minus $4 = 4$, and 4 right-angles $= 4 \times 90°$ or 360°. We check this by adding up the angles measured, viz $35° + 134° + 133° + 58°$, and we find that they add up to 360°, thus checking with the formula.

Further Procedure

The object of the traverse is to give a framework of points capable of being accurately plotted on a plan.

This framework may then form the basis of survey by chain or any other method, using sides of the traverse as base lines. Such a framework would lend itself very well to survey by the two following methods.

A. Suppose we take the base line AB (Fig. 1). First make a rough sketch of the detail in the valley, picking out points which can easily be identified from the other stations. A certain proportion of the valley can be covered from each base line. Number the various conspicuous points in rough sketch. Now set up the compass at A, and take the bearing of each of these points, putting the bearing down in the notebook opposite the number of the point. Then proceed to B, and take the bearing of these points from B; book them in the same way.

All these points can easily be plotted (on the plan) by drawing AB to the required scale on the drawing paper and at the proper bearing (i.e. making an angle of 42° with the side of the drawing paper, which represents a north-south line). Now take point No. 1, look up its bearing from A, and draw a line from A on the plan making this angle with north. Then draw another line from B making an angle with north equal to its bearing from B. These lines intersect at the position of point No. 1 on the plan (see Fig. 2). Similarly all the other points can be plotted; they should be numbered as they are drawn, because they identify the corresponding points in the rough sketch, and all detail can now be drawn in from the sketch.

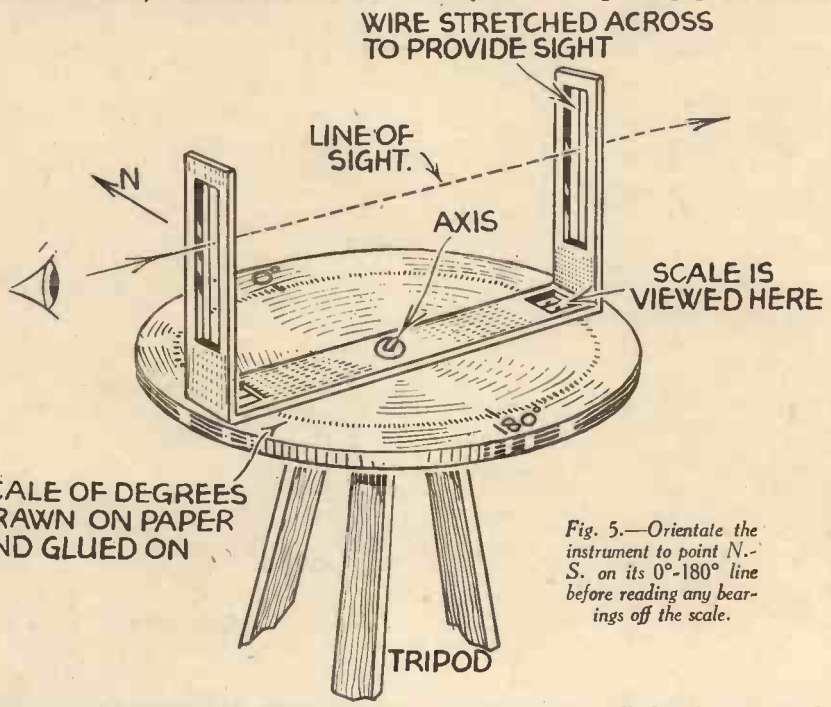


Fig. 5.—Orientate the instrument to point N.-S. on its 0°-180° line before reading any bearings off the scale.

B. Plane-table Surveying

It is actually possible to construct an accurate survey without taking any notes or measurements whatever. This sounds rather a tall order, doesn't it? Yet the method of Plane-table surveying enables the plan to be drawn in directly on the site.

A Plane Table is a small drawing board for use in the field, mounted on a light tripod. It should be provided with a spirit level and a compass. An Alidade or sight-rule is also used (see Fig. 3) for sighting to various points—it is really a flat ruler fitted with sights.

Method

First find a suitable base line from which to conduct the survey, and mark its ends with pegs in the ground. Call this line AB. Preferably, measure its length (because if not, you will not know the scale to which your plan is drawn). Now set up the tripod and plane table at the point A, and set it level. Next, draw on the plan (which at the moment consists of a plain sheet of paper pinned to the plane table) a line representing the base line, and to the appropriate scale—for instance, if your plan is to be to a scale of 12 in. to a mile, and the base line measures $\frac{1}{4}$ mile long, then it will be represented by a line 3 in. long on the plan.

Having drawn in the base line, the table must be turned, or "oriented," until this line points exactly in the direction of B from A (i.e. until it is parallel to the actual base line). Now draw in the north point on the plan, from the compass if available.

Plotting

The method of plotting is the same as in the "compass" method described previously, but no bearings are booked—the points are plotted direct on to the plan. First draw lines from the point A on the plan in the direction of all conspicuous points; number or name the lines. To get the direction of the line accurately, a sight rule is used (see Fig. 3). We then have a series of lines radiating from A, each labelled with the particular point it concerns.

Now take the table to the other end of the base line, at B. Set up the table, level it, and "orient" it, i.e. turn it round until the north point on the plan agrees with the compass. Notice whether the line AB on the board actually points back to A. If this is so, the table is correctly oriented, and we can proceed to draw in the lines of sight from B to all the points previously decided on. These lines will intersect at the actual positions of the points on the plan (see Fig. 2).

All points lying along a road should be joined up, and the remainder of the detail can be sketched in in a similar manner.

OUR BUSY INVENTORS

To Keep the Ball from Rolling

KNITTING to-day appears to be almost a craze. It is a safety-valve for nervous energy and it relieves feminine passengers in the tube from scanning, unconsciously, other people's faces and papers. What makes these addicts knit their brows as well as their yarn is the perpetual tendency of the ball of wool to prove the law of gravitation. They will, therefore, hail with pleasure an improved carrier for a knitting ball. This carrier comprises flexible interlocked grille sections, each having free ends. Expansible means connect the grille sections and control the diameter of the carrier. An extensible opening is provided, and when the loop which supports the carrier is held, the aperture is automatically restricted. This device will not appeal to kittens.

Lip Guards for Girls

IT is with considerable hesitation that I venture to enter that sanctum of beauty—my lady's boudoir. But I succumb to the temptation to do so, owing to a recent invention of peculiar interest to the daughters of Eve. The object of this device is to enable ladies to put on and take off their dresses over their heads without staining those garments with lipstick and rouge. It consists of a shield in shape like the graceful contour of the lips of the fair, and it is held in position by the teeth, which grip a mouthpiece behind the shield. This contrivance should be very useful in the dressing-room of the theatre, where the sylphs of the stage hurriedly don and doff many gowns over faces which are coloured like a sunset.

A Liquid Sherlock Holmes

BANKNOTES, stamps, passports and documents are subject to alterations illicit or otherwise. Hitherto, an expert has been necessary to detect these alterations; but it is claimed for a new process which has been discovered and patented, that it will enable an amateur to decide whether a document is intact. The document is first coated with a solution in which a chemical known as halogen plays the chief rôle. The superfluous liquid is then removed with a dry brush. After the intactness or alteration has been determined, the testing solution is removed by another solution and the document carefully dried. It is affirmed that no damage is caused to the article subjected to this treatment. The detecting solution may be described as a liquid Sherlock Holmes.

A PANORAMIC NAVAL REVIEW

By W. J. Bassett-Lowke,
M.I.Loco.E.

British Models seen at this year's International Exhibition in Paris

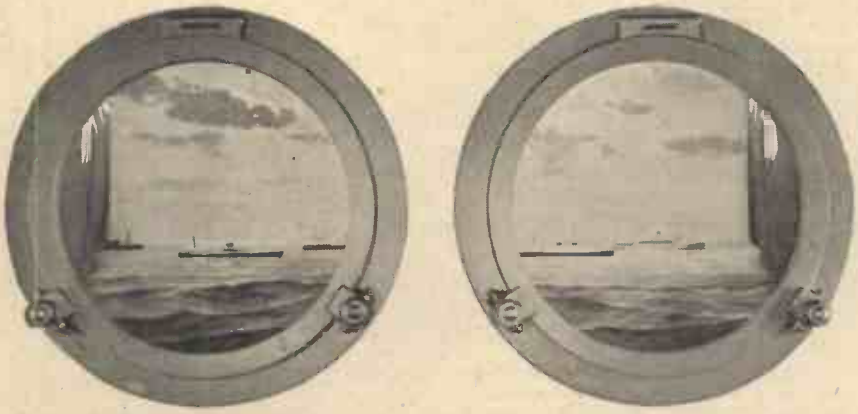


Fig. 4.—The Panorama of British ships showing the two sidelights set in the ships plating with view of the ships and seascape. The draped flags on either side are the two flags of the British Mercantile Marine, the blue and red ensigns.

IN the heart of Paris and on the banks of the river Seine is the International Exhibition devoted to modern progress in Art and Science.

Both in the British and in the French sections there are models of interest to ship lovers, and, as much modern development at this exhibition has been represented by the medium of models, in the article which follows I will try to describe just a few of the model wonders of the exhibition.

In an excellent position near the Pont Jena stands the British Government Pavilion, designed by the British architect Oliver Hill, devoted to all that is best in up-to-date British achievement. In the pavilion are seen models of all kinds, ships, locomotives, aeroplanes, scenic panoramas, whilst one of the "high-lights" is a shipping "review" of our merchant fleet, so realistic that as the onlooker gazes, it is hard indeed to realise that he is not inside a big ocean-going liner, watching, through his port-hole, the ships at sea.

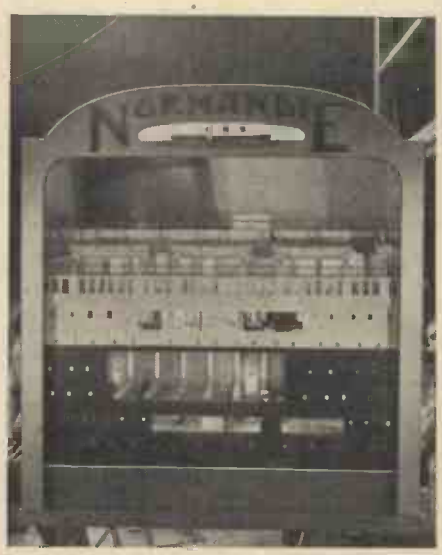


Fig. 1.—Complete front view of the Normandie *model. The scale is ½ inch to the foot and the model approximately 6 ft. wide by 8 ft. high. The procenium is in oak, painted matt gold with black lettering.*

Modern British Shipping

Those in charge of the British Government Pavilion were anxious that the progress of modern British shipping should be shown in a novel and effective manner, and as suitable models were not available from the various principal shipping companies, it was decided to provide a combined effort in which all the ships over 20,000 tons, built in Great Britain during the past ten years and operated by British companies, should be represented.

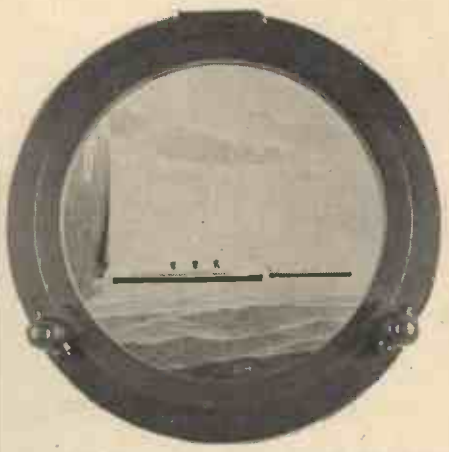


Fig. 5.—Close up of one of the sidelights showing the C.W.S. Queen Mary *in the foreground and the R.M.L.* Alcantara *on the horizon.*

Mr. Oliver Hill, in collaboration with Bassett-Lowke, Ltd., the well-known firm of model-makers, devised the idea of a panoramic review of this merchant fleet, and the illustrations herewith show the results of this co-operation.

The exhibit shows the inside plating of a ship and two life-size side-lights—or port-holes as they are more commonly called by the "landlubber"—beyond which an artistic seascape, painted by Mr. E. W. Twining, is visible, and across which pass two lines of ocean going ships. Each vessel is correctly modelled to a scale of 100 ft. to 1 inch and each company is represented by the latest additions to its fleet.

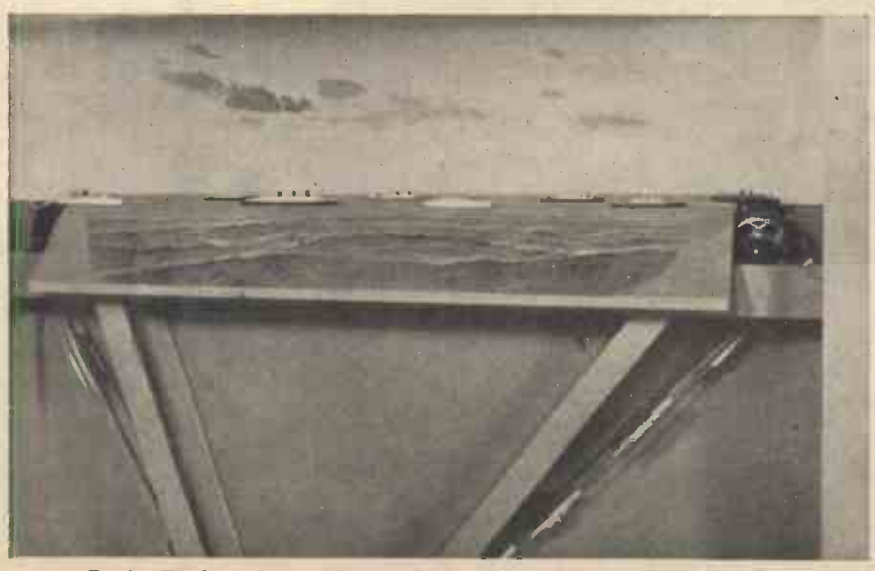


Fig. 6.—The front of the model removed, showing the arrangement of the ships and the mechanism working them.

"Queen Mary"

Among this comprehensive collection of merchant shipping are the *Queen Mary*, Britain's largest and fastest ship, the Orient Liner *Orion*, noted for its modern interior decoration, and which runs on the mail service from London to Australia, besides several cruises during the summer. The new Orient vessel *Orcades*, which does not make her maiden voyage until August, is also included. The attractive white Peninsular and Oriental liner *Strathnaver*, which is the largest turbo-electric ship engaged in traffic from London and Southampton, to India, is a notable model, as is also the

single representative of Royal Mail Lines, Ltd., the *Alcantara*, originally built as a motor ship, but since converted to steam turbines, and now the finest British ship engaged in the Southampton–South American service. This ship is also at times diverted for short pleasure cruises. One cannot fail to notice the striking lavender hulls and red and black funnels of the new Union Castle liners *Stirling Castle* and *Athlone Castle*, which with their higher speed have brought Capetown much nearer to the home country. The C.P.R. is represented, among other vessels, by that huge white craft the *Empress of Britain*, well known as the largest ship on the Canadian service and also for her yearly round-the-world cruise. Each of these companies are also represented by smaller vessels in their fleets, totalling some twenty-four ships in all.

An interesting feature of the device is that the front line of ships moves at a slightly faster speed than the row closer to the horizon, which gives added attraction to the model because it will always present a different grouping of ships to the watcher. The mechanism installed for this is electric, the ships being mounted on steel chains running round sprocket wheels in ball bearings, and is operated by a geared slow speed electric motor giving reliable and constant propulsion.

This panorama model took nearly three months to complete, and is fixed in a special niche prepared to receive it, and quite near to it are models of Britain's latest efforts on land, sea and air.

In the French Section of the exhibition there is quite a new type of display model of the *Normandie* in evidence, and as far as ship models are concerned strikes quite an original note. It is to a scale of ½ inch to the foot, measures 8 ft. by 6 ft. overall, and represents the part of the *Normandie* below her after funnel. The side of the ship is modelled in correct relief, and the shell of the hull is cut away in several places, giving the public a view of a portion of her magnificent interior.

Directly above the waterline we are introduced to the swimming pool with its attractive cocktail bar, and the gymnasium on the same deck close by. On the next deck is the dining saloon, going through three decks of the ship and without doubt the most imposing and brilliant public room in any ship on the seas to-day. Above this room are examples of some suites de luxe, giving accurate modelling of the furniture and equipment of the apartments in which millionaires, people of title, diplomats, statesmen and film stars cross the Atlantic Ocean. The promenade deck is shown in full relief, and beyond can be spied a portion of the grand salon with its modern furnishings. The attraction of the model is increased by the method of illumination. Situated at the base of the model is a Rotary-type device which operates from a motor. First the swimming pool and gymnasium are lit up, then the dining saloon, followed by the suite of rooms on the next deck, the promenade deck and grand salon, and finally the flood-lighting of the funnel itself. For a few moments the whole model is a blaze of light, then a sudden darkness and the lighting operation is repeated.

Fig. 2.—Portion of the interior of the Normandie *model showing electric motor control of the lighting, fan for air circulation and the system of lighting the columns in the dining saloon.*

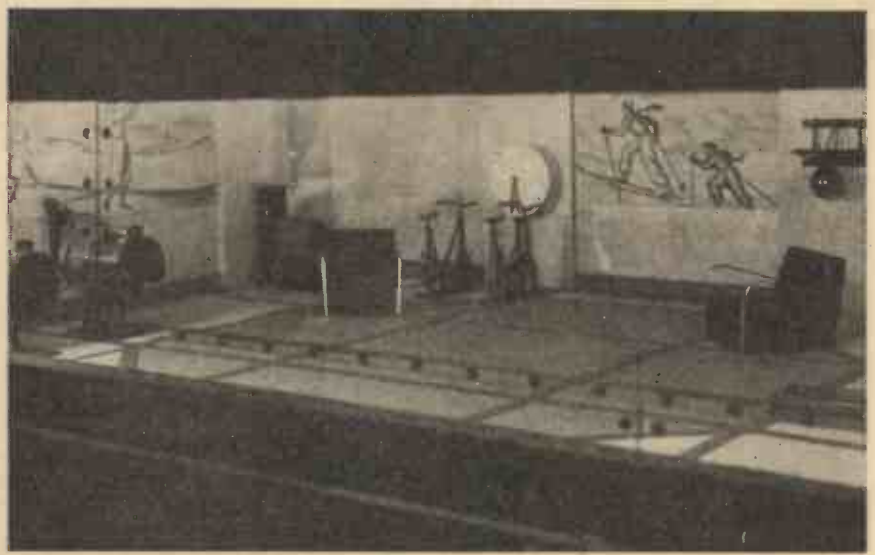


Fig. 3.—Close up of the gymnasium in the Normandie *model.*

NEW INVENTIONS

The following information is specially supplied to "Practical Mechanics," by Messrs. Hughes & Young, Patent Agents, of 9 Warwick Court, High Holborn, London, W.C.1, who will be pleased to send readers mentioning this paper, free of charge, a copy of their handbook, "How to Patent an Invention."

(*See also pages* 610, 622, *and* 637)

Ceiling as Film Screen

A UNITED STATES dentist has found a new use for the ceiling of the room in which he extracts and stops teeth. He employs it as a film screen. I presume that, during extractions, the patients, if conscious, would not be interested in the most thrilling drama. But, while the teeth were being stopped, the occupants of the dental chair, with head well back, would be able to survey a tragedy or a comedy with appreciation.

By the way, the improvisation of a ceiling as a lantern screen is not absolutely new. About a quarter of a century ago, an inventor devised an arrangement whereby an enlarged representation of the dial of a clock could be projected on to the ceiling. Consequently, while recumbent, one could tell the time at night.

The utilization of the ceiling as a screen might be extended to hospitals. Also, hairdressers please copy. A close shave could be accompanied by a "close up."

Vanishing Laundry Marks

A NEW system of laundry marking has been evolved. The usual practice is to mark in ink with a machine. The characters, not large, are placed on a inconspicuous part of the article. Sometimes the mark is impressed on tape which is stitched to the garment.

According to the process which has just been patented, the articles are marked in ink. The characters, being bold, are easily detectable, which facilitates sorting. Eventually, when the garments have been washed and replaced in the customer's bundles, they are exposed to ultra violet light. This action causes the marks to fade out. It remains to be seen whether the new process will be welcomed by the laundry trade. The experienced sorter in a laundry has a lynx eye for detecting even an almost invisible mark. And it is a moot point whether constantly marking and fading out makes for the health of the fabric.

Road Marking

WHILE upon the subject of marks, I am moved to mention a recently invented method of road marking. Roads are usually marked with lines or letters by painting the surface of the highway white or a light colour. This painting has to be renewed at frequent intervals, à la a tennis lawn. In some instance, metal or rubber studs are used. It is contended that these are costly and suitable only for certain types of roads.

Aiming at the production of effective and ecomonical marking, an inventor has devised a strip of a bituminious binding material, in which are embedded pieces of white or light-coloured vitreous material. The strip can be applied to the surface of the road or be laid in a channel therein.

Sock Stretcher

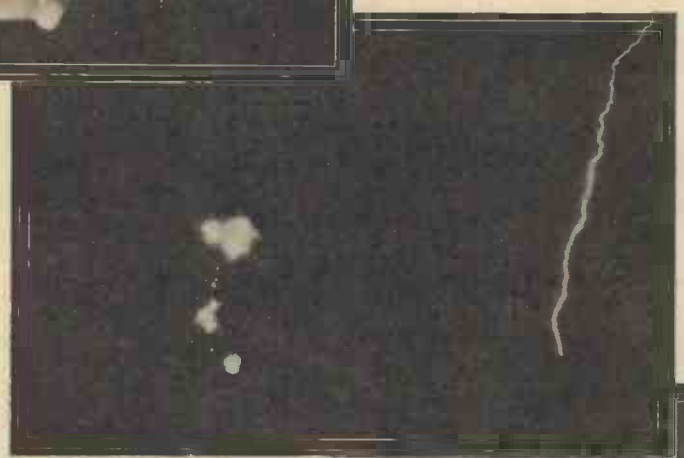
A KIN to the familiar trouser-stretcher is a lately patented appliance for use with socks after washing. Consisting entirely of wire, the construction of this device is remarkably simple. As a result, the cost of manufacture is slight. The wire is twisted in such a manner that there is formed at the top a hook for suspension, while the under part follows the contour of a pair of feet.

DYNAMO.

THUNDER IN THE AIR

By Eric Hardy, F.Z.S.

How the Air Ministry Meteorologists Forecast the Thunderstorm for the Weather Reports



Not a firework display but remarkable illustrations of ball lightning, or as it is more commonly known, thunderbolt. It is thought to be due to the electrification of a vortex of dusty air by the electric discharges from a thundercloud.

"WEATHER will be showery with bright intervals and local thunder." How frequently do we hear this in the broadcast weather report at this time of the year? And how often do listeners wonder how the wireless man gets his thunder report? Always in the summer the Air Ministry meteorologists keep a watchful eye for the conditions that make a thunderstorm, and these are usually an upper atmosphere colder than usual for the time of the year and a lower atmosphere that is warmer and wetter than it should be, which produce that instability in the atmosphere so necessary for the thunderstorm. If in summer a deep depression remains stationary off western Ireland for more than twenty-four hours, the wind will circulate round the centre so that air that is on the north part of the depression—over Iceland—one morning may be on the southern side over England the next, and if this moving air was found to be 45 or 50 degrees on the surface it would be colder still in the upper layers. In passing round the depression, the lower air would be warmed by the Atlantic waters now at their warmest temperature, and would pick up much moisture, but the higher upper air would remain cold, and so when it reached England the unstable conditions necesary for thunder would occur. That, however, would all be surmised beforehand from the reports tabulated on the weather map at the Air Ministry, and all the general public would get is the forecast of thunder.

Not Guesswork

So you see there is none of the astrologer's wild guesswork when the meteorologist forecasts a thunderstorm, and now, under the organisation of the Thunderstorm Census Organisation organised from Huddersfield, a special study of the storms is being made by special observers all over the country, who day and night are recording on special cards the time and direction of lightning, etc. But because this is organised from Yorkshire, do not think Yorkshire is the best place for thunder. In summer East Anglia seems to get most thunder, and in winter western Scotland, though mountainous districts like Derbyshire peaks, Lakeland and North Wales get much more than the lowlands. The East Coast seems to get more summer thunder than the West.

Records are also being made of the frequency of objects struck by lighting. Evergreen trees seem to suffer less than deciduous ones, and the oak seems to be the tree most often struck by lightning (but this may be because it is one of the commonest trees of our country) followed by the elm and much less frequently by the beech, horse-chestnut and holly. The effect of thunderstorms on bird life is less severe. In early summer it often holds up the great pigeon races and occasionally homing pigeons are killed by lightning, but wild birds instinctively seek shelter during a bad storm. Nightingales, however, have been found singing at their very best during a thunderstorm, and I have occasionally heard song thrush, blackbird, cuckoo, wren and willow-warbler singing during a storm. The stormcock or mistle-thrush has usually ceased singing by the summer.

A Bird Omen

Sometimes a thunderstorm is accompanied by severe hail. In the North-east, East and South-east of England a summer weather report that "a depression situated over Iceland is moving south-east," is a bad omen. The moving depression will cause polar winds from the north, veering north-east, to follow with cold showers and cold clouds, and if such clash with a "warm front," a sudden thunderstorm with hail may be the result. A sudden change in the wind altering the path of the depression may upset the weather forecast at the last moment. Most folk, however, expect thunder when the barometer falls and the temperature rises.

Types of Lightning

The popular assumption that the streak lightning frequently seen on a summer's night is essential to ripen the corn is quite erroneous. Most artists depict lightning as a zig-zag, but it is not always so. The well-known streak-lightning is classified according to its variations as ribbon, rocket, fork, zig-zag, and bead lightning. Sheet lightning, and ball or globular lightning are less frequently seen. Streak lightning is

white or pink and may reach anything from an inch to a mile in length though its diameter is small and the discharge of electricity causing it may be made in a cloud, between two clouds, between a cloud and earth, or between a cloud and the surrounding air. Ribbon lightning looks like a lot of parallel streaks, due to several successive discharges being moved by wind. Rocket lightning is slow streaks, bead lightning appears like a string of luminous gloves. Forked lightning, through its forks, is able to strike two or more objects at the same time. Globular lightning moves along the ground or through the air in ball-shaped masses ended in a violent discharge causing damage: it is the popular thunderbolt. Sheet-lightning is a silent discharge sometimes seen in clouds and haze, but in popular talk sheet lightning is wrongly associated with the illumination arising from streak lightning; the true type lasts longer and has comparative slow variation of intensity.

Weather Guides

The broad, noiseless sheets of lightning seen so often towards the close of a hot sultry day are harmless, but it is otherwise when the heat is overcharged with vapours, and great masses of mountain-like cumulo-nimbus or thunder clouds fill the sky. The front of a thunderstorm of wide extent is frequently in the form of a large, low arch above a region of uniformly lighter sky. Horses are said to twitch considerably before lightning and thunder, but their forecasts are fairly similar to those of all nervous people, especially sufferers from corns and rheumatism, and certainly usually truthful.

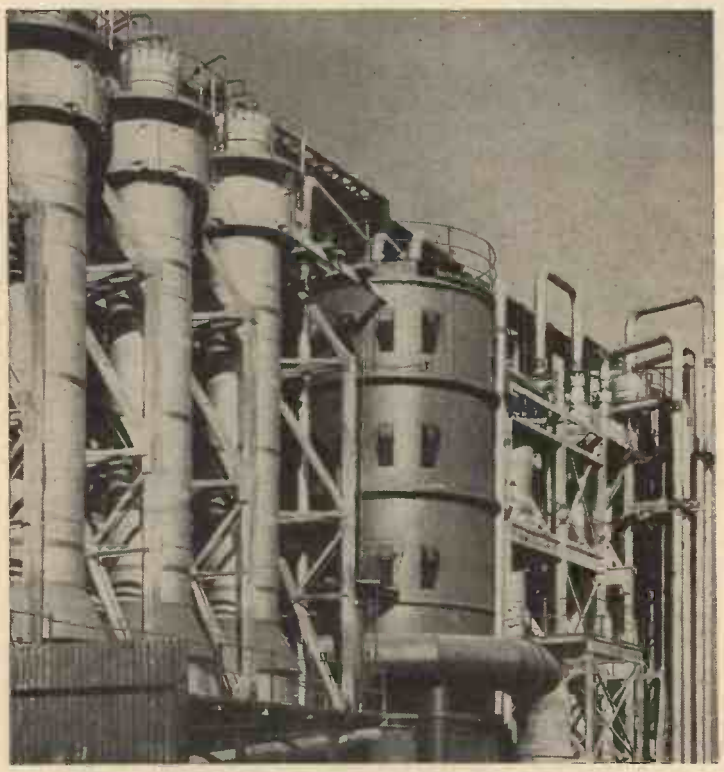
Awful, however, as may be some of our British thunderstorms, they are very mild compared to those that rage in the lands by the Indian Ocean, along parts of the African coast and in Central America, when the event seems a rehearsal of the day when: "the heavens being on fire shall pass away with a great noise."

The speed of lightning is about eight to ten miles a second, or forty times as fast as sound: that is why we see the flash before we hear the report of its discharge. One of the most remarkable examples of the usefulness of a lightning conductor to carry the flash safely to earth without damage is the 360 feet tower of St. Mark's at Venice. This was struck and damaged, often necessitating rebuilding, in 1388, 1417, 1489, 1548, 1565, 1653, 1745, 1761, 1762, but in 1766 the lightning conductor was installed and it has not since been struck. In August 1767, when lightning struck the church of St. Nazaire, at Brescia, Venice, it exploded 207,000 lb. of gunpowder stored in the vaults, killing 3,000 of the inhabitants and destroying one-sixth of the city.

Franklin, the American scientist, flew a kite with a metal guide in a thunderstorm, and recorded the electric ("fluid" as it was then called) discharge of the storm, but when Professor Richman, of Russia, incautiously repeated the experiment he was electrocuted.

THE MOST POWERFUL SPIRIT IN THE WORLD

Chance Discovery that Helped Many Industries



High-pressure vessels termed "converters," where the coal is hydrogenated.

ON June 16, 1825, a blacksmith's son, Michael Faraday, announced to the Royal Society his discovery of benzene, or as we know it commercially to-day, benzole.

The Society was not unduly impressed by this new innocent-looking liquid, and probably even Faraday himself was too interested in his experiments with electricity to enlarge upon it at the time.

He tested its properties and found an extremely powerful and volatile substance. Before very long it was being applied to many branches of industry, but for nearly 100 years the real value of the spirit was not recognised.

The advent of the motor car gave benzole its chance. Tests were made on benzole as a motor fuel and it was found that, in the words of Dr. D. D. Pratt, of the Chemical Research Laboratory at Teddington, "motor benzole gives a ton-mileage to the gallon, 25 per cent. higher than petrol, and has other advantages such as less tendency to knock, whilst allowing a higher compression ratio to be used."

Benzole is extracted from British coal as a by-product in the manufacture of coal gas. To-day hundreds of plants have been established at gas, iron and steel works and coke ovens through out the length and breadth of the country for the extraction of benzole from coal.

Extracted from Coal

The spirit is extracted from coal by a process known as high-temperature carbonisation. The coal is heated in a retort to a temperature of between 1,250° and 1,400° C. At this heat gases are driven off and passed through a valve known as the hydraulic main. They are cooled in a series of long pipes called the condensers, where coal tar and ammonia liquify out, and they then pass on to be purified in scrubbers. Lastly, the gases are "stripped" of benzole by being passed through a heavy oil in which the vapours dissolve. The benzole is again purified and scientifically blended with petrol and sold as benzole mixture.

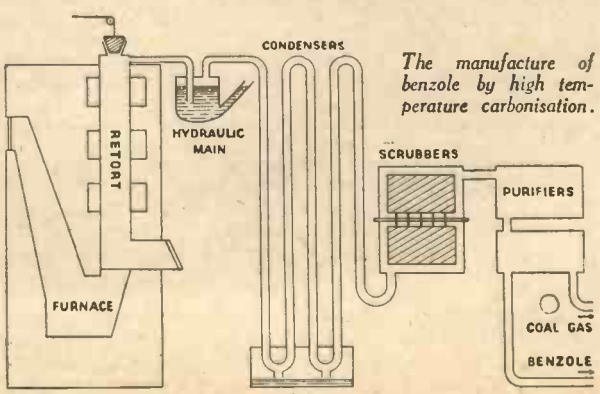
Long before benzole was used as a motor fuel it was an invaluable substance in the synthetic dye industry, for it is one of the five hydro-carbons from which nearly all synthetic dyes are derived.

Many other industries could not do without it. Painters and cleaners use benzole as a solvent and in the hardware industry it is applied as a metal cleaner. It is used by the photographer, the chemist and the cobbler, and is employed in the manufacture of various rubber compounds and adhesives.

Its Applications

The uses of benzole in industry are many, but more important still are its applications to the medical profession, for here its value lies not in finance or economics, but in its significance in human affairs. Benzole and other coal-tar derivatives in their application as antiseptics, hypnotics and anæsthetics have helped doctors in their everlasting battle against disease.

Benzole is a substance which fascinates scientists. When it is passed through a red-hot tube it gives acetylene.



The manufacture of benzole by high temperature carbonisation.

THE MONTH IN SCIENCE AND

Colonel Ermlio Herrera, the Spanish aviator, with the equipment he will use for his study of the stratosphere.

Sleep by Electricity

PROFESSOR G. Kalendarov, a young Soviet scientist, has for some time been engaged in research on electro-narcosis. By introducing electrodes under the skin of the head and at the base of the spinal column of a frog, he succeeded in putting it to sleep with an electric current. When the current was switched on the frog lost all sensibility, and as soon as the current was disconnected, it revived. After carrying out similar experiments, with success, on dogs and rabbits, Professor Kalendarov next proceeded to experiment on himself. He says that during the treatment he first noticed a slight pricking sensation in the forehead and a tightness in the head, everything grew black, his will weakened and senses became dulled. Gradually he closed his eyes and the electrical sleep began. When the electric current was switched off, he immediately woke up without any unpleasant after-effects. Professor Kalendarov has published some 28 papers on electro-narcosis. The Soviet film trust, Soyuztekhfilm, has recently completed a film on electrical sleep, based on Professor Kalendarov's experiments.

Cossor Television

THE two pictures on this page show the Cossor Television Film Transmitter, which, by means of a line distribution system, provides a local signal for the demonstration of receivers at the Television Exhibition now being held at the Science Museum, South Kensington, during the hours when transmissions are not available from Alexandra Palace.

It represents perhaps the most complete development of the cathode-ray tube scanning method. The issues involved here are not at all straightforward, and the complicated problems arising from the screen time constant questions have been successfully solved.

Owing to the use of cathode-ray tube scanning, the system is naturally highly flexible. In the present case a choice is provided of five different line numbers—405, 315, 243, 187, 121, with a choice of sequential or interlaced scanning in all cases. For the first time, an immediate comparison can be made between interlaced and sequential scanning for any given number of lines, and such comparisons are most striking.

The transmitter also illustrates the use of simple time base circuits to derive special forms of synchronising pulse. The wave form of the transmitter, inclusive of picture and synchronising intelligence, is continuously monitored on two oscillographs which may be viewed by the public.

Cossor Television transmitting and receiving tubes are also being exhibited in addition to the Cossor Television Receiver and the transmitter described above.

A Mysterious City

THE Italian Government is offering a prize of £1,000 to the archæologist tracing the mysterious lost city of Sybaris, on the Gulf of Tarentum.

It was founded in 720 B.C. and was one of the most opulent cities of its day. The waters of the River Cruthis were turned over the ruins, after it had been sacked by the Crotonians, in 310 B.C., and ever since the city has been lost.

The Cossor Television Film Transmitter.

Two Air Records

POLINA OSSIPENKO, a Soviet airwoman has recently set up what are claimed to be two new woman's world air records.

Flying a seaplane, she reached a height of over 23,750 ft. with a load of 1,100 lb., and a height of over 19,500 ft. with a load of 2,200 lb. Exact figures of the flight are being worked out scientifically.

THE WORLD OF INVENTION

World's Steepest Railway

THE railway up to the summit of Mount Pilatus, near Lucerne—claimed to be the steepest railway in the world—has now been converted to electrical power.

The journey to the top of the mountain formerly took 1 hr. 20 min. Now it takes only 35 minutes.

Short-wave Blind Flying

OWING to numerous accidents, American air lines are at last following the lead set by the European nations as regards blind flying. An ultra short-wave blind flying system now in use on ten of the leading air lines in Europe has been tested in Indianapolis.

"Walking on Air"

ROBERT SOTTLER, a Jugo-Slav. mechanic of Zagreb, has evolved an apparatus consisting of two umbrella-like contrivances placed on a shaft, at the bottom of which are hand and foot pedals.

Sottler claims that one can rise vertically in the air like an autogiro to an altitude of nearly 1,000 ft. No other driving force is necessary, he states. He has offered to construct his "sky-walking" apparatus for anyone interested for the sum of £30.

The Fastest Train Journey

THE new L.N.E.R.'s special streamlined engines, built for the "Coronation" streamlined expresses to run between King's Cross and Edinburgh in six hours, have been named "Dominion of Canada," "Commonwealth of Australia," "Dominion of New Zealand," "Union of South Africa" and "Empire of India."

The down train, on its run to York, will perform the fastest train journey in the British Empire—188 miles in 157 minutes, or 71·9 m.p.h.

The Leipzig Fair

THE Leipzig Autumn Fair, 1937, will be held from 29th August to 2nd September. In accordance with its traditions, the fair will include an exceedingly comprehensive range of finished products. The Building Fair which has been growing in importance and scope from year to year, will also be a special feature this autumn. The Great Engineering Fair, on the other hand, is held annually in the spring. The Building Fair will comprise building materials, and hygienic installations and probably have more than 300 exhibitors. The area available in the large exhibition halls was fully booked as long ago as May last. This part of the fair will be given a distinctive note by sample displays of gas and electrical appliances.

Miniature Ball Bearings

INDUSTRY is well provided with all manner of ball and roller bearings, varying in size between 5 ft. and ½ in. external diameter. There are, however, countless small mechanisms which at present use plain or jewel bearings in their construction. Such devices as small electric motors, recorders, meters, clockwork, speed indicators, tachometers, pressure gauges, scientific instruments, weighing mechanisms, etc., now make use of the latter. If very small ball bearings were available at reasonable prices they could be employed with great advantage in all these products.

As a result of the recent economic crisis, Switzerland was badly hit, more especially in the watch-making industry. This period of relative inactivity enabled a well-known Swiss manufacturer of watch parts to realise an idea which had long fascinated him—no less than the development and manufacture on a commercial scale of ball bearings so small that they could be substituted for ruby, sapphire and plain bearings in all forms of clockwork, motors, delicate machines and sensitive measuring instruments. This ideal is now a practical commercial reality, miniature ball bearings being produced in quantity to standards of extreme precision, although the overall size of a complete bearing, including race, is less than that of an ordinary pin head. The overall dimensions actually range from 1·5 m/m upwards. A further important advance will shortly be realised when complete bearings of only 1 m/m overall size will become available.

These miniature bearings contain three balls for the small sizes rising to eight for the largest. They operate well up to 10,000 revs. per minute, and owing to their self-aligning properties should be invaluable for small motors. Ball bearings of this type only use 15 per cent. of the oil required for plain bearings and, hence, need not be lubricated for years on end.

The bore of these bearings is machined to + 1/10,000 inch.

These miniature ball bearings are patented in all principal countries, and are the invention and production of Roulements a Billes Miniatures S.A. of Switzerland. Further particulars can be obtained from International Technical Developments Ltd., Thames House, S.W.1., who are the exclusive British agents.

A Wind Power Plant

A COMPLETE wind power plant of a new design is being shown at the "Schaffendes Volk" exhibition in Germany. The installation, which is the biggest of its kind yet erected, has a height of about 130 ft. The plant itself, which contains a dynamo driven by a wind wheel, pivots on a steel mast about 100 ft. high. It consists of four wings measuring over 90 ft. from tip to tip, and automatically turns to the wind without any wind vane. By a special device the revolution of the wings, and therefore of the dynamo, are kept regular even with fluctuating wind speeds. The power capacity of the plant with a wind speed of 6½ metres a second is 5 kilowatts continuous current, which is being used to supply the Reich Labour Service section of the exhibition. This is said to be the first time a wind power plant of such dimensions has been shown at an exhibition.

Exploring the Sea Bed

ON exhibition at the National Inventors' Congress in New York is a self-navigating diving device invented by Emil Kultk, of Brooklyn. The device resembles a deep-sea monster. Its principal feature is that a man in it will be able to work for long periods of time without help from the surface owing to the oxygen tanks carried within. Most functions that a diver is able to perform may be executed by two long interchangeable arms that extend in front of the apparatus and which are controlled from within the machine.

A self-navigating diving device.

Fig. 1.—This is the front view of a large conjuring table with "black art" wells of black velvet. The glass held partly inside one of the wells reveals its position. There is another well in the opposite back corner of the table.

CONJURERS'

By Norman Hunter

Some Easily Constructed Pieces of Apparatus that Help the Wizard to Perform Innumerable Tricks

I SUPPOSE that every reader of PRACTICAL MECHANICS has heard of conjuring tables equipped with traps. The ordinary trap is a metal door hinged to fill the opening in a metal plate. This is screwed to the table and a portion of the table top has to be cut away to accommodate it. The door is fitted with a spring so that when opened, by pressure from above, it tends to close again as soon as pressure is relaxed.

The usual way in which such traps were employed was to place an object such as a ball on the trap, apparently pick it up with the two hands cupped round it but in reality press the trap open with one hand and allow the ball to fall through into a bag under the table. Traps of this kind are, however, rarely used to-day. Their place has been taken by what are called black art wells. In fact the black art table is one of the most generally useful pieces of equipment in the whole armoury of the magician.

A Black Art Table

Briefly, a black art table consists of a table with the top covered with black velveteen and pierced with one or more holes. These holes are fitted with bags of black velveteen, made with the pile of the material inside. The top of the table is marked out, usually in a check design, with narrow bright coloured ribbon to hide the edges of the holes. Such a table, by artificial light, presents an apparently unbroken surface to the spectators. The black velveteen absorbs the light so evenly that it is not possible to tell where the holes, or wells as they are called, are situated. In fact very often the conjurer himself cannot detect the presence of these wells although he is standing close to the table, and has to memorise their position in order to avoid making unintentional vanishes by putting things down where there is no table top.

Fig. 1 gives a general view of a large black art table with the position of one of the wells exposed by the tumbler held part way into it. There is another well of the same size in the opposite back corner of the table.

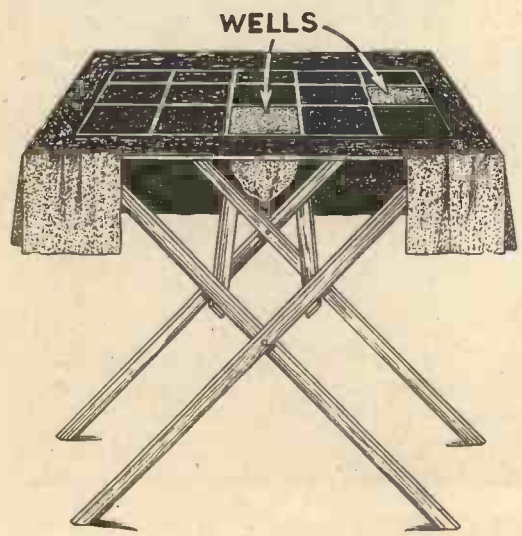


Fig. 3.—A back view of the table showing the wells and table draping.

The uses of such a table will be obvious. A small object placed just in front of a well may be made to vanish by seemingly picking it up, the hand coming in front of the article and gently tipping it into the well. The empty hand is then partly closed and moved away as if holding the object.

Using the Table

Another way of using the table is to cover, say a glass, with a cloth. The cloth is double and has sewn between the thicknesses, a disc of card the same size as the top of the tumbler, as described in a previous article in our April issue. The glass is allowed to drop down into a well and the faked cloth alone is carried forward, the disc representing the glass until it is desired to vanish it.

There are many more uses for a black art table, to some of which I shall refer presently. In the meantime reference to Fig. 5 will reveal the essential method of constructing a table of this kind.

The sides of the table are of thin plywood, hinged down the corners, the hinges being rivetted through the wood. It will be noticed that the ends are hinged to fold inwards so that the whole of the under framing of the table packs flat. The top is removable and consists of a framework of thin batten covered with plywood. The under framing fits within the batten framework of the top. Small metal studs of the

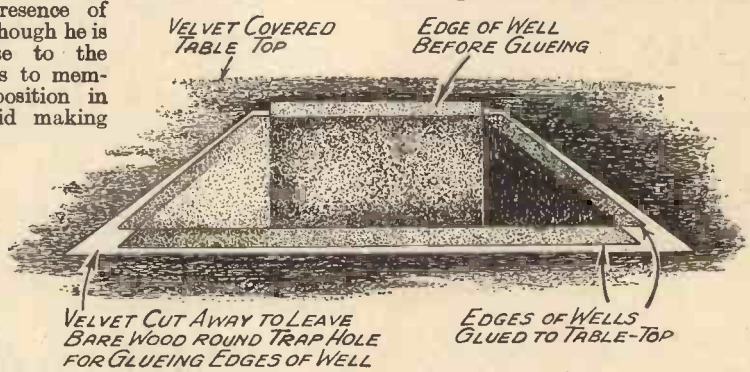


Fig. 2.—Glueing the strips of velveteen into the wells.

Fig. 4.—A table with a music stand base.

FURNITURE

(The Well-known Conjurer of "Maskelyne's Mysteries" Fame)

Further Articles on the Secrets of Conjuring will appear Regularly and Exclusively in this Journal.

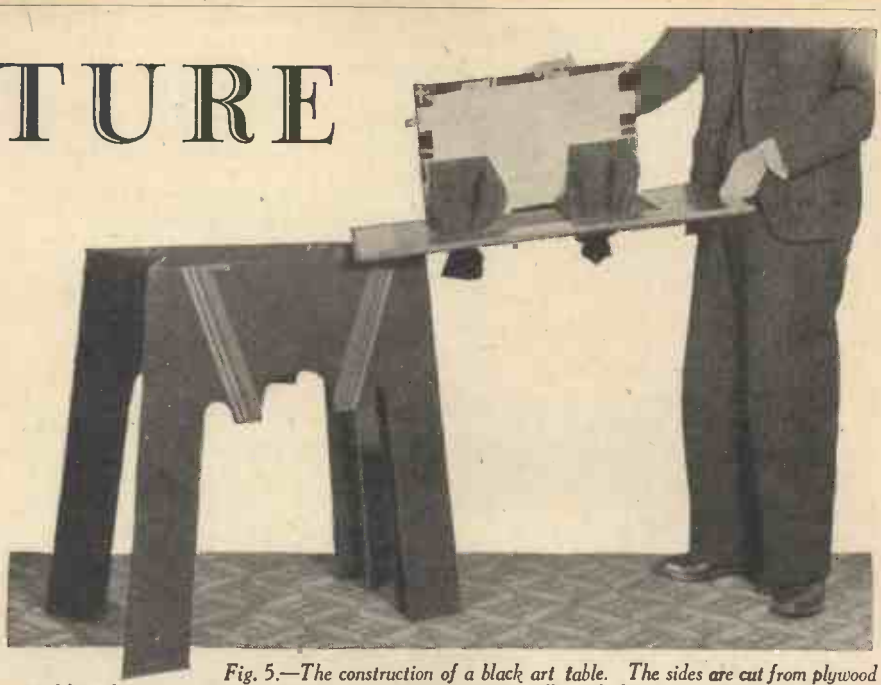


Fig. 5.—The construction of a black art table. The sides are cut from plywood and hinged to fold. There is a loose panel in the top and the wells of black velvet are fitted into this.

kind used for ordinary casement window fastenings, are rivetted on to the sides of the under framing and these go into holes in the inner edges of the framework of the top. Turnbuttons fastened to the under side of the top, press the studs well home and keep all secure. A table made like this is very strong and rigid when set up yet packs down to little more than an inch in thickness.

The Wells

The wells may be cut in the table whenever desired, but a better method is to have a panel cut out of the table top, as shown in the photograph, and fit the wells into this. The whole panel is then covered with black velveteen and lined out with bright yellow ribbon to mask the edges of the wells. The wells themselves are simply strips of velveteen glued round inside the openings and sewn up into bags.

There is one detail of construction that

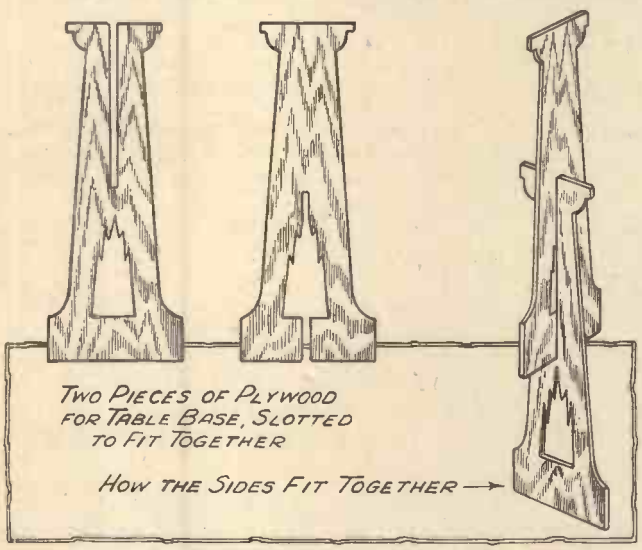


Fig. 7.—Details of the wooden table base.

makes for neatness. After the table top has been covered with velveteen, and after the glue is dry, cut round the wells with a sharp knife, cutting away the velvet for a quarter of an inch all round the openings. Now glue the strips of velveteen for the wells into the space so provided (see Fig. 2). The joint is entirely hidden by the ribbon afterwards put on and there is no lump at the edges of the wells as there would be if the bags were glued on top of the velvet covering. The ribbon is stretched across the table top and glued underneath at the ends only.

An ordinary folding card table can easily be made into a very useful conjuring table by cutting a panel out and fitting it with wells as described, or by simply cutting wells in the top proper. To hide the bags which form the wells a strip of fancy material must then be tacked round the edge of the table top. Fig 3 shows a table of this kind.

Another Type of Table

Another type of table very popular with conjurers consists of a plywood board measuring anything from twelve to sixteen inches square, fitted with wells and draped round with fancy material. This table top is supported on a stand similar to a folding music stand. In fact a folding music stand can be used for the purpose. In that case, however, a threaded bush must be made and the rod of the music stand must be tapped to fit it. The bush is then screwed to the under side of the top to take the rod. Such a table is very portable and the height may be adjusted. This latter point is often an advantage because if the conjurer is performing in a room fairly close to his audience he may like to have the top of his table out of range of the eyes of those sitting in front.

This music stand type of table is shown in Fig. 4. It will be noticed that the draping is not carried round at the back of the table. The space left is used to accommodate what is known as a servante. This is a bag made of either cloth or rather open knitting, on a wire frame. The ends of the frame slide into screw eyes driven into the under side of the table top. The servante is used in much the same way as the wells, for disposing of articles to be vanished, etc.

Reference to Fig. 6 will show another style of black art table. This table was designed for vanishing long narrow objects such as a candle in candlestick or a long staff.

Important Points

The photograph, which shows a view of the back of the table reveals several important points about the construction of a table of this kind. The long narrow bag forming the well is hidden from the view of the spectators in this case by the legs of the table. These legs are made from two pieces of plywood cut out and slotted to fit together after the manner of partitions in an egg crate (see Fig. 7). Small strips of wood at the bottom act as guides and prevent too much play at the base. The *X* shaped formation of the table base provides a very convenient *V* shaped space at the back for hiding the well.

The bottom of the bag is fastened to the table by means of an ordinary strong elastic band. This is looped over a flap picture hook fastened to the wooden part of the table, the other end being stretched slightly and held by an ordinary safety pin in the bag. The object of anchoring the bottom of

Fig. 6.—A black art table with a deep well to vanish or produce long shaped articles. Back view.

Fig. 8.—Large trap in a table. The top is removable and the table may be taken to pieces before and after vanishing or producing objects with its aid. See also Fig. 9.

the bag is to make it easy to draw objects out of it without turning the bag inside out in the process. The well is thus available for producing articles as well as vanishing them. For instance a large flag, pleated and rolled into a long shape parcel can be concealed in the bag. During a previous trick a few small flags are produced and laid on the table. Finally these flags are picked up and the big one is drawn out of the well behind them, to be produced after the performer has moved well away from the table.

Padding

Another point to be noticed in this photograph is the padding between the bag and the wooden part of the table. This consists of a piece of felt, baize or other soft material, folded several times and glued to the table. It deadens the sound of objects which, but for the padding, would strike against the wooden part of the table on their way down the bag. In order to make the two halves of the table detachable this padding is made in two pieces, one of which is fastened to each side of the table.

The table shown in the photograph has the top attached to one of the slotted sides by hinges. When the other piece is slid into position from below it automatically locks the table top firm. No ribbon was used to outline the well in this instance. Instead a piece of stiff cardboard known as leatherboard, was cut to the shape of the top and the entire design cut out with a knife. The black portions were then trimmed and covered with black velvet while the remainder was painted bright green. This jig saw sort of top was finally glued to the wooden top proper and the edge bound with bookbinders cloth and painted.

Figs. 8 and 9 show another form of take-to-pieces table designed either for producing or vanishing articles. The top, as will be seen, is fitted with a large lift up trap which fits flush with the rest of the top when closed. Underneath is a large bag of thin black material. The top is held down by a catch under the rear edge. This top is not fastened to the frame of the table, but simply fits on top, a framing of narrow strips of wood under the top serving to prevent it from slipping sideways.

A Table for "Vanishing"

The table may be used for an effective vanish as follows:—

A large object, such as a stuffed toy dog is shown and a full sheet of newspaper laid

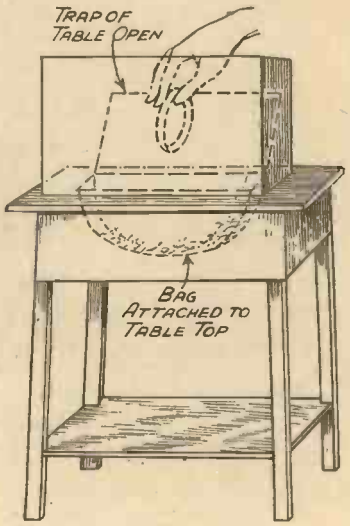
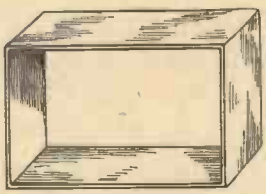


Fig. 10.—Vanishing articles in the bottomless box.



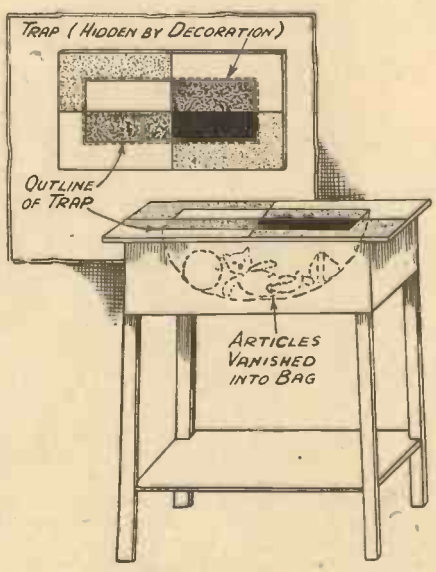


Fig. 11.—Details of the bottomless box and table top.

over the table. The catch is released and when the back edge of the sheet is lifted for the purpose of placing the dog underneath, the trap is lifted with it. The dog is then placed, ostensibly under the paper to be wrapped up, but in reality it goes into the bag. The trap door is allowed to fall, being caught by the tips of the fingers of the hand that held the dog, and lowered into place where the spring catch holds it. The paper is moulded round what I suppose I might describe as a dog shaped piece of nothing. That is to say it is wrapped about to look as if it contained the dog. The supposed parcel is then carried forward and crushed into a ball.

Finally the table is taken to pieces and held as shown in Fig. 9. By concentrating attention upon the framework of the table which obviously affords no room for concealing the vanished object, the conjurer distracts notice from the top, which is casually held as if it were nothing but a thin board.

Productions and disappearances may also be effected with this table by using in conjunction with it a sort of box, having no bottom and a loose, lift off lid.

The table is first taken to pieces and displayed as shown in Fig. 9, after which the bottomless box is shown empty and placed on the table. The box is an inch larger all round than the trap door and fairly deep. Immediately the box is in position the catch is released and articles previously packed into the bag are produced via the bottomless box.

Vanishing a Number of Articles

To vanish a number of articles the same procedure is adopted, the bag in this case being empty to start with. The objects are dropped into the box and so into the bag, the trap having been raised in the act of putting the first article into the box. The lid is then put on the box and given a tap with the magic wand, or a pistol is fired to effect the vanish. The lid of the box is then removed and shown on both sides, the trap door is snicked down and the bottomless box removed and shown to be a mere skeleton. The top of the table is then lifted off with a hinging movement towards the audience and passed casually to an assistant or stood against the leg of a chair while a great fuss is made of showing that the table itself is nothing but a framework.

Figs. 10 and 11 will make the necessary details clear.

Fig. 9.—The table shown in Fig. 8 is here seen taken apart. Objects just vanished or about to be produced are in the bag behind the table top. Notice how attention is attracted to the skeleton framework of the table.

Some Notable Miniature Railways

By E. BEAL

The Kerr Miniature Railway, at Arbroath, which is, perhaps, one of the most complete of such systems in existence

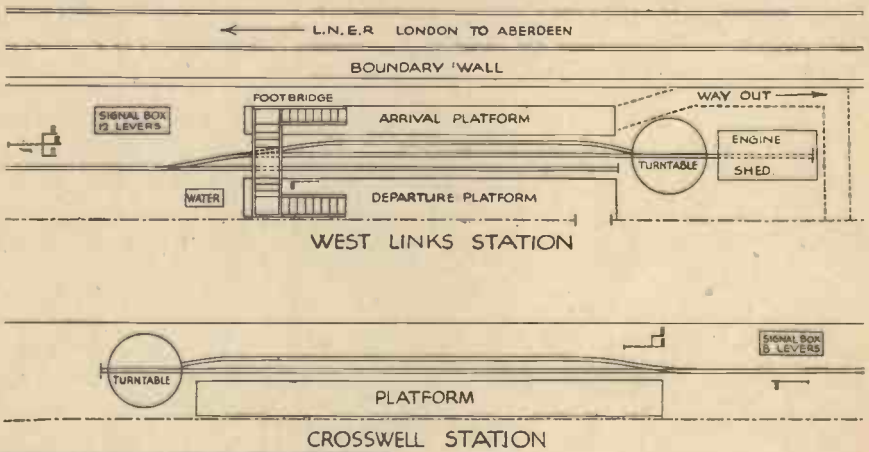
Mr. Matthew Kerr oiling up on the passenger - carrying line.

THE vogue of the diminutive passenger-hauling railway is rapidly spreading; but the interesting lay-out to be described is a strong competitor for the first place in one respect—its gauge is only 7¼ in., yet it regularly hauls in the summer months train-loads of anything from twelve to fifteen passengers over a main line 200 yards in length.

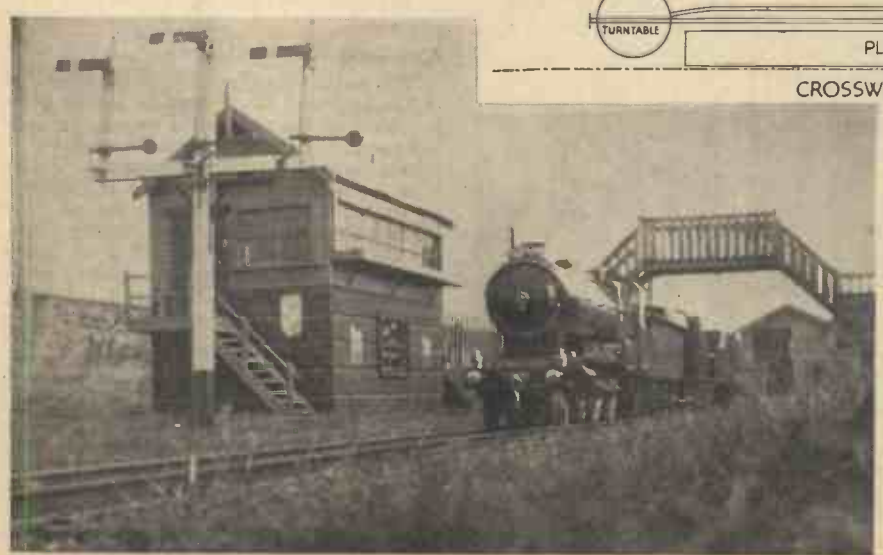
The Kerr Miniature Railway, as it is called, built and owned by Mr. Matthew Kerr, a young man of very decisive railway enthusiasm, is situated at Arbroath, and is not the least of the amenities provided to give pleasure to the public who may visit that enterprising Scottish resort. The little line itself is perhaps one of the most complete of such systems in existence. Every characteristic to be found in real practice is installed to perfection. Indeed, the photograph which shows a view of one of the stations, purposely denuded of all human figures, is extremely deceptive and convincing, and would for a long time keep the tyro guessing as to whether it were a real or a model lay-out. Footbridges, turntables, an engine shed, a complete and correctly operating signal system, and properly spaced trackside telegraph poles conspire to give the tiny trains their precisely correct environment.

A Single Main Line

The general arrangement is that of a single main line, running closely alongside the London & North Eastern main line to Aberdeen. There are two passenger stations, West Links, from which the departure is made, and Crosswell, the "distant" terminus. At each of these termini there is a 9-ft. working turntable. Normally the trains leave the West Links



A diagram of the stations on the Kerr miniature railway.



A general view of the appraoch to West Links Station.

departure platform with the locomotive running in approved style, funnel foremost. On arrival at Crosswell, the engine is run off and turned, and the return journey is made to the arrival platform at West Links. The latter station, the larger of the two, is provided with a timber footbridge of adequate working capacity, an engine shed, with ample space under cover for cleaning, inspecting, and storing the locomotive. The capacity of this shed can, in fact, be increased without structural alterations so as to accommodate two engines at a later date. Coaling and watering facilities are also provided at this point, the water being supplied from an automatic tank which appears in some of the illustrations. There is proper provision for the ingress and exit of passengers at West Links

station, the way out being arranged behind the turntable and separate from all operative tracks. At West Links, also, there is a most interesting working signal cabin, provided with a 12-lever frame, and so small in its proportions as to be capable of accommodating only the most diminutive of operators.

At the other station, Crosswell, there is a second cabin with a frame of eight working levers, and the two cabins are connected with bells and telephones. Here also there is a second 9-ft. turntable. The passenger platforms are properly raised to the height of the carriage decks.

The Track

The permanent way consists of flat-bottom rail, 6½ lb. per yard, spiked down to proper sleepers, which are 18 in. long, 4 in. wide and 2 in. in thickness, being spaced at 18-in. centres. The track itself is ballasted with ¾-in. granulated stone chips, and of this material there are no less than 6 tons on the lay-out. There are three working turnouts to allow for engine movements, etc. Altogether, including platform tracks and sidings, there are 700 ft. of track.

The locomotive is a scale model Atlantic type (4-4-2) with tender, and follows Great Central design. It was built by Messrs. Lewes, Shaw, of Nottingham, and its scale is 1½ in. to the foot, or approximately one-eighth full size. It is provided with two injectors and two water-gauges, and there is a steam brake on the engine itself. The tender is also furnished with a hand-brake for emergencies. Proper sanding gear is installed, and the driving wheels are 7½ in. in diameter, bogie wheels being 4½ in. Of "coaches" there are four two-seaters and two four-seaters, all being equipped with rigid four-wheeled underframes. Their seating accommodation is remarkably comfortable, as the writer can testify from experience.

After a couple of years' running the little railway is proving to be a sound financial proposition; the stringencies of the first year's operation have now been fully surmounted. The fare for the return journey is threepence, for juveniles half-price, and in the somewhat short Scots season it is crowded. The close proximity of the main line from London to Aberdeen is a decided attraction to railway-minded visitors, for it is often possible to run literally alongside the streamlined *Golden Eagle* and *Cock o' the North*, a quite thrilling experience. Passing enginemen are evidently no less thrilled than the happy passengers of the K.M.R.; the former invariably lean over the cabside and give a waving greeting. Not to be forgotten in any description of the system is the amazing railway staff, itself diminutive. Mr. Kerr is assisted by six small porters and signalmen, themselves almost true to the one-eighth-full-size scale—very intelligent and industrious uniformed boys.

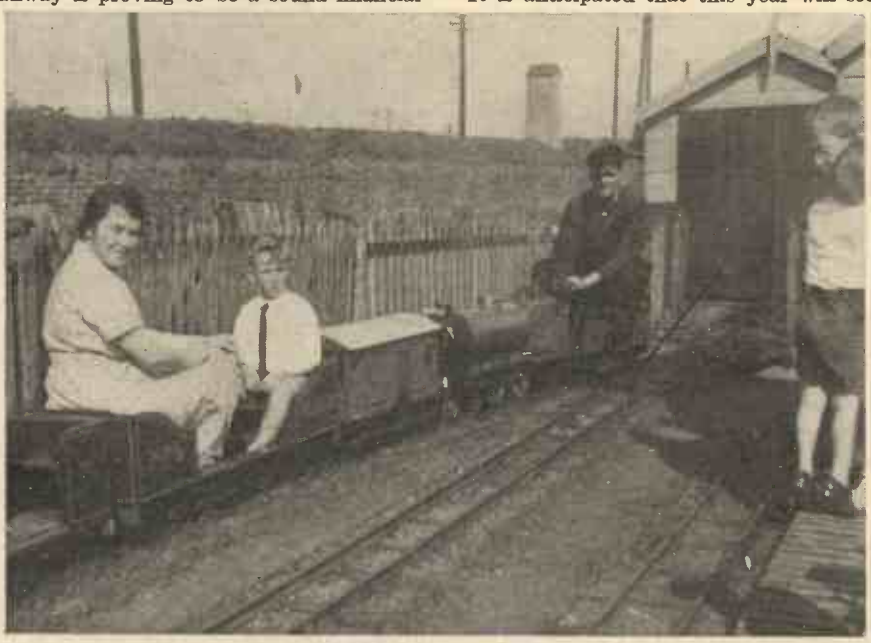
The 7¼-in. gauge miniature passenger line. Note the correct and operating signalling system.

Further Improvements

It is anticipated that this year will see the addition of further interesting features of civil engineering, including a viaduct, a tunnel, and a level-crossing, the latter to be worked from one of the cabins. Upon a dummy siding there are also to be erected a cattle-pen, a platelayer's hut, and some coal offices.

During the hard winter months, the site being extremely exposed to the North Sea, the entire equipment is dismantled and stored with the exception of the tracks and fences. The whole of the constructional work, designing and engineering of the system is carried out personally by the owner, this remark applying to the construction of all rolling stock, signals, and plant. Mr. Kerr is himself a dairy-farmer, but his heart and soul are bound up with the railway industry.

Altogether a most delightful rendezvous, not only for people of kindred minds to Mr. Kerr's, but for all members of the general public who enjoy a thrill, and who appreciate ingenuity and enterprise.



At West Links turntable.

NOTES ON INVENTIONS

Nursery Chair and Baby Carriage

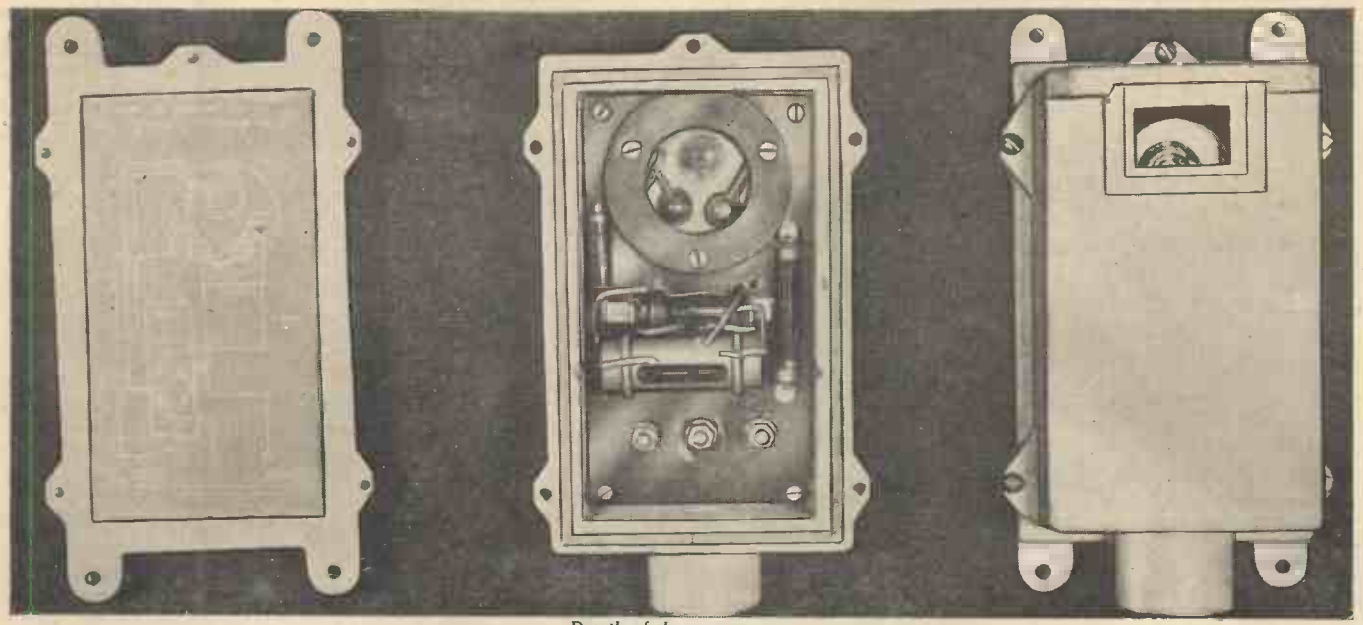
THE nursery chair is indispensable in a home in which there is a "toddler." A newly-designed high chair for infants, in addition to possessing the usual features, is so constructed that the upper part can be detached. Being fitted with wheels, this portion can be used as a baby carriage or a runabout.

Anti-Germ Handkerchief

THE pocket handkerchief is regarded by the hygienist as responsible for the propagation of diseases, such as catarrh and influenza. To reduce this danger to a minimum has been the object of the inventor of a recently devised handkerchief which, he contends, will effectually keep at bay injurious germs. The distinguishing characteristic of this handkerchief is an inner layer of moisture-absorbing material, such as porous cellulose. This is coupled with an outer sheet of fabric which is impervious to moisture and bacteria.

Dame Nature's "Back Chat"

THE advent of an echo-recording apparatus which enables distances to be measured, tempts me to refer to the fact that Mark Twain stated that he knew a man who collected echoes. This connoisseur of natural echoes is alleged to have brought an action against some person who had chipped away a hill and prevented its "back-chat." DYNAMO.



Details of the apparatus.

THE CHILOWSKY LIGHT RELAY

Details of a Device, the Features of which are its Relatively Low Cost, Absolute Simplicity, and Completely Automatic Operation

DURING the past twenty years much time and money has been spent in endeavouring to produce an electric relay operated by light in a cheap and practical form which could be generally available for a number of commercial applications.

One of the most obvious of these applications is the automatic switching on and off of lighting systems.

At present there are two principal methods in use.

The first method employs either a photo-electric cell or a selenium resistance bridge. Both necessitate the use of a valve amplifier and a relay. A second relay is often necessary when large currents have to be dealt with. A unit of this type is much too costly for general application and as it consists of three or four elements which require delicate adjustment it is comparatively easily put out of action.

The second method employs clockwork mechanisms which are also somewhat complicated and subject to the usual mechanical defects. Apart from being rather costly their operation does not depend on the surrounding degree of illumination and they must be set in advance to operate at a definite time.

Its Features

The Chilowsky light relay is a device which appears to be destined to fulfil a number of industrial applications because of its relatively low cost, absolute simplicity, completely automatic operation and also because it requires neither periodical inspection nor servicing.

Its action is based on a photo-chemical reaction long known to chemists. If a glass container filled with equal volumes of hydrogen and chlorine gas be exposed to sunlight the two gases combine instantly. If the light is subdued the rate of combination is slower. In darkness the two gases do not combine.

Chilowsky uses this simple reaction as the basis for his relay. A very small glass bulb is half-filled with aeque hydrochloric acid and two electrodes are sealed through this container. In one ingeniously devised example of its applications—the Tubost Automatic Parking Light Control—these are connected to the battery of the car.

Electrolysis of the acid takes place, hydrogen and chlorine gases being produced within the glass bulb. If this bulb is in darkness the two gases do not combine and a considerable gas pressure is built up in the bulb.

The Bulb

One side of this bulb consists of a thin flexible membrane which bends slightly with the increasing gas pressure. The bending motion either operates a direct acting switch or moves a mercury column which closes a circuit, automatically switching on any lights with which the device is connected—in this case the parking lights of a car.

When the glass bulb containing the two gases is exposed to light of a certain intensity the gases re-combine, dissolve in the acid, and the pressure is reduced. The glass membrane returns to normal and the circuit is broken thus switching off the parking lights.

The above is a brief outline of the principle underlying the new relay. After three years of continuous effort the whole instrument has been assembled within a glass disc roughly 2 in. diameter by ½ in. long and weighing about 2 oz. This highly compact yet practical and robust unit will switch on and off a current of 150 watts, the lag in operation being of the order of ½ second. It requires no attention and once installed should function well indefinitely. Its cost is low and the complete unit for automatically operating car-parking lights should be within the reach of practically every motorist.

An Ingenius Cut-out

This device includes an ingenious cut-out which is operated by the driver on entering his garage, or in any other circumstance where he may wish to put the automatic parking light out of action.

On starting up his car the following morning, or after the first acceleration, this cut-out switch is automatically released and the light-relay is once more ready to function without further intervention on the part of the driver.

A very important application is the automatic switching on and off of the electric lighting of railway coaches, etc., and a particularly robust unit has been designed for this purpose. This is not operating with entire satisfaction on certain of the French railway systems.

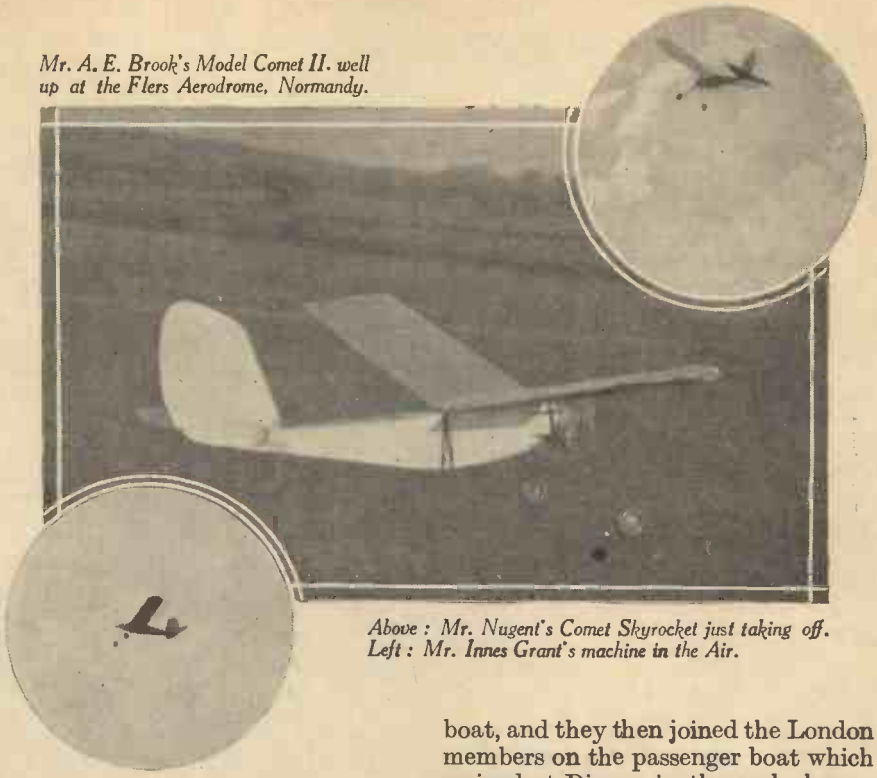
Other uses to which it is being applied include the automatic switching on of public lighting systems, lighting in telephone booths, display windows, as well as for a variety of publicity purposes, road signs, traffic lights, aerodrome beacons, buoys, harbour lights, etc., etc.

The Chilowsky photo-relay is patented in all principal countries and its commercial development and manufacture is in the hands of the well-known French firms, Société Tubost, of Fere-on-Tardemois.

British companies interested may obtain further particulars from International Technical Developments Ltd., Thames House, S.W.1.

MODEL AERO TOPICS

Mr. A. E. Brook's Model Comet II. well up at the Flers Aerodrome, Normandy.



Above : Mr. Nugent's Comet Skyrocket just taking off.
Left : Mr. Innes Grant's machine in the Air.

"Petrel" Contest

AS announced on p. 597 of this issue the "Petrel" competition for the £50 cash prize offered by the proprietors of this journal will take place at Brooklands Aerodrome, Weybridge, on Saturday, August 14th, at 3 p.m. Those competitors who notified us of their intention to compete have already been apprised and the competition bids fair to be the most successful ever held in any country in the world. The cash prize is the largest ever offered in a model aeroplane competition. The judges will consist of the Editor of this journal assisted by judges appointed by the S.M.A.E.

Mounting Petrol Engines

I LEARN that the F.A.I. have recently been debating a new competition rule for petrol models stipulating that the engine must be mounted well back from the nose of the machine. If this rule becomes regularised it would mean that air-screws would have to be coupled by means of a flexible shaft or else a long rigid shaft coupled to the engine shaft proper by means of a miniature Hooke's joint, or a model form of Hardy disc as used for the propeller shaft of motor-cars. Personally I hope this rule is made, for many aero modellers have been discouraged by the frequent engine smashes which accompany the initial tests.

Petrol engines are still fairly expensive, and it would seem unnecessary to have to make a rule compelling competitors to protect their own interests. When the engine is mounted well back a number of advantages are immediately conferred, and fortunately no disadvantages accompany such an arrangement. In the first place those modellers who prefer to incline the thrust line (this, as I have pointed out before is quite unnecessary and is based on a false premise, but it works well) can do so without having to make special provision, for a flexible shaft permits a simple design of propeller bearing hinged to permit of such angular adjustments. Secondly, the engine can be mounted in a convenient position and the thrust line itself quickly altered. Thirdly, the engine is absolutely protected, and by a suitable type of hinged propeller bearing universally mounted there would be little risk of air-screw damage in the event of a crash. Fourthly, it is safer. Fifthly, this is a practice which has been adopted on model boats for many years with entirely satisfactory results. I read a criticism the other day that the use of gears and long shafts means that a flywheel must also be fitted. This is not so. I hope that geared air-screws for petrol models will be encouraged. Most of the engines run at too high a speed to enable an efficient air-screw to be designed. Most of the air-screws have to be too small in diameter and of too fine a pitch. The thrust line of petrol models should always be mounted off-centre (sideways) to counteract torque.

Petrol Model Flying in France

MEMBERS of the Bournemouth Model Aircraft Club had a very interesting week-end giving a flying demonstration in conjunction with the S.M.A.E., at the opening of Flers Aerodrome, Normandy.

The Bournemouth party comprised of G. Rickard, A. E. Brooks, A. W. Brooks, jun., A. T. Fraser, and Innes Grant. The party left Bournemouth and travelled to Newhaven, where the car was consigned to Dieppe per cargo boat, and they then joined the London members on the passenger boat which arrived at Dieppe in the early hours.

The Londoners then departed for Flers by char-à-bancs, and the Bournemouth party cleared the car through the customs and started for Flers by way of Rouen, Bernay, Gace, Argenten and Flers, some 220 kilos which required four hours on the road. Much amusement was caused en route by the requests made for directions during which much tick-tacking ensued. However, they made safe arrival and were treated with great hospitality. The only grumble was, the water being scarce, champagne was the only drink. Despite this great handicap an excellent flying display was given. Both G. Rickard and A. E. Brooks brought forth tremendous applause for their exhibition with petrol models.

As the party did not arrive until 10.30 a.m. and left at 5 p.m. to return to Dieppe and England, during which times breakfast, lunch, speeches and flying display were given, some considerable hustle took place to the great enjoyment of all.

They departed among much cheering to do their run back to Dieppe arriving at 9.30 p.m. with the hope that they have the opportunity of returning the wonderful hospitality extended to them at this well-organised display.

Catapult Glider Record

MR. C. S. RUSHBROOKE'S catapult glider record of 2 min. 25 sec. has been accepted by the S.M.A.E.

STARGAZING FOR AMATEURS

A NEW SERIES

By N. de Nully

A GUIDE FOR AUGUST

SUNSPOTS continue to offer a fascinating study through almost the smallest telescope. The instrument should of course be furnished with a suitable protective dark cap. There are indications that the maximum of the present period of solar activity will be reached rather earlier than usual. It was not expected to do so until the middle of next year; but the time from minimum to maximum (and vice versa) varies, and has been steadily shortening during the past few cycles. Mercury sets too soon after the Sun to be perceived. Venus is still a "morning star," and was sufficiently bright to be seen in full daylight when at greatest brilliancy at the end of last June. The Moon will pass in front of the planet on the third, but unfortunately this rather rare event will take place in daylight. Moreover, the phenomenon will not be visible in this country as a complete disappearance farther south than Cumberland, Westmorland, and North Yorkshire. From situation in lower latitudes Venus will merely approach the Moon very closely; but it will be an interesting sight through a good binocular. If the sky is clear the Moon should be looked for high in the south-south-east shortly before 9 o'clock in the morning (B.S.T.), when Venus will be found near by. Even from places in the north where occultation takes place, the planet will not vanish as suddenly as in the case of a star; for the former exhibits an appreciable disc, whereas the latter is never more than a minute point of light.

Mars

Mars lingers in the south-west, setting at midnight. On the 26th it will be not far from the almost equally reddish star Antares in the southern constellation Scorpius (the Scorpion). The giant planet Jupiter is now very conveniently placed for observation. It rises at 8 o'clock B.S.T. at the beginning of the month and a few minutes earlier each evening. At 11 p.m. on the under-mentioned nights the following satellite phenomena will occur—all discernible through a small astronomical telescope. On the 2nd Sats. I and III will be in transit together across the disc. On the 9th Sat. I, and on the 31st Sat. II, will also be in transit at the same hour. On the 4th, 11th, 16th, 24th, 25th, and 30th—again at the same time—all four of the principal "moons" will be arranged on one or other side of Jupiter. On the 15th, 17th, and 27th—also at 11 p.m.—there will be but three of them visible, the missing one in each instance being hidden in eclipse. Saturn rises in mid-evening but will be more favourably placed next month. It will then be "in opposition" and nearest to the earth during the present "apparition." The southern surfaces of the rings are slowly coming into view; but they are still too much on edge to be discernible as more than a thin line of light.

The Perseid Stream

Meteors of the Perseid stream are confidently expected to make their annual appearances on the nights of the 10th, 11th, and 12th of this month. These August "shooting stars" are the most punctual of all the regular showers. They have returned without fail for centuries; and, as this invariably happens on the day dedicated to that saint, they were known in olden days as "The tears of St. Lawrence." For some weeks past the Earth has been penetrating deeper and deeper into this broad band of meteoric fragments which ceaselessly hurtle through space round the Sun in a very elongated oval path. They are travelling in an opposite direction to that of our world, and this increases the combined speed of impact to forty miles per second. During the three days mentioned, the densest zone of the terrific cosmic barrage will be traversed. Should a specially closely packed swarm be encountered

A meteor exploding. Note the short distance travelled by the main fragment after the explosion.

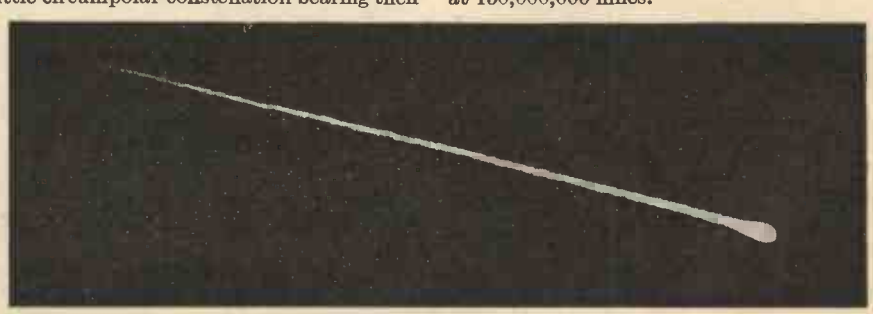
during the hours of darkness, the number of "shooting stars" that will flash across the sky may exceed one a minute. Thousands of rocky particles will be caught in our atmosphere like flies in a spider's web, and raised to incandescence by friction with the air. Few will survive their fiery passages to reach the ground, and those that do will be reduced to mere remnants of their original dimensions. The vast majority of such visitants are entirely consumed before they get within thirty or forty miles of the Earth's surface. There are, however, numerous authenticated instances of huge meteoric masses having been found in various parts of the globe.

Celestial Sky Rockets

The Perseids seem to radiate from the little circumpolar constellation bearing their name. They should be looked for in the north-east from about 11 o'clock until daybreak. There will be no interference by moonlight; consequently, if the weather is clear, watchers may be well rewarded. Though yielding the smallest shooting stars, the thin luminous streaks are always accompanied by large "fireballs." These magnificent celestial sky rockets are often extraordinarily brilliant and burn with a dazzling greenish-white lustre tinged with red. As they shed their glowing substance they leave long coruscating trails that frequently persist for several seconds. Now and then they explode with loud reports or crackling noises, scattering their sparkling elements in a final outburst of momentary splendour. Others simply break up and melt away in ghostly silence. Analyses of these derelicts of the solar system show them to be composed of such familiar minerals as iron, nickel, cobalt, magnesium, sodium, and phosphorus; besides various terrestrial gases. Even real diamonds have been found in the shattered remains of giant specimens. The origin of meteors is not yet determined, but they are believed to be waste material thrown off by those comets in the wake of which they usually follow. The Perseid shower was the first by means of which this remarkable association was established, the comet concerned being the one discovered by Tuttle in 1862 and due to return in 1985. Similarly, the once famous Leonids are evidently connected with Tempel's comet, and there are many others. The track of the Perseids lies along a narrow ellipse extending far beyond the orbit of the remote planet Neptune. They are fairly evenly distributed throughout this vast attenuated loop, and take 120 years to complete their circuits. Meanwhile, when the Earth annually dashes across the never-ending stream of cosmic one-way traffic, we witness the spectacular cremation of considerable quantities of dead cometary matter; and the products of their combustion, in the form of dust and gas, imperceptibly add to the weight of our globe.

Whipple's Comet

Whipple's Comet will be at its nearest to the Earth this month; but the light nights will prevent it from being conspicuous. A good field-glass is needed to detect it and an astronomical telescope to discern its hazy form with any degree of distinctness. The computed position for August 1st is R.A. 15 hrs. 52 min.; N. Dec. 21 deg. 26 min.; which can be located by means of a star atlas. The comet will continue to move southwards and now begin to recede from us. Its present distance is estimated at 150,000,000 miles.



A Perseid "fireball" leaving a luminous trail.

"MESSAGE FROM REUTER"

THE ROMANTIC STORY OF A GENIUS

HOW often have you read in your newspaper the familiar and very ordinary sounding words; "Says a message from Reuter," following some piece of news from a distant country?

Through familiarity the words seem commonplace enough, yet behind them lies the story of one of the greatest romances of our modern civilisation—intimately linked with our newspapers, our politics, our broadcasting, and with the colossal financial transactions of this and every other civilized country in the world.

Transmission of messages by the "ticker." The subscriber receives the message almost simultaneously on his machine at the other end of the wire.

Certain it is that Paul Julius de Reuter, who founded the firm of Reuters over eighty years ago, genius though he was, little dreamed of the wonderful development awaiting his organisation in the present century.

De Reuter was born in Kassel, Germany, on July 21st, 1816. He was employed as a bank clerk in Aix-la-Chapelle, and having a keen eye to business, it very soon dawned upon him that if he could obtain market reports and financial information before anybody else in Aix-la-Chapelle, he could quickly profit by this advantage.

Carrier Pigeons

After pondering this problem for some time, he hit upon a solution. Carrier pigeons. That was the very idea. He very quickly purchased some pigeons, took them to Brussels, and made a secret arrangement with a friend there to send information to him, de Reuter, each day directly the Exchange closed.

The market prices de Reuter obtained in this way, long before the mail coach could bring them, proved a great value to his colleagues in financial circles in Aix-la-Chapelle and they were always willing to pay him well for his carrier pigeon messages.

This scheme was actually the birth of Reuters, although he himself did not then know it. But he was astute enough to see the possibilities opened up by his carrier pigeon service so far as financial circles were concerned, and it was not long before he increased his stock of birds so that he could provide a service from countries further afield. By now he was making a regular business of it, which rapidly extended to quite a number of European countries.

The First Telegraph Cable

The next step in the development of young de Reuter's activities was the laying of the first telegraph cable between England and France. This had nothing to do with him directly, but when it had been accomplished by the telegraphic companies, his imagination was stimulated.

Paul de Reuter said to himself: "the bankers and merchants here are willing to pay well to obtain advance commercial and financial information, why shouldn't people be eager to have general news in more complete form, and more speedily, than they obtain it at the present time? And since England has taken steps to lay a cable to the Continent, England should be the place where such news will be much readily welcomed."

This was an even more important step in the development of Reuter's imagination than the establishment of his carrier pigeons service. He came to England and set up the headquarters of his business in London in 1851. True, he began only in a very small way, with offices in the Royal Exchange Buildings. He confined himself at first to supplying commercial and financial information from the Continent to the big banking firms and brokers in the City, and it was some years before he was able to put into practice his idea for supplying general news from every Continent to the London newspapers.

Magnitude of His Scheme

Now we begin to grasp the magnitude of the scheme which was developing in de Reuter's mind. He had established trustworthy representatives in may parts of Europe, and he was going to rely upon them

A wonderful machine—the automatic typewriter. The narrow tape which has been used earlier to send news to subscribers by means of the "ticker" is used again to operate the automatic typewriter, which cuts a stencil to be used in the duplicating machine. The sheets are sent out by hand in confirmation of the earlier messages.

Duplicating complementary sheets from the special cut by the automatic typewriter.

to furnish him in London with general news day by day, expeditiously and accurately. It was a big scheme, never before undertaken, but now made possible through his realisation of the true importance and scope of the newly developed telegraph. We must therefore admire the courage and initiative of the man in opening up this new field, the news agency.

De Reuter began his activities on this new and larger scale by approaching the *Times*, the leading newspaper of this country—perhaps of the whole world—and told the manager that he could supply him with daily service of news, gathered from all the capitals of Europe, and sent here by by the electric telegraph, at a lower price and with greater efficiency than the *Times* was then obtaining. This was a bold statement to make, but Reuter had the utmost confidence in himself and his service. However his proposition was rejected, the manager of the *Times* having even greater confidence in his own service.

Undismayed, Reuter turned to the *Morning Advertiser*. Here, again, his offer was not very warmly received, although that paper was a little more favourably disposed towards him, especially as he undertook to save them about £10 a month on their foreign news service, which was an item of some consideration in those days.

He Makes an Offer

Reuter thereupon decided to run no risks. It was now or never, and so he offered to give the *Morning Advertiser* a free daily service of Continental news for a fortnight, in order to prove that not only was his news from abroad cheaper than their own service, but also more comprehensive and efficient.

The *Morning Advertiser* accepted this offer, and Reuter immediately went to some half dozen other leading London newspapers with the same offer. This move proved to be a sound one. At the end of the fortnight trial period, these newspapers were all so well satisfied with the results obtained from Reuter's service that everyone of them immediately became a subscriber, and subsequently the *Times* also joined their ranks.

From this point onwards the development of Reuter's business went on at a tremendous pace. Within a few years he had established representatives in every quarter of the globe. Of course, with this increase in efficiency his contracts with the newspaper became more secure than ever. As his service became more and more indispensable, his charges were increased and whereas in the beginning the subscription rate was only £120 a year, within a short time each newspaper was paying him £1,000 a year for his news service.

His Employees

You may wonder what sort of men he employed as his correspondents. They were of several types. Some were gentlemen who had connections in the highest circles abroad; they mixed freely with royalty, diplomats, and rulers of States and with their daily intercourse with these people they were able to glean most valuable, interesting, and exclusive information. Others of Reuter's correspondents were themselves diplomats of a kind, and were in the confidence of people who held high positions in commercial and financial circles. Others, again, were highly trained journalists, who were able to extract from foreign newspapers all those reports and news stories which would be of value to Reuter's offices in London.

All this may sound very simple when it is analysed in this fashion, but we must try to appreciate the great genius of the man who gathered all these threads together in his London offices, and built up this wonderful organisation.

Of course, it cost a great deal of money to do all this, and the expenditure of Reuter was most lavish. At the same time he was repaid handsomely by acquiring a reputation for efficiency and reliability.

His Services Recognised

Reuters became a limited liability company in 1865 with Paul Julius de Reuter at its head. In 1872 he was given the title Baron Reuter by the Duke of Saxe-Coburg, in recognition of his great public services.

Baron de Reuter died at Nice on February 25th, 1899, at the age of 82, having lived to see his organisation grow into one of the greatest forces in the modern civilised world. But it had not finished growing.

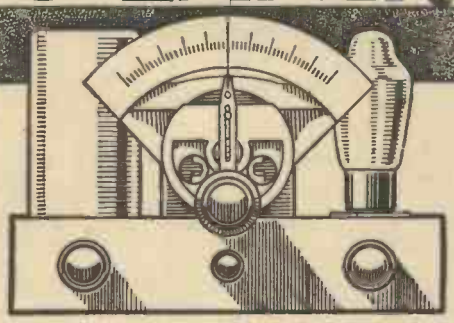
Other news agencies had, of course, sprung up after Reuter had shown the way, but in most cases they entered into a working arrangement with the pioneer organisation, realising that it was better for several agencies of this kind to work hand-in-hand rather than as rivals, and to this day Reuters work in close co-operation with all the biggest news agencies in other parts of the world.

Try to imagine, if you can, the vast stream of news, representing life in every part of the world, which flowed through the offices of Reuters during the years since the business was founded. If it could be recorded, you would see the history of more than three quarters of a century living again as in a mirror. (*Continued on page* 636)

A corner of the telephone room where messages are received from Reuter's correspondents.

The PRACTICAL MECHANICS

WIRELESS EXPERIMENTER



The A.C./D.C. Superhet Four

Circuit and Constructional Details of an A.C./D.C. Four Valve Superhet Incorporating Delayed A.V.C. and Providing Three Watts Undistorted Output.

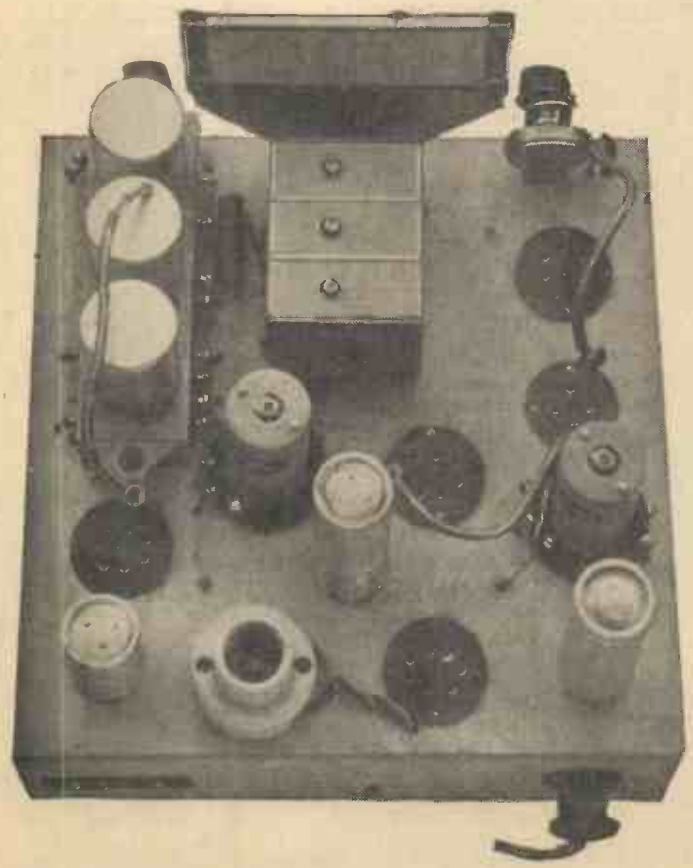
DURING the past eighteen months great improvements have been made in the design of valves and components for use in A.C./D.C. receivers. These have been mainly due to the fact that manufacturers have, at last, realised that a large proportion of the public prefers a universal receiver to the A.C. type, even though an A.C. supply is available. This cautiousness has probably been engendered by the delay in changing over the local supplies from D.C. to A.C. Consumers on D.C. are beginning to wonder whether their supplies will ever be changed over to A.C., and many of those on A.C., on the other hand, are not at all certain whether to believe that their supplies will not be changed to D.C. at some future date. Provided that the receiver is capable of giving as good a performance on A.C. as on D.C., one is certainly justified in obtaining a universal receiver for operation on A.C. mains. Care must be exercised in choosing such a set, however, as many commercial A.C./D.C. receivers have a pronounced hum on A.C. Constructors can rest assured that the A.C./D.C.4 has been thoroughly tested on both types of supply, however, with good results; hum is negligible if the set is built to specification.

Superhet versus Straight

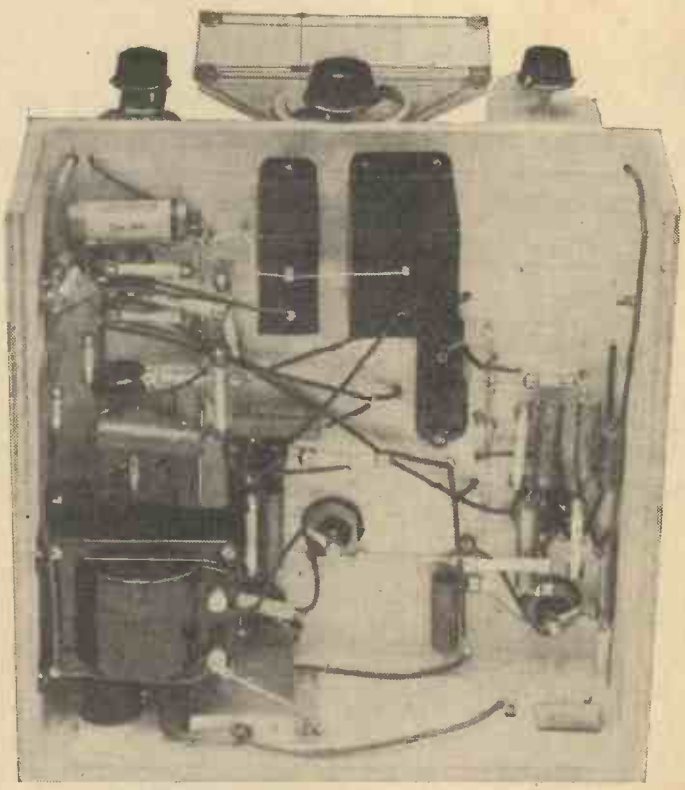
After careful comparative tests had been conducted it was found that greater sensitivity and selectivity could be obtained from a superhet than from a straight set using the same number of valves. The quality of reproduction obtainable from a well-designed superhet was also found to be up to the standard of that of the straight set. The bad quality which was characteristic of the superhet two or three years ago was mainly due to the use of unsuitable valves and to I.F. and L.F. instability. By careful choice of valves and decoupling components, however, it has been possible to eliminate all traces of instability in the present design with the consequence that quality of reproduction is really good.

Circuit Arrangement

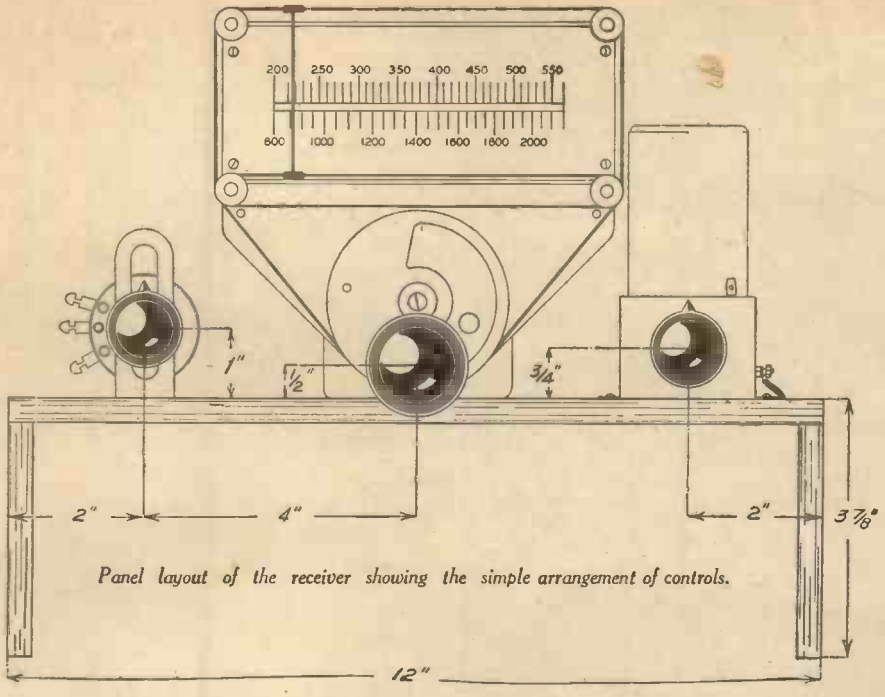
A study of the theoretical diagram will indicate that the receiver employs a pentagrid frequency-changer, an H.F. pentode as I.F. amplifier, a diode detector, and a high-efficiency power pentode output valve. An intermediate frequency of 110 kc/s. has been chosen as this provides a higher degree of selectivity and sensitivity than 465 kc/s. It is true that there is freedom from image interference on the medium wave-band when a high frequency is used, but serious interference can occur on the long wave-band. If efficient band-pass coupling precedes the frequency changer, image interference is negligible with 110 kc/s. components in use and there is a definite improvement in selectivity as compared with 465 kc. sets, especially on the long wave-band. One or two whistles will probably be experienced on the medium wave-band in most localities due to interference from the strong local transmitters. In the London locality the only pronounced whistle



This view shows the careful layout which has been adopted in the Universal receiver.



In this illustration the heavy earth return leads may be seen.



Panel layout of the receiver showing the simple arrangement of controls.

is on a wavelength of approximately 450 metres, but this does not interfere with reception of the two adjacent transmissions and therefore the addition of complicated suppression circuits was not deemed advisable.

The Frequency-changer

Some readers may wonder why a triode-hexode was not used as frequency-changer. This type of valve was tried, however, and in this design its performance was found to be slightly inferior to that of the specified pentagrid. The screen and oscillator anode voltages for this valve have been carefully chosen, and it will be noted that the oscillator anode circuit is very effectively decoupled. The I.F. stage follows standard practice, using variable selectivity iron-core I.F. transformers and a high efficiency H.F. pentode valve. The second transformer is fed into a diode detector, the centre tap on the secondary winding being used in order to reduce damping.

The Detector and Output Stages

It is still difficult to obtain an output of more than 7 watts with A.C./D.C. valves in use, but this wattage is greatly in excess of the requiremnets of the averge listener —a modest 1 watt is sufficient for most living-rooms. When designing the A.C./D.C.4, however, an output of approximately 3 watts was aimed at so as to avoid the possibility of transient distortion. The use of a well-designed diode detector circuit practically eliminates detector distortion. As the diode valve is fed directly into the output pentode it can be given a heavy input voltage, which is the ideal condition for a detector of this type. The output pentode, on the other hand, is capable of providing maximum undistorted output with a comparatively low input voltage owing to its high mutual conductance. The combination of diode and pentode is therefore very suitable provided that the correct values of coupling components are used.

The A.V.C. Circuit

The A.V.C. diode is fed from the anode of the I.F. valve through a ·001 mfd. condenser, and the A.V.C. voltage developed across the two 500,000 ohm resistances is fed back to the grid of the frequency-changer. It was found in practice, however, that for optimum results the I.F. valve did not require as much negative bias as the first valve and therefore the A.V.C. feed for the second valve is taken from the junction of the two 500,000 ohm resistances. Simple A.V.C. would be obtained by connecting the cathode of the diode valve to the H.T.— line but this would materially reduce the sensitivity of the set. It was, therefore, decided to provide a delay voltage, this being done by connecting the cathode to the junction of the 5,000 and 75,000 ohm resistances. This point is positive with respect to H.T.—, and therefore the A.V.C. anode of the diode valve is biased negatively with respect to the cathode, and effective delayed automatic control is thereby provided.

The Smoothing Circuit

The mains voltage is applied through the barretter to the heater circuit and also direct to the anodes of the rectifier. This valve operates on the half-wave principle, its cathodes being joined together and connected to the smoothing choke and thence to the valve anodes. Two electrolytic condensers are used for smoothing, one of these having a very high capacity. A.C. ripple is thereby eliminated, and provided that the receiver layout and wiring is in order freedom from hum is ensured.

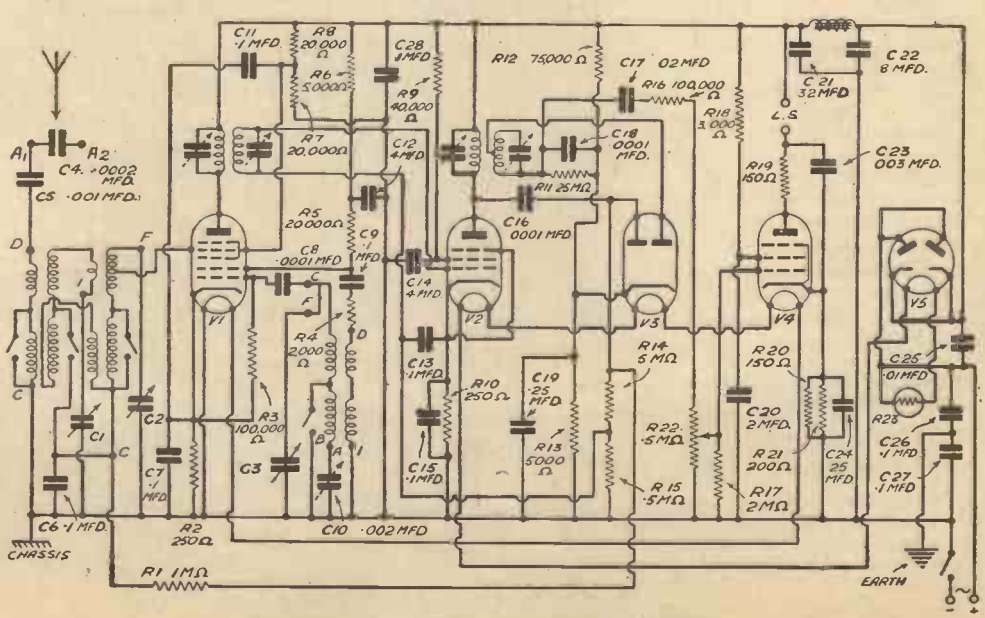
Construction

A metallised chassis has been used in preference to the metal type as wood is much easier to work, and by using a heavy gauge tinned copper connector on the underside of the chassis for the negative line connections satisfactory contact is ensured. This thick connector must not be omitted as the metallised surface of the chassis cannot be relied upon to carry heavy currents. A 1¼-in. drill should be used for the 7-pin valve-holders and a 1 in. for the 5-pin type, care being taken to centralise the sockets so that they are quite clear of the metallised surface. Washers should be placed underneath the heads of the M.B. bolts in order to ensure good contact with the metallising, and soldering tags underneath the nuts for connection to the thick wire connector. It is also advisable to scrape off the metallising around the terminal-strip holes.

After the valve-holder sockets have been mounted the components underneath the chassis may be fixed. All connections to the sockets should be soldered in order to ensure rigidity and perfect contact. If the constructor cannot solder very efficiently he should have his work inspected by a competent mechanic before testing the receiver —poor reception from home-constructed receivers is very often due to bad soldered joints.

Coil Connections

Before mounting the coil unit, three slight alterations should be made to the internal wiring. It is necessary to keep the leads to the fixed vanes of the tuning condenser sections as short as possible, and



Theoretical circuit diagram of the A.C./D.C. Superhet Four.

as the fixed vane terminals of the condenser are a good distance from the coil terminals to which they should be connected it was thought advisable to transfer terminals *I* and *F* of the first two coils to the side of the coil unit nearest the gang condenser. Terminal *D* has also been transferred to the side of the coil unit remote from the gang condenser. To summarise, the leads from the aerial series-condenser, the fixed vane terminal of *C*1, and the fixed vane terminal of *C*2 should be joined to terminals *D*, *I*, and *F* of the first two coils respectively, after the latter have been transferred to the opposite side of the coil unit. No trouble should be experienced in mounting any of the other components, but in order to ensure good contact between the cans of the electrolytic condensers and the negative line connector the wire from the latter should be passed through the fixing hole in the wooden chassis and its free end clamped underneath the condenser can on the surface of the chassis.

List of Components for the A.C./D.C. Superhet Four

One coil unit—BP 111—Varley.

One 3-gang condenser—Midget 110 kc. (C1, C2, C3)—Polar.

One tuning drive—V.P. horizontal—Polar.

Two I.F. transformers—BP84—Varley.

Seventeen fixed condensers, tubular type: Three ·0001 mfd. (C8, C16, C18); ·0002 mfd. (C4); ·001 mfd. (C5); ·003 mfd. (C23); ·01 mfd. (C25); ·02 mfd. (C17); seven ·1 mfd. (C6, C7, C9, C11, C13, C15, C28); ·25 mfd. (C19); 25 mfd./25v. electrolytic (C24)—Dubilier.

Five fixed condensers: 2 mfd. (type 84) (C20); 4 mfd. (type 65) (C14); 4 mfd. (type 812) (C12); 8 mfd. (type 802) (C22); 32 mfd. (type 809) (C21)—T.C.C.

Twenty-one fixed resistances: 1 meg. (R1); two 500,000 ohms (R14, R15); 250,000 ohms (R11); 2 meg. (R17); two 100,000 ohms (R3, R16); 2,000 ohms (R4) (type F½); 75,000 ohms (R12); 40,000 ohms (R9); three 20,000 ohms (R7, R8, R5); two 5,000 ohms (R6, R13); 3,000 ohms (R18); two 250 ohms (R2, R10); 200 ohms (R21); two 150 ohms (type F1) (R19, R20)—Dubilier.

One volume control, 500,000 ohms (R22)—Erie.

One L.F. choke—20H/60 mA/500 ohms—B1—Ferranti.

Five valveholders: Four 7-pin; one 5-pin, chassis mounting without terminals—Clix.

Two socket strips: A1, A2, E. and L.S.—Clix.

Loudspeaker control panel—Clix.

One preset condenser—·002 mfd. max. (C10)—Ward and Goldstone.

One anti-interference condenser unit—A.20 (C26, C27).—Bulgin.

Two screened valve-cap connectors—P64—Bulgin.

One standard connector—P41—Bulgin.

Two feet screened flex wire—Bulgin.

One 2-pin mains plug and socket—P74—Bulgin.

One on-off switch—S80—Bulgin.

One component bracket—Peto-Scott.

One Metaplex chassis, 12 in. by 12 in. by 3½ in.—Peto-Scott.

Three feet 14 S.W.G. T/C wire for earth connections—Peto-Scott.

Quantity 20 S.W.G. T/C wire and sleeving for wiring—Peto-Scott.

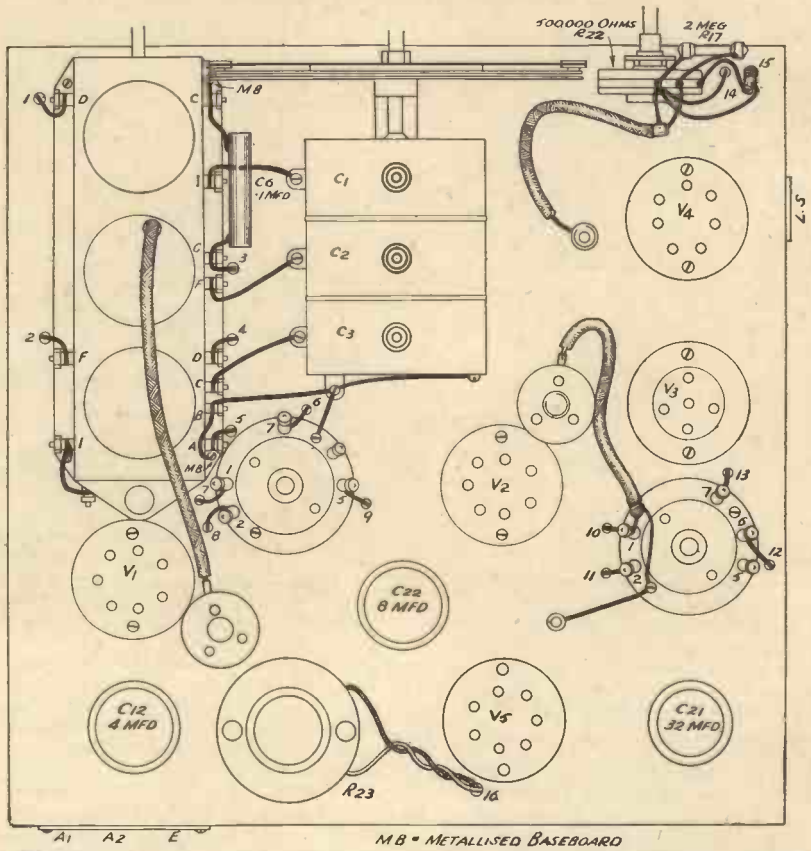
Two ft. ⅛ in. sleeving for screened leads—Peto-Scott.

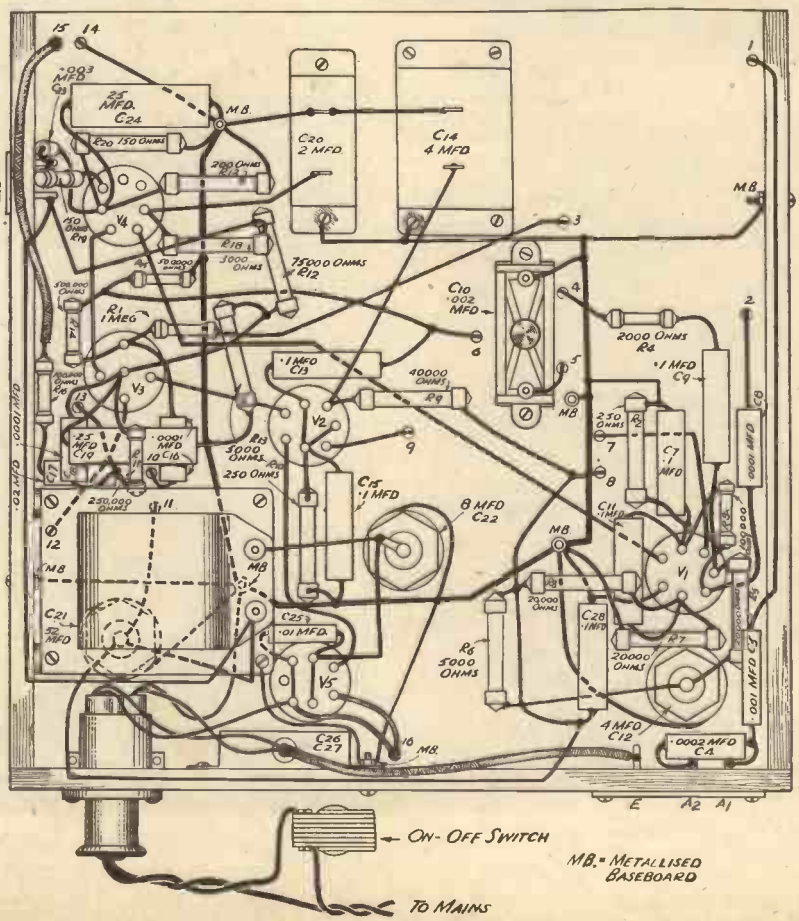
Five valves: X32 (metallised); W31 (metallised); D41 (clear); N31 (carbonised); U30 (clear)—Osram.

One barretter with porcelain holder—type 304 (R23)—Osram.

One speaker—Stentorian Senior—W.B.

WIRING DIAGRAMS OF THE A.C./D.C. SUPERHET FOUR





MASTERS OF MECHANICS

No. 24.—The Life Story of James Nasmyth, Inventor of the Steam Hammer

THE story of Nasmyth is one of an inventor who was successful. Unlike many other inventors and mechanical genuises, James Nasmyth combined with the ability to create a strong commercial and business instinct. It was in consequence of this dual ability of his, coupled, without doubt, with not a little good fortune, that Nasmyth was able to force his way through life from a somewhat lowly status to the position not merely of a famed inventor but to that, also, of a highly successful industrialist.

Edinburgh was the city in which the future creator of the steam hammer first saw the light on the morning of 19th August, 1808. His father, Alexander Nasmyth, was a painter of portraits. He was also interested in mechanical and scientific pursuits and among other noteworthy incidents in the full life which he led we may record his invention of a semi-circular type of bridge and his preparation of a full set of drawings for the construction of a steamship in 1788.

James Nasmyth.

In Reduced Circumstances

Alexander Nasmyth, at the time his famous son, James, was born, had got into somewhat reduced circumstances. As a consequence, the education of his children had to be of a rather perfunctory nature. James Nasmyth attended a local school and was taught mechanical drawing by his father. The latter also initiated him at an early age into the handling of tools, an art which he quickly acquired in consequence of his inborn bent for mechanical pursuits.

Arrived at adolescence, James Nasmyth began to realise that his education was not all that it might have been, and it was not long before he applied himself to the task of remedying its deficiencies. By attending local classes, he assiduously "crammed" chemistry, mechanics, mathematics, physics and other scientific subjects, and during the little spare time which remained to him he fitted up an engineering workroom in his father's house.

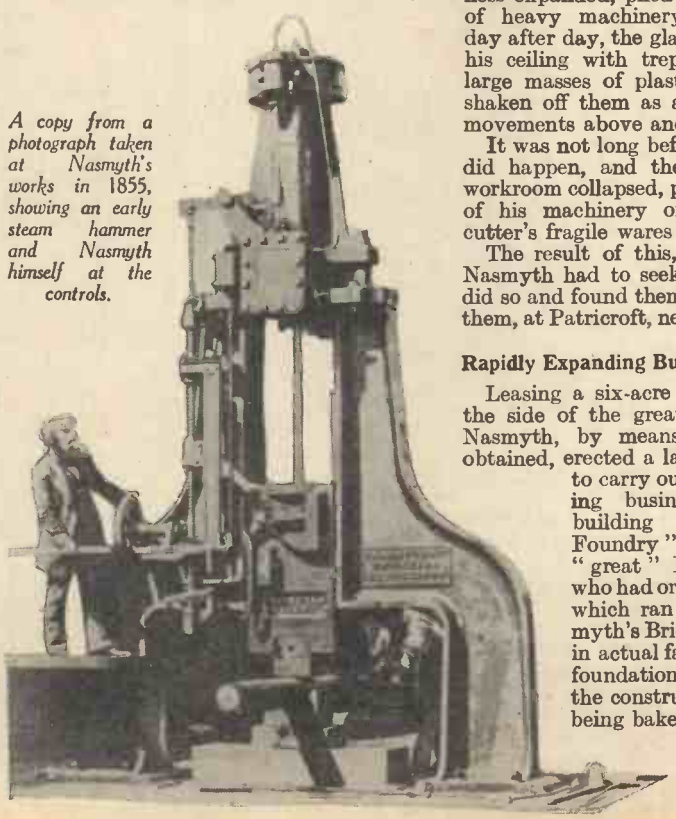
Nasmyth was only seventeen years of age when he constructed a minature working steam engine which he set to the task of grinding up his father's paints and colours. Subsequently he built a model steam coach. This must have been a highly successful model, for, as a result of his demonstration of it, he was commissioned by the Society of Arts in Edinburgh to build a full-sized carriage. This, it is said, was the first steam-propelled vehicle to actually run on Scottish roads. For some peculiar, reason, however, it came to nothing, the Society of Arts apparently considering the vehicle impracticable for commercial use.

His First Job

Nasmyth's next step was to proceed to London and to apply for a job at the works of Henry Maudsley, a leading engineer and tool-maker of the day. Nasmyth offered himself to Maudsley as an engineering pupil, but Maudsley, it seems, had had enough of pupils, having found them lazy and unsatisfactory. However, in the case of Nasmyth, and particularly after he had seen the model engine which the latter had constructed, Maudsley stretched a point and admitted the enthusiastic applicant into his works, giving him the status of personal assistant and paying him the princely wage of ten shillings per week.

Young Nasmyth worked hard in Maudsley's employment. He seldom took a holiday, and even when he did manage to obtain a few days away from his employment, the holiday was a busman's one in its nature, as witness, for instance, his spending a period away from Maudsley's works in a trip to Liverpool in order to be present at the trials of Stephenson's famous locomotive, *The Rocket*, at Rainhill, in September, 1830, and, afterwards, his walking all the way back to London, visiting as many factories as possible on the return journey.

The year after this episode Maudsley died, and soon after Nasmyth determined to commence business as a tool-maker and engineer for himself. For this purpose he returned to his native city of Edinburgh and, for a year or two, executed small jobs for friends and for such customers to whom he could obtain introductions.



A copy from a photograph taken at Nasmyth's works in 1855, showing an early steam hammer and Nasmyth himself at the controls.

More Favourable Fields

Engineering in Edinburgh was a slow job, however, and, towards the end of 1833, Nasmyth decided that there existed more favourable fields for his activities. He selected Manchester, the great "Cottonopolis," and engineering centre, as a district most suited to his commercial projects and, accordingly, in 1834, he commenced business in Dale Street in that city, renting a workroom over a glass-cutter's premises. His total capital at this time was £63.

Nasmyth's Manchester business almost instantly leapt to its feet. It grew and grew—much to the distress and anxiety of the glass-cutter whose workrooms lay beneath Nasmyth's premises, for Nasmyth, as his business expanded, piled up enormous weights of heavy machinery and castings and, day after day, the glass-cutter looked up at his ceiling with trepidation, noticing the large masses of plaster which were being shaken off them as a result of the heavy movements above and fearing the worst.

It was not long before the worst actually did happen, and the floor of Nasmyth's workroom collapsed, precipitating a quanity of his machinery on top of the glass-cutter's fragile wares on the floor below.

The result of this, of course, was that Nasmyth had to seek fresh premises. He did so and found them, or, rather, a site for them, at Patricroft, near Manchester.

Rapidly Expanding Business

Leasing a six-acre site at Patricroft on the side of the great Bridgewater Canal, Nasmyth, by means of capital he had obtained, erected a large foundry in which to carry out his rapidly expanding business. He called the building the "Bridgewater Foundry" in honour of the "great" Duke of Bridgewater who had originally built the canal which ran past its side. Nasmyth's Bridgewater foundry rose in actual fact from the soil of its foundations, the bricks used in the construction of the building being baked from clay found on the site. This historic building, the birthplace of the steam-hammer,

still exists and is still used by the present-day successors of Nasmyth's original concern, Messrs. Nasmyth, Wilson & Co., Ltd., as an engineering works engaged in the production of steam hammers and locomotives.

Nasmyth, at this juncture, took into partnership with him a young man of commercial experience and possessing some capital. His name was Holbrook Gaskell, and the firm became known as Nasmyth and Gaskell. Gaskell undertook control of the business side of the concern and remained in partnership with Nasmyth for sixteen years, after which time he retired on account of ill health. Subsequently, Nasmyth took one of his managers, a practical man named Robert Wilson, into partnership, and, in 1856, the firm became Nasmyth, Wilson and Company, which name it retains at the present day.

It was in Nasmyth's Bridgewater foundry that the invention and creation of the steam hammer took place. Despite the fact that Nasmyth has many other inventions to his credit, his chief claim to fame in the history of engineering is his creation of the steam hammer.

The Story Retold

The story of the steam hammer has often been told but, in brief form, it will well bear repeating here. In 1839, the Great Western Railway Company was building a steamship called the *Great Britain*, and some means of forging a wrought-iron paddle shaft for it of the then colossal diameter of 30 in. was sought. Nasmyth's mind was greatly attracted by the problem in view of its gigantic import, and in his *Sketch Book*, a notebook which he kept for the purpose of jotting down ideas, he detailed a plan for the building of a forging-hammer operated by steam whose terriffic thrust would be amply sufficient for the forging of the thickest shaft which could possibly be made.

Nasmyth began to put his steam-hammer plans into actual practice, when, without warning, came the news that the famous Brunel, the engineer-in-chief of the railway company, had decided that the ship would be equipped with a screw, thus obviating the necessity for forging such a massive paddle-shaft.

Nasmyth at once gave his attention to other matters. His idea for a steam hammer lay buried in his *Sketch Book* among a mass of other immature notions.

About this time a certain M. Schneider, of the Creusot Iron Works at Le Creusot, in France, happened to visit Nasmyth's Bridgewater foundry at Patricroft. Nasmyth was away at the time, but his partner, Holbrook Gaskell, as an act of courtesy, showed M. Schneider and his head mechanic around the foundry and, in the course of subsequent conversation, allowed him to examine Nasmyth's idea for a steam hammer as detailed in the famous *Sketch Book*.

His Own Steam Hammer

Two years later, Nasmyth, paying a return visit to the Creusot Works in France, noticed a large forged shaft lying in the foundry. "How did you forge such an enormous shaft?" was his immediate query. "Why, by one of your steam hammers," was the reply. Great was Nasmyth's surprise when, subsequently, he was shown in the Creusot Iron Works a working steam hammer based exactly upon his own *Sketch Book* model, for he had never seen such a hammer except in his own drawing. A little explanation cleared the mystery up and Nasmyth returned in haste to Patricroft full of projects for the building of a steam hammer in his own foundry.

His ideas were put into actual practice, and without any delay. A month or two later, Nasmyth's first steam hammer was operating in his works and it was patented in the June of 1842.

For years the steam hammer was one of the wonders of the engineering world. Engineers and lay people came from far and wide to see Nasmyth's wonderful hammer in operation at Patricroft.

A Favourite Trick

In demonstration of the very fine degree of control which could be obtained over the steam hammer, Nasmyth's favourite trick was to place on the anvil of the hammer a wineglass containing an egg. The controls of the hammer being suitably adjusted and steam being admitted to the cylinder, down would come the enormous block of iron with terrific force, but the instant before it reached the top of the egg its impetus would be arrested, the result being that the hammer would gently tap-tap upon the top of the egg without even breaking its shell. After a while, Nasymth, re-setting the controls of the hammer and pulling over a lever, the hammer would exert a tremendous blow upon the wineglass and egg, almost annihilating them, or, in the words of an observer, "blasting them into space."

In a similar manner, a watch could be placed upon the anvil of the steam hammer and the controls of the latter so regulated that the hammer would tap gently upon the watch-glass without doing injury to it.

Nasmyth's original steam hammer consisted, in principle, of a massive anvil above which was built an inverted steam cylinder to the piston rod of which a hammer block was fixed. By means of a simple slide-valve arrangement, the piston was caused to rise and fall within the cylinder, carrying, of course, the hammer block with it. By means of controlling the steam pressure, it was almost possible, as Nasmyth himself expressed it, to make the hammer "think in blows."

Nasmyth's hammer, particularly in its improved versions, quickly came into general use. Nasmyth, too, rapidly applied the principle of his hammer to the construction of steam pile-drivers, the first application of such a device being in 1843, in which year Nasmyth's steam pile-driver was used in the construction of the Keyham Docks at Devonport.

In General Use

Nasmyth's was a perpetually fertile and inventive mind and, besides the celebrated Patriocroft steam hammer, his name is to be identified with a considerable number of other inventions. His first invention was forthcoming in 1825 and consisted of a means of applying steam power for dragging canal barges by means of chains laid along the bottom of the canal. The invention was considered impracticable at the time, but it is worth noting that twenty years afterwards—in 1845—Nasmyth's chain system was employed for operating ferry boats across the Hamoaze at Devonport.

Much of Nasmyth's creative engineering work lay in the devising of special tools and in the improvement of existing tools. But Nasmyth, as we have seen, although he shone as an inventor, was also a businessman and, as a general rule, was content to put business before invention. The result of this policy was that the Nasmyth concern succeeded almost beyond the wildest expectations of its founder, and, in 1856, at the early age of forty-eight, he retired from active business, purchasing an estate at Penshurst, in Kent, which, appropriately enough, he named "Hammerfield."

His Retirement

At "Hammerfield" Nasmyth lived with his family until the end of his days, devoting his time in retirement to the pursuit of various mechanical hobbies, chief among which was astronomy and the construction of large telescopes, for which he subsequently gathered much renown.

Nasmyth died at "Hammerfield" on 7th May, 1890, having then arrived at the mature age of eighty-two.

By some curious anticipation of fortune, the ancient crest of the Nasmyth family comprised two crossed hammer shafts, and even in modern days the Nasmyth hammer tradition persists at the original foundry of this engineering personality at Patricroft, Lancs. There, on the banks of the eighteenth century Bridgewater canal, the steam hammer, in its modern form, is still constructed. From thence this famous piece of engineering construction has proceeded to the ends of the civilised world. The Spirit of shrewd James Nasmyth, engineer and inventor, if ever it feels inclined to visit the scenes of its former activities, must often wander along the old horse-trodden canal bank at Patricroft, gazing upwards at the towering buildings which line its sides in mute satisfaction of one of the world's most successful engineering enterprises.

A REMARKABLE RAILWAY

BY G. LONG, F.R.G.S.

THE BUILDING OF THE LEBANON RAILWAY WAS A REMARKABLE FEAT OF ENGINEERING, AS IT MEANT TRAVERSING TWO MIGHTY RANGES OF MOUNTAINS

A level crossing near Damascus.

IT is strange that so little mention has been made in the British Press of the Lebanon—or Damascus—Railway, for no line has ever been built through more romantic country, or along a more historic route.

The track follows the course of that ancient highway which once linked Bagdad and Damascus with the Mediterranean Sea. This is probably the world's oldest road, and and it was certainly in use long before history began, for here we are in the very cradle of mankind, and beside its route we can still discover the traditional tombs of Adam's two sons.

It was by this rocky, sun-baked road that the silks and jewels of Tyre travelled to the City of the Caliphs, so that the glamorous beauties of the Arabian Nights could be clothed in Tyrian purple. It is a road which was travelled by Naaman in his chariot, as by many a Hebrew patriarch, and it was here that the Apostle Paul witnessed that heavenly vision which changed the whole course of his life, and altered the history of the world.

A mineral train passing under the road near the summit of the Lebanon range.

A Formidable Task

It was in the early 'nineties that the great project of the Lebanon Railway began. The task before the engineers was indeed formidable. The country was very difficult, two mighty ranges of mountains stood in the path, their rocky sides were swept by blizzards for half the year, and were baked by a tropical sun in summer. The only roads were narrow, steep, and stony, and infested by robbers, who, from time immemorial, had regarded the traveller as their lawful prey.

There can be no doubt that the simplest way to reach Damascus by rail would have been to pierce the mountains with a long tunnel. This would have greatly reduced the length and the gradients of the line, and would have made it unnecessary to lay the track above the snow line, with the added perils of blizzards and avalanches. Careful calculation however quickly proved that the cost of a tunnel would be economically impossible.

A suburban station near Damascus.

Cost Enormous

The cost of piercing hard rock is enormously high, even when no special difficulties are present, such as hidden faults, or springs, within the mountain. Experience with the Alpine tunnels proved that the cost per foot varied from £49 7*s*. per foot on the great Simplon Tunnel, to as much as £75 per foot on the Mont Cenis, which was the first great mountain boring ever made.

The rate per foot must have been considerably higher here owing to the cost of transporting machinery and skilled workmen to these remote heights, reached only by a narrow and difficult road, years before the motor car was invented.

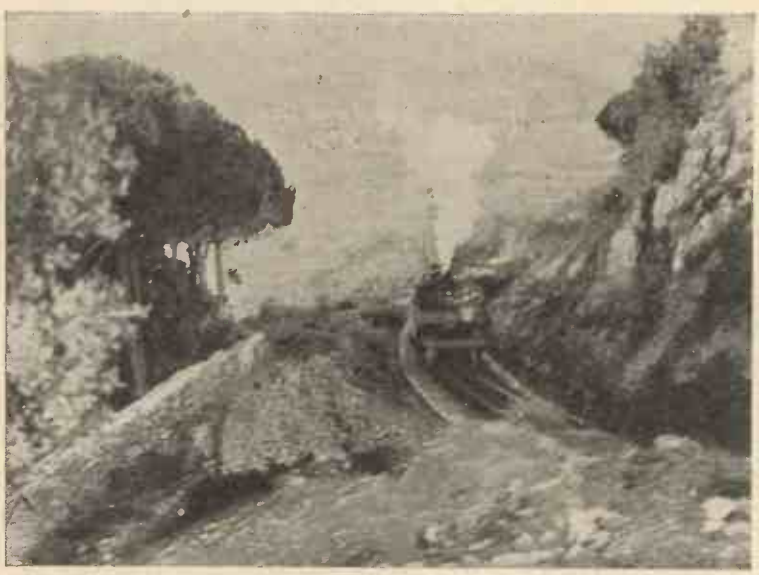
Further, there was no prospect of suffi-

cient traffic on this line to pay the enormous cost of a low-level tunnel. The Swiss tunnels serve important European main routes with a heavy traffic, but for many years after its construction, the Lebanon Railway had one through passenger train each way per day, and although the freight services were better it is clear that the revenue could never be very large.

Through Difficult Country

The problem then was to build a main line railway through difficult country, and to do it cheaply. It was solved in a very daring way. A narrow-gauge line was planned to follow the course of the road, and was fitted with rack and pinion on all the steep sections. The line is 94 miles in length, as against a mere 70 miles by road. This is because many of the road hills were far too steep to be safely negotiated by a heavy train, even with the aid of rack and pinion, so wide zig-zags had to be constructed to ease the gradient.

The line began near the harbour at Beirut, and passing through the town and its suburbs reached the lower slopes of the hills, which are richly covered with glorious groves of oranges, lemons, mulberries, and tobacco. Real climbing began at Baabda, 5½ miles from the harbour.



The Lebanon railway near the summit.

Here the line swung round the base of the mountain in a wide curve, and boldly climbed in daring curves and zig-zags to the summit of the range. The first part was not so bad, but at Aley, 14 miles from Beirut and 2,460 ft. above the sea, the sterner task began.

The actual summit is about five thousand feet; it is approached on both sides by naked rock, for the glorious cedars which once clothed these mountains have long disappeared.

Discomfort

The construction gangs toiled bravely but in much discomfort. During the summer the hated sirocco blew right off the burning desert, and filled the men's lungs with hot sand. In winter their task was even more trying, for the whole range was covered deeply in snow, over which tore howling blizzards of piercingly cold wind, and the course of the line was constantly swept by great avalanches which carried everything before them.

Long before the actual work began, surveyors had studied these bleak mountain sides throughout the year. They had ascended in winter and early spring, when the road was blocked with snow, and the roar of the avalanches was often heard.

Snow Tunnels

They carefully noted which slopes were exposed, and so in danger from the avalanches, and which were protected by crags. They also found where falls of rock and stone occurred, and made their plans accordingly. It was clear that the actual summit was too open for a railway, and so the summit ridge was pierced by a short tunnel at Ain Sofar, and the dangerous approach slopes were protected by cuttings and snow-sheds. Where the snow threatened most, the line was sunk in a rock-cutting about 10 ft. deep, and then roofed over to keep out the snow. The lower slopes were protected by long snow-sheds These were tunnels of wood or stone, in outline like an upturned U, and so shaped that the snow would glide over without carrying them away.

An Important Point

When the zone of snow was passed, the line descended rapidly to the plain, and at Reyak the junction for Baalbeck was built. To-day it is a great air-port, and a most important point on the pilgrims' route to Mecca.

The line now traversed the Bekaa, which means "cleft." It is a narrow ravine between rocky mountains, and from time immemorial has been the haunt of robbers. These gentry regarded the railway builders as their lawful prey, and soldiers had to be placed on guard as the work proceeded. To-day the bandits have been finally routed, there are blockhouses every ten miles, and armed patrols of French troops keep careful watch. At Yafufeh the line passed the traditional grave of Seth, the youngest son of Adam, and at Neby Habil, near the gorge of the Barada, is the tomb of Abel—according to the Koran.

The pass of the Barada was a difficult stretch, as the line had to cling to the sheer side of the cliff, above the rushing river. As it followed the river towards the plain, the country became richer and more fertile, and the line passed through glorious orchards and gardens as it approached the Meidan, where the terminus station was built.

"MESSAGE FROM REUTER"

(*Continued from page* 628)

Scoops

When President Abraham Lincoln was assassinated in America, Reuters were the first by a week to receive the news. In 1859 they were the first to announce the threat of war between France and Austria, in their report of the Emperor Napoleon's sensational speech; they were ahead of all others with their announcements of the death of the Prince Imperial in the Zulu War, the capture of the great African chief, Cetewayo, the famous exploit of Lord Charles Beresford at the bombardment of Alexandria, the attempt on the life of Lord Harding, Viceroy of India in 1913, and many other events of world wide importance.

The way in which Reuters obtained news of the assassination of Abraham Lincoln is particularly interesting, as demonstrating the difficulties attending the transmitting of news in those days, when the Continents were not linked up by telegraph and wireless as they are to-day.

Reuter's New York correspondent at that time used to send his dispatches by steamboat from New York to London, and sailings were not very frequent. The assassination occurred shortly after the mail boat had left America. The New York representative succeeded in getting the news across the Atlantic by boarding a small fast boat, overhauling the mail steamer, and throwing aboard a tin box containing his account of the tragedy.

Relief of Mafeking

One of Reuters greatest scoops was the news of the relief of Mafeking, which they obtained two days before the War Office itself. The great news was announced in the House of Commons by the Secretary of State for the Colonies, and although no official confirmation was forthcoming, such was the reputation of Reuters that the accuracy of the telegram was never doubted.

It can be seen how important a part Reuters has played in the development of the Great British Empire. This wonderful organisation has been intimately connected with our history, and wherever the Empire has grown and flourished, no matter how far from the Mother Country, Reuters branch offices and correspondents have sprung up there and kept the Empire in touch with the Home Land.

A Private Trust

Of course, the Great War was an important era in the history of Reuters. The head of the organisation, Baron Herbert de Reuter, son of the Founder, the first Baron, died early in the War and was succeeded by Sir Roderick Jones, the present chairman. To maintain the integrity and security of the news service, a small private Trust, which included Sir Roderick, the Honourable Mark Napier, Lord Glenconner, and Earl Peel, bought out the shareholders at a cost of over £500,000, and the control of the Company passed wholly into Sir Roderick's hands.

To-day the vast organisation flourishes and continue to develop under Sir Roderick Jones. The great modern force, wireless, has trebled the resources of the news agency, and throughout the whole twenty-four hours of each day the administrative offices in the big building in Carmelite Street, London, are in touch with all that is happening in every quarter of the globe.

A NEW R.A.F. HEIGHT RECORD

THE Air Ministry recently announced that the Royal Air Force experimental high altitude aircraft, the Bristol "138" with a special "Pegasus" engine, piloted by Flight-Lieutenant M. J. Adam, of the Royal Aircraft Establishment, Farnborough, Hants, had broken the world altitude record. It reached a height of 53,937 ft. (16,440 metres), which is 2,575 ft. (785 metres) greater than the figure of 51,362 ft. (15,655 metres) reached by the Italian pilot, Lieutenant-Colonel Mario Pezzi, last month and 3,993 ft. (1,217 metres) more than the height of 49,944 ft. (15,223 metres) achieved by Squadron-Leader F. R. D. Swain, A.F.C., last autumn. The Italian figure has not yet been homologated.

The aircraft took off from the aerodrome at Farnborough, Hants, at 5.40 a.m. and landed there at 7.55 a.m., the total flying time being 2 hours 15 minutes. There was a clear sky and practically no wind when the ascent, which took 1 hour 35 minutes, began. The wind in the upper regions was strong and from a westerly direction. Bad visibility occurred during part of the flight, the sky being completely covered by cloud. The performance of the aircraft and engine was satisfactory and no trouble was experienced with the sealed pressure suit.

The minimum pressure measured during the flight was 77·8 millimetres of mercury, and the lowest temperature was 48·9 centigrade; both those measurements were ascertained at the highest point attained.

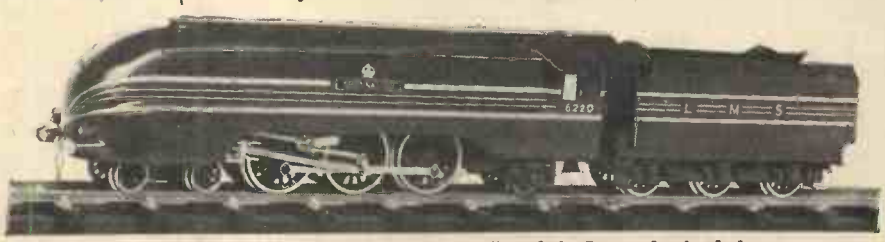
A Novel Method of Laying Cables

THE Post Office is engaged in an important telephone cable programme in Scotland, and a part of this programme entails the laying of two cables from Glasgow via Inveraray across Loch Awe to Oban. Over a considerable portion of the route solid rock has to be blasted out to provide a trench for the cable. The most interesting part of the laying of these cables was perhaps the section comprising 800 yards recently laid across Loch Awe.

The depth of the loch and the abruptness of the loch bed prevented ordinary methods being used. Consequently it was decided to attach 400 empty metal casks, each of 5-gallon size, at two yard intervals and thus to float the cables into position. These casks were sunk with the cable and in order to control the rate at which they sunk, each cask was drilled with a $\frac{3}{16}$-in. hole below the water line. When the cables were in position, Post Office engineers in four motor-boats punctured the tops of the casks commencing from the centre of the loch. Careful timing and control of the work was necessary since the cables when laid must conform with the contour of the bed of the loch. On this account surplus cable was provided on each bank and fed into the water as the cable sank in the centre. To co-ordinate the work the Post Office established an ultra-short wave radio-telephone link between both banks of the loch at Port Sonachan and Kilchrenan.

These new cables will not only provide additional long distance lines connecting Oban with the main trunk system, but will enable this system to be extended to the Highlands and Islands of West Scotland, including the Outer Hebrides which will be extended from Oban by means of wireless telephone.

Emergency Telephone Calls



A model of the new L.M.S. "Coronation" made by Bassett-Lowke, Ltd.

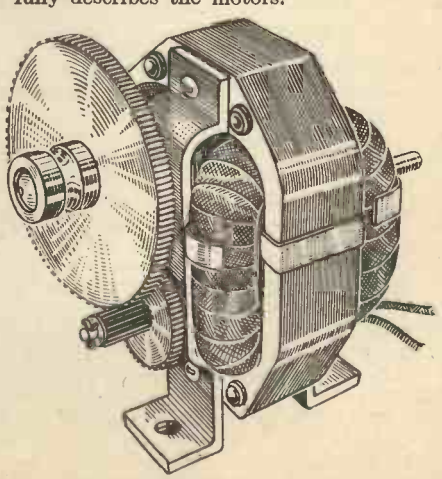
A NEW procedure has been brought into operation to secure the special attention of the exchange operator on calls to the Fire Brigade, Police or Ambulance Authorities in cases of emergency. Special equipment has been installed at automatic exchanges in London which will ensure that when a subscriber, whose telephone dial has letters as well as figures, dials "999," an emergency lamp and buzzer at the exchange will indicate to the operator that the call is specially urgent.

In each exchange the telephone numbers of the Fire, Police and Ambulance Authorities are prominently displayed and when the exchange operator answers the "999" call by saying "Emergency, which Service, please?" the caller should enquire for "Fire!" "Police!" or "Ambulance!" as the case may be, when he will be connected with the service required.

The number "999" has been chosen as the only practicable number after careful examination of the technical and other considerations involved. "O" can still be dialled to call the operator, but the operator will have no means of knowing that the call relates to an emergency, and, in time of pressure, would not therefore give it precedence over other calls which might be claiming attention.

WILKINSON MOTORS

L. WILKINSON, "Electric House," 204, Lower Addiscombe Road, Croydon, have recently introduced on the market some novel mains motors of the induction type for A.C. only. We show on this page one of the geared type which cost 32*s*. Thin laminations reduce temperature rise to a lower degree than usual in this type of motor. The coils are toped, dipped and baked. These motors will stand the 1,000 volts test. The bearings are self-lubricating—bronze impregnated with graphite—and a cup holds wool packing which can be replenished with oil. Interested readers should write to the above address for an illustrated pamphlet which fully describes the motors.



A geared motor which costs 32s., made by L. Wilkinson.

NEW INVENTIONS

Sign Posts for Reserved Seats

THOSE privileged folks who can afford a reserved seat in a theatre will be interested in a new device for enabling them easily to find the seats allotted to them. It is usual for the rows of theatre seats to be lettered or numbered, but these signs are not always readily seen, especially in cinemas in which the light is subdued. The aim of the inventor has been to illuminate these letters or numbers in such a manner that the light in the theatre is not appreciably increased. According to his device, the end seat of a row is provided with a panel of translucent or transparent material with an indicating mark thereon. A source of illumination is placed so that a beam of light is directed upon the edge of the panel. This arrangement will help the unattended searcher to find a seat not reserved for some other patron of the theatre.

How to Pull the Strings

IN the days of Queen Victoria, when the young were initiated into the mysteries of the A B C, they were introduced to an anonymous archer whose name began with A and who shot at a frog. I presume there are still in this country a number of archery clubs. The members of such clubs may be intrigued by a newly devised appliance enabling them to grip an arrow and bowstring without injury to the hand. When this is done by the hand only, even after very slight use of the bow, it is asserted that the tips of the fingers are apt to become sore. No doubt the fingers of an expert like the late Robin Hood would become hardened. But, in the case of the fair sex, some of whom are interested in archery, their tender skin is liable to abrasion. The above-mentioned invention comprises a pair of pivoted arms, each having at one end a clamp and at the other end a handle. The clamps grip the arrow and the strings of the bow. And this makes for a happy release Dynamo.

"Television Up-to-Date," by R. W. Hutchinson, M.Sc., 2/6 net. University Tutorial Press Ltd. 212 pp. Crown Octavo.

This book deals in a non-technical manner with the general principles of television, starting off with the elements of electricity, optics, and ether waves. It goes on to couple up this information with the radio-link before proceeding to the A B C of practical television. Later chapters deal with high definition television from the transmitting and receiving ends, television in the cinema, colour television, other television systems, telephotography, and the B.B.C. television station. The book is well done, illustrated by a number of half-tones and line drawings, and is well indexed.

"Electrical Invention," by Prof. A. M. Low, 2/6 net. Thomas Nelson & Sons, Ltd. 124 pp. Crown Octavo.

Prof. A. M. Low has written a number of popular books dealing in simple language with scientific subjects, and his present volume deals in a very readable way with electric light, electric heating, electric power, natural electricity and lighting, the distribution of electricity, radio, television, the invisible eye, and odd work for electricity. The text is illustrated by a number of drawings and half-tones. It is an excellent book for those who wish to make acquaintance with these fascinating subjects, and it serves as a useful introduction to them. In fact, before studying a textbook of a more technical character this book should be read.

"Panel Beating and Sheet Metal Work," by Sydney Pinder, 4/- net. Sir Isaac Pitman & Sons, Ltd. 88 pp.

The literature of forming shapes from flat sheets of metal is very scanty, although the process of panel beating is being employed more and more particularly in connection with motor-cars. This is a useful and up-to-date treatise on the subject, and deals with metals, machinery, tools, joints, pattern making, panel beating, finishing off, panel beating machinery, mouldings, and all the various branches of oxy-acetylene welding. The text is well illustrated and the book is indexed. Those engaged in the sheet metal working industry should certainly obtain a copy.

"The Design and Construction of Flying Model Aircraft," by D. A. Russell, A.M.I.E., A.I.E.E. 3/6 net. The Harborough Publishing Co. 199 pp. Crown Octavo.

Mr. D. A. Russell has produced a most valuable work on the design of model aeroplanes of all types. It is packed with valuable data, which he has obtained as a result of lengthy practical experiments, both in the laboratory and in the flying of models. A book of this type has been needed for a long time.

The chapters deal very thoroughly with aerofoils, fuselages, drag, control surfaces, aircraft performance, airscrew design, airscrew performance, rubber motors, testing power driven airscrews, wind tunnel testing, wing construction, fuselage construction, landing chassis, tyres and wheels, the mounting of engines and accessories, and engine testing and tuning. The book very adequately covers all of these subjects, and if the information is followed it will enable the beginner to design a successful model without having to resort to the disappointing process of arriving at a successful flying model after trial and error, without knowing how.

The book is well illustrated with photographs and diagrams.

"Petrol-engined Model Aeroplanes," by C. E. Bowden, 3/6 net. Percival Marshall & Co., Ltd. 174 pp. Crown Octavo.

Capt. Bowden needs no introduction to the world of model aeronautics, and many of his models have been described in this journal. It is true to say that he has been responsible for much of the present great interest in petrol driven model aeroplanes, and he has carried out more research work in this connection than any other experimenter. In fact it was not until Capt. Bowden demonstrated the practicability of petrol-engined model planes that it was thought possible to build them successfully. In this book is the cream of his experience, for he deals with the power unit and its mounting, the ignition system and control of flight duration, automatic stability and design, the choice of a type, simple methods of laying out a design, methods of construction of fuselages, wings, undercarriages, tail units, notes on material, airscrews, and proceeds to a description of the design of the machine which won the Sir John Shelley Cup and which is the holder of the British Power Record, a small petrol biplane for 6 c.c. engines, low wing monocoque monoplane, a monoplane for 6 c.c. or 3 c.c. engines, experimental models, practical notes on flying, and some useful conclusions. There is a foreword by the Editor of PRACTICAL MECHANICS and a useful brief history of the petrol driven model aeroplane. The book is packed with photographs and diagrams, and it should take its place as a standard work on the subject. It is a book which can be thoroughly recommended.

"Model Sailing Yachts and How to Build Them," 1/6 net. Percival Marshall & Co., Ltd. 122 pp. Crown Octavo.

This is a revised edition of a well-known handbook which has become almost a textbook on the subject. It deals with types of yacht, the rating of model yachts, the construction of carved models, the construction of built-up or planked yachts, spars and fittings, steering gears, racing schooners, tuning up and sailing, notes on sailing for beginners, and model Yachting Associations and Clubs. A large number of practical diagrams illustrate the text.

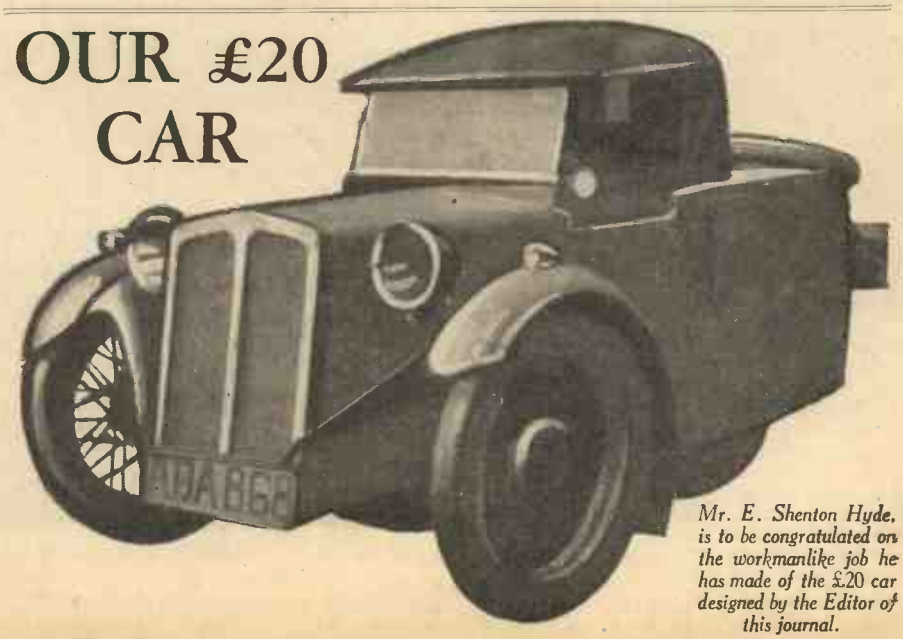
"Aeroplanes and Aeroplane Engines," by P. H. Sumner, 15/- net. The Technical Press Ltd. Demy Octavo. 250 pp. plus index.

In view of the many attractive positions now offered by the Aircraft Industry to those with the necessary knowledge, particularly in connection with design, this book will be found of great value for design must start from the power unit. The author realises this, for his first chapter deals with the principles of sustentation and transition, and he follows with chapters on the airscrew, the engine, types of aero engines, materials, general construction and components of the aeroplane, rigging and truing up aircraft, types and performance of model aeroplanes and aeronautic instruments. The book is not too technical and is well illustrated.

"Electrolytic Condensers, their Properties, Design and Practical Uses," by Philip R. Courset, B.Sc., M.I.E.E., F.Inst.P., etc. 172 pp., 112 illustrations. Published by Messrs. Chapman & Hall, price 10/6.

As its title implies, this book deals with all aspects of the modern electrolytic condenser. The increasing use of this component in wireless apparatus and other electrical equipment has led to much difficulty due to failure to understand the principles upon which it is designed, and many of these misunderstandings will be cleared up after reading the book. It explains very clearly how the different types of electrolytic condenser are designed, the uses to which the different types should be put, the precautions to take in special circuits and other similar details. The nine chapters are well illustrated and include such details as the method of testing these condensers, the differences between the wet and the dry condensers, the electrical characteristics and so on. The book is reasonably free from complicated mathematical data, but includes all the necessary calculations which are introduced in the design and manufacture of these components.

OUR £20 CAR



Mr. E. Shenton Hyde, is to be congratulated on the workmanlike job he has made of the £20 car designed by the Editor of this journal.

QUERIES and ENQUIRIES

A stamped addressed envelope, three penny stamps, and the query coupon from the current issue, which appears on page 643, must be enclosed with every letter containing a query. Every query and drawing which is sent must bear the name and address of the sender. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., Tower House, Southampton Street, Strand, London, W.C.2.

CLEANING A BOILER

"I SHOULD be very much obliged if you would kindly advise me on the following matter.

"I wish to clean out a small domestic hotwater boiler which has been in service, on and off, for about 2 years. The main part of the boiler is a cast-iron U-shaped water jacket, access to the inside of which is obtained by the removal of a plate on the back (the rounded part of the U). I have never cleaned out the boiler before and I expect to find quite a lot of mud in it. But, if in addition to mud there is a hard incrustation similar to that which forms on the inside of a kettle, how can this best be removed?

"The flow and return pipes are copper, 1 in. diameter, and are quite short, being only about 4 ft. in length. If these also have an incrustation how can it be removed?" (A. T., Kent.)

THE only way in which you can remove boiler incrustations (apart, of course, from actual scraping) is by treating them with a weak caustic soda solution. Remove as much suspended matter from the boiler and pipes as possible by simple draining and then fill up the boiler with hot water in which a random quantity of crude caustic soda has been dissolved. This solution should be allowed to remain in contact with the incrustations as long as possible. Afterwards the solution may be drained away, roughly filtered and used for a repetition of the treatment.

Most "boiler compositions" used for boiler scale-removal contain caustic soda as a basic constituent and we anticipate that by careful scraping together with (if necessary) the above simple caustic soda treatment, you will be able to make quite a satisfactory job of your boiler-cleaning task.

COLOURED FIRES

"WHAT proportions by weight of aluminium powder and chlorate of potash are used as an explosive ingredient?

"What chemicals, and in what proportions are required to make the following coloured fires: Red, Green, Blue, Yellow, and White?

"Can I obtain a book on the above subject, if so, from whom?" (F. M., Hants.)

ALUMINIUM powder and potassium chlorate alone do not comprise an explosive compound. If, however, a little flowers of sulphur are mixed with them, the resulting mixture will detonate violently when struck with a hammer. You would be well advised not to attempt the preparation of such a mixture, for many accidents have resulted from it.

In order to make coloured fires, prepare the following "basic" mixture:

Saltpetre . .	25 parts.
Sulphur . .	8-10 parts.
Wood charcoal (not soot or lampblack)	1-2 parts.
Orange shellac .	½ part.

This will give you a white fire of fairly slow-burning properties. The addition to it of two or three parts of barium nitrate will impart a green colour to the fire. If, instead of the barium salt, you incorporate strontium nitrate or strontium carbonate, a red fire will result. A yellow fire is made by substituting sodium nitrate for saltpetre in the above mixture and a light-blue fire results when a little copper sulphate is added to the formula quoted above.

Very few works have been published on the making of coloured fires and other firework pieces, but you might be able to pick up a second-hand volume on such a subject by making inquiry to Messrs. W. & G. Foyle, Ltd., 119-125 Charing Cross Road, London, W.C. 2.

ELECTROLYTIC CONDENSERS

"1. Is there a chemical which will jellify ammonium phosphate or bicarbonate of soda without affecting their chemical properties?

"2. What are the chemical constituents of the electrolyte and plates of wet electrolytic condensers, and in what proportions?"

1. Ammonium phosphate, sodium bicarbonate and other salts can be made up in jelly solution by adding a quantity of gelatine to moderately strong solutions of these salts. The gelatine must be dissolved by heat and the solution afterwards allowed to "set." Agar-Agar and other jellifying substances can be used in place of pure gelatine. Glue may also be used.

2. Electrolytic condensers generally consist of a single lead strip comprising the cathode of the cell and any number of aluminium strips which, when joined together, form the anode of the condenser cell. The electrolyte consists of a 1 per cent. solution of borax, potassium permanganate, potassium cyanide, sodium sulphate, ammonium chromate, ammonium phosphate, sodium silicate and many other salts. Each of these salts when employed in 1 per cent. solution can be used satisfactorily as the electrolyte of a condenser cell. The condenser plates have, of course, to be "formed" by passing a fairly high voltage through them, and upon the exact value of this "formation-voltage" the capacity of the resulting electrolytic condenser to a certain extent depends.

SULPHUR DIOXIDE

"1. Could you give me any information about sulphur dioxide and its properties and uses?

"2. What would be the cheapest and easiest method of producing it in solution in water. Does it readily dissolve into water or is a chemical solution necessary to absorb it? If so, what chemicals could be used for this purpose?

"3. What percentage would be absorbed in proportion to the water or solution?

"4. Is there any means of neutralising this gas fairly quickly?

"What is its effect on foodstuffs?" (C. J., Northants.)

1. Sulphur dioxide—SO_2—is a colourless, invisible gas with a pungent, choking, suffocating odour characteristic of "burning sulphur." It is formed in large quantities when sulphur is burned in air and when a mineral acid is allowed to act upon sodium sulphite. Sulphur dioxide is more than twice as heavy as air and it condenses to a clear liquid when passed through a U-tube cooled to −10° C. A solution of sulphur dioxide in water forms a strong bleaching agent, and, also, an effective preservative.

2/3. The cheapest practical method of preparing sulphur dioxide consists in warming scrap copper with *concentrated* sulphuric acid. The gas is evolved copiously and it is led out of the vessel through a glass tube. The gas is readily soluble in water, one volume of water at normal temperature dissolving about 40 volumes of sulphur dioxide. When this solution is boiled, however, all the dissolved gas is expelled. The solution of sulphur dioxide in water is acid in reaction and it is regarded as consisting of a dilute solution of sulphurous acid, H_2SO_3.

4. Sulphur dioxide gas can be absorbed or "neutralised" by passing through any alkaline solution, lime, etc.

5. Sulphur dioxide acts as a preservative when incorporated with foodstuffs in small amounts, but, in many instances, its use in this respect is now legally prohibited under recent Food and Drugs Acts. The solution has, of course, the same properties and effects as the gas itself.

WATER SEPARATION

"PLEASE could you tell me if it is possible to separate the hydrogen and oxygen from water completely, if so, by what method is this accomplished?" (H. A., London.)

TO split up water into oxygen and hydrogen all you have to do is to add a few drops of sulphuric or hydrochloric acid to a quantity of water contained in a glass tumbler, in order to render the water more readily electrically conductable, and then to immerse two copper wires in the vessel of water, connecting the wires to the terminals of a 6 v. or 10 v. accumulator.

Immediately, bubbles will be noticed streaming off the ends of the wires. These are bubbles of oxygen and hydrogen which have been liberated from the water by the electric current. The negative electrode of the accumulator releases hydrogen from the water, the oxygen being released at the positive electrode. Hydrogen is given off, in practice, at about three times the rate that the oxygen is evolved.

If you place test tubes full of water over the ends of the wires, you will be able to collect both the oxygen and the hydrogen separately.

DEATH MASKS

"I RECENTLY saw at a cinema, in a news reel, casts being made of the living human face. First some stuff was smeared on with a small kind of wooden

spade while the subject was seated in a chair. This then hardened and when taken off became a mould. In this mould some substance was poured. Finally, when the mould had hardened, it was broken off, and a perfect replica of the subject's face emerged as if hewn by hand.

"Could you tell me what materials are used in this art, how they should be treated to make them liquid and hard at will, and what quantities would be required for a face? Also what kind of shop would sell them—and whether there is any book on the subject?"

QUICK-DRYING plaster of Paris (obtainable from any dental-supply or artists' materials house) is usually the material employed for taking human and animal casts. The hollow mould resulting from the actual casting of the face is, after it has hardened, thoroughly greased inside. Further plaster is then poured into this mould and allowed to set. The outer mould is then carefully broken away, revealing the inner replica in plaster.

You would want several pounds of plaster to attempt to mould any portion of the human figure. It should be mixed with cold water until the resulting mass attains the consistency of a fairly thick paste.

So far as we are aware no individual book has been published on the plaster moulding of faces, though, perhaps, in order to ascertain whether such a subject is treated in other volumes, you might inquire of a seller of artists' materials and books.

You should bear in mind, of course, that, except when carried out by competent hands, the taking of face-casts is a dangerous operation, since the "subject" of such activities is only able to breathe by means of straws inserted into his nostrils.

SELENIUM CELLS

"(1) What are the metals and oxides used to emit electrons under the influence of light in a photo-electric cell?

"(2) How are selenium cells of comparatively low resistance made, and how is the selenium prepared, starting from the greyish-silvery stick form?

"(3) Could selenium cells be used for sound-film reproduction or are they too sluggish in their action?

"(4) Can reproduction from selenium cells be effected by connecting the cell in series with a telephone receiver and a high-tension battery, or must several valve amplifiers be used?" (D. W., Co. Durham.)

(1) The chief photo-electric metals are those of the "alkali" group—Cæsium, potassium and rubidium. Some thallium compounds are also photo-electric.

(2) The preparation of selenium in a light-sensitive state is a tedious operation. The ordinary variety of selenium is carefully heated and allowed to flow over a series of parallel wires wound over a porcelain, glass or slate tablet, about 1 in. by 2 in. in size. Only the thinnest coating of selenium should be applied. The tablet is then carefully heated until the selenium flows in a film of even thickness over the tablet and between the wires (which are spaced about $\frac{1}{16}$ in. apart). The molten selenium film is carefully cooled until it turns grey. Immediately this occurs, the tablet is placed on a cold surface, in order that its subsequent cooling may be rapid. Selenium in this "grey" state is fairly light-sensitive, but to obtain it in its best light-sensitive condition, recourse must be made to special operations, details of which are usually to be found in books dealing with selenium and its electrical applications.

(3) Selenium cells are too sluggish for sound-film reproduction.

(4) A selenium cell should be connected in series with a pair of headphones and a 40-60 v. battery. In place of the headphones a galvanometer or other electrical measuring instrument may be employed. Under such conditions, the change in the electrical resistance of the selenium cell will be noted.

GLAZE ON CHINA

"I SHOULD like to know the following.

(1) What is the glazing on china such as cups and saucers, etc., made of, and is it possible for me to make and use it?

"(2) Also what are the ingredients used for the sensitive film on the positive photographic prints, and how can I use them?" (R. B., Surrey.)

(1) Pottery glazes vary enormously in composition. A typical white pottery glaze can be made by mixing 35 parts of china clay, 20 parts of borax, 10 parts sodium carbonate, 15 parts red lead, and ½ part blue-stone. These ingredients are finely ground, sieved and mixed intimately in the form of a paste with water. The liquid glaze is then painted or sprayed on the earthenware articles and the latter are then very carefully "fired" in a specially constructed furnace.

Glazing is not an occupation which can be carried on very well at home, although, of course, there have been a few amateurs who have obtained success in the art. If you desire more extended information with a view to taking up the subject seriously, we would advise you to obtain a reliable book on the art of pottery making, as, for example, C. F. Binns: *The Potter's Guide*, or H. Ansell and A. Searle: *The Making and Burning of Glazed Ware.*

(2) You will find it difficult, nay, almost impossible, to make a photographic emulsion equal to that of commercial bromide or gaslight papers. If, however, you wish to prepare such emulsions, the following will be found an effective formula:

Ammonium bromide	35 gms.
Potassium iodide	0·8 gms.
Best gelatine	75 gms.
Hydrochloric acid (10 per cent. soln.)	7·5 c.cs.
Distilled water	750 c.cs.

Heat this solution to 110° F. and then add:

Silver nitrate	50 gms.
Distilled water	25 c.cs.

Maintain the temperature of the solution for one hour. Filter, subsequently, the solution through cotton wool and finally store for use.

To use the solution or emulsion, place the bottle containing it in warm water until the emulsion becomes liquid and then brush it over sized paper with a flat camel hair brush. Needless to say, all operations with the emulsion from the addition of the silver nitrate solution onwards, must be carried out in a dark room.

A SMOKE-SCREEN

"COULD you please tell me how I can make a really good thick smoke-screen? I wish to use it on model aeroplanes, so complicated apparatus is out of the question." (V. S., London.)

THE densest smoke-screen is provided by burning phosphorus, but the use of this material is, of course, precluded with model aircraft. An efficient non-burning "smoke substance" is silicon tetrachloride. This, when allowed to come into contact with moist air, gives off white fumes. The density of the fumes can be increased by passing dry ammonia gas into the silicon tetrachloride. This is done by warming a quantity of liquid ammonia in a flask and leading the evolved ammonia gas through a cylinder containing quicklime. The quicklime will absorb traces of moisture from the ammonia gas. The latter is then allowed to bubble through the silicon tetrachloride until the liquid is saturated with the ammonia. This ammonia-saturated silicon tetrachloride, when sprayed into moist air, gives off dense white fumes of ammonium chloride.

Silicon tetrachloride is obtainable commercially from many chemical suppliers, as, for instance, The British Drughouses, Ltd., Graham Street, City Road, London, N.1. Only the "technical" or impure grade of the liquid need be obtained. It costs about a shilling per quarter of a pound.

It would not be difficult to equip a model aircraft with a vessel containing silicon tetrachloride either in the untreated state or saturated with dry ammonia gas and to devise some means whereby the liquid could be slowly released from its container during the actual flight of the model. A leaky container would be the simplest means of effecting this requirement.

SAFETY DEVICE FOR AN ELECTRIC IRON

"I WOULD greatly esteem your advice as to whether the following idea is worth patenting.

"It is a safety device to prevent fire being caused by inadvertently leaving a heated electric iron on the material being ironed. Electrical connection is made in the usual way by means of a plug and switch, but a further contact must be made before the iron can be heated. This is brought about by gripping the handle in the process of ironing, or by placing the iron on a special stand (of quite simple construction) which can only hold the iron in such a way as to make electrical contact and so heat the iron. Thus, if an operator thoughtlessly leaves the iron on the material being ironed, the current is switched off and the danger of fire or scorching is eliminated: but if the operator wishes the iron to be kept hot whilst attending to something else, it is placed on the stand and is ready for use on return. Possibility of electrical shock to the operator or of short-circuiting through metal entering the handle is prevented by having the second switch (in the heel of the iron), operated by Bowden wire attached to and passing through the handle grip.

"So far, I have not seen any safety device mentioned in connection with electric irons, and believe the idea to be original. It was prompted by reading in the local paper of a fire caused by a 'live' electric iron being left on the table."

THE improved safety device for electric irons, if novel, could probably be protected by Letters Patent, but without more specific details of the actual construction employed, it is not possible to express a definite opinion. It is doubted whether in view of analogous devices there is sufficient subject matter or invention to obtain a valid Patent for switching on the current to the iron when the handle thereof is grasped

for operation. It is also doubtful if any invention is required to so arrange a stand for the iron as to automatically switch on the current when the iron is placed thereon. However, it may be that the particular means proposed to be employed by you may form subject matter for a Patent in which case, the claims of any such Patent would necessarily be restricted to such means so that such a Patent would not have any great commercial value.

THE P.M. FOLDING BOAT

"BEING interested in the building of the folding boat published in the 'Practical Mechanics' dated May and June, I would like to know the approximate cost of all materials, also if a kit of parts is available." (E. O., York.)

THE list of materials is as follows:

	£	s.	d.
4 pieces of ⅜ pine plywood 10 ft. by 14½ in. purchased in stock pieces, allowing waste at 5d. ft. super	1	8	0
Difficulty may be experienced in obtaining 10 ft. lengths, masonite as an alternative.			
Use 2 boards 12 ft. by 4 ft. stock size masonite prestwood 3/16 in. allowance made for small quantity per board, approx. 22/4	2	4	8
1 piece ⅜ in. ply, 5 ft. by 4 ft., at 5d. super		8	4
1 piece ¾ in. ply, 5 ft. by 4 ft., at 8½d. super		13	2
10 10-ft. lengths oak		10	0
1 piece mahog. ¼ in. by 7 in. by 5 ft.		3	0
Screws, misc. sundries		4	0
4 2-in. butts (hinges)		1	0
4 6-in. gate hinges (approx.)		2	0
2 small 2½-in. door bolts (approx.)		1	0
Marine glue		5	0
Varnish, paints, etc.		4	0
Total cost plywood	3	19	6
Total cost masonite	4	16	2

"WITH reference to the 'Building a Folding Outboard Motor Boat' article, could you let me know if the marine glue is spread all over the canvas joints as a protection from water leakage or whether it is simply for fixing the canvas to the bottom of the boat? In the latter case, is the canvas sufficiently waterproof?

"I have started building this craft, and up to the present I have been able to proceed very well."

THE glue (which must be marine glue) plays an important part and should not be omitted.

The canvas is held in position mainly by the battens, although the glue helps to a minor degree.

The marine glue waterproofs and preserves the canvas, and since the seams are flexible, even when the boat is kept in an assembled state, there must be a certain amount of relative movement between the sides and bottom which would be sufficient to set unproofed canvas leaking.

As the glue never sets hard it combines with the canvas to make a flexible watertight joint.

The glue can be sent to you by parcel post, and you would spoil the whole job by omitting it or using any makeshift methods.

MAKING A SPEEDBOAT

"I AM contemplating making a motorboat and fitting a small car engine, a little more ambitious than the one contained in this month's issue of 'Practical Mechanics.' I do not want a folding boat and contemplate making the lines more after the orthodox 'speedboat' type. I am quite capable of constructing and fitting the motor, etc., but would be glad to have your opinion as to type of engine to fit, and how to get the shape of bows satisfactory. Regarding engine, I had thought of Ford '8' or a Morris '8.'

"The rough shape I had in mind is shown in the enclosed sketch." (H. P., New Cross, S.E. 14.)

THE details given in your inquiry are not sufficient to allow us to give you very much help.

You state that you contemplate using an 8 h.p. engine, but do not state the length, beam, or depth of the proposed hull, therefore we cannot say whether it would be serviceable.

In our issue of PRACTICAL MECHANICS dated July 1936, we gave the designs for a 10-ft. speed boat intended for use with an outboard engine, and although this is too small for an 8 h.p. engine (either of the makes you suggest could be used), the plan could be scaled up to say 15 ft. by the simple process of increasing all dimensions by half or to 17 ft. 6 in. which may prove an even better size by increasing by three-quarters.

In this case the thickness of the planks need not be doubled. The frames should be kept the same for scaling half, but increased ½ in. in width and ¼ in. in thickness if scaled three-quarters.

It will, of course, be necessary to add more frames in scaling up so that the distance between frames remains the same. This hull requires an external stern tube, thus it must be kept afloat or a suitable skeg fitted to protect it. In fitting the stern tube, allow at least 7 in. between the end of the shaft and the bottom of the boat, as you will need to swing a 10-in. diameter propeller.

We are of the opinion that an 8 h.p. engine is too large for this type of craft for ordinary service and not large enough for speed work. We should advise an engine about 3 to 4 h.p. which would give such a boat a speed of about 7 to 8 m.p.h.

To get speedboat performance, very high powers are needed, and special hull construction, and we do not advise you to attempt it.

CAN WE MAKE LIFE?

Continued from page 608

placed it upon the ground for a few days until it decayed and then you found that the meat was full of maggots. Cheese grew blue-mould "of itself" and even a glass of water when allowed to become stagnant would, in time, develop low forms of life. Whence, therefore, thought the ancient philosophers, did such life-forms originate if they had not evolved out of nothing?

The answer is clear to us now, of course. We know that food materials, when unprotected, are visited by flies and by other insects which deposit tiny eggs in them. We are aware, also, that the seeds or "spores" of moulds and bacteria are almost inconceivably minute and that these are carried about by currents of air and deposited here, there and everywhere. Thus it is that lowly life-forms spring up in the most unexpected—and often most unwanted—places.

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PRACTICAL MECHANICS, AUGUST, 1937

MISCELLANEOUS *(continued)*

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