COMPLETING OUR £20 CAR

NEWNES

PRACTICAL MECHANICS

JUNE

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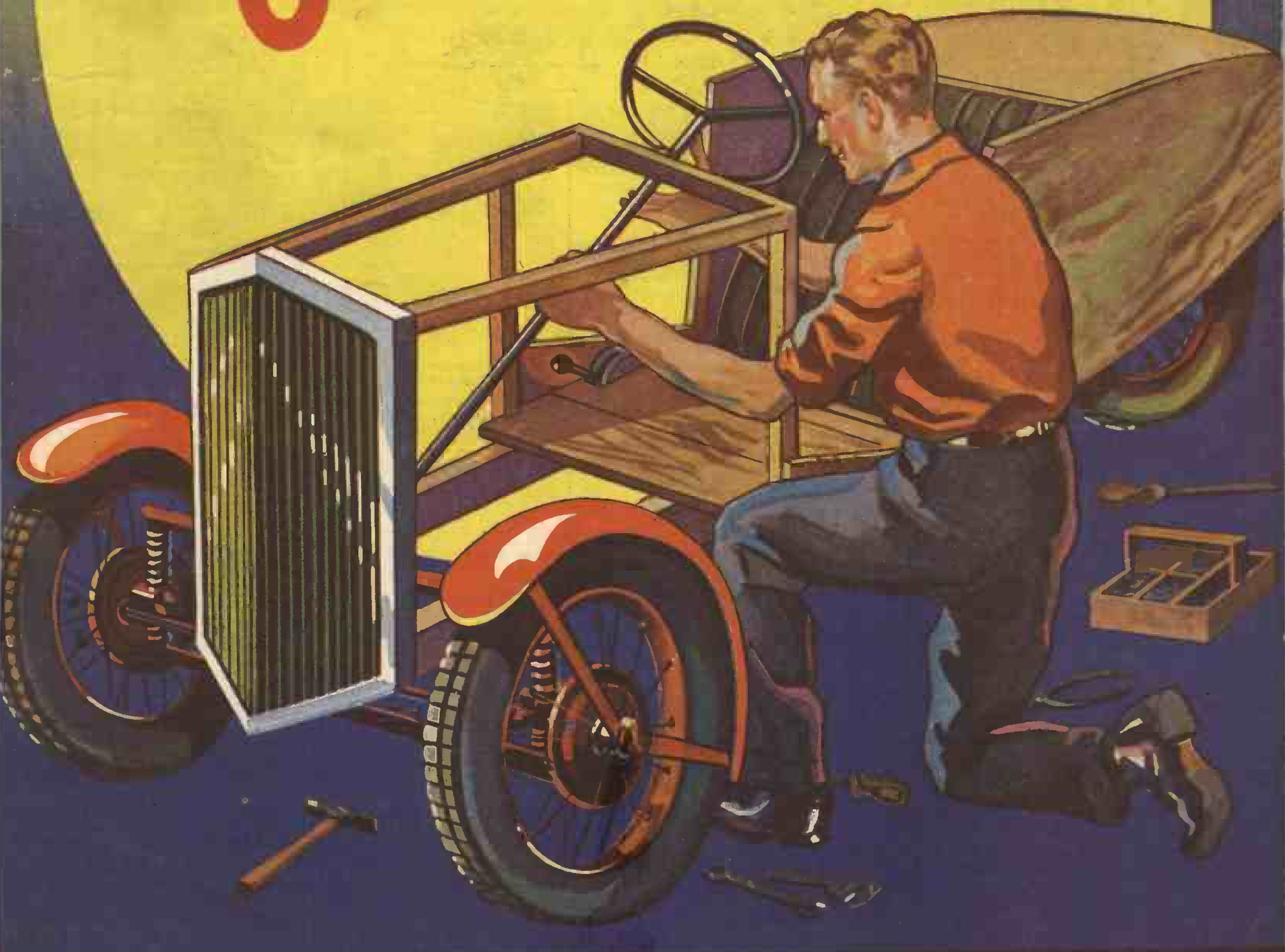

Practical Mechanics

Edited by F. J. CAMM

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Notes, News, and Views

Flying Flea Contests

THE first international speed contest for "Flying Flea" aeroplanes is to be held on August Bank Holiday, August 3rd, at Ramsgate Airport.

World's Largest All-welded Ship

THE motor-ship *Franqueline* (2,000 tons), the world's largest all-welded (rivetless) vessel, was recently launched at Wallsend-on-Tyne.

A Non-stop Flight

A ROUND-BRITAIN non-stop flight of 2,500 miles this summer is going to be the prelude to Britain's first commercial attempt to conquer the North Atlantic.

A Double-deck Train

A DOUBLE-DECK train is now operating between Hamburg and Luebeck. It consists of a locomotive and two coaches.

A New Air Line

IT is officially announced that an agreement has been signed between Rumania, Russia, and Czechoslovakia for the opening of a new air line from Moscow to Prague.

The "Parachute Express Squad"

CONSISTING of twenty doctors and nurses the first "Parachute Express Squad" has been formed by the Soviet Red Cross Unit of Moscow. Members of the squad will drop by parachute to render emergency aid in isolated communities where an aeroplane landing is impossible.

Tunnel Under Mont Blanc

WE learn that there is a possibility of a tunnel being bored under Mont Blanc. The tunnel at its maximum depth will be more than 11,500 ft. below the surface of the mountain; its length will be about 8 miles.

The Coronation Televised

IT is stated that subject to the King's permission, the Coronation next year will be both broadcast and televised.

New Light 'Plane Record

LORD SEMPILL has established a record for ultra-light aeroplanes, by flying from Berlin to Croydon in 9 hours.

75 Miles in a Glider

MR. L. SLATER recently set off from Hucklow, Derbyshire, in a home-made glider, and flew 75 miles to Gosberton, near Spalding, Lincs. The flight is claimed as a record for a British machine.

An All-metal Aeroplane

WE learn that Germany's latest air liner is an all-metal 10-seater machine and has a crusing speed of 211 m.p.h.

A Super-streamlined Locomotive

A LOCOMOTIVE incorporating the most highly perfected and advanced design yet produced by aerodynamic science for the reduction of wind resistance, has just been completed at the Pennsylvania Railroad Works, at Altoona, Pennsylvania, U.S.A.

An Aeroplane-Catapulting Ship

THE launching of a novel aeroplane-catapulting ship for the use of the German air-mail service to South America, recently took place at Kiel.

A New French Military Plane

A NEW military plane, called the "Amiot 144," is now finishing trials at the "Amiot" works. The plane is equipped with two "Hispana Suiza" engines of 1,200 h.p. and is capable of a speed of nearly 390 m.p.h., at over 12,000 ft.

A New Wireless Station

THERE is every possibility that a new and more powerful transmitter will be built in the course of 1937, to improve reception of the London Regional broadcasts.

A Novel Petrol Tank

FOR added storage capacity, a new European petrol tank has been designed to fit in the centre of the spare tyres at the rear of a car.

A Hand Typewriter

AN Austrian inventor has produced a typewriting device in which types on his gloved hands are pressed on to a ribbon held in place by two guide rules which fit over the paper.

Plastics

PLASTICO - CHEMICAL compounds which are compressed under heat into desired shapes, and thereafter are not subject to corrosion, are increasing in use.

World's Smallest Watch

THE Le Caulfre factories have produced what is claimed to be the smallest watch in the world. Full details of this remarkable watch will be given next month.

Empire's Biggest Suspension Bridge

PLANS have recently been drawn up for what is claimed will be the largest suspension bridge in the British Empire. It is to be erected at the entrance to Vancouver Harbour, and will have a central span of 15,000 ft., and be 209 ft. high in the centre.

A New Public Telephone

A NEW type of public telephone has been introduced in Vienna, Austria. It has the advantages of the Continental hand-piece.

Building Up Power

THE Colorado River is now busy filling up the immense artificial lake—man's greatest reservoir of hydro-electric power—behind the 730-ft. Boulder (Hoover) Dam which joins the walls of the Black Canyon.

A New Type of Camera

A NEW home-movie (16-mm.) camera has been brought out by an American manufacturer, with the novel feature of a film magazine which can be interchanged at will, for the use of different types of film.

Floors—of Sawdust

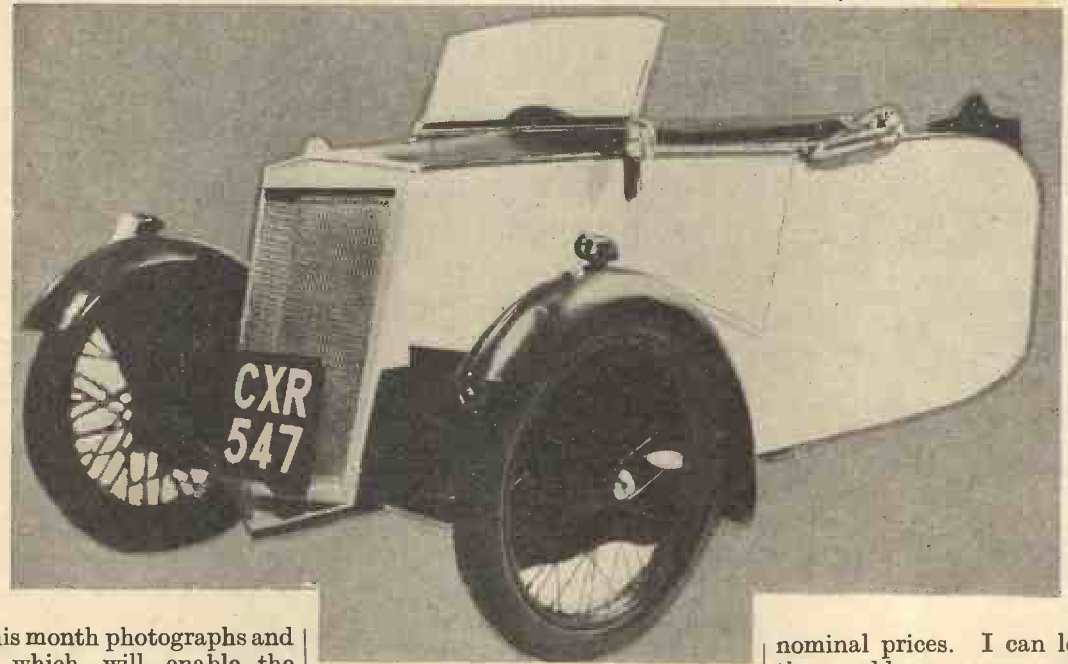
A NEW use has been found for the waste which accumulates in large quantities in a saw-mill. The waste material is ground to a powder and mixed with suitable ingredients which enable it to be used with excellent results as a flooring material. The floors are said to be very resilient and to possess great resistance to wear, and they may also be made in a fireproof form.

Tiles of the material may be made by moulding under high pressure and temperature and the product is said to be specially suitable for public floors which have to withstand considerable wear, for desk and table tops and for electric panelling.

THE PRACTICAL MECHANICS £20 CAR

By F. J. Camm

Final Constructional Details. Previous Articles on this Fascinating and Easily Built Three-Wheeler Appeared in our Issues dated March, April, and May. Blueprints are now Available. The Designer, Mr. F. J. Camm, grants a Free Licence to Every Reader to Build One



The finished £20 car.

I SHOW this month photographs and drawings which will enable the reader to complete this fascinating little vehicle, of which many hundreds are being built from details in this journal. Before dealing with them I should like to dispose of a further batch of queries. Firstly, regarding insurance. Several readers have asked whether there will be any difficulty about this. I have accordingly been in touch with several insurance companies, none of whom have any objection to insuring the car. Messrs. Premier Motor Policies tell me that they are prepared to issue a third-party insurance policy for £3 7*s.* 6*d.*, and I recommend readers to get into touch with them.

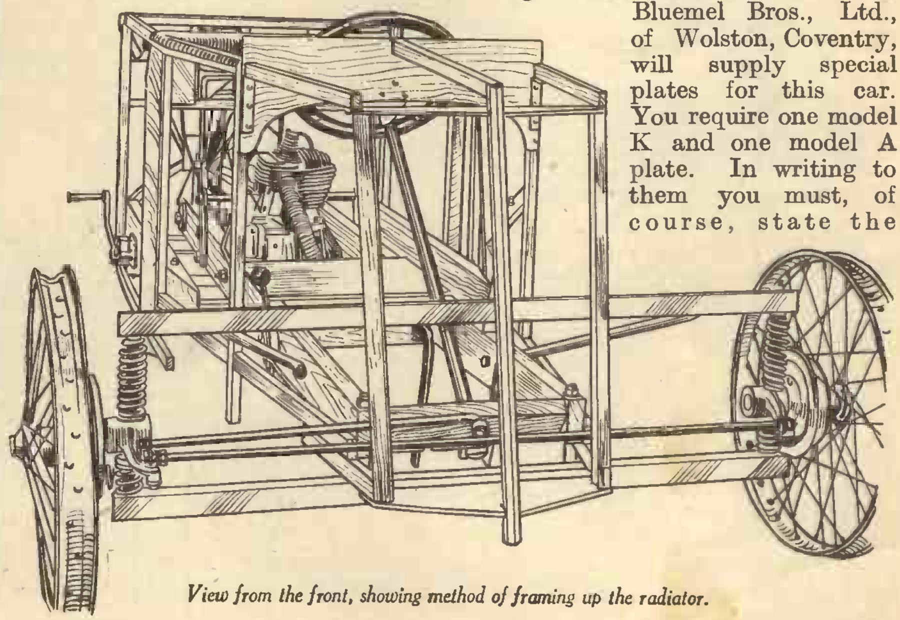
Registration

An important point occurs regarding registration. In the item on Form RF1, which must be filled in in order to obtain the necessary registration numbers, there is a line reading "maker's name." I have been in touch with the London County Council on this point, and would inform readers they must enter the make as "Camm." The registration figures assigned to my own car are CXR547, and if any reader should spot me on the road do not hesitate to stop me if you wish to ask any questions and inspect my vehicle. I expect in the near future, as time permits, to embark upon a series of timed runs, of which I shall disclose details in due course.

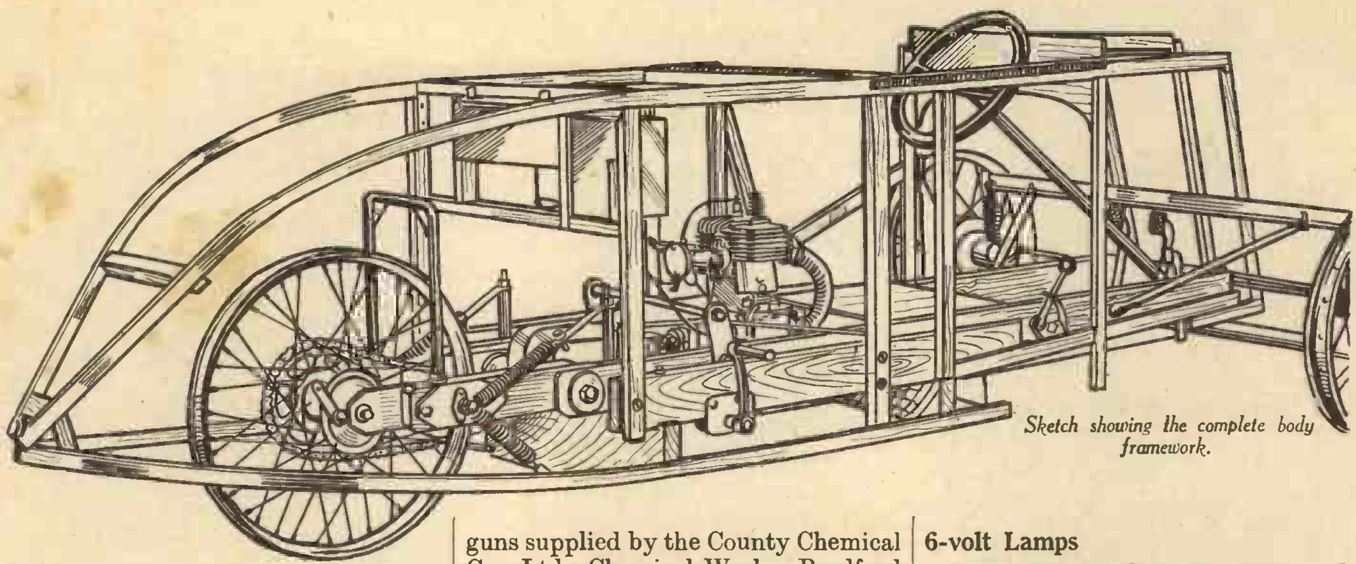
Many readers are asking where they can get fittings made, and I have accordingly arranged with several manufacturers for this to be done at nominal prices. I can let you have these addresses upon application if you will enclose a stamped and addressed envelope. You will appreciate, of course, that the price of the finished car may come out a little higher than £20, if you elect to have some of the parts made, although £20 is actually on the high side.

Number Plates

Regarding number plates, Messrs. Bluemel Bros., Ltd., of Wolston, Coventry, will supply special plates for this car. You require one model K and one model A plate. In writing to them you must, of course, state the



View from the front, showing method of framing up the radiator.



Sketch showing the complete body framework.

registration numbers assigned to your car. The plates will then arrive with very neat and servicable celluloid figures already attached so that the number plates may be immediately affixed to the car, thus avoiding the troublesome business of painting the numbers yourself to the legal dimensions.

Cushions etc.

Some of my readers do not seem too keen on making a cushion, a back squab, and a hood. Here, Messrs. Austers, Ltd., Crown Works, Barford Street, Birmingham, come to the rescue, for they have made at my special request a back squab, a cushion, and a hood. They will supply a very neat windscreen, which also has been specially designed for the car. I recommend readers to use those parts. The colour of the upholstery, which should be chosen to tone with the paintwork of the car, should be stated when ordering. My own car is painted with cream cellulose applied by means of one of the cheap Spray-on guns supplied by the County Chemical Co., Ltd., Chemical Works, Bradford Street, Birmingham, who also supply the spraying cellulose.

Colouring

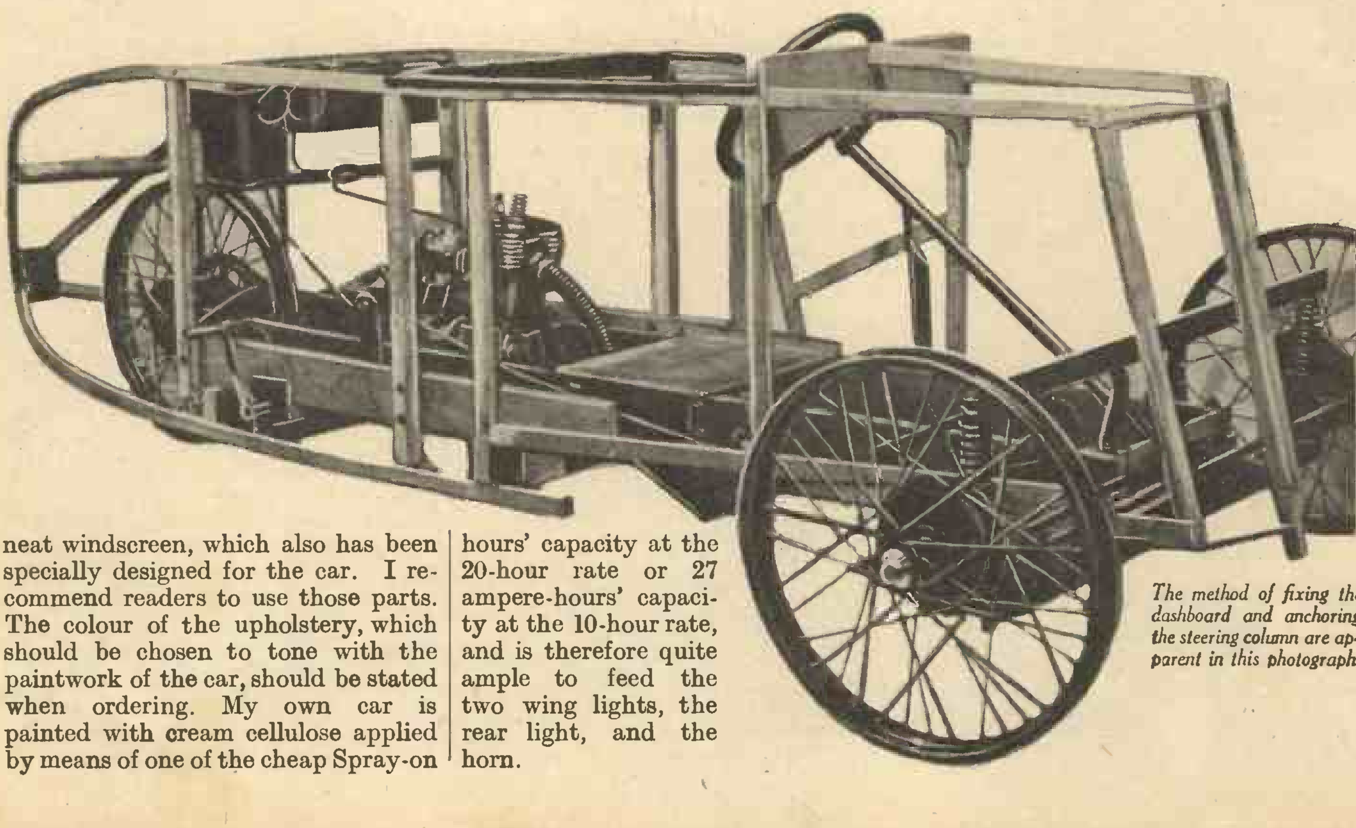
The mouldings and the wings are in maroon, whilst the imitation louvres on the bonnet are picked out in black. You will, of course, choose your own colour scheme.

No provision is made for a dynamo on this car, since there is very little need for one. The car starts quite easily, and it is a simple matter to have a spare accumulator on charge. I have been in touch with Chloride Company, who are arranging to supply a special 6-volt battery for this car. When ordering ask for Exide 3.CZN7–IL. This battery is of 30 ampere-hours' capacity at the 20-hour rate or 27 ampere-hours' capacity at the 10-hour rate, and is therefore quite ample to feed the two wing lights, the rear light, and the horn.

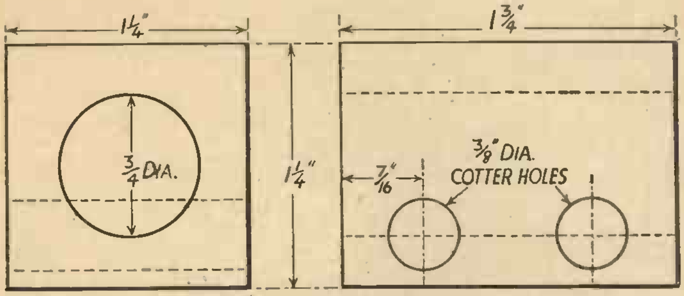
6-volt Lamps

You must use lamps of the 6-volt double-pole type, and a convenient and quick way of coupling them up to the battery is to take two leads to two strips of brass fixed behing the dash. These two strips of brass will form common bus bars from which the leads to the horn (fixed in the centre of the radiator), and the lamp may be taken. This will save a multiplicity of leads to the battery. Excellent wing lights, rear lights, and horns are obtainable from James Grose, Ltd., 379 Euston Road, N.W.1. They are cheap and efficient. This firm will also supply the car type of mudguards if you decide to use those instead of wooden ones. My drawings have shown both types.

A point I wish to stress is that I grant

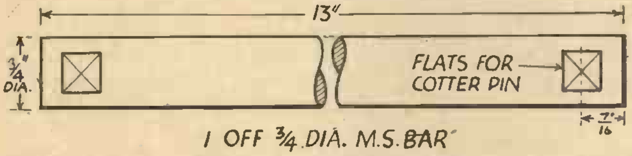


The method of fixing the dashboard and anchoring the steering column are apparent in this photograph.



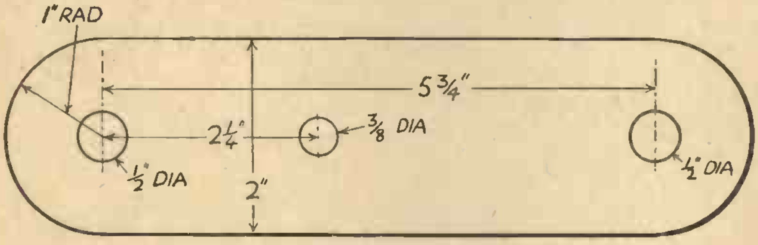
1 OFF 1¼" SQUARE M.S. BAR

The coupling block for the kick-starter shaft.



1 OFF ¾ DIA. M.S. BAR

The extended kick-starter shaft.



2 OFF 2"×¼" M.S PLATE

The side plates for the tie bolts.

every reader of this paper a licence free of all charge to make one car. In no circumstances must it be made for sale, since it is likely that this car will shortly be placed on the market.

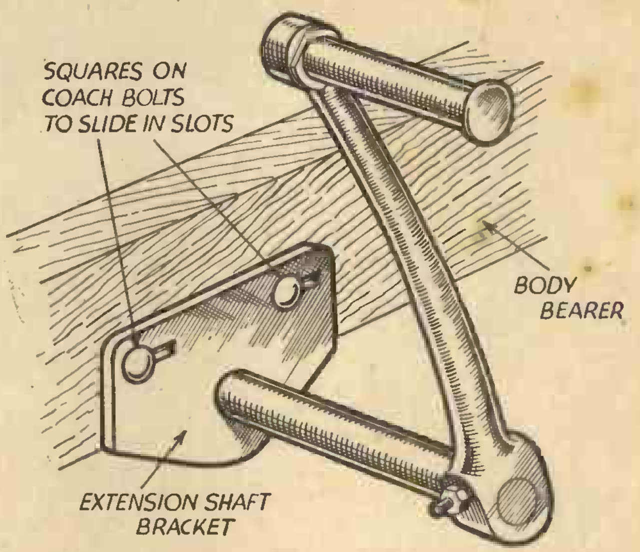
The mudguards I recommend if you use the metal type are the model 109 from Messrs. Grose's catalogue. May I also repeat that my drawings are correct for the components I have already specified, but you will need to modify them if you are using other parts.

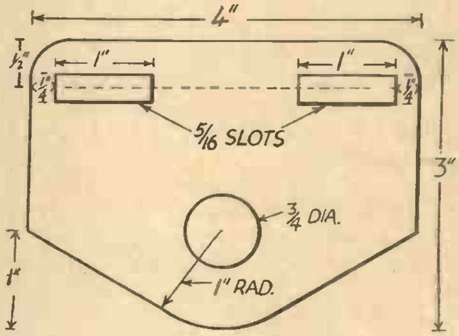
Remedying Whip

One or two readers tell me that they have found the members whip slightly near the front. This is due to the use of unseasoned wood, but it is not a defect which need worry them. Fortunately they will be able to get over it very easily by incorporating the cross-bracing between the axle and a point beneath the floor. My own car has not the slightest trace of whip.

I show in the sketches how to make the adapter for coupling the magneto to the drive shaft of the engine. This detail, of course, applies to the Burney and Blackburne engine and the B.T.H. magneto. If you have bought an engine with magneto attached you will ignore it. I also show drawings for the extension shaft of the kick starter and the means of attaching it to the gearbox. A guide plate is fixed outside the body which has slots at the top. Coach screws secure this plate to the side members, and it will be necessary to slacken them off when adjusting the front chain tension, since the guide plate must move back with the gearbox.

The kick-starter guide plate.



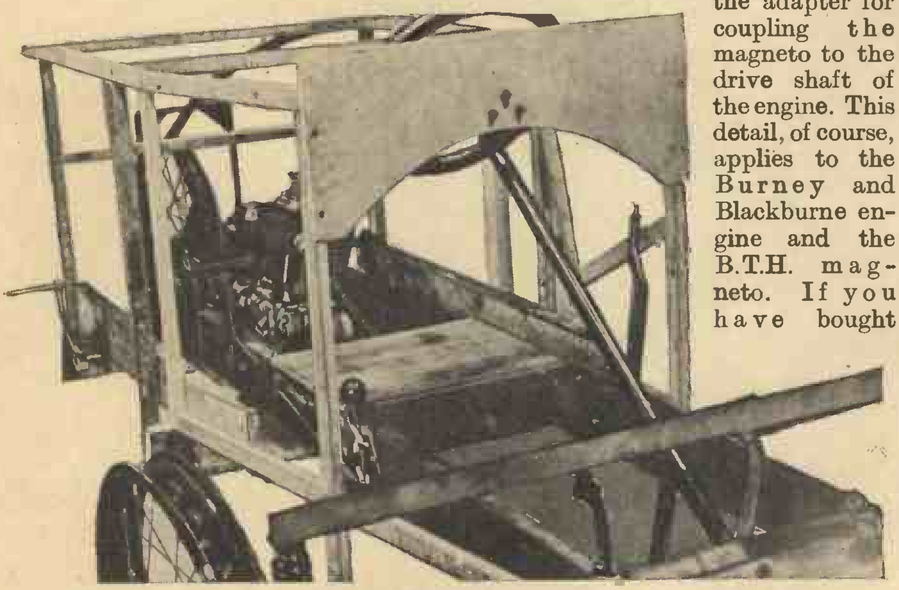


1 OFF 3"×¼" M.S

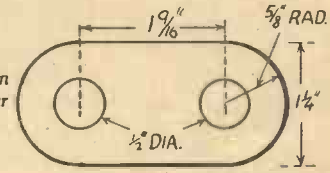
Adjustable guide plate for kick starter.

Exhaust Pipe and Silencer

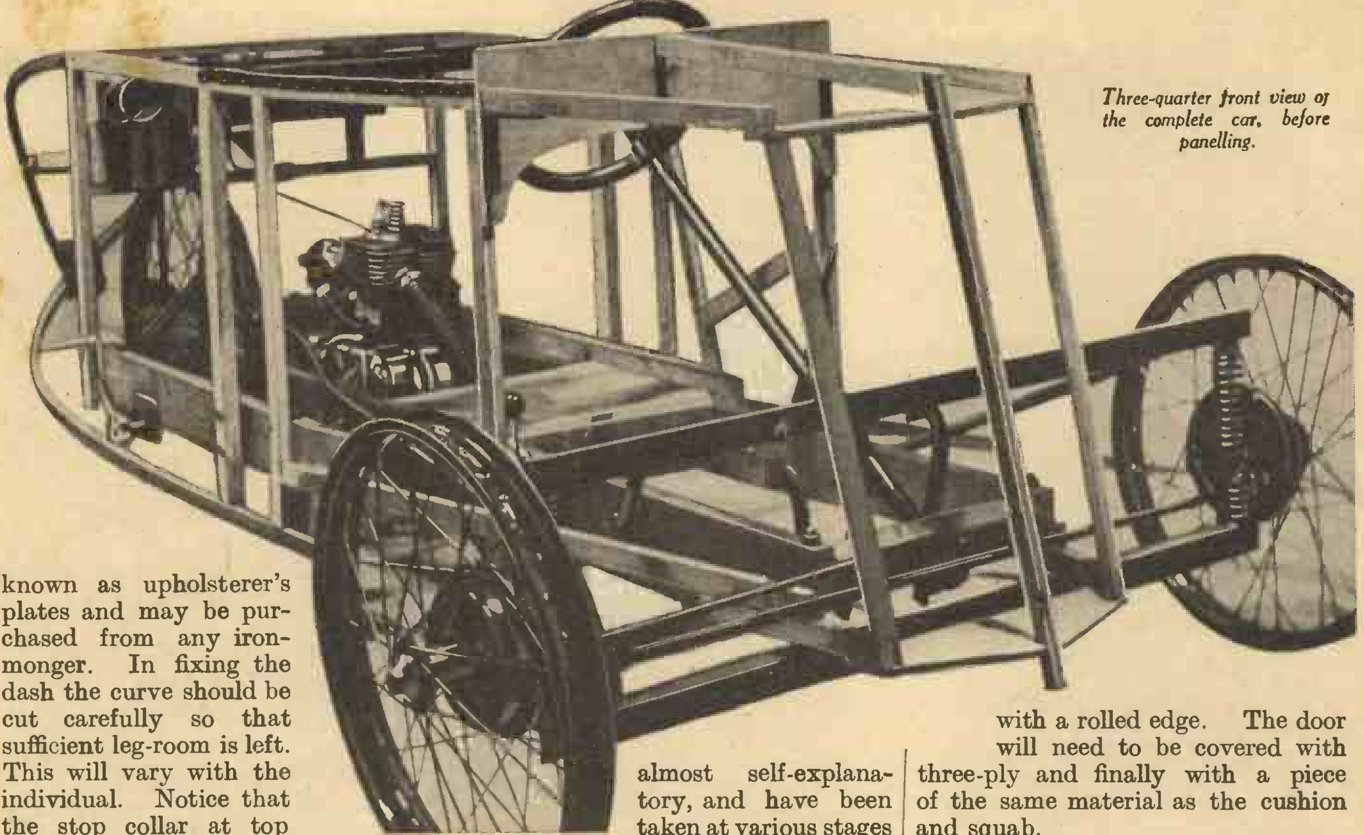
If the engine has not an exhaust pipe and silencer attached, you should use flexible metallic tubing, which is secured to an adapter locked to the exhaust stub by means of the union nut secured to it. A sketch shows the general method employed in framing up the superstructure. It will be seen that angle plates are used. These are


The simple dashboard and method of anchoring the steering column to it are clearly shown.

The extension plates (to clear magneto).



2 OFF 1¼"×1¼" M.S. PLATE



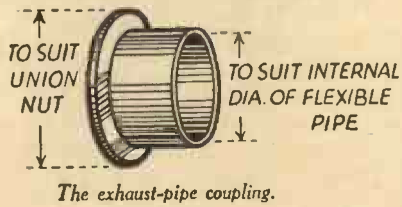
Three-quarter front view of the complete car, before panelling.

known as upholsterer's plates and may be purchased from any ironmonger. In fixing the dash the curve should be cut carefully so that sufficient leg-room is left. This will vary with the individual. Notice that the stop collar at top of steering column is pinned to the latter, and that the lug acting as a guide and anchor for the column is secured to the dash by means of three bolts.

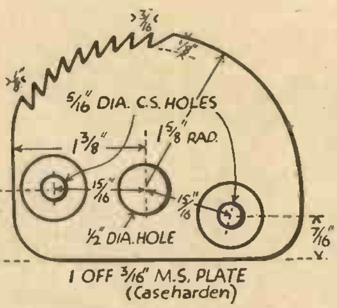
The Panelling

The photographs themselves are almost self-explanatory, and have been taken at various stages of construction. I do not think that any special difficulty will arise. The panelling is attached to the uprights and rails by means of panel pins, and the joints are obscured by half-round moulding. Note that the edges of the seat compartment are upholstered with a rolled edge. The door will need to be covered with three-ply and finally with a piece of the same material as the cushion and squab.

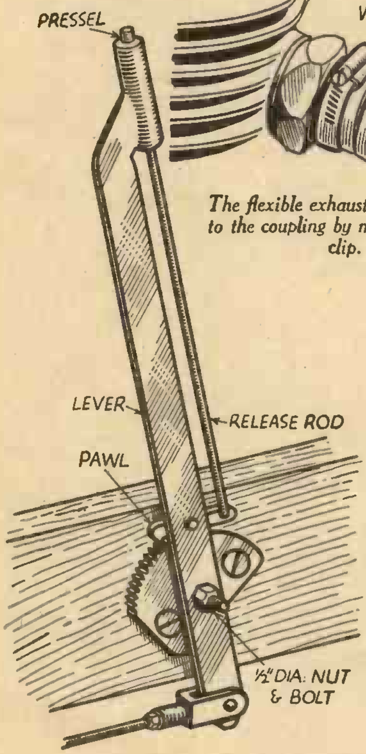
The flexible exhaust pipe is secured to the coupling by means of a hose clip.



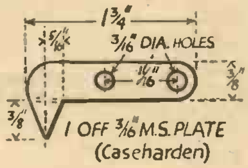
The exhaust-pipe coupling.



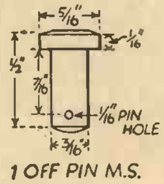
The hand-brake quadrant.



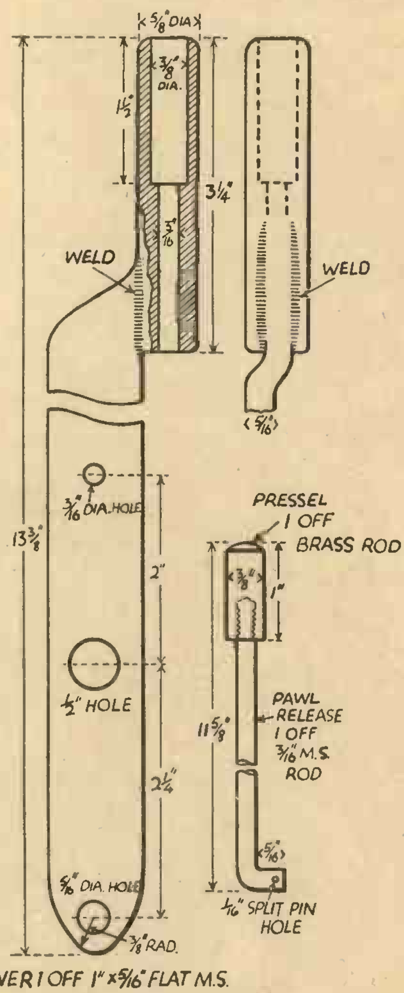
The hand brake.



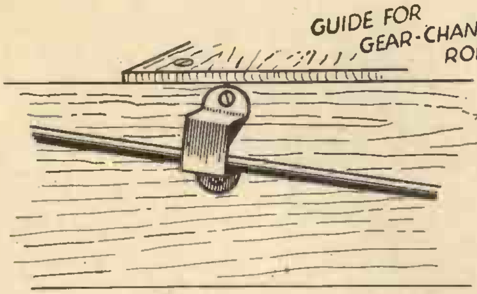
Hand-brake pawl.



Hand-brake pin.



Details of the hand-brake lever.

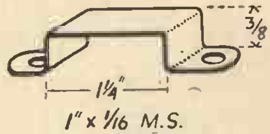


Guide for gear rod.

A similar panel should be cut for the offside of the seat compartment. A good method is to cut the panels, cover them with American cloth, and then to fix them.

Making a Hand Brake

If you are unable to purchase a hand brake you may easily make one as shown in the sketches. Bowden cables are used for the foot brake, the accelerator, and clutch. The gear change, of course, must be a rod, and a guide plate should be attached to the side member as shown in one of the sketches. The rear suspension springs may conveniently consist of very strong motor-cycle front-fork springs, although Messrs. Herbert Terry & Sons, of Redditch, are supplying special springs for the job. If you are able to pick up a pair of springs and find them too short for the job you may make use of them as shown in one of the diagrams by fastening a piece of angle-iron to the rear cross-member and anchoring them by means of an eyed extension bolt.



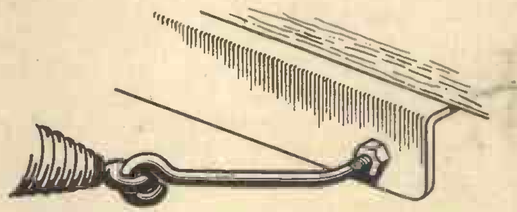
Gear-rod guide details.

Blueprints for the car are now ready, but are limited in number. They cost 10*s.* 6*d.* per set of four sheets, and show the general and detailed arrangement of the parts.

It will be noticed that regarding some of the details the reader will be left to his own devices, since I cannot issue drawings applicable to all of the engines, gearboxes, and other parts which are being used by constructors of this car. The general arrangement must, however, be followed; the shapes will remain and details will differ only as to dimensions. In no case should a twin-cylinder engine be used, since these are of greater cubic capacity and will impose strains and stresses for which the car is not designed.

2" × ¼" ANGLE IRON

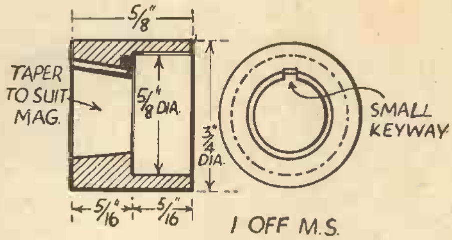
Angle bar for spring anchor bolts (only required for short springs).



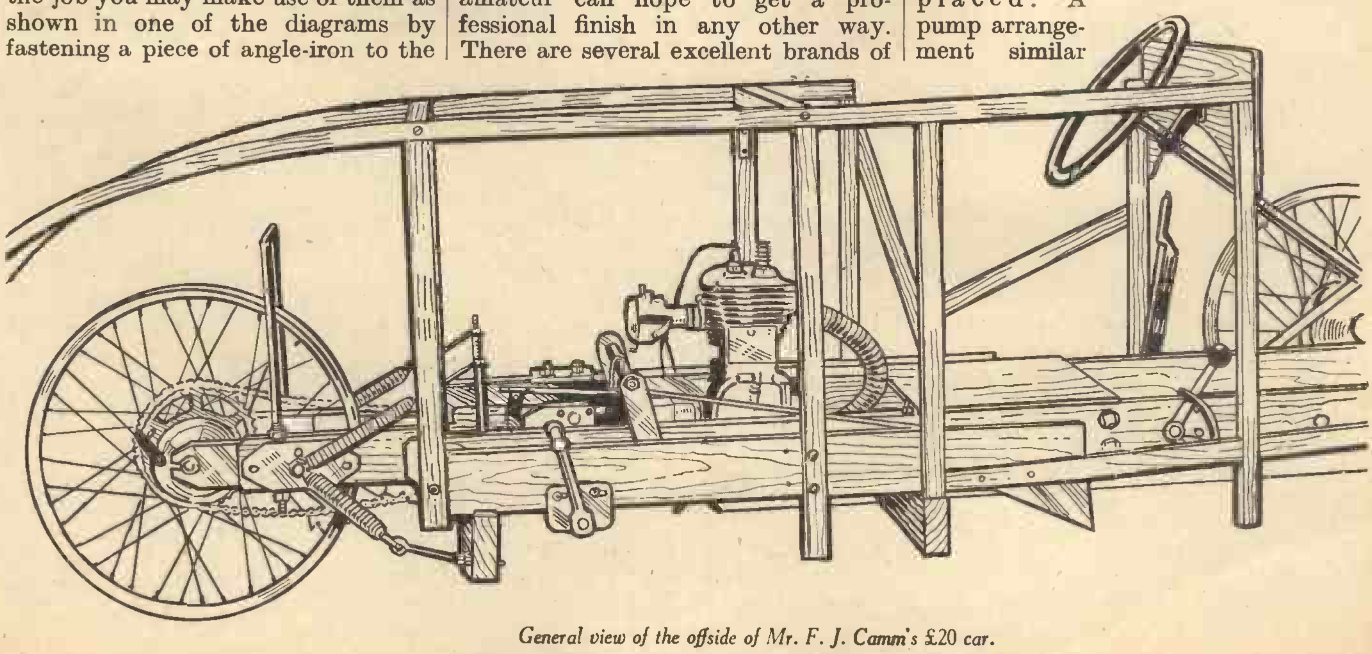
Method of extending the length of and securing short springs

Cellulose Spraying

I have mentioned the colour scheme and that readers will decide upon their own. There are, however, the general methods to be employed. I recommend cellulose spraying since no amateur can hope to get a professional finish in any other way. There are several excellent brands of brushing enamel on the market, but it is my experience that amateurs will never go to the trouble of preparing the work; most of them presume that a coat of paint will hide a rough surface; it will not. It is always wise carefully to rub down the woodwork, to fill up any depressions, scratches, or defects with a suitable wood filler, such as plastic wood, to give a coat of priming (which must be of a lighter colour than the final coat), and then to finish either by brushing on enamel or spraying on cellulose. Remember that, as purchased, the latter is intended to be applied by means of a brush, and a reasonably satisfactory job can be made in this way. You can obtain for 1*s.* or so a spray-on gun, by means of which you can obtain quite a professional finish, although the cellulose will need to be thinned with cellulose thinners using 50 per cent. of each. These guns have a container at one end in which the thinned cellulose is placed. A pump arrangement similar

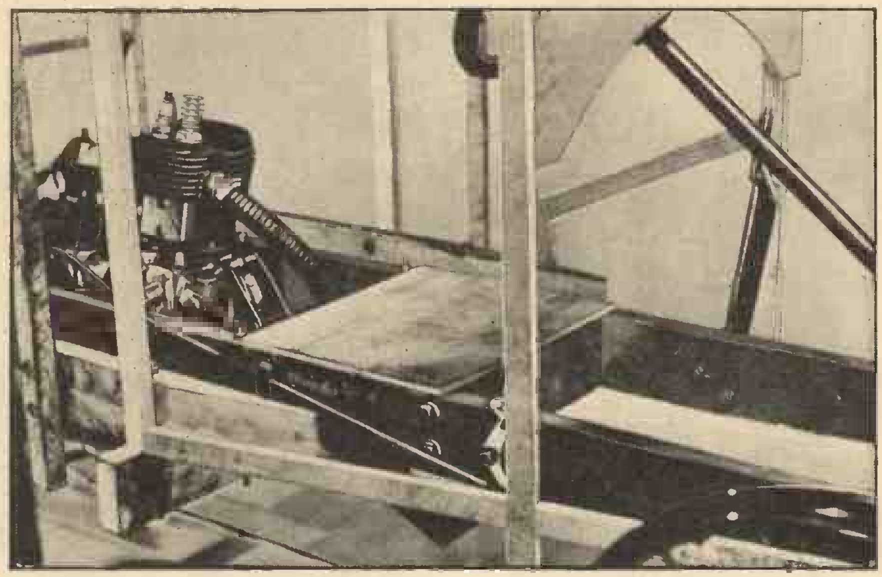


The magneto coupling.



General view of the offside of Mr. F. J. Camm's £20 car.

to a cycle pump causes a jet of air to pass a jet leading into the container, and thus the paint is induced from the jet in the form of a finely atomised spray. In this form it settles on to the woodwork very evenly, and apart from this the method uses very little paint. All joints in the mouldings should be filled with plastic wood, of course, first. After the first coat rub down with pumice dust applied to a piece of wet felt and give a second coat, finally finishing with a soft cloth on which is applied a small quantity of one of the well-known cellulose polishes. If you are using a two-colour scheme for the body it will be necessary to mask off one portion when applying the second colour. This may be done by cutting brown-paper masks to fit the parts not to be coloured, and directing the paint-spray *away from* the edge of the paper. If you reverse this process the paint will creep under the edge and give an irregular and crude effect.



View through the seat compartment.

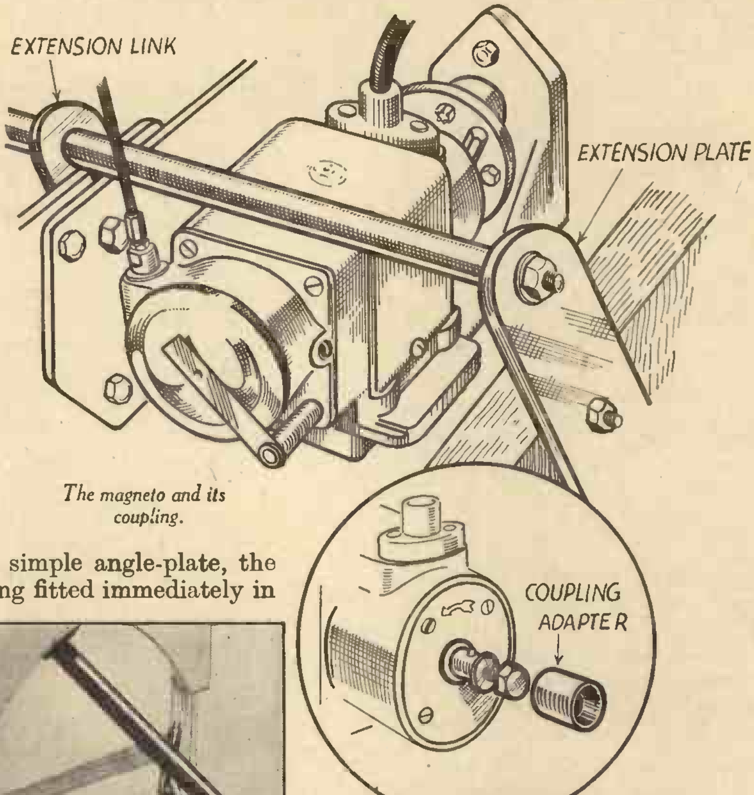
The Radiator

This can be made to simulate a genuine one by fixing a form of netting known as expanded metal. This will need a framework made and mitred together from rebated material such as plain picture framing. The expanded metal will fit inside this framework. It should be painted in aluminium colour for effect. Any simply made piece of carved wood will serve as a dummy radiator cap.

The whole of the radiator assembly should be fixed by means of screws so that it can easily be removed for adjustment to the pedals. This also applies to the tapered-off rear section, so that it will be an easy matter to remove the rear-wheel without jacking up.

Attaching the Number Plate

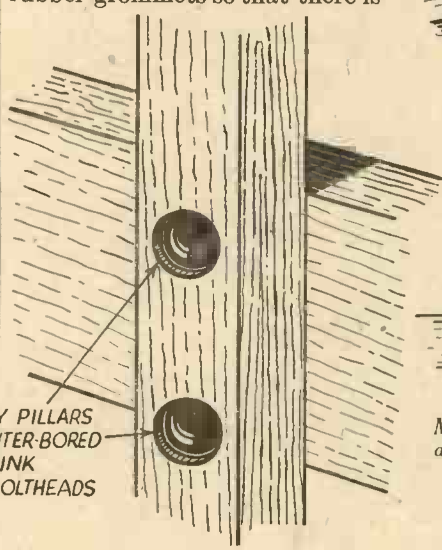
The front number plate is bolted direct to the radiator, whereas the rear one is fixed by means of a simple angle-plate, the toolbox being fitted immediately in front of it. Where it is necessary to pierce the woodwork and the wings for the twin wiring, use rubber grommets so that there is no risk of the rough edges chafing the wires and causing a short-circuit. The lighting switch should be connected in the main lead from the accumulator to the bus-bar, and two separate leads should be connected to the horn, the horn switch being connected in series with one of these leads; thus when the lights are switched off the horn will still be available for operation.

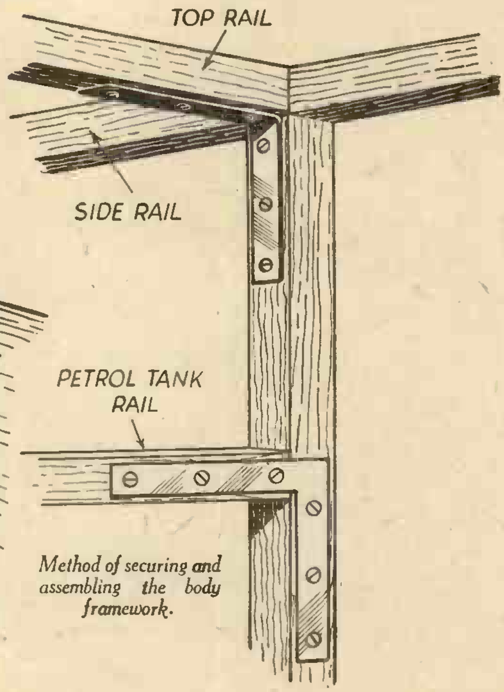


The magneto and its coupling.

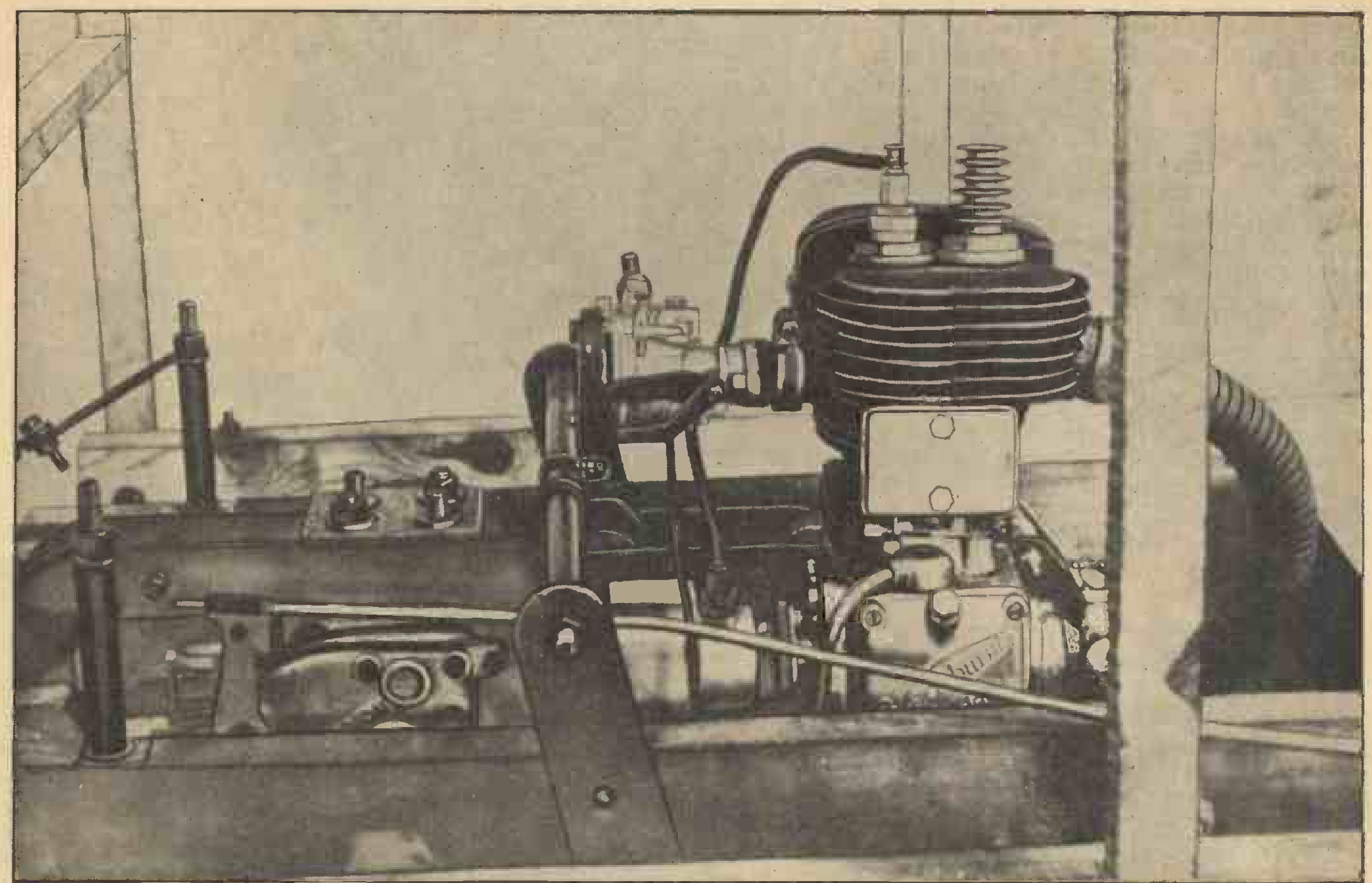
Coupling the Dynamo

Many readers have written asking





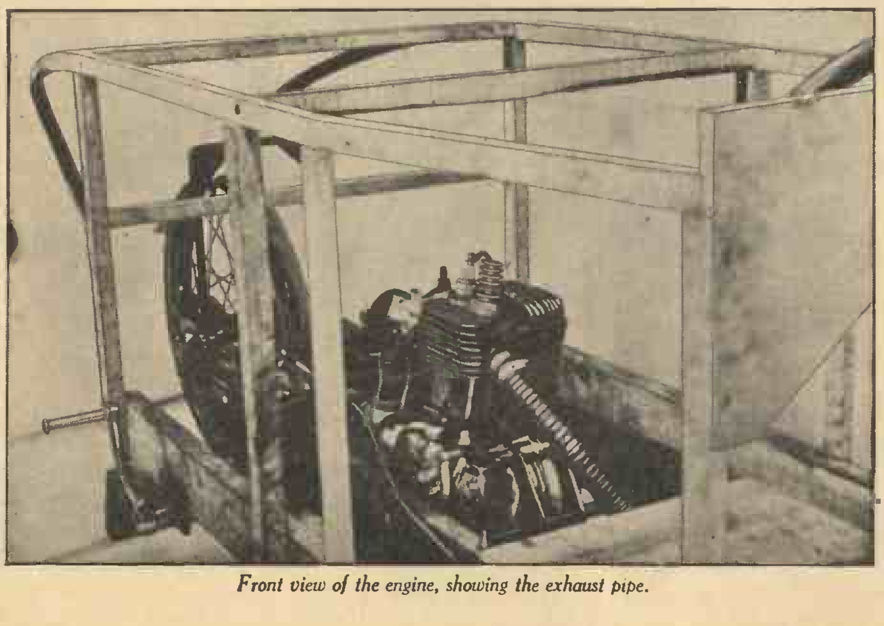
Method of securing and assembling the body framework.



Side view of the engine and gear-box section.

how they can couple a dynamo to the engine. I had not originally planned for this, for the price limit of £20 does not leave an adequate margin. If you are able to purchase a dynamo complete with cut-out fairly cheaply, this may be driven in the same way as on a motor-cycle—either by means of a jockey sprocket fixed to the end of the dynamo shaft or by means of a separate drive from the gearbox. A simpler method is to use a combined magneto and generator such as those supplied by Messrs. B.T.H., Ltd., and Joseph Lucas, Ltd. The M.L. Maglita is also ideally suited to the purposes of this small car. I have made no provision for a head-lamp. If you desire to fit one this should be fitted in the centre of the radiator immediately above the horn. A single head-lamp should be quite adequate. The switch for the lamps will be fixed to the dash, and may consist of any switch capable of carrying a current of at least 8 amperes. An ordinary wireless type of switch is not suitable. The advance and retard lever can be fixed on the off-side of the driver's seat, and the lead from the magneto to the sparking plug can be earthed by means of a simple on/off switch which in the "off" position will earth the lead. It will be appreciated that for foot-control the carburettor must be set to a "tick-over" position, so that when the accelerator pedal is in the "off" position the engine idles

This is contrary to usual motor-cycle practice where the throttle in the "off" position, will shut off the engine. The on/off switch, therefore, is a necessity with this car.



Front view of the engine, showing the exhaust pipe.

The Carburettor

If you are using a motor-cycle type of carburettor the air control should be converted into a choke by means of a suitable Bowden cable with a control knob fixed in the dashboard. This will provide a rich mixture for starting purposes, but for normal running should be in the "fully open" position. The Zenith Carburettor Company supply an adaptor and specially cheap carburettor suitable for pedal control.

I presume that you will have purchased the engine complete with magneto, and it will be correctly timed.

The HINDENBURG'S TRANS-ATLANTIC FLIGHT

By Our Special Correspondent

On the First Trans-Oceanic Flight of the New Giant Zeppelin Airship, L.Z.129, "Hindenburg," our special correspondent Telegraphed by Wireless his Daily Log on Board the Vessel while Crossing the Atlantic

THE day had broken when the *Hindenburg* started on her first Atlantic crossing. We rose easily from the aerodrome at Friedrichshafen and soon after passing Cologne, we reached Holland and made for Tilburg and Rotterdam. Here we encounted fog, and for about an hour we could not see the face of the earth. In the Channel the echo-sounder shrieked raucously.

After lunch we entered the smoking saloon which can be entered at any time, but left only by the special permission of the Steward, who sailed ten years on the *Resolute*. It is his personal responsibility that no one leaves the smoking room with a burning cigar or cigarette. An electric lighter is at hand. Matches and other lighters are prohibited on board the *Hindenburg*.

Oblivious to the Elements

As darkness overtook us the lights were suddenly switched on. Over the much feared Bay of Biscay we were met by rain swirls and the head wind whistled in the fuselage. The searchlight sprang into life and by its aid we could see the restless waves below. But in the bright and friendly decorated lounge, we were oblivious to any threatenings from air or water. From time to time, however, we were made aware of outside turmoil by the thin shrieking of steamship sirens as we passed over battling vessels. The wind rose to an alarming degree and around us a storm raged, yet *Hindenburg* forged ahead without deflection from the true course, nor did she pitch or roll. Indeed, she seemed oblivious to the anger of the elements, yet in the searchlight's path we sometimes caught glimpses of sea vessels being tossed about like corks and smothered time and again in a welter of green water and foam.

Showing the shock-absorbing undercarriage of the airship.

The Sleeping Cabins

These are very much like a first-class sleeping compartment on a Continental express, with soft and wide beds. There is a dressing-table and washing bowl, with hot and cold water, all made of a celluloid like substance. The " bell " which brings the steward when pressed, does not ring, but flashes on a signal light.

Morning brought a surprise ! The searchlights during the night had picked up a powerful vessel in its beam. L.Z.129 signalled by lamp semaphore asking who this great vessel might be, and received in reply, *Rodney*. She was a British warship and before we left her behind she sent us good wishes for our journey.

Things went normally until the afternoon when I was invited by Captain Pruss to visit the " bridge," that is the navigator's gondola. Looking out from here we noticed many a ship changed her course in order to get a view of the *Hindenburg* from a better angle. In the forepart of this gondola stood an officer carefully searching the horizon through powerful field glasses. Behind him stood the wheelsman with his eyes on the compass finger, his movements controlling the ventricle rudders. At the back, another man handled the horizontal rudders and near to him was the instrument board by which the water ballast is regulated, and drawn off from various tanks. On the back wall of the gondola is a second ballast board controlled by a single wheel so that in cases of emergency, rapid action can be taken.

Cruising Speed

Another instrument demonstrated to me was the deflection meter which consists of a telescope directed downwards on to the millimeter face. With this any sideway deflection of the vessel is immediately perceived. Still another, and for the layman, most remarkable piece of apparatus shows, when dialled, the velocity of rotations of the various engines, and at the same time actual cruising speed.

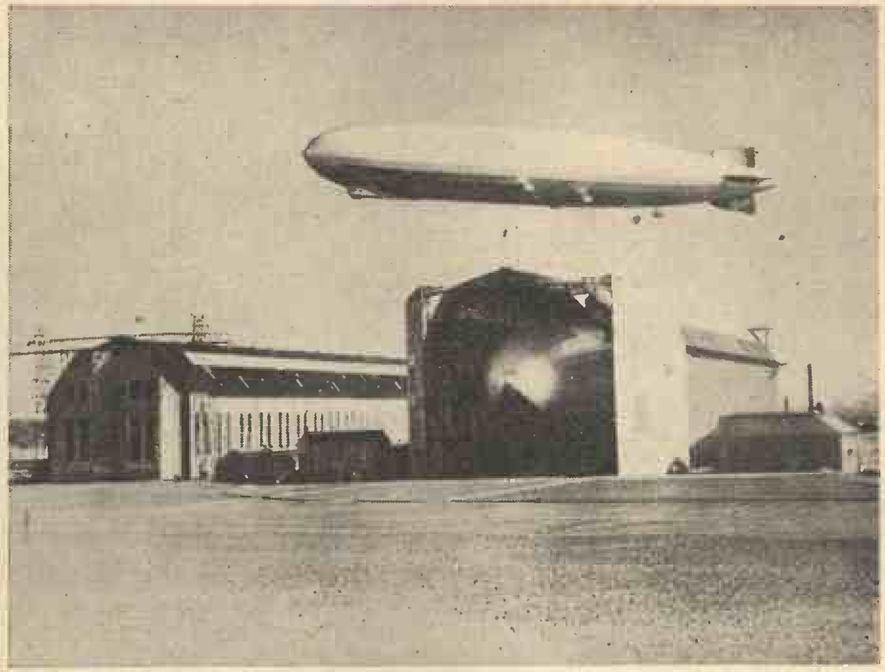
At nine o'clock the Canary Islands came in sight—long tongues of land; starred with coloured lights. Soon Las Palmas lay behind us glimmering in the clear night—and this was the last impressionable sight we had of land before we passed on into the dark heart of the South Atlantic night.

The next morning I awoke in tropical heat. The sun shone brilliantly through the windows and as one looked down on to the waters below, it appeared as if one could see right into the depths and observe the strange creatures living there.

We flew at a height of about nine hundred feet above the water's surface, and, leaning out of the windows, a warm stream of air caressed our faces.

At half-past ten we passed Porto Praia in the Cape Verde Islands. The vista was overwhelming, the colouring magnificent seen from above.

The ship's Commander, I learned, was hoping for some rain, as we had lost quite a lot of ballast and were accordingly rising too much, for if we came to a region of considerably lower pressure we would lose gas. Therefore rain was desired in order to fill the ballast tanks. On the upper part of the airship's structure there is a special channel of about 650 ft. long in which is collected the rain which falls on the envelope, and by which it drains into the ballast tanks.



The "Graf Zeppelin" flying over the hangar containing the "Hindenburg."

As if it is realised that Trans-Oceanic Air Flight will in future appeal as much for its comfort as for its speed, everything on board the *Hindenburg* is planned and executed to this end.

The maximum of comfort is provided for passengers in the limited space available and as an example of thoroughness I would cite the fact that from the writing-room there is a pneumatic post which delivers letters to the central delivery bureau, and so passengers have their letters posted without bother by sending them direct from their desks without further worry.

All the quarters are electrically heated, and as is essential where weight is a consideration, even the windows are of a specially invented material called "Flexiglass," and the walls are lined with a special light and durable cloth called "Zeppelin cloth."

The only exception is in the smoking room. Considerations of safety from fire are here the important factors and so the walls are lined with leather and the floor consists of wood chemically impregnated and made fireproof.

During the voyage across the Southern

The "Hindenburg" photographed over Lake Constance.

Showing the tail of the "Hindenburg" as it enters the hangar.

Atlantic the *Hindenburg* behaved remarkably well. As we were travelling along towards South America we were caught in a very severe storm which tested the airship very considerably. There was a turmoil of cloud and wind, but with engines speeded up, the *Hindenburg* rose easily and never for a moment deviated from her true course.

Then came the morning when the whisper that we were approaching the New World passed round, and in the early light, the passengers crowded to the windows with telescopes and field glasses. Soon a definite line became visible in the distance which grew bolder as we advanced rapidly. The airship dipped as if bowing to the Western Continent and, running smoothly, we passed over the coast, and over Recife with its white churches and cloisters, to the Pernambuco Aerodrome which *Hindenburg* passed round twice and from the navigation gondola dropped a heavy sack of mail. Recife behind us, we began the journey down the coast to Rio. At 10 a.m. the beautiful town of Maceio came into view on the banks of the San Francisco river.

Rio—the end of our outward journey! I was glad instinct had awakened me in time to get the first glimpse. In the pearl morning light we glided over the still dormant city.

We could see police galloping up as many brown figures dashed towards the landing place. We were manœuvring to land. Gently we dipped to earth and as the gondola glided just over the ground Dr. Eckener's son and Capt. Lehmann sprang out to direct the landing crew, who were already hauling on the hawsers which they made fast to winches.

The Return Flight

A brilliant sun spread over the Atlantic as the *Hindenburg* nosed her way out to sea on her return journey. Crossing the Brazilian coast the heat rose to tropical pitch and despite the well-arranged ventilation, the lack of suitable air-streams resulted in stifling cabins. Captain Lehmann explained to me that through air draught is one of the problems of air travel yet to be solved. The streams of air come from different angles, and only through experience and experiment can the right position for the ventilators in the interior of the ship be discovered.

Next morning after breakfast we passed over the stony desert island of Fernando de Noronha, with its terrible prison and wireless station, and towards noon, we crossed the equator once more.

This afternoon our good ship tried her hand at hunting—after clouds. The officers in the navigation gondola sought the horizon for rain and at last a mountainous bank of cloud showed up in the distance. Course was altered to come up with this bank and the water channels on the envelope were opened to collect the rain for the ballast tanks in order to make up for the loss of weight through the burning up of the oil fuel. The weather continued very hot and we were jubilant when in the evening the captain decided to rise five thousand feet into cooler air.

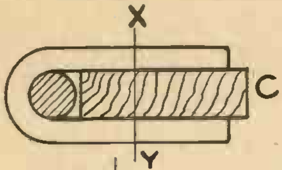
This journey we were to avoid the Canary Islands and run direct for the African coast. Along the African coast a southerly wind was blowing and this would be advantageous. Nevertheless, before we got there the wind had turned into the Eastern quarter. Actually it was four o'clock when we came up to the African coast. I turned out the lights in the observation promenade and looked out. What a sight! The West Sahara which we quickly approached, glowed a metallic yellow in the moonshine and from the plain twinkled reflections as from thousands of diamonds.

The searchlights sought out each yard of the waste and then the head of the airship dipped and we went down to find a more favourable wind. This brought us to within seven hundred feet of the ground surface and we sped along past negro villages where occasionally a figure waved or gesticulated into the silence of the great desert. A remarkable vision appeared ahead—what seemed to be a long avenue of trees. Trees in the middle of the desert. As we came nearer, the avenue turned out to be a long drawn out camel caravan.

We descended still lower and our searchlights began to pick up patches of marsh land, and clumps of bushes from which, now and again, some frightened animal dashed out. A huge shimmering mirror reflecting back the ship's lights resolved itself into (*Continued on page* 546)

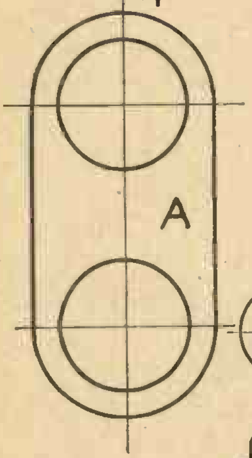
The Strand at Rio de Janeiro—the end of the outward journey.

A view of the passengers lounge inside the airship.



Making Clips, Levers, and Cranks

USEFUL HINTS FOR THE HANDYMAN



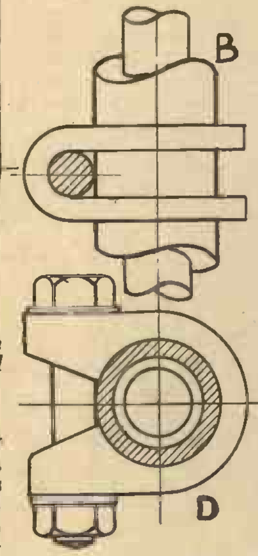


Fig. 1.—How tubes can be held by a strip-steel clip.

IN rigging up any kind of machine, levers and cranks are generally necessary. Forgings are expensive to buy and difficult to obtain, and cannot be made without a forge powerful enough to heat for welding.

By means of rectangular section steel, bar levers and cranks can be made easily, quickly, and cheaply, with an ordinary blow pipe or blow lamp or an open fire, if the procedure here described is followed. The method is also possible in the making of clips or bands, for holding adjustable telescopic tubes in position after adjustment.

Fig. 1 shows how two tubes, one telescoping into the other, can be held by a strip steel clip, which will hold with great security and much more firmly than will a simple bent round clip. It is made of flat steel to the shape shown at *A*, the holes being of the size to take the tube and the distance between them such that, when the ends are bent over to lie parallel with each other, there is space between the bends and the tube to take a securing bolt. This is shown at *B*.

Methods of Drilling

The holes may be drilled first or the clip may be bent round a piece of rod of the diameter of the intended bolt, and the holes drilled afterwards at one drilling, a piece of hard wood being laid between the ends to keep them parallel while drilling the main holes as shown at *C*, the line *XY* indicating the centre line of the holes to be drilled.

Then the end is slotted at an angle, as shown at *D*. When the bolt and nut (with a washer under the head and the nut) is tightened up, the clip will hold with enormous strength, and will not bend as will simple bent clips since the pull is in the direction of the width of the clip, not its thickness.

This method is applicable to levers as shown in Fig. 2, where *A* is a side and *B* a front view. Here the lever is made of a piece of flat bar steel, bent round (as was the clip), drilled through to take the shaft or spindle and slotted as shown and with a keyway which will prevent the lever slipping round out of its correct position, should the pull be great enough to overcome the friction set up by the split end and the bolt and nut. The keyway should be in the lever part and not in the bent-over part, since a keyway there would materially weaken the joint.

Making a Bossed Lever

Where a square projection of the bend below the shaft is for any reason an obstruction, and a bossed lever of the ordinary type would be more suitable, a method of making a boss all in one piece with the lever is shown in Fig. 3, where *A* is a side view and *B* an end view. Here the bar is bent (red hot) over on itself in three bends and, while at full red heat, is hammered down flat with a heavy hammer.

The hole for the shaft should not be drilled nearer the end of the boss than shown, so as to leave room for the keyway. This is shown in the end view, *B*, and the position of the key in the side view, *A*. When brazed, and the hole for the shaft drilled, the end of the boss can be rounded by filing to the shape shown at *B*.

For light levers, a simple fixing is shown in Fig. 4. Here the lever, made of rectangular metal bar, is simply bent round the shaft and a hole drilled through it to take the clamping bolt and nut *A*. It is an advantage, if the lever does not need to have means of angular adjustment on the shaft or spindle, to let the bolt *A* be recessed in a groove of its own radius in the shaft or spindle. This, when the bolt is tightened, will prevent the lever turning on the shaft or spindle or rod *B*.

The lever itself is given a quarter bend at *C* so that it comes with its edge in the direction of the pull. This also simplifies the fitting of a knuckle joint as shown at *D*. A suitable form of hand grip for the end of a big lever is shown in Fig. 5. The end of the lever is shaped as at *A* and, on each side, are riveted pieces of hard wood.

This method of construction can also be used for cranks and cranked handles. The crank shown in Fig. 6 is self-explanatory as is the small crank handle in Fig. 7. In this, the lever part is bent round on itself to form a thickened part for the riveting in of the handle as shown.

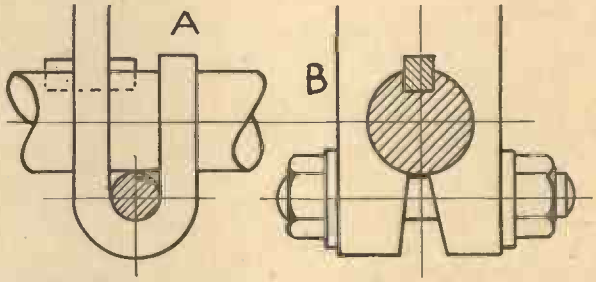


Fig. 2.—A front and side view of a lever clip.

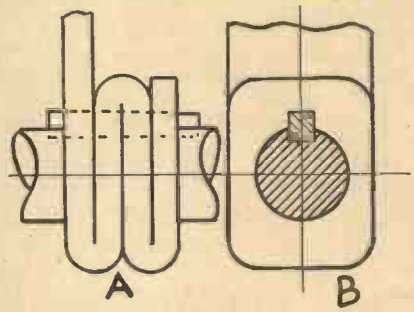


Fig. 3.—Making a boss all in one piece with a lever.

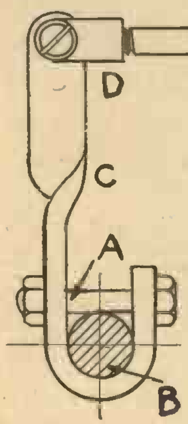


Fig. 4.—A simple fixing for light levers.

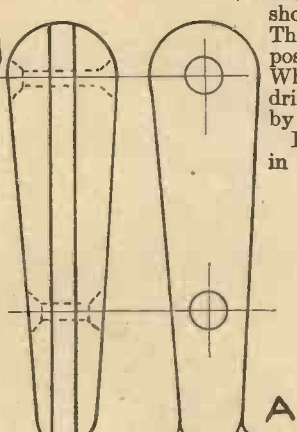


Fig. 5.—A suitable form of handgrip for a big lever.

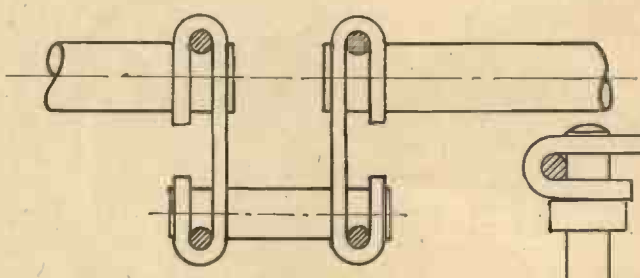


Fig. 6.—Details of an efficient crank.

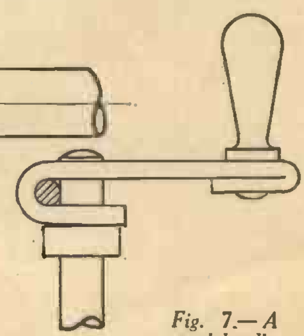
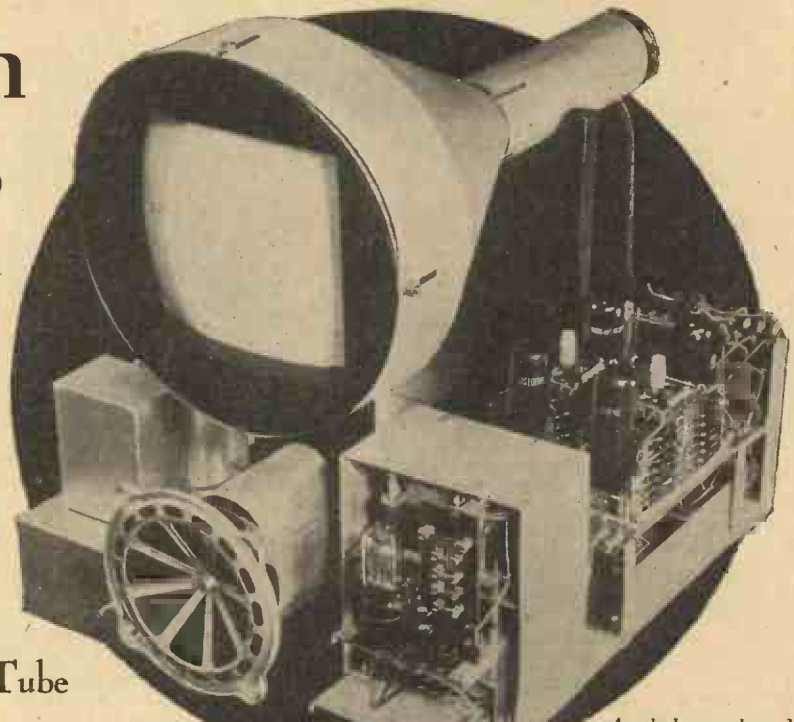


Fig. 7.—A crank handle.

Electrons and their Relation to Optics

By H. J. Barton Chapple, B.Sc.

Scientific Development in One Sphere is Always Acting as a Stimulant to Work in Other Fields which may or may not be Intimately Related with the Original Activities. This is Particularly the case with Television, and can be Traced very Largely to the Cathode-ray Tube



A cathode-ray tube used for portraying pictures in a television receiver.

UNTIL quite recently, the cathode-ray tube was looked upon as a piece of highly scientific apparatus whose uses were confined to measurements and the visual portrayal of electrical phenomena. This has all been altered now that these tubes are proving so consistently satisfactory for portraying the pictures which have to be reproduced in television receivers.

In consequence, it has become essential to very accurately govern the movement and modulation of the beam of electrons which trace out the picture in a series of successive or alternate lines on the fluorescent screen. Anything which stimulates the human eye must be made responsive to optical requirements, and it is surprising to find how readily the electrons are focused so that the image seen is as sharp as one which has been produced by any normal optical lens system. Electron optics is, strictly speaking, a highly scientific and mathematical subject, but the laws which have been established have been reduced to relative simplicity as far as operation is concerned. An entirely new application of electron optics has become manifest in what is popularly termed the electron telescope, a device first shown in a practical form by Zworykin in America, at the beginning of this year.

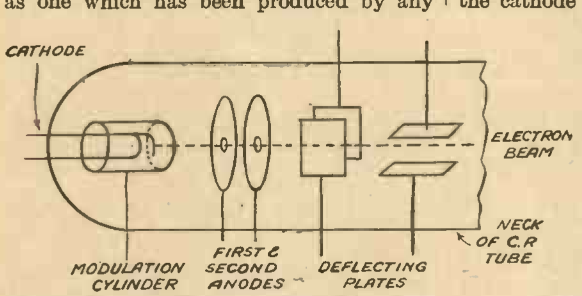


Fig. 1.—The required beam focusing is undertaken by the perforated anodes to which position potentials are applied and varied as required.

With Television

Before dealing with this device, however, it is useful to see how electron optics applies in the modern form of cathode-ray tube used for television. With gas-filled tubes, the gas ionisation plays an important part in focusing the electron beam, but with the highly evacuated hard tubes now used, the beam is subjected to a treatment which resembles the focusing of light by means of lenses. This is carried out in the case of electrostatically operated tubes by a special design of the electrode system located in the neck of the tube. This is shown simply in Fig. 1 where first of all is the cathode whose sole purpose is to emit electrons from its active surface as the result of a passage of direct current through the filament.

The control, or Wehnelt cylinder, regulates or varies the number of electrons in the beam which reach the screen in exact accordance with the applied television signal fed from the radio receiver. Thus the brightness of the spot is varied, but it is essential that the size of the spot must remain constant. The first anode or gun has a very high potential applied to it in order to accelerate the electrons from the cathode towards its surface, and shoot them (hence the term "gun") through the small orifice located in the centre of the anode.

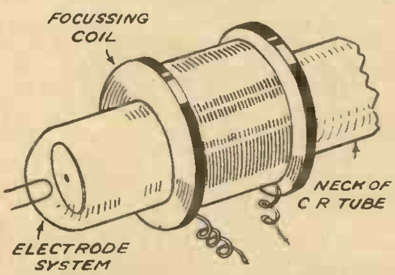


Fig. 2.—With cathode-ray tubes operated on electromagnetic principles, the focusing is undertaken by passing a direct current through a solenoid coil.

Control

If the resultant beam of electrons was now left to its own devices, however, the picture would be of a "fluffy" or misfocused character, so just as a beam of light is passed through a compound optical lens system in order to bring it to a sharp bright spot on a screen interposed in the path of the light, so a system of anodes or plates are made to perform a similar function with the electron beam. One or more additional anodes are positioned inside the neck of the tube as shown in Fig. 1, and owing to their geometric location with reference to the first anode, and their interrelated applied positive voltages, it is possible to obtain any degree of focus that may be required.

Instead of mechanically repositioning or adjusting the lenses, as would be the case with light optics, the magnitude of the voltages are altered, and the resultant electrostatic fields of force so produced inside the tube neck bring about a sharply focused spot of light, which is then made to trace out the required rectangular area on the screen by means of time bases connected to the vertical and horizontal deflecting plates. When worked in this way, the modulation cylinder is relieved of any focusing properties as was the case in the earlier types of tubes, and is concerned solely with governing the brightness of the spot, a function which it fulfills with quite a small range of applied signal voltage.

Another Method

In scientific circles this focusing of the electron beam is referred to quite frequently as fasiculation, which interpreted, literally means a "bundling together" of the electron rays. When we come to the case of electronic devices operated by electromagnetic means as distinct from electrostatic methods, the same requirements of focusing hold good, but it is effected in a different manner. The beam of electrons after passing through the hole in the gun or high-potential anode, now comes under the influence of a magnetic field produced externally. This is done by surrounding the neck with a solenoidal coil wound on a former and passing a direct current through the coil (see Fig. 2). The ampere turns producing the field are under the control of the operator of the tube, by the simple expedient of varying the current through the coil via a resistance. In this way magnetic focusing is achieved, and the degree of focus obtained in this simple manner is very efficient, and just as effective as the electron lens plate method just described.

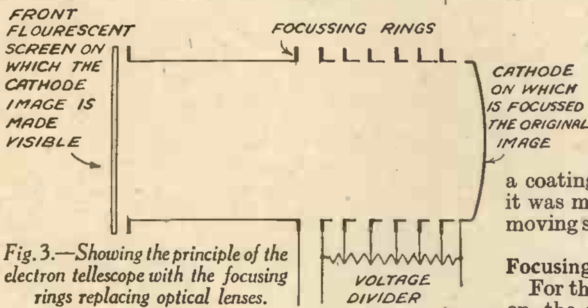


Fig. 3.—Showing the principle of the electron tellescope with the focusing rings replacing optical lenses.

An Electron Telescope

Coming now to the electron telescope, this device has several very important applications particularly in connection with its ability to translate infra-red or invisible light into visible light. Electron optics investigation has shown the very close relationship to light lenses. For example, glass lenses have spherical surfaces and the electron fields used for electron optics are made to have a spherical character to produce similar focusing results. It is now possible to produce electron microscopes or electron telescopes which are capable of carrying out work not within the scope of their prototypes using glass lenses.

The electron telescope itself is essentially an evacuated glass tube, which, in the case of the Zworykin device, had a semi-transparent photo-electric cathode located at one end. On this could be focused by exterior lenses the optical image to be examined. The light image on the photo-electric cathode produced an electron image whose electron density over the whole activated area was exactly proportional to the degree of light and shade existing in the original focused image. This resultant electron image was then drawn forward as a stream towards the far end of the tube which had a coating of fluorescent material where it was made visible as a stationary or moving scene in replica of the original.

Focusing Rings

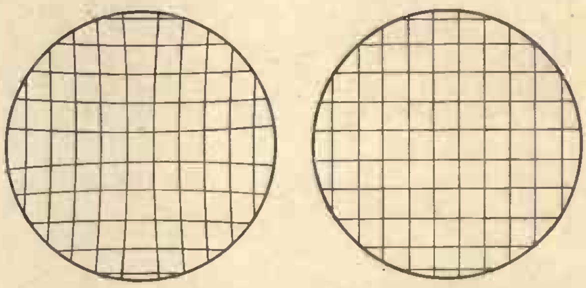
For the purpose of focusing the image on the fluorescent screen, a series of focusing anodes or rings are incorporated inside the tube (see Fig. 3), together with a cylinder, and by adjusting the relative positive potentials between these electron lenses, the degree of magnification and focus of the picture observed on the fluorescent screen can be controlled within the available limits of the equipment. It is possible to make the photo-electric surface of the cathode sensitive to ordinary, infra-red or ultra-violet light.

In the case of the last two, therefore, scenes or objects which are invisible to the naked eye are converted to visible form by the device. This is particularly important when a scene obscured by haze, smoke or fog has to be examined, for the apparent blankness is revealed as a naturally lit scene when observed at the screen end of the tube. Again, with certain micro-organisms the present methods of adding stain or making observations under intense light frequently kill the germs, whereas no harm will occur with infra-red lighting, and the investigations whether medical or biological can be carried on quite successfully.

Curing Distortion

As is the case with ordinary optics, definite sized electron apertures can be inserted inside the tube and the degree of magnification varied by altering the applied positive potential with reference to the electrical lenses placed on either side of the aperture. When using a plain flat cathode, if a relatively large area is covered by the original optical image, then spherical aberration will occur in the picture seen on the fluorescent screen. This is sometimes referred to as a pincushion effect, and with a plain rectangular check pattern the result would resemble that shown in Fig. 4. It is brought about by the changing curvature of the focusing field with respect to the distance from the original cathode.

This can be cured electrically by changing the nature of the focusing fields, but a much simpler solution has been found in geometrically changing the nature of the cathode surface. This is shown in Fig. 3, and really amounts to using a cathode with a spherically shaped surface, being concave towards the observed image. When this is done the pincushion distortion is eliminated and the original rectangular check pattern of Fig. 4 becomes corrected as in Fig. 5. If it is not desired to use a semi-transparent cathode then it is quite an easy matter to optically focus the image on to an opaque cathode from the side, and the method employed in practice is settled largely according to special requirements.



Figs. 4 and 5.—(Left) The spherical aberration distortion occurring when the cathode is flat. (Right) Curing the distortion by using a concave cathode.

In any case, this latest development in the sphere of electron optics is one which has the most important of applications as it presents a solution to many problems which have hitherto baffled the experts. Availability in commercial form is only a matter of time and it is useful to note that the device consumes very little current, being voltage operated with the necessary supplies derived from standard alternating current mains.

TELEVISION IN AMERICA

In some quarters, a recent television experiment carried out by the Radio Corporation of America in Camden, New Jersey, is regarded as an augury of what might be expected when television services are as commonplace as aural broadcasts are to-day. Using the Iconoscope in conjunction with a telescopic lens, a specially staged fire was scanned from a building situated about thirty to forty yards from the scene of the outbreak. The generated signals were then fed as a modulation to an ultra-short wave radio transmitter and the radiated waves received over a mile away. Here a television receiver with a cathode-ray tube picture reproducer, converted the signals to a scene in miniature (about 7 in. x 5 in.) of the distant fire. Although only seen on this small screen, it was claimed that those watching were able to distinguish quite clearly the efforts of the firemen in subduing the flames, the smoke and water together with other details being distinguishable. At the same time, sound signals were radiated so that all the noises associated with a vivid scene of this character added to the reality of the transmission. Bearing in mind that this was an outdoor effort, the results make it abundantly clear that it will soon be possible to televise events as they happen, a development for which television is so well suited.

The experiment is part of the work now being carried out by R.C.A. engineers as promised by David Sarnoff at the last company meeting. A 10 kilowatt ultra-short wave radio transmitter is being installed at the top of the Empire State Building, in New York, where the available height is over 1,000 ft., a factor which should influence very materially the range over which the television signals can be received, assuming that they follow the more usual quasi optical path. The service is quite an experimental one and although due to begin officially at the end of June, the public will not participate in the work. Receiving sets are to be installed in chosen spots so that a number of observers can collect data relative to the transmissions. The collection and analysis of these results will then furnish material on which can be based the inauguration of a public broadcast from one or more stations in New York itself. Much of the R.C.A. work has been carried out with a picture definition of 343 lines worked at 60 frames per second, the scanning being of the interlaced variety. Definitions of a higher order are now being experimented with, but this may necessitate the use of wavelengths as low as 2 to 3 metres in order to accommodate the frequency band required. Rather bad shadow effects are likely to be encountered in this region, and considerable work will have to be undertaken before the vagaries of carrier waves, working on a frequency of one hundred million and above, can be solved.

A Petrol-driven Low-wing Monoplane with Monocoque Fuselage

We recently Published an Article Describing the Main Features of some Experiments Carried Out in Connection with Monocoque Construction for Petrol Models. Details were Given of Monocoque Fuselages for a Low-wing Model, a High-wing Model, and a Biplane. The Low-wing Model is here described.

By C. E. Bowden.

The First Article of a Short Series Dealing with the Construction of an Interesting Type of Model Aeroplane

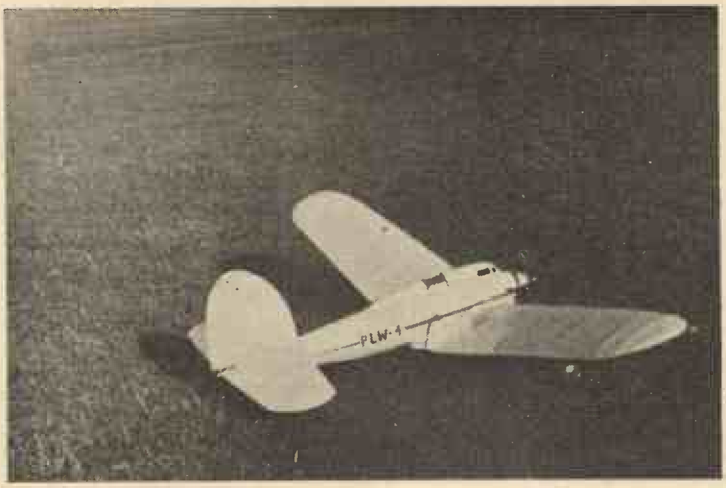


Fig. 1.—The petrol-driven low-wing model P.L.W.4.

SINCE my previous article, I have had a number of requests for more particulars of the low-wing model. Therefore, as it seems to be extremely popular, I have since carried out successful flying tests during which consistently good flights were obtained from R.O.G. take-offs.

The model proved to be very stable and in fact, is the most stable low-wing petrol model that I have so far produced.

It is suitable for a "Brown Junior" engine or a 15 c.c. engine. Actually a "Brown Junior," which is about 10 c.c., flies it rather slowly and just suits it.

Although the "Brown" engine fitted to this model is a special modified Brown in that it has been inverted, and has a float-feed carburetter, an upright Brown "Junior" engine would fit just as well. In fact, I have tried it out with a standard Brown fitted on a special Elektron mounting and there is, of course, no difference in the performance, provided the thrust line is kept in the same position.

The Low-wing Design

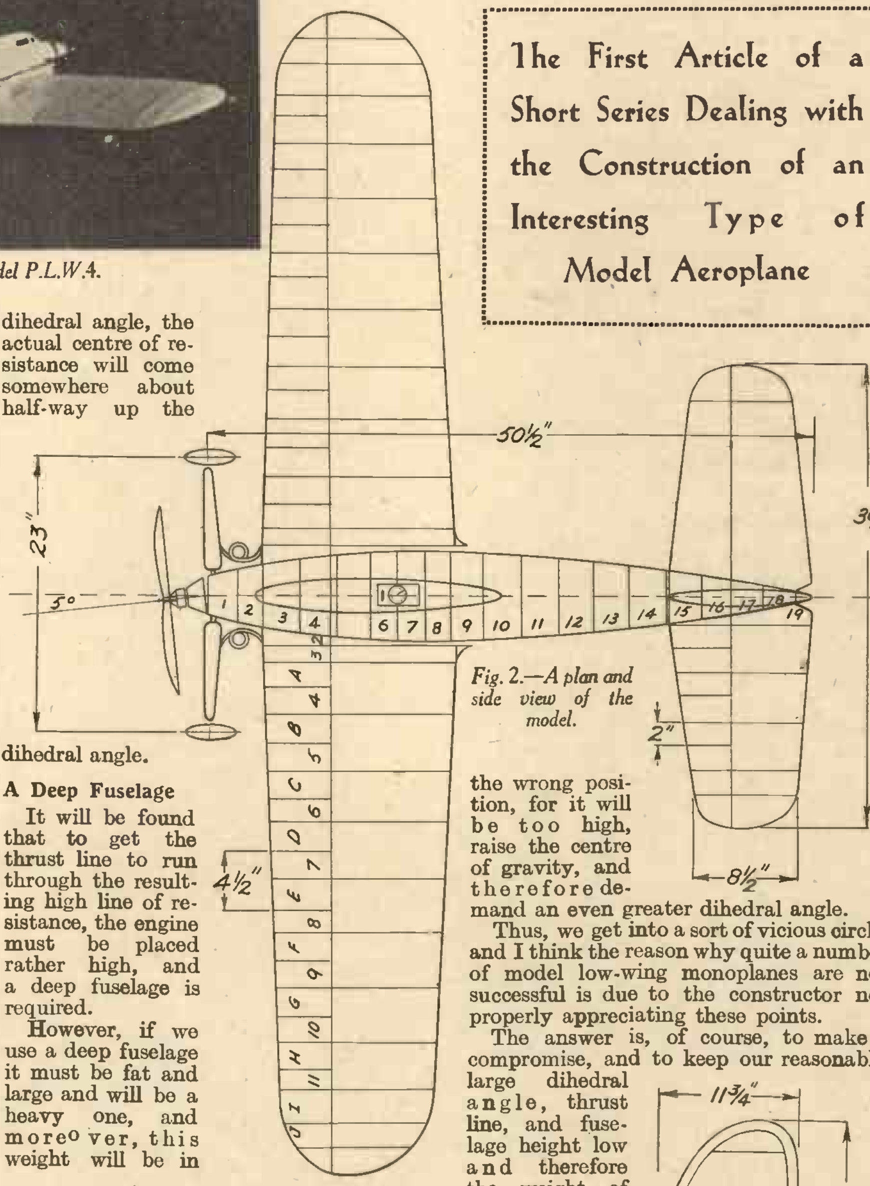
It is as well, before constructing a model, that the constructor should understand the main ideas behind the design. In this way the whole model will be built and operated with more success.

It will be appreciated that a low-wing design for a large model is rather a difficult problem in connection with lateral stability, chiefly owing to the fact that it is more difficult to obtain a low centre of gravity position in relation to the side area that should be shown *above* the C.G. in order to exert a righting effect in a side slip.

This side area is usually obtained by the dihedral angle as regards the forward end of the model, and the fin operates the rear. Of course, the fuselage side areas have to be taken into consideration as well, but these areas are of minor consideration compared to the dihedral angle and the fin.

Therefore, in the design of a stable low-wing model areoplane, we must arrange our weight as low down as possible, and give a greater dihedral angle than normal.

The thrust line of the engine should pass through the centre of resistance of the main plane, but now that we have a large dihedral angle, the actual centre of resistance will come somewhere about half-way up the dihedral angle.



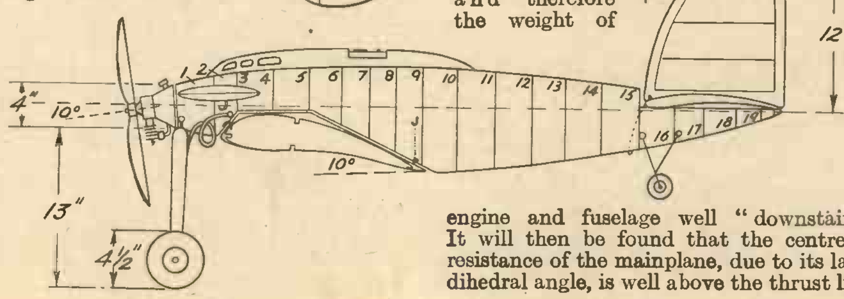


Fig. 2.—A plan and side view of the model.

A Deep Fuselage

It will be found that to get the thrust line to run through the resulting high line of resistance, the engine must be placed rather high, and a deep fuselage is required.

However, if we use a deep fuselage it must be fat and large and will be a heavy one, and moreover, this weight will be in the wrong position, for it will be too high, raise the centre of gravity, and therefore demand an even greater dihedral angle.

Thus, we get into a sort of vicious circle, and I think the reason why quite a number of model low-wing monoplanes are not successful is due to the constructor not properly appreciating these points.

The answer is, of course, to make a compromise, and to keep our reasonably large dihedral angle, thrust line, and fuselage height low and therefore the weight of engine and fuselage well "downstairs." It will then be found that the centre of resistance of the mainplane, due to its large dihedral angle, is well above the thrust line,

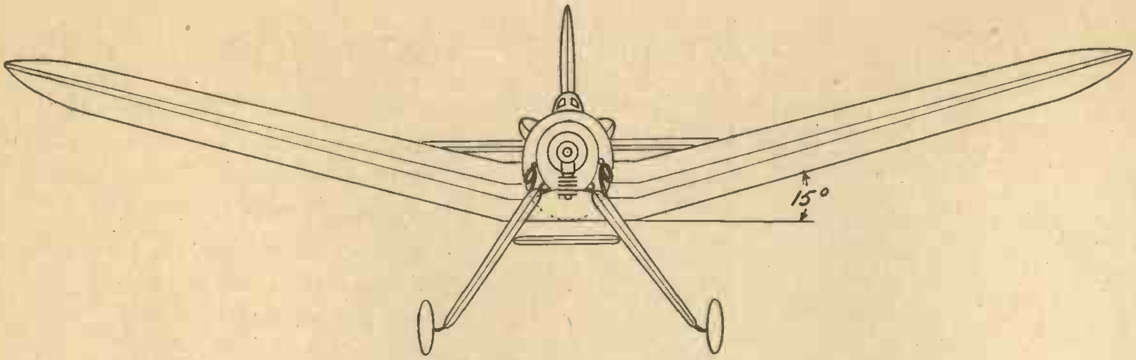


Fig. 3.—A front view of the model.

and the model, if properly lined up for good gliding, will stall when under power. Therefore we must use a certain amount of *down thrust* to counteract this tendency of the engine to pull the nose up *around* the high centre of resistance.

This thought may upset some people, but it works very well in practice, which is the important thing, and it allows us to design a low C.G. in a low-wing model which is essential, for we must have good lateral stability as we have no pilot.

Whilst talking about alteration of thrust line, it will be observed from the drawings of this model, that an offset to the thrust or a side thrust is also given by offsetting the thrust line not only slightly downwards but also to the left (looking from the pilot's cockpit at the nose).

Engine Torque

Some people like to take up engine torque by giving slightly more lift to one wing, or setting the fin or rudder over to the opposite side to which the model tends to turn as a result of the engine torque.

I am strongly against these methods of overcoming engine torque, because they work correctly whilst the model is under power, but as soon as the power ceases, the added lift on one wing or the offset fin asserts itself, and the model gets into a banked turn on the glide. This often eventually becomes a spiral nose dive and will completely upset a normal straight glide. If we are to obtain a good landing, we must at least land with both wings on an even keel, otherwise, if one wing is dropped in a banked turn, it will strike the ground first and the model will have a sickening cartwheel and crash landing.

Therefore on all my models I use side thrust to take up engine torque. If I wish the model to turn in circles on engine torque, then I only give a slight side thrust. If I require a straight flight, then I give more side thrust. But I ensure as straight a glide as possible by setting the fin straight and trying to obtain an equal lift on each plane. This method has been born of bitter experience.

Produce a Glider

How often one sees models flying at meetings that do the most extraordinary evolutions as soon as the power ceases! This means that the owner has lined up the model to fly under power only, and has not considered the matter of thrust position and direction in relation to the centre of resistance of his mainplane. He should produce a good glider in the first place and line up his model accordingly. He should then set his thrust line correctly.

Of course, we can easily design one type of model with the thrust line exactly cutting the centre of resistance, but this is dull; we want model biplanes, low wings and high wings, as well as mid wings and as we have no pilot to alter tail trim to counteract thrust, we must compromise and consider other methods.

I hope that anyone attempting the construction of the model about to be described will now understand the ideas behind its design, and if the model tends to stall, fail to climb, or turn too rapidly, he will understand how to add just a shade more to the required direction of thrust by a slight packing of balsa wood. The design of the model will look after all other matters of stability.

Every model will be found to vary slightly in its settings, but I advise the constructor to use the settings I have found correct on my model as a basis for his first experimental flights. They will be found very nearly correct provided the model has been constructed to closely follow the directions and dimensions given.

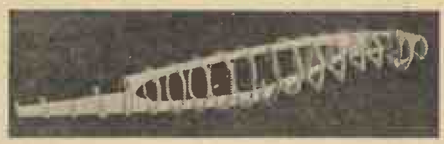


Fig. 4.—Both sides are shown completed on the backbone.

It has been found that on the original model no alterations have had to be made in regard to angles of incidence or weight distribution from the original design.

The Monocoque Fuselage

The fuselage is the most difficult component to construct. It should therefore be commenced first, and it forms a basis for all the rest of the model.

Its oval form gives it great strength in spite of the fact that the greater part is constructed of balsa wood.

The fuselage is constructed on a backbone which is an outline of the side elevation of the fuselage. This backbone is constructed of $\frac{1}{8}$-in. thick 3-ply forward and $\frac{1}{8}$-in. thick balsa wood for the remainder.

First of all, the constructor should get out a full-sized drawing of the fuselage. This can be done from the small-scale outline drawing, Fig. 2, and sufficient details are given for this purpose. After the drawing is complete with all fuselage formers drawn in full size, the paper can have carbon paper slipped under it and 3-ply or balsa sheet under that again where applicable. The shape of the backbone and the formers can then be traced on to the $\frac{1}{8}$-in. thick 3-ply or balsa sheet. The wood can then be cut to the desired shape, in the case of the 3-ply by a fretsaw or fret machine, and the balsa wood by sharp but old safety-razor blades.

Fig. 5.—The backbone upon which the whole fuselage is built up.

When all the formers and backbone are cut out the drawing is placed upon a thick board and covered with grease-proof paper and the whole kept down by drawing pins. The fuselage can then be built on the board and over the drawing so that formers, etc., are stuck into their correct places. The grease-proof paper is to prevent the glue used from sticking to the full-sized drawing.

The Backbone

Let us consider the backbone first. Fig. 5 is a photograph of the backbone with one set of side formers stuck into position. The backbone is made of $\frac{1}{8}$-in. thick 3-ply cut to the shape shown in Fig. 4. Three-ply is used both in the backbone and for the nose, as well as the nose formers, in order to obtain strength where the engine mounting stresses occur and the undercarriage strains take place. The outside edge of the backbone is the side-elevation shape of the fuselage.

On to this backbone the oval formers are stuck. The formers are made in two halves, so that the backbone can be laid flat on the board with the drawing of the fuselage. One set of half formers are then glued upright along the backbone as indicated on the drawing. A *quick-drying aero cement* should be used. This, and all other materials required, can be obtained from a model aircraft stores.

Having let one side of half formers set hard, the more difficult job of gluing on the other side occurs.

I found that the best method was to turn the backbone over and pack up the smaller half ovals with odd pieces of balsa wood, so that the backbone presented a flat surface, looking upwards. The other side half-oval formers were then easily glued into position, and kept there until dry.

Fig. 5 shows one half stuck on while Fig. 4 shows the second half in position. It will be noticed that some formers appear to be missing. These were certain 3-ply formers that had not been made at the time. The balsa formers were made and stuck on first.

Before we leave this question of oval formers perhaps I had better make a few explanatory remarks about their construction. Having obtained the full-sized outline drawing of the fuselage in side elevation, draw in the "thrust line" as shown in Fig. 2.

Now get the full-sized enlargement of the plan or top view. That is to say, the width of the fuselage at its widest points.

(To be continued.)

The Post Office Speaking

Fig. 1.—*Miss Kane, whose voice announces the correct time, to the nearest tenth of a second, to the telephone subscriber.*

Details of the Speaking Constructed by the Post Dollis Hill, to work in don Tele-

An unusual timekeeper, designed to indicate time over telephone circuits by spoken phrases, has been constructed by the Post Office Research Station, Dollis Hill, to work in conjunction with the London Telephone Service.

When in operation, it will enable a subscriber to obtain the time, to the nearest tenth of a second, by dialling "Tim." A spoken phrase, such as, "At the third stroke, it will be five-fifteen, and twenty seconds," will then be heard in the receiver, followed by three "dots," resembling those used in the Morse code, the third indicating the exact instant of the twentieth second. At each hour, minute, and tenth second, the spoken phrase changes, in order to give the correct time indication.

The mechanism of the clock consists essentially of four glass discs, bearing sound-tracks of a similar type to those used for cinematograph films, and of suitable optical scanning systems and photo-electric cells to work in conjunction with the sound-tracks. There is also a selective mechanism, which positions the scanners and cells opposite the appropriate sound tracks for the particular time to be announced.

The Announcing Mechanism

As will be seen in Fig. 2, the discs are mounted on two shafts in line, the first being directly driven by the synchronous operating motor, and the second working through a 2 to 1 reduction gearing, which can be seen between discs 2 and 3. The two discs nearest the motor revolve once per second, and each carries 30 sound tracks, the sixty-minute announcements of the hours being shared between them. The third and fourth discs revolve once in two seconds, the third giving the sections of the spoken phrases relating to the hours, and the fourth bearing the sound-tracks for the seconds.

As the discs rotate, beams of light from small filament lamps pass through suitable condensing lenses, and focus on the sound-tracks, which thus control the light variations received by the photo-electric cells located on the opposite sides of the discs. The varying current set up in the cell circuits is amplified, and supplies the circuits of the subscribers calling for the time signals. One hundred subscribers lines can be connected to the clock at any one time, this being expected to provide ample accommodation for all normal traffic.

The actual phrases heard in the receiver appear continuous, but each is really made up of the collective grouping of the sound-tracks which are opposite the light rays on the various discs, and to achieve this, careful synchronisation is necessary. Each disc has its sound-tracks arranged in a series of concentric rings, and the scanning lamps and their cells are mounted on carriers which can be moved horizontally to bring the light rays opposite any track on their individual discs.

The Carrier Movements

These are controlled by a set of cams, which are mounted in line across the instrument, immediately in front of the disc shafts and scanner carriers. Attached to each cam is a ratchet wheel, having a number of teeth equal to the steps on its cam, and pawls, operated by eccentrics, step the ratchets tooth-by-tooth.

The eccentrics are in turn rotated when required by a selective ratchet mechanism, the details of which are illustrated in Fig. 6. A shaft, driven by the main operating motor through skew gearing, runs the full width of the clock, and is mounted in front of the cams and their attached mechanism. This shaft carries three ratchet wheels at suitable points, these being keyed to the shaft and revolving with it. Normally, the shaft, shown at *A* (Fig. 6), revolves idly, the sleeves *B* remaining stationary, but when the energising of one of the release magnets *E* causes the attraction of its armature *F*, the result is to withdraw the armature tip from under the tail of the pawl *C*, and to allow the pawl to engage with the ratchet. This locks the sleeve to the shaft by way of the ratchet wheel, and the whole assembly will then make one revolution, at the completion of which the armature tip will strike the tail of the pawl and disengage it from the ratchet, which will then rotate idly until the next engagement.

The small coil spring *G*, re-sets the arma-

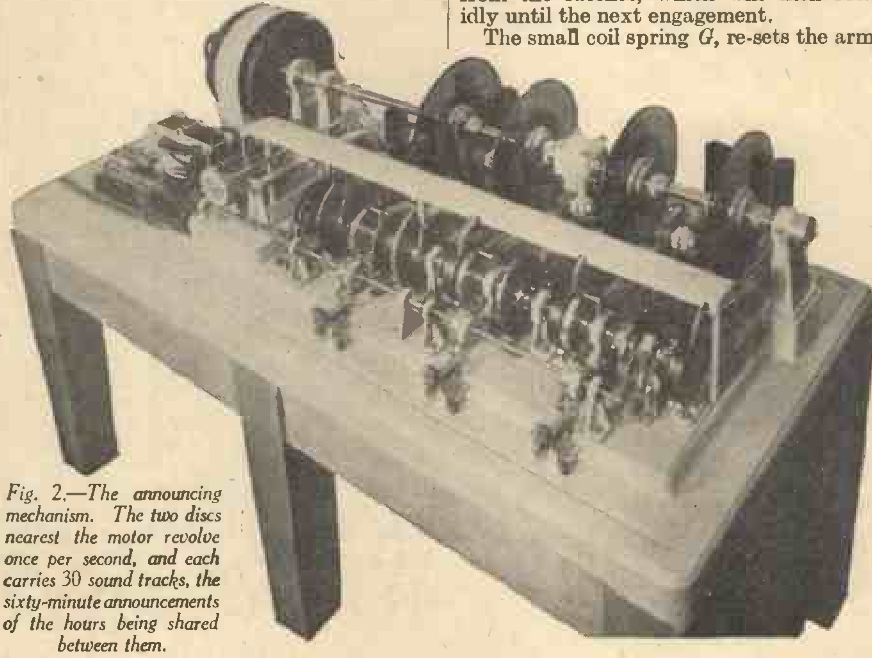


Fig. 2.—The announcing mechanism. The two discs nearest the motor revolve once per second, and each carries 30 sound tracks, the sixty-minute announcements of the hours being shared between them.

Clock

By "Home Mechanic"

Clock which has been Office Research Station, Conjunction with the Lonphone Service

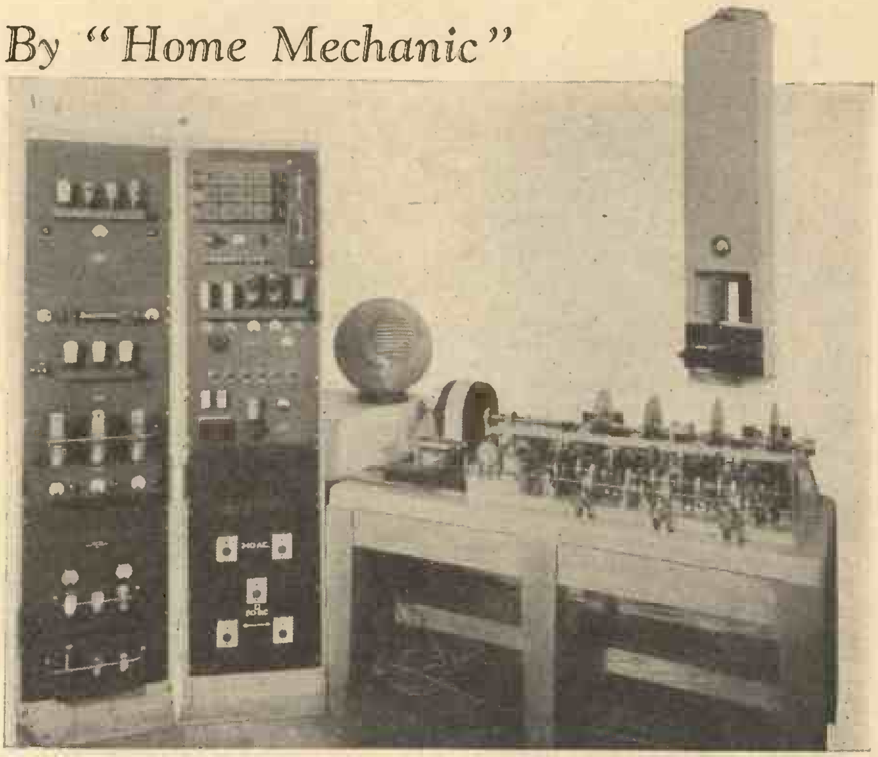


Fig. 4.—A further view of the announcing mechanism.

ture, and the spring-loaded pressure-pad H engages with a roller on the sleeve at the completion of each revolution, and holds the pawl in contact with the armature tip.

The Eccentrics and Magnets

The eccentrics which operate the stepping of the cam-ratchets have their sheaves attached to the sleeves of the release assemblies, and can thus be actuated as necessary, separate releases serving the hour, minute, and second scanners, and their controlling cams.

The energising of the magnets of the releases is controlled by a camshaft, also driven by the motor through spur gears off the first skew shaft. As this camshaft re-

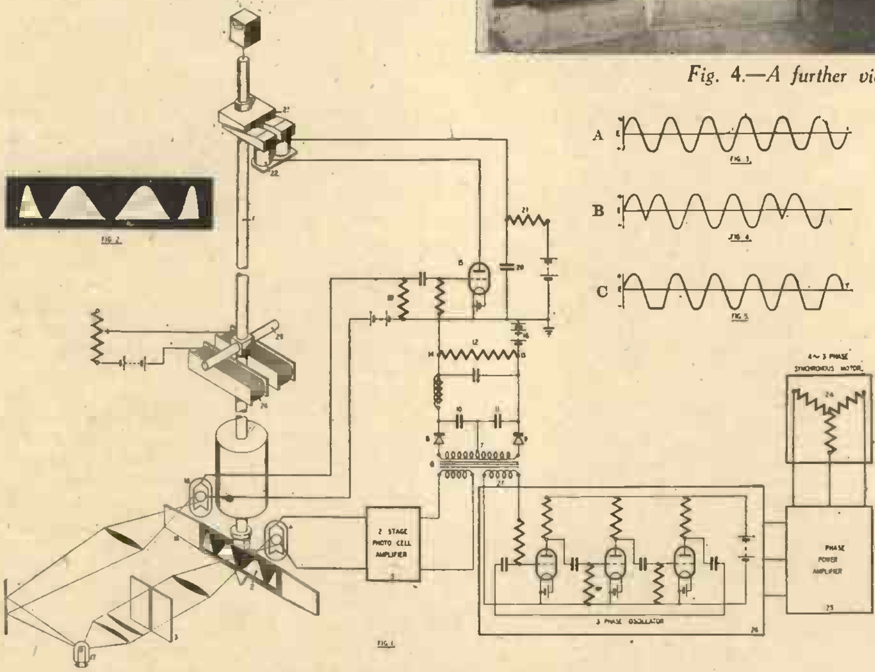


Fig. 3.—A schematic diagram of the drive for the speaking clock.

volves too rapidly to be used for the release of the hour change, additional contacts are included in the circuit, and these are only closed at the correct moment.

An interesting detail of the glass discs and the scanning mechanism is that, in order to dispense with any large horizontal movements of the carriers, the tracks do not follow each other seriatim, but are arranged in an order which permits of the cams being designed to give quite small movements in making scanning changes.

The assembly of the portions of the phrases from the various sound-tracks into a complete phrase is achieved by selective light shutters which control the illumination of the discs, and synchronise the photo-cell currents. The dots are also obtained from special sound-tracks on the records, special fixed scanners located at the rear of the clock dealing with these.

Accuracy

The accuracy of the time indications being dependent on the speed of the driving motor, special means have been devised to maintain this within close limits. The motor is a three-phase separately excited machine, and the frequency of its supply current is controlled by a master pendulum beating seconds. The circuit is illustrated in Fig. 3.

Mounted below the bob of the pendulum (1) is a photographic transparency (2) (also shown enlarged), and the shape of the transparent area on this is such that when the amplitude of the pendulum swing is correct, a beam of light passing through a slit in a mask (3) will, on passing through the transparency and falling on a photo-cell (4) beyond, vary sinusoidally with a frequency of four cycles per second. The cell current feeds a two-stage amplifier (5), and under correct conditions the output from this is a sine-wave of symmetrical form (A). If the swing is too small a wave-form similar to that shown at B will be produced, whilst if it is too great, the curve shown at C will be the result.

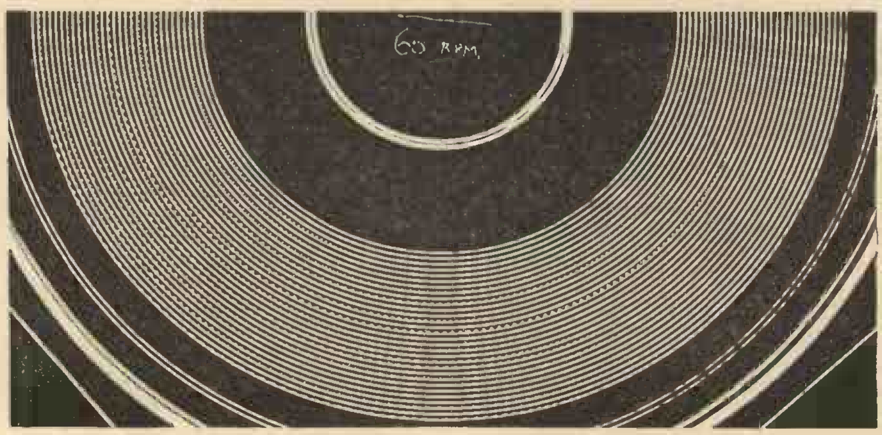


Fig. 5.—Details of the disc upon which the voice is recorded.

The Pendulum Arc

This distortion of the wave-form in incorrect conditions is used to control the impulse given to the pendulum, and to maintain its arc. The amplifier output is applied to a transformer (6), one secondary winding of which is provided with a centre tapping. By means of two rectifiers (8 and 9), and two condensers (10 and 11), the difference of potential between the positive and negative half-cycles of current is applied to the resistance (12). When the pendulum swing is correct the wave-form is symmetrical, and the charges of the condensers are equal. There is then no difference of potential between the points (13) and (14), and the potential of (14) relative to the earth line, or effective bias applied to the grid of the gas-filled relay (15) is only that due to the battery (16).

As the arc of the pendulum decreases, the wave-form becomes unsymmetrical, and the charges in the condensers are rendered unequal, with the result that the effective negative bias on the gas-filled relay is reduced.

Controlling the Pendulum Impulses

This difference of bias controls the application of impulse to the pendulum in an ingenious manner. At the mid-point of each left-to-right swing of the pendulum a shutter (16) permits a narrow beam of light directed by mirrors and lenses from the lamp (17) to fall on a photo-cell (18), and an increase then occurs in the photo-electric current flowing through the resistance (19). This causes a momentary rise of potential on the grid of the gas-filled relay (15), but when the pendulum arc is correct, this is insufficient to make the relay conducting. When the arc falls below a predetermined point the reduction in the effective steady bias produced by the potential difference across the resistance (12) is sufficient to render the relay conducting at the instant of application of the impulse from the photo-cell. The condenser (20), which is charged through a high resistance (21), then discharges through the windings of the magnet (22), causing the latter to attract the armature (23) on the pendulum rod and give an impulse to the pendulum which restores its normal arc.

The pendulum-controlled alternating current is employed to control the motor current through a small additional secondary winding (27) of the transformer (6). Current obtained from this secondary is applied to the grid of one of the valves of a three-phase oscillator (26) and the frequency of the output is maintained at 4 cycles per second. The output of the three-phase oscillator is passed to a three-phase power amplifier (25), which in turn supplies the motor. The operating power required by the motor is about 30 watts, and the motor is an eight-pole machine. The system adopted gives control of both the pendulum arc and the motor speed within very accurate limits, and excellent time-keeping is assured.

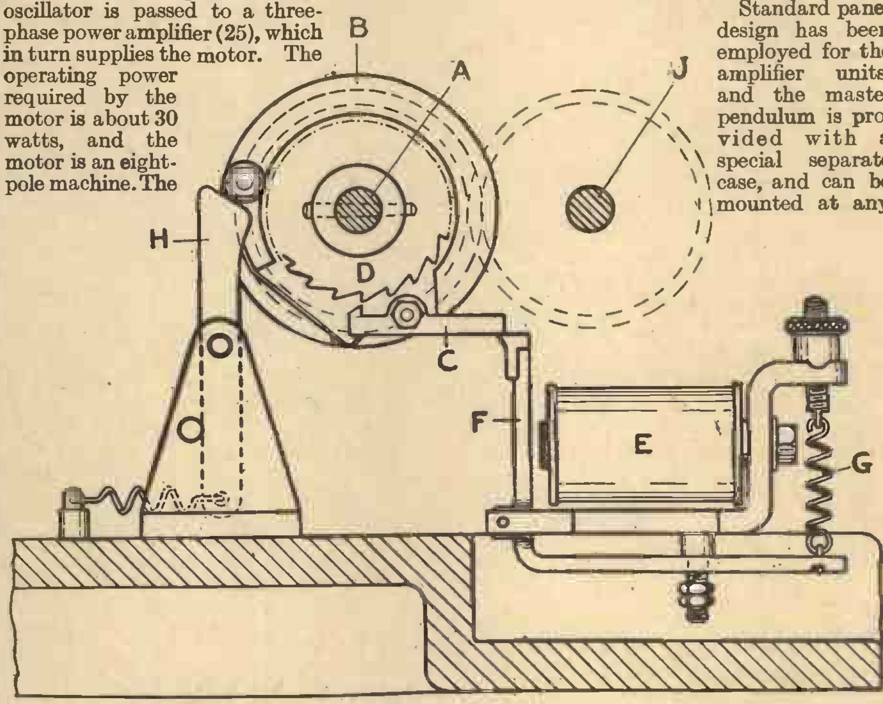


Fig. 6.—The circuit of the speaking clock. Details of the selective ratchet mechanism for driving the eccentrics.

Greenwich Time

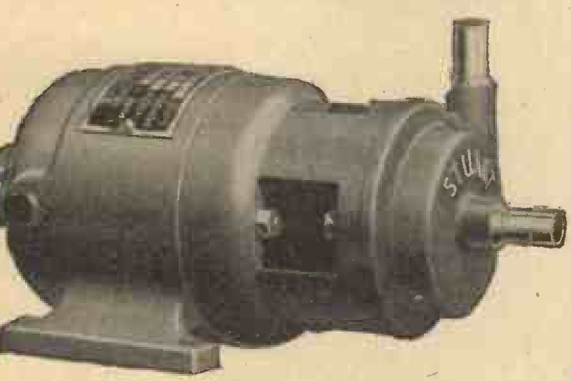
The clock is checked hourly against a time signal from Greenwich Observatory. If the clock is not in the exact position corresponding to the hour at the moment the signal arrives, relays are operated, and the current passing through the windings of the magnet (28) and its consequent attraction on the small armature (29), mounted on the pendulum, is varied accordingly. The attraction of this magnet and armature gives a small force additional to gravity, and by its variation, corrections of pendulum rate can be obtained.

Standard panel design has been employed for the amplifier units, and the master pendulum is provided with a special separate case, and can be mounted at any convenient point where it is free from vibration and external interference. The clock will be located at London Tandem Exchange Building, Holborn, where it will constitute an additional exchange.

Similar clocks will also be constructed for Bristol and Manchester, and, if the demand warrants, for other centres also.

The illustrations reproduced are by courtesy of His Majesty's Post Office.

THE STUART CENTRIFUGAL PUMP



The Stuart centrifugal pump.

THE well-known firm of Stuart Turner, Ltd., have recently produced a new type of centrifugal pump. As will be seen in the illustration, the pump is mounted on an electric motor. The pump impeller is fixed direct on the ball-bearing spindle. All couplings, flexible and otherwise, are completely done away with, and all possibility of mal-alignment eliminated, whilst the overall dimensions are reduced to the smallest limits. The spindle is rustless steel, the pump body and impeller are gun-metal and all other parts are non-ferrous metals, so corrosion is entirely avoided. The pump does not leak, either running or standing, and absorbs so little power that it cannot be measured.

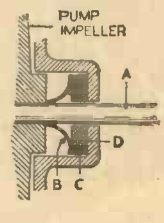
How it Works

As can be seen in the sketch herewith, the rubber trumpet *B* is light on the pump spindle *A*. This resilient trumpet presses the carbon ring *C* against the smooth flat surface *D*. *A*, *B*, and *C* revolve together. Carbon and a hard metal form the most frictionless and wear resisting combination known.

No Leakage

It will be seen that water cannot leak past the shaft, because the rubber trumpet fits tight on it. The trumpet presses against the ring *C* and no leakage can take place there. The higher the head of water delivered by the pump, the more closely will the flexible triumpet be pressed against the carbon ring, automatically increasing the perfection of the seal. The seal can be left running or standing for a fortnight or a year. Sold in three sizes, the No. 10 pump costs £3 7*s*. 6*d*., No. 11, £4 7*s*. 6*d*., and No. 12, £5 7*s*. 6*d*. The adjustable fountain jets for these pumps cost extra : for the No. 10 and 11, 7*s*. 6*d*., and No. 12, 10*s*.

Details of the adjustable fountain jet.

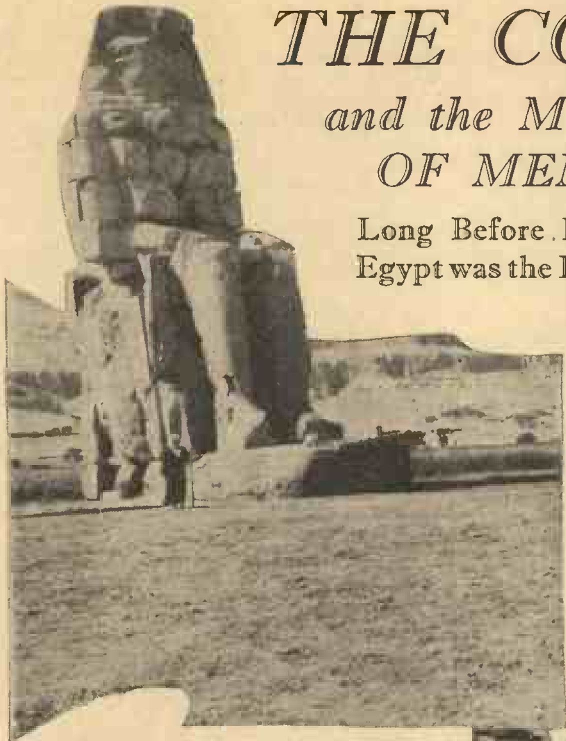


The pump impeller.

THE COLOSSI OF EGYPT

and the MYSTERY OF MEMNON

Long Before History began, Egypt was the Land of Mighty Monuments, and Many of Them have Never been Surpassed Even in these days of Scientific and Mechanical Achievement



The Musical Colossus of Memnon. Note the man standing beside it, which gives some indication of its size.

(Above) Head of a small statue, Thebes.

(Left) The world's biggest statue, Thebes. Note the man standing beside the damaged head of the figure.

NO modern building can compare in size and importance with the greater pyramids, or the mighty Temple of Karnak, and in the realm of sculpture nothing can equal the colossal statues of ancient Egypt. The greatest of all these is, of course, the mighty Sphinx, larger than many churches, and weighing thousands of tons, but it was shaped from the living rock *in situ*, and so represents a far less wonderful feat than the tremendous statues which were hewn from the quarry, shaped and polished with marvellous care, and transported for hundreds of miles to their final position.

The Statue of Rameses II

Thus the great statue of Rameses II, at Thebes, is cut from a single block of granite and weighs over a thousand tons, while the original mass of stone as hewn out, must have scaled at least 1,500 tons, and the quarry was two hundred miles distant. The king is portrayed sitting on his throne, and is 57½ ft. high, while the index finger and ear are each 3½ ft. in length.

He sat in the temple for centuries, and then the statue was overthrown by order of Cambyses, a later monarch, who could brook no rivals. By his order the features of Rameses were damaged, but the huge size of the monument made it impossible for much damage to be done, only dynamite could have achieved this.

The land of Egypt is full of other stupendous statues, which impress us to-day by their enormous size, the dignity of their impassive features, and the perfection of their details.

The "Musical" Statue

There is one statue, however, which is of exceptional interest. In antiquity it was believed to possess supernatural powers, and even to-day its remarkable properties remain an unsolved mystery. This is the famous "Musical" or "Sounding" Statue of Memnon at Thebes, whose mysterious cry to the sun at the hour of dawn was the wonder of the ancient world, and remains a fascinating puzzle for scientists to this day.

The so-called Colossi of Memnon, are two gigantic seated statues of King Amenophis III, placed near the verge of the desert, on the site of ancient Thebes. Both figures are about the same size, say 64 ft. high, with

Giant statues at Luxor, each about 45 ft. high.

a finger 4½ ft. long, and a foot of 10½ ft. It is believed that their enormous weight has caused the bases of the monuments to sink some 7 ft. to 10 ft. below the ground, or perhaps the soil has silted up around them owing to the deposits of mud during the Nile floods, when the statues are partially covered with water. The southern figure is in the best state of preservation but the other is of greater interest, because it is the *vocal statue.* It is not known whether the figure has been musical from the date of its first erection about 1400 B.C., or if the sounding began after it had been partially demolished by a great earthquake in the first century B.C.

The "Miracle of Memnon"

The first historic reference to the "Miracle of Memnon" is by the writer Strabo, who visited Egypt between 19 B.C. and 7 B.C., and there are frequent subsequent mentions of the marvel for a period of two centuries, and then silence! Some modern travellers, however, claim to have heard the mysterious voice, which seems to have been stilled for at least some centuries after the restoration of the damaged statue by the Emperor Septimus Severus about A.D. 170.

At the time of Strabo's visit, the real name and origin of the statue had been lost, and the Greeks regarded it as a figure of their hero-god Memnon, son of Eos (or Aurora—the Dawn), who had been slain by Achilles at the Siege of Troy, and they

The Colossi of Memnon, with the Musical Statue on the right.

regarded it as very fitting that the divine son of Eos should greet his mother with a note of praise each morning.

It is certain that the cold stone *did* send forth a musical note at about the time of sunrise. Large crowds assembled to hear the wonder, and among them were prefects, generals, and even emperors. They stood in the grey light of early dawn to listen to the oracle, and it would have fared hardly indeed, with any trickster who dared to counterfeit the voice of the god. And how *could* he have done it? There was no possible hiding-place on that mighty block of solid rock, no hollow where a man could lie concealed, and no means of climbing up, even if a hiding-place had existed. The ground below was level soil, clear of trees and bushes, and also affording no shelter.

The Cry of the God

The cry of the god has been variously described—the twang of a harp-string, a chord on the lute, a blow on a copper bowl. Sometimes the god remained silent, and then he was believed to be angry. For two hundred years the miracle continued, one of the best attested of marvels in the earth's history, and then it suddenly ceased, after the broken upper part of the statue had been restored.

May we not find here a key to the riddle?

The first historic mention of the "Voice of Memnon" is after the statue had been shattered, and the records cease as soon as it had been restored. Is it not probable that the damaged statue contained fissures in the stonework, in which cool night air could be trapped, and when the statue was heated by the rays of the rising sun the imprisoned air was expelled with a note of music? There is a three-thousand-year-old relic in our own country, which is also musical. This is the famous "Blowing Stone" at Kingston Lisle in Berkshire, which local tradition says was King Alfred's battle horn, but is certainly many centuries older. It is a rough block of stone, about the size and shape of a milestone, and has a hole in it, which, if blown through, produces a loud note like a horn.

A further view of the mighty statues of Memnon.

The standing figures of wives are life size, and reach barely to the king's knee, Luxor.

The Temple of Luxor

There are thousands of mighty statues scattered through the Land of Egypt, and it is impossible to mention a tithe of them; but the Temple of Luxor demands reference. There are six huge statues of King Rameses II, each 45 ft. high, and many smaller examples. There is a very naïve and amusing example of the status of women, even the greatest ladies in the land. There is a tiny figure of a woman, standing beside the king. It is his wife, and she barely reaches to his royal knee!

IN THE WORLD OF SCIENCE

The "Queen Mary's" Radio Equipment

THE radio installation fitted in the *Queen Mary* is the most elaborate ever fitted to an ocean liner. The transmitters and receivers are "remote controlled" by a dial similar to those used on automatic telephones, and in order to provide rapid communication with all parts of the world, the installation can operate on thirty-two different wavelengths, eleven short wavelengths for telegraphy, nine for telephony, besides five medium and seven long wavelengths. Changing from one wave to another can be accomplished in less than five seconds.

The Teleprinter Service

ALTHOUGH the Teleprinter is used by many business firms who have offices both in London and the provinces, its service is not well known by the general public. A teleprinter closely resembles an ordinary typewriter, but it can be connected electrically to one or more instruments many miles away, and as a message is typed on one machine, it is automatically repeated by the other, and it is thus possible to exchange typewritten messages between the various offices without any delay.

The Post Office reserves a private line for every client who instals a teleprinter, and the line is available either at stated times, or twenty-four hours a day if required. The speed at which messages can be transmitted is governed only by the skill of the operators, and two experts can conduct a conversation almost as quickly by wire as by word of mouth.

Another Radio Link

YET another of our colonies is now "on the telephone" to subscribers in England, and thus can now communicate via England with a very large part of the civilised world. This latest addition is Kenya, whose radio telephone service has just been inaugurated.

A Tree Root in a Water Pipe

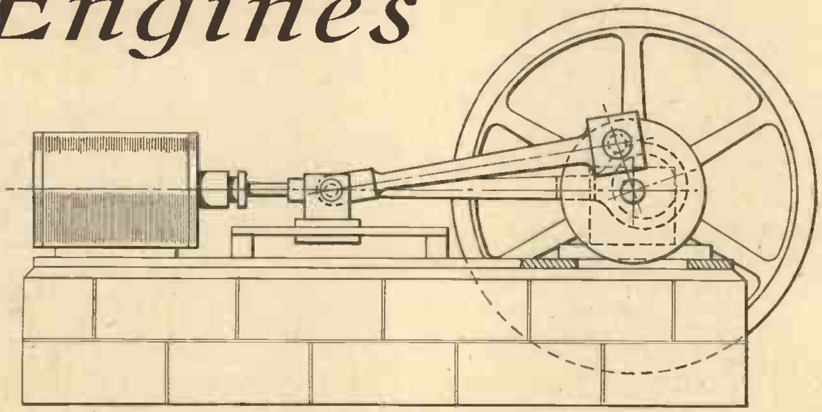
THE firm of R. A. Lister & Co., of Gloucestershire, obtain their water supply for their electro-plating department from a spring which flows through a 4-inch pipe, and during the last year the supply began to fail. This was very serious as the local water is unsuitable. When the supply of spring water failed altogether, an investigation was made, and a small crack was found in one of the sections of the pipe.

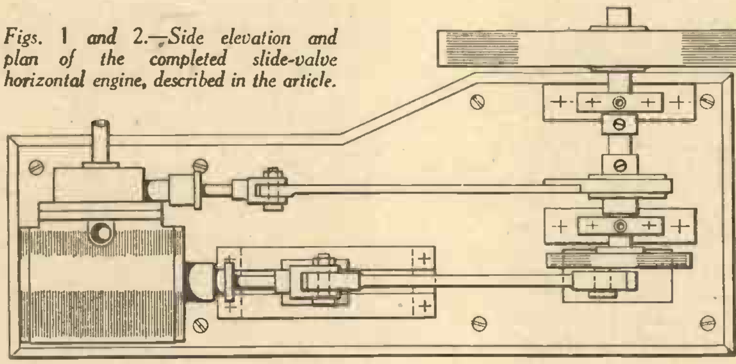
Through this crack, a minute fibrous root from a near-by tree had found its way into the pipe and had thrived so well on the spring water that it practically filled the pipe for a length of over 30 ft. From the tiny root, less than ¼ inch. in diameter, was growing a fibrous "rope" over 30 ft. long.

Vegetable growths in ordinary town water mains are prevented by the addition, at the pumping station, of very minute traces of chlorine gas to the water. The chlorine is a poison to all bacteria and vegetable matter, but is harmless in small quantities to humans beings and it thus renders the water safe for drinking purposes.

Working Model Steam Engines

The Construction of a Horizontal Slide-valve Engine is dealt with in this Eighth Article of the Series





Figs. 1 and 2.—Side elevation and plan of the completed slide-valve horizontal engine, described in the article.

THE working model steam engine, shown in Figs. 1 and 2, is an advance on those previously described, which have been of the single-acting oscillating cylinder type. In the present model a "built-up" double-acting slide-valve cylinder is used, thus dispensing with castings. Other parts such as the connecting rod, crosshead, eccentric and rod, and bearing blocks are also designed to be made without castings. It will be noticed, with reference to the side elevation and plan of the engine, that the cylinder and driving gear are mounted on a metal bedplate, which in turn is mounted on a wooden plinth marked to represent a concrete foundation.

The Bedplate

A piece of planished steel plate should preferably be used for this, and the dimensions are given in Fig. 3. With a scriber, carefully mark the outline and the positions of the various holes. Those round the edge of the plate, for the fixing screws, can be drilled $\frac{3}{32}$ in. diameter, the others being drilled and tapped $\frac{3}{32}$ in. Whit. The rectangular hole, *A*, for clearing the connecting-rod end, can be drilled and cut out with a cold chisel, and afterwards filed up squarely to the scribed line. Roughly cut out the bedplate, with the aid of a hacksaw, and file the edges square to the scribed outline.

Shaping the Plinth

For the plinth on which the bedplate is mounted, a block of wood will be required measuring $7\frac{1}{2}$ in. long, 3 in. wide, and $1\frac{1}{2}$ in. thick. Plane the block to the dimensions given in Fig. 4, saw away part of one side, as indicated, and smooth the rough surfaces with a chisel. Chamfer the top edge of the block at an angle of 45 degrees, to a depth of $\frac{1}{8}$ in., as indicated, and then, using the bedplate as a template, mark the positions of the seven holes for the fixing screws. Bore these holes in the plinth to a depth of $\frac{1}{2}$ in.

Disc-crank and Shaft

The shaft can be cut from a piece of silver-steel rod $\frac{1}{4}$-in. diameter, a Whit. thread being cut on one end for a distance of $\frac{1}{4}$ in., as indicated in Fig. 5.

For the disc-crank a soft iron disc $1\frac{1}{2}$ in. diameter, and $\frac{3}{16}$ in. thick will be required, through the centre of which a $\frac{3}{16}$-in. hole is drilled. On one side of the disc, in the centre, a $\frac{1}{2}$-in. washer, $\frac{1}{16}$ in. thick, can be soldered on to form a boss. Continue the $\frac{3}{16}$-in. hole through the washer, and then tap out with a $\frac{1}{4}$-in. thread to take the screwed end of the shaft.

Drill and tap a hole with a $\frac{3}{16}$-in. thread to take the screwed end of the crank-pin

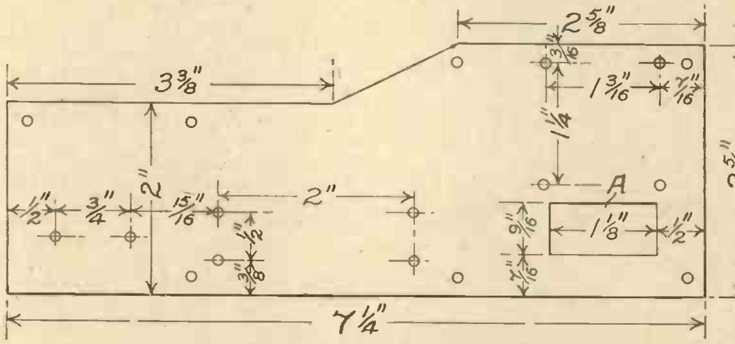


Fig. 3.—Setting out the metal bedplate.

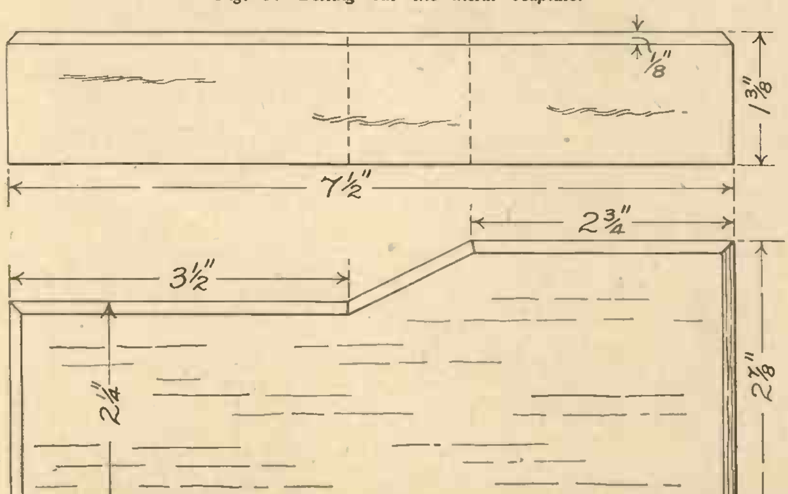


Fig. 4.—Side elevation and plan of the wooden plinth.

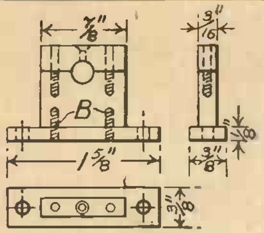


Fig. 6.—The bearing blocks.

which consists of part of a steel screw, 3/8 in. long, with the head filed flat.

Bearing Blocks

Each bearing block is made in three pieces, as shown in Fig. 6, the base parts being cut from sheet brass 1/8 in. thick, the upright parts and caps of each bearing being of 3/16-in. brass. Saw off the top parts forming the caps, and after filing the surfaces flat and square so that they make good joints, sweat them in position, and drill two 1/16-in. diameter holes through each cap into the bearing block, as indicated. Enlarge these holes through the caps to clear 1/16-in. screws, and tap out the holes below the soldered joint with a 1/16-in. Whit. tap. The base-piece of each bearing is sweated to the bearing block, but before doing this drill and tap two 1/16-in. holes through each, as at *B*, to take screwed pins, which should afterwards be filed flush with the underside of the base-piece. After drilling 1/8-in. holes for the crankshaft, separate the caps by holding for a few seconds over a gas flame, and when cool, rub the surfaces over with a fine-cut file, or emery stick, to remove discoloration and superfluous solder. The two holes in each base-piece to take the fixing screws should be drilled 3/32 in. clearing size.

Connecting Rod

To simplify construction the connecting rod can be made in one piece from a strip of brass or gunmetal, 3/16 in. thick. The dimensions are given in Fig. 7. Select a straight strip of metal, and down the centre of one side scribe a line, set out the centres of the holes for the gudgeon and crank-pins, and deeply centre-punch at these points. After marking out the shape of the rod, hold the strip in a vice, and file away the metal down to the scribed line. The centre part of the rod should be filed down on each side so that the rod at this part is 3/32 in. thick. Drill the two holes the required size and then file the edges of the rod quite square. Note that the "big end" of the rod is 3/16 in. thick, and the other end 3/32 in. thick.

Eccentric Rod and Sheave

Fig. 8 gives details of the eccentric rod and sheave which are made from strip brass and a short piece of tubing.

Take a piece of 3/32-in. flat sheet brass of suitable size, and mark out on it the shape of the strap piece *C* with the aid of a pair of compasses. Drill the central hole and, if possible, reamer it to size. If a reamer is not available, carefully file the edge of the

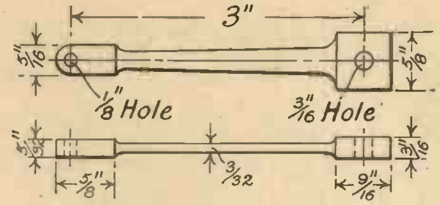


Fig. 7.—How to make the connecting-rod in one piece.

hole to the scribed line with a fine-cut half-round file. Roughly cut out the strap to the outer line with a cold chisel, finish with a file, and after filing the rebate in the projecting piece, drill the two rivet holes 1/16-in. diameter.

A brass disc will now be required, which must be a good fit in the hole in the strap,

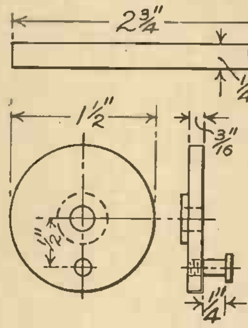


Fig. 5.—Details of disc-crank and shaft.

and on this disc mark the centre, and also the centre of the hole to take the piece of tube. It will be noticed that the distance between the two centres corresponds to the throw of the eccentric as indicated at *D*. The disc should be slightly thicker than the strap. Two discs *E* will also be required for forming the flanges which keep the strap in position. These discs need only be about half the thickness of the centre disc *D*, and about 1/8in. larger in diameter. Mark the position of the two centres on one disc and clamp them together for drilling the hole through for the piece of tubing, and also mark the centres of the two holes *F* on one disc.

After assembling the parts slip the tube in position and adjust the outer discs till they are concentric with the strap, and then solder the tube to each outer disc, leaving 1/4 in. of one end of the tube projecting on one side to take the grub-screw as depicted. Two 1/16-in. holes can now be drilled right through the discs to take copper-wire rivets for clamping the parts forming the eccentric sheave firmly together. Instead of rivets, countersunk-headed screws may be used, which would enable the discs to be more easily taken apart for the purpose of replacing a worn strap.

For the eccentric rod, *H*, a strip of sheet brass 1/8 in. thick can be used. File this down to a thickness of 3/32 in., except at one end which is drilled with a 3/32-in. hole for the pivot pin. File the rod to a taper, as shown, and, after rounding one end, lightly solder the other end in the rebate in the projecting end of the eccentric strap, and drill the rivet holes through. After riveting, remove all superfluous solder, and smooth over the joint with a file.

Crosshead and Guide-bars

The crosshead can be made from two pieces of stick brass, as shown in Fig. 9. The shaping of the top part requires some careful work with a hacksaw and file. After filing down the sides to the required width, mark the position of the gudgeon-pin hole and carefully drill this through at right-angles with a 1/8-in. drill. The slot for the end of the connecting rod can be partly cut with a hacksaw and then chipped out with a small cold chisel. The hole in the boss, *J*, should be drilled and tapped 1/8-in. Whit. to take the screwed end of the piston rod. The bottom plate, *K*, has two 1/16-in.-holes drilled through, as shown, to take the screws which fix it to the upper part of the crosshead.

The guide-bars, shown in Fig. 10, can be cut from a piece of mild steel strip, 1/4 in. wide and 3/32 in. thick, a 3/32-in. clearing hole being drilled through at each end to take the fixing screws. The guide-bars are supported at each end by a block, *L*, cut from 1/4-in. square brass, a 3/32-in. clearing hole being drilled through, as indicated, for taking the fixing screws. When the guide-bars are fixed in position there should be a space of 1/4 in. between the inner edges.

Cylinder Details

As previously mentioned, the cylinder is

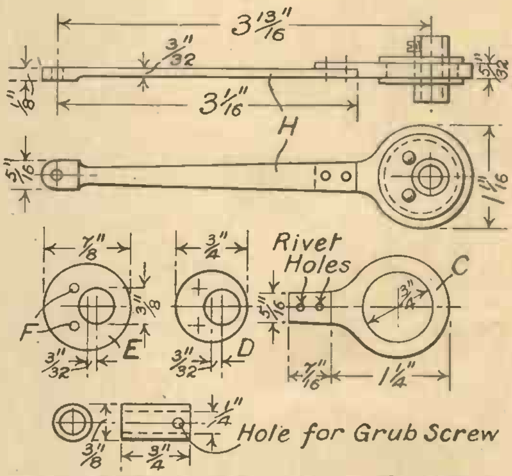


Fig. 8.—Details of the built-up eccentric rod and sheave.

a built-up one, and is intended to be made from a piece of solid-drawn brass tubing and odd pieces of brass. For the cylinder barrel, select a piece of tubing with an internal diameter of 5/8 in. and at least 1/16 in. thick.

(To be continued)

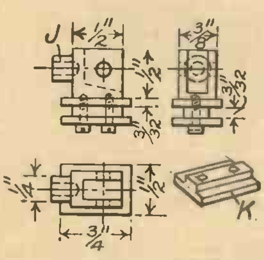


Fig. 9.—Constructional details of the cross-head.

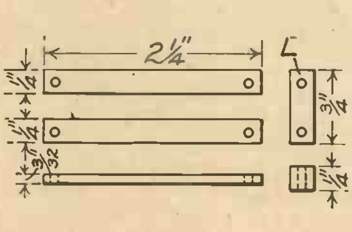


Fig. 10.—Guide bars and supporting block.

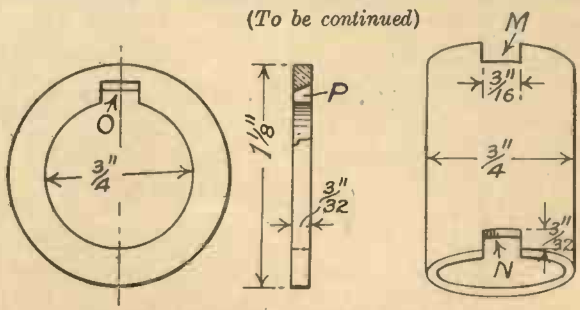
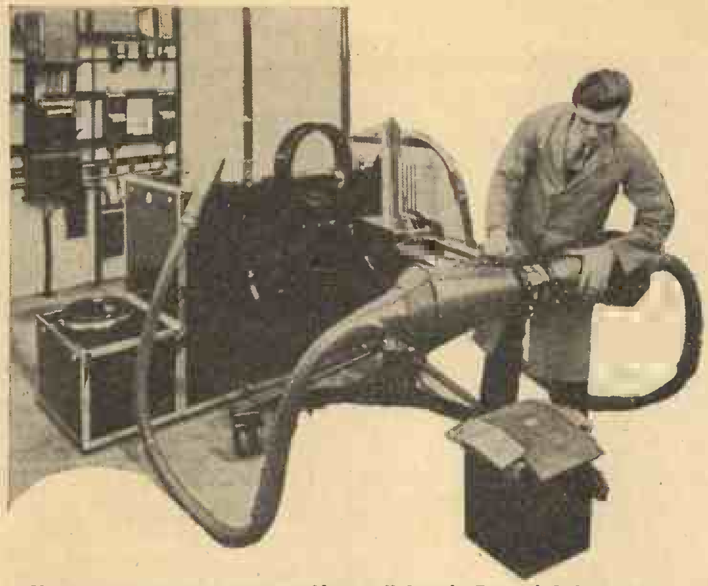


Fig. 11.—Details of the cylinder barrel and flanges.

New Welding Methods

Welding is the Oldest and at the same time the Newest Method of Jointing Metal. The Old Method was the Blacksmith's Art of Hammer Welding. The New Way is to Fuse the Metal Together either Electrically or under the Oxy-acetylene Flame.



X-ray apparatus or examining welds, installed at the Research Laboratories of the British Oxygen Company, Cricklewood, London.

THE old and the new methods meet in the modern method of flash or butt welding. Flash welding is the process used for joining tubes end to end. Long runs of high-pressure steam pipe (as used in modern power stations), are assembled without visible joint. The process is completely automatic. Two lengths of tube are clamped in a machine with their squared ends touching, one clamp being fixed, and the other sliding at the end of a hydraulic ram. A heavy low-voltage current is led into the tubes, via the clamps, from the terminals of a transformer.

Starting the Weld

To start the weld a switch is thrown in. Current flows into the tubes and across the slight air-gap between their ends. The air-gap causes a local high resistance, which rapidly raises the temperature of the tube ends so that they flash into white heat. The flash is allowed to last a few seconds until a timing device actuates the hydraulic ram. The current cuts out, and the ram gives a short 5,000 lb. impulse, which, like a giant blow from a smith's hammer, makes the joint. A perfectly made joint has an extruded fin inside and out, which contains any iron oxide formed in the flash. After cooling, this fin is trimmed, and except for a short tempering process, the joint is finished.

Arc Welding

The weight of the current used in flash welding (it is as much as 360 amps. per square inch) confines the use of this process to small tubes and fittings. Where plates, girders, and large surfaces have to be welded, arc or spot welding is used. In flash welding, no welding rod is used. In arc welding a steel or iron electrode bar is used, and an arc is struck between the rod and the joint which melts metal from the one into the fused face of the other.

To strike the arc, the welder touches the work with the rod and then separates them a fraction of an inch. As the metal flows smoothly, the operator draws along the join, and so makes a continuous joint.

Arc welding can obviously be made automatic, and traversing welding machines with a continuously fed electrode rod are used for shop work wherever possible. If thick metal is to be joined, multi-traversing is used. On each traverse, a thin layer of metal is set in the seam, and layer by layer in this way the joint is built up. The method was used for making the high-pressure drums of the boilers of the Battersea Power Station.

Testing a Weld

It is easy to test the work of a flash welding machine. A trial weld is made and tested to its breaking point. If the metallurgist in charge is satisfied, the O.K. is given and the machine goes into production.

Flash welded tubes twisted and distorted without breaking.

Obviously this method cannot be employed on the fabrication of one big boiler shell which may cost several hundred pounds. Welding engineers have therefore called in X-rays to their aid. A photographic film is spread along the back of the weld, and a portable X-ray machine is then brought up and traversed along the other side of the weld. A radiograph of the joint is thus obtained.

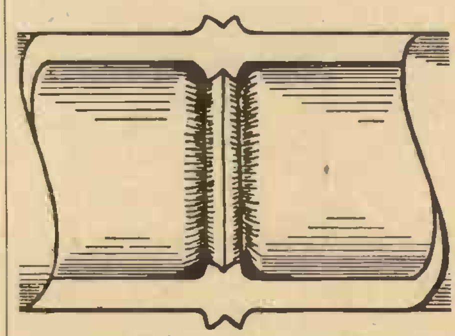
The radiograph would not mean much to the layman, but the welding engineer has reference radiographs of good and bad welds to guide him, and he quickly interprets the picture. Roughly it works out like this. Faults in the weld will be either blow holes or bits of iron slag. To the X-ray, the metal is opaque, slag is semi-transparent, and the blow holes are perfectly transparent. An evenly dark radiograph means a good weld, grey spots mean slag, and white spots are air-holes.

Atomic Hydrogen Process

The welder guards against faults in the weld and burning of the metal by using chemically coated electrodes. The coating produces air, excluding inert gas, which prevents burning of the metal. It also attempts to replace in the weld traces of carbon, phosphorus, silicon, etc., which are boiled off in the arc. These traces are essential to the strength of the weld. Welding experts are, however, not quite satisfied with coated electrodes for the highest class of work.

Coming to the fore for these reasons, is what is called the Atomic Hydrogen Process. Hydrogen is blown on to the work through a high-voltage A.C. arc between tungsten poles. Something happens to the hydrogen which is believed to be the disruption of molecules to atoms. Striking the work, the atoms recombine with the release of intense energy, which heats the metal white hot. A perfect weld in an envelope of hydrogen is thus produced, and the volatilisation of the essential traces of carbon, etc., is prevented. Atomic Hydrogen Welding is probably the welding process of the future.

The ambitious scope of the welder increases almost month by month. They are becoming more and more confident of their results with welded high-pressure steam work. Methods of welding copper, aluminium, and stainless steel have been perfected. Naval architects are still a bit doubtful in England of the all-welded ship. German experts are, however, using welding extensively in the construction of their " pocket battleships " for speed and weight saving.

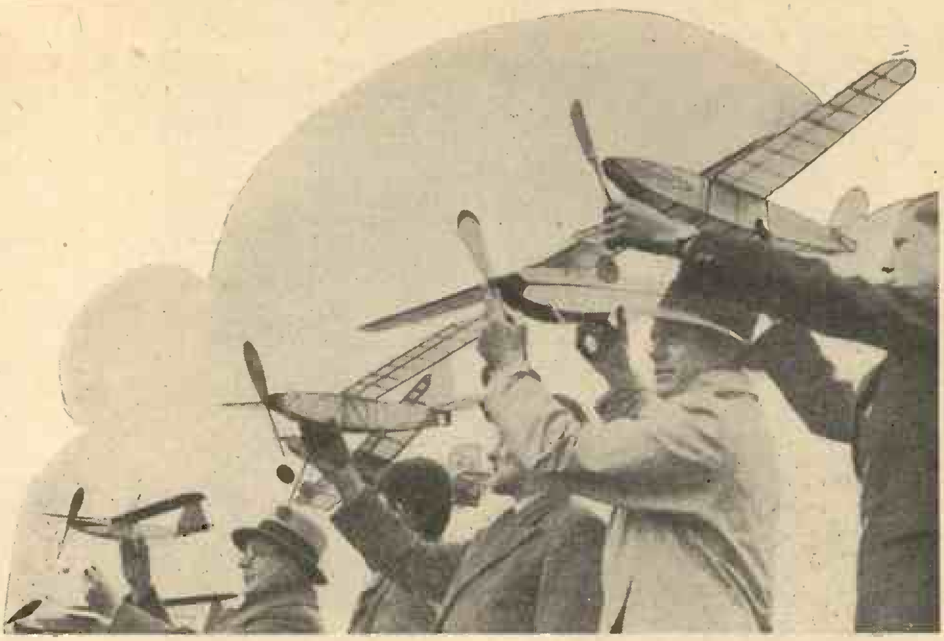


A flash welded tube before removing the extruded fins

Model Aero Topics

By

F. J. CAMM



A Warning

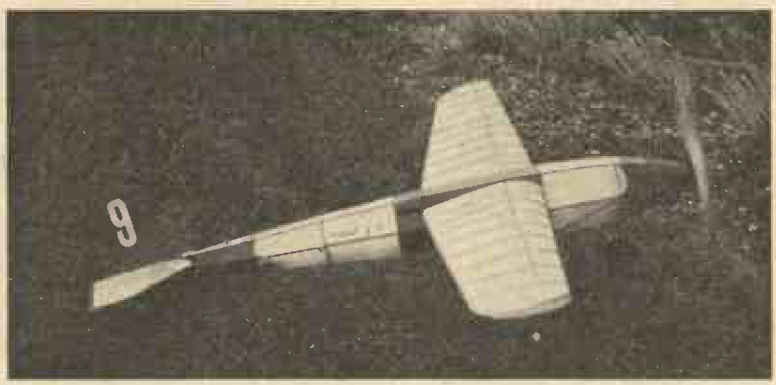
I READ in the paper the other day of a petrol model which smashed into a nursery window half a mile from its launching point. This draws attention to the danger of allowing models weighing several pounds and flying at anything up to 30 miles an hour to fly uncontrolled. One or two of the daily papers have been asking for drastic regulations, so I hope that aero-modellists will take the hint and fit automatic time control as well as automatic aileron or rudder control so that the direction and duration of flight can be predetermined within reasonable limits. We do not want regulations for model flying, but they will be imposed unless we take heed.

From a Brussels Reader

MR. A. VAN WYMERSCH, the well-known model flyer who resides at Rue Berkendael, 14 Forest, Bruxelles, has sent me an interesting picture of one of his models. I reproduce it overleaf; it shows Mr. van Wymersch holding it. One of Mr. Wymersch's models is the Belgium record holder with a performance of 51 seconds, which is good considerating that it was made indoors. It has made two unofficial flights of 41 minutes out-of-doors. The same reader has recently built a petrol-driven model which has made test flights of 2 and 4 minutes' duration. He uses balloon wheels of the American type and a steel wire tripod landing gear. It is equipped with a Brown engine.

From a Leicester Reader

A PHOTOGRAPH on this page shows a model designed and built recently by Mr. F. Fletcher, of 274 Hinckley Road, Leicester. It has a hexagonal shaped fuselage and it will be noticed that the main wings are movable in slots in the fuselage. The frame is of wood and covered with the usual doped silk. It weighs 16 oz. and has a wing span of 56 in. It is driven by a rubber motor and a 16-in. propeller. Although it showed some promise in the air it finally crashed in a strong wind.



A fine model by Mr. F. Fletcher, of Leicester.

S.M.A.E. NOTES.

Gamage Cup Result (General Competition)

MAY 3RD, 1936

1.	Merrifield, G.	Bournemouth	93·86
2.	Copland, R.	Northern Heights	91·3
3.	Harmer, R. J.	Bournemouth	88·91
4.	Crow, S. R.	Blackheath	85·7
5.	Gibson, C.	North Kent	79·33
6.	Allman, J. B.	Midland	75·3
7.	Adcock, G. A.	Bradford	73·06
8.	Davies, E.	North Kent	70·96
9.	Baster, G. F.	Bournemouth	68·00
10.	Worden, J.	T.M.A.C.	67·26

The Gamage Cup Competition, held as a decentralised competition for the first time on the club's own grounds, on May 3rd, brought forth a record entry to the competition, the total numbers being 50, this despite the very high wind which prevailed all over the country. The competition was for all types of rubber-driven machines, the best average of three flights giving the winner. A list of the first ten is given herewith.

To date, the Wakefield Cup fund totals £378 18*s*. This is still short of objective by

One of Capt. Curtis's models just taking off at Fairey's Great West Aerodrome.

a few pounds, and the society would be glad to receive any further donations. Mr. J. C. Smith, Competition Secretary, reports there are 110 entries to date.

The Moffat Trials

THE Moffat Trials will be held on May 17th, 1936, and entries will be accepted on the field. The rules are as follows :

The Contest is for duration of flight according to the rules of the National Aeronautic Association.

The models shall be so constructed that none has an effective wing area greater than 200 sq. in. nor less than 100 sq. in. (This applies to main supporting surfaces only ; tail surfaces are not computed.)

The Fuselage Formula

THE fuselage cross-section rule is: Minimum value of the maximum cross sectional area of each fuselage—

$$\frac{(\textit{length of model overall})^2}{100}$$

(propeller not counted in computing overall length).

The weight of any model shall be at least 1 oz. avoirdupois for each 50 sq. in. of effective wing area.

Any form of power, excepting rockets, be used.

No individual is permitted to enter more than one model.

Entrants shall be through the Society in each country affiliated with the Federation Aeronautique Internationale or through the model plane governing section of such Society.

Entrants shall be bona fide citizens of that country which they represent.

The Pilcher Cup

THE Pilcher Cup Competition, held under Wakefield Rules, was the first competition to be flown under the new S.M.A.E. constitution and calls for congratulation to the winning competitor, as flying conditions practically throughout the country were most difficult. The times of the winning competitors suggest that records can be confidently expected on the Wakefield Elimination Trials day.

At Bristol the weather was such that no flights were possible. Blackheath suffered from overcast skies with some bright periods. Wimbledon and Birmingham both suffered with frequent snow-showers and wind. The Northern Heights and Cockfosters had both bad, damp weather. At Manchester things were so difficult that they had no entries, the models being smashed earlier. At Bournemouth they make no mention of the weather, so it is to be imagined that it was apparently fair.

Competition Results

WILL competition secretaries and timekeepers kindly note that it is requested that results of these general competitions in future be kept secret until the official results are published by the S.M.A.E.? Will they please also note that an error has crept into the official competition sheets, the age for juniors on the sheet being given as twenty-one years whereas it should read sixteen years ? See S.M.A.E. General Competition Rule No. 15.

Pilcher Cup Results

THE official results of the Pilcher Cup Competition are as follows :

		Average of 3 : Total Flight of 3 or less.		
Competitor.	*Club.*	*Min.*	*Sec.*	
C. Gibson	North Kent	4	·73	1st
R. J. Harmer	Bournemouth	3	24·00	2nd
W. Worden	T.M.A.C.	1	26·416	3rd
A. J. Flint	Midland	1	25·8	4th
R. F. Hook	Blackheath	1	20·56	5th
D. Worley	Northern Heights	1	17·46	6th
R. T. Gillett	Park M.A.L.	1	11·7	7th
G. J. Liggett	T.M.A.C.	1	3·66	8th
S. R. Crow	Blackheath	1	2·83	9th
P. L. Wilson	T.M.A.C.	1	0·43	10th

Mr. Van Wymersh, with one of his models.

In all there were 34 entries, of which six were juniors.

The Wakefield Cup Fund now totals £340, and there are still some outstanding donations to come in. These, together with any further offers of financial assistance should be sent to Mr. H. York, 2 Scutari Road, S.E.22.

Clubs Affiliated

AT a meeting of the Council of the Society of Model Aeronautical Engineers, the following clubs were affiliated : The Bradford Model Aircraft Club, Brighton District Model Aircraft Club, Newcastle (Staffs) and District Model Aircraft Club, Windsor Model Aircraft Club (Manchester), Wembley Model Flying Club.

The Council then proceeded to discuss the new Federation Aeronautique Internationale Rules, fixed for timing and granting international records. These Rules, together with the opinions of the Council of the S.M.A.E., are given herewith. The Council of the S.M.A.E. would be glad to receive the opinions of the affiliated clubs on these Rules.

Will competition secretaries and others kindly note an error which has crept into the General Competition Rules, Paragraph 15 ? This should read : " 1*s*. for those over 16 years, and 6*d*. for those under 16 years."

New Press Secretary for the S.M.A.E.

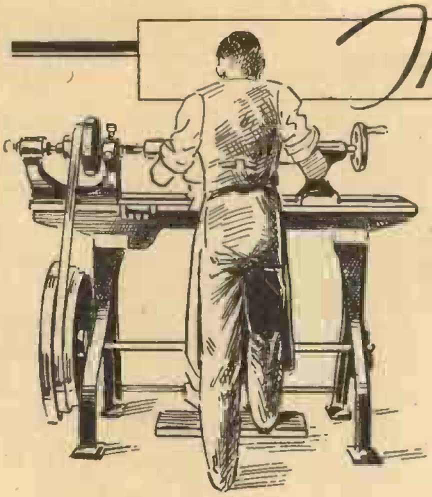
AT a council meeting of the S.M.A.E. Mr. H. York was appointed Press Secretary of the S.M.A.E. All communications should be addressed to him at 171 New Kent Road, London, S.E.1.

A Model by Capt. Curtis

CAPT A. H. CURTIS, of 19 Manor Road, Potters Bar, Middlesex, has sent me the photograph reproduced at the foot of this page showing one of his models just taking off. As will be seen the model is well constructed and of neat design.

An American aero-modellist, with one of his " gas " jobs.

A " gas " model in full flight.



The Beginner's Guide to Woodturning

The Principal Parts of the Lathe, the Correct Running Speed, Tools Required and the Method of Using Them, are Fully Explained in this Article

THIS is truly the steel age, and work in other materials, especially in wood, is often looked upon as old-fashioned or beneath the dignity of the practical man of to-day. It is in many ways unfortunate that wood-turning has been so much neglected during recent years, for it offers a wonderful scope for initiative and real skill. No doubt one strong reason for wood-turning having been ignored is that it is now possible to buy turned parts, such as table legs, candlesticks, and the like, at remarkably low prices from any handicraft store. But these examples of repetition work cannot compete with the hand-made articles which can be produced in styles and finishes which give them a real air of "individuality."

Accuracy of the Work

It must be admitted that the same degrees of accuracy cannot be observed when turning wood as when dealing with steel, but just as much skill is required to turn, say, a wooden dowel to an accuracy of $\frac{1}{64}$ in. as to work to a thousandth of an inch in steel. An additional point in favour of wood-turning is that all the work is carried out entirely by hand; tool holders and lead screws are not used, and the few and simple tools required must be guided with the hands alone. Largely because of this, turning in wood has a fascination of its own, for the worker feels that he has more control over his material, and develops such a fine sense of touch that he gains complete mastery over his hands, and has the feeling of actually moulding the wood to the shape which pleases him.

The Simple Lathe

Another point in favour of wood-turning is that the lathe required is of extremely simple type, even when complicated work has to be produced. This means that it is less expensive and that less experience is required to control the machine. Whether a lathe of the treadle-driven type is used or power is available, the only parts of the lathe which are involved are: the bed; the fast head, with fork centre; the tool rest; and the loose head, with dead centre. These parts are shown in Fig. 1.

The speed of the lathe must be considerably higher than that of the corresponding tool used for metal, but the power required to drive it is actually less. Speed is not critical, but for most classes of small work—up to about 2 in. in diameter—the lathe should be driven at 2,000 r.p.m. or more; for work up to, say, 6-in. diameter the speed can be reduced to a minimum of about 1,000 r.p.m. The drive is usually taken through a three-size cone pulley, so that the speed can be varied simply by moving the belt from one to the other of the "steps."

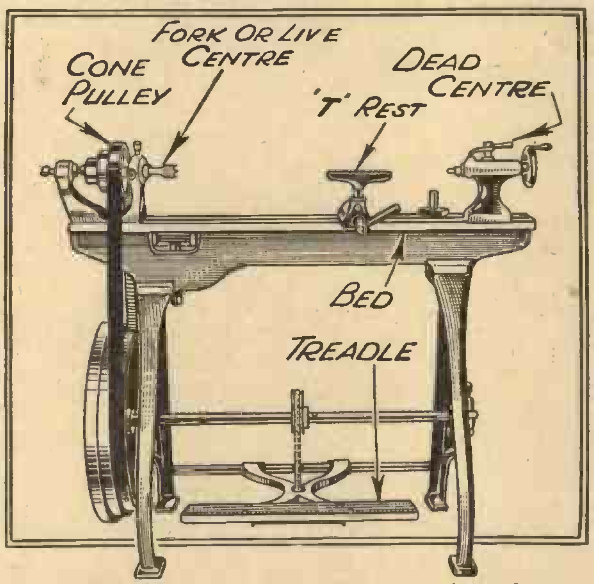


Fig. 1.—This shows the main parts of a typical lathe for woodturning.

The Tools Required

As mentioned above, the tools required are of the simplest possible nature, comprising only gouges and chisels, such as those shown in Fig. 2. The gouges are similar to outside-ground ones used for normal woodwork, except that they are longer and more sturdily made. Three sizes cover most requirements, these having widths of $1\frac{1}{2}$ in., $\frac{5}{8}$ in., and $\frac{1}{4}$ in. The chisels are quite different from those used for woodwork, since they are ground and sharpened on both faces, whilst the edge is at an angle of about 60 degrees to the centre line; these also are made in three main sizes, similar to those of the gouges.

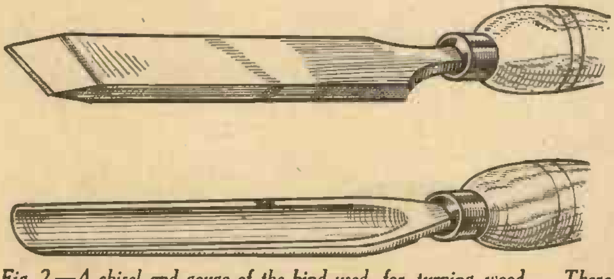


Fig. 2.—A chisel and gouge of the kind used for turning wood. There are usually three sizes of each in a complete set of tools.

Choice of Wood

Most kinds of wood can be turned successfully, but some varieties are easier to work than others. One of the best is sycamore, which is close-grained, free from knots and of very uniform texture. Red deal or northern pine of good quality is also suitable for comparatively rough jobs, but cannot be given a very high finish. Well-seasoned, straight-grained oak of the Japanese and American varieties is generally easy to handle, but British oak presents greater difficulty. Beech is good, due to its uniform texture and straight grain, but is harder, demands greater attention to the sharpness of the tools, and should normally be worked in a lathe revolving at not more than about 2,000 r.p.m. The most difficult of all woods are certain species of mahogany; not only is the grain of this wood frequently very twisted, but the wood contains

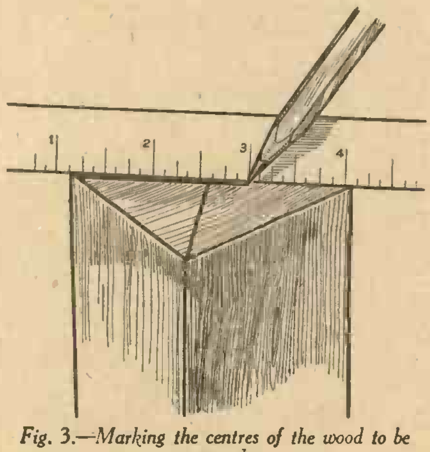


Fig. 3.—Marking the centres of the wood to be turned.

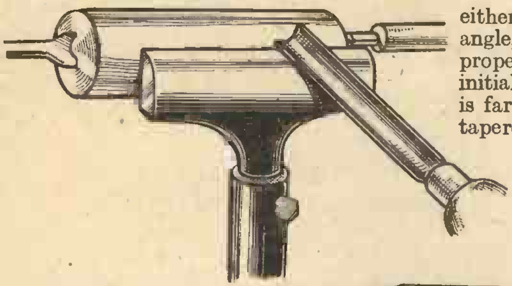


Fig. 4.—Showing how the gouge should be held in relation to the work.

innumerable grains of a glass-like substance which rapidly blunts the tools.

Centring and Mounting the Wood

For reasons which will be apparent from the above, it is best to start with a wood such as sycamore or northern pine. For the first trials, and to gain preliminary experience with the tools, a square piece about 2 in. × 2 in. × 7 in. long should be used. Find the centre at each end by drawing two diagonals, as shown in Fig. 3, and make a small hole with a bradawl at each centre. Next set the loose head so that the wood can be held securely with the centre projecting as little as possible, and place the wood between the two centres. After holding the wood so that the line of the fork centre is along one diagonal of the wood, slowly turn up the dead centre so that the fork grips the wood. It is necessary only that the edges of the fork should just enter the wood, and if an attempt is made to force it beyond this point there will be a danger of splitting. When a proper grip has been ensured, slightly slack back the dead centre and apply a few drops of oil to the wood around the point of the centre.

Setting the Tool Rest

The next step is to adjust the T-rest so that it is slightly higher than the axis of the wood, and so that it just clears the corners when the lathe is slowly rotated by hand. It remains to make the square section wood into a cylinder, and the large gouge is used for this purpose. The blade of this tool should be held near the edge with the left hand, which should also be firmly against the rest; the right hand is used to hold the handle. The gouge is to be run from end to end of the wood, and should be turned so that the portion of the cutting edge which makes contact is just below the centre of the curve. Stand erect with the feet well apart and, keeping the right hand lower than the left, move the gouge across the wood with the hollow face of the tool facing in the direction of travel. The method is shown in Fig. 4.

Using the Gouge

It will be evident that very little pressure should be applied at first and that the cut must be light to ensure that the tool does not "catch" on the corners of the wood, causing it to split or be thrown out of the lathe. As the wood gradually assumes a circular section, the cut can be made increasingly deep, but the work should not be "forced." Additionally, the T-rest can be moved nearer to the wood. By the time a circular section has been reached the wood should be removed in the form of curls or shavings; if it is like sawdust the tool is not cutting, but merely scraping, and is either blunt or being held at the wrong angle, so that the cutting edge is not making proper contact with the material. In the initial stages it will be found that the wood is far from being cylindrical, for it will be tapered towards one end, or it will be hollow in the middle. Practice should be continued until the diameter is reasonably uniform throughout the length.

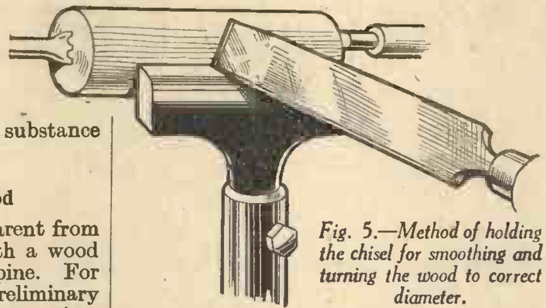


Fig. 5.—Method of holding the chisel for smoothing and turning the wood to correct diameter.

Smoothing the Surface

The cylinder will now be quite rough and probably ridged from end to end. This means that the large chisel should be used to smooth the surface and to bring the cylinder to the required diameter. The chisel is rather more difficult to use than the gouge, and the method of holding it is shown in Fig. 5. Note that it is nearly at right-angles to the T-rest, that it slopes slightly upward to the cutting edge and that the portion of the edge used for cutting is about the centre. In using the chisel the body should remain almost perfectly still, the movement being from the joints of the arms with the shoulders. The same general procedure is followed as with the gouge, and the chisel should be turned round at each end of the wood, so that the cuts can be made from right to left and from left to right.

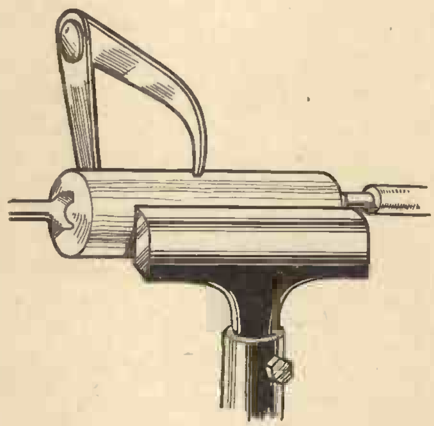


Fig. 6.—Testing the diameter with calipers. Note that they are held on the opposite side to the rest.

The Correct Diameter

Once it has been found possible to make the cylinder reasonably true and to obtain a uniform cut from end to end, an attempt should be made to turn the wood to a definite diameter. Calipers are used for testing, and after being set to the appropriate diameter they should be held against the wood from behind, as shown in Fig. 6. It is important that they should be held lightly and not allowed to catch on the wood, for if that happened, they would be flung into the face of the worker—not a pleasant prospect. It should not be imagined from this that there is any danger in the work, for any tool can be dangerous if wrongly used. The caliper test should be made at various points along the length, and the turning continued until the tips just slip over the wood at each point.

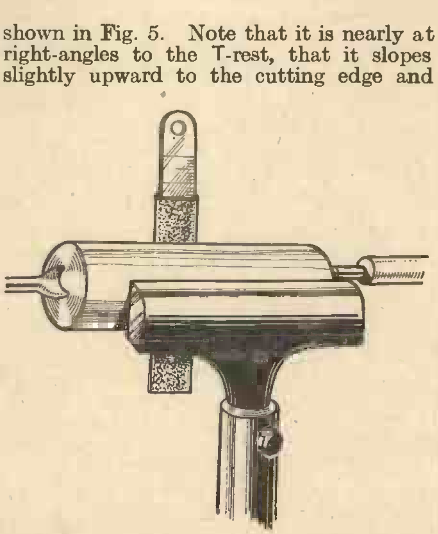


Fig. 7.—Smoothing with glass-paper held flat against a rule.

Glass-papering

If the wood were to be left as a simple cylinder it would probably be necessary next to glass-paper it to obtain a perfectly smooth surface, although eventually this should not be required when using other than soft, open-grained woods. The glass-paper should be of a fine grade and should be held on a rule, as indicated in Fig. 7. Note that it is held *behind* the work, because if it were held on top it might be drawn forward so that it would jam between the rest and the work. The glass-paper should be moved from end to end of the wood and only a light pressure applied to it. Incidentally, it will be found that the best finish is obtained after the initial roughness has been worn off the paper. Another point to bear in mind when accurate work is being done is that the glass-paper will reduce the diameter of the wood, and therefore the callipers should have been set about $\frac{1}{32}$ in. oversize when first testing. It is unwise to apply them again after smoothing, because the tips will damage the finished surface.

Marking Out

If the wood is not to be kept as a cylinder—and it rarely will be—glass-papering should be left until the final stage, the wood being marked out after finishing with the chisel. The method of doing this is to hold a steel rule behind the work, while it is still revolving, and touch the wood with the point of a medium-hard pencil at the required distances along it. The result will be that lines will be made round the wood, and these can be followed when performing the other operations, many of which will be described next month.

Two views of the sea front at Port Said.

How the Suez Canal was Built

By G. Long, F.R.G.S.

How one man, De Lesseps by name, accomplished one of the Mightiest Engineering Feats of All Time

OF all the great engineering works of the nineteenth century, none has been so remarkable as the Suez Canal. It has become of stupendous value to the commerce of the world, and is a vital link in Empire communications, so that its whole length became a battle front during the Great War. It has been no less remarkable from the financial point of view, and is one of the most profitable ventures in history. Thus the shares purchased by Mr. Disraeli for the British government in 1875 cost only four millions sterling, but there has been paid on them since the sum of thirty-eight millions in dividends and interest! A 250 franc share was worth 18,000 francs in 1928.

Even more interesting was the character of Ferdinand de Lesseps, whose pertinacity, diplomatic genius, and foresight, enabled him to carry through this great work almost single-handed when middle-aged, in face of diplomatic opposition and intrigue which formed an obstacle far greater than the natural difficulties of this great engineering achievement. It is sad indeed to record, that in later life he became associated with a group of unscrupulous financiers who floated his Panama Canal scheme. After years of mismanagement, speculation and corruption, the company became bankrupt, involving millions of French investors in ruin, and some of the financiers were sent to long terms of imprisonment, while De Lesseps himself died. I know of no case in history to compare with this for the dramatic way in which dazzling triumph was succeeded by overwhelming disaster; but in spite of this De Lesseps was unquestionably a really great man, who owed his success to his own abilities, while the sordid scandal of Panama was mainly the work of the financial crooks associated with him.

The Largest Waterway

The Suez Canal was the first, and is still the biggest, of those great waterways for shipping, which have altered the geography of the world, and have brought great cities five, or even ten thousand miles nearer to each other. Since the Suez and Panama Canals are by far the most important of artificial waterways, it is natural to compare their main features, and the nature of the country through which they were cut. Suez is one hundred and four miles long, and Panama fifty. The width is more difficult to compare as both were being widened when I visited them recently. In 1928 Panama was 41 ft. *deep*, and Suez 36, and the former had a *bottom* width of 300 ft. to 147 of Suez. The latter is, however, being rapidly widened, and is now being made to a minimum bottom width of 196 ft., with 250 ft. at the bends and 40 ft. deep. Unlike Panama, the Suez Canal is lighted throughout, so that ships can pass through by night as well as by day, and when the present works are finished, two large vessels will be able to pass anywhere while under weigh. At present, there are many places where one of them has to tie up while the other passes. There is an elaborate signalling system, all ships are looked after on their passage, just like trains on a railway, and the exact position of each vessel in transit is continually indicated by a series of graphs to the administration station at Ismailia, which receives reports from thirteen lesser signal stations.

De Lesseps statue on the sea front at Port Said.

Nile to the Red Sea

The *idea* of a Canal through the isthmus of Suez, is vastly older than that of the Panama Canal, and a channel was actually cut from the Nile to the Red Sea either by Sesostris in 2000 B.C., or by Necho in 600 B.C., or very possibly by both. Herodotus says that Necho commenced the work, and Darius continued it until the Red Sea was connected with the Nile. A hundred thousand labourers (or slaves) perished during the task. Pliny says that Sesostris commenced it (2000 B.C.) and that it was 100 ft. wide and 30 ft. deep, but that it was stopped because of a discovery that the Red Sea was higher than the Nile, and it was feared that the whole country would be flooded, and the Nile water made undrinkable. Herodotus says that Necho's Canal was wide enough to allow two triremes (warships) abreast, and Strabo says it was a hundred cubits (150 ft.) wide, and deep enough for the largest ships. The ancient Canal was several times cleared of sand and got working again in later times, once by the Persians about 400 B.C. and again by the Moslems more than a thousand years later, but it was constantly filling with sand and had disappeared long before De Lesseps built his canal. When Napoleon conquered Egypt, he determined to construct a canal, but the survey work was bungled by his engineers, who reported that the level of the Red Sea at low tide was 32½ ft. above the Mediterranean, a *gross error* which held up the project for more than a century. Actually the difference in level between ordinary high and low water at Suez is 3 ft. 9 in., and at Port Said 9 in.; these differences are sufficient to prevent stagnation in the canal, and insufficient to make locks necessary.

Port Said, which before the canal was built was a huddle of mud huts.

Ferdinand de Lesseps

Ferdinand de Lesseps was a French Consular agent, whose early life had been spent in the household of Said Pasha, and who had formed with the latter a lasting friendship. It was not till De Lesseps was fifty years old, that Said came to the throne of Egypt, and the former was able to use his influence with the new ruler in favour of his scheme. There was much political opposition, especially from England, and it was not till five years later that obstacles were overcome and work actually started. It began at the northern end, on a barren, deserted shore, where now stands a thriving port named after Said Pascha (Port Said). The first two years were mostly taken up in preliminaries, surveys, the erection of workshops, and the assembling of machinery, but by 1863 the Canal reached Lake Timsah. Soon after Said died, and was succeeded by his nephew Ismail, whose name is now remembered in the thriving Canal town of Ismailia, which is now the headquarters of the Canal Zone defence and was British G.H.Q. during the war. Meanwhile, there had been great agitation in England and elsewhere, as to the condition of the twenty-five thousand labourers employed on the Canal. They were practically serfs, being compelled to work, and received only six to eight piastres a day (1*s.* to 1*s.* 4*d.*). The country was a barren desert, water had to be brought on camel back, and when supplies failed, many died of thirst.

(Left) The West Breakwater, three and a half miles long, protects the canal from shifting sands, and is itself a mighty achievement.

Forced Labour Stopped

As a result of diplomatic pressure, the "corvee" (or forced labour) was stopped, but owing to the energy and enterprise of De Lesseps this proved a blessing in disguise. A fresh-water canal was cut to supply drinking water, and was ultimately extended to both ends of the Canal, and still conveys water to both Port Said and Suez. The construction of this drinking water aqueduct was a feat only second in importance to that of the maritime canal itself; it crosses salt lakes on an embankment, with road and railway by its side. It has also caused the desert to blossom like the rose, and the leafy town of Ismailia now stands where once was desert sand. It has luxuriant gardens and parks, and is now the Capital of the Canal Zone, and H.Q. of the British forces, many of whom are now stationed here. When labourers became scarce, De Lesseps adopted the idea of digging a shallow trench by hand labour, and letting the water flow in. The shallow canal thus formed was rapidly deepened by light draught dredgers, and the high wages then paid to workmen influenced the natives greatly in his favour.

Meanwhile great difficulty was encountered in keeping the northern end of the canal open, as drifting sand rapidly filled it up, so in 1867–8 the Western Mole, 2,350 yards, and the Eastern Mole, 1,830 yards, were built. They have since been much extended, and the figures to-day are 6,000 and 2,200 yards respectively.

In 1869 the Canal reached the Bitter Lakes, and 1,500 million cubic metres of sea water flowed in, taking six months to fill up. The final triumph was now in sight, and the date of formal opening was fixed for November 17th, 1869, but plans were almost spoiled at the eleventh hour. On November 2nd, a seam of rock was encountered which smashed the buckets of the dredgers, and stopped all work. But De Lesseps blew it up with gunpowder, and the work continued, but on the 16th, the now completed canal was blocked by an Egyptian frigate which ran aground, and stuck fast; while the Empress Eugenie was actually on her way to open the Canal. De Lesseps said he would blow up the ship, rather than delay the official opening; but, happily, it was refloated, and on the appointed day, the *Aigle*, bearing the Empress and M. de Lesseps, proudly proceeded through the Canal to the Red Sea, followed by a flotilla of vessels of all nations.

Port Said, which, before the Canal was a huddle of mud huts at the edge of a desert; is now a flourishing town of more than a hundred thousand inhabitants, and one of the world's great ports. Since the War, a model town for the Canal employees has been erected opposite Port Said, and named Port Fuad, after the late King of Egypt who opened it.

(Right) The West Breakwater and Canal, Port Said.

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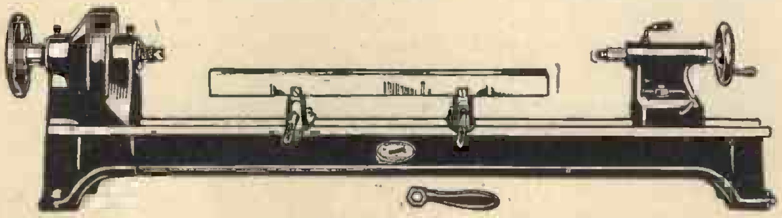

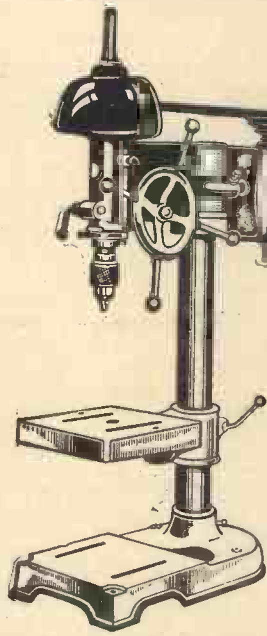

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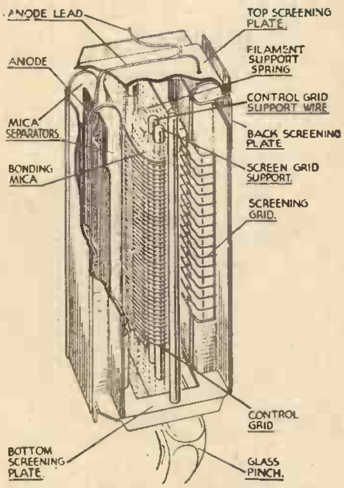

HIVAC VP215 (4-pin)
Illustration shows construction of the two Faraday Boxes.

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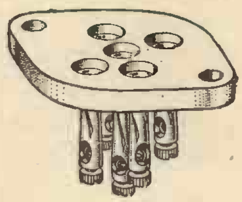

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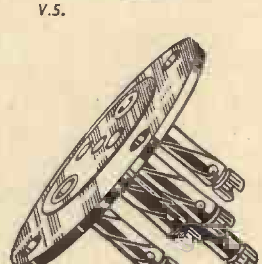

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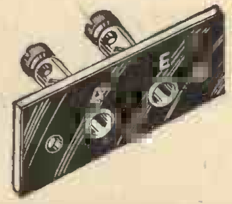

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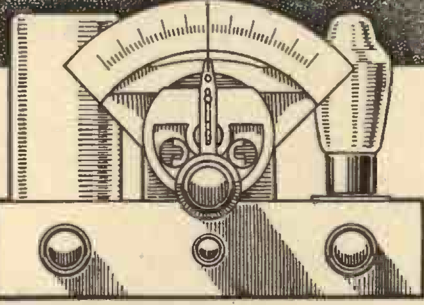


THE EASY-TO-BUILD THREE

It will be seen that the circuit of the "Easy-to-build Three" is of the standard screen-grid, detector, pentode type with bandpass tuning for selectivity, but incorporating special arrangements for cutting out the first coil for purposes which will be described later.

A parallel-fed H.F. transformer coupling is used between the H.F. and detector stages, giving high stage gain and stability of signal strength. Differential reaction with its enormous advantages is employed, and the low-frequency transformer is parallel fed, giving a mild degree of bass resonance partially to counteract the accentuated H.F. response of the pentode.

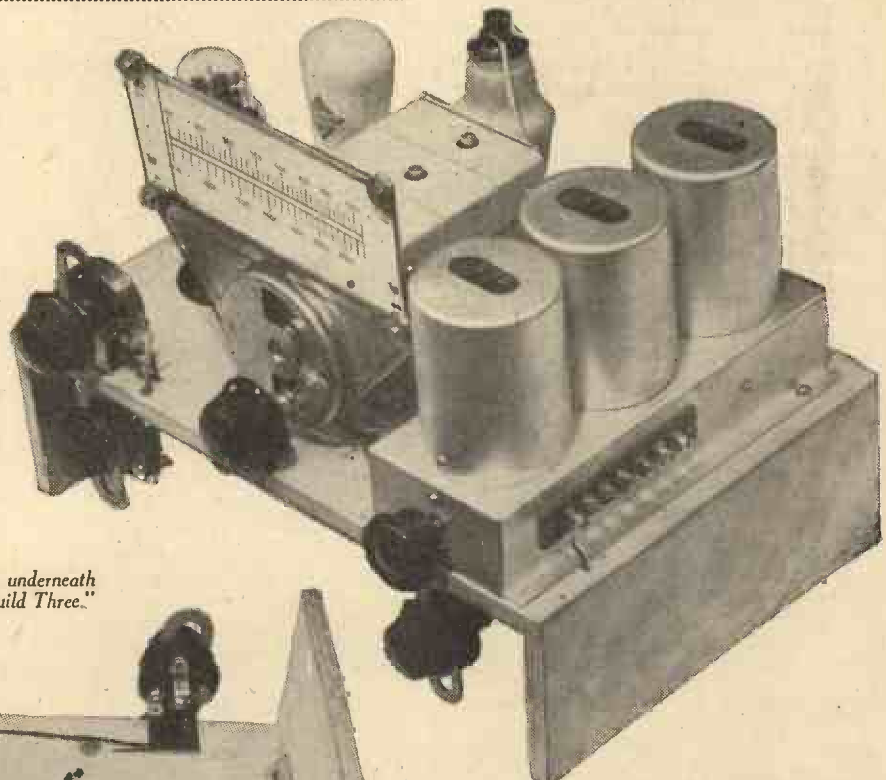
It was not considered advisable to fit tone control, but it may be added if desired. All that is required is the usual 10,000-ohm resistance in series with a ·01-mfd. condenser shunted across the speaker. Note that the on/off switch is so connected that it breaks the grid-bias circuit and thus avoids discharge of the G.B. battery through the H.F. volume control.

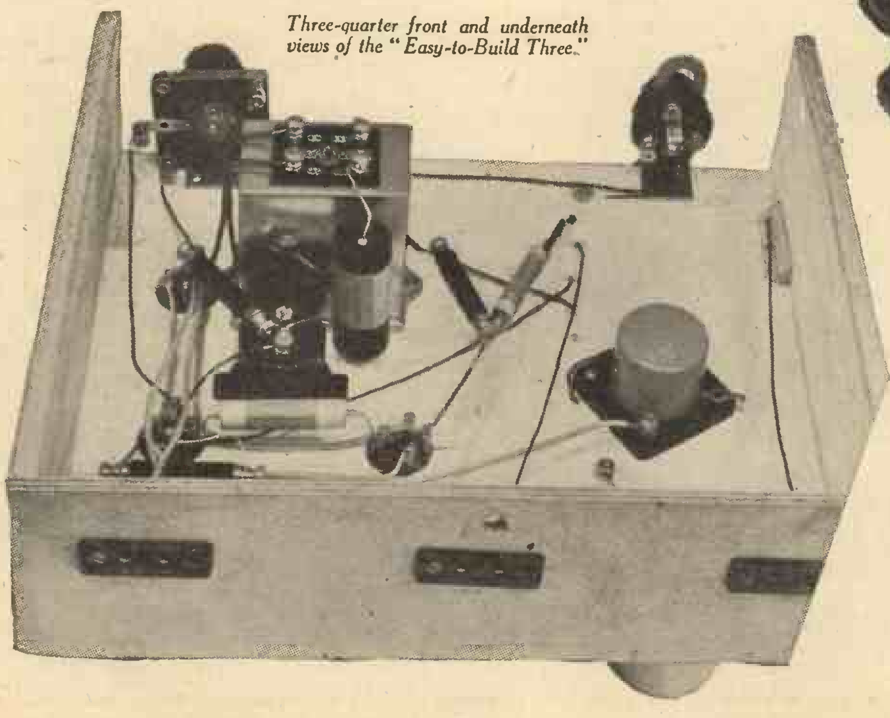
Construction

The constructional work may be undertaken by the novice with the utmost confidence, and the work will be greatly simplified if a chassis is obtained ready drilled. If this is done, then the only tools which will be needed are a screwdriver and pair of pliers, although soldering should be resorted to in certain places. However, even this may be dispensed with in an extreme case and connecting links employed. As will be seen from the wiring diagram there are three large holes for the valve-holders, and if you are drilling your own chassis these should be cut with a 1-in. bit, and for the socket strips on the rear of the chassis separate $\frac{3}{8}$-in. holes may be drilled to clear each socket, or slots may be cut to accommodate both sockets in each strip. An additional hole, $\frac{3}{8}$-in. or $\frac{1}{2}$-in. in diameter, may then be drilled at any convenient position on the rear runner through which the multi-battery cord may be passed.

Drilling Operations

It will be seen from the wiring diagram that there are also a number of small holes in the chassis through which the connecting wires are passed and these are numbered from 1 to 8. These may be drilled with a $\frac{1}{8}$-in. drill, and when making these holes an additional one may be drilled near the end terminal on the coil chassis, next to the group of terminals marked on the wiring diagram "Not used." It will be seen that the end terminal is not included in the bracket identifying these terminals, and it will be explained later how this extra terminal may be employed as an additional aerial connection. To facilitate wiring, the holes may be numbered as on the wiring plan on both the top and the underside of the chassis, and then the valve-holders and socket strips may be screwed into position.





Three-quarter front and underneath views of the "Easy-to-Build Three."

Wiring

Each constructor has his own idea as

to the best method of carrying out wiring, and there are several schemes which may be adopted. Firstly, the under-chassis components may be mounted, and all wiring on this side completed, whilst the chassis stands firm in an upside-down position. On the other hand, all the components may be mounted, and to enable the chassis to be stood firmly in any position side supports of scrap wood may be fitted to the side runners and cut to such a length that they clear the coil screens. The first method is the simplest, and by passing good long pieces of connecting wire through the appropriate holes when the underside is wired the operation of wiring may be practically completed before the chassis is turned over and the upper components placed in position and the leads then joined to the respective terminals.

Wire-ended Condensers

The wire ends which are fitted to the fixed condensers will, in the case of $C7$ and $C10$, enable these components to be connected direct to the valve-holder sockets and the H.F. choke and transformer. In the case of $C6$ an additional length of wire will have to be attached to one end to enable connection tobe made, *via* hole No. 2, to the coil unit. The resistances will be supported by the connecting wires, and thus a fairly stout wire should be used for this purpose, as there is a moderate weight in the resistances and it is necessary to guard against short circuits which might arise owing to the resistances falling slightly when the chassis is reversed. It will be seen in the wiring plan that the coil unit is held down to the wooden chassis by four bolts and nuts, two of the locking nuts acting as earth return points (marked M.B.). An alternative scheme would be to employ ordinary wood screws to hold down the coil unit and to pass wires through additional holes in the chassis connected to the heads of the screws. The first method will prove more efficient, and it is a good plan to make quite certain that the surface of the metallised chassis and the flanges of the coil unit are perfectly clean before fitting the two together, and no difficulties will then arise at a later date due to poor contact.

Precautionary Measures

It will be noted that the on off/switch and the reaction condenser are mounted on component brackets screwed to the underside of the chassis, and this is of

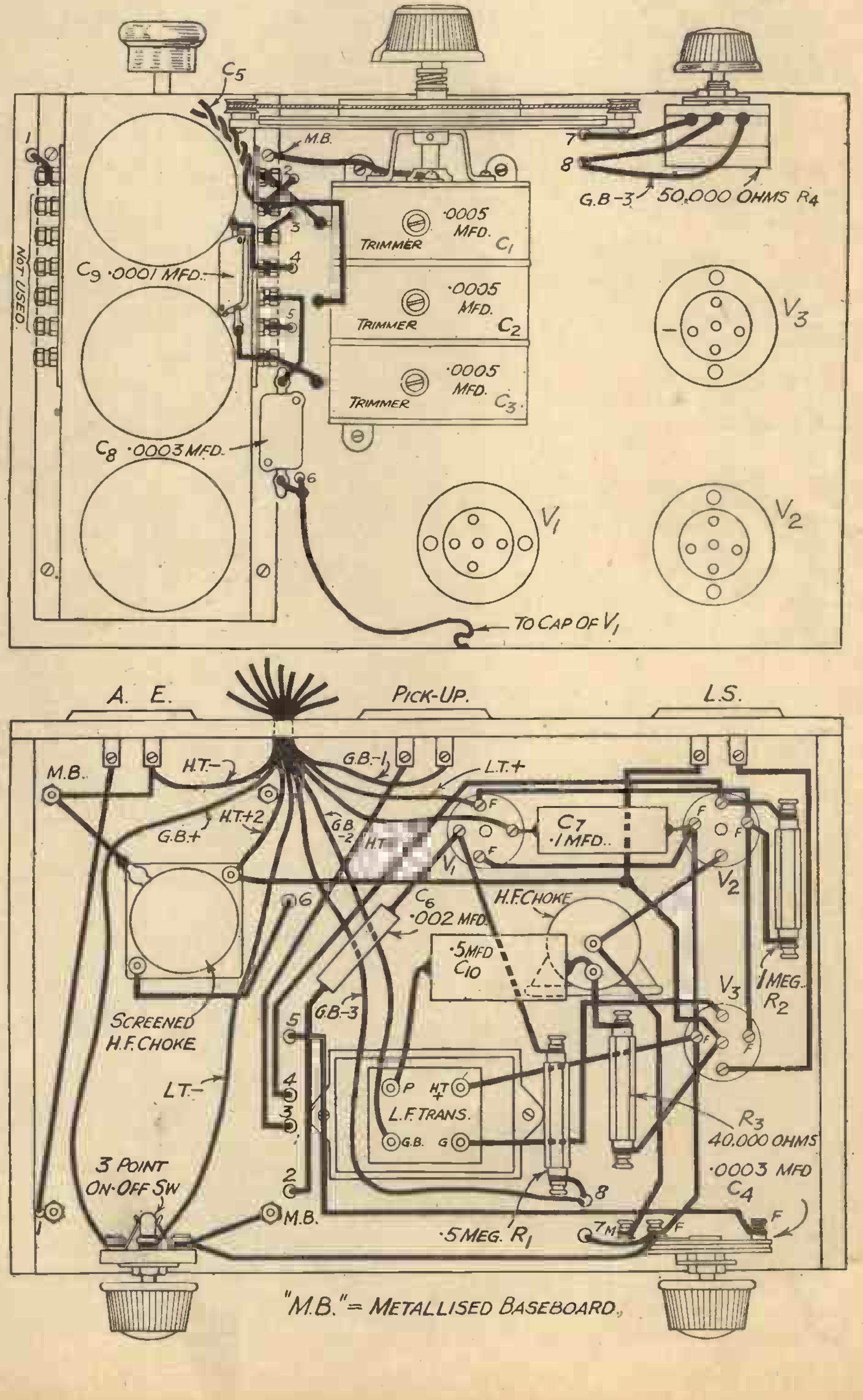
List of Components for the "EASY-TO-BUILD THREE"

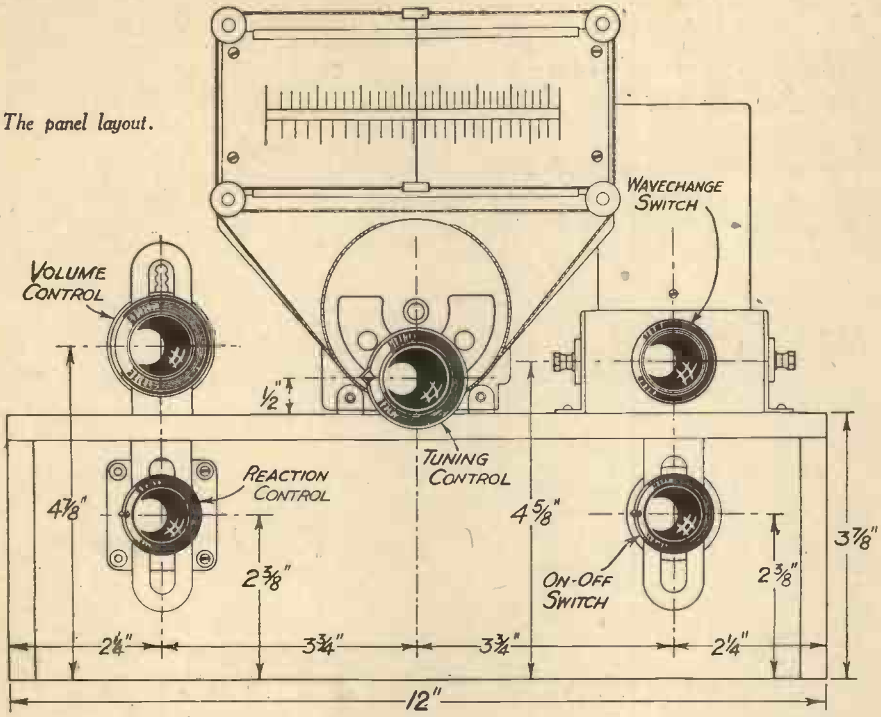
- One set of Tutor Coils on Chassis (B.T.S.).
- One Three-gang Midget Condenser (·0005 mfd. each section) ($C1$, $C2$, $C3$) (Polar).
- One V.P. Horizontal Drive (Polar).
- One ·0003-mfd. Differential Reaction Condenser ($C4$) (Graham Farish).
- Five Fixed Condensers:
  - ·0001 mfd., type M. ($C9$)
  - ·0003 mfd., type M. ($C8$)
  - ·002 mfd., tubular ($C6$) T.C.C.
  - ·1 mfd., tubular ($C7$)
  - ·5 mfd., tubular ($C10$)
- Three Fixed Ohmite Resistances, 40,000 ohms, 5 megohms, and 1 megohm ($R3$, $R1$, $R2$) (Graham Farish).
- Two H.F. Chokes: one type H.M.S., one Disc type (Graham Farish).
- One 50,000-ohm Volume Control, type VC.47 ($R4$) (Bulgin).
- One Ace L.F. Transformer (1 : 3) (Telsen).
- One Three-point Switch, type S.36 (Bulgin).
- Three Socket Strips, A.E., L.S., P.U. (Belling-Lee).
- Three Chassis-type Valve-holders: two 4-pin and one 5-pin (Clix).
- Three Mounting Brackets (Peto-Scott).
- Seven Wander Plugs: H.T.,— H.T.1, H.T.2, G.B.1, G.B.2, G.B.3, G.B.+ (Bowspring) (Belling-Lee).
- Two Spades, L.T.+ and L.T.— (Belling-Lee).
- One Metallised Chassis, 12 in. × 8 in. with 3½-in. runners (Peto-Scott).

ACCESSORIES

- Three Valves, V.P.215 (Four pin), D.210, Y.220 (Hivac).
- One 120-volt H.T. Battery, Drydex Superlife (Exide).
- One 9-volt G.B. Battery, H1001 (Drydex).
- One 2-volt Accumulator, DMG-C. (Exide).
- One Model 36S Stentorian Loud Speaker (W.B.).
- One Tutor Cabinet (Peto-Scott).

A Top and Underneath Chassis Wiring Diagram of the "Easy-to-Build Three"





The panel layout.

plain wood. Thus, there is no connection between the spindle of the switch or the moving vanes of the reaction condenser. Therefore, when mounting these two brackets very short screws should be employed (¼-in. round-head No. 4 screws will be found ideal), and it will be seen on examination that if any longer screw is employed there is a risk of it protruding as far as the upper metallised surface and thereby connecting these two points together, with the result that the H.T. supply will be short-circuited through *R*3 and the H.F. choke. If the chassis is handled very much during constructional work there is a risk also of poor contact due to grease from the hands, and also a fracture of the metal surface. The coil unit is, however, connected direct to the earth terminal *via* one of the fixing bolts, but the condenser assembly normally obtains contact with the rotors through the mounting feet. It will be seen that the precaution has been taken of connecting a wire from the front of the condenser chassis to one of the holding-down bolts on the coil unit, and in this way any possibility of trouble arising has been overcome, but it is necessary to make certain that the wire makes good clean contact with the coil unit side runner.

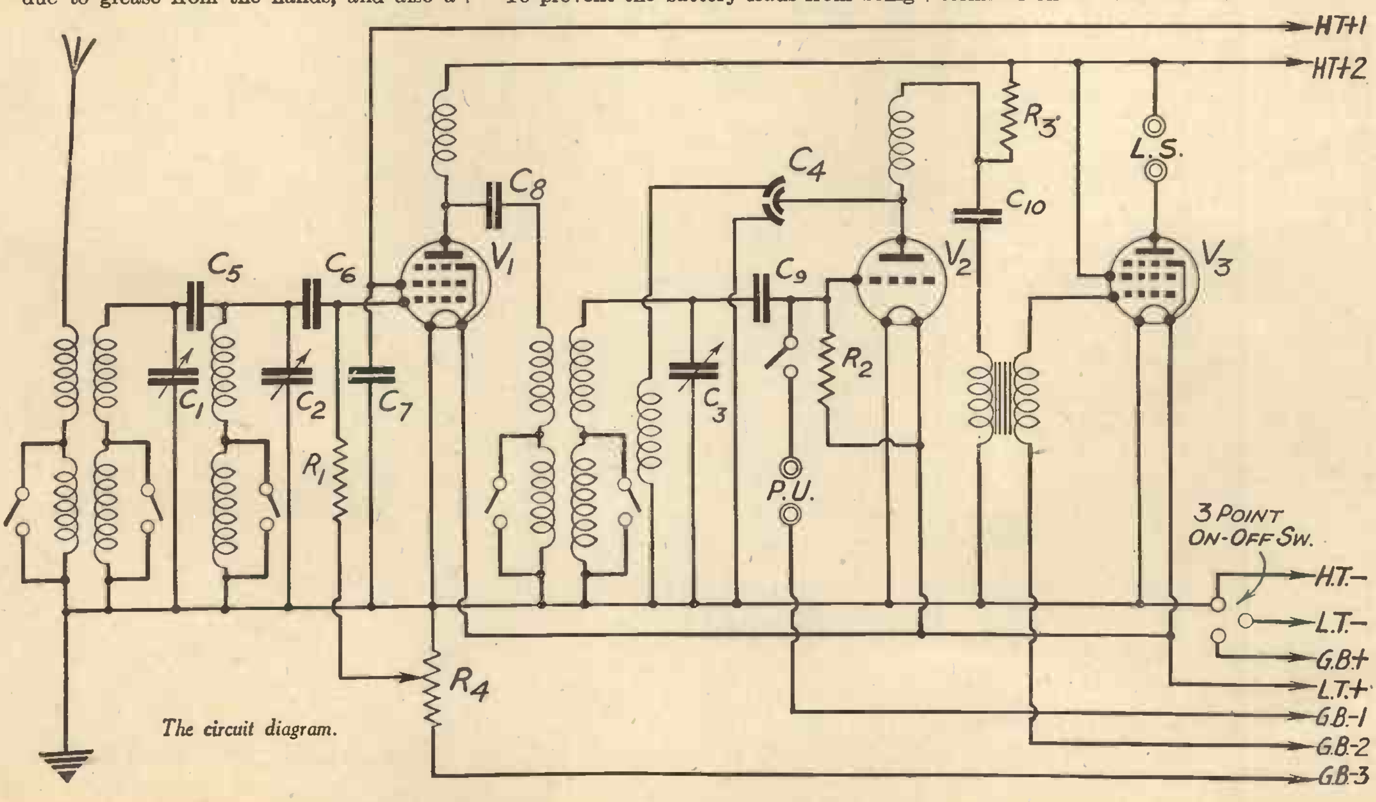
Battery Leads

To prevent the battery leads from being pulled away from the various connecting points a piece of insulating tape may be wrapped round them on the inside of the chassis so as to form a large " knot " which will not pull through the hole drilled in the rear of the chassis, but alternatively a small ebonite or wooden cleat may be cut and screwed across the cords on the rear strip. Do not be tempted to use a strip of metal for this purpose, as it may rub against the leads and cut through the insulation and thereby result in a short circuit.

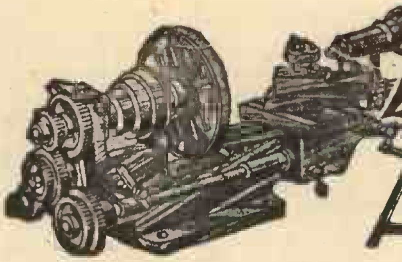
Operating the Receiver

The tuning-in of programmes is accomplished on the " Easy-to-Build Three " merely by the manipulation of the single knob tuning control. Volume is regulated by the upper left-hand control, whilst the strength of weak stations is increased by the lower left-hand control. The right-hand top control merely changes the wavelength upon which the receiver functions, whilst the lower right-hand control switches the set on and off. Before maximum results will be obtained the condenser must be adjusted so that each coil is tuned to the same wavelength, and this preliminary trimming must be carried out carefully in order to reap the full benefit of the three-circuit tuner. Choose a weak station at the lower end of the medium-wave band, and if necessary use the reaction control in order to obtain a sufficiently strong signal to make the process simple. Then with an insulated screwdriver carefully turn the trimming screws first in one direction and then in the other. As soon as the signal increases in strength the reaction control must be turned back, and in this way the procedure is carried out always on the weakest signal which can be heard. When no further improvement can be effected, the set should be turned to the upper end of the medium-wave band and a further station trimmed.

The sensitivity with the band-pass tuned circuit may be modified by eliminating one of the coils, and for this reason the aerial lead should be transferred to the end terminal on the coil chassis.



The circuit diagram.



Lathe Work FOR AMATEURS

A MILLING ATTACHMENT FOR THE LATHE

A SMALL milling attachment for a screw cutting lathe is shown in the accompanying drawings. It is suitable for a 6-in. lathe, and can be adjusted to suit smaller or larger tools. In Fig. 1 is shown a side view, in Fig. 2 a rear view from the operator's end, and in Fig. 3 a plan.

There are only three main parts—*A*, *B*, and *C*, shown in Fig. 2. *C* is a simple cast-iron base $\frac{3}{4}$ in. thick, and can be made of a size to suit the lathe compound slide-rest. It is bolted down to the latter by the stud which holds the tool-post; this latter being removed when the milling attachment is to be used. *A* is a gun-metal casting, the shape and dimensions of which are all given from Figs. 1, 2, and 3. It has a vertical and a horizontal member (all one in the casting). The vertical member slides up a circular column *B*, which is screwed and locked in the cast-iron base plate. It is bored out parallel on the lathe face plate to $1\frac{1}{4}$-in. diameter—the diameter of the column *B*—and is drilled transversely to take the clamping bolt and nut, and is then slotted down as shown in Fig. 3, so that it may be clamped tightly to the column.

The Column

The column can be made from a piece of bright mild steel bar $1\frac{1}{4}$-in. diameter, and 5 in. long. At the bottom it is turned down to $\frac{3}{4}$ in. for $\frac{7}{16}$ in., and the $\frac{13}{16}$ in. at the end is turned down to $\frac{5}{8}$ in. and screwed with a Whitworth thread—11 threads to the inch. This takes the lock nut. It fits into a recessed or counterbored hole in the base plate and screws into the reduced tapped length of this hole. The fitting is shown in section in Fig. 1. The top of the column is shouldered to take the $\frac{3}{8}$-in. thick top plate which forms an outward bearing for the draw-screw. Fig. 4 shows the arrangement.

The top of the column is reduced (for just under $\frac{3}{8}$-in. length) to $\frac{3}{4}$-in. diameter to form a spigot and shoulder to fit the top plate. The latter is shown in plan view below the section which shows how the plate fits on the spigotted end of the column and is held down by a $\frac{3}{8}$-in. Whitworth set-screw and a washer.

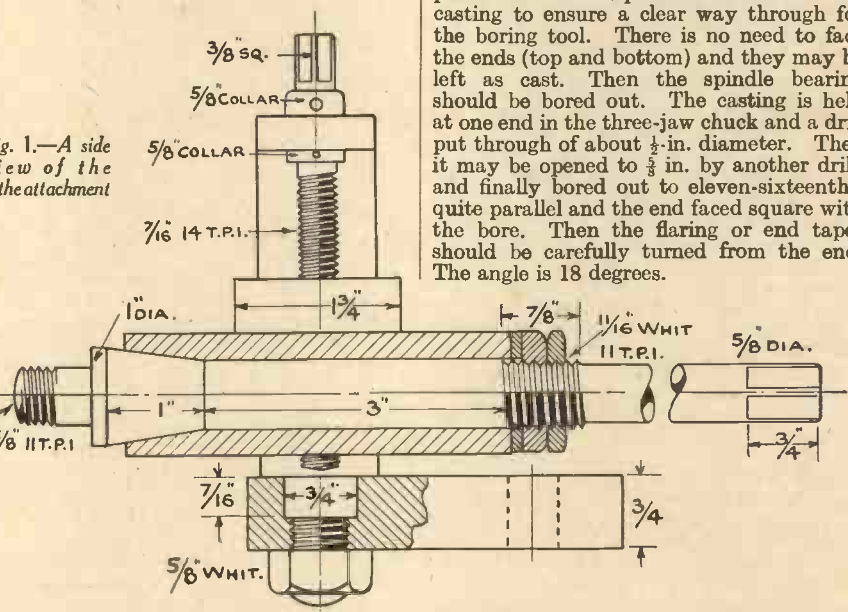


Fig. 1.—A side view of the lathe attachment

The Top Plate

In this top plate, which can be made of a piece of $\frac{3}{8}$-in. iron plate, is the top bearing for the draw-screw, the centre of this being $\frac{15}{16}$ in. away from the centre of the column.

The casting *C* should be made in gun-metal or brass. It is quicker to machine, and it provides also an antifriction bearing for the milling-cutter arbor or spindle. The wooden pattern is simple to make. The horizontal length which forms the long bearing for the cutter spindle, can be turned from a piece of hard wood and recessed, pinned and glued in the block *A* (Fig. 2). The latter has a long lug similarly recessed into it at the back. The pattern can be solid as far as the spindle bearing is concerned; but the upright part to take the pillar may have core prints top and bottom, so that the foundry will core out the centre hole. The core prints should be $\frac{3}{4}$ in. long and 1 in. in diameter. This will leave room for carefully boring the $1\frac{1}{4}$-in. hole to fit the column.

To do this, the casting, *A*, should be bolted to the lathe face plate with packing pieces between the plate and the face of the casting to ensure a clear way through for the boring tool. There is no need to face the ends (top and bottom) and they may be left as cast. Then the spindle bearing should be bored out. The casting is held at one end in the three-jaw chuck and a drill put through of about $\frac{1}{2}$-in. diameter. Then it may be opened to $\frac{5}{8}$ in. by another drill, and finally bored out to eleven-sixteenths, quite parallel and the end faced square with the bore. Then the flaring or end taper should be carefully turned from the end. The angle is 18 degrees.

The Top Slide

This should be set over 9 degrees to bore this cone bearing, and the setting should be marked so that it can be used to turn the coned end of the spindle.

After completing the bore of the bearing, a deep spiral groove should be run up it by a sharp round-nosed inside tool; this groove should have about one turn in 2 in., and is to help in lubricating the spindle. The spindle should be turned out of cast-steel round bar, 1 in. in diameter. The length will depend on the lathe on which the attachment is to be used.

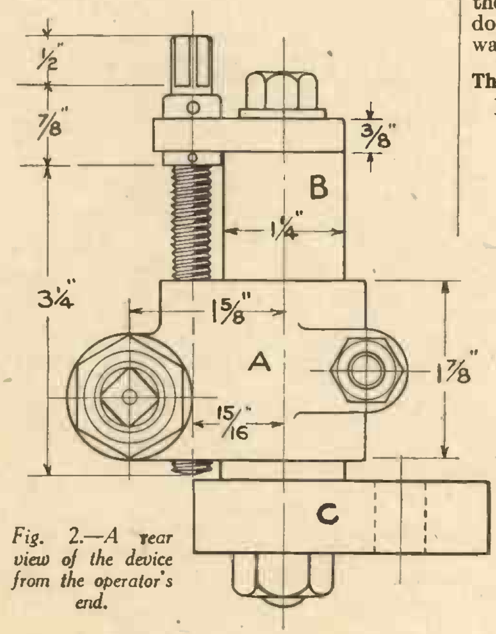


Fig. 2.—A rear view of the device from the operator's end.

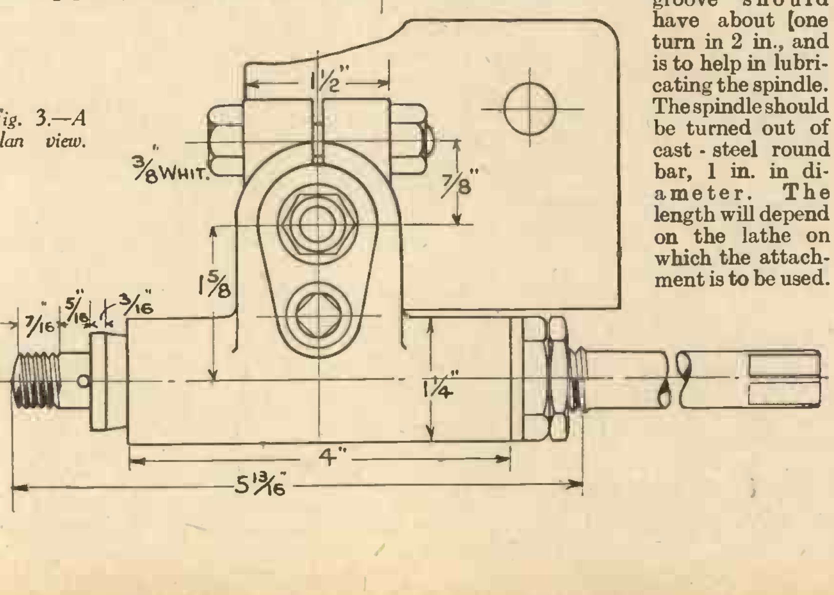


Fig. 3.—A plan view.

It should project far enough to prevent its handle fouling any of the slides or draw screw handles of the compound slide rest. An overall length of 10in. should, generally, be enough.

In the drawing the dimensions are only given for the front end. The nose is $\frac{5}{8}$ in.

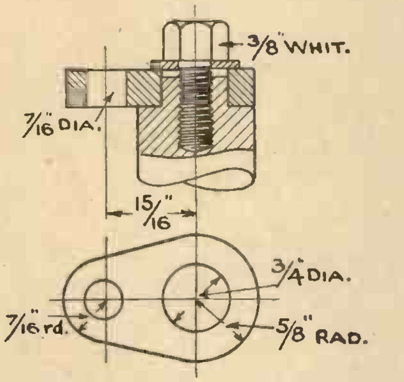


Fig. 4.—The outward bearing for the draw screw.

in diameter up to the 1-in. shoulder. Part of this is screwed $\frac{5}{8}$-in. Whitworth eleven threads per inch. This is to take the washer and nut to hold the milling cutter which is driven (or prevented from turning on the spindle) by the pin shown in Fig. 3, which is of $\frac{1}{8}$-in. cast steel driven into a radial hole in the spindle nose close up against the shoulder.

The taper is turned down with the slide set over to the angle required and is continued till the diameter reaches eleven sixteenths of an inch. There can be little—very little—rounding in here so that the tool can come along the parallel bearing part and clear the end without touching the taper.

Testing the Slide

The top slide of the lathe should be tested to see that all is parallel, or a sliding cut should be taken along by the self feed to ensure parallelism. The same precaution should, of course, have been taken when boring out the spindle boring.

The thread at the end of the parallel part is then cut. It is standard Whitworth and carries a nut and a lock nut with a steel washer to face up to the end of the bearing. The rest of the length of the spindle is turned down to bottom thread diameter, which will be a trifle less than $\frac{5}{8}$ in. Actually 5·7 in. It must be just small enough to allow the two lock nuts and the washer to be pushed along it up to the threaded portion. The end of the spindle is squared $\frac{1}{2}$ in. across the flats.

The top plate for the pillar *B* shown in Fig. 4, should be bored to fit the reduced end of the pillar and bed down on the shoulder

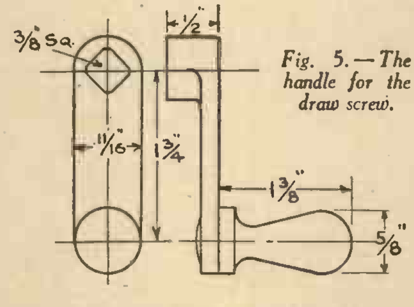


Fig. 5.—The handle for the draw screw.

and the set screw and washer should be put on and the plate fastened, the casting *A* having previously been put on the pillar and both lined up central with each other. Then the centre for the $\frac{7}{16}$-in. diameter hole shown in plan in Fig. 4 should be marked off at $\frac{15}{16}$ in. from the centre of the pillar and drilled down, tapping size, through the plate and through casting *A*. The hole in casting *A* should then be tapped right through with a $\frac{7}{16}$-in. Whitworth tap. The draw screw is of $\frac{7}{16}$-in. diameter all along and screwed for $3\frac{1}{4}$ in. and the rest left plain to size. The square on the end should be cut and two collars turned and bored to fit and, when the whole is assembled in the casting *A*, and the plate *B*, the collars and spindle should be bored through and taper pins fitted through both collars and through the spindle.

The Handle

The handle (Fig. 6), for the cutter spindle, and the handle (Fig. 5), for the draw screw, (for raising and lowering the spindle to feed the cutter into the work), should be made to size from mild steel strip stock, and the square holes drilled and filed to fit the squares on the milling spindle and the draw screw. The handles are turned from mild steel or brass and shouldered and rivetted in the levers as shown in the sectional view (Fig. 6). The hole in the lever for the draw screw handle will be $\frac{5}{16}$ in., and the handle turned down to fit back of the shoulder. The hole will be countersunk on the back, and the handle rivetted over as in the case of Fig. 6.

When using the attachment, the cutter is above the work and the milling spindle is normally at right angles to the work between lathe centres. The cutter can be traversed in both directions by the com-

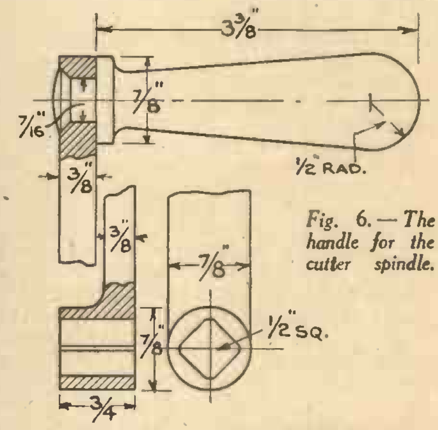


Fig. 6.—The handle for the cutter spindle.

pound rest slides and, if necessary, the cutter can be presented at an angle to the work (as in cutting helical teeth) by loosening the top set screw on the pillar *B*, and the clamp nut of casting *A*, and slewing both round to the required angle on the pillar *B*.

THE MODERN SYSTEM OF METEOROLOGY

To visit the Meteorological Department of the Air Ministry, in Kingsway, London, and to study the working of the Weather Bureau at the Croydon air-port, is to obtain fascinating glimpses of a system which, in its comprehensiveness, accuracy, and speed, is now in many respects unique. From points all over Europe, and from ships far out on the Atlantic, messages pour into the Air Ministry which give information of barometric pressures, temperatures, wind-strengths, cloud-formation, and all such details as are needed in preparing the weather maps which are the basis of the work of the meteorological department. During pioneer stages of civil flying between London and the Continent, pilots were served only by a sketchy system of weather forecasts; and their difficulties were often increased owing to the fact that, in those early days, there was no wireless communication between ground stations and machines in flight.

The System To-day

To-day, not only has a splendid organisation been brought into being for collecting meteorological information, but methods have been established by which all such information is flashed from point to point by wireless, and also communicated from air-ports to air-liners in flight. The position and probable movement of cyclones and anti-cyclones, and of such unwelcome phenomena as quickly-moving secondary depressions, are plotted out on the weather maps—which are being altered frequently to conform with the news flashed in from the network of observing stations.

Speed the Keynote

In addition to all the work of a routine character, experts are constantly making fresh studies of the weather in its flying aspects; and of course an airman's view of meteorological conditions differs considerably from that of those moving about at earth-level. The question of the amount of cloud that there may be in the sky is, for example, an important one to air-liner captains. They are concerned, also, as to the possibility of conditions developing in the air which may cause ice formation on wings and control surfaces. And of course it is essential for pilots to know what visibility is likely to be at air-ports where they are scheduled to alight.

Speed is the keynote of the whole system. All day long main air-ports are broadcasting news by wireless as to weather conditions in their locality, and this information becomes available immediately for pilots who may be about to start on flights. Arriving at the air-port some little time before they are due to leave, air-liner captains go into the meterological department to see for themselves what weather lies ahead of them along the route they may be scheduled to follow. From this information they plot out a flight just as a ship's captain works out the course of his vessel. According to the varying conditions of wind and cloud, an air captain will decide to fly at different heights during his journey, always looking for assistance from the wind and, at the same time, aiming to fly at a height where his passengers may avoid bumpy air. The functions of meteorology, in its application to flying, deal not only with what is going on at or near ground level, but also with what is happening high up in the air. Aeroplanes ascend daily to collect upper-air data. Small pilotless balloons are employed in tests to ascertain wind-strength and direction at various heights. In foggy weather special observations are made to determine the height of fog-banks above the ground. In winter, too, the experts are keenly on the look-out for conditions likely to bring about ice formation, and the pilots are warned accordingly.

MASTERS OF MECHANICS

No. 10.—Richard Trevithick, the Cornish Steam Engine and Locomotive Pioneer

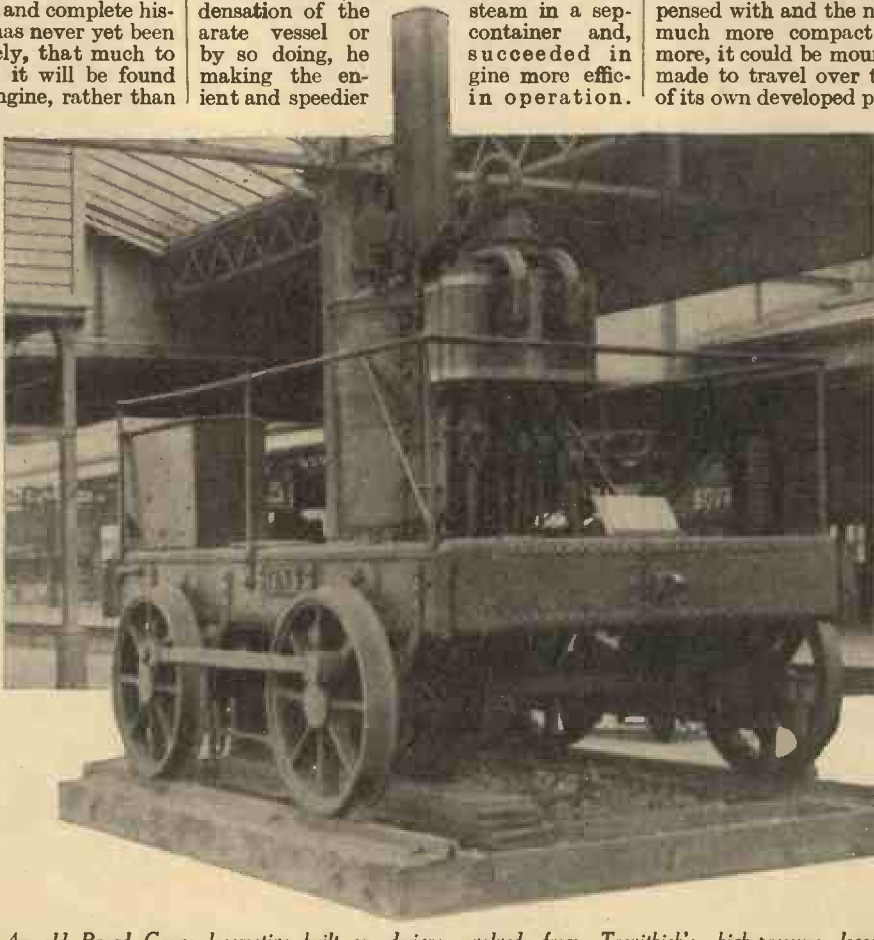
DURING some portion of our schooldays, most of us, unless our instructors happened to be more enlightened than usual, were taught that James Watt invented the steam engine. That is the statement of official history, and, as such, it is still propagated by those who ought to know better. James Watt no more invented the steam engine than the writer of these lines originated permanent waving or submarines or the principles underlying modern refrigeration machinery. As a matter of fact, of course, to no one individual can be ascribed the complete "invention" of the steam engine, just as no single personage can be honoured with the origination of the modern aeroplane.

Unfortunately, the true and complete history of the steam engine has never yet been written. When, ultimately, that much to be desired work appears, it will be found that the modern steam engine, rather than being based upon the much lauded work of James Watt, has been developed upon lines originated by a hitherto more or less obscure Cornish engineer, one Richard Trevithick, by name, who, living in the age which saw the rise to fame of Watt and his shrewd business partner, Matthew Boulton, was forced by a variety of circumstances to witness the commercial success of the Watt-Boulton enterprises and, at the same time, to look upon the seeming failure of his own inventions.

During Recent Years

It is only within comparatively recent years that Richard Trevithick has been accorded a portion of the honour which is due to him. As time passes, however, the work of Trevithick is being assessed by engineering historians at a higher and higher value, and it is becoming clearly apparent that, of the two contemporaries, Trevithick and Watt, the mind of the former was by far the more originative and inventive, if not, perhaps, the more astute one.

Let us, before dealing with the personal side of Trevithick's history, examine, for a moment, the state of the steam engine throughout the eighteenth century. The "atmospheric" engine, invented by Thomas Newcomen at the beginning of the eighteenth century, operated in virtue of the external pressure of the atmosphere upon a large piston on the other side of which a vacuum had been obtained by means of the condensation of steam. The Newcomen, or "atmospheric" engine, although it was put to commercial usages—mainly for mine-pumping—was a very cumbersome and wasteful engine and, in many instances, it was not automatic in operation. James Watt merely took the existing Newcomen engine and gave to it a separate condenser. That is to say he arranged for the condensation of the steam in a separate vessel or container and, by so doing, he succeeded in making the engine more efficient and speedier in operation.



An old Broad Gauge locomotive built on designs evolved from Trevithick's high-pressure locos. It now stands in a Devon railway station.

The Newcomen Engine

Nevertheless, despite the fact that Watt obtained by special Act of Parliament a virtual monopoly of steam-engine manufacture over a period of many years, he was content to leave the Newcomen engine more or less at the stage he found it.

Watt never attempted to construct boilers which would stand up to steam pressure. The Newcomen boiler was merely a hot-water tank. Watt left it as a hot-water tank. At the best, Watt's engines were low-pressure steam engines only and, apart from certain improvements in the matter of obtaining rotary motion from the oscillations of the "beam" or cross-piece of the "atmospheric" engine, even the most advanced of Watt's engines was little more than a converted Newcomen engine.

It is to Richard Trevithick, mining engineer, of Cornwall, that one of the first advances in the application of steam power is due. It occurred to the mind of Trevithick that steam, being an expansive medium, a much more satisfactory engine would be obtained were it possible to construct a boiler which would resist the expanding power of steam so that the entire expansive energy of the latter could be expended upon the piston. If such an engine could be made practicable, the cumbersome and unwieldy mechanism inherent in the Newcomen engine would be able to be dispensed with and the newer engine would be much more compact in build. What is more, it could be mounted upon wheels and made to travel over the ground by means of its own developed power. In all respects therefore, the "high-pressure" engine formulated by Trevithick would represent an enormous and, indeed, a truly radical improvement upon the early Newcomen and the later Watt-Newcomen types of engine.

The High-pressure Engine

The story of Trevithick's active life is, to a large extent, the story of his efforts to build and to make practicable the high-pressure engine, the only radical form of steam engine. Trevithick's life-story, however, is, alas, the tale of a life spent in disappointing endeavour, of a life pitting itself against powerful interests and monopolies, and of a life which came to a close amidst impoverishment! Such is frequently the fate of the pioneer.

Richard Trevithick first opened his eyes in the upper room of a cottage situated in the Cornish parish of Illogan. The date of his birth was April 13th, 1771. His father was a mine manager and thus it is evident that from his earliest years the young Richard was reared in an atmosphere of mechanics and of matters engineering. Young Trevithick went to school at Camborne, which was then a village just a little more than a mile distant. His school-reports were anything but favourable. "Richard Trevithick," the schoolmaster wrote, "is disobedient, slow, obstinate, and spoiled. He is frequently absent and very inattentive." The whole truth of the matter was that Richard was a dreamer. He was not of the ordinary brand of boys.

And, growing up and entering upon the real difficulties of life, Richard Trevithick remained for ever a dreamer, although he diverted the main current of his dreams towards essentially useful and practical ends.

Served with an Injunction

During Trevithick's boyhood, James Watt, in conjunction with his partner, Matthew Boulton, descended upon Cornwall and, in virtue of the Watt patent of 1769, obtained a practical monopoly of steam-engine construction and development. Early in his career as an engineer, Trevithick fell foul of the Watt-Boulton monopoly. We find Trevithick being served, in 1796, with an injunction in respect of his alleged infringement of Watt's master patent. But he cared little about this. Watt's engine, commercially successful though it was, Trevithick saw to be founded upon fallacious and unpracticable principles. Already the dreams of a real steam engine, of an engine which would function by reason of its inherently-developed steam power had assailed Trevithick's mind and in the following year—the year of his marriage—he constructed the world's first "high-pressure" steam engine, that is to say, the first engine which ran in consequence of its internally-generated steam power. The engine was but a model, but it served for the basis of a still more significant model—the working model of a "high-pressure" steam engine which ran along the ground on road wheels which were driven by its own power.

The idea of the locomotive fascinated Trevithick. In his spare time—he was now a Cornish mining engineer—he worked incessantly at the building of locomotive models. At last he succeeded in building a locomotive which was sufficiently powerful to carry passengers and to run on the roads. This was in 1801, and on the Christmas Eve of that year he gave his new locomotive its first practical road trial just outside the village of Camborne.

An Eye-witness Account

The event was an historic one and a colourful account of it has been left by an eye-witness of the proceedings:

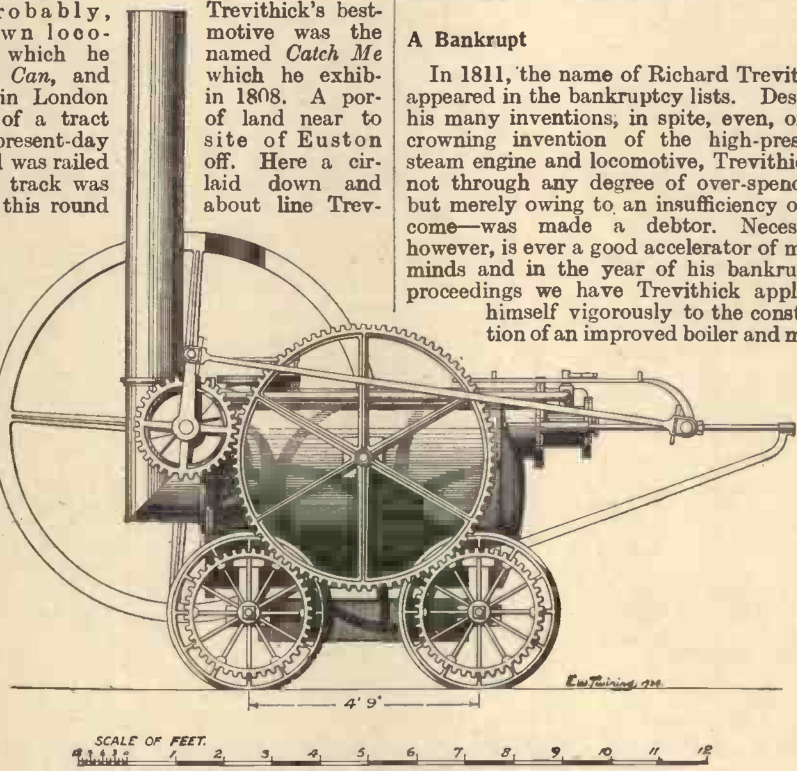
"In the year 1801, upon Christmas Eve, towards evening, Captain Dick (*i.e. Trevithick*) got up steam out in the high road, just outside the shop at the Weith. When we see'd that Captain Dick was a-going to turn on steam, we jumped up, as many as could—maybe seven or eight of us. 'Twas a stiffish hill going up from the Weith up to the Camborne beacon, but she went up like a little bird. When she had gone about a quarter of a mile, there was a roughish piece of road, covered with loose stones. She didn't go quite so fast, and as it was a flood of rain, and we were very squeezed together, I jumped off. She was going faster than I could walk, and went up the hill about a quarter or half a mile farther, when they turned her, and came back to the shop."

Two years later, Trevithick constructed another locomotive on lines similar to the above. This he actually employed on a railroad used in conjunction with a South Wales ironworks. In the same year, he appears, also, to have built a second "road-carriage," as he termed his locomotives, and to have sent this to London.

Trevithick was now making a name for himself as an inventor and a constructor of high-pressure steam engines, both of the stationary and the mobile variety. As was only to be expected, he incurred the wrath of the Watt-Boulton faction by his activities in the steam-engine world. It is on record that Watt himself—the *great* James Watt!—actually stated that his humbler contemporary, Trevithick, deserved hanging for bringing into use his high-pressure engine. Watt certainly did all he could to run counter to Trevithick's activities and it is, in no uncertain manner, due to the opposition which he received that Trevithick's life-work failed to bring comfortable circumstances to him, let alone affluence.

In 1805, Trevithick built a locomotive for a railway at Newcastle-upon-Tyne, and in the same year he succeeded in propelling a barge along a canal by means of paddle-wheels actuated by one of his portable steam engines.

Probably, Trevithick's best-known locomotive was the one which he named *Catch Me Who Can*, and which he exhibited in London in 1808. A portion of a tract of land near to the present-day site of Euston Road was railed off. Here a circular track was laid down and over this round about line Trevithick's *Catch Me Who Can* locomotive ran daily during a period of a few weeks. The engine drew a carriage at the speed of about twelve miles an hour. Admittance to the enclosure was at the rate of a shilling per person, which admittance-charge included the right to a ride in the locomotive carriage for any individual who was more adventurous than the rest.



A locomotive designed by Richard Trevithick, built at Gateshead, 1805.

"Catch Me Who Can"

Ultimately, a rail fractured and Trevithick's new wonder, *Catch Me Who Can*, ran off its track at a tangent and overturned. No one was injured, but the proceeds of the admissions to the enclosure were not sufficient to bear the expense of overhauling the locomotive, and so the railroad exhibit came to an end.

Trevithick's *Catch Me Who Can* locomotive was built upon the high-pressure principle. The steam generated within the locomotive's boiler directly actuated the piston and the movement of the latter was communicated to the rear wheel of the vehicle by means of a reciprocating mechanism. If Trevithick had invented and exhibited his improved steam locomotive twenty years later, he might have made a fortune for himself and have had his memory hailed as the world's first successful locomotive constructor. But Trevithick was, by some strange mannerism of Destiny, just a little too soon with his inventions. "Steam-mindedness" had not yet fully descended upon the country. Railways stretching from town to town were, indeed, mooted in Trevithick's heyday, but, usually, they were pooh-poohed as vain imaginings and utter impossibilities.

The patent literature of the year 1809 contains a number of Trevithick's inventions. In that year, along with another individual, he took out patents for floating docks, iron masts for ships, timber-bending appliances, iron buoys, iron ships, and so on. Even a patent for a process of cooking by steam appears in his name!

A Bankrupt

In 1811, the name of Richard Trevithick appeared in the bankruptcy lists. Despite, his many inventions, in spite, even, of his crowning invention of the high-pressure steam engine and locomotive, Trevithick—not through any degree of over-spending, but merely owing to an insufficiency of income—was made a debtor. Necessity, however, is ever a good accelerator of men's minds and in the year of his bankruptcy proceedings we have Trevithick applying himself vigorously to the construction of an improved boiler and mine-engine and erecting it at the Wheal Prosper mine, in Cornwall.

Much of the success of Trevithick's improved steam engines was due not only to their radically different nature from the Watt-Newcomen engines but, also, more fundamentally, to the strength of the steam boilers which Trevithick constructed. The Watt-Newcomen boilers were only capable of withstanding pressures of a few pounds per square inch. Trevithick's boilers, on the other hand, were frequently able to stand up to internal pressures of 150 lb. per square inch. Trevithick, in reality, gave to the engineering world the well-known Cornish boiler and from this boiler the well-nigh universal Lancashire boiler descended.

In 1821, Trevithick visited Chili on a copper mining expedition. He had already been to Peru in connection with the erection of steam-engine plant. His overseas enterprises, however, were doomed to the same back luck which was accorded to his English activities. After several years spent in South American lands, Trevithick returned to England in a penniless condition.

He died at the "Bull Inn," Dartford, Kent, where he had been lodging, on April 22nd, 1833, and he was buried, by semi-public subscription, in the local churchyard.

Sharpening and Setting Woodworking Tools.—By "Home Mechanic"

In this Second Article the Methods of Setting a Plane and of Sharpening and Setting Saws are Explained.

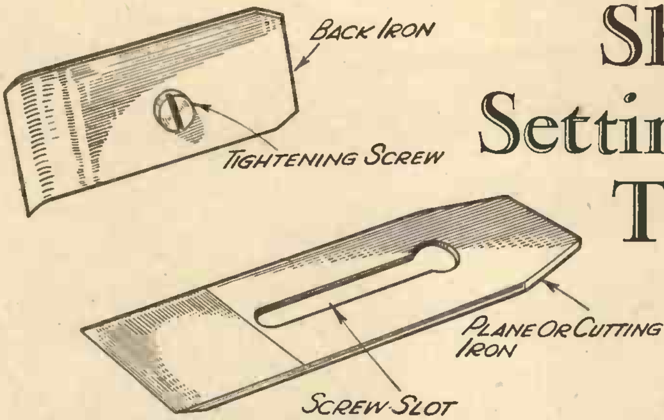


Fig. 1.—Plane cutting iron and back iron or cap, showing how they are fitted together.

HAVING dealt last month with the methods of sharpening various so-called edge tools, it is appropriate now to consider the setting of such tools as planes and saws, and also the method of sharpening the latter. A plane, whether it be of the smoothing, jack or trying variety, is by no means an easy tool to set correctly, and there are many points which must be understood.

In the first place it will be assumed that the plane has a wooden stock, for this type is more generally used than the steel-bodied kind, mainly because it is so much less expensive. It may be imagined that the cutting iron has just been sharpened, as described before, for this gives a definite starting point. The first step is to fit the back-iron or cap, shown in Fig. 1, and this is done by passing the head of the short screw through the circular hole at the end of the slot in the plane iron, placing the cap against the flat side of the blade. Next, the cap is moved along until its edge is between $\frac{1}{16}$ in. and $\frac{1}{8}$ in. away from the cutting edge. The exact distance depends upon the kind of wood with which the tool is to be used, as well as upon the variety of plane which is being used; for a jack plane (normal length up to 14 in.) to be used with soft wood the greater distance may be allowed; when hard wood, such as oak, ash, sycamore or beech, is to be planed the lesser distance should be left; in the case of a trying plane or a smoothing plane, it is possible to go between the two extremes, again depending upon the hardness of the wood.

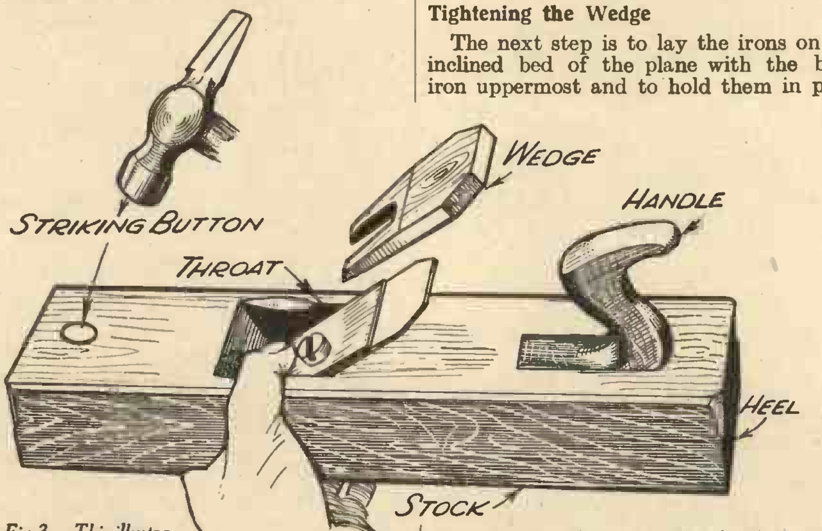


Fig. 3.—This illustration shows the various parts of a wooden jack plane.

Attaching the Back Iron

Having set the cap to the approximately correct distance, the screw can be tightened by means of a screwdriver as shown in Fig. 2. It will be seen that the two irons are held in the left hand with the first two fingers "astride" the threaded brass bush which projects from the cap. Before the screw is fully tightened, again examine the distance separating the edges of the two irons, because this may have been altered. If it is correct, and assuming that the two edges are perfectly parallel, the tightening can be completed.

Tightening the Wedge

The next step is to lay the irons on the inclined bed of the plane with the back iron uppermost and to hold them in place with the left thumb, while the fingers grip the stock. By holding the plane in this manner it can easily be turned in any direction and there is no feeling of "gaucheness." Turn the plane over so that the line of the sole is in line with the eye and, looking down the plane with one eye, adjust the irons until the cutting edge projects a suitable distance from the sole. Once again the amount of projection depends upon the wood to be treated and the type of plane, but generally varies between $\frac{1}{32}$ in. and $\frac{1}{16}$ in. For a smoothing or trying plane, or for a jack plane for hard wood, the cutting edge should appear merely as a fine hair-line running across the sole. It is essential that the amount of projection should be uniform across the sole, with the exception that the extreme ends are slightly curved.

Having adjusted this distance, insert the wedge (see Fig. 3), still keeping the thumb in place holding the irons. Push down the wedge as far as it will go with the fingers, and then strike it with a wide-faced hammer. When the wedge is tightly in place, it is necessary once again to check the projection of the cutting edge, for it might have been increased by driving in the wedge, or the cutting iron might have been turned towards one side so that one corner projects more than the other. If it is found necessary to "take-back" the iron, the method in the case of a jack or trying plane is to strike the button or front of the plane shown in Fig. 3. One quick blow should be given—holding the plane as before when it will be found that the iron has sprung back. Tighten the wedge and examine the projection again; if it is still too great, repeat the process; if it has been made too small the iron can be driven down by tapping the upper end with the hammer.

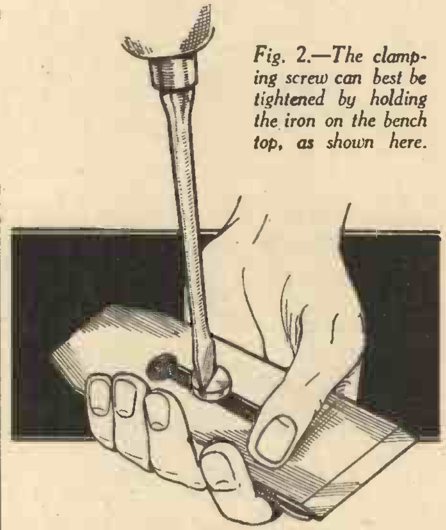


Fig. 2.—The clamping screw can best be tightened by holding the iron on the bench top, as shown here.

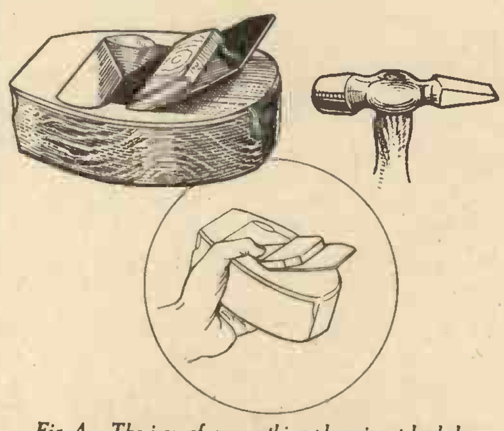


Fig. 4.—The iron of a smoothing plane is set back by striking the heel of the plane with a hammer or mallet.

When dealing with a smoothing plane, the process is similar, except that instead of striking the front of the plane to move the iron backward it is the heel which is struck, as shown in Fig. 4.

The method described above will probably appear somewhat lengthy and tedious, but it is neither. After quite a small amount of practice, the whole job can be done in approximately one minute.

Truing the Sole

While the plane is being used it might occasionally be necessary to reset it because it is found that the iron is "digging-in," or because the wood is being planed too slowly. This can be done in precisely the same manner as the preliminary setting just described.

It might sometimes be found with an old plane that, although the iron is apparently set well forward, it is impossible to cut with it. When the iron is driven down still more, it will probably be found that it "tears" the surface of the wood, or that the plane "dithers," leaving ridges across the wood. This indicates that the sole is worn out of truth, and requires to be straightened. This is a job which the amateur would do well to entrust to a competent joiner, because only a slight amount of wood must be removed, and a steel trying plane is desirable for carrying out the work. A possible alternative is carefully to glue a sheet of coarse glass-paper on a perfectly flat board and, after removing the iron and wedge, to rub the sole of the plane backward and forward over this. Care must be taken that an even pressure is applied to the plane stock, and that the sole is kept in close contact with the glass-paper. After rubbing backward and forward a few times, test the surface of the stock in both directions, and in several places, with a straight edge (a steel rule is ideal). When the sole is true, repeat the process using a sheet of fine glass-paper.

Oil the Stock

After this be careful to wipe off any traces of glass which have adhered to the wood, and then paint the smooth surface with raw linseed oil. Rub the oil into the wood with a rag, and then make one or two additional applications. It is worthy of mention in passing that the whole stock should be painted with raw linseed oil every few months; this keeps the wood supple and prevents cracking or the ingress of moisture. In the case of a new plane it is an excellent plan to stuff up the mouth with a strip of wood or a roll of paper and to fill the opening with oil, allowing this to remain for at least twenty-four hours. The same treatment can be given to an old plane which has been standing idle for some time.

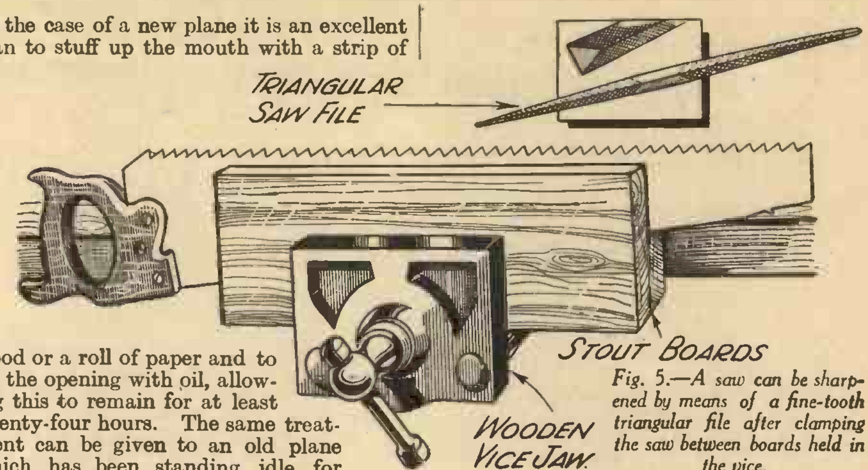


Fig. 5.—A saw can be sharpened by means of a fine-tooth triangular file after clamping the saw between boards held in the vice.

Sharpening a Saw

The sharpening of a saw is work which the amateur rarely attempts, although it is not unduly difficult for those who are prepared to practice—preferably on an old saw. All that is required is a triangular saw file, as shown in Fig. 5. This is a fine file, and an ordinary three-cornered file with coarse teeth must not be used. The saw blade should be held in the vice by clamping it between two stout boards, as shown in Fig. 5.

Fig. 6.—This is a section through a saw, and shows the angle set for the teeth.

Starting at one end, carefully observe the angle at which the teeth have previously been filed, and apply the saw file at exactly the same angle. It will be seen that alternate teeth are filed in opposite directions; the lines of filing are at right-angles to each other, but are not at right-angles to the edge of the saw.

Insert the file between the first two teeth and at the same angle as that to which they have previously been filed (about 80 degrees to the face of the blade) and make about three strokes forward and backward. Next move the file to the *third* space between the teeth and repeat. In this manner *alternate* teeth should be filed over the length of the vice jaws, after which the saw should be moved along until the next 6 in. or so is gripped. Continue in this manner to the end of the blade, always taking care that the file is maintained at the same angle throughout. It is also important that all teeth be filed to the same extent. When one half of the teeth have been filed, the saw should be turned round in the vice, and the remaining teeth sharpened.

Methods of Saw-setting

When the teeth have all been sharpened in this manner they should be set—that is, they must be bent outward slightly so that the cut made by the saw is wider than the blade is thick. If this were not done it would be difficult to cut with the saw due to the friction between it and the sides of the cut.

In setting, alternate teeth are bent in opposite directions, and should each be turned outward to the extent of about 10 degrees, as shown in Fig. 6. There are several methods of setting, the most popular of which is by means of the simple tool shown in Fig. 7, and which consists of a strip of steel with cuts of varying width made in one edge to grip teeth of different thicknesses. All that is necessary is to grip the saw in the vice as before, slip the saw-set over each tooth in turn, and bend it outward; the set merely forms a convenient lever.

Another method is by using a special "automatic" type of tool like that shown in Fig. 8. This is used like a pair of pliers, and after inserting a triangular jaw of correct size for the teeth to be bent it is necessary only to grip the handles to set the teeth to the correct angle.

A method of setting which is not as well known, but which is ideal for use with dovetail saws and others having very small teeth, consists of laying the edge of the saw on a board of fairly soft wood and bending the teeth with a fine pin punch and hammer.

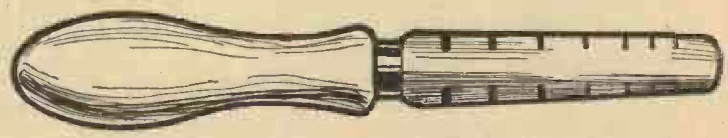


Fig. 7.—A simple saw-set consisting of a strip of steel with notches of different widths. One of these is used to grip the teeth when bending.

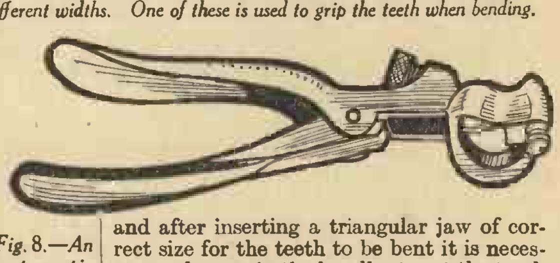


Fig. 8.—An automatic saw-setting tool which is gripped in the same manner as a pair of pliers. Different triangular jaws can be fitted to suit the size o the teeth.

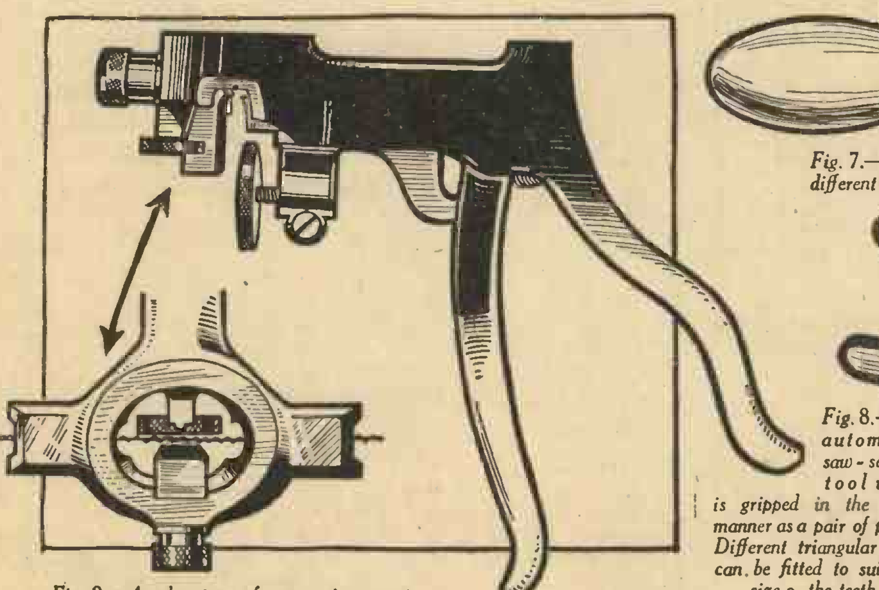


Fig. 9.—Another type of automatic saw-set.

The Latest in Railway Modelling

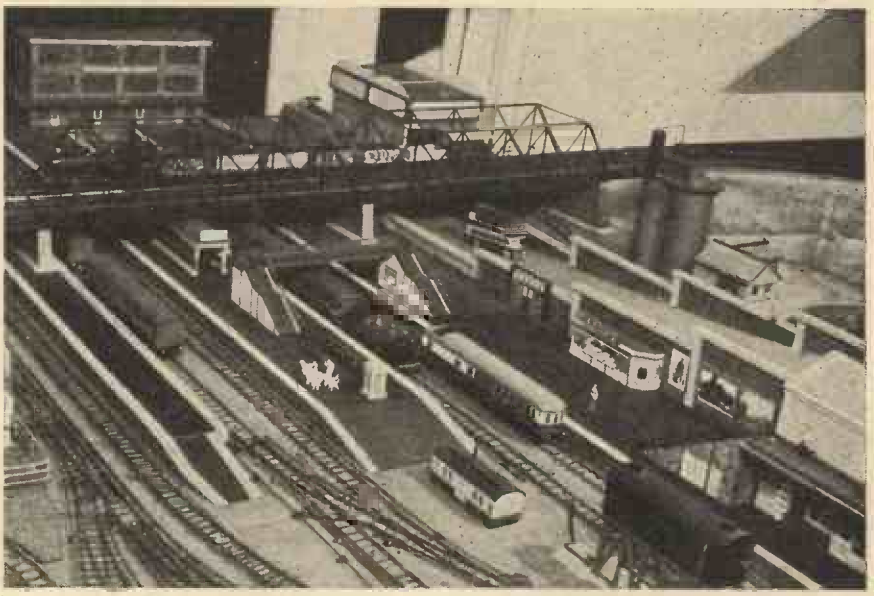


Fig. 1.—A comprehensive view of the West Midland Railway station.

By E. Beal

More about Gravity Hump Yards

HAVING incorporated in the previous article some instructions as to hump wagon-sorting yards, it will perhaps be desirable to proceed forthwith to elaborate somewhat upon the subject. The present stage might be a good one at which to give more detailed information and suggestion. I have stated that this feature is the most attractive one of all railway features to model and operate; the excellent Lanal Uncoupler is largely responsible for making the manipulation of traffic in such a yard practicable. This appliance is almost infallible in its action and makes remote control of shunting work feasible. It is also possible to obtain the new Reidmere locomotive mechanism, for an extra shilling or two, specially geared for this work, so that one has that sluggish yet free and easy movement of the engine which is so necessary. In the large picture which accompanied the last article there is shown an 0.6.0 tender engine built by the writer and fitted with the loop for this uncoupler, as well as being low-geared to a ratio of 40 to 1.

Railway Clearing Houses

It is the frequent practice nowadays to send off trains of wagons as loaded at goods depots, unsorted, to the nearest marshalling yard. This is often located at a point not far away from, but rarely within the immediate bounds of great towns and cities. Here, trains from the depots and docks or from other railways are made up in ordered shipments or series, to be taken off to their specific destinations by main line engines. One long train may be made up into a dozen lesser or local trains. Coal wagons are sorted for their respective companies or owners. At these large yards also those special purpose wagons are picked out and included in trains bound for places where such vehicles are needed. Under the modern Railway Clearing House Regulations, every wagon in use has to be carefully kept account of so that its whereabouts can at all times be traced by reference to documents. The introduction of the gravity or "hump" yards has enormously speeded up the handling of such traffic. Whereas formerly it was necessary for almost every wagon to be pulled and pushed from one siding to another, there is only one movement for each wagon in this modern device. As the train is pushed slowly over the hump by the yard engine, shunters at the summit uncouple the vehicles one by one, and by the operation of various switches in the control cabin divert each wagon to its proper road in the yard. The sudden descent causes the wagons to break away rapidly from one another and allows the necessary space and time between each wagon's movements for the operation of the points from the cabin. The usual speed for a wagon near the top of the hump is about 2 m.p.h. At this speed it sets off down a sharp, short gradient and is given a good start ahead of the following wagon. The gradient then flattens out for a steadier speed of 3 to 4 m.p.h. The gradients vary slightly according to whether the yard is for up or down traffic, and whether loaded or unloaded wagons are the more usual on this up or down road. In America, many such yards have a summer and winter hump, allowing for the condition of lubrication and so forth. In actual practice the requisite gradients are not so very severe, varying as they do from 1 in 25 to 1 in 100 or more.

Speed Regulator

Wagon retarders are frequently installed, by means of which the speed can be regulated after the wagon has broken away from its train, according to the distance it has to travel along its track; if the latter is fairly

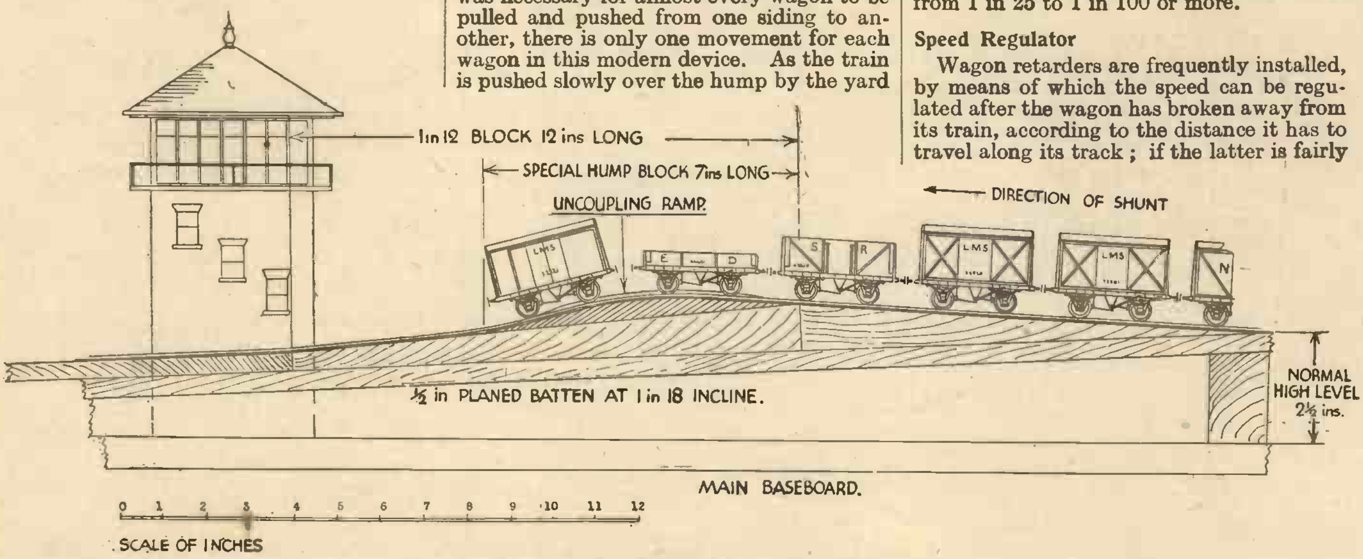


Fig 2.—A sectional view of the hump yard.

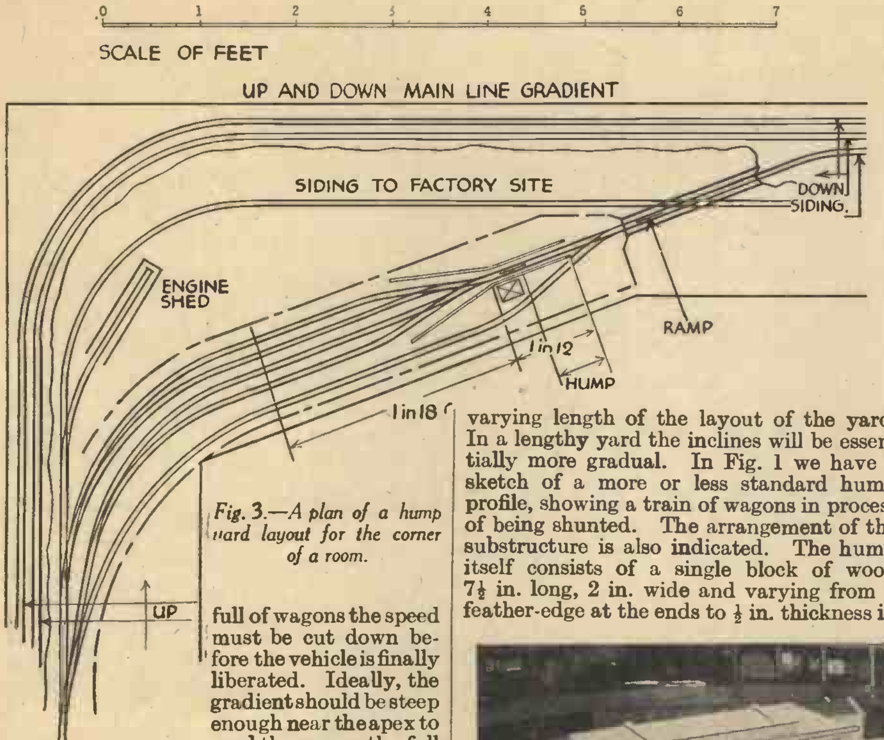


Fig. 3.—A plan of a hump yard layout for the corner of a room.

full of wagons the speed must be cut down before the vehicle is finally liberated. Ideally, the gradient should be steep enough near the apex to send the wagon the full length of the siding, and gradual enough towards the end of the siding to check the wagon before it has run right through. In model practice the gradients have to be much steeper owing to the extreme lightness of the tiny wagons even when loaded. As the vehicles pass over the hump they are weighed while in motion on a weighbridge. There are also tracks immediately near the arrival track for defective wagons and for brake vans, as well as a short siding in which the yard engine finds refuge in order to get behind the entering train from the main line. The actual size of these yards varies greatly with different localities. In a model it is possible, even in the smallest scale, to have only a few sorting sidings, and of course the length has greatly to be restricted. But the OO-gauge and lesser standards are the first real opportunity for the modelling of this feature at all indoors. With the most compact arrangements of the needful tracks there is inevitably a great demand for length of site.

The procedure followed in the sorting of a newly arrived train has already been outlined in the earlier article, and there is no need of repetition. Nor is it necessary to repeat the suggested percentage of the various gradients, except to say that these, of course, will naturally differ with the varying length of the layout of the yard. In a lengthy yard the inclines will be essentially more gradual. In Fig. 1 we have a sketch of a more or less standard hump profile, showing a train of wagons in process of being shunted. The arrangement of the substructure is also indicated. The hump itself consists of a single block of wood $7\frac{1}{2}$ in. long, 2 in. wide and varying from a feather-edge at the ends to $\frac{1}{2}$ in. thickness in the centre. This is carefully shaped on its upper surface to allow the very easy shape of the track-surface when the rails are laid. The other gradients are to be seen in the drawing. In the two plans given the whole of that portion of the yard base which has to be raised at one end is shown by dotted lines. Fig. 1 also indicates the position of the uncoupling ramp, which, since it has to lie on a humped surface, must consist either of springy wood or of other flexible material. It might conceivably be made of some metal strip or other. The main point is that the ramp's upper surface must be of correct height and in perfect alignment with the surface of the rail, though slightly higher all the way, and sloping downwards at the ends.

The Site

It has been said that a good site for such a yard is a position between a high level and a low level main line, so that trains may enter from the former and depart by the latter, and so that the incline falls naturally within the yard limits. But this is not absolutely necessary. The yard may take out from a low level main line provided, of course, that there is allowed enough length for the arrival track, prior to the hump, to rise to the normal high level grade of $2\frac{1}{2}$ in.

Fig. 3 shows a layout plan for a hump yard to suit the corner of a layout. A double track main line at a rising gradient skirts the outer wall of the room, and from the foot of it there turns out a branch single line to say, a factory site in the north-east corner. From the summit of the main line in the north-east there also turns out a short arrival siding for goods trains. A bridge spans the factory siding, and the uncoupling ramp is situated on it. A crossover should be placed in a trailing direction near the summit of the main line, and up trains can enter the yard by taking this crossover; the main-line engine in such an event departing forthwith by the main line and not entering the yard at all. The necessary gradients are indicated, though these are in all cases subject to experiment.

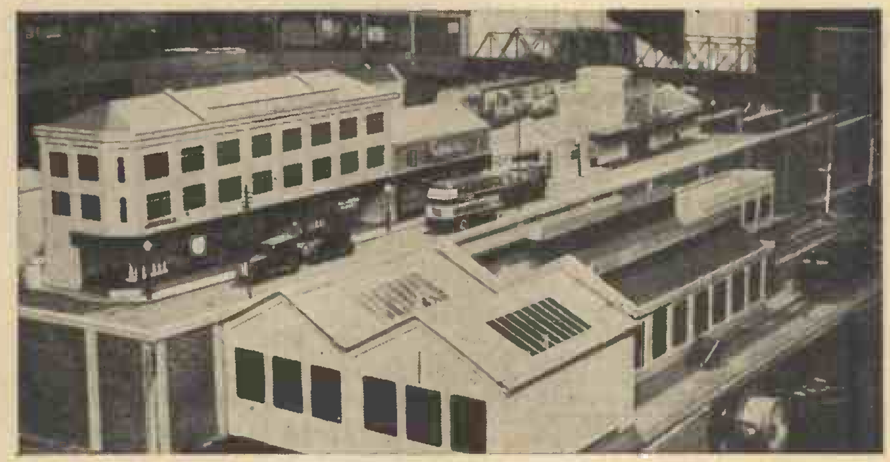


Fig. 4.—A street scene and locomotive depot on the West Midland Railway.

An "Up and Down" Yard

A much more typical standard "up and down" yard for the straight side of a room, and for both sides of a low level double main line, is shown in Fig. 5. In this instance it has been necessary to include a

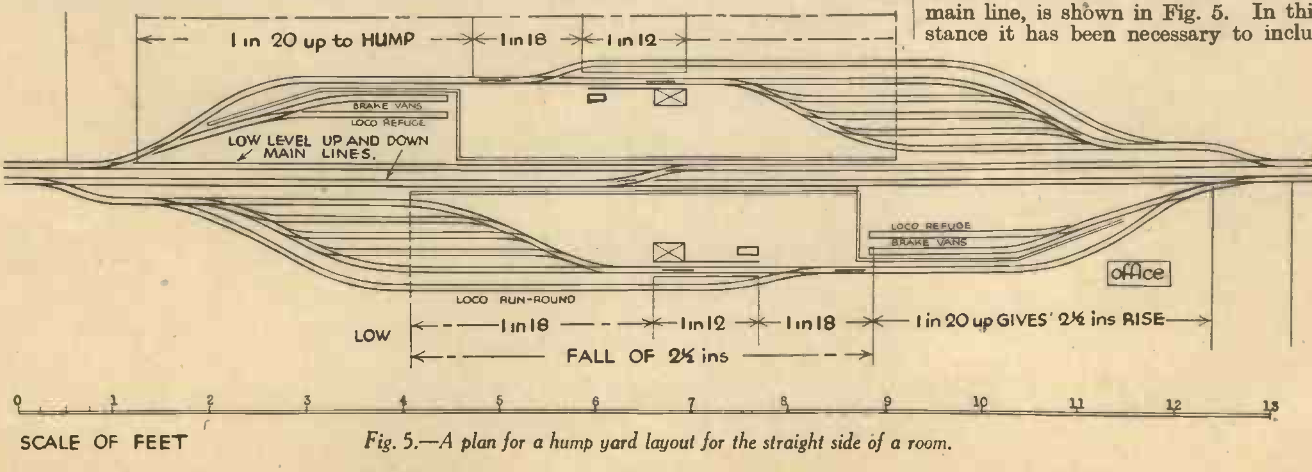


Fig. 5.—A plan for a hump yard layout for the straight side of a room.

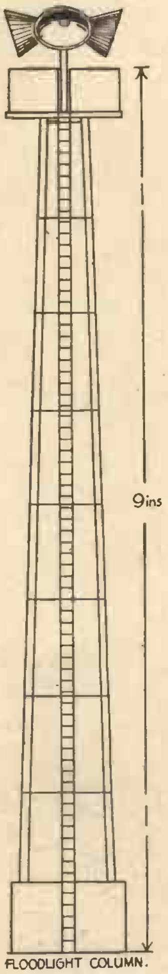


Fig. 6.—Details of a flood-light column.

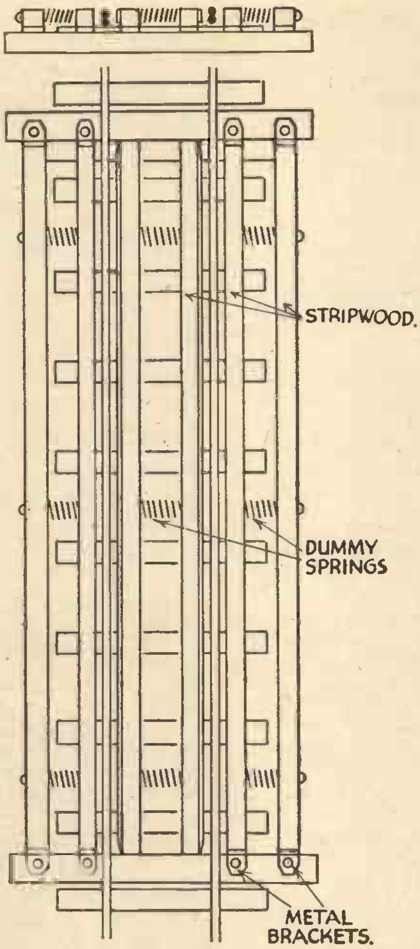


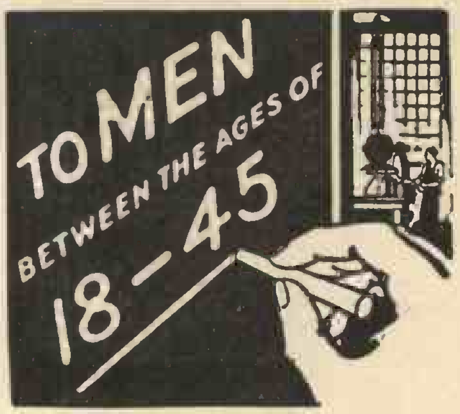
Fig. 7.—A sketch of dummy wagon retarders.

lengthy arrival track so as to secure the needed rise to the hump. Even then, the length is short enough and the gradient is severe—but not too severe for a hump yard. Note that the loco run-round track is intended to avoid the necessity of the engine taking the hump, and it should therefore avoid the ugly gradient of the hump itself. Yet in real practice, as for example at Toton (L.M.S.), the engines themselves pass right over the hump gradients, a fearsome and thrilling sight.

There are naturally a number of buildings and considerable track-side equipment at gravity yards of this order. Food and drink for yard engines must be provided, so as to avoid waste of time in repeatedly resorting to some distant place for these. There is usually, indeed, a fair-sized engine depot in the immediate vicinity, though in a model this is not an essential provided that a small tank and coal reserve are installed. Scales and weigh-house adjoin the outer end of the hump section. There is a small and rather tall signal cabin near the king-point of the entrance grid, and from it all the directions and movements of wagons are controlled. This set of buildings would be duplicated for a double yard as in Fig. 5. There will also be a power house for the track retarders, though the latter would no doubt be left to imagination. Lighting is another important item. Be it observed that hump yards are always much busier during the night than in the daytime, and many forms of up-to-date electric flood-lighting are installed. For 00-gauge these lamp standards would no doubt be dummies, but they are desirable for the effective appearance of the layout. In real practice the yard is frequently wholly lighted from, say, between six and twelve batteries of floodlights placed on steel posts which often reach a height of about 90 ft. A design for such a post is given.

The Control of a Hump Yard

The controlling of a model hump yard for 00-gauge would doubtless be carried out by means of a normal lever frame within some convenient building not far from the signal cabin. The position of the cabin itself will generally render it hardly conveniently near the baseboard edge for this purpose. Perhaps an imaginary yard-master's office could be pressed into service for the task. A suitable lever frame is obtainable from Hambling's, where the requisite angle cranks for point rods can also be had. Ground signals might be included. It is a noteworthy item that there is no need to electrify the sorting tracks on and beyond the hump up to that point where the sorting yard becomes level. There is also no need to control automatically any current for given sections of track. But if the general control of the yard is, as will be found more fascinating, to be carried out from a remotely situated main switchboard, it will be advisable to control all the sorting yard points electrically, and for this purpose the solenoid point-motor (of the double 0-gauge variety) as sold by Miller, Swan & Co., is recommended. It works well over a long period of years if operated by electric push-button switches. Care should be taken in fitting it to see that switch-blades have an absolutely free and untrammelled movement. If a roofing felt formation is used on the layout, strips of this material must be cut away underneath the moving sleepers of the points. The motors themselves may be located underneath the gradient board of the hump, and Reidpath's rocking bars employed to transfer movement of points from above to below the baseboard. A good idea is to make the gradient board to lift out bodily, and to attach the motors to the underside of the board. This renders the whole mechanism easy of access at all times.



THE "HINDENBURG'S" TRANS-ATLANTIC FLIGHT

(*Continued from page* 507)

a waterhole where numerous animals were drinking. What kind of animals could not be distinguished, but the noise of our engines and the glare of the searchlights stampeded them and they all dashed off before we got too close.

When I next left the cabin it was clear daylight. Behind us I saw houses and mosques. We reached Rabat then Casablanca, and so on to Larache, the largest garrison town in Spanish Africa.

Night came on and soon we came in sight of the brilliantly lighted Rock of Gibraltar at the foot of which the lights of the township were reflected on the vessels at rest in the harbour.

I found later that things were not all as they should be. Captain Lehmann was obviously worried. It appeared that we could not venture through the storm-ridden Bay of Biscay owing to motor trouble, and were steering a course for Genoa with a view to passing up over the Swiss Alps. Should weather be unfavourable, we would avoid climbing the Alps and pass eastward of them. Naturally we hoped the weather would be advantageous, for a flight over the great mountains would be glorious.

During the night I awoke several times worried by a noise which seemed unusual. The wind howled about the vessel and above it, inside the ship there was a sound which appeared to be different from anything I had heard before. In the early morning I learned that a motor had given out and a second one was troublesome.

Captain Lehmann was anxious. With two engines only we were all right, given good weather, but storms might be difficult to deal with. I asked the Captain what he intended to do and he told me that in the circumstances they had wirelessed the French authorities for permission to pass up the Rhône Valley across France. With two engines only functioning properly it was too great a risk to try crossing the Alps. About noon we came to the mouth of the Rhône, and then learnt that permission had been obtained to cross French territory. We pushed on, lamely but safe. No one doubted the ability of the *Hindenburg* to get home. In fact, but for the slightly different hum inside the vessel's conditions appeared normal, and there was nothing to cause any excitement. As to speed, perhaps we had slackened off a bit, but it was hardly noticeable. In brilliant sunlight we were able to enjoy the view of this pleasant land of the Rhône Valley as we went northwards, accompanied by French Military aeroplanes, which we learned were not there for our protection but rather to see that we did not deviate from the course set for us, which was a seven miles wide corridor.

There was no further trouble and we passed the frontier without having offended. Lake Constance now appeared a gleaming mass far ahead. With great eagerness we all pressed to the windows to watch. Crowds were gathering everywhere. The weather was fine as Friedrichshafen appeared on the map below us. Soon we saw it was black with people. We were to be given a real welcome home. Circling over the town, *Hindenburg* turned her head in to the wind, her engines were stopped and the towing ropes thrown out, and in a minute or so a hundred and fifty soldiers were hauling the vessel to the mooring mast. Then her tail was brought round and within forty minutes we were ready to land. How happy we were! Yet it was rather reluctantly that we descended to solid earth. It had been magnificent while it lasted and so sound that only now did we learn of the seriousness of the engine trouble, though I am told that apart from meeting very bad storms the airship could continue on one engine. The strain of the double journey had told on a couple of the motors and bearings had burned out.

"Woodcarving and Design." By Lynn Miller. 207 pp. and 8 pp. of half-tone plates. Price 7s. 6d. Published by Sir Isaac Pitman and Sons, Ltd., London.

THIS book is excellently produced and contains a wealth of illustration in both line and half-tone. Intended for the beginner, it achieves its object of arousing the interest of the would-be woodcarver by covering the course in a progressive manner, and by providing attractive suggestions for all kinds of design. The beginner is frequently at a loss to know what design he should use for any particular purpose, and this frequently presents a greater difficulty than does the execution of the work. Any reader of this book should not encounter that difficulty, and should rapidly cultivate the habit of producing his own original designs.

In his Preface the author rather modestly states that the object of the book is ". . . to stimulate rather than to satisfy." It does, however, include material and examples for practice which are bound to lead to a good deal of satisfaction in the mind of the new worker. The book is obviously written by one with practical experience of his subject, and provides an excellent guide to the new worker in the craft, besides offering valuable suggestions to those who are not new to woodcarving from the amateur's point of view.

"Science in the World of Work," Volumes 1 and 2. By Frank R. Denning and Joseph T. Nerden. Price Vol. 1, 7s. 6d., Vol. 2, 8s. 6d. Published by McGraw-Hill Publishing Co., Ltd., London, W.C.2.

THESE two valuable handbooks represent a successful attempt to give "text-book" information on all branches of physical science in a straightforward and readable manner. The first volume deals with subjects from simple machines such as levers, blocks and tackle and the wheel and windlass, whilst later chapters explain work, power, efficiency, friction, parallel forces and angular forces. In every case stress is laid upon the practical application of the principles explained.

The second volume is somewhat more advanced, although prepared in the same interesting style. It covers the properties of gases and liquids, whilst dealing with sources of power, light, sound and electricity.

Both books are particularly suitable for the student who is preparing for an examination in his spare time, but they are also of interest to the practical man who wishes to revise the physics which he learned at school. Additionally, of course, they are excellent as class books for evening or technical schools.

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, a copy of their handbook, "How to Patent an Invention," free of charge.

Stepping on the Gas

IT is stated that there is an intimate relation between the foot and the brain, and that uncomfortable shoes cause depression. Consequently, the inventor who literally puts mankind upon a good footing confers a boon upon the human race, especially the tender foot. In this connection, a new device combines with an arched metal spring and a pressure-distributing sole. a layer of spongy material with sealed gas-filled pores. The effect is that of the pneumatic tyre. With such resilience in the sole, one could at least "step on the gas" and the result should be accelerated speed owing to a fatigue-preventing shoe.

Illuminated Heels

ANOTHER recently announced invention upon the subject of shoes, may be said to provide footlights in motion. Its object is to produce scenic effects on ladies' and children's wearing apparel. High heels are made from celluloid or similar transparent material. They are constructed hollow in order to accommodate a lamp whose rays shine through the wall of the heel. The footwear is provided with electrical contacts, and when these touch current-carrying strips on the stage, the wearer is illuminated. The lamp, when not required, may be easily removed from the heel. This device would certainly have added lustre to the famous glass slipper of Cinderella.

A Lamp for the Feet

THE idea of a lamp for the feet incorporated with the boot or shoe is not without a predecessor. It has already been proposed to form a cavity in a wooden heel, and to place therein an electric dry cell which is connected to a lamp on the toe of the shoe. This can be illuminated by pressure on the heel of a push button on the tread of the heel. Such an arrangement might be developed and made convenient to throw light upon one's path on a dark night. It might replace the lantern which our forefathers carried when walking along a country lane when the shades of night had fallen.

Reflector for Caps

TO pass from the feet to the opposite extreme—the head—a cap has been invented having on the back and sides discs adapted to be illuminated by the lights of a motor-car on the principle of a reflector on the rear of a bicycle. It is proposed that there be, in each case, a red central disc with a white surround of ring shape formed by threads stitched on to the material of the cap or on to material adapted to be sewn on to the cap. The number of discs is optional. This warning device could be used either by pedestrians or cyclists and should prove a valuable means of protection.

Tobacco Extinguisher

IN what are known as "the good old times," our forebears put out their candles with an extinguisher, which prevented an odour not as fragrant as incense. A cigarette end on an ash-tray can make itself equally offensive. To obviate this, an inventor has devised an improved ash-tray which has an extinguisher chained to it. The chain is of sufficient length to allow the extinguisher to be moved to any part of the tray. It may also be used for pressing tobacco into the bowl of a pipe, and, if roughened, it could be formed to clean the bowl.

Handkerchief with a Pocket

AMONG the devices which have recently emanated from the United States is one which is in a double sense a pocket handkerchief. It has in the centre a small square pocket. In the present age, as far as the dress of a lady is concerned, I believe the pocket is obsolete, except, of course, in the coat of the fair one. She uses her handbag as a receptacle for anything she wishes to carry. Therefore, the pocket in this handkerchief might be employed to contain a powder-puff or some other not too bulky article which she wishes to be easily available. For instance, that elusive coin—the threepenny bit—might be safely kept therein, until its insertion into the offertory bag.

Diverse Devices

THE versatility of the inventor is demonstrated by the variety of the devices for which, during the last few weeks, applications for British patents have been made. These include a cinematographic screen for three-dimensional coloured projection; a device for making beef steaks tender; a non-tobacco smoking mixture; and an invention for holding in position artificial teeth. A number of devices are suggestive of national defence, their subjects being gas-masks, anti-gas helmets and means for locating submerged submarines.

DYNAMO.

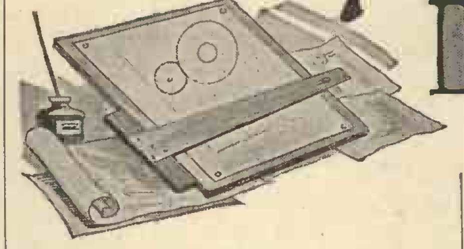
INDUSTRIAL CHEMISTRY IN PALESTINE

IN a recent paper before the Institution of Chemical Engineers some interesting facts were given in reference to the valuable chemical resources of the Dead Sea. The Dead Sea is only 47 miles long and has an average width of 9 miles. Its surface lies about 1,300 ft. below the level of the Mediterranean, the lowest point on the earth's surface.

The sea receives about 2,000,000,000 gallons each day from the River Jordan, from the Judean hills, and from springs, but its only method of discharge of this huge intake is by evaporation, which is very rapid under the intense heat of the tropical sun. The waters which feed the Dead Sea carry with them quantities of valuable chemicals, muriate of potash, magnesium, calcium and bromide being the most important, and since the chemicals are not evaporated, the water of the Dead Sea has become saturated with the chemicals, and enormous quantities have been deposited on the bed and shores. The water is so dense that it is impossible to sink in it.

With the industrial growth of Palestine, attention is being paid to the utilisation of this immense supply of raw chemicals, and chemical works are springing up all around the sea. Already 1,000 tons of bromine and 30,000 tons of potash are being produced annually, but these productions will make only a microscopic inroad into the total resources which have been estimated at 40,000,000,000 tons.

Money Making IDEAS



Advice by our Patents Expert

A COMBINATION LOCK

"I HAVE devised what I consider to be a new type of combination lock, but am doubtful as to its originality. Can you advise on this?" (R. T., Leeds.)

THE improved combination lock for safes may embody a specific construction which could be patented, but since particulars of the invention are not given it is not possible to give any definite opinion and then only after knowing the result of a search amongst prior patent specifications covering similar inventions. It is not, however, thought that the combination of a combination lock is an unalterable sequence of numbers, at least in locks for safes and strong rooms of banks. It should be possible to readily ascertain if this presumption be correct, in which case it would not be possible to obtain any broad patent for the invention but only for the specific construction.

In view of the above, it is not thought that the invention has any great commercial possibilities.

A NEW CYCLING CAPE

"I SHOULD like your advice on the practicability of a new type of cycling cape. I enclose rough drawing from which I think you will get the main idea. It consists of a cap made of waterproof material, into the folds of which is housed a cycling cape of silkskin, which only weighs about 8 oz. The cape is, of course, made part of the cap and the result is one complete waterproof garment. It has a number of advantages that will appeal to cyclists." C. N. (Staffs.)

THE improved cycling cape is, from personal knowledge, believed to be novel and forms fit subject matter for protection by patent. The idea is ingenious and practicable and if properly marketed should be a commercial success. The inventor is advised to protect his invention by filing an application for patent with a provisional specification, which will give him protection for about twelve months during which time it should be possible to make arrangements for marketing the invention before having to incur any great expense.

FOR STEAM LOCOMOTIVES

"I HAVE thought of a device which I consider will be a big improvement on all existing railway engine smoke boxes. It is an improved blast pipe nozzle, and is extremely efficient. Can you advise me on same." T. G. (Lincs.)

THE improved blast pipe nozzle for steam locomotives is from personal knowledge thought to be novel, but the only method of ascertaining the novelty of the device is by making a search amongst prior patent specifications dealing with the subject. The inventor may be aware that no search is made by the Patent Office on filing an application for patent with a provisional specification, but only after a complete specification is filed, for which reason it is often difficult to interest people likely to take up such an invention until the result of the official search is known. The improvement is ingenious and appears to be sound in theory. It certainly, if novel, forms fit subject matter for protection by patent.

The inventor may approach the railway companies, first addressing his letter to the mechanical engineer and enquiring if an improved blast pipe nozzle would be of interest to him. On an affirmative reply, particulars of the invention should be furnished either by letter or a personal interview. Other manufacturers of steam locomotives, apart from the railway companies, might be interested in the invention. If the inventor should desire professsional assistance in completing his patent application, he should get into touch with a reliable patent agent, as advertised in this journal.

A DEVICE FOR A KETTLE

"I HAVE thought of a device for fitting on a kettle, to replace a lid. It would obviate the risk of scalds (which are sustained when taking off a lid) as water can be poured straight in. When pouring, there is no lid to drop off, and the fitting is very cheap to manufacture.

"Could you please tell me if this is novel, and if so if it is worth patenting? If this is the case, would it be worth patenting the fitting alone, or embodying it in a kettle, with the added improvement of a specially corrugated bottom for quick boiling?

"Is it worth while in patenting, to employ an agent, and if so, could you tell me approximately the cost of filing a provisional patent?

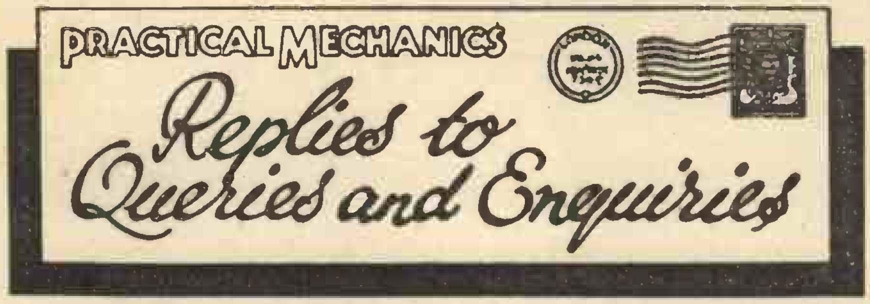
"In conclusion, if the patent was obtained, how could I make contact with a manufacturer." R. C. (Sussex.)

THE improved kettle obviating the use of a loose lid with its attendant advantages is from personal knowledge thought to be novel and forms fit subject matter for protection by patent. The invention appears to be a practicable one and if properly marketed should meet with a certain measure of commercial success.

The invention should be protected as an improved kettle, since it does not appear to be applicable for saucepans and like articles. The proposed added improvement of a corrugated bottom to increase heating area has already been proposed and is no longer novel.

It is always advisable to employ professional assistance in the matter of patenting an invention, and suggest you get into touch with Mr. R. Millward Flack, Imperial Buildings, Ludgate Circus, E.C.4.

The inclusive cost of filing an application for patent, including the patent agent's fee and stamp duty giving protection for about twelve months, is approximately £4 4*s*.



If a postal reply is desired, a stamped addressed envelope must be enclosed. Every query and drawing which is sent must bear the name and address of the sender and be accompanied by the coupon appearing on page iii of cover. Send your queries to the Editor, PRACTICAL MECHANICS, Geo. Newnes Ltd., 8–11 Southampton Street, Strand, London, W.C.2.

REFRACTION OF LIGHT

"IF a beam of light travelling in an evacuated space passed through a stream of electrons (being emitted from a cathode), would it be refracted (the same as passing through a gas) to a degree varying with the intensity of the electron stream?

"If so, would the refraction be to any intelligible extent?

"I would be glad if it were possible to give me any figures with reference to this subject, and also to quote a suitable textbook dealing directly with the matter." (R. R. W., Northants.)

YOU raise an interesting query, and one which is seldom dealt with by modern authors. A beam of light is always refracted or bent aside at the boundary of two media, unless the incident ray of light is perpendicular to the surfaces of both media. In all such instances, the amount of refraction is expressed by the ratio of the sine of the angle of incidence to the sine of the angle of refraction. When a ray of light is refracted (*i.e.* bent aside) it also undergoes dispersion, that is to say, separation (partial or complete) into its various components. Such is a general statement concerning the fate of a light ray passing through two different media.

Theoretically, when a light ray travelling in an evacuated space comes into contact with an electron beam, some interference of the above nature will take place because, although the electrons are sub-atomic in most of their properties, they possess mass. Theoretically, also, the extent of the interference of the light beam by the electron beam should be governed by the density of the latter. Practically, however, the light interference will be extremely small, too small, in fact, to be of any practical use. Under astronomical conditions, as, for instance, in the case of a bundle of light rays coming into contact with an imaginary mass-stream of electrons, the light rays would be profoundly influenced, although to what extent it is impossible to say.

As before mentioned, the subject of the mutual behaviour of light and electrons in the respects you mention is one which little information is as yet available. For the most up-to-date information concerning the nature and properties of light consult Professor Wood's *Physical Optics*. There is no textbook dealing solely with the matter.

THERMO-COUPLES

"PLEASE could you let me know the best metals to use in a thermo-couple, so as to obtain a maximum voltage for a given heat (about 700° F.—or less) at the hot junction, and room temperature or lower if possible at the cold junction).

"What would be the millivolts and milliamps. generated at one pair of junctions?

"I believe antimony and bismuth are the best metals. Would these metals be expensive? Where would I likely to be able to purchase them? If these metals are rather expensive perhaps you could let me know the next best pair of metals. Can you let me have a reply please?

"I want to use a large number of pairs in series in order to obtain, if possible, 120 volts, but at a small current. (H. B., Norfolk.,)

BISMUTH and antimony form a well-known and quite a practicable thermo-couple. A bismuth-antimony couple will develop about one ten-thousandth of a volt per degree C. increase in temperature. Thus a hundred of these couples heated to about 200 degrees C. would generate about 2 volts.

Bismuth and antimony can be obtained in the pure metallic state from any firm of wholesale chemists and laboratory suppliers, as, for instance, the British Drughouses, Ltd., Graham Street, City Road, London, N.1. The current retail price of metallic bismuth is about 1*s.* an ounce; that of antimony approximately 1*s.* 4*d.* an ounce.

The disadvantages of using bismuth and antimony for thermo-couple purposes lie in their low melting-point (bismuth melts at a temperature below that of soft solder), and also in their brittleness and difficulty of working.

A thermo-couple composed of iron and nickel is free from the above disadvantages, but does not develop so high a current as the bismuth-antimony couple.

Couples composed of copper and constanton alloy or brass and thermalloy can be used at much higher temperatures and are very serviceable in use.

For temperatures about 500 degrees a platinum thermo-couple is essential. This is composed of a junction between a thin wire of pure platinum and a wire composed of 90 per cent. of platinum and 10 per cent. of irridium. Naturally, couples of these metals are very expensive but they have the advantage of being indestructible.

Platinum metals can be obtained from Messrs. Johnson Matthay & Co., Hatton Garden, London, E.C. Other alloys, such as "Constanton" or "Thermalloy" are usually obtainable from chemical and laboratory suppliers.

LIQUID GASES

"1. WOULD liquid oxygen and liquid hydrogen when ignited in a common combustion chamber give rocket force? Would this be practical?

"2. Could you please give me a design for a vaporiser for vaporising liquid gas?

"3. Where can I get a book on the designing of an aeroplane, and at what price?" (G. T., Northumberland.)

It would be not practicable to obtain rocket propulsion force by the continuous ignition of liquid hydrogen and oxygen, the main reason being that the two *liquids* themselves would not ignite. Only the vapours of these liquids (which constitute, of course, the normally gaseous oxygen and hydrogen) would ignite satisfactorily and the energy derived from their ignition would not be sufficient to propel any rocket. Consider, also, the fact that heavy steel cylinders would have to be used for containing the liquid gases and, also, the fact that since no amount of pressure will serve to liquefy oxygen and hydrogen at ordinary temperatures a powerful refrigeration apparatus would have to be provided in order to keep the gas supplies in a liquefied condition until, at least, the rocket reached outer space. For this and many other reasons, a rocket worked by the ignition of hydrogen and oxygen is not feasible. It may interest you, however, to note that liquid oxygen has been tried out as an explosive. Small cartridges containing liquid oxygen mixed with petrol and charcoal have been used for blasting purposes. Such cartridges have to be used immediately they are charged with liquid oxygen.

It is not necessary to employ a special vaporiser for vaporising a liquid gas. Merely a suitably designed and efficiently working gas tap or valve attached to the vessel containing the liquid gas is sufficient, the vaporisation of the gas being controlled by the tap.

It is presumed that you require a book on the designing of *model* aeroplanes. The following will, no doubt, suit you: *Model Aeroplanes and Airships*, by F. J. Camm (George Newnes, Ltd., 1s. net) and *Power-driven Model Aircraft*, by F. J. Camm (price as above).

REPLIES IN BRIEF

O. A. A. (South India).—You omitted to enclose a query coupon and a stamped addressed envelope. We regret, therefore, that we cannot answer your questions.

D. E. R. (No Address).—If you will let us know your address we will give you the information you require.

N. E. A. (Southchurch).—You omitted to enclose a coupon and a stamped addressed envelope. We are shortly publishing a handbook at 2*s.* 6*d.* giving all details of the "Flying Flea."

D. J. O. (Ireland).—You did not enclose a stamped addressed envelope nor a query coupon for a reply. This is a breach of our rules. Blue prints (4 sheets) of Mr. F. J. Camm's Petrol-driven Model Aeroplane are available for 7*s.* 6*d.* See also *Power-driven Model Aircraft*, a copy of which can be sent to you for 1*s.* 2*d.* The engine is obtainable from Messrs. Stuart Turner, Ltd., Henley-on-Thames. It is the Brown Junior.

P. W. (Bangor).—We cannot trace any firm who supply the diagrams you require. We recommend you to use silver spruce. You omitted to enclose a stamped-addressed envelope.

B. B. P. (Soddon).—The components you require are obtainable from Messrs. Peto Scott, Ltd., 77, City Road, London, E.C.1.

F. A. I. (Birmingham).—We regret that it is impossible to give you really useful information regarding your cinema projector. It would be best to get the gears first and construct the projector to suit.

BUY, EXCHANGE OR SELL

Advertisements are accepted for these columns at 2d. per word (minimum 12 words at 2s.—advertisements of less than 12 words are charged at the minimum rate of 2s.), subject to a discount of 2½% for 6 consecutive monthly insertions or 5% for 12 consecutive monthly insertions. TERMS :—Cash with order. Cheques, Postal Orders, etc., should be made payable to George Newnes Ltd. *The Proprietors reserve the right to refuse or withdraw advertisements at their discretion.* All advertisements must be received on or before the 5th of the month preceding date of publication and should be addressed to the Advertisement Manager, "Practical Mechanics," George Newnes Ltd., 8-11 Southampton Street, Strand, W.C.2.

BUSINESS OPPORTUNITIES

"WHERE TO BUY" anything, "Directory" English and Foreign Wholesalers and Manufacturers, 1/3. (12 Razor Blades Free.)—"Technocraft," 41 Longford Place, Manchester.

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ARTISTIC CINE FILMS. Exclusive 9·5 mm. and 16 mm. productions. List Free. Projectors, Cine Cameras.—P. M. Dane, 64 Stanley Street, Liverpool, 1.

CINEMATOGRAPH FILMS.—Standard size from 6d. 100 feet. Machines, Accessories. Sample Films 1/- and 2/6 post free. Catalogues free.—"Filmeries," 57 Lancaster Road, Leytonstone, E.11.

MOVIES AT HOME. How to make your own Cinema Projector. Particulars free. Moviescope (N), Pear Tree Green, Doddinghurst, Essex.

ELECTRICAL

ELECTRIC CIRCUITS for Bells, Alarms, Clocks, Lighting Control, Model Railways, Telephones, etc., etc. Information given on all Electrical Matters. Charges from 2/6. Write BM/NNMM, London, W.C.1.

ELECTRIC MOTORS, DRILLS, GRINDERS, BATTERIES, all voltages, from 18/-. Lists free. Repair specialists.—EASCO, Electrical Service, 18 Brixton Road, S.W.9.

USED GUARANTEED BARGAINS. Electric motors from 1/16 h.p. from 12/6. Electric drills ¼ max. £1, also ⅜ max., 27/6. Electric grinders, 16/-. Vacuum cleaners from 15/-.—A.C.R. Co., c/o Grout Service Garage, Ronalds Road, Holloway Road, N.7.

SURPLUS ELECTRICAL and Engineering Materials, low prices.—The London Electric Firm, Croydon.

A.C. INDUCTION MOTORS, 1/25 h.p. to 25 h.p. from stock. Unequalled prices.—John P. Steel, Bingley.

¼ H.P. NEW, Double-ended Spindle, Universal, Ball-bearing Motors, 37/6.—John P. Steel, Bingley.

ELECTRIC LIGHTING, 5/- a point; progressive wiring diagrams and instructions, 6d., materials, wholesale prices; lists free.—P. Symax & Co., 263 Lichfield Road, Birmingham, 6.

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LIGHT ENGINEERING, EXPERIMENTAL, MODEL and Repair Work. Accuracy guaranteed. Estimates given.—Woodfall, Willowbrook Grove, Trafalgar Road, London, S.E.15.

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ENGINES. Build Butler's Practical Model Petrol Engine, ½-h.p., castings, 9/9. Interesting Catalogue 3d. Charging Dynamos, Boat Propellers, Sterntubes, Shafting Blocks.—Write Butler's Profit-sharing Works, Wade Street, Littleover, Derby.

FORMULAS

FORMULAS, TRADE SECRETS, PROCESSES, from 1/- upwards. Lists, literature, catalogue, sent for 4d. Stamps. (None Free.)—"Technocraft," 41 Longford Place, Manchester.

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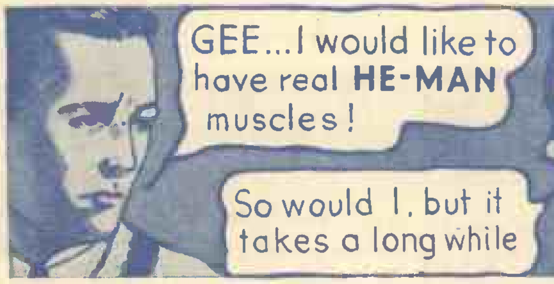

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