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NEWNES

PRACTICAL MECHANICS

MARCH

6D

WONDERS OF THE UNDERGROUND RAILWAY

THE MARVELS OF MODERN CANALS – ESCAPING FROM THE EARTH – "WEIGHING" THE ELECTRON – THE AUTOMATIC PISTOL – MAKING IGNITION COILS – A SCALE MODEL D.H. GYPSY MOTH – MODEL RAILWAYS – LATHE WORK – PATENT ADVICE – MONEY-MAKING IDEAS ETC. ETC.

MARCH 1935

86, St. Peter's Grove,
Canterbury.
Class Number L 131682. 17th Dec., 1934.

Dear Sir,

You may remember me as a pupil of your College, taking a correspondence course for the recent Civil Service Examination. The result of this examination has now been published and I learn that I was fortunate enough to secure the top place out of over 1,400 other candidates. I consider that this result reflects great credit upon your course and your tutors, for their interest and their willingness to help me with my studies.

May I wish you the compliments of the season and every success in the future?

Yours very gratefully,
C. P. Cayley.

3 LETTERS

Read them—then you will realise what is happening and why

A VOCATIONAL TRAINING FROM THIS COLLEGE IS A CAREER—A SUCCESSFUL PROGRESSIVE CAREER

110, Victoria Road, Dundee,
Angus.
16th January, 1935.

MR. J. H. BENNETT,
Bennett College Ltd.,
Sheffield.

Class Number L159929.

Dear Sir,

A short time ago I enrolled as a student of the Clerk of Works Architecture, etc., course; although still in my twenties, I have, through the excellent tuition provided in the above course, been successful in my application for the position as Clerk of Works with the Dundee Town Council.

Yours faithfully,
George Moffatt.

OPEN LETTER TO PARENTS

Dear Sir or Madam,—When your children first arrived they brought with them a wonderful lot of sunshine. Later you became proud of the intelligence they displayed, but still later you became anxious as to what would become of them in the future. Perhaps you were anxious when you visualised them as grown men and women. Even with plenty of money it is not always easy to select the right career, and a parent is sometimes inclined to ask advice of some relative and in ninety-nine cases out of a hundred that relative knows nothing at all about the possibilities of employment. Why not let me relieve you of some of your anxieties? In fact, why not let me be their Father? We do not profess to act as an employment agency, but the nature of our business compels us to keep an eye upon the class of men and women that are wanted and who wants them. There are some people who manufacture an article and put it on the market to sell. We do not do that, we work in exactly the opposite direction. We find out what employers want and we train our students to fill those jobs. We have to be experts in the matter of employment, progress and prosperity. If you have any anxieties at all as to what your sons and daughters should be, write to me, or better still, let them write to me personally—Fatherly Advice Department—and tell me their likes and dislikes, and I will give sound, practical advice as to the possibilities of a vocation and how to succeed in it. Yours sincerely,

J. H. Bennett

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Jim Duck

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Jim Duck **Art Dept. 76.**

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or on the high seas, a good supply of lessons is given, so that they may be done in their order, and despatched to us for examination and correction. They are then sent back with more work, and in this way a *continuous stream of work* is always in transit from the Student to us and from us to the Student.

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EVERY STUDENT IS A CLASS TO HIMSELF.

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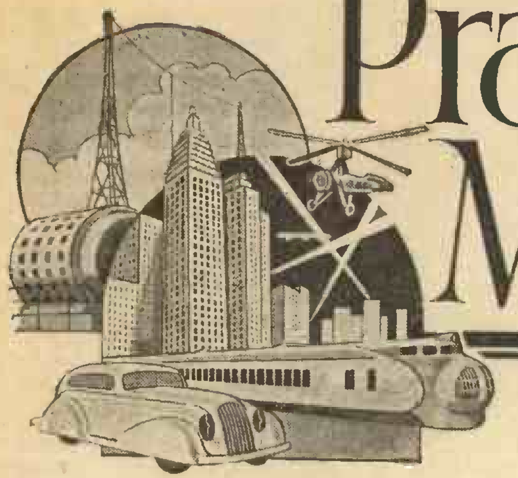

Practical Mechanics

Edited by F. J. CAMM

VOL. II. No. 18
MARCH
1935

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Notes, News and Views

Sound-proof Aeroplane Cabins

ACCORDING to a recent report, experiments are being carried out at Slough, as a result of which aeroplane cabins that are both sound- and fire-proof may be in general use in the near future. In the new cabins, asbestos—well known for its fire- and sound-resisting properties—will be extensively used, and between the forward part of the machine and the passenger cabin there will be a thick asbestos bulkhead. The passenger cabin, apart from the windows, will be lined with asbestos felting, attractively decorated. It is stated that there will be less noise in these new cabins than passengers are accustomed to in trains or motor cars, and air travel will also be safer as the cabins will be practically fire-proof.

New High Explosive

THE discovery of a new "foolproof" high explosive which is 20 per cent. more powerful than T.N.T. (trinitrotoluene) was recently announced by the Du Pont Company of America. To test its "foolproof" qualities a quantity of it was shot at with rifles, thrown in a fire, bored with red-hot irons, and subjected to the flame of a blowlamp, and yet it did not explode. The name of the new explosive is Nitramon. It is a nitro-ammonia explosive containing 40 per cent. oxygen, and only a dynamite cartridge detonates it.

A Mobile Hydraulic Tower

A NEW form of extendable tower for giving access to overhead wires, lighting lamps and for similar uses, has just been constructed by the Wood Hydraulic Hoist Co., Ltd., of Stockport. It is operated hydraulically and is mounted on a motor chassis, which also carries a van body which is used for storing spare parts and tools, or as a travelling workshop. The ram which carries the platform is operated by a rotary pump driven by gearing from the change-speed gear-box of the motor. The movement of the platform, which rises to a full height of 30 ft., can be controlled either from the platform itself or from the cab. In its lowest position the platform is 11 ft. 6 in. from the ground, and is then accessible by a short ladder fixed to the back of the van.

The Great Boulder Dam

THIS remarkable undertaking, which is part of the huge scheme for harnessing the Colorado river, has just been completed. and is the first part of a colossal electricity and irrigation scheme. The dam will form one wall of a 115-miles long reservoir—the largest man-made lake in the world—and when filled it will be nearly 600 feet deep at one end.

THE MONTH'S SCIENCE SIFTINGS

With a span of over 500 ft., the reinforced concrete bridge, recently put into service at La Roche Guyon, is stated to be the widest single-span bridge of its kind in France.

According to a recent report a process for case-hardening aluminium has been invented by Dr. C. R. Gower, which, in addition to imparting a highly polished hard surface, allows the metal to be attractively coloured.

It is stated that a stratosphere balloon, 40 yards in diameter and of 47,700 cubic yards capacity, has been built for the Spanish War Ministry.

A mammoth 100,000-kw. steam turbo-generator now being designed at the Turbine Bureau of the Stalin plant in Leningrad will be the most powerful machine of its type in the world. It will run at 3,000 m.p.h.

At Balaclava, in the Crimea, a windmill power station, developing 100 kw., has been running successfully for the past two years.

In a new brick works at Colnbrook a machine has been installed capable of turning out 5,000 concrete bricks an hour. The bricks are the same size as, but heavier than, the ordinary clay brick, 1,000 weighing approximately 3 tons.

During recent trials at Loriente, the new French destroyer, "Le Terrible," is reported to have reached the speed of 45·05 knots, which makes it the fastest vessel of this type in the world.

New French Seaplane

A NEW French seaplane, the "Lieutenant Paris," has recently undergone its trials at the Biscarosse seaplane base. Weighing 37 tons when fully loaded it is one of the largest machines of its kind yet constructed, and is equipped with six Hispano Suiza 860 h.p. liquid-cooled engines. The machine, which has been designed for passenger and postal services, has a cruising speed of 125 m.p.h. and a range of over 2,800 miles. Passenger accommodation includes 12 de luxe cabins, each containing two beds, a cupboard, and a small toilet-room. In the bow of the machine is a saloon for ten first-class passengers, and there is also a kitchen and a bar.

Raising Sunken Vessels

A FRENCH engineer, M. Julien Guillaume, after several years of experimenting, recently conducted a test with apparatus he has invented for raising sunken vessels. The demonstration took place in a large reservoir in Paris, and a disused yacht, about 30 ft. long, was used for the purpose. M. Guillaume entered a watertight cabin with a dispatch case which contained the boat-raising apparatus. A flooding cock was opened and within a few minutes the yacht sank out of sight. After a few minutes the superstructure of the yacht appeared above the surface, and after the yacht was successfully afloat, M. Guillaume emerged from the cabin. The invention is being kept a closely guarded secret.

Kay Competition—Result

IN our September issue (page iii of cover) we announced a splendid competition run by Kay (Sports and Games), Ltd., Pembroke Works, London, N.10. This competition, in which 185 prizes were awarded, consisted of writing on a postcard, in not more than twenty-five words, the reason "Why Kay chemistry and electrical outfits are best." The prizes were made up as follows: 10 first prizes, each a 21*s*. Kay Chemistry or Electrical Outfit; 25 second prizes, each a 10*s*. 6*d*. Chemistry or Electrical Outfit; 50 third prizes, each a 5*s*. Chemistry or Electrical Outfit; and 100 smaller Kay Chemistry or Electrical Outfits as consolation prizes. To those readers interested, the complete list of prize-winners in the above competition appears in this issue on page 294.

The Wonders of the UNDERGROUND Railway

Automatic Devices Play an Enormous Part in Promoting the Safety and Efficiency of Subterranean Travel

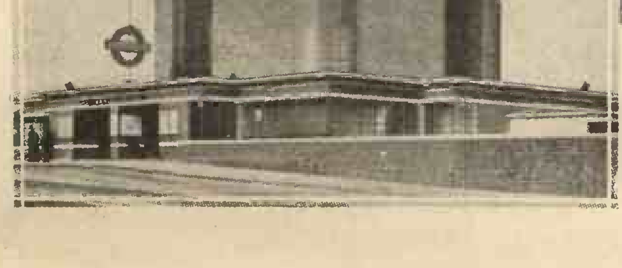
LONDONERS have grown so accustomed to efficient organisation of public services that for the most part they take it all very much for granted, and it is only when they obtain wrong numbers on the telephone, or are diverted from an accustomed street, following the minor eruption there of some self-assertive gas main, or are some minutes late in arriving at their destinatious one day, because of a temporary hold-up on the Underground, that they are prepared to give much attention to the matter. How many Underground season-ticket holders, for instance, can tell you whence comes, in the first place, the power which a dozen times weekly carries them backwards or forwards? How many give a passing thought even to obvious facts, such as that an ascending escalator (other things being equal) requires more power behind it to transport a useful load than a descending one, which may, in fact, require no power at all, or that the acceleration and retardation of the trains themselves, though high in value, are remarkably smooth, causing practically no feeling of discomfort such as may be experienced in even the most luxurious motor cars by the fierce application of clutch or brakes?

Conservation of Energy

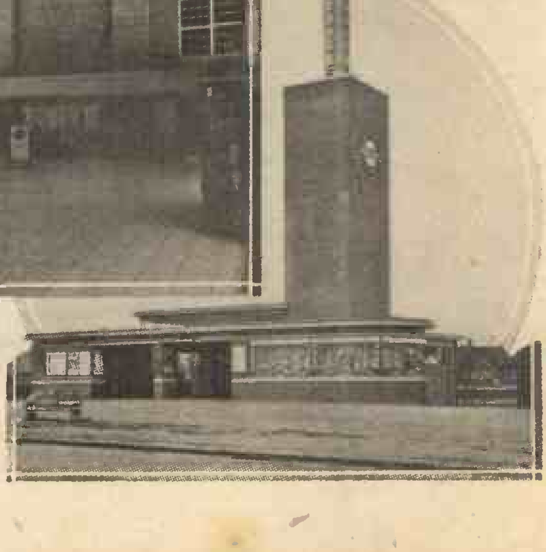
An Underground passenger would do well to meditate occasionally, in the midst of his journeyings, on the interesting fact that, to the burning of a small amount of coal at a distant power station, must be ascribed the rapid transportation of himself and luggage from one place to another, and to the burning of other similar small amounts, the transportation of his fellow passengers. The combustion of the coal produces so many units of heat per pound, which are used to transform definite weights of water into steam at a required pressure. The steam, in turn, in seeking an outlet, is forced to act upon a mechanism (in this case a turbine) in such a way as to produce rotary motion. By this means dynamos are made to revolve, in a sense very reluctantly, since in order to do so certain magnetic lines of force have to be cut. An electric current is generated simply by virtue of the overcoming of this opposition to motion, and its effect is transmitted to an electric motor on the distant train. Again a state of "antagonism," as it were, is set up in another magnetic field in an endeavour to escape from which the armature of the motor is made to revolve, and can thus transmit motion to the train itself.

Chain of Efficiency

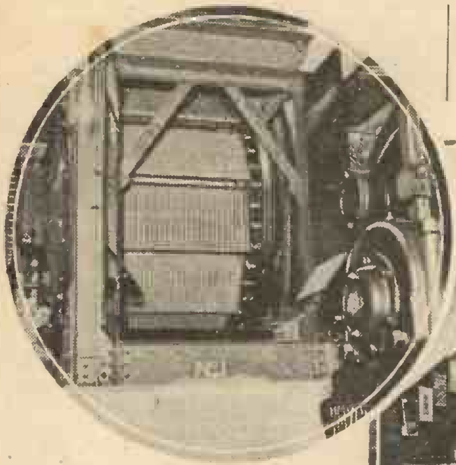
No system of utilising energy is 100 per cent. efficient, and it may be interesting to trace briefly the losses which occur along the chain just outlined. A pound of coal can be made to produce a certain and definite number of heat units, some of which are unavoidably wasted in heating, unnecessarily, the atmosphere surrounding the furnaces. The steam that is formed possesses a definite amount of energy, only part of which is transmitted to the turbine, the emerging steam still possessing an amount of energy (greatly reduced) which is lost. Other losses include frictional losses, various electrical losses at both dynamo and motor, unnecessary heating of dynamo and motor (in this case part of the original heat produced by the coal has been transformed into work, and is now being transformed back into heat again), and losses due to the overcoming of resistance in electrical conductors. Thermal efficiency, mechanical efficiency, and electrical efficiency all demand con-

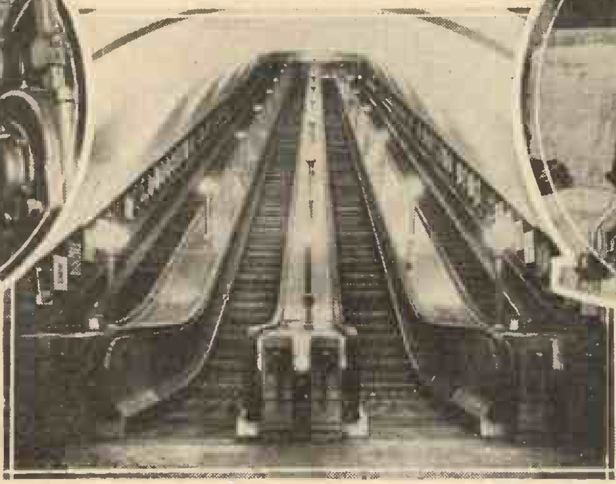


(Left) *An exterior view of Arnos Grove Station—Piccadilly Line and* (Above) *showing the ticket hall of Enfield West Station—Piccadilly Line.*

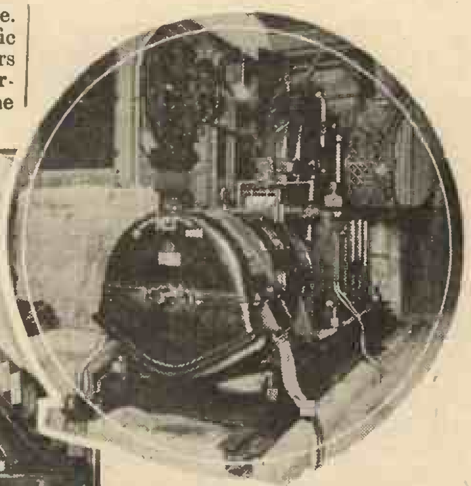


(Below) *An exterior view of Osterley Station—District Line.*





Above) *The treads at the turning point at the top of the escalator, Wood Green Station—Piccadilly Line, and* (Centre) *showing the escalators at Holborn Station —Piccadilly Line.*



(Above) *The escalator machinery chamber at Wood Green Station—Piccadilly Line.*

sideration in this case, and all things considered, the overall efficiency is remarkably high.

In the power stations which supply current for the operation of London Underground trains about 975 tons of coal are consumed daily, and about 97 tons of ash require to be disposed of as a result. The amount of steam thereby delivered is 1,380,000 lb. and the daily electrical output is 1,540,000 kilowatt-hours, the voltage of distribution being 11,000. The combined length of high-tension cable used is 600 miles.

Early Days

The pioneer City and South London Railway was incorporated fifty years ago as the City of London and Southwark Subway, and had at the outset a no more ambitious programme than for the construction of twin tunnels between a point near the Monument and the Elephant and Castle. The initial section was opened to traffic on December 18th, 1890, and ten years later the Central London was inaugurated between Shepherd's Bush and the Bank. Originally a uniform fare of 2*d.* was charged, irrespective of distance, and this remained in force long enough to give the railway its nickname of the "Twopenny Tube." Since those early days developments have steadily proceeded, taking the Tubes as far afield as Cockfosters on the north and Morden on the south.

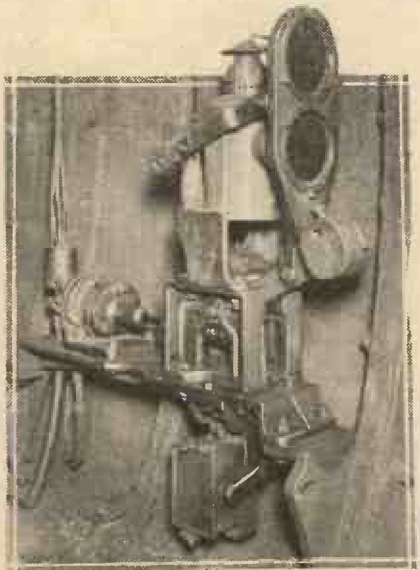
Work of Construction

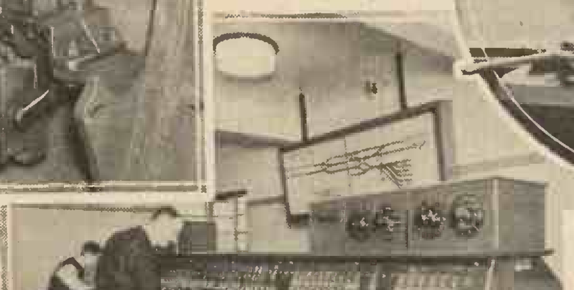
Construction proceeds from several points along the line of route, the various sections linking up in perfect alignment. The maximum deviation from the true line, permissible in a section of tunnel half a mile or so in length, is 1¼ in., but as a rule the extent of error is a fraction of this figure. When it is borne in mind that however straight a tube railway may appear on a small map, the line is often almost serpentine in its windings, and there are undulations between the stations, the important part played by mathematical calculation in tube engineering will be appreciated. Shields for adjoining sections of tunnel are built up in the earth, in some cases as much as 6,000 ft. (more than a mile) apart, and are driven towards each other. No bore-holes or other fixed checking-points are made between the two shields, and although these follow a sinuous course they are directed so accurately that when they meet their centre lines coincide within a fraction of an inch!

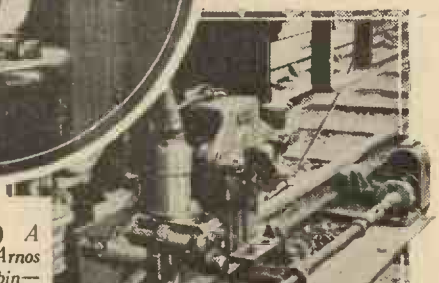
Between stations each pair of twin tunnels is separated by an average distance of 5 ft. At stations they are considerably further apart. On leaving the stations each tunnel has a fall of 1 in 30 for about 100 yd., whilst on approaching stations it has a rise of 1 in 60 for about 200 yd. These dipping gradients are applied wherever practicable on tube railways to promote acceleration of trains as they depart from stations, and to retard speed as they approach stations, thus making for economy in current consumption, and relieving wear and tear on the brakes.

Power Houses

There are three power houses, namely, Lots Road, Chelsea; Neasden; and Greenwich. The function of the last-named, however, is chiefly in connection with tramways. Lots Road, the largest, was opened in 1905. Its equipment consists of ten 15,000-kw. turbo-generators with a total output capacity of 201,000







(Left to Right) *A tunnel signal; Arnos Grove signal cabin—Piccadilly Line. The Deadman's Handle. The automatic train stop and trip arm.*

h.p. The human element is here merely the controlling and supervising element, every operation being mechanical. As the coal barges come into the private dock (the power house is on the banks of the Thames) their contents are mechanically discharged, weighed, and hoisted to the top of the building. Thence the fuel is moved by mechanical conveyors and discharged in due course into the furnaces of the forty boilers, stoking also being entirely mechanical. In fact, from the moment the barges have tied up until the ash is finally disposed of, the coal is not touched by hand. The capacity of the Neasden Station is 97,000 kw. (129,980 h.p.) with an annual output of 155 million units.

SOME INTERESTING FACTS ABOUT THE UNDERGROUND

Greatest depth below ground surface (at Hampstead): 192 ft.

Best average speed inclusive of stops (Hammersmith-Hounslow and Uxbridge): 28·2 m.p.h.

Highest routine speed for loaded eight-car train (Metropolitan Railway, Pinner Bank): 55 m.p.h.

Acceleration of loaded eight-car train (Piccadilly Railway): 1·33 m.p.h. per second.

Total length (visible) of escalators: nearly two miles.

Aggregate mileage of escalators: 2,600 per day.

Number of passengers served at Piccadilly Station: 27,000,000 per annum.

Capacity of Piccadilly Station: 50,000,000 per annum.

Longest tube run in the world (Cockfosters-Uxbridge): 32 miles, of which 12¾ are in tunnel.

Traction System

In the first Tubes locomotives were used, which fact proved to have numberless drawbacks. A locomotive with enough power to haul the long trains required during the rush hours became an uneconomic unit during the slack periods, and it produced considerable noise and vibration. Accordingly locomotives gave way to the now universal multiple-unit system, in which two, three, or more cars on each train are equipped with driving motors, all motors being controlled from a single driving cabin, and with equal facility from either end.

Signals

The number of trains which can be worked safely is determined by the signalling system. Most signals and points are operated by either compressed air or electric power, controlled by electric valves or circuit controllers. The breaking of any wire, or the failure of electric current, causes a signal to assume the "danger" position. The "track circuit" principle ensures that the signal behind any train is held at "danger," and remains there until the train passes out of the section controlling that signal. Operation is entirely automatic, depending on the train's own movement. Signal cabins are provided where points have to be operated. Conspicuous in their equipment is the illuminated diagram which shows in miniature the lay-out of the track under control. A dark patch on the illuminated track indicates the position of a train, and this automatically traces the movement of that train. The signalling levers are interlocked with one another, so that a signalman cannot pull levers that might set up a conflicting route. Electrical locking also prevents a signalman from moving points after he has once given a driver permission to pass over them.

The Deadman's Handle is an interesting device. Should the driver of a train remove his hand from this, the brakes of his train are automatically applied, and signals along the route behind set at danger.

Ventilation

Analyses of the air in tube tunnels have been made, both by various public authorities and by experts called in by the railways. It has been found that in all cases the air is of a high standard of purity, though the temperature may sometimes be rather high. The residue of current consumed in running the trains finally exhibits itself as heat, and this has to be disposed of by ventilation of the tunnels. Suction fans therefore draw from mid-way between stations ensuring at all times a flow through the tunnels of cooler air. The sizes of individual fan plants have reached a capacity of 75,000 cubic ft. per minute, and arrangements are in hand for the installation of plants reaching 140,000 cubic ft. per minute. The range of temperature on the platforms varies only about 10° F. from winter to summer.

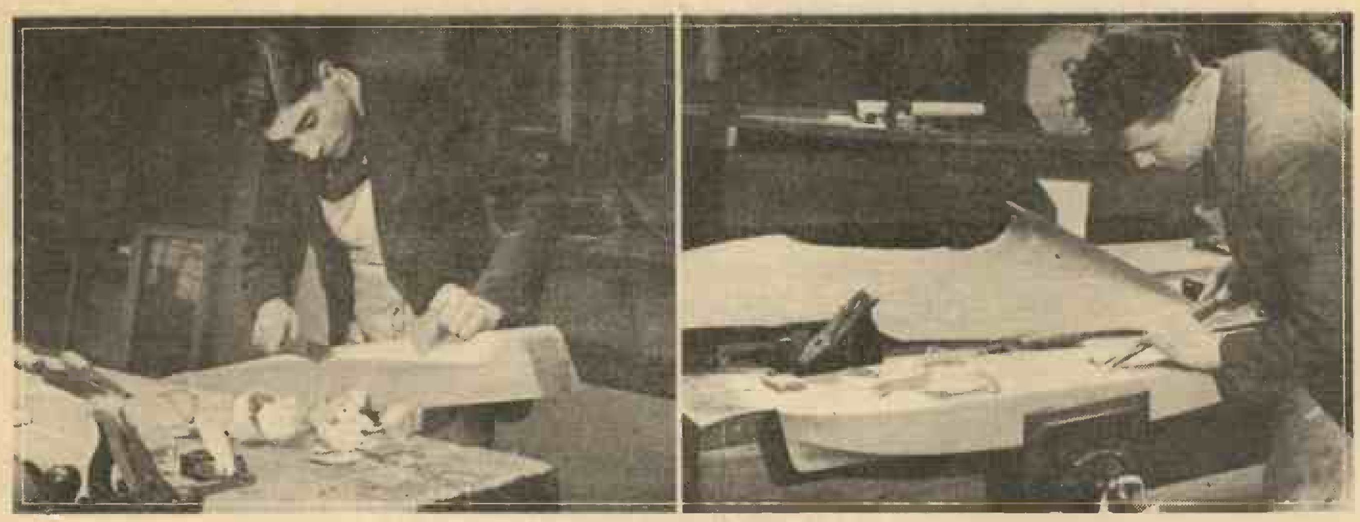
The New Leicester Square Station

Newly-excavated regions in the form of a modern and convenient station are shortly to be open to the public at Leicester Square, where, incidentally, is now being installed what will be the longest escalator in the world. Many of the difficulties which have to be surmounted in the construction of underground systems in general, and, above all, in the modification of existing and comparatively early systems to suit modern requirements without interrupting the normal train service were pointed out to the writer during a recent visit.

A sectional drawing of Leicester Square Station as it will be.

(Left) *A station tunnel segment erector at Turnpike Lane, Southgate Extension—Piccadilly Line, and* (Right) *Escalator shaft at Manor House Station*

A short depth below street level is what will one day be the booking hall, and this at present takes (in plan) a circular form, except for a wedge-shaped piece projecting from one side as far as the centre. Within this wedge-shaped piece the present lift shafts are still in operation, but following the change-over it will disappear altogether.



Two photographs showing constructional work on the hull in progress.

BUILDING "STREAMLINIA"

Constructional Details of our fine Model Speedboat. The boat is metre size, 8 in. in beam with slipper stern. The Hull is carved from the solid and the deck houses are built up.

OBTAIN for the hull a block of carefully-chosen, well-seasoned, suitable wood of dimensions (or better still, obtain the Kit of Parts) 3 ft. 4 in. × 8½ in. (breadth) × 4½ in. Yellow pine or deal will do splendidly, though for lightness, toughness, rendering it easy to work, and immunity, during the lifetime of usage in front of it, against warps and splits, red cedar is hard to beat, and is recommended here. Specific gravity considerations apart (the wood must not be too heavy), the particular variety of wood used is not so important, however, as fineness and evenness of grain and condition, and it is wise to associate oneself mentally in this respect with a worldly and fastidious smoker buying himself a new pipe! Unfortunately, the march of progress has rendered the seasoning of wood an uneconomic proposition unless the process is speeded up by artificial means, and the results are not always so dependable.

The Elevation Profile

Cutting the hull from the solid is far more simple and straightforward than by building up, and leaves considerably more margin for the minor errors that might creep in. The piece of timber obtained should be carefully planed down to size: 1 metre × 8 in. × 4 in. Ensure that the edges are perfectly square and the surfaces smooth. Do not hurry the elementary part of the work in hand. Some may find it an advantage to carry out the operations stage by stage on two blocks of wood, the experience gained on the first often making the workmanship on the second surprisingly better. Mark out the ordinates with painstaking accuracy on all sides right round the block, and the result should appear as in the appropriate photograph.

Referring to the sheer plan, now reproduce the elevation profile, and cut this out, with plane and chisel, to produce the required result. Mark on this the fore-and-aft centre line right round the block. From the centre line carefully mark out the appropriate ordinates, and obtain, with scrupulous accuracy, the top and bottom outlines. Both top and bottom stern outlines should be marked out on deck as they differ considerably here owing to the heavy "tumble-home."

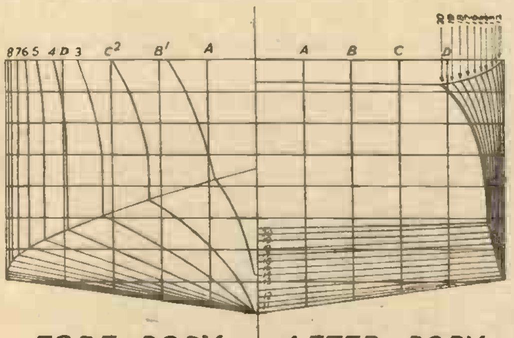
Stern and Bow

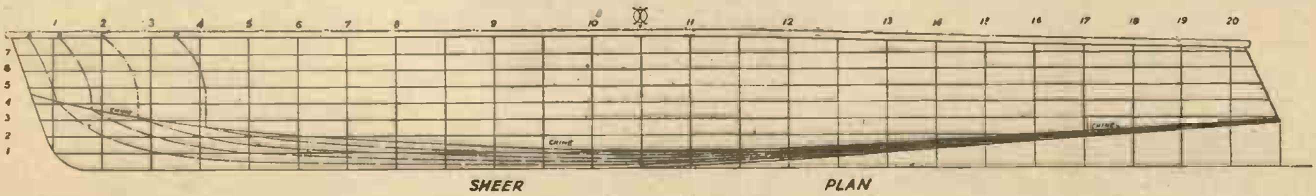
It should not now be found difficult to cut the stern to shape, but since the work has now proceeded to a stage when it would be extremely discouraging to have to begin all over again in case of mishap, carry this out unhurriedly and with a nice precision, care being taken to produce evenness of form between deck and chine throughout.

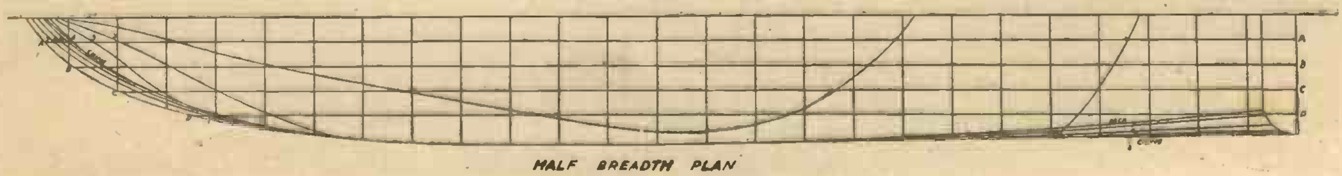
Passing in due course to the bow, where more care than ever is called for, first cut the top outline to shape. Carefully study the elevation and sheer plans until the lines of the bow are thoroughly understood. Templates and dividers will be invaluable here, and their services should be called upon repeatedly.

Hollowing Out

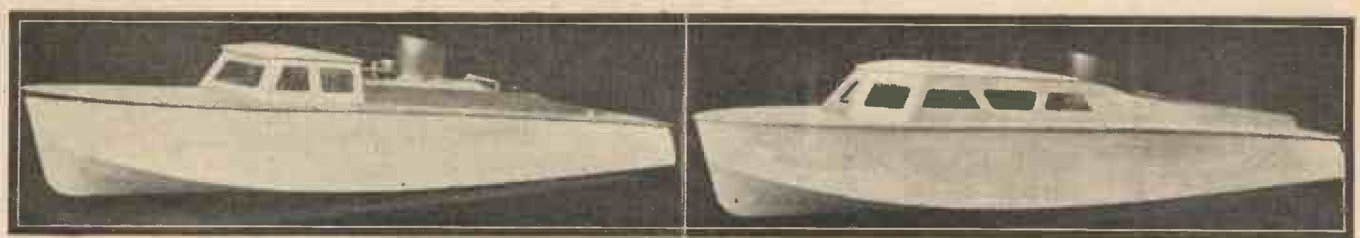
When the hollowing-out process is reached it is advisable to pause and consider that discretion is often the better part of valour, and it is easy to modify a hull that is found not to have been hollowed out sufficiently, and impossible to correct a hull that has been hollowed out too much. Therefore it is wise to allow a small margin of extra thickness all round, say ⅛ in., at any rate to begin with. A good sturdy bow is also an advantage, and there is

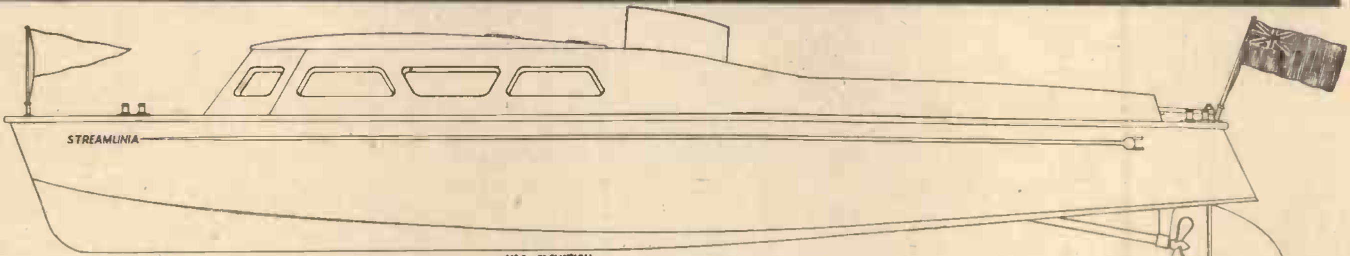




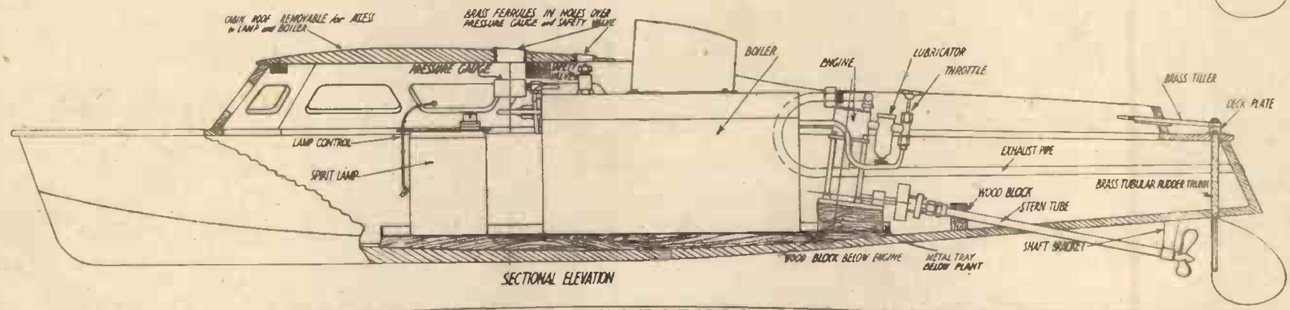


Lines and cross sections of the hull.

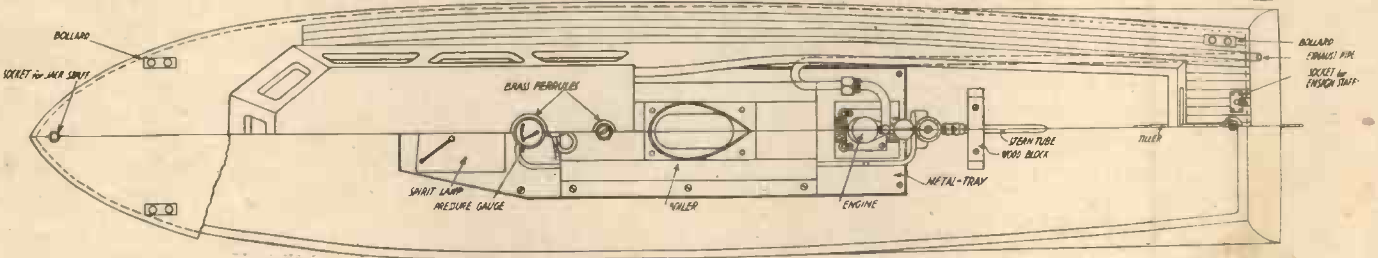




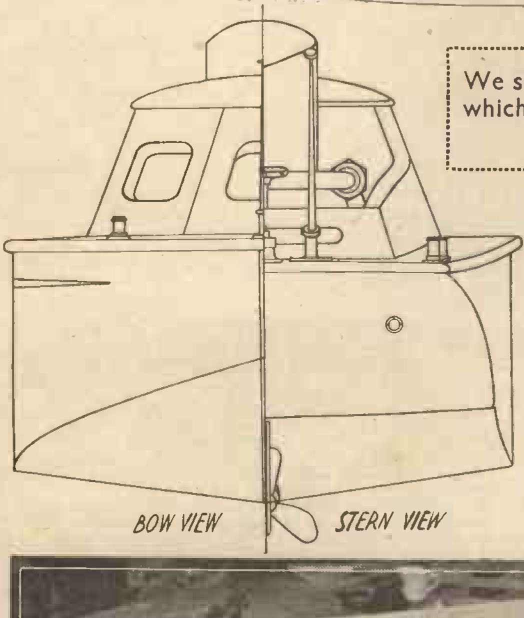
SIDE ELEVATION



SECTIONAL ELEVATION



PART SECTIONAL PLAN

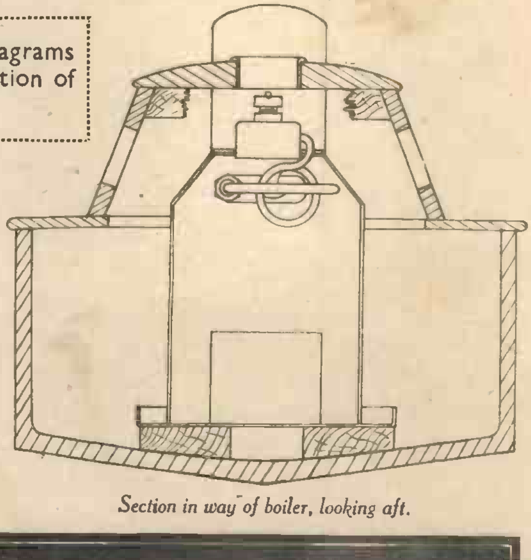


We show on this page various diagrams which will facilitate the construction of the model

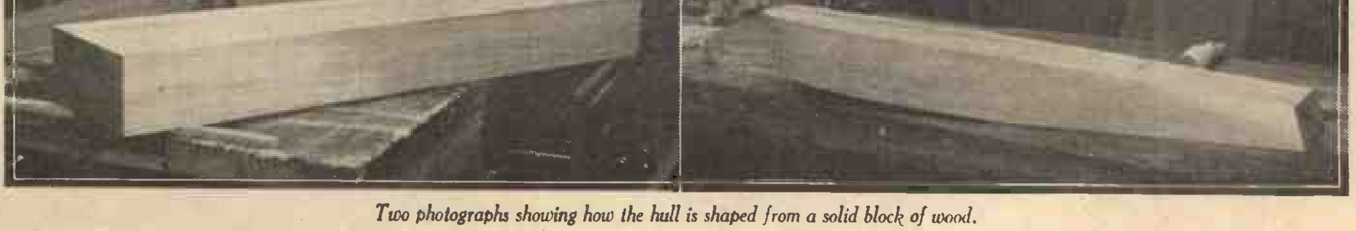
room to leave a good solid portion here, and also, to a less extent, at the stern.

Mark out a line according to the thickness of the hull parallel to the deck outline except at bow and stern, which are to be left rather more solid, say 3½ in. and 2 in. respectively, along the fore-and-aft line. Exercise care with regard to a symmetrical outline at bow and stern, and then, with pressure applied to a sharp, wide-edged chisel, cut round the

(*Continued on p. 296*).



Section in way of boiler, looking aft.



Two photographs showing how the hull is shaped from a solid block of wood.

Lathe Work

TOOLS AND TOOL ANGLES

By W. H. DELLER

AT no time is the importance of correct tool grinding in respect of lathe tools more appreciated than when the only power available for driving the lathe is by treadle, or is otherwise only sufficient to do the job when conditions are almost ideal. Naturally, when work is being roughed out the object is to remove the surplus material in the minimum amount of time, and unless the right tool is used for the job in hand this will not be so. Then again, finish is to a very great extent dependent on the tool itself, and as the tool must alter, particularly as regards "rake," for different materials, it is not surprising that proficiency in tool-grinding is usually the result of long experience.

It is therefore proposed to give particulars of what is considered the best range of tool shapes for general use together with grinding angles for different materials. The reader must, however, understand that others of a special nature may be wanted from time to time as occasion arises.

Many of the tools illustrated may be ground from bar material of appropriate section, or for that matter filed up prior to hardening. Where the latter practice is adopted care must be taken that the filing is done in such a manner to allow the tool being ground after hardening, that is to say, do not file "top-rake" with a small round file, for instance, as it will be difficult to grind this portion of the tool on a standard wheel.

Section of Steel

Before proceeding further, a word on the steel used may not come amiss. Where solid tools are used it is better to have a steel as deep in section as possible. Thus, if the tool post will accommodate a tool $\frac{1}{2}$ in. high, use that size in preference to, say, $\frac{3}{8}$ in. Generally speaking, rectangular sectioned steel will make "handier" tools and, while making for rigidity, will be no more costly for material than square tools of the lesser height. The rectangular sections referred to run as follows: $\frac{1}{2}$ in. × $\frac{3}{8}$ in., $\frac{5}{8}$ in. × $\frac{5}{16}$ in., $\frac{3}{4}$ in. × $\frac{3}{8}$ in., and so on, and are obtainable in both carbon and high-speed varieties. High-speed steel tools are the most advantageous, even for amateur use, but unfortunately the steel is comparatively expensive. The most economical way to use high-speed steel is in "tool-bit" form in a special holder or to use "tipped tools." This type of tool consists of a shank of carbon steel to the end of which is brazed or welded a comparatively small piece of high-speed steel in a suitable position. Tools such as these are now relatively cheap but are not to be had in small sections.

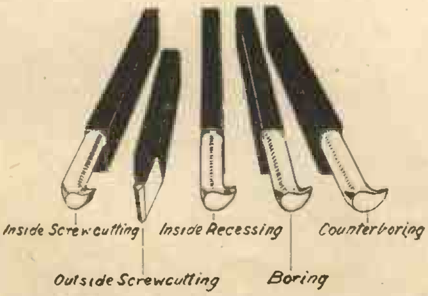


Fig. 4.—Outside and inside screw-cutting tools.

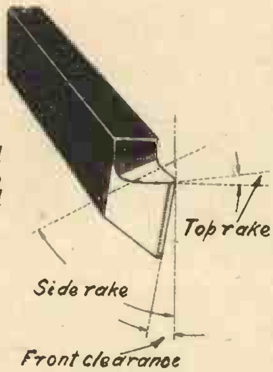


Fig. 1.—The tool shown is marked to show the cutting and clearance angles.

Cutting and Clearance Angles

The tool illustrated in Fig. 1 is marked to show the cutting and clearance angles. Before proceeding further it will be as well to state that even though properly made and ground, a tool cannot function correctly if improperly set, that is to say, the bottom face of the tool must be set in a horizontal plane. Where the lathe is fitted with a "rocker-bar" type tool-post, it is easy to overlook this point, but it must be remembered that the effect of rising or dipping the nose of the tool to obtain correct centre height so that the bottom face is not lying parallel with the cross slide, is to alter the front clearance and top-rake angles. Thus, if the base of the tool is rising towards the front, the front clearance angle is decreased and the top-rake increased in relation to the work. If rising towards the back the clearance is increased and the top-rake diminished.

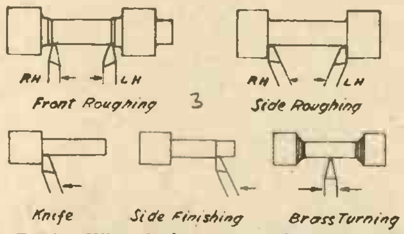


Fig. 3.—When the long cutting edge is presented square to the work, the front face has a back slope of 5 degrees.

The tool shown in Fig. 1 is a right-hand tool—that is, it cuts towards the chuck and produces the right-hand side of the work as turned. The front clearance angle is the angular amount that the front of the tool slopes out of perpendicular. Top-rake is the amount of back slope from the nose of the tool; side-rake is the amount that the top of the tool slopes away from the direction that the tool feeds along the work. The tool is also ground on both sides to give side clearance.

Therefore, if the tool is laid flat on its base the top edges of the ground portion would be clear of the bottom if tested with a square.

The Relationship of Tool to Material

As a general rule the variation in front and side clearance is only very slight, but the top and side rake must be altered considerably effectively to machine different classes of material. For soft mild steel the top and side rakes may be at their greatest, meaning that the cutting may form a very acute angle. Tougher material like nickel and such steels and cast-steel require machining with tools of less rake, on account of the fact very keen-edged tools will not stand up to them. Therefore the harder the material the more the rake is reduced, to afford strength to the cutting edge. Brass and cast-iron tools are rather different. Tools for hard brass, at all events, are made flat-topped to check digging tendencies, whereas with iron the rake is reduced to provide a cutting edge that will withstand the abrading action of the metal for the greatest time. The group of tools shown in Fig. 2 may be made from the bar without prior forging. Their uses are as follows.

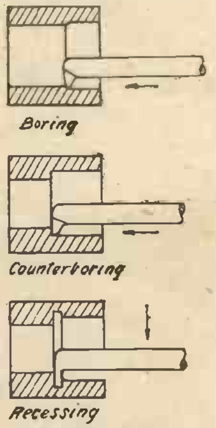


Fig. 5.—Methods of using the round-nosed tool, the counter boring tool, and the recessing tool.

Front Roughing Tools

General roughing out, turning or facing, particularly suitable for tough material and cast iron. Fig. 3 shows method of application to bar work, arrows show direction of

Fig. 2.—The group of tools shown may be made from the bar without forging.

feed for right- and left-hand tools. For slender work the radius at the nose should be made small. Both top and side rake.

Side Roughing Tools

General turning of a shouldered character when set at angle as shown in Fig. 3 or when set square with the work, for rapid removal of mild or soft steel. When so used the "swarf" or shaving comes away over the tool clear of the work. Use with a deep cut and medium feed. In profile the nose of the tool should form an angle of a few degrees less than 90, the corner being radiused. Both top and side rake.

Knife Tools

Chiefly used for working with mild steel. The tools are made in such a manner that when the long cutting edge is presented square to the work the front face has a back slope of 5 degrees. (See Fig. 3.) Deep cut, fine feed. Side rake only.

Side Finishing Tools

Like a knife tool excepting that a small flat is stoned on the front square with the direction of travel, the object being to obliterate feed marks such as are produced by pointed or fine round-nosed tools. Light cut, fine feed. Slight top rake and side rake. In a different form may have a wider face and top rake only for use with coarse feed. They then require very careful setting to be successful.

Brass Turning

The small round-nosed brass tool is suitable for machining hard brass, gun-metal and the like. Used for roughing out and turning as in Fig. 3, and can be fed in either direction. Flat-topped, no rake.

Outside and Inside Screw-cutting Tools

Both made with top and side rake. Front clearance of inside tool as for boring tools. Main cutting should be done on leading flank of tool by feeding top slide along slightly, as well as increasing depth of cut. Allow both flanks to cut on last one or two cuts to obtain correct thread form. Representative tools are shown in Fig. 4.

Boring Tools

Also shown in Fig. 4 are three boring tools, their respective uses being shown in Fig. 5. The round-nosed tool is suitable for straight-through holes and has top and side rakes. The counter-boring tool can be used for boring into corners or flat bottoming. Has both top and side rake. The recessing tool is suitable for cutting oil channels in bushes or bearings, or such jobs as cutting clearance recesses for internal screw cutting. Made with top rake only. Feed in direction of arrow.

Feed and depth of cut for boring will depend on the rigidity of the shank of the tool, but the types of tool shown are most suitable for light duties. Rather than increase the front clearance to prevent interference by rubbing, the clearance face should be reduced in depth by grinding away at the bottom in a manner similar to that shown.

The table, Fig. 6, gives tool grinding angles and coolants for various metals.

Parting Tools

The purpose of the parting tool is for cutting off or grooving. It is essential that the blade of the tool be made wider at the cutting edge to prevent binding as the tool is fed into the work. Where top rake is required it must not be made excessive on account of weakening the tool. It is preferable to grind the rake by holding the tool vertically against the face of the grinding wheel to reproduce a concave surface equal to the radius of the wheel.

REPAIRING SPECTACLE FRAMES

A BROKEN spectacle frame is often judged to be too fiddling to be repaired at home, although with a little care most amateurs could easily undertake this type of work. Broken lenses, or any rearrangement of lenses, must be left to a skilled optician, but repair of metal frames is easily dealt with in the home workshop.

A card of fretwork files, a couple of spring paper clips, borax, a little silver solder, and a blow-pipe throwing a fine-pointed flame and preferably automatic, are all that is really required. For any very complicated work a small tin, about the size of a 2-oz. tobacco tin, filled with asbestos, is very helpful.

Commence the work always by marking the lenses. This is easily done with a fountain pen, marking each lens on the front surface left or right, and putting a dot adjacent to the joint where the sides join the eye wires. This marking must be done accurately, as the lenses have to be replaced in exactly the same position as previously. Rotation in the frame will spoil the effect of most lenses.

If the eye wire is covered with xylo rims these must be removed first. They clip on the metal rim beneath and can be gently levered off with a knife blade, taking care not to break the xylo at the bridge where it is recessed. Loosen the screws in the joints and take out the lenses and the sides, and clean up the surfaces of the break by scraping bright. Borax rubbed to a smooth paste with water is the usual flux, and a little of this should be applied to the broken parts.

The frame may now be set up for brazing. An old flat file about 7 in. long makes a good bar for setting, and each eye is secured to it by a paper clip, making sure that the two screw joints and the two sides of the bridge are in a straight line. The broken edges should almost touch, the small gap allowing for the expansion of the metal on heating.

The actual brazing is accomplished in the usual manner, taking care not to heat more of the frame than is absolutely necessary. Temper in water from a good red heat and clean up with a fine file.

Heat marks are removed by cleaning with dilute sulphuric acid, and after washing thoroughly the frame is finally burnished and reassembled.

Occasionally a break may occur near an old repair. If this happens the frame is supported on a bed of asbestos in the tin previously mentioned, and the broken fragment held in position by a twist of iron wire. Once the parts are arranged in position they can easily be brazed on the asbestos packing.

Hard solder is used for all spectacle repairs, except for fastening collets to retain a spring, where a touch of soft solder is preferable, as it does not destroy the temper of the spring wire.

The main things to remember in spectacle repair are to mark the lenses, and remove all tortoiseshell and xylonite from the frame before applying the flame.

CHEAP METHOD OF PURIFYING AIR

CHEMISTS have devised a new process for dealing with the sulphur gases which at present are such a serious contributor to atmospheric pollution. The new process is technically perfect and only awaits favourable economic conditions for its commercial application.

Sulphur in its various forms is still one of the world's most important heavy chemicals. Industry uses over 7,000,000 tons of sulphur annually and wastes at least 2,000,000 tons. In Scandinavia thousands of tons of sulphur are imported annually for the wood-pulp industry, the whole of which could be provided by waste from neighbouring ore smelting works. A similar position holds in Australia. It is cheaper to import pure sulphur than to recover the waste. The reason is that at the present day sulphur gases are only recovered as sulphuric acid, which is expensive and difficult to transport, and is limited in its uses. It costs £10 per ton per 100 miles in rail charges. The new process has the advantage that it turns out pure elemental sulphur.

10s. per Ton

Pure sulphur is easily handled and stored, and costs only 10*s.* per ton in rail charges. It can be converted into sulphuric acid in small easily operated catalytic plants, and has a multitude of other uses, as in making wood-pulp, explosives, dyes and solvents. In agriculture it is extensively used as a fungicide.

The new process is applicable to gases from cement kilns and metal smelting works, which contain up to 6 per cent. of sulphur gases as sulphur dioxide and sulphuric acid vapour. The gas is washed with a special solution which absorbs the sulphur gases and gives them up again when it is boiled in pure concentrated form. These are then decomposed by passing them over a red-hot coke bed to give pure sulphur. Over £10,000,000 worth of sulphur could be recovered annually by commercial application of this process.

Boiler Stack Gases

Boiler stack gases contain sulphur from the coal. The treatment of these is a totally different question, because they only have about ·03 per cent. of sulphur. Small as is the percentage, the total amount of sulphur is immense. The Battersea Power Station could, if desired, turn out as much as 20 tons of sulphur a day into the air. The stack gases are washed with lime water which removes the sulphur as a slurry of lime sulphate. At present the slurry is not turned to any account. But it could be collected and burnt with clay in cement kilns and turned into cement and pure sulphur.

From the sulphur in her coal resources alone, Great Britain could supply more than her needs of industrial sulphur. In fact, as the prize of purer air we could have the cornering of the world's sulphur market.

THE AUTOMATIC PISTOL

EVER since the introduction of the first pistol, which was a single-barrel affair, improvements have been mainly concerned with increased speed in reloading and firing. The first step was, as may be supposed, to make a pistol with two barrels side by side like a double-barrelled gun. A third and similar barrel was next added, making a triple pistol, and the number of barrels was increased until there were six grouped together. The six-barrel pistol was, of course, quite a clumsy contrivance, but no doubt this weapon pointed the way towards the revolver, which has held the field for a long period. The introduction of the automatic pistol, of which the "Colt" is perhaps the best-known type, threatened the revolver with extinction for a time, but the revolver was found to possess certain advantages over an automatic, and is still the type of weapon used by the British Army.

The Revolver

The revolver usually carries six cartridges in a chamber which rotates on an axis parallel with the barrel, so that after a shot has been fired a new cartridge is brought in line with the barrel, ready for firing, by rotating the chamber one-sixth of a revolution. This partial rotation of the chamber is carried out by the trigger, which has a long pull. In the case of an automatic, the empty cartridge is extracted, a new one placed in the breech and the trigger is cocked ready for firing, all by the action of the recoil, so that it is possible to fire a succession of shots as quickly as it is possible to pull the trigger, which has a short pull and can be worked very quickly. The short light pull of the trigger favours accuracy of aim and rapidity of fire with the automatic, but the latter suffers from the objection that should a cartridge misfire, both hands must be used to clear the "dud" cartridge and it is necessary to take one's eye off the target for a moment, both of which entail loss of time and may easily place one at a serious disadvantage. With the revolver, if one cartridge should misfire it is only necessary to pull the trigger again to fire the next cartridge, and it is not even necessary to take one's eye off the target.

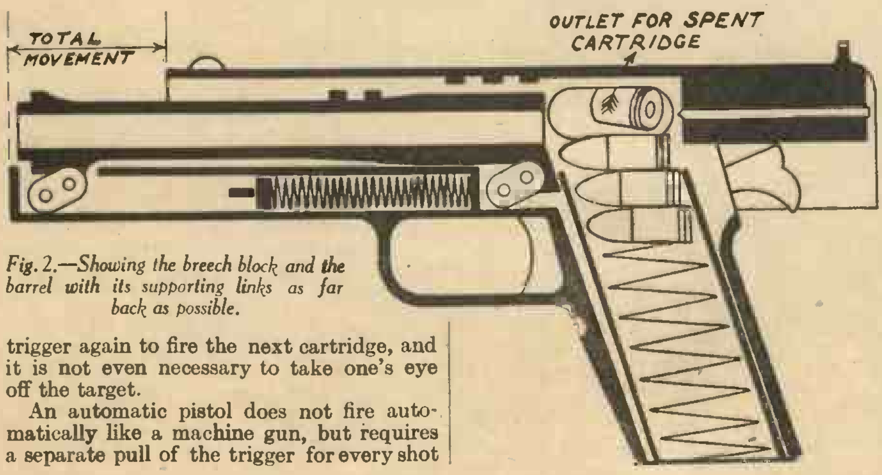


Fig. 2.—Showing the breech block and the barrel with its supporting links as far back as possible.

An automatic pistol does not fire automatically like a machine gun, but requires a separate pull of the trigger for every shot that is fired; the ejection of the spent cartridge case and the loading of a new cartridge is, however, quite automatic.

The "Colt" Automatic

Fig. 1 is a simplified section of a "Colt" automatic pistol to show how the mechanism works. On pulling the trigger (which has a sliding movement) the hammer falls on the firing pin, which transmits the blow to the cap of the cartridge. The cordite in the cartridge thereupon explodes and drives the bullet from the barrel. Now the force due to the explosion not only acts on the bullet but also on the breech block of the gun, which is driven back with considerable force, compressing the spring which may be seen below the barrel. The breech block is, however, locked to the barrel by means of two projections on the top of the barrel, which engage with two recesses cut in the underside of the cover, forming an extension of the breech block proper. The barrel and the breech block therefore start to move back together, but the barrel is held on two short links which cause the barrel to move downwards as the breech block slides backwards, so that the two parts become unlocked and the breech block continues its backward movement without the barrel. Fig. 2 shows the breech block and the barrel with its supporting links as far back as possible.

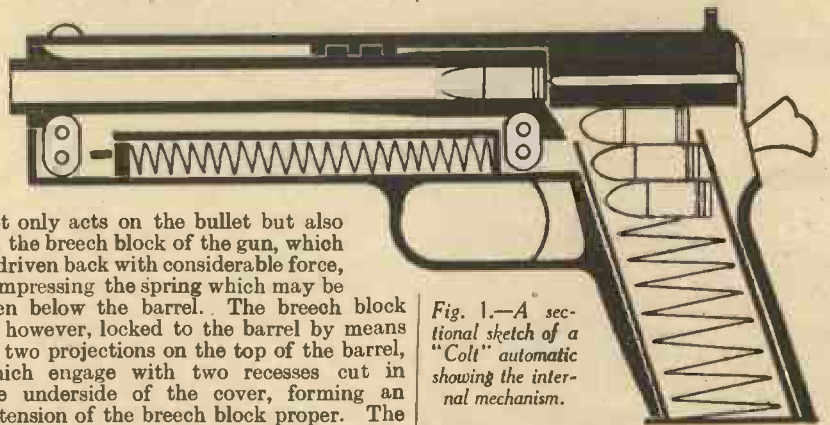


Fig. 1.—A sectional sketch of a "Colt" automatic showing the internal mechanism.

By an ingenious arrangement of the parts the cartridge is held by the breech block and pulled out of the barrel, after which a projection specially designed for the purpose knocks the empty cartridge case sideways through a hole arranged for the escape of the empty case.

The Cartridge Supply

The supply of cartridges is carried in a "clip" holding seven cartridges, inside the handle, and immediately the empty case has been disposed of a new cartridge is pushed upwards by the spring below. The breech block then returns under the action of the spring and pushes the new cartridge into position in the barrel. This gives a forward movement to the barrel, which rises to the position shown in Fig. 1, thus locking the breech to the barrel, and the pistol is again ready for firing. The trigger is cocked automatically by the rearward movement of the breech block, so that nothing remains to be done except to pull the trigger again. Although the action takes a little time to describe, the actual working is almost instantaneous.

The pistol is loaded in the first instance by inserting a full clip of cartridges in the handle, but to get the first cartridge into the barrel ready for firing it is necessary to pull the breech back by hand. This action also cocks the trigger, so if the gun is not required for immediate use, the trigger should be let back to half-cock position for safety.

A Source of Danger

One ever-present source of danger with this type of weapon is that when the gun is unloaded by withdrawing the clip containing the cartridges, it is very easy to forget the cartridge that remains in the barrel, so that the trigger may be pulled in the belief that the gun is empty and a shot will be fired. The remaining cartridge may be removed by pulling back the breech smartly, when the cartridge will jump out of the hole provided for empty cartridge cases.

The barrel of a "Colt" is rifled by making it of a hexagonal shape, the corners of the hexagon being rounded off.

THE ERA OF RAYS

ALREADY it has been discovered that X-rays are produced from many other sources than the vacuum-tube, while the curative rays thrown out by radium have recently been produced by a giant cathode tube utilising 2,000,000 volts and giving a penetrative power equivalent to about £35,000,000 worth of radium. Possibly before many decades have passed the manipulation of rays will revolutionise the face of the earth. Power will be carried on an electronic beam, providing light, heat, and aerial locomotion without wires or engines. Special rays may be used to disintegrate soil and rock, thus doing away with laborious mechanical contrivances for tunnelling and mining, while cauterising rays may prove a weapon of such terrible power and range that warfare would be an impossibility.

TELEVISION

By H. J. BARTON

The first article of a series
systems function

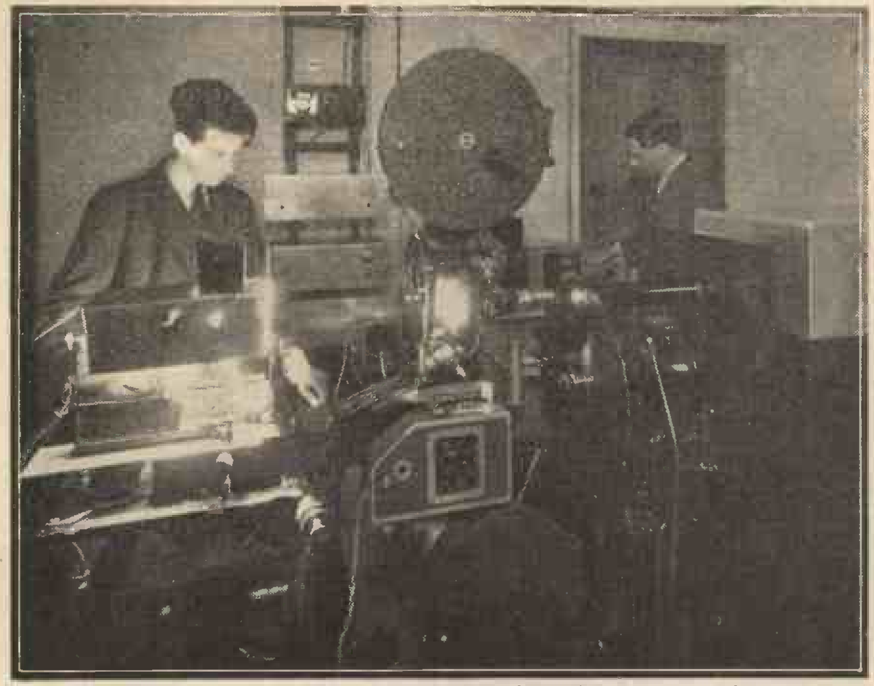


Fig. 8.—Showing a talking film Baird projector designed to work in conjunction with scanning apparatus for producing television signals.

SINCE the appointment of the Television Committee by the Postmaster-General in May of last year, considerable speculation has been rife as to the possible nature of their recommendations for a form of public service that would not only stimulate public interest, but maintain it. The report has now been issued, and in view of its very important decisions, especially in connection with the proposed high-definition television service which is to start this year, it is essential to enlighten readers on this new technique which will combine sight and sound for home entertainment, as well as open up avenues in the establishment of new communication services.

From the first issue of PRACTICAL MECHANICS the editor has pursued a policy of conviction that this new science was sure to take its part very soon in everyday life, and it is the purpose of this series of articles to explain in simple language how the television systems function, both at the transmitting and receiving ends.

A Combination of Methods

Even quite modern dictionaries fail to include a definition of the term, so it is small wonder that few people really understand what television means. Briefly, it is a scientific development which combines electrical, optical and mechanical methods for the purpose of producing pictures of scenes or objects, animate and inanimate, stationary and moving, although outside the direct optical vision of such scenes or objects. Another way of regarding the same thing is to say that television is the process which employs electrical methods of communication in order to transmit images of any scene to a distance with absolute clarity, and so give the same visual impression as would be obtained by eye-witnesses on the spot.

It is not always appreciated that Nature has provided every normal human being with a television system, that is the eye, and the earliest inventors directed the bulk of their energies towards attempting to duplicate the functioning of this wonderful organ. Their efforts, however, were crude and failed completely, but even so, there is really a measure of similarity between the working of the eye and all modern methods of television. This is bound up in the simple term, "scanning," as we shall see in a moment.

The Sensation of Sight

First of all, the eye when it views a scene has a minute image of that scene (built up by varying light values) focussed by means of a "lens" on to a portion of the eye called the retina. This stimulates millions of nerve cells which are really light sensitive, that is to say, they are capable of responding to light stimulation in direct proportion to the amount of light which they receive *viâ* the focussing lens. Although finite in size, the cells are infinitesimally small, but their action is to communicate to the brain an impression of the scene in the finest granular structure and so bring about the sensation of sight.

Another important fact to remember is that when we gaze at any scene we unconsciously scan it, that is to say, we allow our eye to wander over it and take in detail by detail the whole panorama it is intended to view. Yet another point is the power of being able to concentrate the gaze over a very small relative area so that the remainder of the view is somewhat blurred and not brought into true focus until the concentration on the small area is relaxed.

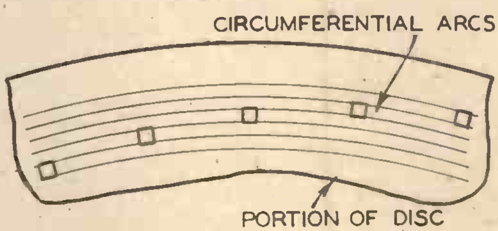
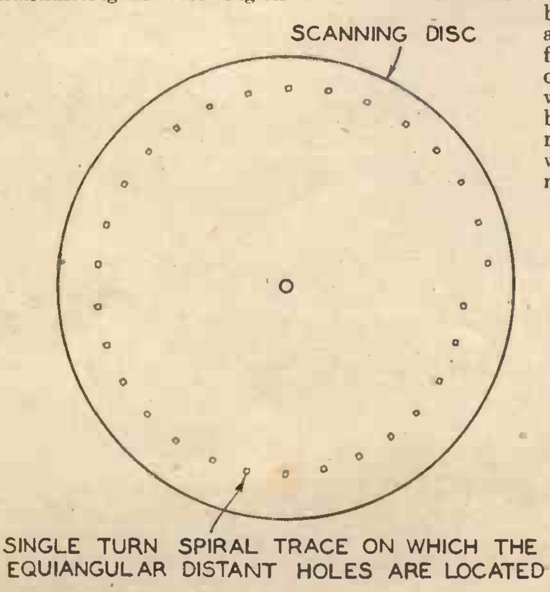


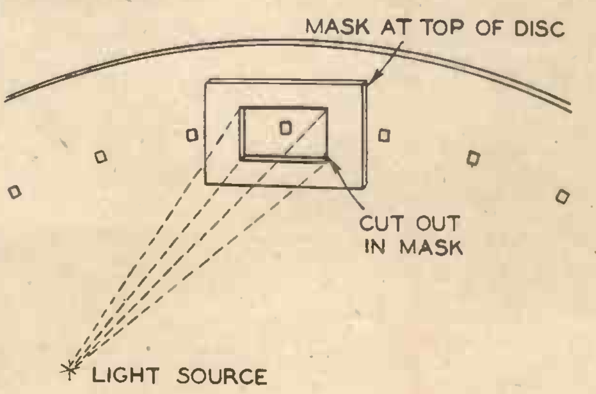
Fig. 2.—The inner edge of each hole is on the same arc as the outer edge of the succeeding hole.

Necessary to Scan

With every form of television transmission, light sensitive devices of different types have to be employed in order to convert the scene's light values into equivalent electrical signals for transmission purposes, and since these devices have a single large active area which can only respond to the average light effect with which they are influenced, it is impossible to transmit a scene or object as a whole. It is for this reason that a scanning



Figs. 1 and 3.—(Left) Showing how the scanning holes are positioned on the disc and (right) arranging a mask with cut out at the top of the disc.



MADE EASY

CHAPPLE, Wh.Sch., B.Sc., etc.

describing in simple language how the various television at the transmitting and the receiving ends.

Fig. 6.—Showing how the photo-electric cells are arranged round the subject in the Baird light-spot studios.

or exploring device has to be brought into play, the purpose of this being to break up the whole scene into elemental sections so that the relative light values of the whole area can be dealt with in a rapid and pre-ordered sequence.

The degree of dissection employed for this purpose governs the definition of the transmitted and received image. That is to say, if the scene or object to be transmitted is explored in a series of fine straight lines, then the resulting detail obtained will be considerable, but if the scanning of the same scene is effected by a small number of lines, then the resultant detail will be poor. This gives the prime difference between what is called a high-definition television service—that proposed by the Television Committee for the first public service is to have a definition of 240 lines—and a low-definition service similar to that now featured by the B.B.C. from their studio in Portland Place, where 30-line television images are broadcast *viâ* the London National Station for two three-quarter-hour periods each week. A proper appreciation of this very important question of line scanning will result when some of the methods for carrying it into practice are described, so to maintain continuity of thought, a few remarks on this will be given.

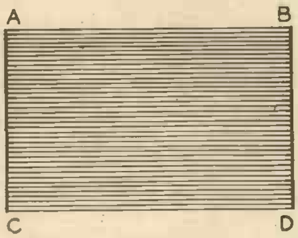


Fig. 5. — The area ABCD is scanned by a series of horizontal lines in ordered sequence.

Simple Scanning

Any study of the history of television development will disclose that the methods propounded by various inventors to produce the effect of scanning are legion, but the bulk of them have been discarded in the light of modern television requirements. One of the very simplest, and incidentally one which is still employed in modern high-definition television systems, is to use a scanning disc. This was invented originally by a German called Paul Nipkow in 1884, and is employed in two distinct ways.

The first method is included in the light-spot system of television transmission originated by Mr. J. L. Baird. A thin, flat, circular disc is placed in front of an intense source of light, the disc being revolved at high speed. Near the outer edge of the disc is punched a series of minute apertures, each one of these holes being separated by the same angular width and lying on the trace of a single turn spiral, as indicated diagrammatically in Fig. 1. In addition to being positioned on the spiral track, it is arranged that the inner edge of each hole lies on the same circumferential arc as the outer edge of the succeeding hole (see Fig. 2).

Tracing the Light Area

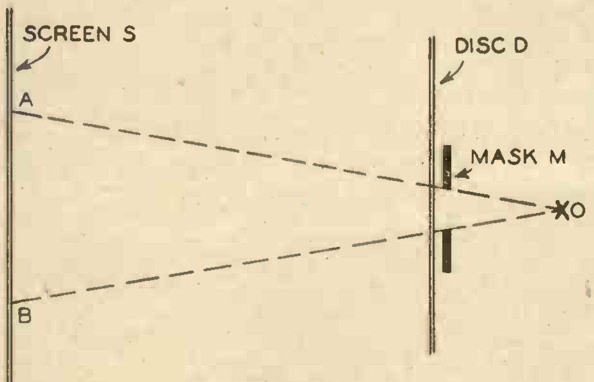
By positioning the source of light at the top of the disc, and arranging for the rays to be focussed on to a mask which has an area cut out bounded by the positions of the first and last disc holes, as shown in Fig. 3, it is easy to see what happens as the disc revolves. As a hole comes within the mask cut out, a tiny pencil of light will pass right through the hole, and since the light source is stationary and the hole moving, the effect will be to cause the pencil of light to trace an arc of light across any screen placed in its path. This is shown as a plan in Fig. 4 where O is assumed to be the source of light, M the mask, D the apertured disc and S the screen. The limit of scan in the horizontal direction will obviously be the width AB corresponding to the first light beam OA, when the disc aperture just appears in the cut-out area of the mask, and the same light beam OB, when the disc aperture just disappears from the mask area.

Since, strictly speaking, the hole movement is circumferential, the line of light traced out is an arc, but by making the disc diameter large, the spot of light to all intents and purposes traces out a horizontal line. As one hole finishes its movement across the mask another hole performs a similar operation, but since it is a hole width nearer to the centre of the disc, then the beam of light does not trace the same path as its predecessor, but one just below it.

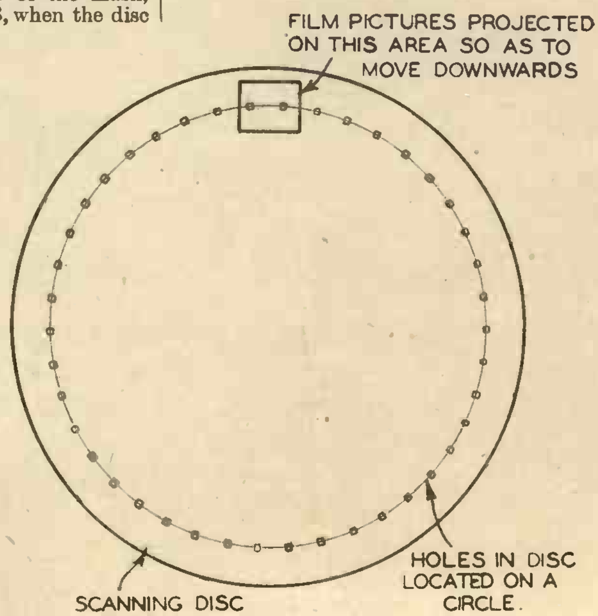
Producing the Signal

Now each hole in the spiral is a hole width nearer to the disc centre, so that for one revolution of the disc the complete area traced out is the rectangle ABCD (shown as a rectangle, although this is not strictly correct owing to the arc formation mentioned previously), the area being scanned as a series of horizontal lines in ordered sequence (see Fig. 5). Any scene, object or person located within the area ABCD is therefore covered or traced over by the minute spot of light. At any and every instant during this exploration the light spot illuminates a definite area, the size of the area depending upon the number of holes into which the disc is divided, and concurrently the line definition of the televised picture.

(*Continued on page* 272.)



Figs. 4 and 7.—(Left.) A plan view of the light area covered on the screen and (right) the scanning film pictures the holes on the circumference of a circle.



The Marvels of Modern Canals

(Above) A bridge over the Welland Ship Canal, Ontario, Canada. (Right) Towing a ship through Gaton Lock. The electric loco is seen climbing to the level of the second lock (four locos are used to each vessel).

AMONG all the mighty achievements of modern engineering, the making of great ship canals stands first. The canal builder can alter the geography of cities or countries, shorten the sea mileage between ports by 5,000 or even 10,000 miles, and make water climb hills and carry big ships on its back! Thus Manchester (which for many centuries was an inland city) is now our fourth seaport, and there are towns on the Great Lakes of America which have direct ocean communication with the world by means of connecting canals, although they are 2,000 or 3,000 miles from the sea.

Canal building is an exceedingly ancient art. The Romans built a canal in Lincolnshire forty miles long, of which eleven miles still remain, and there was a canal connecting the Red Sea with the Nile as long ago as 1380 B.C. But these ancient canals were mere ditches for boats or barges, and so fade into insignificance beside the mighty modern waterways which divide continents, and carry the biggest ships afloat. The most important of these are the main arterial routes of shipping in time of peace, and become vital strategic objectives in war. Thus, during the Great War, the whole length of the Suez Canal was entrenched and defended by our armies; and both the Panama and Kiel Canals were strongly fortified, and are of vital importance to the navies of U.S.A. and Germany.

The Invention of the Lock

The first important discovery in canal building was the invention of the lock, which enables canals to climb over ranges of hills, and even to connect seas which are at different levels. As long ago as 1681 the French built the Languedoc Canal, which climbed to a height of 620 ft. and had 119 locks in a distance of 140 miles. We have two examples of this kind in our own country, each built about a century ago. "Neptune's Staircase" on the Caledonian Canal climbs 80 ft. by means of eleven locks, and the Kennett and Avon Canal ascends the steep hill to Devizes town from the west by means of about a dozen locks. If you turn left on the main road under the railway bridge about a mile from Devizes you can get a striking view of this remarkable water-staircase.

The first important ship canal was that of Suez, 100 miles long, which shortens the voyage from England to India by 5,000 miles, and gives a still greater advantage to the Mediterranean ports. This mighty enterprise was carried out by Ferdinand de Lesseps, who was helped in his projects by Said Pasha, whose name is commemorated by Port Said.

De Lesseps had the greatest difficulties to overcome, owing to political intrigue, and the fact that certain Powers wished to prevent the work. It was started in 1859 and finished ten years later. It began by means of forced labour—or slavery—but owing to English action this was stopped, and probably this was an advantage, as it forced De Lesseps to make use of machinery. He had a shallow canal dug by hand labour, and then put in dredgers, which quickly deepened the canal. The greater part of the distance was quite easy, as the ground was level and consisted of sand, while about a third of the length was made up of the Bitter Lakes.

The canal has been several times deepened and widened, and since the War, a new seaport called Port Fuad has been built opposite Port Said.

It has been a wonderful financial success, the 250 franc shares were worth 18,000 in 1928, and the four millions sterling invested by England in 1875 has already been repaid eight times over in interest and dividends, leaving us still with the capital.

The Panama Canal

Although only about half the length, the Panama Canal is a much greater enterprise. Its length from shore to shore is 40·27 miles, and from deep-water to deep-water 50·72, and no doubt this is why De Lesseps declared when planning his ill-fated canal that it was a "much easier job" than Suez. His plan failed, to the ruin of thousands of French investors, and with gigantic loss of life among the engineers and labourers, but it is wrong to suppose that unhealthy climatic conditions were the sole cause of the disaster. The fact is that if Panama had been as healthy as Margate, De Lesseps *must* have failed. There was wholesale graft, peculation and mismanagement (the American corruption fund alone absorbed £480,000), and in addition his design was hopelessly impracticable. The plan was for a sea-level canal without locks, and this must have failed, because the canal for many miles runs near the course of the Chagres River, and is also intersected by the Rio Grande and Rio Obispo. During the rainy season the Chagres River *has been known to rise 40 ft. in a few hours,* and so would of course immediately burst and destroy the canal, the bottom of which would be 100 *ft. below the river level.* There is a further

(Left) Hercules and Ajax, two 300-ton cranes on the Panama Canal, and (above) North Sea sluice or lock, Kiel Canal.

difficulty at the Culebra cut, where the cliff is of soft shale so friable that you can wash the rock away with a hose-pipe. This has caused great trouble and expense even with the modern canal, which is 85 ft. above sea-level at this point. Constant slips have taken place, and it has been necessary to widen it again and again, using for the purpose a mighty hose-pipe like a fire-engine, but several feet in diameter.

A Mighty Dam

The modern engineers solved this problem very cleverly. A mighty dam 105 ft. high, and a mile and a half long at the crest was built across the valley of the Chagres River, and so formed a huge artificial lake twenty-four miles long and 162 square miles in area. Gatun Lake is the largest artificial lake in the world, and about the size of the Lake of Geneva. It is very beautiful, as the hills rise through it and form romantic islands, which after the flooding were highly dangerous, owing to fierce, starving wild beasts which had been trapped there. The lake swarms with alligators, which makes it a source of danger. They often overturn boats and devour the occupants. The canal climbs up to the Gatun Lake by means of three locks, each 1,000 ft. long, and 110 ft. wide. Three parallel locks are provided so that ships can pass both ways at once. Each lock is lighted by electricity and furnished with small electric engines which tow the ships through. All the current required is obtained from the surplus water of the river at the "Spill-way," so that the element which must have ruined De Lesseps' canal actually works this one. There is a dredged channel through the lake to the Pedro Miguel Lock, and we then descend to the Miraflores Lake 30 ft. below, and by two more locks to the Pacific level. These lakes are full of dead trees which died when the water rose, and their bare branches rise like ghosts from the water, ex.ept in the dredged channel.

(Left) A Dutch drainage canal and windmills, Schemerhoorn, and (below) part of a water stair, Devizes, Wilts, which carries the Kennett and Avon Canal up to Devizes town.

Widening the Culebra Cut, Panama Canal.

This canal shortens the voyage from New Orleans to San José (Guatemala) by 9,330 miles, and to the same city from Liverpool by 6,128 miles. The journey from New York to San Francisco has been reduced from 13,135 to 5,262 miles, a vital matter if the American Fleet wants to get round in a hurry.

The Kiel Canal

This is 53·3 miles long, and 37·07 ft. deep; in size, generally, it approximates closely to the Panama Canal, but had no natural obstacles to surmount. Its course lies mainly through level pastures, and the hills encountered are few and of moderate altitude, the most striking parts of the canal are the two stupendous locks at each end, and the imposing viaduct by which the Sleswig-Holstein railway crosses the canal at a stupendous height. There are no towns along the course of the canal, and only small villages. Although its primary purpose was strategic it is useful commercially, as it avoids the long and dangerous voyage round the Skaw into the Baltic. Ships take eight hours to pass through.

(Above) The city of New Panama and (right) a view of Culebra Cut, Panama.

Other important ship canals of recent construction are those connecting the following cities with the sea—Leningrad, Amsterdam, Bruges and Manchester—to mention a few of the most important.

Drainage canals also can alter the geography of whole districts, as in the case of the recent Zuider Zee reclamation, which has added half a million acres of land to Holland, and almost totally abolished the Zuider Zee, the old sea entrance of which has been closed by a dam twenty-five miles long. This work has been completed during the last two years.

Almost the whole of Holland was originally reclaimed from the ocean in this way, and thousands of windmills were employed for pumping water from drainage canals which are below sea-level.

These few examples show the great *practical* value of the canal and the way in which it can alter the geography of whole countries.

Escaping from the Earth

Will it ever be accomplished? The Cold Facts concerning Mankind's Age-old Dream.

THE great amount of success which has attended the recent endeavours of Professor Piccard and others to explore the upper regions of the earth's atmosphere has brought once again into some degree of prominence a problem which seems to be nearly as old as the human race itself.

It is the problem of escaping from the earth, of exploring not only the extreme upper limits of the earth's envelope of air, but also the void of Space beyond and of traversing by some means the distances intervening between the earth and the moon and the various planets of the solar system.

A fascinating problem, indeed. Could it be surmounted, even merely to a limited extent, it would enormously advance the activities of the human race. What, however, are the chances of any member of the human race ever managing to get away from the earth and to voyage safely in outer Space? Are such chances close ones or remote? Or, alternatively, is it an utter impossibility for any man to leave this world behind in the strictly material sense implied in these lines?

Thousands of years ago man tried to imitate the birds and to fly. It was, after all, a more or less natural desire to escape from the tardy means of locomotion which legs alone provide us with. More than 2,000 years ago, according to the old Greek story, a celebrated artist and inventor named Dædalus and his son, Icarus, were both imprisoned in Crete. In endeavouring to escape from the prison they devised wings which they attached to their shoulders by means of wax. Dædalus succeeded in flying across the sea to another land, but Icarus, who evidently was the more adventurous of the two, flew too near the sun, with the result that the heat of that luminary melted the wax which secured his wings in position. He fell into the sea and was drowned, the present-day Icarian Sea being named after this legendary aerial disaster.

Dr. Francis Godwin

In 1638 a Dr. Francis Godwin, of Hereford, devised a scheme for getting away from the earth. So enthusiastic was the learned doctor over his notion that he wrote a book on the subject and therein he detailed his proposals for the projected space-voyage. Dr. Godwin's idea was to fly to the moon on a frame-like contraption to which were to be harnessed ten wild swans. The voyager sat in, or rather hung on to a small seat from which he drove the swan team and, for steering purposes, he manipulated a small sail which was fixed at the back of the space-chariot. Needless to say, Dr. Godwin's fantastic invention never got beyond the pages of his curious and interesting book.

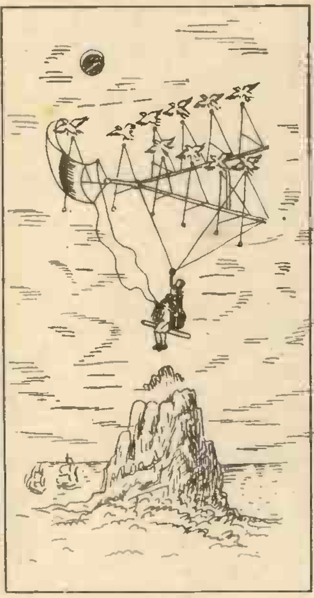
Another equally mad scheme for flying upwards to the moon was that of Cyrano de Bergerac, who at a later date proposed, by means of certain feathered wings and various magical incantations, to do the journey in less than twelve hours! There still exist to this day old prints depicting the redoubtable Cyrano stepping off from Mother Earth with great gusto.

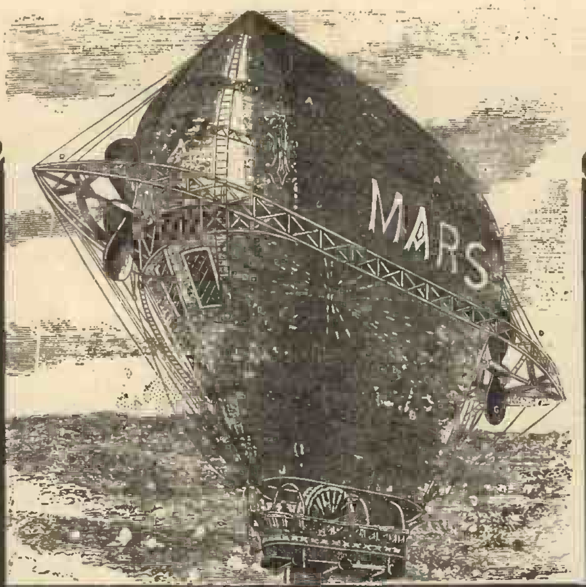
Coming to more recent times, nearly every reader of this paper will be aware of the imaginative scheme of that scientific pioneer novelist, Jules Verne, for escaping from the earth and voyaging to the moon. In his "From the Earth to the Moon," published in the later years of the last century, Jules Verne encases his space voyagers in a specially-constructed steel projectile and he shoots them from the face of the earth by means of an enormous cannon. Owing to certain miscalculations the imaginary lunar explorers do not actually land on the surface of our satellite. Instead they glide past it at a distance of forty miles, eventually, by an ingenious manœuvre, returning to the earth and landing in the middle of the ocean. Mr. H. G. Wells, in his "First Men in the Moon," gets his explorers to the moon by means of a gravity-insulating material, whilst certain American romancers have attempted to visualise the construction of enormously long rigid tubes of light metal extending from the earth's surface beyond the utmost limits of the atmosphere and through which some sort of traffic could be propelled by the force of compressed air.

(Right) The moon seen through a powerful telescope. Note the craters and the dark plains or "seas," and (below) a photograph of one of the many vast fire-clouds which are present out in the depths of space. Space voyagers encountering even the—

—nearest fringe of one of these clouds would meet with instant disaster.

(Below) Dr. Francis Godwin's projected journey to the moon. The sketch shows him seated on a frame-like contraption harnessed to ten swans.





Before the days of dirigibles this airship was projected for the purpose of exploring the upper reaches of the earth's atmosphere. It was to be driven by steam!

(Below) Cyrano de Bergerac, who proposed by means of certain feathered wings and various magical incantations to journey to the moon in less than twelve hours.

"All nonsense," you say. And, indeed, you are right. There has been more nonsense talked and written about escaping from the earth than there has been on any other scientific or pseudo-scientific subject in modern times.

The popular scheme nowadays for escaping from the earth is by means of a specially constructed rocket. And, naturally enough, the moon, being our nearest neighbour in the heavens, is usually the destination of the proposed journey.

Let us see, however, how such schemes fare when they are calmly examined in the light of modern scientific knowledge.

Escaping from Gravitational Influence

In the first place, for a body to escape from the earth's gravitational influence it must leave the earth with a speed of at least seven miles per second. That is, of course, assuming that there were no atmosphere to impede the progress of the rocket or whatever other projectiles were employed for the journey. As, however, the earth possesses a fairly dense atmosphere, the space-projectile must leave the earth at a much greater speed than the above.

At such required speeds, however, friction with the atmosphere would quickly heat up the sides of the projectile so that they would rapidly become incandescent and burn away like a meteor in the sky.

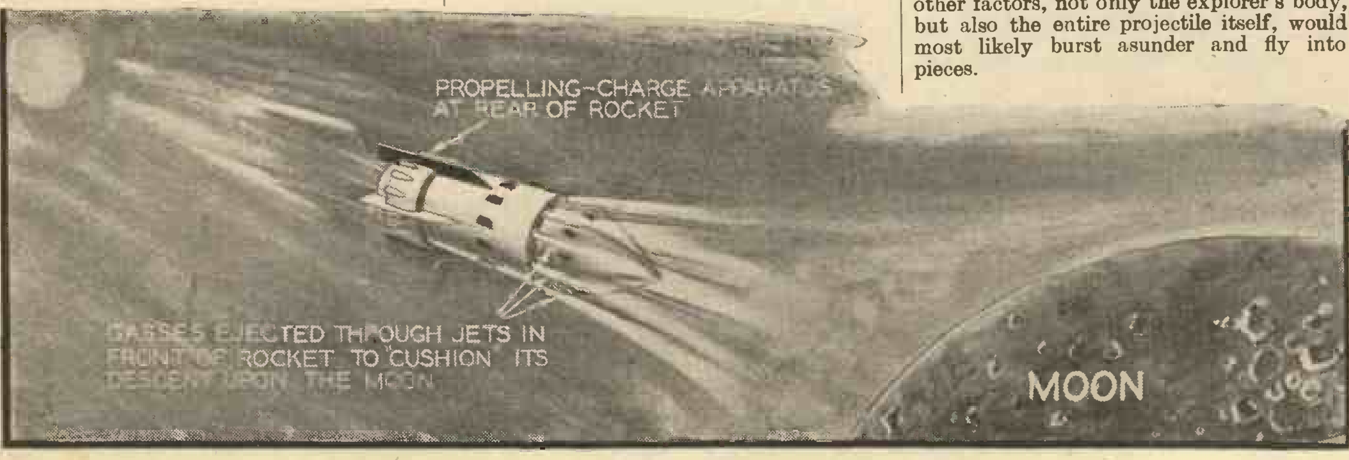
In order, therefore, to overcome this drawback it has, from time to time, been proposed to employ for the journey a projectile which would leave the earth with a much smaller velocity. A specially designed rocket would be used. It would be equipped with a number of separate propelling-charges, each coming into operation successively. The first propelling-charge would shoot the rocket about 200 miles above the earth's surface, the journey occupying about twenty or thirty seconds. A second propelling-charge would then automatically come into operation. After this has been spent a third charge would be ignited automatically, and so on until the rocket-projectile had journeyed beyond the immediate sphere of the earth's attraction.

In order to lessen the force of the rocket's descent upon the moon certain "braking charges" would be brought into action by the lunar navigators—that is to say, if they still remained sufficiently alive to control the rocket's mechanism. By explosively forcing out a stream of gases in front of the rocket as it descended upon the moon's surface it is supposed that the excessive and inevitably destructive landing-velocity of the projectile could be counteracted.

There are a thousand and one difficulties connected with schemes such as the above. But even supposing that in course of time such difficulties were all surmounted and that a space-worthy projectile became an accomplished fact, we are utterly without knowledge as to how the human system would react to the conditions of the voyage. In the opinion of many scientists the human organism, accustomed as it has been for so many thousands of years to living at the bottom of a deep ocean of air, would become totally disorganised before the voyage to the moon was even one-third completed—if, indeed, the human frame proved itself capable of withstanding without injury the initial shock of the rocket's propelling-charge.

Deep-sea fishes, when they are brought up from the depths of the ocean, literally burst into pieces owing to the much reduced pressure which is exerted upon their bodies. So, also, in the opinion of many people whose judgment is to be relied upon, would it be with the would-be space-explorer seated within the control-room of a hermetically-sealed space-projectile.

Due to disturbances of gravity, the enormous lowering of pressure outside the region of the earth's atmosphere and various other factors, not only the explorer's body, but also the entire projectile itself, would most likely burst asunder and fly into pieces.



Steering the Space Projectile

Let us suppose, however—for one should never deem anything to be totally impossible—that the ghastly possibility previously outlined could be eliminated with certainty and that a trip outwards into Space could be undertaken with, at least, a fair chance of success. How now, could the space-projectile be steered so that it would land accurately upon the moon or upon the surface of some other heavenly body and not fly past it into the depths of unknown and, perhaps, unfathomable Space ?

The usual answer to this vitally important question is to the effect that the precise "landing-direction" would be given to the projectile by "calculation." Meaning, one supposes, that a troop of mathematicians and an army of physicists would work out the necessary elevation and line of direction of the rocket, and also the exact time of its journey's commencement in order that it could hit the moon accurately and at any required area.

Such a mathematical feat might not be impossible in actual practice. It would certainly be an extremely difficult task, however. For one thing the motions of the earth and the moon are not constant. They are both subject to a good deal of unexplained irregularities. Then again, rockets are notoriously unreliable so far as their speed and direction of travel are concerned. And when, to this, is added the fact that the rocket-projectile would be subjected to unknown influences during its journey through Space, the chances of a rocket falling upon the moon's surface, even when fired under the most careful and accurate mathematical supervision, would be remote. The chances of an earth-fired rocket reaching the surface of a neighbouring planet such as Mars or Venus are pretty well infinitesimal. The successful Space-traveller of the future, if he materialises at all, will therefore have to devise and rely upon his own steering arrangements and not leave that important task to the earth-bound mathematicians and physicists.

The Return Journey

Last, but not least, in our brief review of the enormously difficult problems which are associated with the various proposals for escaping from the earth, is the highly important one of returning safely to the home planet. Curiously enough, this problem—perhaps the greatest of all the multitudinous difficulties connected with Space-voyaging—is usually relegated to a position of merely secondary importance by the pseudo-scientific visionaries who propose their daring schemes of Space exploration. Having reached the moon, for instance, by one means or another, how are the lunary travellers to return to the earth ?

On the moon's surface there is no air, no water, no food, no ordinary sources of energy, no projectile-firing appliances, no planetary observatories, no calculating mathematicians. Truly, therefore, it would appear that the adventurous Space-voyager, having by some extraordinary means reached the surface of the moon unharmed, would have to remain on that satellite for the remainder of his days—which, considering the complete absence of food, water and oxygen, would not be likely to be very numerous.

The truth about the matter of Space-journeying is a very simple and straightforward one. Modern science, with all its marvellous powerful and far-flung resources, is utterly unable at the present time to devise any means of flinging a projectile, a mass of rock, a small stone or even a single atom into the unknown void of Space which exists beyond the boundaries of the earth's atmosphere. The very best which modern science can do is to cause a shell or rocket to traverse in an obliquely-upwards direction a few miles of the earth's atmosphere. How, therefore, whilst the relatively simple and preliminary feat of hurling away from the earth a few pounds of inanimate matter remains totally unaccomplished, can human beings, with their finely adjusted and delicately poised internal and sensory mechanisms, hope to escape successfully and unharmed from the earth and also to return to it again ?

Mankind has ever cried for the moon. Taking all things into consideration, however, it is not very likely, unless at some future period an enormous expansion of human knowledge and human capabilities occurs, that either Man or his corpse will ever be found beyond the confines of old Mother Earth.

IN THE NEWS

The Indian Rope Trick.

TO most people the Indian rope trick is considered a myth, one explanation being that it is carried out by means of mass hypnotism, during which the audience imagine they see a youth climb up a rope which apparently stands up on end. Others suggest that it is performed with a specially prepared rope, but it is difficult to decide whether either explanation is correct. The pictures on this page show the trick actually being performed at Devonport, and the photographer who examined the rope used for the trick is certain that it was genuine.

The Indian rope trick being performed on Roborough Down, Devonport.

If any readers think they have a suitable solution to this trick, write to the Editor, their explanation being given in not more than 200 words.

The Leipzig Spring Fair, 1935

THE Leipzig Spring Fair, 1935, will be held from Sunday, March 3rd, till Sunday, March 10th. The Samples Fair closes Saturday, March 9th, noon, whilst the Great Engineering and Building Fair will be open till March 10th, evening. The Textile Fair closes on the evening of March 6th ; the Fair for Office Requisites in the "Jaegerhof," the State Furniture Fair and the Fair for Sports Goods will be open until the evening of March 7th. The "Bugra" (Book Trades) Machine Fair closes March 9th, noon. The special Fair of the Optical, Photographic and Cinema Industries, hitherto housed in the "Turnhalle" (gymnasium) at the Frankfurter Tor, will in future take place within the Great Engineering and Building Fair on the Exhibition Grounds in Hall 12. The Special Fair of the Optical, Photographic and Cinema Industries will therefore last from March 3rd until the evening of March 10th.

Pistol-fired Rocket Trials

TRIALS have recently been carried out with a new type of life-line rocket. It is a pistol which fires a miniature rocket with a life-line, on the same principle as the rockets fired by the Board of Trade life-saving apparatus. It is reported that in a recent trial at Brixham the pistol-fired rocket carried the life-line a far greater distance than the ri e usually employed.

A Mammoth Crane

WHAT is claimed to be the largest Titan crane in the United Kingdom has just been erected at Billingham by Sir William Arrol & Co. It is designed to handle a load of 170 tons.

Beacons in India

A VAST scheme for the improvement of aviation in India has recently been put in hand, one feature being the erection of beacons every hundred miles along a 3,000-mile route from Karachi, in Sind, to Victoria Point, in Burma.

Showing a youth climbing the rigid rope.

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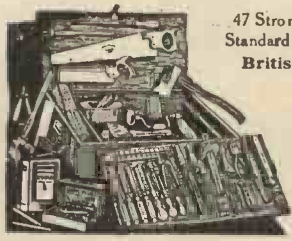

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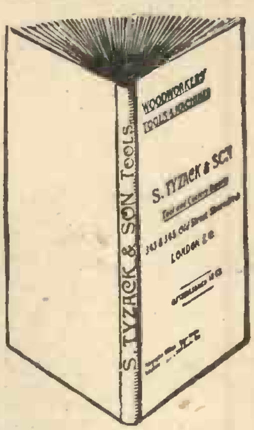

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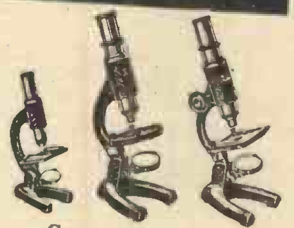

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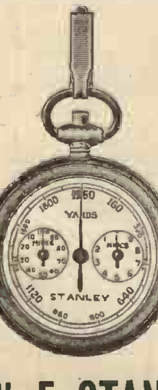

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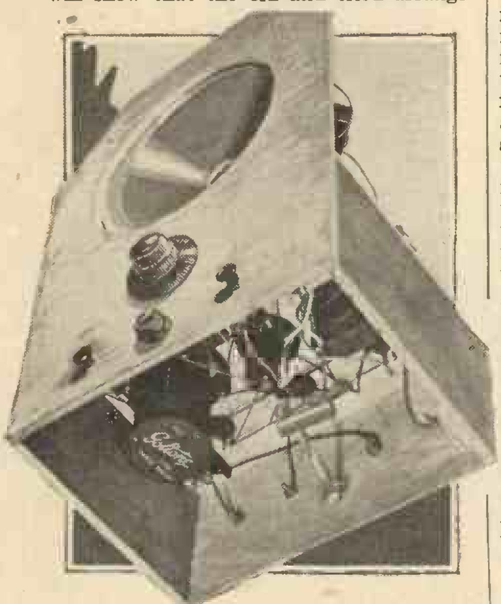
THE "£3 STRAIGHT THREE"

A simple and cheap receiver that will give good loud-speaker results from a number of stations

EFFICIENCY is required in any receiver, and it is true that a three-valver could be constructed for a sum lower than three pounds, but so much would have to be sacrificed that it would not be worth while building up such a receiver. As an instance of the care which has been exercised in designing the "£3 Straight Three," it may be mentioned that a moving-coil loud speaker has been included. The amount which has been mentioned does not, of course, include the speaker, valves and batteries.

The Circuit

An examination of the theoretical circuit will show that the old and tried arrange-



Showing the neat and compact arrangement of the components underneath the chassis.

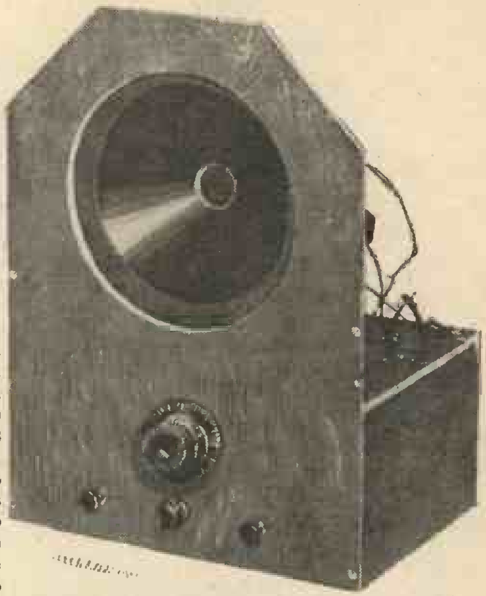
ment of detector and two low-frequency stages has been incorporated, and although this cannot be classed as an arrangement designed for station getting, there is no doubt that a detector valve, when properly handled, can give a really good account of itself. For instance, a circuit of this nature will provide in London no less than twelve stations at comfortable loud-speaker strength, and there is the added advantage that very little likelihood of instability will arise. In addition, the circuit arrangement does not require any great care in setting up in view of the absence of the high-frequency stage. The coupling between the detector and first L.F. stage is on the resistance-capacity principle. A simple L.F. transformer couples the output valve to the first L.F., and the only point of note here is the inclusion of a high resistance between the grid terminal of the valve and the grid terminal of the transformer in order to remove possibility of oscillation. The loud-speaker is fitted with an input transformer and this is included direct in the anode circuit of the output valve, and thus removes the cost and necessity of providing an output-filter circuit.

The Layout

The photographs will show that the entire receiver, including the speaker, has been arranged on a form of cabinet chassis which, while complete in itself, may yet be inserted into a cabinet of suitable design. Thus the receiver may be set up and tested, and when finally complete may be placed into any type of cabinet required. Alternatively, a framework may be placed round the chassis and the front of this may be cut out with some form of design instead of the plain hole which has been cut in the experimental model which is illustrated. The valves are the only components which are included on the top of the chassis, all other components, including the tuning coil, being enclosed in the lower portion of the receiver. The grid-bias battery has been left in this receiver in a readily accessible position, although there is really no need to adjust this after the preliminary setting-up has been carried out. Aerial, earth and pick-up terminals are fitted on the rear of the chassis, and these are attached direct to the wood, a practice which can lead to no difficulties, provided the receiver is not placed in a damp position. The spacing between them will ensure that there is no loss.

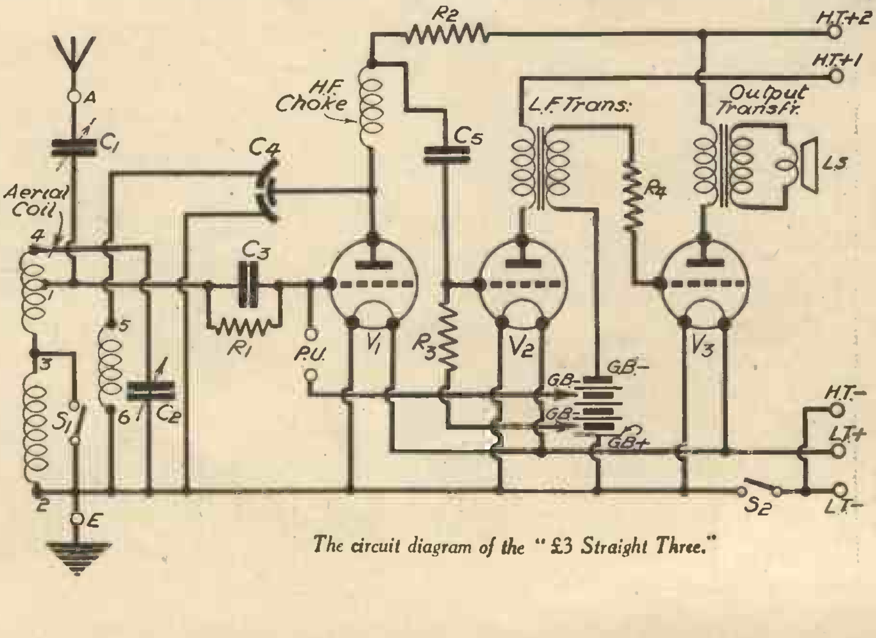
Construction

The construction is best carried out in the following order: The front of the chassis should be cut from ¼-in. plywood, no thicker material being used unless it is intended that the front will be kept in the finished receiver by enclosing the remainder of the chassis. If this point is not borne in mind difficulty will be experienced in passing the control spindles through the front of the cabinet at a later period. When the front has been cut, the remainder of the wood for the chassis should be cut from ⅜-in.



A three-quarter front view of the receiver showing the neat panel layout.

ply, whilst the rear portion is best cut from some thinner material. By using plywood all risk of warping is avoided, and the structure will be firm without being unduly weighty. A sufficient quantity of wood can be purchased for about one shilling.



The circuit diagram of the "£3 Straight Three."

Drill the necessary screw holes for assembly, and, using the wiring plan, drill the holes through which the various wires pass, as well as those for the valve-holders. These latter are 1 in. in diameter. Before assembling the chassis the valve-holders and other components should be mounted in their respective positions, and the loud-speaker fitted to the front portion, with the transformer in the lower corner, as shown in the illustrations.

Wiring

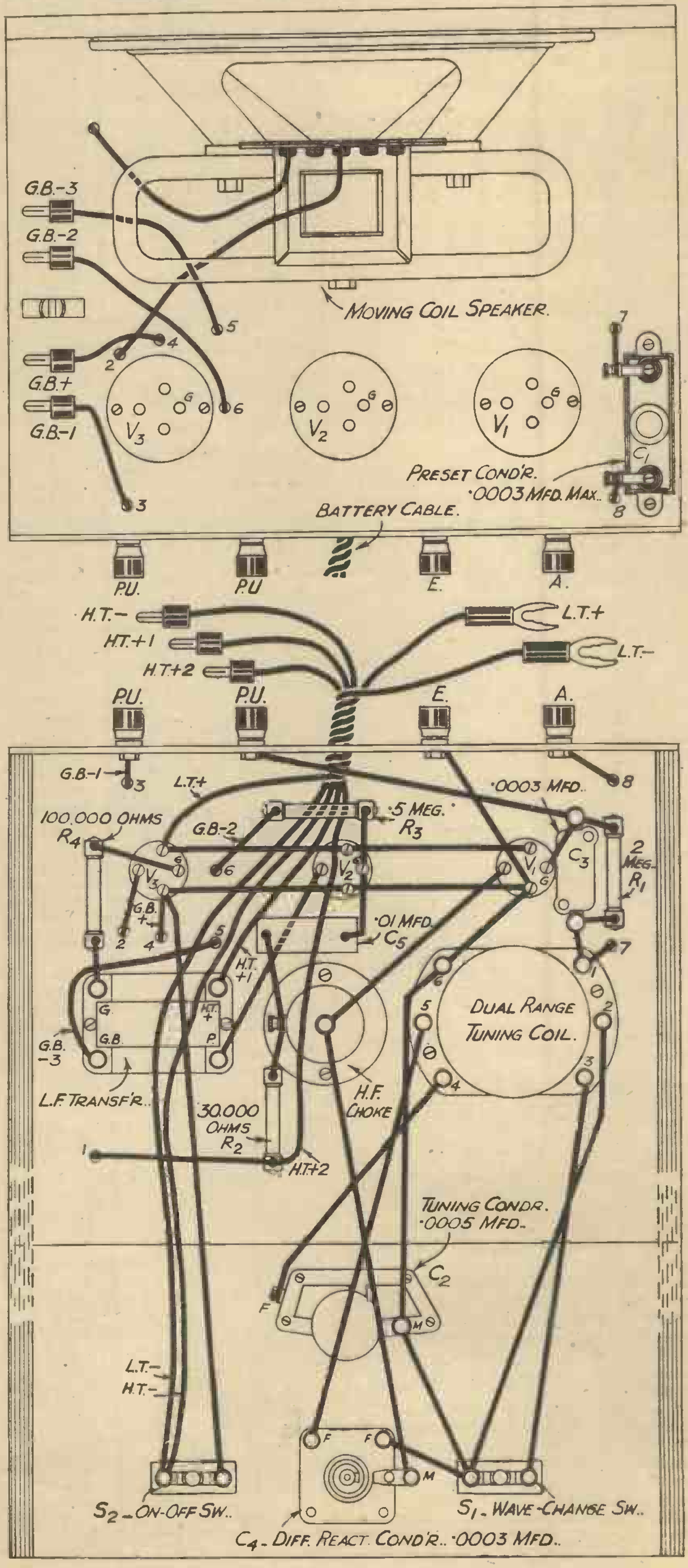
The wiring will not be found difficult, but it is best to commence by putting in the filament leads, using the red and black wires if desired to denote the separate positive and negative circuits. Upon examination of the wiring plan, it will be seen that many wires couple components on the chassis, whilst others pass to the terminals and to the components which are mounted on the front of the chassis. Wire all those parts which are actually fitted to the chassis before attempting to put the framework together, and when this has been completed screw the side of the chassis which is remote from the tuning coil to the front, and then place in position the upper portion of the chassis. Mount the tuning condenser, reaction condenser, and switches, and carry out the wiring to these points. This will not be found difficult if you have followed the foregoing instructions. If, however, the chassis has been completely assembled, you will find great difficulty in getting at the terminals on the reaction condenser, for instance, and will probably only be able to complete the receiver by removing one side.

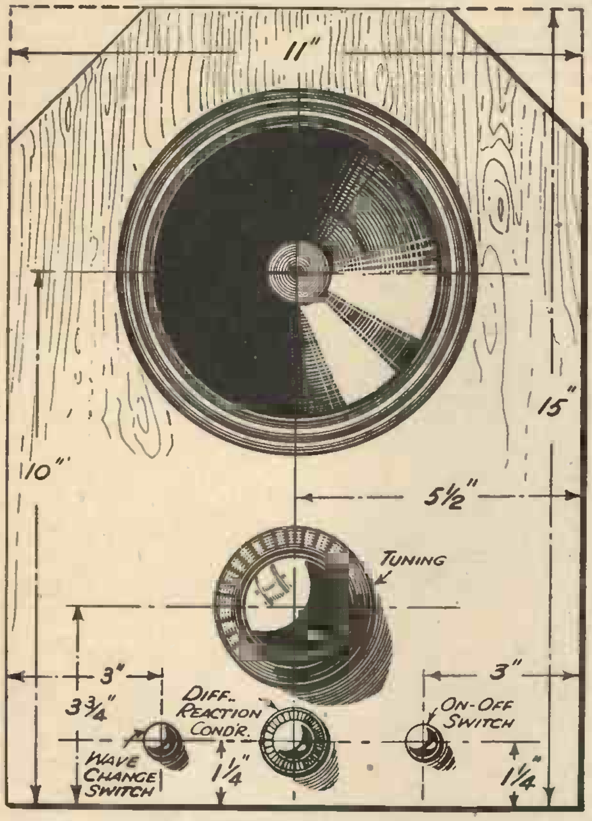
(Continued on page 272.)

LIST OF COMPONENTS FOR THE "THREE POUNDS STRAIGHT THREE."

- One Goltone Type DW/8 Dual Range Coil.
- One J.B. ·0005 popular Log Condenser, with slow-motion dial (C2).
- One Polar ·0003 mfd. Differential Reaction Condenser (C4).
- One Dubilier 30,000 ohm 1 watt Fixed Resistance (R2).
- One Bulgin Screened Midget H.F.Choke (H.F.8).
- Two Ward and Goldstone On-off Switches (S1 and S2).
- Three Clix 4-pin Chassis-mounting Valve Holders.
- One B.R.G. 3 : 1 L.F. Transformer.
- One Goltone Type J Compression Condenser (C1).
- One Dubilier ·01 mfd. Tubular Condenser (C5).
- One Dubilier 2 megohm Grid Leak (R1).
- One Dubilier ·5 megohm Grid Leak (R3).
- One Dubilier ·0003 mfd. type 670 Fixed Condenser (C3).
- One Dubilier 100,000 ohm 1 watt Fixed Resistance (R4).
- One Amplion "Dragon" Moving-Coil Loudspeaker.
- One Bulgin Five-Way Battery Cable (B.C.3).
- Seven Clix Wander Plugs and Two Spades. One red spade, one black spade, one H.T. —, one G.B.+, one H.T.+1, one H.T.+2, one G.B.−1, one G.B.−2, and one G.B.−3.
- One Bulgin No. 3 Grid Bias Battery Clip.
- Four Clix Terminals marked (A, E, Pick-up and Pick-up).
- Two coils of B.R.G. connecting wire.
- Wood for framework, screws, flex, etc.
- Three Hivac Valves: types D.210, L.210 and P.220.

A TOP AND UNDERNEATH CHASSIS WIRING PLAN OF THE £3 "THREE"





Details of the front of chassis layout.

The battery leads should now be passed through a $\frac{3}{8}$-in. hole drilled in the centre of the rear section of the chassis, and a knot should be tied in them, to prevent the leads being pulled from their position. The position for this knot will easily be found by holding the back in position and roughly measuring the leads up to the on-off switch, which is the longest lead which is required. Now screw on the back and attach the battery leads to the various positions, using any colour of lead you desire. Attach the wires from aerial, earth and pick-up terminals and the wiring should now be complete. It will be noticed, of course, that soldering has to be adopted for the majority of the connections, but this is unavoidable where expense is being spared, and should occasion no difficulty to our readers by now. Many hints on soldering have appeared in our pages in the past, and provided that the principal rule, "Keep the iron clean," is borne in mind, the work will be found extremely simple. Now, before connecting up, the leads will have to be provided with the necessary plugs, and the wiring plan should carefully be followed to see that correct identification is given to the different leads. The short flexible leads for the grid-bias connections may be cut from a suitable length of twin flex, and, if desired, the red and black cotton covering may be retained for this purpose, or it may be removed and the plain rubber employed. The plug will offer sufficient identification.

Adjustment

Plug the D.210 valve into the left-hand s cket and the P-220 valve into the socket at the other end of the chassis. Into the centre socket the L.210 low-frequency valve should be inserted. The two flexible leads from the L.F. transformer and the anode terminals of the output valve should be joined to the centre and one outside terminal on the transformer on the speaker, and the grid-bias battery should be inserted in the clip and the plugs inserted into the requisite positions. These will depend upon the valves which are being used. Both switches should now be pulled out, when the receiver will be switched on and tuned to the lower wave-band. No difficulty whatsoever should be experienced in tuning in the local station, and the reaction is used for the purpose of bringing up the strength of weak and distant stations. For the long waves the left-hand switch should be pushed in, when Droitwich, Radio-Paris and the other long-wave stations will be found on the tuning scale.

Gramophone Reproduction

For gramophone-record reproduction the pick-up should be joined to the two pick-up terminals, and the plug marked G.B.-3 should be inserted in a socket on the grid-bias battery at 1·5 or 3 volts. The tuning condenser should be set to its minimum position so that no interference is experienced due to the local station programme being heard above the gramophone record. No change-over switch has been incorporated on the ground of expense, and no trouble should be experienced, provided it is remembered that the grid-bias plug must be inserted for record reproduction, and must be removed for radio reproduction.

The Amplion Speaker

The Amplion Dragon P.M. moving-coil speaker specified for this receiver should prove a very popular model. It is a very well finished instrument, having a 7-in. cone, and is fitted with a multi-ratio input transformer. The speech coil is very freely suspended and therefore we were not surprised at the exceptionally good bass response obtained. The input transformer is fitted with terminals and soldering tags, and has ratios suitable for matching power, super-power, pentode, push-pull and Class B valves. When the correct ratio is used, surprisingly uniform response is obtained, and outputs up to approximately 3 watts are handled without trace of overloading. It costs 29*s*. 6*d*.

The Amplion Dragon moving coil speaker specified for the "£3 Straight Three."

TELEVISION MADE EASY

(*Continued from page* 261.)

The television signal is produced by allowing the light *reflected* from the area illuminated by the light spot to fall on one or more photo-electric cells located in suitable positions round the scene or object. These cells, as we shall see later, have the property of responding electrically to the variations of light activating their electrodes. As the whole scene is built up by varying light values this process of scanning will produce a *continuously* varying reflected light response in the photo-electric cells, and the cells in turn convert this to a continuously varying signal voltage, which, of course, is the television signal. The Baird light-spot studio, where this optical and electrical disintegration takes place, is shown in Fig. 6, the five cells being housed in the screening boxes held on the frame, together with the associated initial-stage amplifiers.

Another Method

A scanning disc can also be employed for producing television signals from standard talking films. Here, the cinematograph projector focusses the individual film pictures on to a small area at the top of a rotating scanning disc. The disc, however, instead of being perforated by a series of apertures in a spiral track, has the holes located on the circumference of a circle (see Fig. 7). The film is passed downwards through the gate continuously (the shutter mechanism of the standard talking-film projector is removed), so that the pictures projected on to the disc move downwards at a constant rate.

By revolving the disc at high speed the circle of holes moves across these pictures at another constant rate. Each hole therefore scans across a horizontal line in the picture separated from the previous line by a hole width. The double-motion in this way gives a complete dissection of each individual film picture into a number of lines depending upon the number of holes in the disc and the speed with which it revolves, coupled with the rate of movement of the film through the projector gate. A Baird telecine projector machine built for this purpose is shown in Fig. 8, the arc source of light, film gate and spool containers, scanning disc in cover and focussing lens being clearly visible.

Since each picture is built up from varying light values, each individual hole as it moves across will allow varying degrees of light to pass right through it. This continuously varying light emerging from every hole as it takes charge of the scan is focussed on to a photo-electric cell, which, as stated previously, converts this to a proportional voltage variation to become the television signal.

(*To be continued.*)

PERMANENT WAY FOR A $4\frac{3}{4}$-in. GAUGE LOCOMOTIVE

By E. W. TWINING

An engine of the type described in the series of articles " A 4¾-in. Gauge Garden Railway Locomotive," will, especially as the primary object of the engine is to run and haul passengers and is not intended to be in any sense a glass case job, be quite useless if no permanent way is laid, or is available, on which to run it. As the title implied, the track must be laid in the garden, for a coal burning model such as this, would be out of the question indoors.

AS everyone knows, to correctly imitate the standard British form of track bull-headed rails should be used supported in cast iron chairs secured with wooden keys, but, although this form of rail is obtainable in miniature for all the recognised scales and gauges up to about ⅝-in. to 1 ft., nothing larger is to be had until we get to 1½ in. to the foot for 7¼-in. gauge track. There are plenty of ¾ in. to the foot and quite a number of 1 in. to the foot scale models in existence, and yet there is no supplier who has listed materials for the permanent way for engines of these sizes.

The reader who has built the engine described in these pages, and wishes to lay a track for it, will, therefore, have to find a substitute for bull-head permanent way; in fact, he will have to abandon chairs altogether.

Vignoles Pattern Rail.

As it is impossible to use rails with chairs, the flat-bottomed rail designed by the engineer Vignoles is suggested.

One or two London model railway firms stock a rail of the Vignoles section which is exactly right for 4¾-in. gauge; that is to say, it is correct in cross-sectional form and measurements, and is sold in either 3 ft. or 6 ft. lengths in brass. Unfortunately, the use of brass makes the rail somewhat costly, but, on the other hand, it will last for years out of doors with very little deterioration. These firms supply, in addition to the rail, both sleepers (which, by the way, are quite low in price) and holding-down spikes for securing the rail to the sleepers.

The layout of the railway will obviously depend upon the amount of ground available. If one is fortunate enough to have an acre or two it will be best to make a scale plan of such acreage and plot the curves in the track and straight runs, sidings and so on, but if the ground is small, less than, say, 35 ft. in width, it will not be possible to lay a complete circular railway, whilst in a small garden a straight run, with perhaps a short curve, will have to suffice. Even so, however, with this last restricted area it is well worth while introducing a set of points and a short branch line; bearing in mind that the minimum radius of the curves should be in the neighbourhood of 15 ft: that is to say, no circle should be less than 30 ft. in diameter.

Gradients should be avoided, or if they are permitted, nothing steeper than an incline of 1 in 100 should be constructed.

Permanent Way

Turning now to details of the track, there are two alternative methods of supporting the rails; one by the orthodox cross-sleeper and the other on longitudinal timber. This latter is much the easier to make; not only is it more simple to construct, but requires much less attention to keep it true. Take the cross sleeper road first (Fig. 1), since this is likely to be the more popular. The plan view indicates two methods of securing the rail to the sleepers: on the left hand is shown round-headed brass screws passing through holes drilled in the flange of the rail and on the right-hand side hooked spikes driven into the sleeper.

The fish plates are flat bits of steel plate bent to embrace the bottom flanges of the rail. T steel is obtainable in 16-ft. lengths and for convenience in making up and laying the track it is best to construct in 8-ft. lengths, so that a pair of fish plates will be required at intervals this distance apart. Although it involves more labour, especially

(Continued on page 275.)

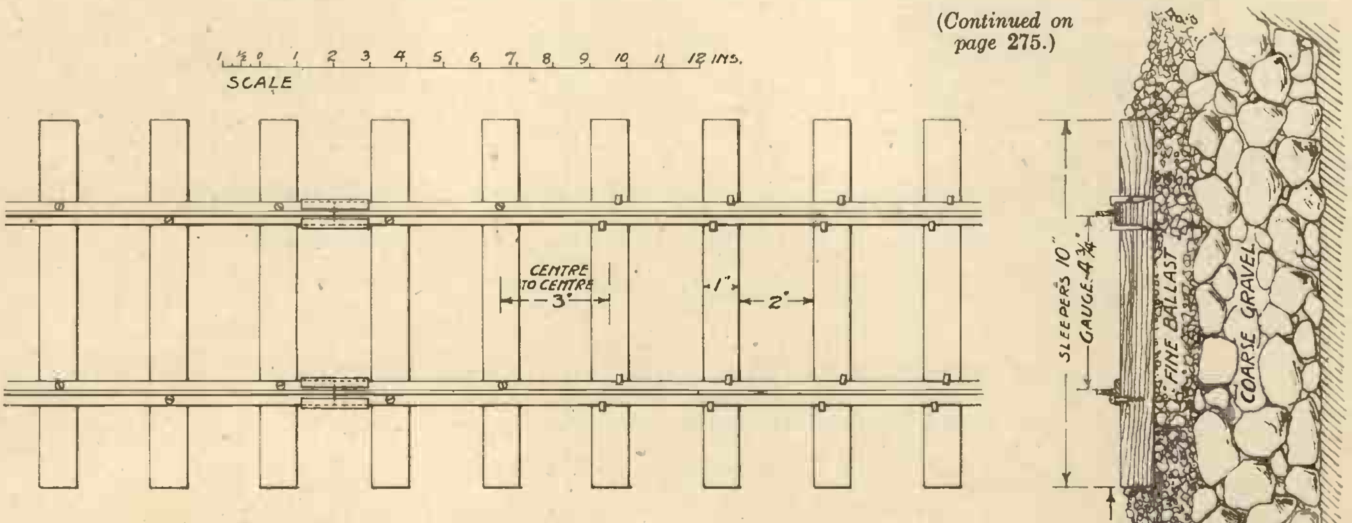


Fig. 1.—Details of the cross-sleeper track.

PERMANENT WAY FOR A 4¾-in. GAUGE LOCOMOTIVE

(Continued from page 273.)

in drilling, screwing the rails to the sleepers makes the best job.

The proper thing to do in preparing to lay the track after it is made up is to excavate a shallow trench in the ground perfectly flat at the bottom to the depth and width shown in the cross-section in Fig. 1, levelling and making true with a long straight-edge and spirit level. Then

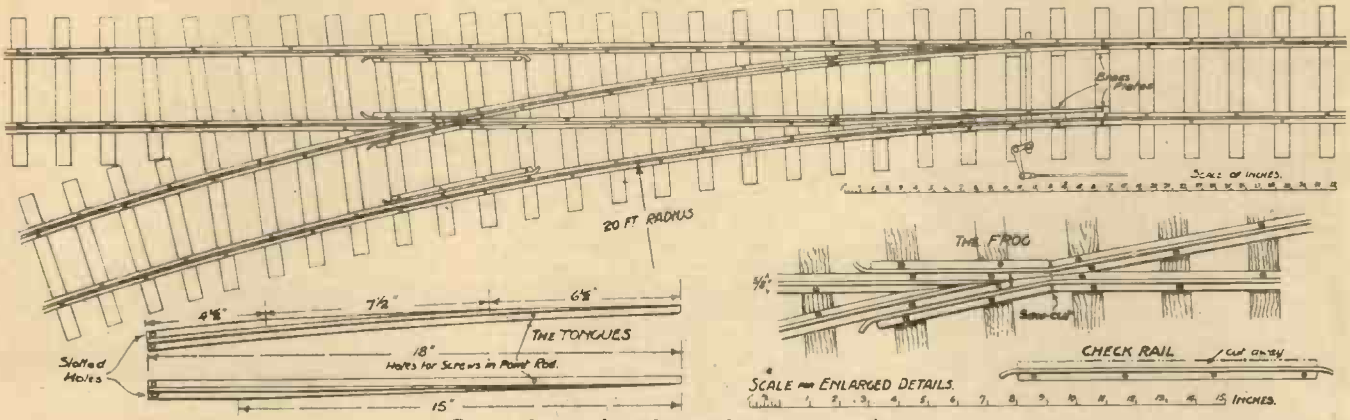


Fig. 2.—Layout of complete switch points on cross-sleeper.

place in this trench to a depth of 3½ in. ordinary coarse gravel, the top of which should also be approximately true and rammed down. Above this, and flush with the normal ground surface, lay 1 in. of fine ballast, which can be bought from Messrs. Bassett-Lowke Ltd. The top surface of this must also be struck off perfectly true with the straight-edge, and upon this the track is laid. More ballast is then added to fill in the space between and along the ends of the sleepers, so that it comes flush with the top faces of them. If the filling has been carefully done, the top edges of the rails should then be found to be straight and true. If there are any undulations packing should be resorted to in just the same way as platelayers pack up full size permanent way, in this case using a hammer to ram

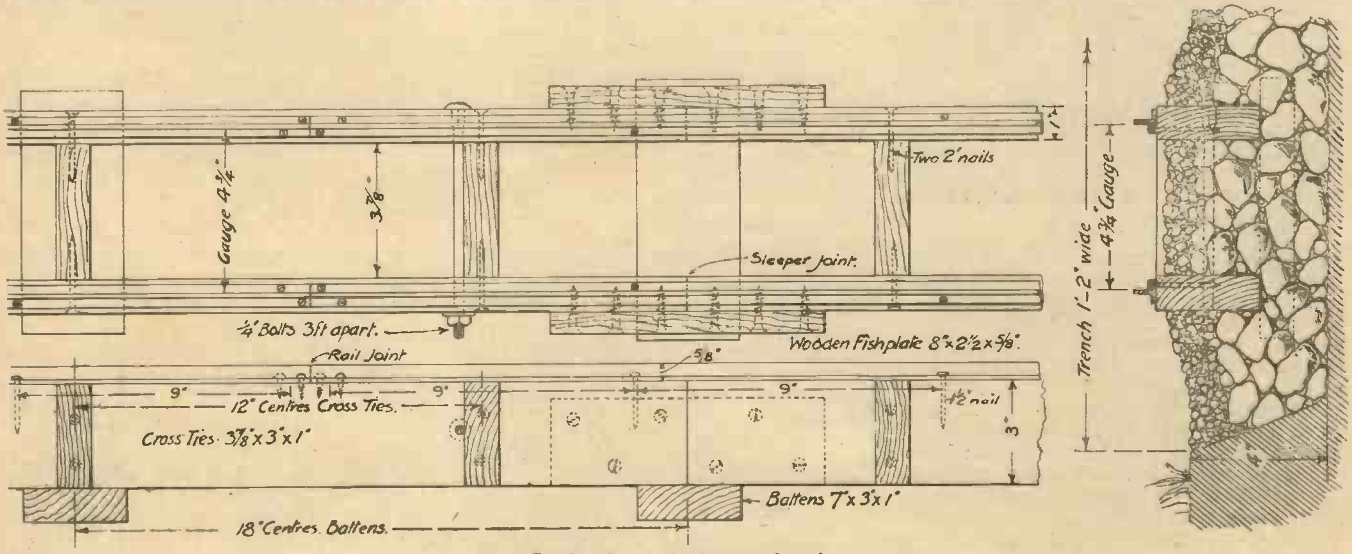


Fig. 3.—Longitudinal timbered track.

ballast under the owest sleepers, or those which are not properly bedded down.

Points for Branch Line

If a branch line is permitted by the size of the ground, a complete set of switch tongues, frog and check rails, will be required. The complete layout for a set of points is shown in Fig. 2. There is nothing very complicated about the set of switch points as are here shown, nor does the making call for a great amount of skill. The particular thing to bear in mind is that the correct radius of the curve must be carefully maintained throughout the rails of the branch line, including the movable tongue on the outside of the curve. Cutting away the flanges in the tongues, portions of the fixed rail where the tongues work, and of the check rails is, of course, done with a hacksaw, the heaviest portion of the work being on the ends of the tongues where they taper off to feather edges. Fig. 2 will make clear all the cutting which is to be done. The reader will notice that in these details is shown the chequered heads of French nails for holding down the rails. This, by the way, is another alternative to screws or spikes. If such nails are used the flanges must be drilled, the nails driven through rail and sleeper, the track turned over and the heads of the nails held up whilst the points are clenched over.

Longitudinal Timber

The other form of permanent way consists of two boards of unplaned timber measuring each 3 in. × 1 in. with distance pieces at intervals of 12 in. apart cut from the same 3 in. × 1 in. stuff. The particular deal board referred to is a standard size which can be bought very cheaply from any timber merchant and only needs to have one edge planed true, that on which the rail is to be fixed. Fig. 3 explains the whole of the construction. The sleepers are joined by fish plates of hardwood screwed on the ends. The ties are nailed in place and at intervals of about 3 ft. apart, close up to a tie, a ¼-in. black bolt is inserted to hold the track to gauge.

The trench in the ground is prepared in the same way, though not quite so deep. A 2-in. layer of gravel is put in and the sleepers placed on this. Then additional gravel is packed between the sleepers to come about half way up their height and on the outside also to about the same depth, above which fine ballast is laid as shown in the cross-section in Fig. 3. Before placing the track in position, however—and this applies to the cross-timbered road as well if the sleepers are in the white—the whole of the woodwork should be thoroughly treated with two coats of creosote.

It will be seen from the plan and side view of this longitudinal timbered track that French nails can very well be used for holding down the rail, and, moreover, they will not need to be nearly so close together as with cross sleepers. The ends of the rails where they butt together should be screwed as shown in the plan. No fish plates are needed.

With longitudinal timber points and turnouts are somewhat easier to make than they are with cross sleepers, but under the curved rail it is not possible to use the same 3 in. × 1 in. sleeper, for reasons which will be obvious. Under curves, therefore, it will be best to use two thicknesses of ½-in. board bending these to the proper radius separately and then nailing them together.

"WEIGHING" THE ELECTRON

Although it is not literally possible to weigh the electron on a pair of chemist's scales, the results obtained below have since been corroborated by an ingenious use of a condenser "balance."

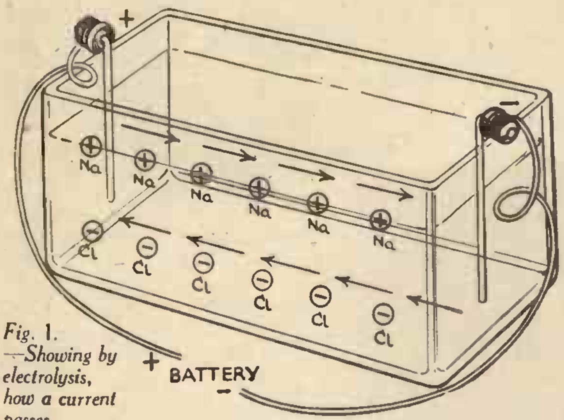


Fig. 1.—Showing by electrolysis, how a current passes.

THE discovery of the electron may be said to be due to an intelligent study of the different behaviour of electricity as it passes through the three typical forms of matter, namely, solids, liquids, and gases.

In the first place a current passing through a solid conductor, such as a length of wire, is usually compared with the flow of water through a pipe. Actually the analogy holds good only so long as the wire is cold, because once it is heated, the wire allows small "spurts" of electricity to escape into the surrounding space. In this respect it behaves more like a leaky hose-pipe, as is seen, for instance, in the heated filament of a wireless valve or a cathode-ray tube.

In the second place most pure liquids, such as water, alcohol, or ether, are almost perfect non-conductors, though mercury and other metals in the melted state readily pass an electric current and in the same way as a solid conductor. But solutions, such as that of salt in water, behave very differently. They conduct, by the process known as electrolysis, in the course of which the electrolyte is decomposed or split up into its chemical constituents by the action of the current.

A Clue to the Existence of the Electron

In a given solution the same amount of current always liberates a constant quantity of metal or gas at the electrodes. Moreover, when different chemical solutions are used, the amount so decomposed or liberated is exactly proportional to the atomic weight of the element concerned.

This law, which was discovered by Faraday, gave the first clue to the existence of the electron, by establishing the fact that each chemical element is always associated with a definite and unalterable charge of electricity.

In the case of a solution, say, of common salt, NaCl, we assume that the atoms of sodium and chlorine are separated in some mysterious way so that, without actually passing out of chemical combination, they are able to act as "carriers," one atom delivering a fixed positive and the other an equivalent negative charge of electricity to the respective electrodes (Fig. 1). At the same time, until they reach the electrodes, the "dissociation" of the two atoms is not complete, since the solution still remains "salty" to the taste, and the original salt can always be recovered by the simple process of evaporation.

Glow Discharge

In the third place, when a high voltage is applied across a tube containing rarefied air or gas the electric current passes in the form of a glow discharge. One sees a series of alternate dark and light bands, together with a stream of what appears to be a bluish light, which strikes straight across from the cathode towards the anode. In addition, if the cathode is perforated, parallel streams of a reddish colour spread out behind it.

On closer examination the bluish light is found to consist of a stream of negative electricity, whilst the reddish rays turn out to be positively-charged molecules. There are other manifestations with which we are not at present concerned, but the presence of the two streams shows that the gas contained in the tube has been broken up into "carriers" of positive and negative electricity, comparable with those created in the process of electrolysis.

compare the mass of the electron with that of hydrogen.

Faraday had already shown, in the case of liquids, that each element is associated with a definite and unalterable charge of electricity. Actually when hydrogen is liberated in electrolysis it takes 9,649 coulombs to produce 1 gramme-molecule of the gas, from which it can be calculated that the ratio of the electric charge to the mass of the atom is only 10,000 to 1. This is some 1,800 times smaller than the ratio found in the case of the cathode stream. Since the charge is the same in both cases, the obvious conclusion is that the particles forming the negative stream through rarefied gas must be 1,800 times smaller

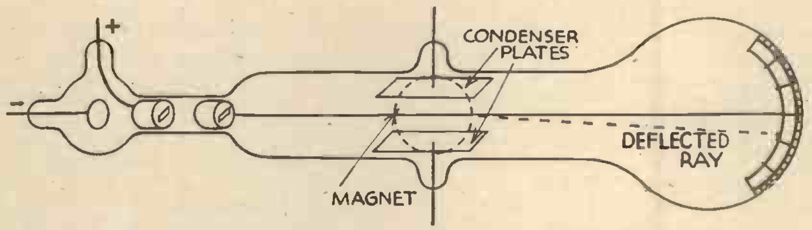


Fig. 2.—Deflection of the electron streams in a cathode-ray tube.

There is, however, one important difference. Sir J. J. Thomson found that the stream of negative electricity, flowing from the cathode to the anode, is always the same in character no matter what gas is contained in the tube.

With the aid of a magnet he first deflected the stream through a measured angle. This allowed him to equate the *unknown* mass of the particles of the stream, the charge they carried, and their velocity, to the *known* strength of the applied magnetic field and the measured angle of deflection.

He next used an electrostatic charge to counteract the magnetic deflection (Fig. 2). A comparison of the electro-magnetic and electrostatic fields of force gave him the velocity with which the particles were travelling. From this he was able to calculate the ratio of the electric charge carried by each particle to the mass of that particle.

Eighteen Million to One

This proved to be $1 \cdot 8 \times 10^7$, or, in round figures, 18 million to 1. Now, as hydrogen is the lightest known chemical element, the next step was to

in mass than the hydrogen atom, which, up to then, was regarded as the smallest entity known in the physical world.

When a small particle falls through air, or a gas under the pull of gravity, it acquires a constant limiting speed, which depends in part on the size of the particle, and in part on the viscosity or frictional drag of the gas. A large particle is only slightly affected by friction and falls freely, whilst a very small one may be almost completely buoyed up.

(*Continued on p.* 288.)

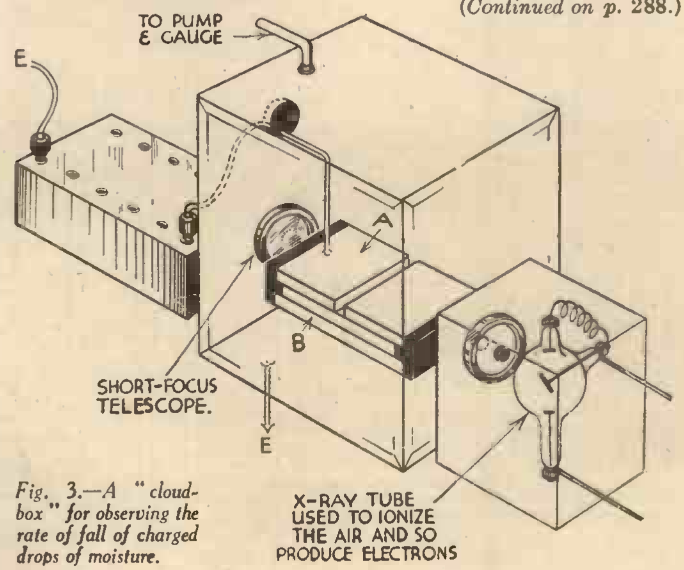
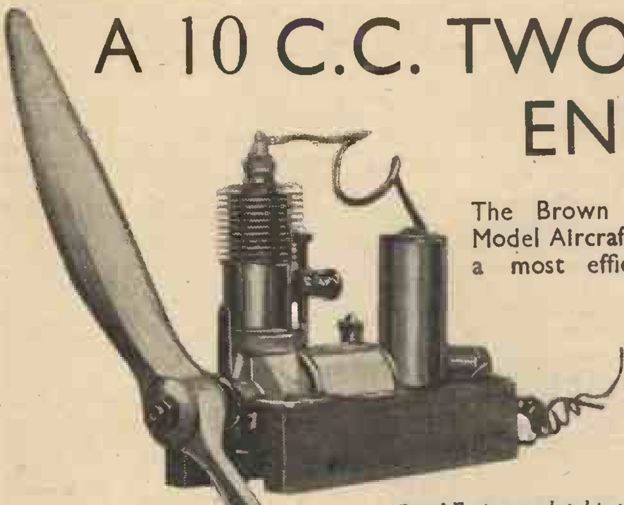


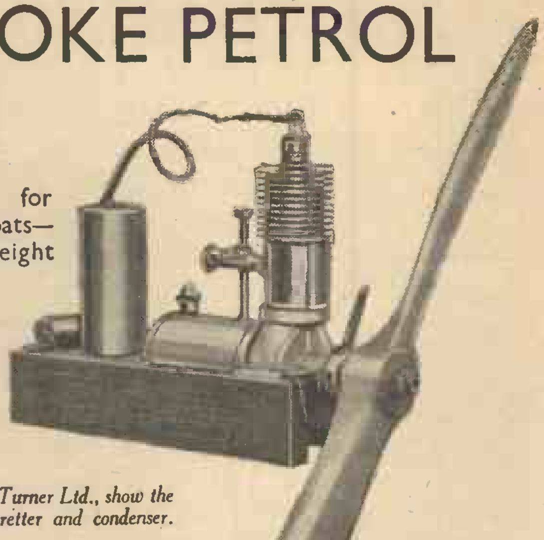
Fig. 3.—A "cloud-box" for observing the rate of fall of charged drops of moisture.

A 10 C.C. TWO-STROKE PETROL ENGINE

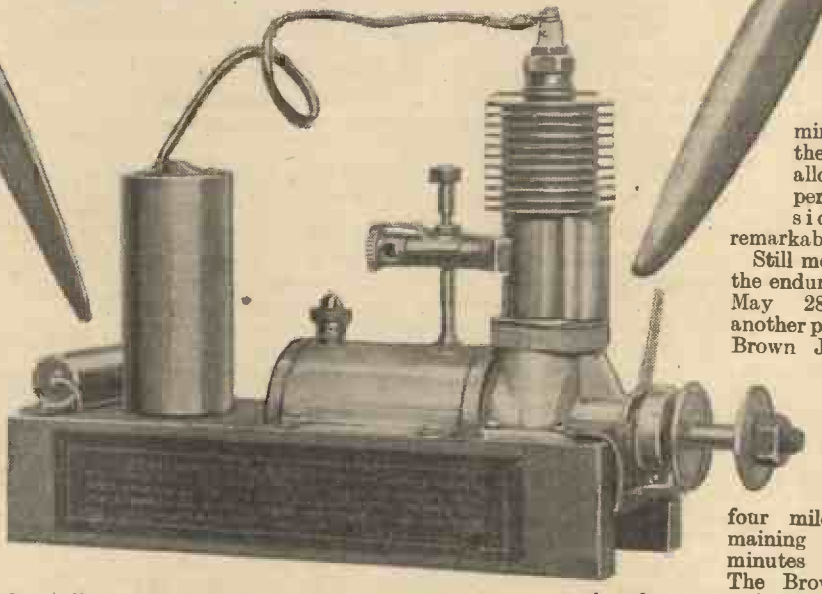
The Brown Junior Engine for Model Aircraft and Model Boats—a most efficient featherweight unit.

By F. J. CAMM





The three views of the Brown Junior Petrol Engine, marketed in this country by Stuart-Turner Ltd., show the unit as supplied, complete with tank, coil, carburetter and condenser.



RAPIDLY following the recent successes with the 15 c.c. two-stroke engines for model aircraft and model boats, many satisfactory designs have been produced of only 10 c.c., and in one case of only 9 c.c. The illustrations on this page show the Brown Junior Motor, which is of American origin but is marketed in Great Britain by the well-known firm of Stewart Turner. Ltd., of Henley-on-Thames.

I have had one of these Brown Junior motors on test for some weeks and am thoroughly impressed with its reliability, easy starting, low weight, smooth running, and particularly its low price. As illustrated, it is supplied complete with coil, condenser, carburetter, and petrol tank at the inclusive price of only £6 10*s*. Additionally, for convenience of testing it is supplied mounted to a wooden case (really a dummy fuselage) and is wired and ready for running. Each motor is tested prior to dispatch and it is neatly and safely packed in a dovetailed box with a sliding lid. The sparking plug is only about one-third of the size of the miniature plugs usually sold for model engines. It really is a model in every respect, and it is quite evident that the design is the outcome of very careful thought and experiment. The design is practical and certainly combines light weight and robust construction with good workmanship. The specification at the foot of the centre column gives important details concerning this remarkably efficient little unit.

Phenomenal Flights

Model aeroplanes driven by Brown Junior motors have made phenomenal flights in America as long ago as 1933. One of them flew for 14 minutes 55 seconds, another for 22 minutes 22 seconds, and yet another for 28 minutes 18 seconds.

On May 19th, 1934, at the Eastern States Meet, at the Newark Airport, model planes powered with Brown Junior motors took first and second place in the Gas (*i.e.*, petrol) Powered Class. The winning plane made a world's record under the new rule governing the amount of fuel allowed per pound of weight. This 4-lb. plane, which was allowed $\frac{1}{8}$ oz. of gas for each pound of weight flew for 6 minutes 7 seconds on the $\frac{1}{2}$ oz. of fuel allotted to it, and this performance is considered quite a remarkable one.

Still more remarkable was the endurance flight made on May 28th, 1934, when another plane, powered with a Brown Junior motor, flew from the Central Airport, Camden, N.J., to Armstrong's Corner (near Middletown), Delaware, a distance of fifty-four miles—the plane remaining aloft 2 hours 35 minutes and 39$\frac{1}{4}$ seconds. The Brown Junior carried the plane over three States (New Jersey, Pennsylvania and Delaware), on about 17 oz. of fuel, and attained an altitude of 8,000 ft.

Again, at the National Meet held at Akron, Ohio (June 28th, 1934), the model planes which took the first five places in the petrol-powered class were all powered with Brown Junior motors.

An Endurance Flight

The model aeroplane which made the endurance flight on May 28th, referred to above, was built by Mr. M. B. Bassett, of Philadelphia, who is nineteen years old. During the flight it was followed by an aeroplane piloted by Mr. Jack Byrne, of Camden, who was a pilot in the War. His passenger was Mr. V. R. Fritz, Field Director of the Philadelphia Model Aeroplane Association, who made the arrangements for the flight.

Mr. Byrne described his experience in the *Philadelphia Evening Bulletin* (May 29th) as follows :—

"After leaving the airport, the model kept circling so fast that we could hardly keep up with it. As its 17-oz. load of gas was being used up, it began to climb so speedily that it caught up with us and for the rest of the trip it was flying at the same height as we were.

"It headed over South Camden to Gloucester, crossed the Delaware to South Philadelphia, sped over the Navy Yard and

(*Continued on page* 280.)

Specification of the Brown Junior Motor

$\frac{7}{8}$-in. Bore × 1-in. Stroke = 10 C.C.

SPEED.—1,500 to 6,000 r.p.m. approximately 1/5 b.h.p., at 4,000 r.p.m.

TRACTIVE EFFORT.—2 to 2$\frac{1}{4}$ lbs.

WEIGHT.—Engine, 6$\frac{1}{2}$ ozs. Tank, coil and condenser, 5 oz. Battery, propeller and petrol, 9 oz. Total, 20$\frac{1}{2}$ oz.

HEIGHT.—Above bearers 3$\frac{15}{16}$ in. Width overall 2$\frac{1}{4}$ in.

LENGTH—Including petrol tank, 5 $\frac{5}{16}$ in.

CRANKCASE.—Die-cast aluminium silicon alloy. Crankcase bearing is of bronze with oil grooves.

CYLINDER.—Alloy steel, machined from the solid. The bore is honed. Carburetter and transfer passage brazed on.

PISTON.—Alloy steel, machined from the solid. Hardened, ground and lapped to perfect fit.

GUDGEON PIN.—Tool steel, tempered and lapped ; full floating type ; retaining washer prevents scoring of cylinder.

CONNECTING ROD.—Steel drop forging ; big and small end bearings hardened and lapped.

CRANKSHAFT.—Steel drop forging. Heat treated and finished all-over. Drilled for lightness. Bearings hardened and lapped.

TIMING GEAR.—The cam is alloy steel hardened. Contact breaker is fitted with adjustable tungsten points and timing is adjustable.

CARBURETTER.—The jet is adjustable by the needle valve on top. The air inlet is controlled by the horizontal cap with micrometer adjustment. The petrol is sucked direct from the sump of the petrol tank, which has capacity of 2 oz. for 10 to 12 minutes running. There is a petrol filter at the entrance to the carburetter suction tube.

SPARKING PLUG.—$\frac{3}{8}$ in. 24 S.A.E. thread ; may be taken apart for cleaning.

IGNITION COIL AND CONDENSER.—Light weight ; oil, petrol and waterproof. They have been specially developed for this engine ; 2 standard flash lamp cells are required.

The Power of the Tides

HOW SEA POWER MAY YET HELP MECHANICAL INDUSTRY

A view of Slipper Mill, Sussex, from below the dam at low tide

Emsworth Tide Mill from below the dam at low tide.

DURING the last century there has been an enormous development in transport, industry, and domestic amenities based on coal; but it is an alarming fact that our coal supplies are strictly limited. Estimates as to duration naturally vary, since future consumption cannot be definitely stated, and the possibilities of still deeper mines are not fully understood, but it may be assumed that we shall have used all our coal within a period somewhere between one and two centuries from now, and long before *that* the price of coal will have risen sufficiently to kill some industries and cripple others. If we do not deal with the problem while there is time, a future generation will have to face a crisis vastly worse than anything suffered during the War. Think of it! No coal, no gas, no electricity—trains and trams would cease to run, and ships lie rotting in harbour. All our factories would close down, and our unemployed population would be living in unwarmed, unlighted homes, where even the radio was silent!

Meanwhile countries which have developed water power, such as Norway, Sweden, Finland, Switzerland, Austria, and Italy would carry on "business as usual," but we, alas, have no high mountains, and so cannot tap the energy of mountain torrents.

Twenty Thousand Million Units of Electricity

There remains the mighty power of the tides, which in Britain are the highest in the world, with the sole exception of those in the Bay of Fundy. In the Bristol Channel a rise of 40 ft. is not unusual, and rises of 30 ft. are found all round our coasts. Here, then, is a power which can be tapped in every creek and inlet from Land's End to John o' Groat's, and from Cape Wrath to Dungeness. It could easily supply the twenty thousand million units of electricity which will presently be needed by our vast electric grid, and there will be enough left to keep essential services and industries going. Some years ago a suggestion was made by an eminent engineer that we should harness the mighty tides of the Severn by constructing a gigantic barrage across the mouth of the river, which would also provide a main-road short cut to Wales. The scheme was denounced as visionary and impracticable, but something of the kind may well be built in the future. Actually tidal power *can* be harnessed in this way, and there are in this country several old tide-mills which are still running, and have been working without a hitch for a couple of centuries or so. The method is the same as the Severn plan, except that mill-wheels are used instead of turbines.

(Right). The outfall from the wheel and dam at the Slipper Tide Mill, showing the amount of head obtained, and (left) the dam and sluices of the Slipper Tide Mill.

A dam is constructed across the mouth of a tidal creek or river and fitted with sluices. When it is full at high tide, the water is held back until the level below the dam has fallen sufficiently to permit the mill-race to get away. Then the mill is started, and can run until the rising tide clogs the outfall; so the mill stops and the sluices are opened to enable the tide to refill the pond above the dam. These "ponds" in tide-mills hold a vast amount of water; at Birdham Mill in Sussex there are two connected by sluices and holding ten and thirteen acres respectively.

The main advantages of a tide-mill are these—no drought can interfere with water supplies, and no frost can solidify them.

Eling Tide Mill at New Forest, Hants

Inactive Periods

The chief disadvantage is that it is impossible to run the mill continuously throughout the twenty-four hours, as there is a period *before and after* high tide when the mill cannot run. The length of the period depends upon the level at which water is admitted into the pond, but in most of the working tide-mills the running period is from five to six hours for each rise of tide, that is, ten to twelve hours in each twenty-four.

In a hydro-electric scheme this difficulty could be overcome by pumping water to reserve ponds at a higher level in order to keep some turbines running when the main battery was stopped by high tide.

Wootton Tide Mills, Isle of Wight. Note the sluices on the right.

Readers who are interested in the subject can still see tide-mills at work around our coasts, and the following are still running :

Eling, near Totton (Hants) ; Wootton, near Ryde (Isle of Wight) ; Emsworth (Hants) ; and Slipper, just over the county border in Sussex ; Birdham, near Chichester (Sussex) ; and Woodbridge, in Suffolk.

Woodbridge Tide Mill, Suffolk, from the pool above the dam.

In addition, there were formerly tide - mills working in the following places, but it is not certain if they are still running :

Bembridge (Isle of Wight) ; Fishbourne and Shoreham (Sussex) ; and Walton-on-the-Naze (Essex).

Mountain Electric Stations

It should be mentioned that the power from tide-mills is exceedingly cheap, and this has enabled the flour mills worked this way to stand against the brutal competition which has killed nearly all our old river water mills. It is calculated that water-power in Norway costs, since the War, one-tenth of a penny per unit, while in pre-war days the almost incredibly low figure of *twelve shillings per horse-power year* was quite usual. These mountain electric stations, however, have one advantage, and that is the tremendous *head* of water, which enables a tiny jet to produce enormous energy. Thus at the Fully Station, in Switzerland, with a head of over 5,000 ft., the water leaves the nozzle at a speed of 590 ft. per second, or nearly the same speed as that attained by the winner in the Schneider Cup Race, and seven times the speed of an express train. The jet of water is less than 1½ in. in diameter, and gives a pressure of 1½ tons per square inch. If this water struck a man's body it would go through like a bullet, and would smash him to pulp !

Our tidal turbines would be *large* and SLOW, not *small* and *fast* as in mountain regions, but when finished there would be practically no running costs. The main item of expenditure would be in the constructional work, and especially in making the dams, and this would employ large numbers of unskilled labourers.

A view of the interior of a cutting mill. The stones rotate inside the wood casing.

A 10 c.c. TWO-STROKE PETROL ENGINE

(*Continued from page 278.*)

the Philadelphia airport and thence to Chester. Here the wind changed and it flew back over the river to Gibbstown, N.J., with us in close pursuit all the time.

"Then the model led us a merry chase to Salem, where it gained its greatest altitude, that of 8,000 ft. We thought we might lose it for a while. The wind changed once again and the plane crossed Delaware Bay to Delaware City. Shortly after reaching the Delaware side, the motor 'conked' at a height of 8,000 ft. The gas load was exhausted.

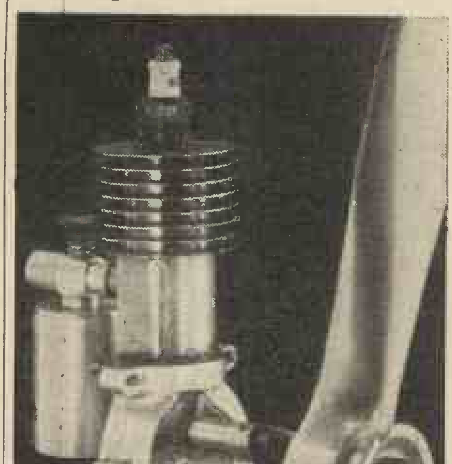
"All we had to do now was to watch the ship glide lazily in circle after circle. I would never have believed it if I hadn't seen it myself. That little plane glided ten miles. Fritz and I were almost pop-eyed, following it. After a 20-minute glide the ship landed in the pasture in the midst of a herd of cows, who didn't even notice it."

The straight-line distance from Camden Airport to Armstrong's Corner is fifty-four miles, and the pilot estimated the distance actually flown by the model at 180 miles.

Messrs. Stuart Turner Ltd. have developed a special electron propeller for this engine. It is light—only two-thirds the weight of aluminium, having the great advantage over wood that in an accident it may bend but will not break, and may be straightened for further use. It is 14 in. in diameter, 9 in. pitch, weighs 3 oz. and costs 12*s*. 6*d*.

The A. E. Jones' "Andrich" 1935 Model Petrol Engine

The engine illustrated below is a featherweight high performance internal combustion engine of *only* 9 c.c. capacity operating on the two-cycle principle, using petroil mixture.



View of the A. E. Jones "Andrich" 1935 Model Petrol Engine.

Its weight, complete with sparking plug, contact breaker, carburetter, and two-minute petrol tank, is only 8 oz.

The cylinder is produced from a solid bar of steel, specially heat - treated to ensure a glass - smooth bore and hard-wearing properties, and the piston, fitted to fine limits, is of aluminium alloy fitted with two rings $\frac{1}{16}$ in. wide.

The gudgeon pin is of steel, hardened, tempered and ground, and fitted with bronze retaining caps, whilst the connecting rod is machined from solid duralumin.

The crank case is an aluminium casting of light weight, specially strengthened and webbed to withstand shocks likely to be encountered when used on model aircraft.

The main bearing is an iron casting pressed in.

Contact breaker of special design incorporating totally enclosed contact points (oil-proof).

The engine will drive a 13½ in. diameter propeller at 3,600 r.p.m. Estimated B.H.P. 0·125.

Interchangeable petrol tanks may be fitted instantly to give any duration of flight. Engines run on Shell No. 1, and "Mobiloil," proportion 6–1. Price £6 6*s*.

MAKING IGNITION COILS

This article deals with two types of coil, one being for model boats and aeroplanes where weight and size are of great importance, and the other for engines up to 1 B.H.P. where the above factors are of little account.

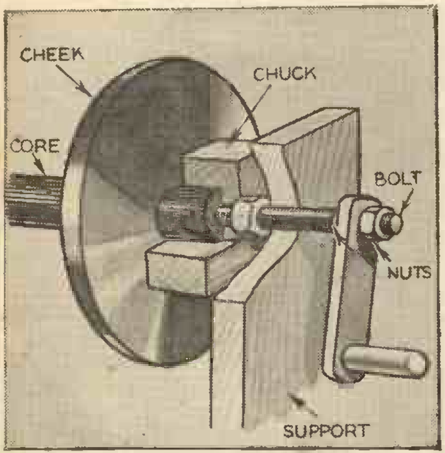


Fig. 1.—Constructional details of the winding apparatus.

THE construction of an ignition coil necessitates great attention to details. Those readers who have made spark coils will understand the care necessary, and have little difficulty with the work. In the first place do the winding on a perfectly clean table, but if the ordinary workshop is used, place papers on the bench to exclude all dust and metallic filings, etc. It is also necessary to work with perfectly clean hands when winding the secondary.

Two types of coil are described; one for use in model boats and aeroplanes where weight and size are of great importance, and the second is for engines up to 1 B.H.P. where the above factors are of little account and the coil can be run from an accumulator. In practice two types of coil are used, namely, with and without a trembler, but the winding details are the same, the only difference being that an interruptor is fitted to the trembler coils. The condenser is the same except that it is connected across the contacts on the engine, instead of on the coil.

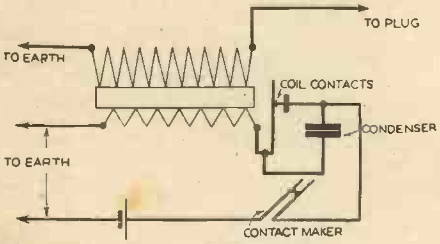


Fig. 2.—A circuit for a trembler coil.

Construction of a Light-weight Coil

The core consists of a number of soft iron wires packed into a bundle 3½ in. long and $\frac{7}{16}$ in. in diameter. It is essential that the core be dead soft, and even if the wires are bought annealed, they should be brought to a dull red heat and allowed to cool slowly. The wires should then be immersed for some time in dilute sulphuric acid (1 part of acid of S.G. 1·260, to 20 parts of water), until most of the scale is dissolved, and on removing, wash in plenty of water and dry in a hot oven. If, when bought, the wires are straight and cut to the required length, they *must* be annealed. Obtain a piece of rod 3 in. long and $\frac{7}{16}$ in. in diameter, and wrap it with two turns of stiff brown paper, each of which must be secured with good shellac varnish. When dry, remove and pack with clean wires 3½ in. long. With a trembler-type coil, one end of the core must be ground or filed quite flat, so as to present a perfectly flat surface to the armature. Two cheeks are cut from ⅛-in. ebonite 2¼ in. in diameter and drilled so that they are a tight fit on the core, but with a trembler coil, one cheek (on which the interruptor and terminals are fixed) must be made of ¼-in. ebonite. The primary is wound with three layers of No. 22 enamelled wire. Drill a small hole in one cheek close to the core, and pass 6 in. of wire through from the inside. Now commence winding, putting the turns on evenly and tightly, and packing each one close to the preceding one. Continue until all the layers are on (there is no need for an insulating layer between the primary wires), and pass the end of the wire out through a small hole in the cheek as before. Coat the primary with several layers of shellac, allowing each to dry before the next is applied. Now wind on five layers of brown paper, securing each turn with shellac. The primary should then be tested for continuity.

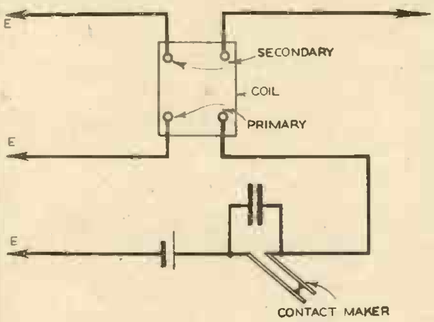


Fig. 3.—A circuit for a non-trembler coil.

The Secondary Winding

The secondary is wound with 3 oz. of No. 40 enamelled wire and to do this, a winder, and several other small and simple pieces of apparatus, must be made. Make a frame from ½-in. wood, by nailing two pieces 2 × 4 in. to a suitable base about 5 in. apart. Slots are then cut in the uprights to accommodate the coil chucks. Drill a $\frac{7}{16}$-in. hole to a depth of ¼ in. in a block of *hard wood* 1 in. square and ½ in. thick, and then finish the drilling with a ¼-in. drill. A bolt is then passed through the hole and secured with a nut. Two similar chucks are required, but one is fitted with a crank handle. The bolts should be about 2 in. long so that there is no possibility of the coil slipping out of the supports. The crank arm, about 2 in. long, is secured to the end of one of the bolts, the core is pushed as far as possible into the chucks, and the whole is placed in the supports. Everything should be tested before the actual winding is commenced, and if the core moves or is too slack a fit in the chucks, it should be cemented in with sealing wax (see Fig. 1). Each layer is separated from the previous one by two turns of waxed paper, which is cut into strips just wide enough to go between the cheeks. Obtain a flat tin tray and fill it to a depth of ½ in. with molten paraffin wax, and in this, soak the strips of paper, keeping one pile soaking while the other is being used. Keep the wax molten by placing a small electric lamp above it, or actually in the wax, if there is room.

Winding Operations

The wax used must be of good quality and free from dust, and, when melted in a test tube, a sample should not give a precipitate and should be quite clear (candle wax cannot be used). Arrange the bobbin of wire in a stand so that it will turn freely, and when all is ready the winding can be commenced. Put two layers of waxed paper over the brown, allow it to dry, pass the end of the 40-gauge wire through a *small* hole in one ebonite cheek and commence to turn the coil, placing the first turn ¼ in. from the cheek. Guide the wire carefully with the fingers, taking care that no two turns cross and that each turn is close up to the preceding one. Stop winding ¼ in. from the end cheek, paint the layer with molten wax with a soft hair brush and then put on two layers of waxed paper, pressing it down to leave a smooth surface free from air-balls and excessive wax. The next layer is then wound back again and the process repeated until all the wire has been used. When taking the wire from one layer to the next the turns must be taken round with the paper as follows. Place the paper from the bobbin under the wire, and then turn the crank, thus winding both the paper and wire on to the coil. The exact diameter of the secondary will depend on the worker's skill, but it should be about 2 in. Great care must be taken to see that the turns do not go nearer the cheeks than ¼ in., and that each layer is given a good even coat of wax. To finish the coil, select a length of cardboard or composition tube, cut it to the exact size and fit it over the cheeks. This can be sealed at each end to protect the windings from moisture and mechanical damage. A coil, used as a non-trembler unit only, requires fitting with connecting wires; terminals are not used because of the increase in weight, and also because in a piece of apparatus of this type, they are unnecessary. The connecting wires are soldered to the fine secondary windings near their exit holes, and are then cemented into them with sealing wax.

The two circuits shown in Figs. 2 and 3 show how the coil is connected, and reference to these will give details of the ignition systems.

When fitting the coil with a trembler, start the winding at one cheek and finish at the other, so that a primary and secon-

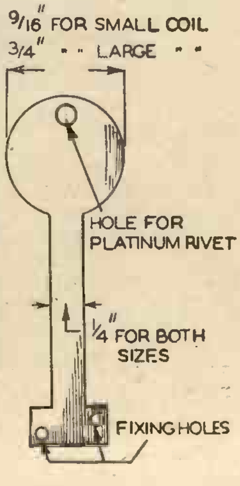


Fig. 4.—A suitable design for a trembler.

dary lead are at each end. If it is desired to connect the primary and secondary together, this is best done at the interrupter end. It is a good plan to finish the secondary windings at opposite ends, even if an interrupter is not being fitted.

The Trembler

This must be fitted with platinum contacts and is cut from thin clock spring ·015 in. thick to the pattern shown in Fig. 4. It is softened, drilled where holes are marked, retempered, and then cleaned up. The trembler is riveted to a piece of aluminium so that it is $\frac{3}{32}$ in. above the core, the aluminium being secured to the ebonite by screws passing through it and tapped into the ebonite. The platinum contact, which is of No. 18 gauge, is riveted into the hole in the armature and then cleaned with fine sandpaper. The bridge is made from aluminium, and is supported on blocks $\frac{1}{8}$ in. above the armature. The contact-screw must be of a fine thread (about 40 per inch), and fitted with a lock-nut made by drilling and tapping a $\frac{1}{4}$-in. diameter $\frac{1}{8}$ in. thick disc of aluminium. The contact screw is of brass and has $\frac{1}{8}$ in. of platinum wire soldered to the tip. Clean off all flux and see that the screw turns freely, but does not wobble in the bridge. If the aluminium wears too quickly it may be tightened up by the method shown in Fig. 6 which gives other details of the trembler. Connect up the coil as in Fig. 3, securing the wires under the various parts before the screws are finally driven home.

The condenser consists of 15 sheets of aluminium foil 1 in. × 1$\frac{1}{2}$ in. interleaved with sheets of mica 1$\frac{1}{2}$ in. × 1$\frac{1}{2}$ in., the whole being tightly packed together with alternate aluminium strips sticking out $\frac{1}{8}$ in. at opposite ends. Bind everything firmly with silk. Solder a lead to each set of plates and connect them to the interrupter if it be on the engine or coil. In the latter case, the circular protecting tube should be lengthened by about $\frac{3}{4}$ in. and the condenser packed in this space, leads being taken up to the trembler outside the tube. Before sealing the end with a disc of wood fill the space with molten paraffin wax, as this not only serves as an insulator, but keeps the condenser firm and prevents damage due to vibration.

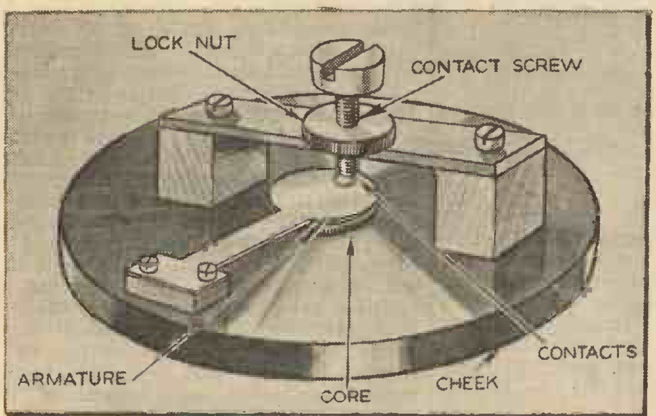


Fig. 5.—Showing the completed interrupter.

To test the coil, connect it in series with a 2-volt accumulator and arrange the high-tension leads about $\frac{1}{4}$ in. apart. A spark should pass, and with a little careful adjustment, it can be increased to $\frac{1}{2}$ in. or $\frac{5}{8}$ in.; with 4 volts a slight increase should be noted.

A Large Coil

The construction of a large coil suitable for engines up to 1 b.h.p. is carried out in a similar manner, except that the secondary is wound in two sections. The core is made of dead-soft iron wires 6 in. × $\frac{3}{4}$ in. The primary consists of two layers of No. 18 D.C.C. wire wound neatly and tightly and varnished with shellac. The insulating layer over it must be of at least eight layers of brown paper. Cut a disc of $\frac{1}{8}$ in. ebonite, 2$\frac{3}{4}$ in. in diameter to fit tightly over the insulating tube, and mount it in the centre of the core. Mount the coil as before, pass the end of the secondary under the disc and wind outwards, starting $\frac{1}{4}$ in. from the ebonite. Proceed with the insulation as before, and when half of the secondary has been wound to a depth of 2$\frac{1}{2}$ in., finish winding at the outer end of the coil, leaving about 6 in. of wire for connections. The second half is wound in the opposite direction. Connect the end of the secondary projecting through the ebonite disc, to the end of the winding coil, making a neat soldered join and continue as for the first section, winding outwards, finishing off at the end of the coil.

For a non-trembler coil, make a box, fitted with an ebonite panel, to easily accommodate the complete apparatus, and on the panel mount four terminals for the primary and secondary circuits. The coil should be mounted on small wooden blocks and the box should then be filled with molten battery sealing compound. Heat the compound *gently*, until it is just sufficiently fluid to pour by its own weight, and completely fill the box and secure the lid.

For a trembler coil a similar box is made, but the ebonite end is drilled to take the core so that it will project about $\frac{1}{4}$ in. In this case all the interrupter parts must be secured before the box is filled with the compound. It is usual to connect one end of the secondary to the earthed primary terminal, thus dispensing with one terminal. When this method is adopted, remember to connect the frame of the engine to the correct pole of the battery, in order to complete the H.T. circuit. In this article most of the coils have been fitted with two H.T. terminals so that readers can more easily adapt them to their existing engines and experimental work. This interrupter is very similar to the previous one, but brass is used instead of aluminium.

The Platinum Contact

This is riveted to the blade as before, and is of No. 16 platinum wire, the contact screw is $\frac{1}{4}$ in. in diameter and 40 t.p.i., and is fitted with a lock-nut of $\frac{1}{4}$-in. brass. The cross-piece is of $\frac{1}{4}$-in. brass, supported on $\frac{3}{8}$-in. blocks, the various parts being shown in Fig. 5. The blade is riveted to a $\frac{1}{4}$-in. strip and is then bolted to the ebonite, the connections being made as in the sketch. The condenser consists of 30 sheets of tinfoil 2 in. × 3 in. interleaved with waxed sheets of paper $\frac{1}{2}$ in. wider than the foil. Place a piece of paper on the bench, and on it put a piece of foil with the end projecting $\frac{1}{2}$ in. over the paper. Now place another sheet of paper over the first and then a piece of foil projecting at the opposite end, and repeat until all the material is used. When finished bind the sheets together with silk threads and press them together with a warm flat iron. Solder a No. 18 copper wire to each set of plates and immerse them in molten paraffin wax. When the condenser is mounted in the box by the coil, the two must be separated by a sheet of $\frac{1}{4}$-in. glass before filling with the sealing compound, and the connections are made to the bolts of the armature and bridge.

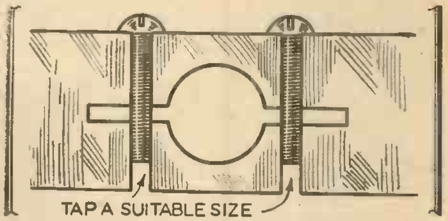


Fig. 6.—The method of locking the contact screw in the aluminium.

COLOURED ALUMINIUM
DETAILS OF A NEW PROCESS

A NEW aluminium alloy possessing remarkable properties has recently been perfected. It is fire-proof, will not corrode, and can be hardened to such an extent that it will cut glass as easily as a diamond. Another feature of the alloy is that it can be produced in any "self-colour" with a permanent lustre, thus making it suitable for decorative work such as house tiles, shop fronts, etc. It is also stated that the surface renders the complete metal part non-conductive to electricity. The manufacture of the alloy will be carried out by a huge factory, now being erected on the North Circular Road.

The Inventor

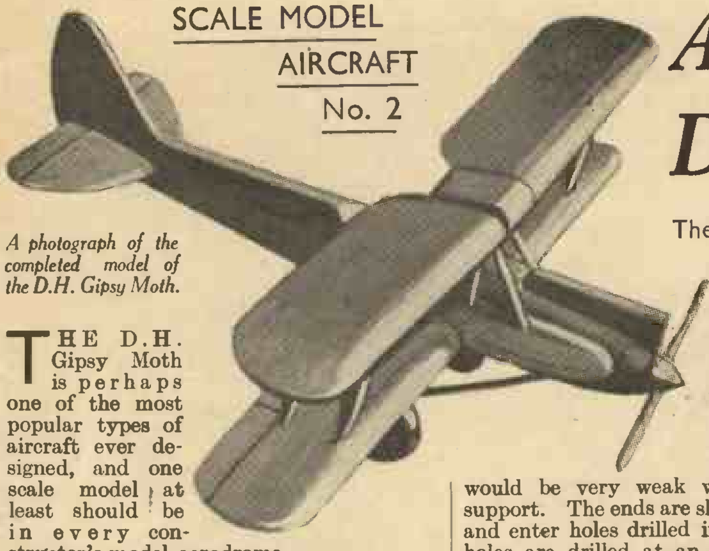
The inventor of the processes is Dr. Charles Robert Huges Gower, a Welshman, who has been experimenting with the alloy since the War. The colour is produced by dipping the alloy in an electrolytic bath, which converts the surface of the alloy into aluminium oxide, microscopically pitted. It is then dipped into dye of any required shade, and the colour is subsequently sealed within the surface pores.

Seventeen factories have already started work on the material in Germany, and we learn that it will be used in the Zeppelin works. For cooking utensils the sealing is accomplished with a silicate, thus giving, literally, a glass finish. The vessels so treated cannot stain, and their powers of resistance to burning are remarkable.

Other Uses

As well as being a durable and decorative material, it may be used in the future design of the bodywork of motor vehicles. Already we learn that in the United States the pistons of cars are being subjected to the treatment in large quantities, no doubt owing to the wear-resisting, heat-resisting, and non-corrosive properties of the finished product.

SCALE MODEL AIRCRAFT No. 2



A photograph of the completed model of the D.H. Gipsy Moth.

A SCALE MODEL D.H. GIPSY MOTH

The Second Article of a Series dealing with Scale Models of most of the present-day Aeroplanes

THE D.H. Gipsy Moth is perhaps one of the most popular types of aircraft ever designed, and one scale model at least should be in every constructor's model aerodrome.

Below is shown a list of the parts which are required, the dimensions given referring to the size of wood from which they are cut. General remarks on choice of wood and the methods of working were given in last month's issue.

Some of the items in the list show the actual length of the wood required to pass into the fuselage and not to the length shown in the drawings.

The Fuselage

Start by making the fuselage, which forms a base to which most of the other parts can be fitted. Next add the engine cowling, the tail piece and the elevators. The cowling is glued in position, but the tail piece and the elevators have additional fixing pins. The interplane struts are oval and can be made, as all the other struts, from narrow strips of wood cut from three-ply. Plane off one edge of a piece of three-ply, having the top layer of suitable thickness, ·05 in. approximately, set a cutting gauge to the required width, and carefully cut through the top layer only. Then lift the strip by inserting a chisel under the end. Keep the back of the chisel flat and the strip will lift without cracking. Sandpaper the strips to round off the corners, and when these parts have been fitted, clean up the fuselage and give it a preliminary coat of paint.

The Wings

Next make the wings, which are similar to each other, in main dimensions. The insides of the top planes are radiused off to meet the petrol tank, and forms the cut-away for the pilot. Ailerons are fitted to bottom planes only, and can be made to work as described for the D.H. Comet (see last month's issue). The interplane struts are not cut to shape until after they are fitted into the wings, as the narrow points would be very weak without additional support. The ends are shaved off to a point and enter holes drilled in the wings. The holes are drilled at an angle to give the wings the necessary incidence and stagger, and the struts are then glued and pressed into the holes, until the gap is of the correct dimensions. The protruding ends of the struts are then cut off, sandpapered flat, and any holes filled with plastic wood or putty.

The Petrol Tank

Next make the petrol tank and pass a pin, with its head cut off, right through from end to end, to make additional support for the wings. Two pins are also fitted near the bottom of the fuselage to secure the lower wings. Glue the ends of one pair of wings and press the bottom wing in position, and then glue and fit the petrol tank. The second pair of wings should now be fitted, making sure that the stagger, incidence and dihedral of the wings are correct. It may be advisable to set the plane on little blocks of wood to keep the wings in position whilst the glue is drying. The remaining six interplane struts are secured with glue only, the lower ends being cut to fit against the fuselage and the upper ends to the junction of the tank and the wing. These struts should be fitted one after the other, allowing each to set hard before fitting the next. When these have been attached, shape the ends of the four large interplane struts to a sharp point where they enter the wing surfaces; the rigidity of the structure now allowing this to be done without fear of the struts snapping off.

Now go over everything and smooth off any roughness on the paint and give the final coat. The photograph shows the model just previous to this operation. The under-carriage is shown fitted, but it is better to leave this off until the final painting of the underside is completed.

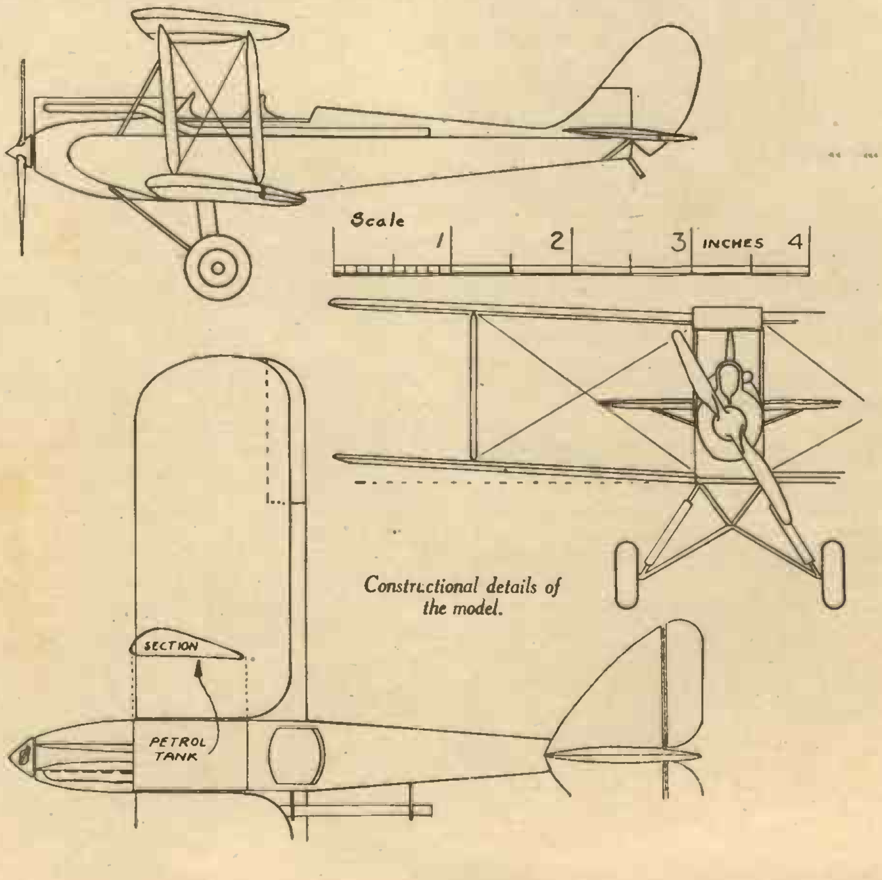
Colouring the Model

Fuselage, wings, etc., red; panels on each side of fuselage, cream; struts and under-carriage, yellow; wheel rims, grey; discs, red; bosses, cream. The movable controls, rudder, etc., can be lined with black and filled with yellow. The registration letters which appear across the whole of the upper surface of the top wing and the under surface of the lower wing, and also from the back of the pilot's cockpit

(*Continued on* p. 288.)

LIST OF PARTS FOR 1/50th SCALE MODEL D.H. GIPSY MOTH

	Long.	Wide.	Thick.
Fuselage	5·5	·6	·85
Petrol tank	·8	·6	·25
Wings—four	3·3	1·1	·15
Elevators—two	1·1	1·05	·1
Fin and rudder	1·1	1·25	·1
Interplane Struts—			
Centre—six	1·1	·05 diam.	
Bays—four	1·4	·1	·05
Under-carriage struts—			
Rear vee	1·4	·05 diam.	
Forward—two	1·5	·05 diam.	
Axle	1·8	·05 diam.	
Shock absorbers	·6	·15	·05
Spinner	·3	·35 diam.	
Propeller—two	·8	·2	·75
Cowling	1·5	·4	·15
Wheels	·7 diam.		·15



Constructional details of the model.

AN A.B.C. OF ENGINEERING TOOLS

(Continued from page 238, February 1935 issue.)

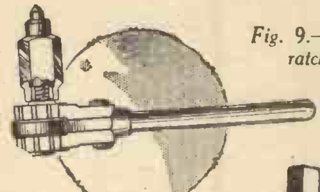


Fig. 9.—(Left.) A ratchet drill.

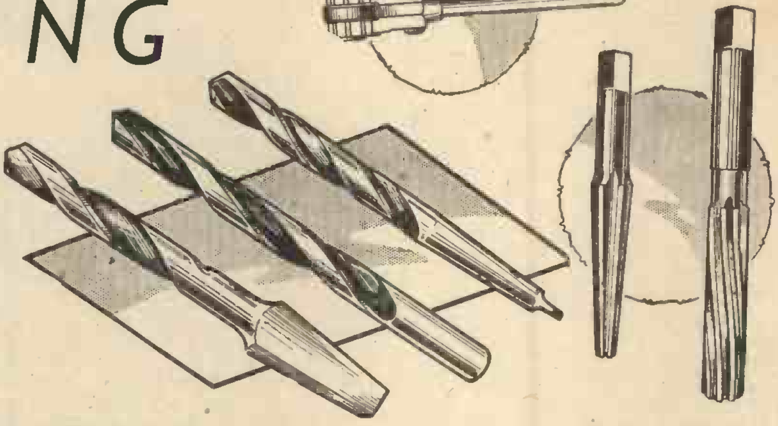


Fig. 10.—(Left) Three forms of twist drills (square taper shank, straight shank and morse taper shank), and (right) a taper reamer and parallel reamer.

Metal Piercing Saw

A LIGHT saw with an adjustable frame for taking different lengths of saws; used for cutting holes or piercings of varying shapes in sheet metal or other light work. To start the saw, a small hole is first drilled so that the saw blade can be passed through before being clamped in the frame (see Fig. 11).

Micrometer

A precision tool for making measurements to very fine limits. Fig. 12 shows a common form of micrometer, of which there are several patterns, consisting of a U-shaped frame A, carrying a fixed stop, or anvil B, and a sliding adjustable rod C. The other end of the rod, which is inside the sleeve, or thimble D, usually has a screw of forty threads per inch cut upon it, so that one complete revolution of the thimble will cause the rod C to move in or out a distance of 1/40 in., thus increasing or decreasing the distance between the anvil and the end of the rod C by that amount. The bevelled edge of the thimble is divided into twenty-five equal parts, so that if it is turned through one of these divisions only, the rod C will move exactly 1/1,000 in. The circular part E of the frame is also divided into a number of divisions, each one being equivalent to the distance the edge of the thimble moves in one complete revolution, *i.e.*, 1/40 in. To read a micrometer, count the number of divisions that are visible on the scale at E, multiply this number by 25 (the number of thousandths of an inch that each division represents), and add to the product the number of that division on the thimble D, which coincides with the datum line on the part E. The result will be in the diameter of the part being measured in thousandths of an inch. As the numbers opposite every fourth division of the datum line indicate hundreds of thousandths it is a simple matter to take the reading mentally. For example, if the thimble were screwed out, so that the graduation 1 and three additional sub-divisions were visible, and that graduation 10 on the thimble coincides with the datum line, as in Fig. 12, the reading then would be 0·100 + 0·075 + 0·010 = 0·185 in.

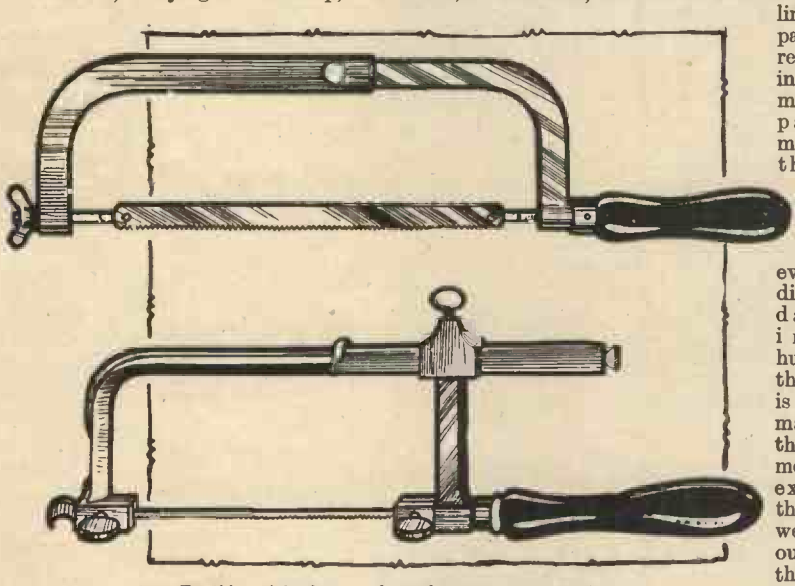


Fig. 11.—A hacksaw and metal piercing or jeweller's saw.

Pliers

For bending or cutting wire or metal strips, and for holding small work, or for use as a wrench for round rods, etc. There are several types of pliers, and two of the most common patterns in general use are round-nose pliers and flat-nose pliers (see Figs. 13 and 14). Other patterns are gas pliers, taper-nose pliers, snipe-nose pliers, and glass pliers.

Ratchet Brace

In cases where a hole has to be drilled in a confined space, or on work where a drilling machine cannot be applied, an engineer's ratchet brace is used. The drill is held in a socket in the end of the brace, which is caused to slowly rotate by moving the ratchet handle backwards and forwards. The drill is fed into the metal, being drilled by means of a central screw which is threaded into a pointed end piece, the point of which takes a bearing against the portion of the machine or casting directly opposite the hole to be drilled. In cases where a ratchet brace is used for drilling girders, railway permanent way, and similar work, a special angle frame is clamped to the metal being drilled, to take the thrust.

Reamer

A tool having a series of grooves, or flutes, round its surface forming cutting edges. A parallel reamer is used for enlarging holes already drilled and for accurately finishing a hole to a particular size. In use, the tool is turned round by means of a wrench which grips the squared end of the shank. Holes which have afterwards to be reamered should be drilled only slightly smaller than the finished size, so that only a small amount of metal is left for the reamer to remove. For finishing taper holes for taper pins a taper reamer is used, and this is fluted in the same manner as the parallel reamer.

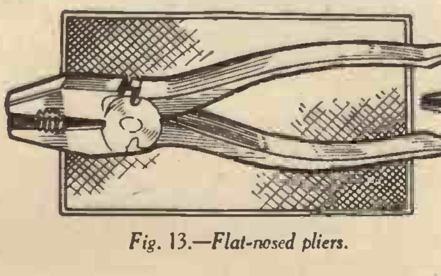


Fig. 13.—Flat-nosed pliers.

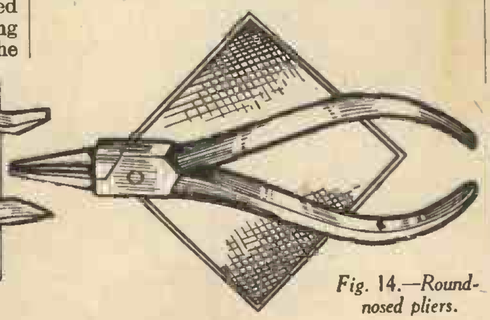


Fig. 14.—Round-nosed pliers.

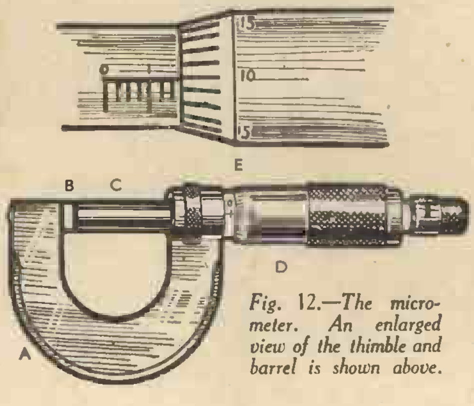


Fig. 12.—The micrometer. An enlarged view of the thimble and barrel is shown above.

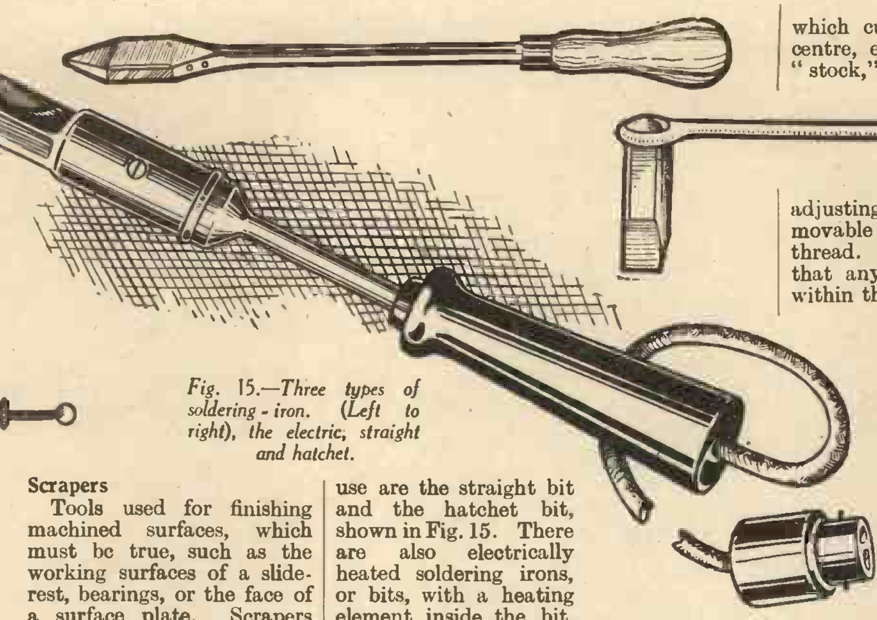


Fig. 15.—Three types of soldering-iron. (Left to right), the electric, straight and hatchet.

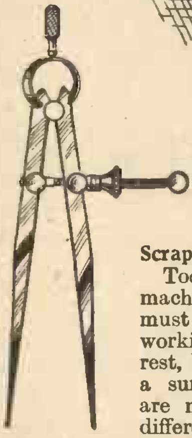


Fig. 16.—Spring dividers.

Scrapers

Tools used for finishing machined surfaces, which must be true, such as the working surfaces of a slide-rest, bearings, or the face of a surface plate. Scrapers are made in a number of different patterns, and three in common use are of triangular, rectangular, and half-round sections respectively. They are made of cast steel, ground after hardening to form cutting edges, and are provided either with wood or metal-handles, the latter being knurled to afford a firm grip (Fig. 17).

Screw Plate—See Stocks and Dies.

Scriber

A tool used for marking the surface of a machine part, or casting, for locating the position of holes to be drilled, and other purposes. There are two patterns in general use—one is straight with a point at one end, and the other a double-ended tool, one of the pointed ends being bent at right angles. They are made of tool steel, properly tempered, and are knurled over the centre parts to afford a firm hold.

Snips—See Tinmen's Shears.

Soldering Bit

A tool used for making soldered joints with soft solder. The shaped end, which has to be heated in a gas flame or fire, is made of copper. Two patterns in common use are the straight bit and the hatchet bit, shown in Fig. 15. There are also electrically heated soldering irons, or bits, with a heating element inside the bit. To the handle is fitted a length of flex with an adaptor for plugging into an ordinary lamp-holder. An electric soldering iron gives an even temperature all the time it is in use, and is very economical in current, consuming about 60 watts. Over sixteen hours' use is therefore obtained for 1 unit of electricity.

Spring Dividers

A similar tool to compasses, and used for marking out circles and curves, and for dividing and spacing out. The legs have a special spring joint at the top which tends to keep them apart, the necessary adjustment being made by turning a milled nut on the threaded spindle. The knurled projection at the top, which is held between the finger and thumb, facilitates the manipulation of the dividers when scribing circles or spacing out the positions of holes (see Fig. 16).

Square—See Steel Square.

Stocks and Dies

Used for external threads on rods, tubes, or other cylindrical metal parts. The die which cuts the thread is split across the centre, each half fitting in the holder or "stock," which is provided with an adjusting screw for applying pressure to the movable half of the die when cutting the thread. The dies are interchangeable, so that any diameter of thread can be cut within the capacity of the stock.

For cutting the smaller sizes of threads all the dies are arranged together in a row in one stock, the adjusting screw applying pressure on the end die. This pressure is transmitted to whichever pair of dies are being used.

In another pattern the dies are in one piece, circular in shape, but split on one side. The depth of the cut can be regulated by turning the adjusting screw.

For cutting external screw threads of small diameter, up to about ¼ in., a screw plate is sometimes used. This consists of a cast steel plate having a series of tapped holes of various diameters. The holes are slotted at the sides to form two, three or four cutting edges, according to the size of thread to be cut. When in use the plate is worked to and fro by means of the handle on one end.

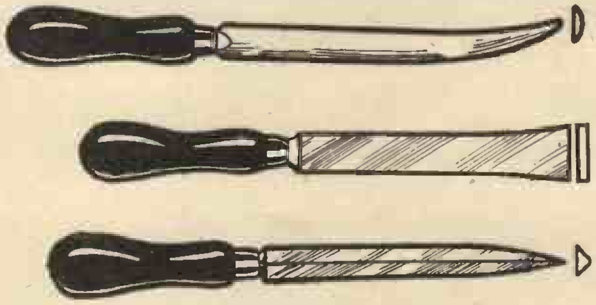


Fig. 17.—Three types of scraper—half-round, flat and triangular.

Surface Gauge

A tool used in conjunction with a surface plate (which see) for marking out the surface of a casting or other machine part. The tool consists of a turned steel post mounted in a heavy metal base, the underside of which is faced true. Sliding on the post is a clamp which can be adjusted and fixed in any position, and this clamp holds the steel scriber, which can be held firmly at any angle by screwing up the milled nut. It is common practice to rub some ordinary chalk over the surface of the metal to be marked out so that the scribed lines can be clearly seen.

(To be continued.)

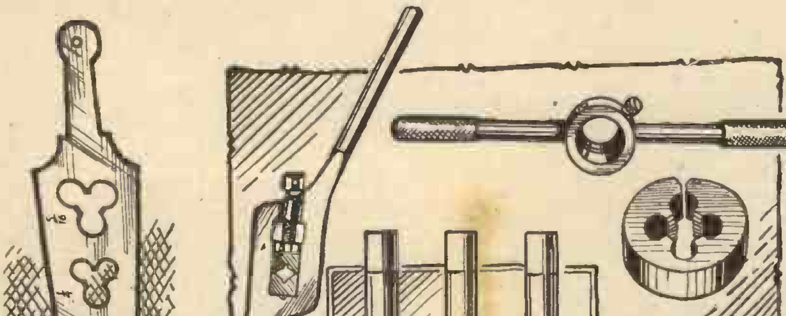


Fig. 18.—Various screw-cutting tools. Stocks and dies and taper, second and plug taps.

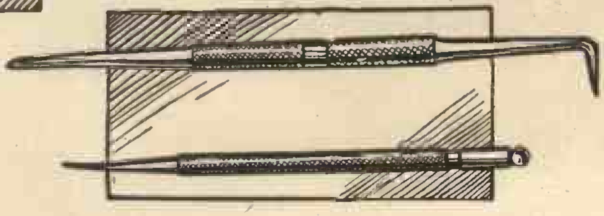


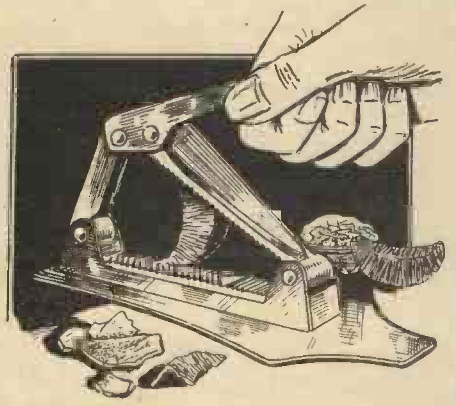
Fig. 19.—Two types of scriber—the single and double-ended.

The LATEST Novelties

The address of the makers of any device described below will be sent on application to the Editor, PRACTICAL MECHANICS 8-11, Southampton St., Strand, W.C. 2. Quote number at end of paragraph.

An Efficient Nutcracker

AS most readers know, it is an extremely tedious job cracking large nuts with ordinary nutcrackers, as invariably the kernel is crushed in the process of removing the shell. The reason for this is that it is impossible to judge the correct amount of pressure to exert on the shell. The nutcracker shown in the sketch will, however, overcome this difficulty effectively



The ingenious nutcracker shown will crack nuts quickly and efficiently, as full cracking leverage can be applied without risk of damage to the kernel.

and efficiently. To use, lift the lever handle, as shown, to its utmost limit, and insert the nut endwise in the "V" jaws. Now hold the nut to prevent it slipping at the commencement of the cracking and press the lever down sharply to its lowest limit. The kernel of the nut can then be removed quite easily. An important feature with this type of nutcracker is that full cracking leverage can be applied without risk of damaging the kernel. It is obtainable for 4*s.* post free. [103.]

A Self-luminous Reading Glass

KNOWN as the "Magnalume," the ingenious device illustrated on this

A self-luminous magnifying glass suitable for a variety of purposes, such as reading a programme in a darkened theatre, inspecting small mechanical movements, etc.

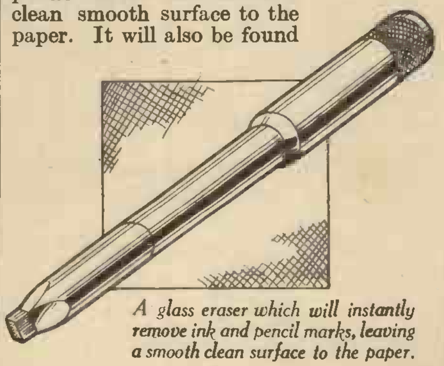
page enables one to read in the dark by illuminating and magnifying the particular section of the text under inspection. The current for the light is obtained from a standard dry-battery concealed in the handle, which folds back for compactness. To switch on the light, give a slight turn to the screw switch fitted to the end of the handle (see sketch). The model illustrated is the "theatre model" and is supplied complete in a morocco case for 22*s.* 6*d.* Numerous other models, fitted with larger or higher power lenses and operated from accumulators, mains or the wiring system of a car, are available. [104.]

The Ashton Cage Aerial

THE Ashton No-mast cage aerial is eminently suitable for houses, flats, etc., which are restricted as to space. The aerial consists of eleven vertical, staggered loops, and is non-directional. The aerial may be fixed to a chimney stack, wall, or on the corner of a house, and will give very satisfactory results. It should also find favour with those who do not wish to erect conspicuous, unsightly poles. The price of the aerial, complete with 20 ft. of insulated lead-in and a wrought-iron bracket for a window frame, wall, or chimney, is 18*s.* carriage paid. [105].

A Glass Ink Eraser

THE spun-glass ink eraser shown herewith will rapidly remove ink and pencil marks and leave a clean smooth surface to the paper. It will also be found



A glass eraser which will instantly remove ink and pencil marks, leaving a smooth clean surface to the paper.

useful for cleaning wireless terminals and preparing metal surfaces where good electrical contact is essential. It costs 2*s.* 9*d.* post free, and glass refills for the container may be obtained for 5*d.* each. [106.]

A Lamp for the Handyman

A CLEVERLY designed lamp which can be used for a multiplicity of purposes is illustrated on this page. It consists of a standard two-contact holder fitted with a reflector, two cut-glass ruby lenses and mounted on a soft rubber "sucker." By means of the latter the lamp can be fitted in any desirable position, providing the "sucker" is pressed against a smooth surface. The lamp is also provided with a two-pin plug and a correspondingly double socket.

It is supplied with either a 6-volt or 12-volt bulb and 12 ft. of twin flex. It sells at 6*s.* 6*d.* [107.]

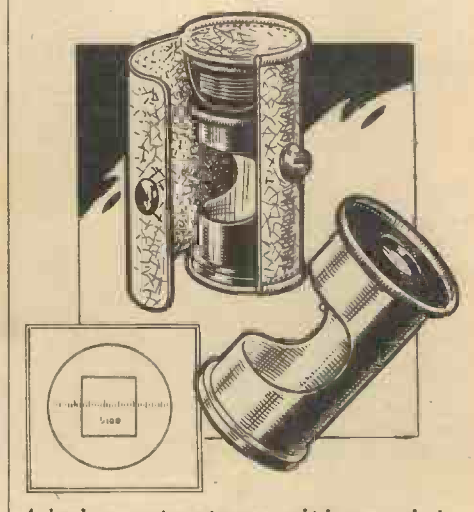
A serviceable portable electric light, which can, by means of a rubber sucker, be attached to any smooth surface.

A Measuring Microscope

THE pocket microscope shown on this page is for measuring screw threads, gauges, etc., and will also be found useful for testing paper and cloth. It is supplied with two glass graticules for measuring 1/100th of an inch, or 1/10th of a millimetre. Obtainable in a stout leather case, it costs 25*s.* 6*d.* post free. [108.]

An H.T. and L.T. Battery Charger

AN efficient charger, moderately priced, and fitted with an ammeter to show correct polarity and charging current, will undoubtedly make its appeal to wireless enthusiasts. Fitted in a brown moulded insulated case, it is supplied complete with cord and adaptor, and will charge high-tension wireless accumulators or one or more low-tension accumulators. The charging current is varied in accordance with the lamp used, the maximum rate being 1 ampere. It is for use on direct current mains only, and full instructions are provided with each charger. Highly finished and attractive in appearance, it sells at the reasonable price of 22*s.* 6*d.* [109.]



A handy measuring microscope which can easily be carried about in the pocket.

A MAINS UNIT FOR 9·5 MM. CINEMAS

A complete mains transformer and switching unit for use with 12-volt cinema projector lamps.

WHEN a low voltage projector lamp is employed, the usual method of reducing the mains voltage is by means of a resistance in series with one of the A.C. mains leads. If the projector lamp is rated at 12 volts 0·5 ampere, and the mains voltage is 230 volts, the difference in voltage is dissipated as heat in the resistance.

This is not an economical method. Assuming that the lamp mentioned above be used, it will be necessary to drop 218 volts in the resistance which, at 0·5 ampere, is over 100 watts. When the projector is in use for two or three hours and electricity is 6*d.* per unit, the cost is by no means negligible.

It is now possible to obtain a mains transformer with a secondary winding rated at 12 volts 0·5 ampere, which is equivalent to 6 watts. With this transformer the cost of running is practically negligible, even after allowing for losses, compared with the series resistance method of obtaining the voltage drop. The economy effected, therefore, will easily repay the outlay.

Alternative Tappings

It will be found that a tapping is provided on the secondary of the mains transformer. The secondary voltage is 14 volts with a tapping point at 12 volts, thus enabling the maximum amount of illuminations to be obtained.

A word of warning is, however, necessary. It is not intended to convey that the lamp should be overrun, as its life would be shortened, but by employing a variable-resistance in series with the secondary winding, a fraction over 12 volts might be employed on occasions to obtain super results. In actual practice the 12-volts tapping will be found quite satisfactory and then the variable-resistance can be employed as a dimmer, so prolonging the life of the lamp.

Now by employing the full 14 volts and using a 6-ohm filament-resistance in series, 11 volts are obtained, and by adjusting the variable-resistance to about half of its rating, will provide 12½ volts, which is highly satisfactory.

The next thing is to obtain an ebonite panel measuring 9 in. × 4½ in., together with a small box made of any suitable material. The size of the box should be arranged so that the ebonite panel will act as a cover, and should be 3½ in. deep. The mains transformer should be mounted on the underside together with the other components.

A double-pole, double-throw switch is fitted, arranged so that when the projector lamp is switched off another lamp mounted on the panel is automatically switched on.

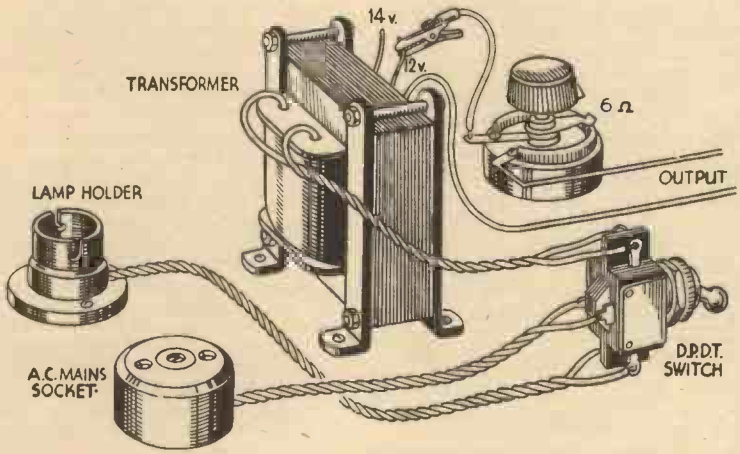


Fig. 1.—Showing the circuit arrangement adopted.

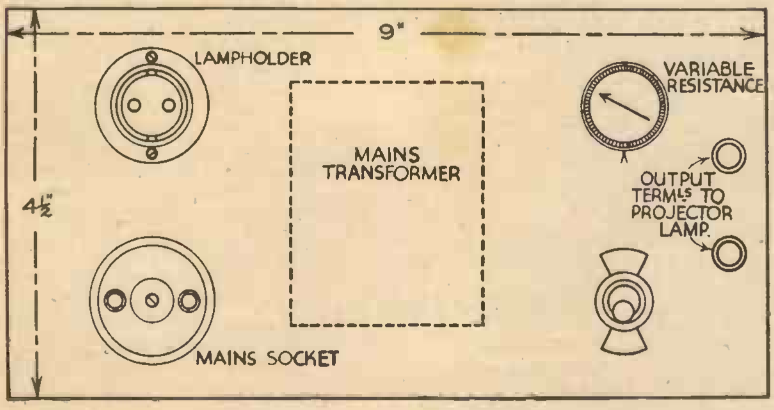


Fig. 2.—The layout of the components.

At the end of the programme, or should a break in the film occur, its advantages are obvious; the necessity of searching in the dark for the house lighting switch is obviated.

The circuit arrangement adopted is shown in Fig. 1, and a suggested layout of the components is outlined in Fig. 2. There is no need to adhere strictly to this arrangement; the layout is not critical and can be modified to suit individual requirements.

All the components are attached to the panel, and after completing the wiring, the panel is screwed to the top of the plywood box.

A flexible lead is taken from one terminal on the filament-resistance through a hole drilled in the panel, and a plug is attached to enable alternate tappings to be obtained. Leads are taken from the 12- and 14-volts terminals on the transformer to the two sockets screwed in the panel. The filament-resistance and switch are mounted in the usual way for radio components. All the wiring is carried out on the underside of the panel, which is then fitted on the plywood box.

The unit will not only prove its value, but will add a professional appearance to your projector.

LIST OF PARTS REQUIRED

One Lamp Holder.
One D.P.D.T. Switch.
One Projector Lamp Transformer.
One Variable Resistance, 6-ohms, Type FR.
Two Terminals.
Two Plugs and Sockets.
One Panel, 9 × 4½ in.
One Mains Plug and Socket.

"WEIGHING" THE ELECTRON

(*Continued from page* 276.)

Sir George Stokes

The famous mathematician, Sir George Stokes, has worked out the precise relation between the size of any particle and the rate at which it will fall through a given gas. Fig. 3 shows how this principle has been applied in the case of an electron.

When moist air is suddenly chilled the contained water condenses around the dust particles (which are always present in ordinary air) and forms a "mist," which then gradually settles down. By measuring the rate at which the upper layer descends the size of the drop can be calculated. If a layer of enclosed air is first carefully freed from every trace of dust, and then suddenly expanded, so as to cool it, the presence of free electrons will act in the same way as dust and will cause the contained moisture to condense about them. The resulting cloud or mist is allowed to settle down for a sufficient length of time to measure the size, and therefore the mass of each drop.

The mist collects in the space between the two plates A, B of a condenser. A positive voltage is applied to the upper plate and its value is adjusted so that it just offsets the effect of gravity and "holds" the layer of mist absolutely stationary.

In this way the pull of gravity is set against the electrostatic attraction of a given charge on the plates of a condenser. The result is the same as before. Stated in round figures, the mass of an electron—the atom of electricity—is 9×10^{-28} grams, or 1,800 times less than the mass of the hydrogen atom. The charge it carries is $4{\cdot}77 \times 10^{-10}$ electrostatic units, which means that six million billion electrons are required to pass a current of 1 ampere for one second.

A SCALE MODEL D.H. GIPSY MOTH

(*Continued from page* 283.)

(the rear) to the front edge of the rear wings, should be black.

The Under-carriage

These parts appear small, but are not so difficult to fit as might first appear. Drill two small holes at the junction of the wings and the fuselage. Cut the top "vee" to the dimensions given in the table and soak it in water for about a minute. Remove from the water and bend the "vee" in the middle (it will now bend without snapping), glue the ends and insert them into the two holes, pressing them in until they are in the correct position. When the glue is dry fill the apex of the "vee" flat, and secure the tip of the lower "vee" (bent in the same manner) to it. The shock absorbers and the front chassis stays can now be fixed and the under-carriage painted. The wheels can be turned or cut with a fret-saw and the edges rounded off with sandpaper. Drill a small hole through the centre of each and glue to the ends of the bottom "vee" struts.

The wire stays are best put on after everything else has been attached and painted, cotton or thin wire being used for this purpose. These stays are best attached by threading them through holes in the wings. A little glue is worked into the holes and the plane held up on the stretched wire until the glue is set, when the ends are cut off.

Two small pieces of celluloid are then cut and glued in position for windscreens.

THE CHEMISTRY OF PHOTOGRAPHY

THE action of hypo on silver bromide is first to form silver thiosulphate and then a double thiosulphate of silver and sodium. This latter is a soluble salt and passes into solution. The action is as follows:—

Sodium thiosulphate		silver bromide		silver thiosulphate		sodium bromide
$Na_2S_2O_3$	+	$2AgBr$	=	$Ag_2S_2O_3$	+	$2NaBr$

Then:—

$$Na_2S_2O_3 + Ag_2S_2O_3 = Na_2S_2O_3Ag_2S_2O_3$$

The hypo does not, of course, attack the silver deposits which have been produced by the action of the light and the developer and which constitute the image or picture. It merely dissolves away the creamy-coloured silver bromide and iodide in the unexposed areas, leaving clear gelatine.

After fixing the negative a thorough soaking in water is necessary to remove the last traces of hypo. If this is not done the negative will, in the course of time, develop stains, and is liable to fade.

The finished plate or "negative" is a reversal picture. That is to say, those parts which were brightly lighted in the original view, such as the sky or a white costume, are represented by a dark or black area on the negative, while the dark parts of the original, such as the shadows, constitute the clear portions on the negative. To obtain a positive from this negative a piece of sensitised paper is placed in contact with the negative and exposed to the light. Where the light can pass through the negative most readily, namely, in the clear parts, there will it have most effect on the sensitised face of the paper. A fully illustrated article on this subject appeared in our February, 1934, issue.

FACTS ABOUT LEVERS

Many of Archimedes' works are lost, but sufficient remain to support the opinion that his achievements may justly be likened to those of Newton in later times.

Fig. 1.—How Archimedes visualised lifting the world.

THERE was born at Syracuse, in Sicily, about 287 B.C., a man, Archimedes by name, who boasted, "Given a fulcrum on which to rest my lever and a place in space on which to stand and I will move the earth."

In a fanciful way he was merely extolling the virtues of the lever, by means of which it is theoretically possible to lift a weight, no matter how ponderous, by the application of a force, no matter how minute. All that matters is the relation between the two distances by which the fulcrum, or turning point of the lever, is separated from either end. To balance a weight of 100 lb. by a force of 1 lb., for instance, all that is required is a lever with the fulcrum placed say 1 in. away from the point of application of the heavy weight, the opposing force acting at a point 100 in. from the fulcrum along the long arm of the lever. There is a simple equation that must be satisfied, namely, that the product of the greater weight and the shorter distance must equal the product of the lesser weight and the longer distance. In the example given, 100 lb. multiplied by 1 in. equals 1 lb. multiplied by 100 in., that is, 100 in.-lb., in each case. Similarly a weight of, say, 77 lb. might be balanced by a force of 7 lb. by a leverage of 11 to 1, as in the case of a lever with fulcrum 3 in. from the point of application of the 77 lb. weight and 33 in. from the point of application of the 7 lb. force. If Archimedes were to be taken seriously, he would have needed a tremendous leverage to lift the earth, the weight of which has been calculated at six-thousand-billion tons, and allowing him to be able to exert a force of, say, a tenth of a horse-power.

The Archimedean Screw

Apart from his famous demonstration of the lever and its principles, he invented a most ingenious method of raising water, illustrated in Fig. 2. It is in effect a pipe twisted in the form of a corkscrew, inclined at not too great an angle, with one end dipping below the water to be raised. When made to revolve about its axis, water is drawn up at each successive winding of the screw until it emerges from the top.

Archimedes' Bath Experiment

After the King of Syracuse came to the throne he gratefully ordered a votive crown to be placed in a certain temple. The skilled goldsmith to whom he assigned the block of gold for the purpose returned in due course a beautifully executed crown. Its weight was the same as the block, but the king suspected fraud, or, in other words, that the crown was not of pure gold, but an alloy, for gossip went round Syracuse that the smith had stolen some of the gold and substituted a baser metal. The indignant king asked Archimedes to investigate the matter. His problem was to find out whether the crown was pure gold or not, without damaging it.

One day Archimedes went as usual to the baths, and happening to select a tub brimful of water he noticed that after immersing himself he could easily support his own weight with one finger, and that the water had risen at the sides; the more his body was immersed the more and more the water overflowed. Suddenly, he realised that he had solved the king's problem. So delighted and excited

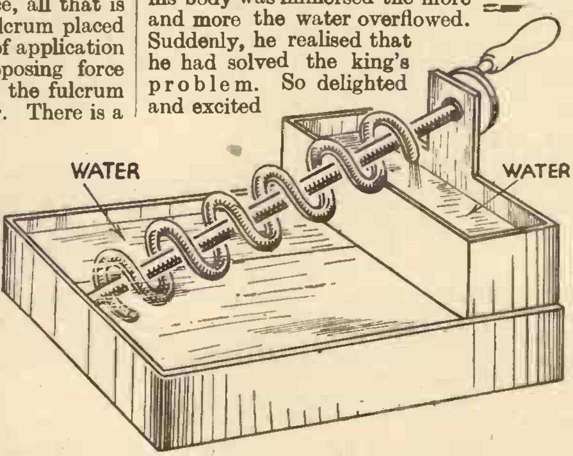


Fig. 2.—An ingenious method of raising water invented by Archimedes.

was he that, jumping out of his bath and quite forgetting to dress, he ran naked through the streets shouting, "*Eureka! Eureka!*" which meant, "I've found it! I've found it." What he had found was that if the crown contained metal less heavy or dense than gold, then the density of the crown was less than it should have been, or that *the volume of the crown would be greater than that of the same volume of gold.*

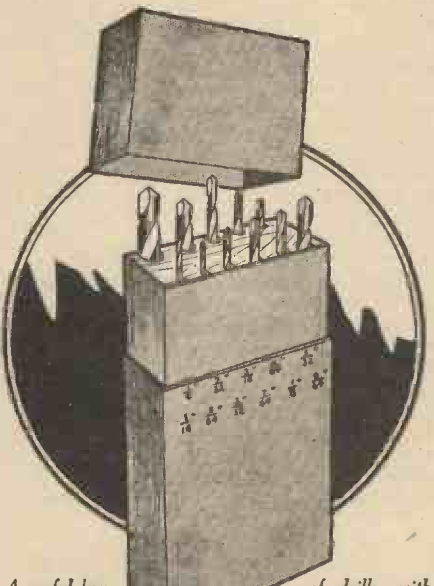
Proof

The bath experiment had led him to conclude that his body displaced its own bulk of water. He obtained two blocks, one of silver and one of gold, each the same *weight* as the crown. Taking a vessel partly full of water, he immersed the gold block in it and noted the height to which the water rose. He did the same with the silver block, and with the crown. The crown caused the water to rise *between* the gold block mark and the silver one, thus proving it to be made only partly of gold.

A Review of the Latest Devices for the Amateur Mechanic. *The address of the Makers of the Items mentioned can be had on application to the Editor. Please quote the number at the end of the paragraph.*

A Handy Set of Drills

THE case of high-quality drills shown on this page should prove extremely useful to the handyman. Each drill fits into a marked compartment of its own, and the case can conveniently be carried about in the pocket. The drill sizes range from $\frac{1}{16}$ in. to $\frac{1}{4}$ in., and the complete case of drills costs 3/3 post free. [112.]

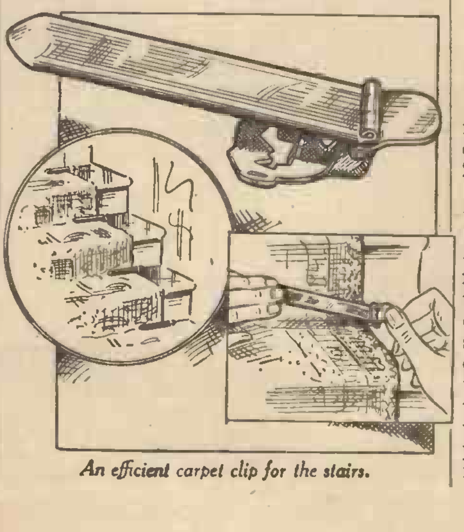


A useful box of drills, with their sizes marked on conveniently the outside of the case.

Ingenious Carpet Clips

THE extremely neat spring carpet clips shown in the illustration below are strongly made and will firmly grip the carpet. The clip is easily released by pulling the small trigger, and hinging back the clamping strip. The chief advantage with this type of clip is that the carpet, when taken up, is not marked by the clip.

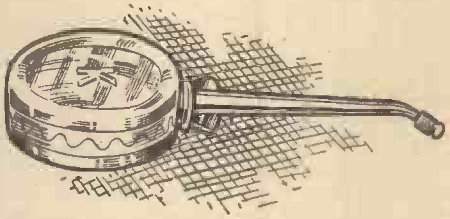
They are finished in florentine bronze, which has been found to be most serviceable in use. Other finishes such as chromium, oxidized bronze, etc., are obtainable if desired. The clips sell at 1/- per pair post free. [113.]



An efficient carpet clip for the stairs.

A Drill Grinding Jig

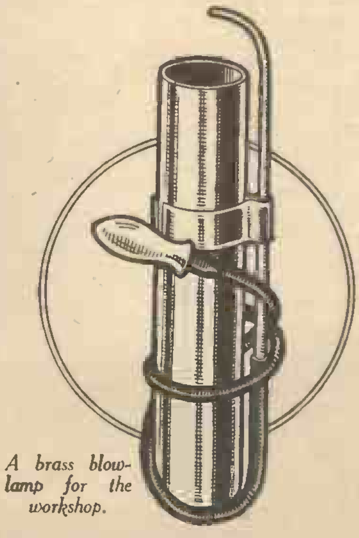
A DRILL grinding jig, known as the "Reliance," is now obtainable at a very moderate price that will suit the pocket of every home mechanic. The tool is fixed by a single nut to any size of grinder. It may be used on either face of the wheel, or horizontally for wet grinding. The jig may be mounted on a baseboard, clamped to a lathe bed, the wheel running in the headstock. The drill is held firmly in position by a single clamp while it is being ground. The trough in which the drill is placed is detachable from the bracket, thus allowing the setting of the drill to be done easily and accurately. The length of the spindle ensures a steady swing, and a true conical backing off is obtained. It is obtainable in three sizes, namely: Jig 02 (to $\frac{1}{2}$ in.), 12*s.* 6*d.*, postage 9*d.*; No. 1 (to 1 in.), 35*s.*; and No. 22 (to 2 in.), 70*s.* [114.]



A neat and sturdy oilcan.

Brass Blow-lamps

WE show on this page a cheap, yet efficient, brass blow-lamp made of specially selected solid drawn tube. The blow tube is fixed on a sliding spring, which grips the body of the lamp, and adjustments are easily effected. It is 1 in. in diameter and $4\frac{3}{4}$ in. long overall. It costs 2*s.* 3*d.* [115.]



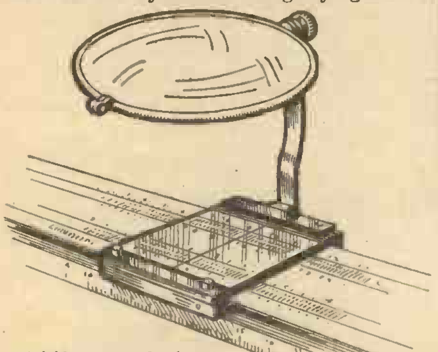
A brass blow-lamp for the workshop.

A Serviceable Oilcan

A SMALL oil-feeder of sturdy construction is illustrated on this page. The feed-hole screw is grooved to receive the two pressed sides of the oil-feeder, and it is consequently impossible to wrench the spout and screw away from the body as so often happens with cheaper makes. The tapering brass spout is drawn from the tube and is therefore seamless. It is fitted with a pin cap-screw and a wing nut. The price is 1*s.* 4*d.* each, post free, from the makers. [116.]

A New Folding Magnifier

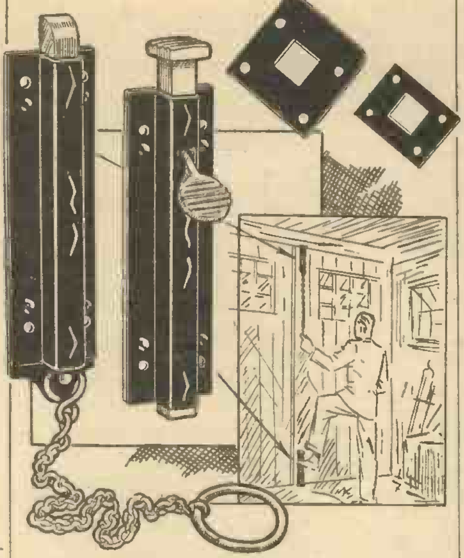
THE folding magnifier shown herewith is for use with 10-in. slide rule cursors, and enables measurements to be read with greater speed and accuracy. The whole cursor is in view, which enables the hair to be instantly located, and so the chief objection to the cylindrical magnifying cursor has been entirely eliminated. The magnifier without cursor costs 5*s.* 6*d.*, but complete with cursor, for 5-in. or 10-in. standard pattern rules, costs 9*s.* [117.]



A folding magnifier for use with 10-in. slide rule cursors.

"Remote Control" Bolts

NO bending or reaching need be done when the bolts shown in the next column are fitted to your doors. The upper bolt is released by pulling a chain, and, being spring loaded, it returns to its socket when the chain is released. The lower bolt is operated by pressing the foot on the lower pedal to open, and on the top pedal to close. The bolts sell at the moderate price of 2*s.* post free. [118.]



Details of the new type of bolt described in the text.

ROYAL AIR FORCE RESERVE (PILOTS) FREE FLYING TUITION

THE Air Ministry announces :—

A large number of vacancies exist for entry into the Royal Air Force Reserve during the next few months for initial training in flying. The vacancies will be filled by direct entrants from civil life. Experience of flying is not necessary as a complete course of flying instruction is given at no cost to the candidate.

Applicants must not have reached their 25th birthday and must be physically fit and of good education. The initial period of service in the Reserve is 5 years.

The preliminary instructional course consists of 50 hours' flying, which must be carried out in a maximum period of 3 months. With good weather, candidates should, however, be able to complete the course in about 2 months. Within certain limits the course may be broken and flying instruction carried out at times convenient to candidates.

Entrants are required to do 10 hours' flying in the second half of their first year of service. Thereafter they must carry out 20 hours' flying annually within a maximum period of 20 days. Entrants may also be required to attend a short 4–6 day course at a R.A.F. unit in their second and subsequent years of service.

Vacancies also exist for holders of Civil Pilots licences. Candidates may be considered in this category up to their 28th birthday and are required to pass a flying test to demonstrate their ability as pilots. On passing this test they are not required to attend a course of preliminary instruction but proceed direct to the annual training referred to in the preceding paragraph.

Flying training is carried out at civilian flying schools, at present situated at Bristol, Brough (East Yorks.), Hamble (Hants.), and Hatfield (Herts.). The instruction is given by qualified flying instructors of the R.A.F. Reserve, and the types of aircraft used are the de Havilland "Tiger Moth," "Avro," "Cadet," and Blackburn "B.2." The syllabus of instruction includes practice in air pilotage, aerobatics, "blind flying," camera gun work, and photography.

The pay and allowances of airman pilots during training amount to 16*s.* 6*d.* a day until qualified as a pilot, and thereafter to 17*s.* 6*d.* a day. When so qualified they also receive reserve pay and flying reserve pay amounting to approximately £23 10*s.* a year.

Further information can be obtained from the Secretary, Air Ministry, (S. 7 C), Adastral House, Kingsway, London, W.C.2.

An interesting composite photograph of a scale model aeroplane made by Skybirds.

What the Clubs are Doing

Club Reports for inclusion in this feature should not exceed 250 words in length, and should be received not later than the 12th of each month for inclusion in the subsequent month's issue.

THE MALDEN SOCIETY OF MODEL AND EXPERIMENTAL ENGINEERS

THE above society has moved to new premises, the address of which is 84A Kings Avenue, New Malden, Surrey. Any interested readers who care to call on club nights (Tuesday and Friday) between 6 and 10 will be made welcome.

Our subscription rates are now 2s. a month, which includes a key to the workshop so that members can use it at any time.

We have quite a good show of work being done by members, which includes a ½-in. scale model of the "Princess Royal" loco, and a 2-6-0 loco also in ½-in. scale; and there is also a 1-in. scale tractor, and a fine flying scale model of a U.S. Army 'plane.

If any readers residing in this district are interested in speed boats or power boats, we have two members interested and also two prospective members; one of them has a speed boat capable of about 30 m.p.h.

Our workshop is equipped with a 3½-in. Drummond lathe, and a ½-in. power drill, and also a planisher, etc. The secretary's address is R. W. Blake, 31 Idmiston Road, Worcester Park, Surrey.

THE PARK MODEL AIRCRAFT LEAGUE

ON Wednesday, January 30th, the League, in order to develop the social side, tried a new venture in the form of a Dance and Exhibition of Models, etc., at the Farnan Hall, Streatham. As well as the dancing, competitions of an appropriate nature were held. One hundred and twenty members and friends were present, and a most enjoyable evening was spent by all. It is therefore hoped to make this an annual function in future.

On Friday, February 1st, the Fourth Annual General Meeting was held at the Streatham Hall. The President briefly reviewed the League's activities during the past year. Although he considered that progress had undoubtedly been made, he did not think that it was so great as in the previous year. An interesting announcement made was that the League had obtained permission to fly on Wimbledon Common, and that it was intended to fly off all competitions requiring space on that ground. This move has been made in view of the close proximity of factories and other buildings to the area on which flying is permitted on Mitcham Common, it having been found that quite a large amount of time was spent by members in retrieving stranded models from roofs, telephone wires, etc. The League will also be prepared to form a Wimbledon Group should any local model flyers be interested. The distribution of the main trophies then took place, the present holders being:—

Shanly Trophy: Mr. R. T. S. Gillett.
Duration Trophy: do. do.
S.M.A.E. Medal: Mr. G. Mogford.
Silver Badge: do. do.
Record Trophy: Mr. R. T. S. Gillett.

The Election of Officers for the forthcoming season resulted as follows:—

President: F. J. Saul.
Vice-President & Treasurer: R. T. S. Gillett, 4 Upp. Green, East Mitcham.
Hon. Organizing Secretary: H. W. King, 23 Cambray Road, S.W.12.
Hon. Competition Secretary: G. S. Broadway, 19 Kirkstall Road, S.W.2.
Hon. General Secretary: F. H. Dillistone, 112 Rodenhurst Road, S.W.4.
Hon. Asst. Gen. Secretary: H. H. Love, 69 Edith Grove, S.W.10.

Any model flyers interested in the formation of a Wimbledon Group should communicate with the Secretary as above.

THE STREATHAM COMMON MODEL RAILWAY CLUB

OUR clubroom at 201 Gleneldon Mews, High Road, S.W.16, is open every Friday night for visitors. Here you will find a "0" gauge track in the course of construction, and a workshop in which you can make the models you want.

On January 18th we had a very interesting lecture by Mr. Jack Carter of the West Essex Model Railway Club on "The Building of My Garatt Locomotive." We had a good attendance of members and visitors. Mr. Carter, accompanied by four West Essex M.R.C. members, brought his Garatt locomotive and his well wagon, and gave us a most instructive talk on it.

Our fixture list for March, 1935, is as follows:—March 8th, Track Meeting; March 15th, Lantern Lecture; March 22nd, Track Meeting; March 29th, Mr. Hart's lecture, "Passenger-carrying Locomotive Driving." We shall be glad to welcome readers to these meetings. All at 8 p.m. It would be of great assistance if you would let the Secretary know beforehand if you are coming.

The latest issue of "The Rocket" is now available, and can be obtained price 5d., post free, from the Secretary, Brooke House, Rotherhill Avenue, S.W.16, together with full particulars.

INSTITUTE OF SCIENTIFIC RESEARCH

ON Saturday, January 19th, a meeting was held of the new Radio Section, at which Mr. P. Tyndall gave a lecture, illustrated by experiments, entitled "From Microphone to Ether."

On Saturday, January 26th, a visit was paid to Oakwood Automatic Telephone Exchange, Leeds. After inspecting the incoming wires and fuses, we traced the path of a call right through the exchange until the circuit was complete. We concluded this visit by inspecting the battery room and watching the action of the machines as we "rang up" various parts of the building. On Saturday, February 2nd, a general meeting was held, at which the following officers were elected: President, Mr. D. W. F. Mayer; Treasurer, Mr. P. W. Berry; Secretary of Physics and Chemistry Section, R. Nathan, 118 Spencer Place, Potternewton, Leeds 7; Secretary of Radio Section, P. Tyndall, 2 West Park Drive, Roman Avenue, Leeds 8; Secretary of Canterbury Branch, Mr. J. H. Potts, 26 Whitstable Road, Canterbury; Secretary of Correspondence Section, Mr. D. W. F. Mayer, 20 Hollin Park Road, Roundhay, Leeds 8.

For further details about either of the three branches, or of the new International Correspondence Section for persons interested in science throughout the world, please send a stamped addressed envelope to the appropriate secretary.

TAPERED ROLLER BEARINGS IN ROLLING MILLS

A PAPER on "The Tapered Roller Bearing and its Application to Rolling Mill Equipment" was read quite recently to the Scottish branch of the Institution of Mechanical Engineers by Mr. E. H. Doughty, A.M.I.Mech.E., of British Timken Ltd., at the Royal Technical College, Glasgow.

He made the interesting prediction that "the pressure of competition will, in a few years, necessitate the general adoption of roller bearings throughout the metal rolling industry."

He described various types of one-, two- and four-row tapered roller bearings used in rolling mill equipment, including the largest sizes for roll neck mountings, which are capable of carrying loads of from 6,000,000 to 7,000,000 lb.

He then mentioned what economies result from the use of tapered roller bearings in place of plain journals. "The chief of these are," he said, "a 25 to 50 per cent. saving in power, which means a corresponding saving in first cost of motors and driving gears; a greater output thanks to higher rolling speed, a greater accuracy of product thanks to the elimination of bearing wear, a long service life for the bearings, an improved service from pinion stands and gears because of the absence of bearing wear and maintenance of shaft centres, and savings in lubrication and maintenance costs." The extent of these economies he illustrated with detailed figures derived from current practice.

Mr. Doughty then explained mountings for vertical rolls for universal mills, roll neck and thrust blocks for tube piercing mills and for pinion stands; reduction gears, hot saws, live rollers, coiler shafts and general transmission gears. Lantern slides showed various mills in which tapered roller bearings have been fitted.

REPLIES TO QUERIES & ENQUIRIES

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.

A MUFFLE FURNACE

"As I have taken up a new hobby—that of pottery making—I find it is a great inconvenience to get the goods fired.

"The prices of muffle furnaces are prohibitive for a man in my position, and without one, a potter is handicapped.

"My enquiry is—can you please instruct me how to raise by electricity, the temperature in a small furnace of my own construction—a box of fire-clay slabs. I should need to go to 1,250° Centigrade on some occasions, but chiefly about 900° C. I shall be thankful for any details regarding the safest way of wiring, etc." (E. W., Leeds.)

The subject of electric muffle furnaces is too large to answer in one reply, but the following notes will help you. Calculate the surface area of the muffle and the ends, and allow 4 watts per sq. in., for temperatures up to 1,000° C., from this you can find the wire size, knowing the voltage of the supply. For temperatures up to 1,100° C. you can use an 80–20 nickel chromium wire of the binary series, but for temperatures above this a platinum wire will probably be more economical. From tables supplied by the makers the spacing of the wire and its working characteristics can be found and the other necessary details determined. Your best plan is to consult Messrs. Henry Wiggin and Co. Ltd., Thames House, Millbank, S.W.1, who will supply a catalogue and any other necessary details.

A DYNAMO QUERY

"Would you kindly let me have your advice on the following points:—

"(1) I have a 70 volt 8 amp. dynamo with which I intend to charge five 12-volt car batteries. The dynamo has no cut-out. Could I adapt a car type of cut-out to suit this dynamo? and, if so, please give particulars of the necessary windings. If this cannot be undertaken by an amateur, please give approximate cost of such an instrument.

"(2) What gauge and what amount of Eureka wire is necessary to make a field regulating resistance for the above dynamo?

"Field current at 70 volts = 1.5 amps.

"(3) Would it be a satisfactory proposition to light a house from five 12-volt car type batteries of 80 amp. hour capacity? The amount of current required would be about 12 amp. per night. (1, 60 watt and 1, 20 watt lamp burning for 8 hours, other 20 watts allowed for switching on both room and hall light occasionally)." (K. M., Ross-shire.)

You can experiment with a car cut-out on a 70-volt circuit, if you place a resistance in series with the shunt coil to limit this current to the normal value. Our experiments have shown that this is possible, but it is essential to have the series resistance.

You will find that a shunt regulator of 10 ohms will give sufficient voltage control for your needs, and for this use 15 yd. of No. 20 Eureka wire, also, arrange the studs so that the arm slides from one to the next, thus avoiding arcs, if the field circuit is broken every time.

Car batteries are quite often used as stationary batteries for house lighting, the disadvantage being that the plates cannot be examined, thus you must depend on the voltage and gravity readings in order to diagnose low cells.

The capacity you mention is quite suitable, and the set will probably need two charges a week.

MIXING CHEMICALS

"I use a considerable amount of potassium ferricyanide for photographic work. I realise the danger of this deadly poison, but I should like to know what is likely to happen by chemical reaction, should sulphuric hydrochloric or nitric acid be accidentally mixed with this cyanide salt of potassium and iron. As I use all these acids at various times, there is always a risk. I rather think prussic acid gas would be evolved, but am not sure. Information on this point would oblige." (E. C., Herts.)

Hydrocyanic (prussic) acid gas is liberated under the circumstances outlined by correspondent. Care should always be exercised in handling ferricyanide.

THE DECOMPOSITION OF WATER

"(1) What ratio does the volume of water bear to the combined volumes of oxygen and hydrogen that is liberated from the electrodes?

"(2) How long would it take to decompose 1 c.c. of water, using a stated voltage and current?

"(3) What change in time would occur by (a) increasing the wattage used, and (b) altering the distance separating the electrodes?

"(4) As slightly acidulated water would have to be used, what ratio should the acid bear to the rest of the water in volume?

"(5) What change in temperature may one expect to take place?" (A. H. B., Bucks.)

(1) Approximately the values are:—

Water	.	36 gm.
Hydrogen		4 gm. (volume 44·6 litres).
Oxygen	.	32 gm. (volume 22·3 litres).

These figures are given at N.T.P. and the values of H and O have been taken in round figures as 1 and 16. In electrolysis some of the oxygen passes into solution in the water, and consequently there is a slightly less yield.

(2) Commercially, the figures, time and yield are reckoned as follows: 1 gm. of H is liberated by the passage of 96,500 coulombs, therefore 1 amp. hour (3,600 coulombs) yields ·0374 gm. H (·0148 cu. ft.).

In practice the current used is in the neighbourhood of 400 amperes, giving 400 × ·0148 cu. ft. of H, rated per hour at 5·93 cu. ft. H and 2·96 cu. ft. O. This amount of gas will be given by 400 × 1·67 = 668 watt hours. At a voltage of 1·67, 8·8 cu. ft. of H are liberated by one k.w.h.

(3) (*a*) Voltage increase would cause temperature rise. An increase in current would quicken the output. The closer the electrodes the quicker the output.

(4) 10 to 15 per cent. acid is used.

(5) At the normal working pressure of approx. 1·67 volts temperature should remain fairly constant. An increase of voltage will raise the temperature. In the electrolytic production of ozone a high current density is employed at the anode, which is water-cooled and kept at as low a temperature as possible below 0° C.

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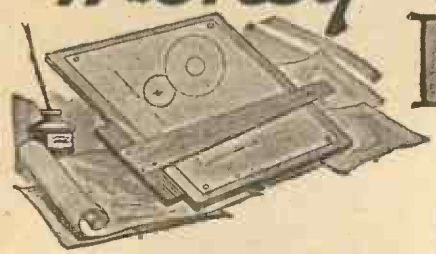

ADVICE BY OUR PATENT EXPERT

DOMESTIC ARTICLES

"I would like your opinion on two domestic articles (drawings enclosed), especially if you can let me know whether or not they have been thought of before." (L. W., London.)

The device for use in cooking eggs is not thought to be novel, but a definite opinion could only be given after making a search amongst previously protected devices. In any case it is not thought to contain sufficient subject matter for protection by Letters Patent. It would probably be possible to obtain a certain measure of protection by registering it as a design. The commercial value of the idea is not considered sufficient to spend any money on protecting the device.

The mitten for handling hot dishes is also not considered novel, or of any commercial value.

ELECTRIC RADIATORS

"I have thought of an idea for increasing the efficiency of electrical radiators, the principle being to keep the hot air continuously circulating by means of a fan. I have not yet been able to carry out any experiments to test the idea, but I should be grateful if you will give your opinion as to whether the arrangement is original and, if so, the prospects of developing same." (R. G., Sussex.)

The proposed improvement for electrical radiators, provided it is novel, is capable of being protected by Letters Patent. The inventor is probably aware that it is already known in electrical radiators to employ a fan either as a mask or for operating a mask to simulate the effect of the flame of a coal fire. In such cases, the fan is operated by the ascending hot air, whereas it is presumed that in the proposed arrangement the fan is driven by a motor. Bearing in mind the fact that hot air naturally rises, it is considered doubtful if the extra expense involved in fitting and running a motor to operate a fan would be commensurate with the advantages obtained. For these reasons, it is not thought that the invention is likely to be of very much commercial value.

A CARD GAME

"I would be very glad if you would advise me on the following points :—

"(1) Can one protect or patent a card game, particulars of which are below ?

"(2) If so, what fees are payable ?

"(3) Would the patent protect the 'idea' of the game, or could somebody else substitute the names of radio stars or famous people, and compete with me ?

"(1) 52 cards are in the pack.

"(2) 51 bear christian or surnames of film stars, whilst one card is a 'Free Pass,' and is used as either.

"(3) Object is to pair off cards to make a film star's name. (One card bears christian and the other the surname.)

"(4) Ten cards are dealt to each player.

"(5) Remainder of pack are put in centre, and top card is turned up.

"(6) First player takes this card if it helps to complete a name, and throws out another card. If upturned card is not wanted he can take card on top of pack. If this does not help he puts it down, face up.

"(7) Other players take it in turn to do likewise.

"(8) When a player has five pairs of names he calls 'cut.'

"(9) Players then have one turn each to get rid of cards not making a name, and bearing high numbers, as all odd cards count against holder.

"(10) If player calling 'cut' has three of the surnames in alphabetical order, points against others are doubled.

"(11) Game is played again until points against a player reach or exceed, say, 50 points. Winner is person with least points.

"The above are the rules of the 'Film Star' game, but I have also invented two other games to play with the 'Film Star' cards, so that if the game is marketed, players will not become tired of playing the one game again and again. Also, I have film star portraits on the face of each card." (J. E., Ealing.)

(1) The proposed card game is not patentable. An application for patent will not be accepted where no material product of a substantial character is realised or affected by an alleged invention, or where the only material product is a printed sheet or its equivalent for use in carrying out some scheme or game.

(2) The cost of protecting an invention was given to the applicant in reply to his letter in February, 1934.

(3) As it is not possible to Patent the proposed game, this question does not require an answer.

The only possible methods of obtaining some sort of protection for the game is (1) by registering a Trade Mark and selling the game under such registered Trade Mark, and (2) by obtaining copyright for the rules for playing the game and for the cards themselves.

So far as one can judge from the description of the game, it appears to closely resemble the game of "Lexicon."

The applicant is also probably unaware that the use of portraits of "Film Stars" in ordinary packs of playing cards in place of the more usual court card stereotyped pictures of Knaves, Queens and Kings, has already been done.

AN EASY CHANGE GEARBOX

"I should like to submit the following to your approval, and to know if it is practicable. The idea is for an easy change gearbox for a car. A clutch is connected up at the back of the box and coupled to the usual one at the front. When the clutch pedal is put out to change gear the two clutches are freed so that the driving and driven shafts of the gearbox are disconnected at both ends, and so come to a standstill. The required gear can then be changed in perfect silence and the clutch pedal let back in the usual way. Any gear can be selected, either up or down,

by just putting out the pedal, no 'double de-clutching' being necessary." (T. M., Kingsbridge.)

The invention is thought to be practicable, but would probably require some careful designing to work it out in a commercial form.

So far as is known from personal knowledge, the invention is thought to be novel, and it forms fit subject matter for protection by Letters Patent. If the inventor desires to test the novelty of his invention, it would be necessary to make a search amongst prior Patent Specifications relating to the subject matter, but due to the large number of Patents granted in the classification to which the invention relates, such a search would probably be more expensive than filing an application for Patent with a complete Specification, after which an official search is made before the Specification is accepted. The inventor could apply for a Patent with a Provisional Specification, which would give him protection for about twelve months, during which time he could submit his idea to manufacturers likely to take an interest in such an invention. No search for novelty, however, is made on filing an application with a Provisional Specification.

AN ADAPTABLE SPIRIT LEVEL

"As a regular reader of 'Practical Mechanics' I would like to ask your advice upon the validity of the following idea for a spirit level. The level is for use chiefly on portable hand or electric drills; the article described has been in constant use on a Research Laboratory work-bench for several years, and, although I have not yet seen a similar device, it has proved almost invaluable. The innumerable badly drilled and tapped holes which have been avoided by its use cause me to think that there may be some commercial value in the idea." (J. B., Cambridge.)

A certain amount of protection could be obtained for the level by a design registration, the cost of which is considerably less than the cost of patenting.

The possible drawback in obtaining protection for the idea may be the fact that it has already been used by the inventor for a number of years, presumably such use has been a secret use and not a commercial one. Under the amended Patent Act a valid patent cannot be obtained by an inventor who has commercially worked the invention in the United Kingdom otherwise than for the purpose of reasonable trial of the invention prior to the date of the application for patent. A valid design registration can be obtained, provided the design has not been published prior to the date of application for registration.

BUILDING "STREAMLINIA"

(Continued from page 256.)

outline of the inner wall of the hull. In no circumstances use a hammer for this part of the work.

Hollow out with the chisel in the thinnest of shavings till the deck is level all round. This part of the work is simply to guard against splitting the wall of the hull during subsequent operations, which are performed with gouges. Test the thickness of the walls with callipers at intervals. Considerations as to the floor on which the plant will be mounted must be kept in mind. The neatest job will probably be the result of fitting a new floor afterwards over the gouge-marked surface that is difficult to get perfectly level. Finish all surfaces with glass-paper, and apply a coat of grey priming.

"CIRCUIT DUST," by Barre Lyndon, *7s. 6d.* nett, Simpkin Marshall Ltd., Stationer's Hall Court, London, E.C.4, 296 pages, plus index. This book details the adventures of a certain racing car from its creation, and its rise to fame. The reader will find plenty of references to famous drivers of famous cars, and will appreciate the thrill of high-speed car driving.

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Containing 3,000 recipes, many of which will prove extremely valuable to the amateur mechanic and handyman, "Wilkes' Priceless Recipes" is an interesting book, as a list of contents selected at random will demonstrate: Artificial rubber; Cements, various; Inks, black and coloured; Varnishes, various; Chemical barometer; Coppersmith's solder; Etching on glass; Fire and waterproof glue; Alloy which melts in boiling water; Fireworks and explosives; To bore holes in glass; How to thaw out a water pipe; Silver-plating fluid; Indelible ink; To remove rust; Rendering textiles fireproof; Waterproofing for clothing. Some of the recipes are of a medical nature, and the discriminating reader will leave these severely alone, however harmless some of them may be, and confine himself to the trade and household sections of the book, of which there is a plentiful and useful selection.

The contents, compiled by Dr. N. T. Oliver, are alphabetically arranged. The book is published at 3/6 by H. B. Turner, 41 Longford Place, Victoria Park, Manchester, 14.

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